NAME

grdraster – extract subregion from a binary raster and write a grid file

SYNOPSIS

grdraster [*filenumber* | *"text pattern"*] **−R***west*/*east*/*south*/*north*[**r**] [**−G***grdfile*] [**−I***xinc*[**m**|**c**][*/yinc*[**m**|**c**]
] [**−J***parameters*] [**−V**] [**−bo**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1*/*...*]]]

DESCRIPTION

grdraster reads a file called *grdraster.info* from the current working directory, the directories pointed to by
the environment variables **$GMT_DATADIR** and **$GMT_USERDIR**, or in **$GMT_SHAREDIR**/dbase
(in that order). The file *grdraster.info* defines binary arrays of data stored in scan-line format in data files.
Each file is given a *filenumber* in the info file. **grdraster** figures out how to load the raster data into a grid
file spanning a region defined by **−R**. By default the grid spacing equals the raster spacing. The **−I** option
may be used to sub-sample the raster data. No filtering or interpolating is done, however; the *x_inc* and
y_inc of the grid must be multiples of the increments of the raster file and **grdraster** simply takes every
n'th point. The output of **grdraster** is either grid or pixel registered depending on the registration of the
raster used. It is up to the **GMT** system person to maintain the *grdraster.info* file in accordance with the
available rasters at each site. Raster data sets are not supplied with **GMT** but can be obtained by anony-
mous ftp and on CD-ROM (see README page in dbase directory). **grdraster** will list the available files if
no arguments are given. Finally, **grdraster** will write xyz-triplets to stdout if no output gridfile name is
given

filenumber

If an integer matching one of the files listed in the *grdraster.info* file is given we will use that data
set, else we will match the given text pattern with the data set description in order to determine the
data set.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map
coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global
domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively,
specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are
copied from the grid. If **r** is appended, you may also specify a map projection to define the shape
of your region. The output region will be rounded off to the nearest whole grid-step in both
dimensions.

OPTIONS

−G   Name of output grid file. If not set, the grid will be written as ASCII (or binary; see **−bo** xyz-
triplets to stdout instead.

−I   *x_inc* [and optionally *y_inc*] is the grid spacing. Optionally, append a suffix modifier. **Geographi-
cal (degrees) coordinates**: Append **m** to indicate arc minutes or **c** to indicate arc seconds. If one
of the units **e**, **k**, **i**, or **n** is appended instead, the increment is assumed to be given in meter, km,
miles, or nautical miles, respectively, and will be converted to the equivalent degrees longitude at
the middle latitude of the region (the conversion depends on **ELLIPSOID**). If */y_inc* is given but
set to 0 it will be reset equal to *x_inc*; otherwise it will be converted to degrees latitude. **All coor-
dinates**: If = is appended then the corresponding max *x* (*east*) or *y* (*north*) may be slightly adjusted
to fit exactly the given increment [by default the increment may be adjusted slightly to fit the given
domain]. Finally, instead of giving an increment you may specify the *number of nodes* desired by
appending + to the supplied integer argument; the increment is then recalculated from the number
of nodes and the domain. The resulting increment value depends on whether you have selected a
gridline-registered or pixel-registered grid; see Appendix B for details. Note: if **−R***grdfile* is used
then grid spacing has already been initialized; use **−I** to override the values.

−J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modi-
fier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but
this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value.
When central meridian is optional, default is center of longitude range on **−R** option. Default

standard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-** to the width, respectively.

More details can be found in the **psbasemap** man pages.

CYLINDRICAL PROJECTIONS:

−Jc*lon0/lat0/scale* (Cassini)
−Jcyl_stere/[*lon0/*[*lat0/*]]*scale* (Cylindrical Stereographic)
−Jj[*lon0/*]*scale* (Miller)
−Jm[*lon0/*[*lat0/*]]*scale* (Mercator)
−Jm*lon0/lat0/scale* (Mercator - Give meridian and standard parallel)
−Jo[**a**]*lon0/lat0/azimuth/scale* (Oblique Mercator - point and azimuth)
−Jo[**b**]*lon0/lat0/lon1/lat1/scale* (Oblique Mercator - two points)
−Joc*lon0/lat0/lonp/latp/scale* (Oblique Mercator - point and pole)
−Jq[*lon0/*[*lat0/*]]*scale* (Cylindrical Equidistant)
−Jt*lon0/*[*lat0/*]*scale* (TM - Transverse Mercator)
−Ju*zone/scale* (UTM - Universal Transverse Mercator)
−Jy[*lon0/*[*lat0/*]]*scale* (Cylindrical Equal-Area)

CONIC PROJECTIONS:

−Jb*lon0/lat0/lat1/lat2/scale* (Albers)
−Jd*lon0/lat0/lat1/lat2/scale* (Conic Equidistant)
−Jl*lon0/lat0/lat1/lat2/scale* (Lambert Conic Conformal)
−Jpoly[*lon0/*[*lat0/*]]*scale* ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−Ja*lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
−Je*lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
−Jf*lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
−Jg*lon0/lat0*[*/horizon*]*/scale* (Orthographic)
−Jg*lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
−Js*lon0/lat0*[*/horizon*]*/scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−Jh[*lon0/*]*scale* (Hammer)
−Ji[*lon0/*]*scale* (Sinusoidal)
−Jkf[*lon0/*]*scale* (Eckert IV)
−Jk[**s**][*lon0/*]*scale* (Eckert IV)
−Jn[*lon0/*]*scale* (Robinson)
−Jr[*lon0/*]*scale* (Winkel Tripel)
−Jv[*lon0/*]*scale* (Van der Grinten)
−Jw[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
−Jx*x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. This option applies only if no **−G** option has been set.

EXAMPLES

To extract data from raster 1, taking one point every 30 minutes, in an area extended beyond 360 degrees to allow later filtering, run

grdraster 1 **−R**-4/364/-62/62 **−I**30**m −G**data.grd

To obtain data for an oblique Mercator projection we need to extract more data that is actually used. This is necessary because the output of **grdraster** has edges defined by parallels and meridians, while the oblique map in general does not. Hence, to get all the data from the ETOPO2 data needed to make a contour map for the region defined by its lower left and upper right corners and the desired projection, use

grdraster ETOPO2 **−R**160/20/220/30**r −Joc**190/25.5/292/69/1 **−G**data.grd

To extract data from the 2 min Geoware relief blend and write it as binary double precision xyz-triplets to standard output:

grdraster "2 min Geoware" **−R**20/25/-10/5 **−bo** >! triplets.b

SEE ALSO

gmtdefaults(1), *GMT*(1), *grdsample*(1), *grdfilter*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.

Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME

      gshhs − Extract ASCII listings from binary GSHHS or WDBII data files

SYNOPSIS

      gshhs *binaryfile.b* [**−I***id*] [**−L**] [**−M**] > *asciifile.txt*

DESCRIPTION

      gshhs reads the binary coastline (GSHHS) or political boundary or river (WDBII) files and extracts an ASCII listing. It automatically handles byte-swapping between different architectures. Optionally, only segment header info can be displayed. The header info has the format *ID npoints hierarchical-level source area f_area west east south north container ancestor*, where hierarchical levels for coastline polygons go from 1 (shoreline) to 4 (lake inside island inside lake inside land). Source is either W (World Vector Shoreline) or C (CIA World Data Bank II); lower case is used if a lake is a river-lake. The *west east south north* is the enclosing rectangle, area is the polygon area in km^2 while f_area is the actual area of the ancestor polygon, container is the ID of the polygon that contains this polygon (-1 if none), and ancestor is the ID of the polygon in the full resolution set that was reduced to yield this polygon (-1 if full resolution). For line data the header is simply *ID npoints hierarchical-level source west east south north*

      binaryfile.b

            GSHHS or WDBII binary data file as distributed with the GSHHS data supplement. Any of the 5 standard resolutions (full, high, intermediate, low, crude) can be used.

      −I   Only output information for the polygon that matches *id* [default outputs all polygons].

      −L   Only output a listing of polygon or line segment headers [default outputs headers and data records].

      −M   Start all header records with the GMT multiple segment indicator '>' [Default uses P for polygons and L for lines].

EXAMPLES

      To convert the entire intermediate GSHHS binary data to ASCII, run

      gshhs gshhs_i.b > gshhs_i.txt

      To only get a listing of the headers for the river data set at full resolution, try

      gshhs wdb_rivers_f.b **−L** > riverlisting.txt

BUGS

      While the GSHHS data is organized as a set of closed polygons, the rivers and boundary data are just a set of line segments in no particular order. Thus, it is not possible to extract information pertaining to just one river or one country.

SEE ALSO

      GMT(1), *gshhs_dp*(1) *gshhstograss*(1)

NAME
gshhs_dp − Line reduction using the Douglas-Peucker algorithm

SYNOPSIS
gshhs_dp *input.b tolerance output.b* [**−v**]

DESCRIPTION
gshhs_dp reads the binary coastline (GSHHS) or political boundary or river (WDBII) files and and reduces the complexity of the line by applying the Douglas-Peucker algorithm. It automatically handles byte-swabbing between different architectures.

input.b   GSHHS or WDBII binary data file as distributed with the GSHHS data supplement. Any of the 5 standard resolutions (full, high, intermediate, low, crude) can be used.

tolerance
tolerance is maximum mismatch in km. The larger the value the more reduction will take place.

output.b
The reduced data set.

OPTIONS
−v   Reports progress and statistics while running.

EXAMPLES
To simplify the full GSHHS data set with a custom tolerance of 2 km, try

gshhs_dp *gshhs_f.b 2 gshhs_2km.b*

REFERENCES
Douglas, D. H., and T. K. Peucker, Algorithms for the reduction of the number of points required to represent a digitized line of its caricature, *Can. Cartogr., 10*, 112-122, 1973.

AUTHOR
This implementation of the D-P algorithm has been kindly provided by Dr. Gary J. Robinson, Environmental Systems Science Centre, University of Reading, Reading, UK (gazza@mail.nerc-essc.ac.uk); his subroutine forms the basis for this program.

SEE ALSO
GMT(1), *gshhs*(1), *gshhstograss*(1)

NAME
gshhs2grass − Extracting GSHHS and WDBII data in GRASS-compatible ASCII format

SYNOPSIS
gshhs2grass −i gshhs_[f|h|i|l|c].b [**−x**_minx_] [**−X**_maxx_] [**−y**_miny_] [**−Y**_maxy_]

DESCRIPTION
gshhs2grass reads the binary coastline (GSHHS) and and translates it into an ASCII format suitable for import into GRASS. It automatically handles byte-swabbing between different architectures.

gshhs_[f|h|i|l|c].b
> One of the GSHHS binary data file as distributed with the GSHHS data supplement. Any of the 5 standard resolutions (full, high, intermediate, low, crude) can be used. The resulting files are called dig_[ascii|att|cats].gshhs_[f|h|i|l|c].

OPTIONS
−x   Specify a minimum (west) longitude.

−X   Specify a maximum (east) longitude.

−y   Specify a minimum (south) latitude.

−Y   Specify a maximum (north) latitude.

EXAMPLES
To convert the full GSHHS data set , try

gshhs2grass *gshhs_f.b*

BUGS
Not updated to handle the WDBII line data (borders or rivers).

AUTHOR
Original version by Simon Cox (simon@ned.dem.csiro.au) with some maintenance by Paul Wessel (pwessel@hawaii.edu).

SEE ALSO
GMT(1), *gshhs*(1) *gshhs_dp*(1)

NAME

img2mercgrd – Extract region of img, preserving Mercator, save as grd

SYNOPSIS

img2mercgrd *imgfile* **−G***grdfile* **−R***west/east/south/north*[**r**] **−T***type* [**−C**] [**−D***minlat/maxlat*] [**−N***navg*]
[**−S***scale*] [**−V**] [**−W***maxlon*] [**−m***minutes*]

DESCRIPTION

img2mercgrd reads an img format file and creates a grid file. The Spherical Mercator projection of the
img file is preserved, so that the region **−R** set by the user is modified slightly; the modified region corre-
sponds to the edges of pixels [or groups of *navg* pixels]. The grid file header is set so that the x and y axis
lengths represent distance from the west and south edges of the image, measured in user default units, with
−Jm1 and the adjusted **−R**. By setting the default **ELLIPSOID** = Sphere, the user can make overlays with
the adjusted **−R** so that they match. See **EXAMPLES** below. The adjusted **−R** is also written in the grd-
header remark, so it can be found later. The **−T***type* selects all data or only data at constrained pixels, and
can be used to create a grid of 1s and 0s indicating constraint locations. The output grid file is pixel regis-
tered; it inherits this from the img file.

imgfile   An img format file such as the marine gravity or seafloor topography fields estimated from satellite
altimeter data by Sandwell and Smith. If the user has set an environment variable
$GMT_IMGDIR, then **img2mercgrd** will try to find *imgfile* in **$GMT_IMGDIR**; else it will try
to open *imgfile* directly.

−G   *grdfile* is the name of the output grid file.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map
coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global
domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively,
specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are
copied from the grid.

−T   *type* handles the encoding of constraint information. *type* = 0 indicates that no such information is
encoded in the img file (used for pre-1995 versions of the gravity data; all more recent files do not
support this choice) and gets all data. *type* > 0 indicates that constraint information is encoded
(1995 and later (current) versions of the img files) so that one may produce a grid file as follows:
−T*1* gets data values at all points, **−T***2* gets data values at constrained points and NaN at interpo-
lated points; **−T***3* gets 1 at constrained points and 0 at interpolated points.

OPTIONS

−C   Set the x and y Mercator coordinates relative to projection center (lon = lat = 0) [Default is relative
to lower left corner of grid].

−D   Use the extended latitude range -80.738/+80.738. Alternatively, append *minlat/maxlat* as the lati-
tude extent of the input img file. [Default is -72.006/72.006].

−N   Average the values in the input img pixels into *navg* by *navg* squares, and create one output pixel
for each such square. If used with **−T***3* it will report an average constraint between 0 and 1. If
used with **−T***2* the output will be average data value or NaN according to whether average con-
straint is > 0.5. *navg* must evenly divide into the dimensions of the imgfile in pixels. [Default *1*
does no averaging].

−S   Multiply the img file values by *scale* before storing in grid file. [Default is 1.0]. (img topo files
are stored in (corrected) meters; gravity files in mGal*10; vertical deflection files in microradi-
ans*10, vertical gravity gradient files in Eotvos*10. Use **−S**0.1 for those files.)

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"]. Particu-
larly recommended here, as it is helpful to see how the coordinates are adjusted.

−m   Indicate *minutes* as the width of an input img pixel in minutes of longitude. [Default is 2.0].

−W   Indicate *maxlon* as the maximum longitude extent of the input img file. Versions since 1995 have
            had *maxlon* = 360.0, while some earlier files had *maxlon* = 390.0. [Default is 360.0].

EXAMPLES

To extract data in the region **−R**-40/40/-70/-30 from *world_grav.img.7.2*, run

img2mercgrd world_grav.img.7.2 **−G**merc_grav.grd **−R**-40/40/-70/-30 **−T**1 **−V**

Note that the **−V** option tells us that the range was adjusted to **−R**-40/40/-70.0004681551/-29.9945810754.
We can also use **grdinfo** to find that the grid file header shows its region to be **−R**0/80/0/67.9666667   This
is the range of x,y we will get from a Spherical Mercator projection using
−R-40/40/-70.0004681551/-29.9945810754 and **−Jm**1. Thus, to take ship.lonlatgrav and use it to sample
the merc_grav.grd, we can do this:

gmtset ELLIPSOID Sphere
mapproject   **−R**-40/40/-70.0004681551/-29.9945810754   **−Jm**1   ship.lonlatgrav | **grdtrack**
−Gmerc_grav.grd | **mapproject −R**-40/40/-70.0004681551/-29.9945810754 **−Jm**1 **−I** > ship.lonlatgravsat

It is recommended to use the above method of projecting and unprojecting the data in such an application,
because then there is only one interpolation step (in **grdtrack**). If one first tries to convert the grid file to
lon,lat and then sample it, there are two interpolation steps (in conversion and in sampling).

To make a lon,lat grid from the above grid we can use

grdproject merc_grav.grd **−R**-40/40/-70.0004681551/-29.9945810754 **−Jm**1 **−I −F −D**2m **−G**grav.grd

In some cases this will not be easy as the **−R** in the two coordinate systems may not align well. When this
happens, we can also use (in fact, it may be always better to use)

grd2xyz merc_grav.grd | **mapproject −R**-40/40/-70.0004681551/-29.994581075 **−Jm**1 **−I** | **surface**
−R-40/40/-70/70 **−I**2m **−G**grav.grd

To make a Mercator map of the above region, suppose our .gmtdefaults4 **MEASURE_UNIT** is inch. Then
since the above merc_grav.grd file is projected with **−Jm**1 it is 80 inches wide. We can make a map 8
inches wide by using **−Jx**0.1 on any map programs applied to this grid (e.g., **grdcontour**, **grdimage**, **grd-
view**), and then for overlays which work in lon,lat (e.g., **psxy**, **pscoast**) we can use the above adjusted **−R**
and **−Jm**0.1 to get the two systems to match up.

However, we can be smarter than this. Realizing that the input img file had pixels 2.0 minutes wide (or
checking the nx and ny with grdinfo merc_grav.grd) we realize that merc_grav.grd used the full resolution
of the img file and it has 2400 by 2039 pixels, and at 8 inches wide this is 300 pixels per inch. We decide
we don't need that many and we will be satisfied with 100 pixels per inch, so we want to average the data
into 3 by 3 squares. (If we want a contour plot we will probably choose to average the data much more
(e.g. 6 by 6) to get smooth contours.) Since 2039 isn't divisible by 3 we will get a different adjusted
OPT(R) this time:

img2mercgrd world_grav.img.7.2 **−G**merc_grav_2.grd **−R**-40/40/-70/-30 **−T**1 **−N**3 **−V**

This time we find the adjusted region is **−R**-40/40/-70.023256525/-29.9368261101 and the output is 800 by
601 pixels, a better size for us. Now we can create an artificial illumination file for this using **grdgradient**:

grdgradient merc_grav_2.grd **−G**illum.grd **−A**0/270 **−N**e0.6

and if we also have a cpt file called "grav.cpt" we can create a color shaded relief map like this:

grdimage merc_grav_2.grd **−I**illum.grd **−C**grav.cpt **−Jx**0.1 **−K** > map.ps
psbasemap −R-40/40/-70.023256525/-29.9368261101 **−Jm**0.1 **−B**a10 **−O** >> map.ps

Suppose you want to obtain only the constrained data values from an img file, in lat/lon coordinates. Then run **img2mercgrd** with the **−T**2 option, use **grd2xyz** to dump the values, pipe through grep -v NaN to eliminate NaNs, and pipe through **mapproject** with the inverse projection as above.

SEE ALSO

GMT(1), *grdproject*(1), *mapproject*(1)

NAME

img2grd – Extract region of img in Mercator or geographic form

SYNOPSIS

img2grd *imgfile* **−G***grdfile* **−R***west/east/south/north*[**r**] **−T***type* [**−C**] [**−D***minlat/maxlat*] [**−E**] [**−L**] [**−M**] [**−N***navg*] [**−S***scale*] [**−V**] [**−W***maxlon*] [**−m***minutes*]

DESCRIPTION

img2grd is a front-end to **img2mercgrd** which reads an img format file and creates a grid file. The **−M** option dictates whether or not the Spherical Mercator projection of the img file is preserved.

imgfile An img format file such as the marine gravity or seafloor topography fields estimated from satellite altimeter data by Sandwell and Smith. If the user has set an environment variable **$GMT_DATADIR**, then **img2mercgrd** will try to find *imgfile* in **$GMT_DATADIR**; else it will try to open *imgfile* directly.

−G *grdfile* is the name of the output grid file.

−R *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−T *type* handles the encoding of constraint information. *type* = 0 indicates that no such information is encoded in the img file (used for pre-1995 versions of the gravity data) and gets all data. *type* > 0 indicates that constraint information is encoded (1995 and later (current) versions of the img files) so that one may produce a grid file as follows: **−T***1* gets data values at all points, **−T***2* gets data values at constrained points and NaN at interpolated points; **−T***3* gets 1 at constrained points and 0 at interpolated points.

OPTIONS

−C Set the x and y Mercator coordinates relative to projection center [Default is relative to lower left corner of grid]. Requires **−M**.

−D Use the extended latitude range -80.738/+80.738. Alternatively, append *minlat/maxlat* as the latitude extent of the input img file. [Default is -72.006/72.006].

−E Can be used when **−M** is not set to force the final grid to have the exact same region as requested with **−R**. By default, the final region is a direct projection of the original Mercator region and will typically extend slightly beyond the requested latitude range, and furthermore the grid increment in latitude does not match the longitude increment. However, the extra resampling introduces small interpolation errors and should only be used if the output grid must match the requested region and have x_inc = y_inc. In this case the region set by **−R** must be given in multiples of the increment (.e.g, **−R**0/45/45/72).

−L With no other arguments, list all *.img files found in the directory pointed to by **$GMT_DATADIR**, or the current directory if not defined. Ignored if other options are present on the command line.

−M Output a Spherical Mercator grid [Default is a geographic lon/lat grid].

−N Average the values in the input img pixels into *navg* by *navg* squares, and create one output pixel for each such square. If used with **−T***3* it will report an average constraint between 0 and 1. If used with **−T***2* the output will be average data value or NaN according to whether average constraint is > 0.5. *navg* must evenly divide into the dimensions of the imgfile in pixels. [Default *1* does no averaging].

−S Multiply the img file values by *scale* before storing in grid file. [Default is 1.0]. (img topo files are stored in (corrected) meters; gravity files in mGal*10; vertical deflection files in microradians*10, vertical gravity gradient files in Eotvos*10.)

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"]. Particu-
          larly recommended here, as it is helpful to see how the coordinates are adjusted.

−m   Indicate *minutes* as the width of an input img pixel in minutes of longitude. [Default is 2.0].

−W   Indicate *maxlon* as the maximum longitude extent of the input img file. Versions since 1995 have
          had *maxlon* = 360.0, while some earlier files had *maxlon* = 390.0. [Default is 360.0].

EXAMPLES

To extract data in the region **−R**-40/40/-70/-30 from *world_grav.img.7.2* and preserve the Mercator grid-
ding:

img2grd world_grav.img.7.2 **−G**merc_grav.grd **−R**-40/40/-70/-30 **−M −T**1 **−V**

Without the **−M** option the same command will yield a geographic grid.

SEE ALSO

GMT(1), *img2mercgrd*(1)

NAME

img2google − Create Google Earth KML overlay tiles from bathymetry Mercator img grid

SYNOPSIS

img2google −**R**west/east/south/north[**r**] [*imgfile*] [−**A**mode[*altitude*]] [−**C**] [−**F**fademin/fademax] [−**G**prefix] [−**L**LODmin/LODmax] [[−**N**layername]] [[−**T**doctitle] [−**U**URL] [−**V**] [−**Z**]

DESCRIPTION

img2google reads a 1x1 minute Mercator surface relief img file and creates a Google Earth overlay KML file and associated PNG tile for the specified region. If no input file is given we use topo.11.1.img.

−**R**   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands −**Rg** and −**Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the −**R** settings (and grid spacing, if applicable) are copied from the grid.

OPTIONS

imgfile   An img format bathymetry/topography file such as those created by Sandwell and Smith. If this files does not exist in the current directory and the user has set the environment variable **$GMT_DATADIR**, then **img2mercgrd** will try to find *imgfile* in **$GMT_DATADIR**.

−**A**   Selects one of 5 altitude modes recognized by Google Earth that determines the altitude (in m) of the image: **G** clamped to the ground, **g** append altitude relative to ground, **a** append absolute altitude, **s** append altitude relative to seafloor, and **S** clamp it to the seafloor [Default].

−**C**   Turn on clipping so that only portions below sea level will be visible in the image [no clipping].

−**F**   Sets the distance over which the geometry fades, from fully opaque to fully transparent. These ramp values, expressed in screen pixels, are applied at the minimum and maximum end of the LOD (visibility) limits, respectively. [no fading (0/0)].

−**G**   Specify the prefix for the output image file (the extensions are set automatically). Default uses the naming topoN|S<*north*>E|W<*west*>.

−**L**   Measurement in screen pixels that represents the minimum limit of the visibility range for a given Region Google Earth calculates the size of the Region when projected onto screen space. Then it computes the square root of the Region's area (if, for example, the Region is square and the viewpoint is directly above the Region, and the Region is not tilted, this measurement is equal to the width of the projected Region). If this measurement falls within the limits defined by *LODmin* and *LODmax* (and if the region is in view), the Region is active. If this limit is not reached, the associated geometry is considered to be too far from the user's viewpoint to be drawn. *LODmax* represents the maximum limit of the visibility range for a given Region. A value of â1, the default, indicates "active to infinite size." [always active].

−**N**   Append the layername of the image (use quotes if strings contain spaces) [topoN|S<*north*>E|W<*west*>].

−**T**   Append the document title (use quotes if strings contain spaces) ["Predicted bathymetry"].

−**U**   By default, images are referenced locally relative to the KML file. Specify an URL to prepend a server address to the image name reference [local].

−**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−**Z**   Uses zip (which must be installed) to create a *.kmz file for easy distribution; append + to delete the KML and PNG file after zipping [No zipping].

EXAMPLES

To create a 10x10 degree Google Earth KML tile for the region −**R**170/180/20/30 using the default *topo.11.1.img* and output naming convention, try

img2google **−R**170/180/20/30

To make the same tile with the previous *topo.10.1.img*, run in verbose mode, clip so only oceanic areas are visible, name the output oldimage, specify the KML metadata directly (including setting the image altitude to 10 km), and make a single *.kmz file, try

img2google *topo.10.1.img* **−R**170/180/20/30 **−AA**10000 **−C** **−G***oldimage* **−N**"My KML title" **−T**"My KML title" **−U**http://my.server.com/images **−V** **−Z**

DATA SETS
For topo.11.1.img and other Sandwell/Smith altimetry-derived Mercator grids, visit http://topex.ucsd.edu.

SEE ALSO
GMT(1), *img2grd*(1) *img2mercgrd*(1) *ps2raster*(1)

NAME

psmeca – Plot focal mechanisms on maps

SYNOPSIS

psmeca *files* **−J***parameters* **−R***west/east/south/north*[**r**] [**−B**[**p**|**s**]*parameters*] [**−C**[*pen*][**P***pointsize*]] [**−D***depmin/depmax*] [**−E***fill*] [**−G***fill*] [**−H**[**i**][*nrec*]] [**−K**] [**−L**[*pen*]] [**−M**] [**−N**] [**−O**] [**−P**] [**−S**<*symbol*><*scale*>[/**d**]] [**−T***num_of_plane*[*pen*]] [**−U**[*just/dx/dy/*][**c**|*label*]] [**−V**] [**−W***pen*] [**−X**[**a**|**c**|**r**][*x-shift*[**u**]]] [**−Y**[**a**|**c**|**r**][*y-shift*[**u**]]] [**−Z***cptfile*] [**−z**] [**−a**[*size*[*P_symbol*[*T_symbol*]]]] [**−g***fill*] [**−e***fill*] [**−o**] [**−p***pen*] [**−t***pen*] [**−:**[**i**|**o**]] [**−c***copies*]

DESCRIPTION

psmeca reads data values from *files* [or standard input] and generates *PostScript* code that will plot focal mechanisms on a map. Most options are the same as for **psxy**. The *PostScript* code is written to standard output.

ARGUMENTS

files List one or more file-names. If no files are given, **psmeca** will read standard input.

−J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modifier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value. When central meridian is optional, default is center of longitude range on **−R** option. Default standard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-** to the width, respectively.

More details can be found in the **psbasemap** man pages.

CYLINDRICAL PROJECTIONS:

−Jc*lon0/lat0/scale* (Cassini)
−Jcyl_stere/[*lon0/*[*lat0/*]]*scale* (Cylindrical Stereographic)
−Jj[*lon0/*]*scale* (Miller)
−Jm[*lon0/*[*lat0/*]]*scale* (Mercator)
−Jm*lon0/lat0/scale* (Mercator - Give meridian and standard parallel)
−Jo[**a**]*lon0/lat0/azimuth/scale* (Oblique Mercator - point and azimuth)
−Jo[**b**]*lon0/lat0/lon1/lat1/scale* (Oblique Mercator - two points)
−Joc*lon0/lat0/lonp/latp/scale* (Oblique Mercator - point and pole)
−Jq[*lon0/*[*lat0/*]]*scale* (Cylindrical Equidistant)
−Jt*lon0/*[*lat0/*]*scale* (TM - Transverse Mercator)
−Ju*zone/scale* (UTM - Universal Transverse Mercator)
−Jy[*lon0/*[*lat0/*]]*scale* (Cylindrical Equal-Area)

CONIC PROJECTIONS:

−Jb*lon0/lat0/lat1/lat2/scale* (Albers)
−Jd*lon0/lat0/lat1/lat2/scale* (Conic Equidistant)
−Jl*lon0/lat0/lat1/lat2/scale* (Lambert Conic Conformal)
−Jpoly[*lon0/*[*lat0/*]]*scale* ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−Ja*lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
−Je*lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
−Jf*lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
−Jg*lon0/lat0*[*/horizon*]*/scale* (Orthographic)
−Jg*lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
−Js*lon0/lat0*[*/horizon*]*/scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−Jh[*lon0/*]*scale* (Hammer)
−Ji[*lon0/*]*scale* (Sinusoidal)
−Jkf[*lon0/*]*scale* (Eckert IV)
−Jk[**s**][*lon0/*]*scale* (Eckert IV)
−Jn[*lon0/*]*scale* (Robinson)
−Jr[*lon0/*]*scale* (Winkel Tripel)
−Jv[*lon0/*]*scale* (Van der Grinten)
−Jw[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
−Jx*x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−S   Selects the meaning of the columns in the data file . In order to use the same file to plot cross-sections, depth is in third column. Nevertheless, it is possible to use "old style" **psvelomeca** input files without depth in third column using the **−o** option.

−Sa*scale[/fontsize[/offset*[**u**]]]
Focal mechanisms in Aki and Richards convention. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. Scale is the size for magnitude = 5 in inch (unless **c**, **i**, **m**, or **p** is appended). Use the **−T** option to render the beach ball transparent by drawing only the nodal planes and the circumference. The color or shade of the compressive quadrants can be specified with the **−G** option. The color or shade of the extensive quadrants can be specified with the **−E** option. Parameters are expected to be in the following columns:

1,2:   longitude, latitude of event (**−:** option interchanges order)

3:   depth of event in kilometers

4,5,6:   strike, dip and rake in degrees

7:   magnitude

8,9:   longitude, latitude at which to place beach ball. Entries in these columns are necessary with the **−C** option. Using 0,0 in columns 8 and 9 will plot the beach ball at the longitude, latitude given in columns 1 and 2. The **−:** option will interchange the order of columns (1,2) and (8,9).

10:   Text string to appear above the beach ball (optional).

−Sc*scale[/fontsize[/offset*[**u**]]]
Focal mechanisms in Harvard CMT convention. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. Scale is the size for magnitude = 5 (that is M0 = 4.0E23 dynes-cm) in inch (unless **c**, **i**, **m**, or **p** is appended). Use the **−T** option to render the beach ball transparent by drawing only the nodal planes and the circumference. The color or shade of the compressive quadrants can be specified with the **−G** option. The color or shade of the extensive quadrants can be specified with the **−E** option. Parameters are expected to be in the following columns:

1,2:   longitude, latitude of event (**−:** option interchanges order)

3:   depth of event in kilometers

4,5,6:   strike, dip, and rake of plane 1

7,8,9:   strike, dip, and rake of plane 2

10,11:   mantissa and exponent of moment in dyne-cm

12,13:   longitude, latitude at which to place beach ball. Entries in these columns are necessary with the −**C** option. Using (0,0) in columns 12 and 13 will plot the beach ball at the longitude, latitude given in columns 1 and 2. The −**:** option will interchange the order of columns (1,2) and (12,13).

14:   Text string to appear above the beach ball (optional).

−**Sm|d|z***scale[/fontsize[/offset*[**u**]]]
> Seismic moment tensor (Harvard CMT, with zero trace). *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. Scale is the size for magnitude = 5 (that is scalar seismic moment = 4.0E23 dynes-cm) in inch (unless **c**, **i**, **m**, or **p** is appended). (−**T***0* option overlays best double couple transparently.) Use −**Sm** to plot the Harvard CMT seismic moment tensor with zero trace. Use −**Sd** to plot only the double couple part of moment tensor. Use −**Sz** to plot the anisotropic part of moment tensor (zero trace). The color or shade of the compressive quadrants can be specified with the −**G** option. The color or shade of the extensive quadrants can be specified with the −**E** option. Parameters are expected to be in the following columns:

1,2:   longitude, latitude of event (−**:** option interchanges order)

3:   depth of event in kilometers

4,5,6,7,8,9:   mrr, mtt, mff, mrt, mrf, mtf in 10*exponent dynes-cm

10:   exponent

11,12:   longitude, latitude at which to place beach ball. Entries in these columns are necessary with the −**C** option. Using (0,0) in columns 11 and 12 will plot the beach ball at the longitude, latitude given in columns 1 and 2. The −**:** option will interchange the order of columns (1,2) and (11,12).

13:   Text string to appear above the beach ball (optional).

−**Sp***scale[/fontsize[/offset*[**u**]]]
> Focal mechanisms given with partial data on both planes. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. Scale is the size for magnitude = 5 in inch (unless **c**, **i**, **m**, or **p** is appended). The color or shade of the compressive quadrants can be specified with the −**G** option. The color or shade of the extensive quadrants can be specified with the −**E** option. Parameters are expected to be in the following columns:

1,2:   longitude, latitude of event (−**:** option interchanges order)

3:   depth of event in kilometers

4,5:   strike, dip of plane 1

6:   strike of plane 2

7:   must be -1/+1 for a normal/inverse fault

8:   magnitude

9,10:   longitude, latitude at which to place beach ball. Entries in these columns are necessary with the −**C** option. Using (0,0) in columns 9 and 10 will plot the beach ball at the longitude, latitude given in columns 1 and 2. The −**:** option will interchange the order of columns (1,2) and (9,10).

          11:   Text string to appear above the beach ball (optional).

−Sx|y|t*scale[/fontsize[/offset*[**u**]]]
> Principal axis. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. Scale is the size for magnitude = 5 (that is seismic scalar moment = 4*10e+23 dynes-cm) in inch (unless **c**, **i**, **m**, or **p** is appended). (−**T***0* option overlays best double couple transparently.) Use −**Sx** to plot standard Harvard CMT. Use −**Sy** to plot only the double couple part of moment tensor. Use −**St** to plot zero trace moment tensor. The color or shade of the compressive quadrants can be specified with the −**G** option. The color or shade of the extensive quadrants can be specified with the −**E** option. Parameters are expected to be in the following columns:

          1,2:   longitude, latitude of event (−**:** option interchanges order)

          3:   depth of event in kilometers

          4,5,6,7,8,9,10,11,12:
> value (in 10*exponent dynes-cm), azimuth, plunge of T, N, P axis.

          13:   exponent

          14,15:   longitude, latitude at which to place beach ball. Entries in these columns are necessary with the −**C** option. Using (0,0) in columns 14 and 15 will plot the beach ball at the longitude, latitude given in columns 1 and 2. The −**:** option will interchange the order of columns (1,2) and (14,15).

          16:   Text string to appear above the beach ball (optional).

OPTIONS
No space between the option flag and the associated arguments.

−B   Sets map boundary annotation and tickmark intervals; see the **psbasemap** man page for all the details.

−C[*pen*][**P***pointsize*]
> Offsets focal mechanisms to the longitude, latitude specified in the last two columns of the input file before the (optional) text string. A small circle is plotted at the initial location and a line connects the beachball to the circle. Specify *pen* and/or *pointsize* to change the line style and/or size of the circle. [Defaults: *pen* width = 1, color = 0/0/0, texture = solid; *pointsize* 0].

−D*depmin/depmax*
> Plots events between depmin and depmax.

−E*fill*   Selects filling of extensive quadrants. Usually white. Set the shade (0–255) or color (r/g/b) [Default is 255/255/255].

−G*fill*   Selects filling of focal mechanisms. By convention, the compressional quadrants of the focal mechanism beach balls are shaded. Set the shade (0–255) or color (r/g/b) [Default is 0/0/0].

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use −**Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−K   More *PostScript* code will be appended later [Default terminates the plot system].

−L[*pen*]

> Draws the "beach ball" outline with *pen* attributes. [Defaults width = 1, color = 0/0/0, texture = solid].

−M   Use the same size for any magnitude. Size is given with −**S**.

−N   Does **NOT** skip symbols that fall outside frame boundary specified by −**R** [Default plots symbols inside frame only].

−O   Selects Overlay plot mode [Default initializes a new plot system].

−P   Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

−T[*num_of_planes*]
         Plots the nodal planes and outlines the bubble which is transparent. If *num_of_planes* is
            0: both nodal planes are plotted;
            1: only the first nodal plane is plotted;
            2: only the second nodal plane is plotted.

−U   Draw Unix System time stamp on plot. By adding *just/dx/dy/*, the user may specify the justifica-
         tion of the stamp and where the stamp should fall on the page relative to lower left corner of the
         plot. For example, BL/0/0 will align the lower left corner of the time stamp with the lower left
         corner of the plot. Optionally, append a *label*, or **c** (which will plot the command string.). The
         GMT parameters **UNIX_TIME**, **UNIX_TIME_POS**, and **UNIX_TIME_FORMAT** can affect
         the appearance; see the **gmtdefaults** man page for details. The time string will be in the locale set
         by the environment variable **TZ** (generally local time).

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−W

SPECIFYING PENS
    pen   The attributes of lines and symbol outlines as defined by *pen* is a comma delimetered list of *width*,
         color and *texture*, each of which is optional. *width* can be indicated as a measure (points, centime-
         ters, inches) or as **faint**, **thin**[**ner**|**nest**], **thick**[**er**|**est**], **fat**[**ter**|**test**], or **obese**. *color* specifies a gray
         shade or color (see SPECIFYING COLOR below). *texture* is a combination of dashes '-' and dots
         '.'.

−X −Y   Shift plot origin relative to the current origin by (*x-shift,y-shift*) and optionally append the length
         unit (**c**, **i**, **m**, **p**). You can prepend **a** to shift the origin back to the original position after plotting,
         or prepend **r** [Default] to reset the current origin to the new location. If **−O** is used then the
         default (*x-shift,y-shift*) is (0,0), otherwise it is (r1i, r1i) or (r2.5c, r2.5c). Alternatively, give **c** to
         align the center coordinate (x or y) of the plot with the center of the page based on current page
         size.

−Z*cptfile*
         Give a color palette file and let compressive part color be determined by the z-value in the third
         column.

−z   Overlay zero trace moment tensor.

−a[*size*/[*P_axis_symbol*[*T_axis_symbol*]]]
         Computes and plots P and T axes with symbols. Optionally specify *size* and (separate) P and T
         axis symbols from the following: (**c**) circle, (**d**) diamond, (**h**) hexagon, (**i**) inverse triangle, (**p**)
         point, (**s**) square, (**t**) triangle, (**x**) cross. [Defaults: 0.2**c**/**cc** or 0.08**i**/**cc**.]

−e*fill*   Selects filling of T axis symbol. Set the shade (0−255) or color (r/g/b). Default is white.

−g*fill*   Selects filling of P axis symbol. Set the shade (0−255) or color (r/g/b). Default black.

-o   Use the **psvelomeca** input format without depth in the third column.

−p[*pen*]
         Draws the P axis outline using default pen (see **−W**), or sets pen attributes.

−t[*pen*]   Draws the T axis outline using default pen (see **−W**), or sets pen attributes.

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (lon-
         gitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−c   Specifies the number of plot copies. [Default is 1].

EXAMPLES

The following file should give a normal-faulting CMT mechanism:
psmeca **−R**239/240/34/35.2 **−Jm**4 **−Sc**0.4 **−H**1 <<END>! test.ps
lon   lat   depth str dip slip st dip slip mant exp plon plat
239.384 34.556 12. 180 18 -88 0 72 -90 5.5 0 0   0
END

SEE ALSO

GMT(1), *psbasemap*(1), *psxy*(1)

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NAME

        pscoupe − Plot cross-sections of focal mechanisms.

SYNOPSIS

        pscoupe *files* **−J***parameters* **−R***west*/*east*/*south*/*north*[**r**] **−A***parameters* [**−B**[**p**|**s**]*parameters*] [**−F***fill*] [**−G***fill*] [**−H**[**i**][*nrec*]] [**−K**] [**−L***[pen]*] [**−M**] [**−N**] [**−O**] [**−P**] [**−S**<*symbol*><*scale*>[/**d**]] [**−s**<*symbol*><*size*>[/**d**]] [**−T***n*] [**−U**[*just*/*dx*/*dy*/][**c**|*label*]] [**−V**] [**−W***pen*] [**−X**[**a**|**c**|**r**][*x-shift*[**u**]]] [**−Y**[**a**|**c**|**r**][*y-shift*[**u**]]] [**−Z***cpt*] [**−a**[*size*/[*P_symbol*/[*T_symbol*]]]] [**−g***fill*] [**−e***fill*] [**−p***pen*] [**−t***pen*] [**−:**[**i**|**o**]] [**−c***copies*]

DESCRIPTION

        pscoupe reads data values from *files* [or standard input] and generates *PostScript* code that will plot symbols, lines or polygons on a cross-section. Focal mechanisms may be specified and require additional columns of data. The *PostScript* code is written to standard output.

        files list one or more file-names. If no files are given, **pscoupe** will read standard input.

        A *new file* is created with the new coordinates (**x**, **y**) and the mechanism (from lower focal half-sphere for horizontal plane, to half-sphere behind a vertical plane). When the plane is not horizontal, - north direction becomes upwards steepest descent direction of the plane (u) - east direction becomes strike direction of the plane (s) - down direction (= north^east) becomes u^s
Axis angles are defined in the same way as in horizontal plane in the new system.
Moment tensor (initially in r, t, f system that is up, south, east) is defined in (-u^s, -u, s) system. A *file* is created with extracted events.

    −J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modifier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value. When central meridian is optional, default is center of longitude range on **−R** option. Default standard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-** to the width, respectively.
More details can be found in the **psbasemap** man pages.

        CYLINDRICAL PROJECTIONS:

        −Jc*lon0*/*lat0*/*scale* (Cassini)
        −Jcyl_stere/[*lon0*/[*lat0*/]]*scale* (Cylindrical Stereographic)
        −Jj[*lon0*/]*scale* (Miller)
        −Jm[*lon0*/[*lat0*/]]*scale* (Mercator)
        −Jm*lon0*/*lat0*/*scale* (Mercator - Give meridian and standard parallel)
        −Jo[**a**]*lon0*/*lat0*/*azimuth*/*scale* (Oblique Mercator - point and azimuth)
        −Jo[**b**]*lon0*/*lat0*/*lon1*/*lat1*/*scale* (Oblique Mercator - two points)
        −Joc*lon0*/*lat0*/*lonp*/*latp*/*scale* (Oblique Mercator - point and pole)
        −Jq[*lon0*/[*lat0*/]]*scale* (Cylindrical Equidistant)
        −Jt*lon0*/[*lat0*/]*scale* (TM - Transverse Mercator)
        −Ju*zone*/*scale* (UTM - Universal Transverse Mercator)
        −Jy[*lon0*/[*lat0*/]]*scale* (Cylindrical Equal-Area)

        CONIC PROJECTIONS:

        −Jb*lon0*/*lat0*/*lat1*/*lat2*/*scale* (Albers)
        −Jd*lon0*/*lat0*/*lat1*/*lat2*/*scale* (Conic Equidistant)
        −Jl*lon0*/*lat0*/*lat1*/*lat2*/*scale* (Lambert Conic Conformal)
        −Jpoly[*lon0*/[*lat0*/]]*scale* ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−**Ja***lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
−**Je***lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
−**Jf***lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
−**Jg***lon0/lat0*[*/horizon*]*/scale* (Orthographic)
−**Jg***lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
−**Js***lon0/lat0*[*/horizon*]*/scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−**Jh**[*lon0/*]*scale* (Hammer)
−**Ji**[*lon0/*]*scale* (Sinusoidal)
−**Jkf**[*lon0/*]*scale* (Eckert IV)
−**Jk**[**s**][*lon0/*]*scale* (Eckert IV)
−**Jn**[*lon0/*]*scale* (Robinson)
−**Jr**[*lon0/*]*scale* (Winkel Tripel)
−**Jv**[*lon0/*]*scale* (Van der Grinten)
−**Jw**[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−**Jp**[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
−**Jx***x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−**R**   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands −**Rg** and −**Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the −**R** settings (and grid spacing, if applicable) are copied from the grid. If frame is defined from cross-section parameters (see **-A**) this option is not taken into account, but must be present.

−**A**   selects the cross-section.
    −**Aa***lon1/lat1/lon2/lat2/dip/p_width/dmin/dmax*[**f**]
    lon and *lat* are the longitude and latitude of points 1 and 2 limiting the length of the cross-section.
    dip is the dip of the plane on which the cross-section is made.
    p_width is the width of the cross-section on each side of a vertical plane or above and under an oblique plane.
    dmin and *dmax* are the distances min and max from horizontal plane, along steepest descent direction.
    Add **f** to get the frame from the cross-section parameters.
    −**Ab***lon1/lat1/strike/p_length/dip/p_width/dmin/dmax*[**f**]
    lon1 and *lat1* are the longitude and latitude of the beginning of the cross-section.
    strike is the azimuth of the direction of the cross-section.
    p_length is the length along which the cross-section is made.
    The other parameters are the same as for **-Aa** option.
    −**Ac***x1/y1/x2/y2/dip/p_width/dmin/dmax*[**f**]
    The same as −**Aa** option with *x* and *y* cartesian coordinates.
    −**Ad***x1/y1/strike/p_length/dip/p_width/dmin/dmax*[**f**]
    The same as −**Ab** option with *x* and *y* cartesian coordinates.

−**S**   selects the meaning of the columns in the data file and the figure to be plotted.

−**Sa***scale[/fontsize[/offset*[**u**]]]
    Focal mechanisms in Aki and Richards convention. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. The *scale* is the size for magnitude = 5

in **MEASURE_UNIT** (unless **c**, **i**, **m**, or **p** is appended to indicate that the size information is in units of cm, inches, meters, or points, respectively). Use the −**T** option to render the beach ball transparent by drawing only the nodal planes and the circumference. The color or shade of the compressive quadrants can be specified with the −**G** option. The color or shade of the extensive quadrants can be specified with the −**E** option. Parameters are expected to be in the following columns:

1,2: longitude, latitude of event (−**:** option interchanges order)

3: depth of event in kilometers

4,5,6: strike, dip and rake

7: magnitude

8,9: not used; can be 0 0; allows use of the psmeca file format

10: text string to appear above the beach ball (default) or under (add **u**).

−**Sc**scale
Focal mechanisms in Harvard CMT convention. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. The *scale* is the size for magnitude = 5 (that is M0 = 4E+23 dynes-cm.) in **MEASURE_UNIT** (unless **c**, **i**, **m**, or **p** is appended to indicate that the size information is in units of cm, inches, meters, or points, respectively). Use the −**T** option to render the beach ball transparent by drawing only the nodal planes and the circumference. The color or shade of the compressive quadrants can be specified with the −**G** option. The color or shade of the extensive quadrants can be specified with the −**E** option. Parameters are expected to be in the following columns:

1,2: longitude, latitude of event (−**:** option interchanges order)

3: depth of event in kilometers

4,5,6: strike, dip, and slip of plane 1

7,8,9: strike, dip, and slip of plane 2

10,11: mantissa and exponent of moment in dyne-cm (if magnitude is uses instead of scalar moment, magnitude is in column 10 and 0 must be in column 11)

12,13: not used; can be 0 0; allows use of the psmeca file format

14: text string to appear above the beach ball (default) or under (add **u**).

−**Sp***scale[/fontsize[/offset[***u**]]]
Focal mechanisms given with partial data on both planes. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. The *scale* is the size for magnitude = 5 in **MEASURE_UNIT** (unless **c**, **i**, **m**, or **p** is appended to indicate that the size information is in units of cm, inches, meters, or points, respectively). The color or shade of the compressive quadrants can be specified with the −**G** option. The color or shade of the extensive quadrants can be specified with the −**E** option. Parameters are expected to be in the following columns:

1,2: longitude, latitude of event (−**:** option interchanges order)

3: depth

4,5: strike, dip of plane 1

6: strike of plane 2

7: must be -1/+1 for a normal/inverse fault

8: magnitude

9,10: not used; can be 0 0; allows use of the psmeca file format

11:   text string to appear above the beach ball (default) or under (add **u**).

−Sm*scale[/fontsize[/offset*[**u**]]]
     Seismic moment tensor. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. The *scale* is the size for magnitude = 5 (that is seismic scalar moment = 4E+23 dynes-cm) in **MEASURE_UNIT** (unless **c**, **i**, **m**, or **p** is appended to indicate that the size information is in units of cm, inches, meters, or points, respectively). (**−T***0* option overlays best double couple transparently.) Put **−Sd***scale[/fontsize[/offset*[**u**]]] to plot the only double couple part of moment tensor. Put **−Sz***scale[/fontsize[/offset*[**u**]]] to plot anisotropic part of moment tensor (zero trace). The color or shade of the compressive quadrants can be specified with the **−G** option. The color or shade of the extensive quadrants can be specified with the **−E** option. Parameters are expected to be in the following columns:

1,2:   longitude, latitude of event (**−:** option interchanges order)

3:   depth of event in kilometers

4,5,6,7,8,9:
     mrr, mtt, mff, mrt, mrf, mtf in 10*exponent dynes-cm

10:   exponent

11,12: Not used; can be 0 0; allows use of the psmeca file format

13:   Text string to appear above the beach ball (default) or under (add **u**).

−Sx*scale[/fontsize[/offset*[**u**]]]
     Principal axis. *scale* adjusts the scaling of the radius of the "beach ball", which will be proportional to the magnitude. The *scale* is the size for magnitude = 5 (that is seismic scalar moment = 4*10e+23 dynes-cm) in **MEASURE_UNIT** (unless **c**, **i**, **m**, or **p** is appended to indicate that the size information is in units of cm, inches, meters, or points, respectively). (**-T***0* option overlays best double couple transparently.) Put **−Sy***scale[/fontsize[/offset*[**u**]]] to plot the only double couple part of moment tensor. Put **−St***scale[/fontsize[/offset*[**u**]]] to plot anisotropic part of moment tensor (zero trace). The color or shade of the compressive quadrants can be specified with the **−G** option. The color or shade of the extensive quadrants can be specified with the **−E** option. Parameters are expected to be in the following columns:

1,2:   longitude, latitude of event (**−:** option interchanges order)

3:   depth of event in kilometers

4,5,6,7,8,9,10,11,12:
     value (in 10*exponent dynes-cm), azimuth, plunge of the T, N, and P axes.

13:   exponent

14,15: longitude, latitude at which to place beach ball. Entries in these columns are necessary with the **−C** option. Using 0,0 in columns 9 and 10 will plot the beach ball at the longitude, latitude given in columns 1 and 2. The **−:** option will interchange the order of columns (1,2) and (9,10).

16:   Text string to appear above the beach ball (optional).

−s*symbol[size[/fontsize[/offset*[**u**]]]
     selects a symbol instead of mechanism. Choose from the following: (**c**) circle, (**d**) diamond, (**i**) itriangle, (**s**) square, (**t**) triangle, (**x**) cross. *size* is the symbol size in **MEASURE_UNIT** (unless **c**, **i**, **m**, or **p** is appended to indicate that the size information is in units of cm, inches, meters, or points, respectively). If *size* must be read, it must be in column 4 and the text string will start in column 5. Parameters are expected to be in the following columns:

1,2:   longitude, latitude of event (**−:** option interchanges order)

3:   depth of event in kilometers

4:   Text string to appear above the beach ball (default) or under (add **u**).

OPTIONS

No space between the option flag and the associated arguments.

−B   Sets map boundary annotation and tickmark intervals; see the **psbasemap** man page for all the details.

−E_fill_   Selects filling of extensive quadrants. Usually white. Set the shade (0–255) or color (r/g/b) [Default is 255/255/255].

−G_fill_   Selects filling of focal mechanisms. By convention, the compressional quadrants are shaded. Set the shade (0–255) or color (*r/g/b*) [Default is *0/0/0*]. Optionally, specify **−G**_picon_size/pattern_, where *pattern* gives the number of the image pattern (1-90) OR the name of a Sun rasterfile. *icon_size* sets the unit size in inches. To invert black and white pixels, use **−GP** instead of **−Gp**. See Appendix E for information on individual patterns.

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−K   More *PostScript* code will be appended later [Default terminates the plot system].

−L[*pen*]
              Draws the "beach ball" outline using current pen (see **−W**) or sets pen attributes.

−M   Same size for any magnitude.

−N   Does **NOT** skip symbols that fall outside map border [Default plots points inside border only].

−O   Selects Overlay plot mode [Default initializes a new plot system].

−P   Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

−T[*num_of_planes*]
              Plots the nodal planes and outlines the bubble which is transparent. If *num_of_planes* is
                  0: both nodal planes are plotted;
                  1: only the first nodal plane is plotted;
                  2: only the second nodal plane is plotted [Default: 0].

−U   Draw Unix System time stamp on plot. By adding *just/dx/dy/*, the user may specify the justification of the stamp and where the stamp should fall on the page relative to lower left corner of the plot. For example, BL/0/0 will align the lower left corner of the time stamp with the lower left corner of the plot. Optionally, append a *label*, or **c** (which will plot the command string.). The **GMT** parameters **UNIX_TIME**, **UNIX_TIME_POS**, and **UNIX_TIME_FORMAT** can affect the appearance; see the **gmtdefaults** man page for details. The time string will be in the locale set by the environment variable **TZ** (generally local time).

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−W   set pen attributes for text string or default pen attributes for fault plane edges. [Defaults: width = *1*, color = *0/0/0*, texture = *solid*].

−X −Y   Shift plot origin relative to the current origin by (*x-shift,y-shift*) and optionally append the length unit (**c**, **i**, **m**, **p**). You can prepend **a** to shift the origin back to the original position after plotting, or prepend **r** [Default] to reset the current origin to the new location. If **−O** is used then the default (*x-shift,y-shift*) is (0,0), otherwise it is (r1i, r1i) or (r2.5c, r2.5c). Alternatively, give **c** to align the center coordinate (x or y) of the plot with the center of the page based on current page size.

−Zcptfile

> Give a color palette file and let compressive part color be determined by the z-value in the third column.

−a[*size*/[*P_axis_symbol*/[*T_axis_symbol*]]]

> Computes and plots P and T axes with symbols. Optionally specify *size* and (separate) P and T axis symbols from the following: (**c**) circle, (**d**) diamond, (**h**) hexagon, (**i**) inverse triangle, (**p**)point, (**s**) square, (**t**) triangle, (**x**) cross. [Defaults: 0.2**c**/**c**/**c** or 0.08**i**/**c**/**c**.]

−e*fill*   Selects filling of T axis symbol. Set the shade (0–255) or color (r/g/b) [Default is color of extensive parts.]

−g*fill*   Selects filling of P axis symbol. Set the shade (0–255) or color (r/g/b) [Default is color of compressive parts.]

−p[*pen*]

> Draws the P axis outline using current pen (see **−W**), or sets pen attributes.

−t[*pen*]   Draws the T axis outline using current pen (see **−W**), or sets pen attributes.

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−c   Specifies the number of plot copies. [Default is 1].

SEE ALSO

> *GMT*(1), *psbasemap*(1), *psmeca*(1), *psxy*(1)

REFERENCES

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> Aki, K. and P. Richards, Quantitative Seismology, Freeman, 1980.
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NAME

pspolar - Plot polarities on the inferior focal half–sphere on maps

SYNOPSIS

pspolar *files* **−J***parameters* **−R***west/east/south/north*[**r**] **−D***lon/lat* **−M***size* **−S***<symbol><size>* [
−B[**p**|**s**]*parameters*] [**−C***lon/lat*[*/dash_width/pointsize*]] [**−F***color*] [**−G***fill*] [**−g***fill*] [**−H**[**i**][*nrec*]] [**−h**
] [**−K**] [**−L**] [**−N**] [**−O**] [**−P**] [**−s***Half-size*[**v**[[*v_width/h_length/h_width/shape*]][**g**[*color*]][**l**] [**−T***angle/form/justify/fontsize*] [**−t***pen*] [**−U**[*just/dx/dy/*][**c**|*label*]] [**−V**] [**−W***pen*] [**−X**[**a**|**c**|**r**][*x-shift*[**u**]]] [
−Y[**a**|**c**|**r**][*y-shift*[**u**]]] [**−c***copies*]

DESCRIPTION

pspolar reads data values from *files* [or standard input] and generates *PostScript* code that will plot stations on focal mechanisms on a map. The *PostScript* code is written to standard output.

Parameters are expected to be in the following columns

1,2,3,4 station_code, azimuth, take-off angle, polarity

polarity:
- compression can be c,C,u,U,+
- rarefaction can be d,D,r,R,-
- not defined is anything else

ARGUMENTS

files List one or more file-names. If no files are given, pspolar will read standard input.

−J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modifier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value. When central meridian is optional, default is center of longitude range on **−R** option. Default standard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-** to the width, respectively.
More details can be found in the **psbasemap** man pages.

CYLINDRICAL PROJECTIONS:

−Jc*lon0/lat0/scale* (Cassini)
−Jcyl_stere/[*lon0/*[*lat0/*]]*scale* (Cylindrical Stereographic)
−Jj[*lon0/*]*scale* (Miller)
−Jm[*lon0/*[*lat0/*]]*scale* (Mercator)
−Jm*lon0/lat0/scale* (Mercator - Give meridian and standard parallel)
−Jo[**a**]*lon0/lat0/azimuth/scale* (Oblique Mercator - point and azimuth)
−Jo[**b**]*lon0/lat0/lon1/lat1/scale* (Oblique Mercator - two points)
−Joc*lon0/lat0/lonp/latp/scale* (Oblique Mercator - point and pole)
−Jq[*lon0/*[*lat0/*]]*scale* (Cylindrical Equidistant)
−Jt*lon0/*[*lat0/*]*scale* (TM - Transverse Mercator)
−Ju*zone/scale* (UTM - Universal Transverse Mercator)
−Jy[*lon0/*[*lat0/*]]*scale* (Cylindrical Equal-Area)

CONIC PROJECTIONS:

−Jb*lon0/lat0/lat1/lat2/scale* (Albers)
−Jd*lon0/lat0/lat1/lat2/scale* (Conic Equidistant)
−Jl*lon0/lat0/lat1/lat2/scale* (Lambert Conic Conformal)
−Jpoly[*lon0/*[*lat0/*]]*scale* ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−Ja*lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
−Je*lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
−Jf*lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
−Jg*lon0/lat0*[*/horizon*]*/scale* (Orthographic)
−Jg*lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
−Js*lon0/lat0*[*/horizon*]*/scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−Jh[*lon0/*]*scale* (Hammer)
−Ji[*lon0/*]*scale* (Sinusoidal)
−Jkf[*lon0/*]*scale* (Eckert IV)
−Jk[**s**][*lon0/*]*scale* (Eckert IV)
−Jn[*lon0/*]*scale* (Robinson)
−Jr[*lon0/*]*scale* (Winkel Tripel)
−Jv[*lon0/*]*scale* (Van der Grinten)
−Jw[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
−Jx*x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−D*longitude/latitude*
          Maps the bubble at given longitude and latitude point.

−M*size* Sets the size of the beach ball to plot polarities in. *Size* is in inch (unless **c**, **i**, **m**, or **p** is appended).

−S<symbol_type><size>
          Selects *symbol_type* and symbol *size*. Size is in inch (unless **c**, **i**, **m**, or **p** is appended). Choose symbol type from st(*a*)r, (*c*)ircle, (*d*)iamond, (*h*)exagon, (*i*)nverted triangle, (*p*)oint, (*s*)quare, (*t*)riangle, (*x*)cross.

OPTIONS

          No space between the option flag and the associated arguments.

−B   Sets map boundary annotation and tickmark intervals; see the **psbasemap** man page for all the details.

−C   Offsets focal mechanisms to the latitude and longitude specified in the last two columns of the input file.

−E*fill* Selects filling of symbols for stations in extensive quadrants. Set the shade (0–255) or color (r/g/b) [Default is 250/250/250]. If **−E***fill* is the same as **−F***fill*, use **−e** to outline.

−e[pen]
          Outline symbols in extensive quadrants using *pen* or the default pen (see **−W**).

−F*fill* Sets background color of the beach ball. Default is no fill.

−f[pen] Outline the beach ball using *pen* or the default pen (see **−W**).

−G*fill*   Selects filling of symbols for stations in compressional quadrants. Set the shade (0−255) or color (r/g/b) [Default is 0/0/0].

−g[pen]
        Outline symbols in compressional quadrants using *pen* or the default pen (see **−W**).

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−h   Use special format derived from HYPO71 output

−K   More *PostScript* code will be appended later [Default terminates the plot system].

−N   Does **NOT** skip symbols that fall outside map border [Default plots points inside border only].

−O   Selects Overlay plot mode [Default initializes a new plot system].

−P   Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

−s*half−size/[***V***[v_width/h_length/h_width/shape]][***G***r/g/b][***L***]*
        Plots S polarity azimuth.
        S polarity is in last column. It may be a vector (**V** option) or a segment. Give half−size,v_width,h_length,h_width in inch (unless **c**, **i**, **m**, or **p** is appended). [**L**] option is for outline.

−T*angle/form/justify/fontsize in points*
        To write station code. [Default is 0.0/0/5/12].

−tpen   Set pen color to write station code. Default uses the default pen (see **−W**).

−U   Draw Unix System time stamp on plot. By adding *just/dx/dy/*, the user may specify the justification of the stamp and where the stamp should fall on the page relative to lower left corner of the plot. For example, BL/0/0 will align the lower left corner of the time stamp with the lower left corner of the plot. Optionally, append a *label*, or **c** (which will plot the command string.). The **GMT** parameters **UNIX_TIME**, **UNIX_TIME_POS**, and **UNIX_TIME_FORMAT** can affect the appearance; see the **gmtdefaults** man page for details. The time string will be in the locale set by the environment variable **TZ** (generally local time).

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−W   Set current pen attributes
         [Defaults: width = 1, color = 0/0/0, texture = solid].

−X −Y   Shift plot origin relative to the current origin by (*x-shift,y-shift*) and optionally append the length unit (**c**, **i**, **m**, **p**). You can prepend **a** to shift the origin back to the original position after plotting, or prepend **r** [Default] to reset the current origin to the new location. If **−O** is used then the default (*x-shift,y-shift*) is (0,0), otherwise it is (r1i, r1i) or (r2.5c, r2.5c). Alternatively, give **c** to align the center coordinate (x or y) of the plot with the center of the page based on current page size.

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−c   Specifies the number of plot copies. [Default is 1].

EXAMPLES
        pspolar −R239/240/34/35.2 **−JM**8 **−N −Sc**0.4 **−H**1 **−D**239.5/34.5 **−M**5 <<END>! test.ps
        stat azim ih pol
        0481 11 147 c
        6185 247 120 d
        0485 288 114 +
        0490 223 112 -
        0487 212 109 .

```
            END
            or
            pspolar −R239/240/34/35.2 −JM8 −N −Sc0.4 −H1 −D239.5/34.5 −M5 −h <<END>! test.ps
            Date   Or. time stat azim  ih
            910223  1 22  0481  11  147  ipu0
            910223  1 22  6185  247 120  ipd0
            910223  1 22  0485  288 114  epu0
            910223  1 22  0490  223 112  epd0
            910223  1 22  0487  212 109  epu0
            END
```

SEE ALSO

GMT(1), *psbasemap*(1), *psxy*(1)

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NAME
psvelo – Plot velocity vectors, crosses, and wedges on maps

SYNOPSIS
psvelo *files* **−J***parameters* **−R***west*/*east*/*south*/*north*[**r**] [**−B**[**p**|**s**]*parameters*] [**−D***sigma_scale*] [**−F***color*] [**−E***color*] [**−G***fill*] [**−H**[**i**][*nrec*]] [**−K**] [**−L**] [**−N**] [**−O**] [**−P**] [**−S***symbol*/*scale*/*conf*/*font_size*] [**−U**[*just*/*dx*/*dy*/][**c**|*label*]] [**−V**] [**−W***pen*] [**−X**[**a**|**c**|**r**][*x-shift*[**u**]]] [**−Y**[**a**|**c**|**r**][*y-shift*[**u**]]] [**−:**[**i**|**o**]] [**−c***copies*]

DESCRIPTION
psvelo reads data values from *files* [or standard input] and generates *PostScript* code that will plot velocity arrows on a map. Most options are the same as for **psxy**, except **−S**. The *PostScript* code is written to standard output. The previous version (**psvelomeca**) is now obsolete. It has been replaced by **psvelo** and **psmeca**.

ARGUMENTS
files List one or more file-names. If no files are given, **psvelo** will read standard input.

−**J**   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modifier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value. When central meridian is optional, default is center of longitude range on **−R** option. Default standard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-** to the width, respectively.
More details can be found in the **psbasemap** man pages.

CYLINDRICAL PROJECTIONS:

−**Jc***lon0*/*lat0*/*scale* (Cassini)
−**Jcyl_stere**/[*lon0*/[*lat0*/]]*scale* (Cylindrical Stereographic)
−**Jj**[*lon0*/]*scale* (Miller)
−**Jm**[*lon0*/[*lat0*/]]*scale* (Mercator)
−**Jm***lon0*/*lat0*/*scale* (Mercator - Give meridian and standard parallel)
−**Jo**[**a**]*lon0*/*lat0*/*azimuth*/*scale* (Oblique Mercator - point and azimuth)
−**Jo**[**b**]*lon0*/*lat0*/*lon1*/*lat1*/*scale* (Oblique Mercator - two points)
−**Joc***lon0*/*lat0*/*lonp*/*latp*/*scale* (Oblique Mercator - point and pole)
−**Jq**[*lon0*/[*lat0*/]]*scale* (Cylindrical Equidistant)
−**Jt***lon0*/[*lat0*/]*scale* (TM - Transverse Mercator)
−**Ju***zone*/*scale* (UTM - Universal Transverse Mercator)
−**Jy**[*lon0*/[*lat0*/]]*scale* (Cylindrical Equal-Area)

CONIC PROJECTIONS:

−**Jb***lon0*/*lat0*/*lat1*/*lat2*/*scale* (Albers)
−**Jd***lon0*/*lat0*/*lat1*/*lat2*/*scale* (Conic Equidistant)
−**Jl***lon0*/*lat0*/*lat1*/*lat2*/*scale* (Lambert Conic Conformal)
−**Jpoly**[*lon0*/[*lat0*/]]*scale* ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−**Ja***lon0*/*lat0*[/*horizon*]/*scale* (Lambert Azimuthal Equal-Area)
−**Je***lon0*/*lat0*[/*horizon*]/*scale* (Azimuthal Equidistant)
−**Jf***lon0*/*lat0*[/*horizon*]/*scale* (Gnomonic)
−**Jg***lon0*/*lat0*[/*horizon*]/*scale* (Orthographic)
−**Jg***lon0*/*lat0*/*altitude*/*azimuth*/*tilt*/*twist*/*Width*/*Height*/*scale* (General Perspective).
−**Js***lon0*/*lat0*[/*horizon*]/*scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−Jh[*lon0/*]*scale* (Hammer)
−Ji[*lon0/*]*scale* (Sinusoidal)
−Jkf[*lon0/*]*scale* (Eckert IV)
−Jk[**s**][*lon0/*]*scale* (Eckert IV)
−Jn[*lon0/*]*scale* (Robinson)
−Jr[*lon0/*]*scale* (Winkel Tripel)
−Jv[*lon0/*]*scale* (Van der Grinten)
−Jw[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
−Jx*x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−SSelects the meaning of the columns in the data file and the figure to be plotted.

−Se*velscale/confidence/fontsize*.
          Velocity ellipses in (N,E) convention. *Vscale* sets the scaling of the velocity arrows. This scaling gives inches (unless **c**, **i**, **m**, or **p** is appended). *Confidence* sets the 2-dimensional confidence limit for the ellipse, e.g., 0.95 for 95% confidence ellipse. *Fontsize* sets the size of the text in points. The ellipse will be filled with the color or shade specified by the **−G** option [default transparent]. The arrow and the circumference of the ellipse will be drawn with the pen attributes specified by the **−W** option. Parameters are expected to be in the following columns:

1,2   longitude, latitude of station (**−:** option interchanges order)

3,4   eastward, northward velocity (**−:** option interchanges order)

5,6   uncertainty of eastward, northward velocities (1-sigma) (**−:** option interchanges order)

7   correlation between eastward and northward components

8   name of station (optional).

−Sn*barscale*.
          Anisotropy bars. *Barscale* sets the scaling of the bars This scaling gives inches (unless **c**, **i**, **m**, or **p** is appended). Parameters are expected to be in the following columns:

1,2   longitude, latitude of station (**−:** option interchanges order)

3,4   eastward, northward components of anisotropy vector (**−:** option interchanges order)

−Sr*velscale/confidence/fontsize*
          Velocity ellipses in rotated convention. *Vscale* sets the scaling of the velocity arrows. This scaling gives inches (unless **c**, **i**, **m**, or **p** is appended). *Confidence* sets the 2-dimensional confidence limit for the ellipse, e.g., 0.95 for 95% confidence ellipse. *Fontsize* sets the size of the text in points. The ellipse will be filled with the color or shade specified by the **−G** option [default transparent]. The arrow and the circumference of the ellipse will be drawn with the pen attributes specified by the **−W** option. Parameters are expected to be in the following columns:

1,2   longitude, latitude, of station (**−:** option interchanges order)

3,4   eastward, northward velocity (**−:** option interchanges order)

5,6   semi-major, semi-minor axes

7   counter-clockwise angle, in degrees, from horizontal axis to major axis of ellipse.

8   name of station (optional)

−Sw*wedge_scale/wedge_mag*.

    Rotational wedges. *Wedge_scale* sets the size of the wedges in inches (unless **c**, **i**, **m**, or **p** is appended). Values are multiplied by *Wedge_mag* before plotting. For example, setting *Wedge_mag* to 1.e7 works well for rotations of the order of 100 nanoradians/yr. Use **−G** to set the fill color or shade for the wedge, and **−E** to set the color or shade for the uncertainty. Parameters are expected to be in the following columns:

1,2   longitude, latitude, of station (**−:** option interchanges order)

3   rotation in radians

4   rotation uncertainty in radians

−Sx*cross_scale*

    gives Strain crosses. *Cross_scale* sets the size of the cross in inches (unless **c**, **i**, **m**, or **p** is appended). Parameters are expected to be in the following columns:

1,2   longitude, latitude, of station (**−:** option interchanges order)

3   eps1, the most extensional eigenvalue of strain tensor, with extension taken positive.

4   eps2, the most compressional eigenvalue of strain tensor, with extension taken positive.

5   azimuth of eps2 in degrees CW from North.

OPTIONS

No space between the option flag and the associated arguments.

−A   *Arrow_width/Head_length/Head_width* Size of arrow in inches. [Default is 0.03/0.12/0.09].

−B   Sets map boundary annotation and tickmark intervals; see the **psbasemap** man page for all the details.

−C   Offset focal mechanisms to the latitude and longitude specified in the last two columns of the input file.

−D   *Sigma_scale* can be used to rescale the uncertainties of velocities (**−Se** and **−Sr**) and rotations (**−Sw**). Can be combined with the *confidence* variable.

−F*fill*   Sets the color or shade used for frame and annotation. [Default is 0/0/0 (black)]

−E*fill*   Sets the color or shade used for filling uncertainty wedges (**−Sw**) or velocity error ellipses (**−Se** or **−Sr**). [If **−E** is not specified, the uncertainty regions will be transparent.]

−G*fill*   Select filling of ellipses, wedges, and focal mechanisms. By convention, the compressional quadrants of the focal mechanism beach balls are shaded. Set the shade (0–255) or color (r/g/b) [Default is 0/0/0]. Optionally, specify **−Gp***icon_size/pattern*, where *pattern* gives the number of the image pattern (1-90) OR the name of a icon-format file. *icon_size* sets the unit size in inches. To invert black and white pixels, use **−GP** instead of **−Gp**. See **pspatterns** for information on individual patterns.

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−K More *PostScript* code will be appended later [Default terminates the plot system].

−L Draw lines. Ellipses and fault planes will have their outlines drawn using current pen (see **−W**).

−N Do **NOT** skip symbols that fall outside the frame boundary specified by **−R**.
    [Default plots symbols inside frame only].

−O Selects Overlay plot mode [Default initializes a new plot system].

−P Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

−U Draw Unix System time stamp on plot. By adding *just/dx/dy/*, the user may specify the justification of the stamp and where the stamp should fall on the page relative to lower left corner of the plot. For example, BL/0/0 will align the lower left corner of the time stamp with the lower left corner of the plot. Optionally, append a *label*, or **c** (which will plot the command string.). The **GMT** parameters **UNIX_TIME**, **UNIX_TIME_POS**, and **UNIX_TIME_FORMAT** can affect the appearance; see the **gmtdefaults** man page for details. The time string will be in the locale set by the environment variable **TZ** (generally local time).

−V Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−W Set pen attributes for velocity arrows, ellipse circumference and fault plane edges.
    [Defaults: width = 1, color = 0/0/0, texture = solid].

−X −Y Shift plot origin relative to the current origin by (*x-shift,y-shift*) and optionally append the length unit (**c**, **i**, **m**, **p**). You can prepend **a** to shift the origin back to the original position after plotting, or prepend **r** [Default] to reset the current origin to the new location. If **−O** is used then the default (*x-shift,y-shift*) is (0,0), otherwise it is (r1i, r1i) or (r2.5c, r2.5c). Alternatively, give **c** to align the center coordinate (x or y) of the plot with the center of the page based on current page size.

−: Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−c Specifies the number of plot copies. [Default is 1].

EXAMPLES

The following should make big red arrows with green ellipses, outlined in red. Note that the 39% confidence scaling will give an ellipse which fits inside a rectangle of dimension Esig by Nsig.

psvelo << END **−H**2 **−R**-10/10/-10/10 **−W**0.25p,red **−G**green **−L** **−Se**0.2/0.39/18 **−B**1g1 **−Jx**0.4/0.4 **−A**0.1/0.3/0.3 **−P −V** >! test.ps

```
 Long. Lat.  Evel Nvel  Esig Nsig CorEN SITE
 (deg) (deg)  (mm/yr)    (mm/yr)
  0.   -8.   0.0  0.0   4.0  6.0 0.500 4x6
 -8.    5.   3.0  3.0   0.0  0.0 0.500 3x3
  0.    0.   4.0  6.0   4.0  6.0 0.500
 -5.   -5.   6.0  4.0   6.0  4.0 0.500 6x4
  5.    0.  -6.0  4.0   6.0  4.0 -0.500 -6x4
  0.   -5.   6.0 -4.0   6.0  4.0 -0.500 6x-4
END
```

This example should plot some residual rates of rotation in the Western Transverse Ranges, California. The wedges will be dark gray, with light gray wedges to represent the 2-sigma uncertainties.

psvelo <<END **−Sw**0.4/1.e7 **−W**0.75p **−G**darkgray **−E**lightgray **−H**1 **−D**2 **−Jm**2.2 **−R**240./243./32.5/34.75 **−B**f10ma60m/WeSn **−P** >! test.ps

```
 lon    lat   spin(rad/yr) spin_sigma (rad/yr)
241.4806 34.2073  5.65E-08 1.17E-08
241.6024 34.4468 -4.85E-08 1.85E-08
241.0952 34.4079  4.46E-09 3.07E-08
241.2542 34.2581  1.28E-07 1.59E-08
```

    242.0593 34.0773 -6.62E-08 1.74E-08
    241.0553 34.5369 -2.38E-07 4.27E-08
    241.1993 33.1894 -2.99E-10 7.64E-09
    241.1084 34.2565 2.17E-08 3.53E-08
    END

SEE ALSO

GMT(1), *psbasemap*(1), *psxy*(1)

REFERENCES

Bomford, G., Geodesy, 4th ed., Oxford University Press, 1980.

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NAME

mgd77convert – Translate between different formats of MGD77 files

SYNOPSIS

mgd77convert *NGDC-ids* **−Fa|c|t −T**[**+**]**a|b|t** [**−L**[**w**][**e**][**+**]] [**−V**] [**−4**]

DESCRIPTION

mgd77convert reads versions of MGD77 files and writes the same data in (probably) another format to a new file in the current directory. Both pre- and post-Y2K MGD77 formats can be processed.

NGDC-ids

Can be one or more of five kinds of specifiers:
1) 8-character NGDC IDs, e.g., 01010083, JA010010etc., etc.
2) 2-character <agency> codes which will return all cruises from each agency.
3) 4-character <agency><vessel> codes, which will return all cruises from those vessels.
4) =<list>, where <list> is a table with NGDC IDs, one per line.
5) If nothing is specified we return all cruises in the data base.
(See mgd77info **−L** for agency and vessel codes). The ".mgd77" or ".nc" extensions will automatically be appended, if needed (use **−I** to ignore certain file types). Cruise files will be looked for first in the current directory and second in all directories listed in **$MGD77_HOME**/mgd77_paths.txt [If **$MGD77_HOME** is not set it will default to **$GMT_SHAREDIR**/mgd77].

−F	Specifies the format of the input (From) files. Choose from **a** for standard MGD77 ASCII table (with extension .mgd77), **c** for the new MGD77+ netCDF format (with extension .nc), and **t** for a plain ASCII tab-separated table dump (with extension .dat). Use **−FC** to recover the original MGD77 setting from the MGD77+ file [Default will apply any E77 corrections encoded in the file].

−T	Specifies the format of the output (To) files. Choose from **a** for standard MGD77 ASCII table (with extension .mgd77), **c** for the new MGD77+ netCDF format (with extension .nc), and **t** for a plain ASCII tab-separated table dump (with extension .dat). We will refuse to create the file(s) if they already exist in the current directory. Prepend + to override this policy.

OPTIONS

No space between the option flag and the associated arguments.

−L	Set the level of verification reporting [none] and where to send such reports [stderr]. Append a combination of **w** for warnings, **e** for errors, and **+** to send such log information to stdout.

−V	Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−4	By default, the storage types used in a MGD77+ netCDF file greatly exceed the precision imposed by the ASCII MGD77 format. However, for the five items **faa**, **eot**, **mag**, **diur** and **msd** we use 2-byte integers with implied precisions of 0.1 mGal, 0.1 nTesla, and 1 m as in the MGD77 format. It is possible that at some point these items will need to be stored as 4-byte ints which would allow precisions of 1 fTesla, 1 nGal, and 0.01 mm, respectively. This option activates such storage [Default uses 2-byte integers].

EXAMPLES

To convert 01010047.mgd77 and 01010008.mgd77 to new netCDF .nc files, and capture all verification messages, try

mgd77convert 01010047 01010008 **−Fa −Tc −V −Lew+** > log.lis

To convert 01010047.nc back to MGD77 ASCII and make sure it is identical to the original file, try (Bourne shell syntax)

orig=`**mgd77path** 01010047 **−Ic**`
mgd77convert 01010047 **−Fc −Ta −V**

diff $orig 01010047.mgd77

To convert 01010047.nc to a plain ASCII table for manual editing, overwriting any existing table, try

mgd77convert 01010047 **−Fc −T+t −V**

To recover the original NGDC MGD77 version of 01020051.nc and ignore any E77 corrections, use
mgd77convert 01020051 **−FC −Ta −V**

FILE FORMATS

mgd77convert handles three different formats. (1) The MGD77 ASCII tables are the established standard for distribution of underway geophysical data to and from the NGDC data center. Normally, only the ship-operations people and the cruise PI might be involved in *making* an MGD77 ASCII file for transmission to NGDC; users are more interested in *reading* such files. (2) The MGD77+ netCDF format was developed to fascilitate the use of MGD77 data by scientists. It contains all the information of the original MGD77 file and if you convert back and forth you end up with the original. However, file sizes are typically ˜30% of the original ASCII format and is much faster to operate on. (3) The plain ASCII tab-separated dump is available for users who need to manually edit the content of a MGD77 file. This is usually easier to do when the columns are tab-separated than when they are all crunched together in the MGD77 punch-card format.

OTHER TOOLS

The MGD77+ netCDF files are CF-1.0 and COARDS compliant and can be examined with general-purpose tools such as ncBrowse and ncView.

SEE ALSO

mgd77manage(1), *mgd77list*(1), *mgd77sample*(1), *mgd77track*(1) *x2sys_init*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

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Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

ncBrowse, see *http://www.epic.noaa.gov/java/ncBrowse/*

ncView, see *http://meteora.ucsd.edu/˜pierce/ncview_home_page.html*

The Marine Geophysical Data Exchange Format - "MGD77", see *http://www.ngdc.noaa.gov/mgg/dat/geodas/docs/mgd77.txt*

NAME

        mgd77info − Get information about MGD77^{+} files

SYNOPSIS

        mgd77info *NGDC-ids* [**−C**[**m**|**e**]] [**−E**[**m**|**e**]] [**−I**ignore] [**−Mf**[*item*]|**r**|**e**|**h**] [**−L**[**v**] [**−V**]

DESCRIPTION

        mgd77info reads <legid>.[mgd77|nc] files and produces a single record of information about each cruise specified. The information includes beginning and end times, total track distances in km, longitude and latitude range, and the total number of geophysical observations. Optionally, choose instead to see the original MGD77 header meta-data section or its individual members.

        If you need to know which tracks are crossing through a given region and what kinds of geophysical observations are available, consider using the x2sys tools to set up a tracks index data base (see **x2sys_init** for more information).

        NGDC-ids

                Can be one or more of five kinds of specifiers:

                1) 8-character NGDC IDs, e.g., 01010083, JA010010etc., etc.

                2) 2-character <agency> codes which will return all cruises from each agency.

                3) 4-character <agency><vessel> codes, which will return all cruises from those vessels.

                4) =<list>, where <list> is a table with NGDC IDs, one per line.

                5) If nothing is specified we return all cruises in the data base.

                (See mgd77info **−L** for agency and vessel codes). The ".mgd77" or ".nc" extensions will automatically be appended, if needed (use **−I** to ignore certain file types). Cruise files will be looked for first in the current directory and second in all directories listed in **$MGD77_HOME**/mgd77_paths.txt [If **$MGD77_HOME** is not set it will default to **$GMT_SHAREDIR**/mgd77].

OPTIONS

        No space between the option flag and the associated arguments.

        −C   List abbreviations for all columns present in the MGD77^{+} files. Append **m** or **e** to limit the display to the MGD77 standard or MGD77+ extended set only.

        −E   Give a one-line summary for each cruise listed.

        −M   List the meta-data (header) and (if present) the MGD77+ history for each cruise. Append **f** for a formatted display. This will list individual parameters and their values, one entry per output line, in a format that can be searched using standard UNIX text tools. Alternatively, append the name of a particular parameter (you only need to give enough characters - starting at the beginning - to uniquely identify the item). Give - to display the list of all parameter names. You may also specify the number of a parameter. For the raw, punchcard-formatted MGD77 original header block, append **r** instead. For the MGD77+ E77 status, append **e** instead. Finally, for the MGD77+ history, append **h** instead.

        −I   Ignore certain data file formats from consideration. Append **a**|**c**|**t** to ignore MGD77 ASCII, MGD77+ netCDF, or plain tab-separated ASCII table files, respectively. The option may be repeated to ignore more than one format. [Default ignores none].

        −L   No cruise information is listed. Instead, we just display a list of the GEODAS institution 2-character codes and their names. Optionally, append **v** to also display the vessels and their 4-character codes for each institution. The following is the list of institutions:

              (01) LAMONT (LDEO), (02) WOODS HOLE O.I., (03) NOAA, (04) US ARMY, (05) NEW ZEALAND, (06) US GEOL. SURVEY, (07) OREGON ST. UNIV, (08) U.HAWAII SOEST, (09) US NAVY, (10) UNIV OF TEXAS, (11) RICE UNIV., (12) CANADA, (13) UNIV OF CONN., (14) U.MIAMI (RSMAS), (15) SCRIPPS INST.OC, (16) CHINA, (17) U RHODE ISLAND, (18) DUKE UNIVERSITY, (19) UNITED KINGDOM, (20) U.WASHINGTON, (22) WESTERN GEOPHY., (23) TEXAS A&M UNIV., (24) AUSTRALIA, (25) MONACO, (29) RUSSIA, (30) SPAIN, (35) NIMA, (58) NETHERLANDS, (60) MIN MGMT SVC, (63) ISRAEL, (67) FRANCE, (71) SOUTH AFRICA, (75) US COAST GUARD, (76) BRAZIL, (77) INT. GRAV.

BUR, (83) GERMANY, (84) ORSTOM NEW CAL, (86) CUBA, (87) ARGENTINA, (88) US NSF, (89) INDIA, (90) PORTUGAL, (92) FINLAND, (93) CHILE, (J1) HYDR DEPT JAPAN, (J2) GEOL SRVY JAPAN, (J4) UNIV TOKYO, (J5) KOBE UNIV, (J7) UNIV OF RYUKYUS, (J8) J.O.D.C. JAPAN, (J9) CHIBA UNIV, (JA) INST.POLAR RES., (ZZ) INST NOT CODED.

–V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

To get one-line summary information about the cruises 01010047.mgd77 and 01010008.mgd77, try

mgd77info 01010047 01010008 **–E** > listing.lis

To see the original raw MGD77 header meta-data for cruise 01010047.mgd77, run

mgd77info 01010047 **–Mr**

To determine all the parameters related to Gravity during cruise 01010047.mgd77, run

mgd77info 01010047 **–Mf** | grep Gravity

To determine the Magnetic sampling rate used during cruise 01010047.mgd77, run

mgd77info 01010047 **–Mf**Magnetics_Sampling_Rate

To see all the columns that the MGD77+ cruise 01010047.nc contains, run

mgd77info 01010047 **–C**

To see the E77 status of all MGD77+ cruises collected by the University of Hawaii, run

mgd77info 08 **–Ia** **–Me**

SEE ALSO

mgd77list(1), *mgd77manage*(1), *mgd77path*(1), *mgd77track*(1) *x2sys_init*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

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The Marine Geophysical Data Exchange Format - "MGD77", see *http://www.ngdc.noaa.gov/mgg/dat/geo-das/docs/mgd77.txt*

NAME
>   mgd77list – A data-extractor for MGD77^{+} files

SYNOPSIS
>   **mgd77list** *NGDC-ids* **−F***columns*[,*logic*][:*bittests*] [**−A**[+]**c**|**d**|**f**|**m**|**t***code*] [**−Cf**|**g**|**e**] [**−DA**|**a***startdate*] [
>   **−DB**|**b***stopdate*] [**−E**] [**−Ga***startrec*] [**−Gb***stoprec*] [**−H**[**i**][*nrec*]] [**−I***ignore*] [**−L**[*corrtable*]] [
>   **−Nd**|**s***unit*] [**−Qa**|**v***min/max*] [**−R***west/east/south/north*[**r**]] [**−Sa***startdist*[unit]] [**−Sb***stopdist*[unit]] [
>   **−T**[**m**|**e**]] [**−V**] [**−W***weight*] [**−Z**+|**-**] [**−bo**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−m**[*flag*]]

DESCRIPTION
>   **mgd77list** reads <NGDC-id>.[mgd77|nc] files and produces an ASCII [or binary] table. The <NGDC-
>   id>.[mgd77|nc] files contain track information such as leg-id, time and position, geophysical observables
>   such as gravity, magnetics, and bathymetry, and control codes and corrections such as Eotvos and diurnal
>   corrections. The MGD77+ extended netCDF files may also contain additional user columns (for a listing of
>   available columns, use **mgd77info −C**, and to learn how to add your own custom columns, see **mgd77man-**
>   **age**). The user may extract any combination of these parameters, any of six computed quantities (distance,
>   heading, velocity, Carter correction, and gravity and magnetic global reference fields), calendar sub-units of
>   time (year, month, day, hour, min, sec), the NGDC id, and finally a preset weight (see **−W**). A sub-section
>   can be specified by passing time- or distance-intervals along track or by selecting a geographical region.
>   Finally, each output record may be required to pass any number of logical tests involving data values or bit
>   flags.

> *NGDC-ids*
>>   Can be one or more of five kinds of specifiers:
>>   1) 8-character NGDC IDs, e.g., 01010083, JA010010etc., etc.
>>   2) 2-character <agency> codes which will return all cruises from each agency.
>>   3) 4-character <agency><vessel> codes, which will return all cruises from those vessels.
>>   4) =<list>, where <list> is a table with NGDC IDs, one per line.
>>   5) If nothing is specified we return all cruises in the data base.
>>   (See mgd77info **−L** for agency and vessel codes). The ".mgd77" or ".nc" extensions will automat-
>>   ically be appended, if needed (use **−I** to ignore certain file types). Cruise files will be looked for
>>   first in the current directory and second in all directories listed in
>>   **$MGD77_HOME**/mgd77_paths.txt [If **$MGD77_HOME** is not set it will default to
>>   **$GMT_SHAREDIR**/mgd77].

> **−F**   The required *columns* string must be a comma-separated list of parameter abbreviations given in
>   the desired output order. Any parameters given in UPPER case must not be NaN in a record for
>   output to occur. Unless specified separately, the output format (if ASCII) is controlled by the
>   GMT parameter **D_FORMAT**. The available abbreviations are:

> **drt**   The digital record type, usually 3 or 5 (for Y2K-compliant cruises).

> **id**   The survey ID string (leg name).

> **ngdcid** The 8-character NGDC cruise ID string (usually the file prefix).

> **time**   Choose between Absolute calendar time (**atime**, the default) in the format dictated by the GMT
>   parameters **OUTPUT_DATE_FORMAT** and **OUTPUT_CLOCK_FORMAT**, Relative time
>   (**rtime**) in the format dictated by the GMT parameters **D_FORMAT** and **TIME_SYSTEM** (or
>   **TIME_EPOCH** and **TIME_UNIT**)), or Fractional year (**ytime**) in the format dictated by
>   **D_FORMAT**.

> **lon**   Longitude in the format dictated by the GMT parameter **OUTPUT_DEGREE_FORMAT**.

> **lat**   Longitude in the format dictated by the GMT parameter **OUTPUT_DEGREE_FORMAT**.

> **twt**   Two-Way Travel time (in s).

> **depth** Corrected bathymetry (in m, positive below sealevel).

mtf1   Magnetic Total Field intensity from sensor 1 (in nTesla).

mtf2   Magnetic Total Field intensity from sensor 2 (in nTesla).

mag   Residual magnetic anomaly (in nTesla).

gobs   Observed gravity (in mGal).

faa   Free-air gravity anomaly (in mGal).

ptc   Position Type Code (1 = fix, 3 = interpolated, 9 = unspecified).

bcc   Bathymetric Correction Code, indicating the procedure used to convert travel time to depth. (01-55 = Matthews' zone used to correct the depth, 59 = Matthews' corrections used but the zones is unspecified in the data record, 60 = S. Kuwahara formula for T-S, 61 = Wilson formula for T-S, 62 = Del Grosso formula for T-S, 63 = Carter's tables, 88 = Other, described in header sections, 99 = unspecified).

btc   Bathymetric Type Code, indicating how the bathymetry value was obtained (1 = observed, 3 = interpolated, 9 = unspecified).

msens   Magnetic sensor for used to evaluate the residual field (1 = 1st or leading sensor, 2 = 2nd or trailing sensor, 9 = unspecified).

msd   Depth (or altitude) of the magnetic sensor (in m, positive below sealevel).

diur   Magnetic diurnal correction (in nTesla).

eot   Eotvos correction (in mGal).

sln   Seismic Line Number string.

sspn   Seismic Shot Point Number string.

nqc   Navigation Quality Code (5 = suspected, by source institution, 6 = suspected, by NGDC, 9 = no problems identified).

In addition, the following derived quantities can be requested:

year   The year of each record.

month   The month of each record.

day   The day of the month of each record.

hour   The hour of each record.

min   The minutes of each record.

sec   The decimal seconds of each record.

dist   Along-track distance from start of leg. For method of calculation, see **−C** [spherical great circle distances], and for distance units, see **−N** [km].

az   Ship azimuth (heading) measured clockwise from north (in degrees).

vel   Ship speed; see **−N** for units [m/s].

weight   Weight assigned to this data set (see **−W**).

carter   Carter depth correction, if **twt** is present in file (in m). Sign: Correction is to be subtracted from uncorrected depths to yield a corrected depth.

igrf   International geomagnetic reference field (total field) (in nTesla).

ngrav   International Gravity reference Field ("normal gravity") (in mGal). Field is selected based on the parameter Gravity Theoretical Formula Code in the cruise's MGD77 header. If this is not set or is invalid we default to the IGF 1980. Alternatively, specify the field directly using **−Af** (see that option for more details).

The following short-hand flags are also recognized:

all   This returns all data columns in the file.

mgd77   This results in all 27 MGD77 fields being written out in the offical MGD77 order.

geo   This limits the output to 10 fields (**time**, **lon**, **lat** plus the seven geophysical observations **twt**, **depth**, **mtf1**, **mtf2**, **mag**, **gobs**, and **faa**). By appending + to either of these set we will also append **dist**, **azim**, **vel**, and **weight** as listed above.

As an option, logical tests may be added for any of the observations by appending ,*logic*, which is itself composed of one or more comma-separated instructions of the form *par***OP***value*, where *par* is one of the parameters listed above, **OP** is a logical operator (<, <=, =, !=, >=, >, |), and *value* is a constant used in the comparison. Floating point parameters are compared numerically; character parameters are compared lexically (after leading and trailing blanks have been removed). The bit comparison (|) means that at least one of the bits in *value* must be turned on in *par*. At least one of the tests must be true for the record to be output, except for tests using UPPER case parameters which all must be true for output to occur. Note that specifying a test does not imply that the corresponding column will be included in the output stream; it must be present in *columns* for that to occur. Note: some of the operators are special UNIX characters and you are advised to place quotes around the entire argument to −**F**.

Finally, for MGD77+ files you may optionally append :*bittests* which is : (a colon) followed by one or more comma-separated +-*col* terms. This compares specific bitflags only for each listed column. Here, + means the chosen bit must be 1 (ON) whereas - means it must be 0 (OFF). All bit tests given must be passed. By default, MGD77+ files that have the special **MGD77_flags** column present will use those flags, and observations associated with ON-bits (meaning they are flagged as bad) will be set to NaN; append : with no trailing information to turn this behavior off (i.e., no bit flags will be consulted).

OPTIONS

No space between the option flag and the associated arguments.

−**A**   By default, corrected depth (**depth**), magnetic residual anomaly (**mag**), free-air gravity anomaly (**faa**), and the derived quantity Carter depth correction (**carter**) are all output as is (if selected in −**F**); this option adjusts that behavior. For each of these columns there are 2–4 ways to adjust the data. Append **c**(arter), **d**(epth), **f**(aa), or **m**(ag) and select the *code* for the procedure you want applied. You may select more than one procedure for a data column by summing their numerical *code*s (1, 2, 4, and 8). E.g., −**Ac**3 will first try method −**Ac**1 to estimate a Carter correction but if **depth** is NaN we will next try −**Ac**2 which only uses **twt**. In all cases, if any of the values required by an adjustment procedure is NaN then the result will be NaN. This is also true if the original anomaly is NaN. Specify −**A**+ to recalculate anomalies even if the anomaly in the file is NaN. Additionally, you can use −**At** to create fake times for cruises that has no time; these are based on distances and cruise duration.

−**Ac**   Determines how the **carter** correction term is calculated. Below, C(**twt**) stands for the Carter-corrected depth (it also depends on **lon**, **lat**), U(**twt**, *v*) is the uncorrected depth (= **twt** * *v* / 2) using as *v* the "Assumed Sound Velocity" parameter in the MGD77 header (if it is a valid velocity, otherwise we default to 1500 m/s); alternatively, append your preferred velocity *v* in m/s, TU(**depth**, *v*) is the 2-way travel time estimated from the (presumably) uncorrected **depth**, and TC(**depth**) is the 2-way travel time obtained by inverting the (presumably) corrected **depth** using the Carter correction formula. Select from
−**Ac**1[,*v*] returns difference between U(**twt**, *v*) and **depth** [Default].
−**Ac**2[,*v*] returns difference between U(**twt**, *v*) and Carter (**twt**).
−**Ac**4[,*v*] returns difference between (assumed uncorrected) **depth** and Carter (TU(**depth**)).
−**Ac**8[,*v*] returns difference between U(TC(**depth**), *v*) and **depth**.

−**Ad**   Determines how the **depth** column output is obtained:
−**Ad**1 returns **depth** as stored in the data set [Default].
−**Ad**2[,*v*] returns calculated uncorrected depth U(**twt**, *v*).

−**Ad4** returns calculated corrected depth C(**twt**).

−**Af**   Determines how the **faa** column output is obtained. If **ngrav** (i.e., the International Gravity refer-
ence Field (IGF), or "normal gravity") is required it is selected based on the MGD77 header
parameter "Theoretical Gravity Formula Code"; if this code is not present or is invalid we default
to 4. Alternatively, append the preferred *field* (1−4) to select 1 (Heiskanen 1924), 2 (IGF 1930), 3
(IGF 1967) or 4 (IGF 1980). Select from
−**Af1**[,*field*] returns **faa** as stored in the data set [Default]. Optionally, sets the IGF *field* to use if
you also have requested **ngrav** as an output column in −**F**.
−**Af2**[,*field*] returns the difference between **gobs** and **ngrav** (with optional *field* directive).
−**Af3**[,*field*] returns the combination of **gobs** + **eot** - **ngrav** (with optional *field* directive).

−**Am**   Determines how the **mag** column output is obtained. There may be one or two total field measure-
ments in the file (**mtf1** and **mtf2**), and the column **msens** may state which one is the leading sen-
sor (1 or 2; it may also be undefined). Select from
−**Am1** returns **mag** as stored in the data set [Default].
−**Am2** returns the difference between **mgfx** and **igrf**, where **x** is the leading sensor (**1** or **2**) indi-
cated by the **msens** data field (defaults to **1** if unspecified).
−**Am4** returns the difference between **mgfx** and **igrf**, where **x** is the sensor (**2** or **1**) *not* indicated
by the **msens** data field (defaults to **2** if unspecified).

−**C**   Append a one-letter code to select the procedure for along-track distance calculation (see −**N** for
selecting units):
> **f** Flat Earth distances.
> **g** Great circle distances [Default].
> **e** Geodesic distances on current GMT ellipsoid.

−**Da**   Do not list data collected before *startdate* (yyyy-mm-dd**T**[hh:mm:ss]) [Default is start of cruise].
Use −**DA** to exclude records whose time is undefined (i.e., NaN). [Default reports those records].

−**Db**   Do not list data collected on or after *stopdate* (yyyy-mm-dd**T**[hh:mm:ss]). [Default is end of
cruise]. Use −**DB** to exclude records whose time is undefined (i.e., NaN). [Default reports those
records].

−**E**   Exact match: Only output records that match all the requested geophysical columns [Default out-
puts records that matches at least one of the observed columns].

−**Ga**   Do not list records before *startrec* [Default is 0, the first record].

−**Gb**   Do not list data after *stoprec*. [Default is the last record].

−**H**   Issue a header record with names for each data field.

−**I**   Ignore certain data file formats from consideration. Append **a|c|t** to ignore MGD77 ASCII,
MGD77+ netCDF, or plain tab-separated ASCII table files, respectively. The option may be
repeated to ignore more than one format. [Default ignores none].

−**L**   Apply optimal corrections to columns where such corrections are available. Append the correc-
tion table to use [Default uses the correction table mgd77_corrections.txt in the **$MGD77_HOME**
directory]. For the format of this file, see CORRECTIONS below.

−**n**   Issue a multi-segment header record with cruise ID for each cruise.

−**N**   Append **d** for distance or **s** for speed, then give the desired *unit* as **e** (meter or m/s), **k** (km or
km/hr), **m** (miles or miles/hr), or **n** (nautical miles or knots). [Default is −**Ndk** −**Nse** (km and
m/s)].

−**Qa**   Specify an accepted range (*min/max*) of azimuths. Records whose track azimuth falls outside this
range are ignored [0-360].

−**Qv**   Specify an accepted range (*min/max*; or just *min* if there is no upper limit) of velocities. Records
whose track speed falls outside this range are ignored [0-infinity].

−**R**   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
           degrees or in [+−]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map
           coordinates are given instead of w/e/s/n. The two shorthands −**Rg** and −**Rd** stand for global
           domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively,
           specify the name of an existing grid file and the −**R** settings (and grid spacing, if applicable) are
           copied from the grid.

−**Sa**   Do not list data that are less than *startdist* meter along track from port of departure. Append **k** for
           km, **m** for miles, or **n** for nautical miles [Default is 0 meters].

−**Sb**   Do not list data that are *stopdist* or more meters along track from port of departure. Append **k** for
           km, **m** for miles, or **n** for nautical miles [Default is end of track].

−**T**   Turns OFF the otherwise automatic adjustment of values based on correction terms that are stored
           in the MGD77+ file and used to counteract such things as wrong units used by the source institu-
           tion when creating the original MGD77 file from which the MGD77+ file derives (the option has
           no effect on plain MGD77 ASCII files). Append **m** or **e** to limit the option to the MGD77 or
           extended columns set only [Default applies to both].

−**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−**W**   Set the weight for these data. Weight output option must be set in −**F**. This is useful if the data
           are to be processed with the weighted averaging techniques offered by **blockmean**, **blockmedian**,
           and **blockmode** [1].

−**Z**   Append the sign you want for **depth**, **carter**, and **msd** values below sea level (−**Z-** gives negative
           bathymetry) [Default is positive down].

−**bo**   Selects binary output mode (single precision; append **d** for double precision, or use **S**|**D** to swap
           bytes on output) [Default is ASCII]. −**H** is ignored if −**bo** is selected. Likewise, string-fields can-
           not be selected. Note that if time is one of the binary output columns it will be stored as Unix-
           time (seconds since 1970). To read this information in GMT to obtain absolute calendar time will
           require you to use --TIME_SYSTEM=unix.

EXAMPLES

To get a (distance, heading, gravity, bathymetry) listing from 01010047.mgd77, starting at June 3 1971
20:45 and ending at distance = 5000 km, use the following command:

mgd77list 01010047 −**Da**1971-06-03T20:45 −**Sb**5000 −**F**dist,azim,faa,depth > myfile.d

To make input for **blockmean** and **surface** using free-air anomalies from all the cruises listed in the file
cruises.lis, but only the data that are inside the specified area, and make the output binary:

mgd77list ‘cat cruises.lis‘ −**F**lon,lat,faa −**R**-40/-30/25/35 −**bo** > allgrav.b

To extract the locations of depths exceeding 9000 meter that were not interpolated (**btc** != 1) from all the
cruises listed in the file cruises.lis:

mgd77list ‘cat cruises.lis‘ −**F**"depth,DEPTH>9000,BTC!=1" > really_deep.d

To extract dist, faa, and grav12_2 from records whose depths are shallower than 3 km and where none of
the requested fields are NaN, from all the MGD77+ netCDF files whose cruise ids are listed in the file
cruises.lis, we try

mgd77list ‘cat cruises.lis‘ −**E** −**Ia** −**F**"dist,faa,grav12_2,depth<3000" > shallow_grav.d

To extract dist, faa, and grav12_2 from all the MGD77+ netCDF files whose cruise ids are listed in the file
cruises.lis, but only retrieve records whose bitflag for faa indicates BAD values, we try

       mgd77list 'cat cruises.lis' **−E −Ia −F**"dist,faa,grav12_2:+faa" > bad_grav.d

       To output lon, lat, mag, and faa from all the cruises listed in the file cruises.lis, but recalculate the two residuals based on the latest reference fields, try:

       mgd77list 'cat cruises.lis' **−F**lon,lat,mag,faa **−Af**2,4 **−Am**2 > data.d

RECALCULATED ANOMALIES

       When recalculated anomalies are requested (either explicitly via the **−A** option or implicitly via E77 metadata in the MGD77+ file) we only do so for the records whose original anomaly was not a NaN. This restriction is implemented since many anomaly columns contains corrections, usually in the form of hand-edited changes, that cannot be duplicated from the corresponding observation.

IGRF

       The IGRF calculations are based on a Fortran program written by Susan Macmillan, British Geological Survey, translated to C via f2c by Joaquim Luis, U Algarve, and adapted to GMT-style by Paul Wessel.

IGF

       The equations used are reproduced here using coefficients extracted directly from the source code (let us know if you find errors):

(1) $g = 978052.0 * [1 + 0.005285 * \sin^2(lat) - 7e-6 * \sin^2(2*lat) + 27e-6 * \cos^2(lat) * \cos^2(lon-18)]$

(2) $g = 978049.0 * [1 + 0.0052884 * \sin^2(lat) - 0.0000059 * \sin^2(2*lat)]$

(3) $g = 978031.846 * [1 + 0.0053024 * \sin^2(lat) - 0.0000058 * \sin^2(2*lat)]$

(4) $g = 978032.67714 * [(1 + 0.00193185138639 * \sin^2(lat)) / \sqrt{1 - 0.00669437999013 * \sin^2(lat)}]$

CORRECTIONS

       The correction table is an ASCII file with coefficients and parameters needed to carry out corrections. Comment records beginning with # are allowed. All correction records are of the form

       cruiseID observation correction

       where *cruiseID* is a NGDC prefix, *observation* is one of the abbreviations for geophysical observations listed under **−F** above, and *correction* consists of one or more *term*s that will be summed up and then **subtracted** from the observation before output. Each *term* must have this exact syntax:

       factor[**[function]*(*[scale]*(*abbrev*[*-origin*]))[*^power*]]

       where terms in brackets are optional (the brackets themselves are not used but regular parentheses must be used as indicated). No spaces are allowed except between *term*s. The *factor* is the amplitude of the basis function, while the optional *function* can be one of sin, cos, or exp. The optional *scale* and *origin* can be used to translate the argument (before giving it to the optional function). The argument *abbrev* is one of the abbreviations for observations listed above. If *origin* is given as **T** it means that we should replace it with the value of *abbrev* for the very first record in the file (this is usually only done for *time*). If the first record entry is NaN we revert *origin* to zero. Optionally, raise the entire expression to the given *power*, before multiplying by the amplitude. The following is an example of fictitious corrections to the cruise 99999999, implying the **depth** should have the Carter correction removed, **faa** should have a linear trend removed, the magnetic anomaly (**mag**) should be corrected by a strange dependency on ship heading and latitude, and **gob**s needs to have 10 mGal added (hence given as -10):

```
99999999 depth   1.0*((carter))
99999999 faa     14.1     1e-5*((time-T))
99999999 mag     0.5*cos(0.5*(azim-19))^2   1.0*exp(-1e-3(lat))^1.5
99999999 gobs    -10
```

SEE ALSO

       mgd77convert(1), *mgd77info*(1), *mgd77manage*(1), *mgd77track*(1)

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The Marine Geophysical Data Exchange Format - "MGD77", see *http://www.ngdc.noaa.gov/mgg/dat/geodas/docs/mgd77.txt*

IGRF, see *http://www.ngdc.noaa.gov/IAGA/vmod/igrf.html*

NAME

mgd77magref – Evaluate the IGRF or CM4 magnetic field models

SYNOPSIS

mgd77magref [*inputfile*] [**−A**[**+a***alt***+t***date***+y**]] [**−C***cm4file*] [**−D***Dstfile*] [**−E***f107file*] [**−F***flags*] [**−G**] [**−H**[**i**][*nrec*]] [**−Sc**|**l***low/high*] [**−V**] [**−:**[**i**|**o**]] [**−b**[**i**|**o**][**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−f**[**i**|**o**]*colinfo*] [**−m**[**i**|**o**][*flag*]]

DESCRIPTION

mgd77magref will evaluate the IGRF or the CM4 geomagnetic models at the specified locations and times.

OPTIONS

No space between the option flag and the associated arguments.

inputfile

Contains the moments in space-time where we want to evaluate the magnetic reference field. The first two columns must contain longitude and latitude (however, see **−:** for latitude and longitude instead). Normally, the third and fourth columns must contain altitude and time, respectively, but if one or both of these are constant for all records they can be supplied via the **−A** option instead and are thus not expected in the input file. If no input file is given we read *stdin*. A note about the CM4 validity domain. The core field of CM4 is valid from 1960-2002.5 but the ionospheric and magnetospheric fields are computed after the *Dst* and *F10.7* coefficient files. We extended here those coefficient files up to 2006, which means that one can compute external contributions up until 2006 but the Secular Variation will be biased (non reliable). New indices files may be retrieved from:ftp://ftp.ngdc.noaa.gov/STP/GEOMAGNETIC_DATA/INDICES/DST/ (the *Dst* coefficients) and ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SOLAR_RADIO/FLUX/ (The *F10.7* index file is a MONTHPLT.ABS). NOTE: since the *Dst* files in the .../DST/ directory are still only up to 2006, for GMT4.5.1 we extended the *Dst* till August 2009 by reformating the data in the preliminary file Est_Ist_index_0_mean.pli, which is at ftp://ftp.ngdc.noaa.gov/STP/GEO-MAGNETIC_DATA/INDICES/EST_IST/

−A

Adjusts how the input record is interpreted. Append **+a** to set a fixed *altitude* that should apply to all data records [Default expects *altitude* to be in the 3rd column of all records]. Append **+t** to set a fixed *time* that should apply to all data records [Default expects *time* to be in the 4th column of all records]. Finally, append **+y** to indicate that all times are specified as decimal years [Default is ISO *date*T*colck* format].

−C

Specify an alternate CM4 coefficient file [umdl.CM4].

−D

Specify an alternate file with hourly means of the Dst index for CM4 [Dst_all.wdc]. Alternatively, simply specify a single index to apply for all records.

−E

Specify an alternate file with monthly means of absolute F10.7 solar radio flux for CM4 [F107_mon.plt]. Alternatively, simply specify a single flux to apply for all records.

−F

Selects output items; *flags* is a string made up of one or more of these characters:

r means output all input columns before adding the items below (all in nTesla).

t means list total field.

h means list horizontal field.

x means list X component.

y means list Y component.

z means list Z component.

d means list declination.

i means list inclination.

Append one or more number to indicate the requested field contribution(s):

0 means IGRF field (no combinations allowed)

1 means Core field

2 means Lithospheric

3 Primary Magnetospheric field

4 Induced Magnetospheric field

5 Primary ionospheric field

6 Induced ionospheric field

7 Toroidal field

9 means Core field from IGRF and other contributions from CM4. DO NOT USE BOTH 0 AND 9.

Appending several numbers (1-7) will add up the different contributions. For example **−Ft/12** computes the total field due to Core and Lithospheric sources. Two special cases are allowed, wich mix which Core field from IGRF and other sources from CM4. **−Ft/934** computes Core field due to IGRF plus terms 3 and 4 from CM4 (but you can add others). **−Ft/934** the same as above but output the field components. The data is written out in the order they appear in *flags* [Default is **−Frthxyzdi/1**].

−G   Specifies that coordinates are geocentric [geodetic].

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−L   Computes J field vectors from certain external sources.
           r means output all input columns before adding the items below (all in Ampers/m).
           t means list magnitude field.
           x means list X component.
           y means list Y component.
           z means list Z or current function Psi.
           Append a number to indicate the requested J contribution:
           1 means Induced Magnetospheric field.
           2 means Primary ionospheric field.
           3 means Induced ionospheric field.
           4 means Poloidal field.

−Sc   Limits the wavelengths of the core field contribution to the band indicated by the low and high spherical harmonic order [1/13].

−Sl   Limits the wavelengths of the lithosphere field contribution to the band indicated by the low and high spherical harmonic order [14/65].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 4 input columns unless **−A** is used].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default is reflected by **−F**].

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

TIME SETTINGS

If binary input files are used then absolute time are stored as time relative to the selected epoch. However, since the epoch used is not stored in the data files there can be problems decoding the correct time. The mgd77 supplement uses the Unix time system as its default; thus you should make sure that binary data

files with time uses the same system (see the GMT default TIME_SYSTEM).

EXAMPLES

To get the CM4 Total field, Declination and Inclination due to all but lithospheric and toroidal field at a one point location and decimal time 2000.0, try

echo -28 38 0 2000.0 | **mgd77magref −A**+y **−F**tdi/13456

To do the same as above but at noon (Universal Time) of first May 2001, try

echo -28 38 0 2001-05-01T12:00:00 | **mgd77magref −F**tdi/13456

SEE ALSO

GMT(1) *mgd77info*(1) *mgd77list*(1) *mgd77manage*(1) *mgd77track*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

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Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

"Comprehensive Modeling of the Geomagnetic Field", see *http://denali.gsfc.nasa.gov/cm/*.

"The International Geomagnetic Reference Field (IGRF)", see *http://www.iugg.org/IAGA/iaga_pages/pubs_prods/igrf.htm*.

NAME

mgd77manage − Manage extra columns in MGD77+ files

SYNOPSIS

mgd77manage *NGDC-ids* [−**A**[+]**a**|**c**|**d**|**D**|**e**|**E**|**g**|**i**|**n**|**t**|**T***fileinfo*] [−**C**f|**g**|**e**] [−**D***abbrev1,abbrev2,...*] [−**E***empty*] [−**F**] [−**I***abbrev/name/unit/***t***/scale/offset/comment*] [−**N**e|**k**|**m**|**n**] [−**Q**[**b**|**c**|**l**|**n**][[**/**]*threshold*]] [−**V**] [−**bi**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]]

DESCRIPTION

mgd77manage deals with maintaining extra custom columns in MGD77+ netCDF files. You can either delete one or more columns, add a new column, update an existing column with new data, or supply error correction information (*.e77 files). New data may come from a table (ASCII unless −**b** is used), be based on existing columns and certain theoretical expressions, or they may be obtained by sampling a grid (choose between GMT grid or a Sandwell/Smith Mercator *.img grid) along track. The new data will be appended to the MGD77+ file in the form of an extra data column of specified type. The data file will be modified; no new file will be created. For the big issues, see the DISCUSSION section below.

NGDC-ids

Can be one or more of five kinds of specifiers:
1) 8-character NGDC IDs, e.g., 01010083, JA010010etc., etc.
2) 2-character <agency> codes which will return all cruises from each agency.
3) 4-character <agency><vessel> codes, which will return all cruises from those vessels.
4) =<list>, where <list> is a table with NGDC IDs, one per line.
5) If nothing is specified we return all cruises in the data base.
(See mgd77info −**L** for agency and vessel codes). The ".mgd77" or ".nc" extensions will automatically be appended, if needed (use −**I** to ignore certain file types). Cruise files will be looked for first in the current directory and second in all directories listed in **$MGD77_HOME**/mgd77_paths.txt [If **$MGD77_HOME** is not set it will default to **$GMT_SHAREDIR**/mgd77].

OPTIONS

No space between the option flag and the associated arguments

−**A**   Add a new data column. If an existing column with the same abbreviation already exists in the file we will cowardly refuse to update the file. Specifying −**A**+ overcomes this reluctance (However, sometimes an existing column cannot be upgraded without first deleting it; if so you will be warned). Select a column source code among **a**, **c**, **d**, **D**, **e**, **g**, **i**, **n**, **t**, or **T**; detailed descriptions for each choice follow:

a Append filename of a single column table to add. File must have the same number of rows as the MGD77+ file. If no file is given we read from stdin instead.

c Create a new column that derives from existing data or formulas for corrections and reference fields. Append **c** for the Carter corrections subtracted from uncorrected depths, **g** for the IGF gravity reference field (a.k.a "normal gravity"), **m** for the IGRF total field magnetic reference field, and **r** for recomputed magnetic anomaly (append 1 or 2 to specify which total field column to use [1]). For gravity we choose the reference field based on the parameter Gravity Theoretical Formula Code in the cruise's MGD77 header. If this is not set or is invalid we default to the IGF 1980. You can override this behaviour by appending the desired code: 1 = Heiskanen 1924, 2 = International 1930, 3 = IGF1967, or 4 = IGF1980.

d Append filename of a two-column table with the first column holding distances along track and the second column holding data values. If no file is given we read from stdin instead. Records with matching distances in the MGD77+ file will be assigned the new values; at other distances we set them to NaN. Alternatively, give upper case **D** instead and we will interpolate the column at all record distances. See −**N** for choosing distance units and −**C** for choosing how distances are calculated.

e Expects to find an e77 error/correction log from **mgd77sniffer** with the name *NGDC_ID*.e77 in the current directory or in $MGD77_HOME/E77; this file will examined and used to make modifications to the header values, specify a systematic correction for certain columns (such as scale and offset), specify that a certain anomaly should be recalculated from the observations (e.g., recalculate mag from mtf1 and the latest IGRF), and add or update the special column **flag** which may hold bitflags (0 = GOOD, 1 = BAD) for each data field in the standard MGD77 data set. Any fixed correction terms found (such as needing to scale a field by 0.1 or 10 because the source agency used incorrect units) will be written as attributes to the netCDF MGD77+ file and applied when the data are read by **mgd77list**. Ephemeral corrections such as those determined by crossover analysis are not kept in the data files but reside in correction tables (see **mgd77list** for details). By default, the first character of each header line in the e77 file (which is ?, Y or N) will be consulted to see if the corresponding adjustment should be applied. If any undecided settings are found (i.i, ?) we will abort and make no changes. Only records marked Y will be porcessed. You can override this behavior by appending one or more modifiers to the −**Ae** command: **h** will ignore all header corrections, **f** will ignore all fixed systematic trend corrections, **n**, **v**, and **s** will ignore bitflags pertaining to navigation, data values, and data slopes, respectively. Use −**A+e** to replace any existing E77 corrections in the file with the new values. Finally, e77 corrections will not be applied if the E77 file has not been verified. Use −**AE** to ignore the verification status.

g Sample a GMT geographic (lon, lat) grid along the track given by the MGD77+ file using bicubic interpolation (however, see −**Q**). Append name of a GMT grid file.

i Sample a Sandwell/Smith Mercator *.img grid along the track given by the MGD77+ file using bicubic interpolation (however, see −**Q**). Append the img grid filename, followed by the comma-separated data scale (typically 1 or 0.1), the IMG file mode (0-3), and optionally the img grid max latitude [80.738]. The modes stand for the following: (0) Img files with no constraint code, returns data at all points, (1) Img file with constraints coded, return data at all points, (2) Img file with constraints coded, return data only at constrained points and NaN elsewhere, and (3) Img file with constraints coded, return 1 at constraints and 0 elsewhere.

n Append filename of a two-column table with the first column holding the record number (0 to nrows - 1) and the second column holding data values. If no file is given we read from stdin instead. Records with matching record numbers in the MGD77+ file will be assigned the new values; at other records we set them to NaN.

t Append filename of a two-column table with the first column holding absolute times along track and the second column holding data values. If no file is given we read from stdin instead. Records with matching times in the MGD77+ file will be assigned the new values; at other times we set them to NaN. Alternatively, give upper case **T** instead and we will interpolate the column at all record times.

−**C** Append a one-letter code to select the procedure for along-track distance calculation when using −**Ad|D** (see −**N** for selecting distance units):
      f Flat Earth distances.
      g Great circle distances [Default].
      e Geodesic distances on current GMT ellipsoid.

−**D** Give a comma-separated list of column abbreviations that you want to delete from the MGD77+ files. Do NOT use this option to remove columns that you are replacing with new data (use −**A+** instead). Because we cannot remove variables from netCDF files we must create a new file without the columns to be deleted. Once the file is successfully created we temporarily rename the old file, change the new filename to the old filename, and finally remove the old, renamed file.

−**E** Give a single character that will be repeated to fill empty string values, e.g., '9' will yield a string like "99999..." [9].

−F   Force mode. When this mode is active you are empowered to delete or replace even the standard MGD77 set of columns. You better know what you are doing!

−I   In addition to file information we must specify additional information about the extra column. Specify a short (16 char or less, using lower case letters, digits, or underscores only) abbreviation for the selected data, its more descriptive name, the data unit, the data type 1-character code (**b**yte, **s**hort, **f**loat, **i**nt, **d**ouble, or **t**ext) you want used for storage in the netCDF file, any scale and offset we should apply to the data to make them fit inside the range implied by the chosen storage type, and a general comment (< 128 characters) regarding what these data represent. Note: If text data type is selected then the terms "values" in the **−A** discussion refer to your text data. Furthermore, the discussion on interpolation does not apply and the NaN value becomes a "no string" value (see **−E** for what this is). Place quotes around terms with more than one word (e.g., "Corrected Depth").

−N   Specify the distance unit used when using **−Ad|D** by appending **e** (meter), **k** (km), **m** (miles), or **n** (nautical miles). [Default is **−Nk** (km)].

−Q   Quick mode, use bilinear rather than bicubic interpolation [Default]. Alternatively, select the interpolation mode by adding **b** for B-spline smoothing, **c** for bicubic interpolation, **l** for bilinear interpolation or **n** for nearest-neighbor value. Optionally, append *threshold* in the range [0,1]. This parameter controls how close to nodes with NaN values the interpolation will go. E.g., a *threshold* of 0.5 will interpolate about half way from a non-NaN to a NaN node, whereas 0.1 will go about 90% of the way, etc. [Default is 1, which means none of the (4 or 16) nearby nodes may be NaN]. **−Q0** will just return the value of the nearest node instead of interpolating. This is the same as using **−Qn**. Only relevant when **−Ag|i** is selected.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1*/*var2*/... to specify the variables to be read. This applies to the input 1- or 2-column data files specified under some of the **−A** options. The binary input option is only available for numerical data columns.

EXAMPLES

To append Geosat/ERS-1 gravity version 11.2 as an extra data column in the cruises 01010047.nc and 01010008.nc, storing the values as mGal*10 in a 2-byte short integer, try

mgd77manage 01010047 01010008 **−Ai**10/1/grav.11.2.img **−I**satgrav/"Geosat/ERS-1 gravity"/"mGal"/s/10/0/"Sandwell/Smith version 11.2" **−V**

To append a filtered version of magnetics as an extra data column of type float for the cruise 01010047.nc, and interpolate the filtered data at the times given in the MGD77+ file, try

mgd77manage 01010047 **−AT**mymag.tm **−I**filtmag/"Intermediate-wavelength magnetic residuals"/"nTesla"/f/1/0/"Useful for looking for isochrons" **−V**

To delete the existing extra columns satfaa, coastdist, and satvgg from all MGD77+ files, try

mgd77manage ‘cat allmgd77.lis‘ **−D**satfaa,coastdist,satvgg **−V**

To create a 4-byte float column with the correct IGRF reference field in all MGD77+ files, try

mgd77manage ‘cat allmgd77.lis‘ **−Acm −I**igrf/"IGRF reference field"/"nTesla"/f/1/0/"IGRF version 10 for 1990-2010" **−V**

DISCUSSION

1. Preamble

The mgd77 supplement is an attempt to (1) improve on the limited functionality of the existing mgg supplement, (2) incorporate some of the ideas from Scripps' gmt+ supplement by allowing extra data columns, and (3) add new capabilities for managing marine geophysical trackline data stored in an architecture-independent CF-1.0- and COARDS-compliant netCDF file format. Here are some of the underlying ideas and steps you need to take to maintain your files.

2. Introduction

Our starting point is the MGD77 ASCII data files distributed from NGDC on CD-ROMS, DVD-ROMS, and via FTP. Using Geodas to install the files locally we choose the "Carter corrected depth" option which will fill in the depth column using the two-way traveltimes and the Carter tables if twt is present. This step yields ˜5000 individual cruise files. Place these in one or more sub-directories of your choice, list these sub-directories (one per line) in the file mgd77_paths.txt, and place that file in the directory pointed to by **$MGD77_HOME**; if not set this variable defaults to **$GMT_SHAREDIR**/mgd77.

3. Conversion

Convert the ASCII MGD77 files to the new netCDF MGD77+ format using **mgd77convert**. Typically, you will make a list of all the cruises to be converted (with or without extension), and you then run

        mgd77convert –Fa –Tc –V –Lwe+ ‘cat cruises.lis‘ > log.txt

The verbose settings will ensure that all problems found during conversion will be reported. The new *.nc files may also be placed in one or more separate sub-directories and these should also be listed in the mgd77_paths.txt file. We suggest you place the directories with *.nc files ahead of the *.mgd77 directories. When you later want to limit a search to files of a certain extension you should use the **–I** option.

4. Adding new columns

mgd77manage will allow you to add additional data columns to your *.nc files. These can be anything, including text strings, but most likely are numerical values sampled along the track from a supplied grid or an existing column that have been filtered or manipulated for a particular purpose. The format supports up to 32 such extra columns. See this man page for how to add columns. You may later decide to remove some of these columns or update the data associated with a certain column. Data extraction tools such as **mgd77list** can be used to extract a mix of standard MGD77 columns (navigation, time, and the usual geophysical observations) and your custom columns.

5. Error sources

Before we discuss how to correct errors we will first list the different classes of errors associated with MGD77 data: (1) Header record errors occur when some of the information fields in the header do not comply with the MGD77 specification or required information is missing. **mgd77convert** will list these errors when the extended verbose setting is selected. These errors typically do not affect the data and are instead errors in the *meta-data* (2) Fixed systematic errors occur when a particular data column, despite the MGD77 specification, has been encoded incorrectly. This usually means the data will be off by a constant factor such as 10 or 0.1, or in some cases even 1.8288 which converts fathoms to meters. (3) Unknown systematic errors occur when the instrument that recorded the data or the processing that followed introduced signals that appear to be systematic functions of time along track, latitude, heading, or some other combination of terms that have a physical or logical explanation. These terms may sometimes be resolved by data analysis techniques such as along-track and across-track investigations, and will result in correction terms that when applied to the data will remove these unwanted signals in an optimal way. Because these correction terms may change when new data are considered in their determination, such corrections are considered to be ephemeral. (4) Individual data points or sequences of data may violate rules such as being outside of possible ranges or in other ways violate sanity. Furthermore, sequences of points that may be within valid ranges may give rise to data gradients that are unreasonable. The status of every point can therefore be determined and this gives rise to bitflags GOOD or BAD. Our policy is that error sources 1, 2, and 4

will be corrected by supplying the information as meta-data in the relevant *.nc files, whereas the corrections for error source 3 (because they will constantly be improved) will be maintained in a separate list of corrections.

6. Finding errors

The **mgd77sniffer** is a tool that does a thorough along-track sanity check of the original MGD77 ASCII files and produces a corresponding *.e77 error log. All problems found are encoded in the error log, and recommended fixed correction terms are given, if needed. An analyst may verify that the suggested corrections are indeed valid (we only want to correct truly obvious unit errors), edit these error logs and modify such correction terms and activate them by changing the relevant code key (see **mgd77sniffer** for more details). **mgd77manage** can ingest these error logs and (1) correct bad header records given the suggestions in the log, (2) insert scale/offset correction terms to be used when reading certain columns, and (3) insert any bit-flags found. Rerun this step if you later find other problems as all E77 settings or flags will be recreated based on the latest E77 log.

7. Error corrections

The extraction program **mgd77list** allows for corrections to be applied on-the-fly when data are requested. First, data with BAD bitflags are suppressed. Second, data with fixed systematic correction terms are corrected accordingly. Third, data with ephemeral correction terms will have those corrections applied (if a correction table is supplied). All of these steps require the presence of the relevant meta-data and all can be overruled by the user. In addition, users may add their own bitflags as separate data columns and use **mgd77list**'s logical tests to further dictate which data are suppressed from output.

CREDITS

The IGRF calculations are based on a Fortran program written by Susan Macmillan, British Geological Survey, translated to C via f2c by Joaquim Luis, and adapted to GMT style by Paul Wessel.

SEE ALSO

mgd77convert(1), *mgd77list*(1), *mgd77info*(1), *mgd77sniffer*(1) *mgd77track*(1) *x2sys_init*(1)

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Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

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Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

The Marine Geophysical Data Exchange Format - "MGD77", see *http://www.ngdc.noaa.gov/mgg/dat/geodas/docs/mgd77.txt*

IGRF, see *http://www.ngdc.noaa.gov/IAGA/vmod/igrf.html*

NAME
mgd77path – Get full pathname for MGD77 files

SYNOPSIS
mgd77path *NGDC-ids* [**−D**] [**−I***ignore*] [**−P[-]**] [**−V**]

DESCRIPTION
mgd77path returns the full pathname to one or more MGD77 files. The pathname returned for a given cruise may change with time due to reshuffling of disks/subdirectories.

NGDC-ids
Can be one or more of five kinds of specifiers:
1) 8-character NGDC IDs, e.g., 01010083, JA010010etc., etc.
2) 2-character <agency> codes which will return all cruises from each agency.
3) 4-character <agency><vessel> codes, which will return all cruises from those vessels.
4) =<list>, where <list> is a table with NGDC IDs, one per line.
5) If nothing is specified we return all cruises in the data base.
(See mgd77info **−L** for agency and vessel codes). The ".mgd77" or ".nc" extensions will automatically be appended, if needed (use **−I** to ignore certain file types). Cruise files will be looked for first in the current directory and second in all directories listed in **$MGD77_HOME**/mgd77_paths.txt [If **$MGD77_HOME** is not set it will default to **$GMT_SHAREDIR**/mgd77].

OPTIONS
No space between the option flag and the associated arguments.

−D   Instead of cruise listings, just show the directory paths currently used in the search.

−I   Ignore certain data file formats from consideration. Append **a|c|t** to ignore MGD77 ASCII, MGD77+ netCDF, or plain tab-separated ASCII table files, respectively. The option may be repeated to ignore more than one format. [Default ignores none].

−P   Display the full path to each cruise [Default]. Optionally, append **-** which will list just the cruise IDs instead.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"]. Reports the total number of cruises found.

EXAMPLES
To obtain pathnames for cruises 01010008 and 01010007, run

mgd77path 01010008 01010007

To obtain pathnames for cruises 01010008 and 01010007, but only if there are MGD77+ version in netCDF, run

mgd77path 01010008 01010007 **−Ia −It**

To see the list of active directories where MGD77 files might be stored, run

mgd77path −D

SEE ALSO
GMT(1) *mgd77info*(1) *mgd77list*(1) *mgd77manage*(1) *mgd77track*(1)

REFERENCES
Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.
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Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

The Marine Geophysical Data Exchange Format - "MGD77", see *http://www.ngdc.noaa.gov/mgg/dat/geo-das/docs/mgd77.txt*

NAME

      mgd77sniffer – Scan for errors in MGD77 data

SYNOPSIS

      mgd77sniffer *NGDC-ids* [−**A***fieldabbrev,scale,offset*] [−**C***maxspd*] [−**Dd**|**e**|**E**|**f**|**l**|**m**|**s**|**v**][*r*] [−**g***fieldab-brev,imggrid,scale,mode*] [−**G***fieldabbrev,grid*] [−**H**[**i**][*nrec*]] [−**I***fieldabbrev,rec1,recN*] [−**K**] [−**L***cus-tom limits file*] [−**N**] [−**Q**[**b**|**c**|**l**|**n**][[**/**]*threshold*]] [−**R***west/east/south/north*[**r**]] [−**Sd**|**s**|**t**] [−**T***gap*] [−**V**] [−**Wc**|**g**|**o**|**s**|**t**|**v**|**x**] [−**bo**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]]

DESCRIPTION

      mgd77sniffer scans old (pre-Y2K) and new format ASCII MGD77 files for errors using point-by-point sanity checking, along-track detection of excessive slopes, and optional comparison of cruise data with global gravity and predicted bathymetry grids. Detected data problems are output by default as verbose descriptions of each detected error, often resulting in multiple messages per scanned record. Data problems are optionally output (−**De** option) using a computer-parseable format (see E77 ERROR FORMAT description below). Default error thresholds are derived from histograms of all MGD77 geophysical data collected between 1952 and January, 2006. Thresholds are adjustable with the −**L** option.

      NGDC-ids

            Can be one or more of five kinds of specifiers:

            1) 8-character NGDC IDs, e.g., 01010083, JA010010etc., etc.

            2) 2-character <agency> codes which will return all cruises from each agency.

            3) 4-character <agency><vessel> codes, which will return all cruises from those vessels.

            4) =<list>, where <list> is a table with NGDC IDs, one per line.

            5) If nothing is specified we return all cruises in the data base.

            (See mgd77info −**L** for agency and vessel codes). The ".mgd77" or ".nc" extensions will automat-ically be appended, if needed (use −**I** to ignore certain file types). Cruise files will be looked for first in the current directory and second in all directories listed in **$MGD77_HOME**/mgd77_paths.txt [If **$MGD77_HOME** is not set it will default to **$GMT_SHAREDIR**/mgd77].

REQUIREMENTS

      The mgd77sniffer links with Generic Mapping Tools 4.0 or later along with the supplemental GMT pack-ages x2sys and mgd77. See http://gmt.soest.hawaii.edu for GMT details. Grids for comparison with cruise data may be downloaded via the web.

OPTIONS

      −**A**   Apply scale factor and DC adjustment to specified data field. Allows adjustment of cruise data prior to along-track analysis. CAUTION: data must be thoroughly examined before applying these global data adjustments. May not be used for multiple cruises.

      −**C**   Set maximum ship speed in m/s, or knots with −**N** option. Ship speeds exceeding 10 m/s (~20 knots) are flagged as excessive by default.

      −**D**   Suppress default warning output and only dump cruise data row-by-row such as values, gradients, grid-cruise differences, E77 error summaries for each record, re-created MGD77 records or sniffer limits. Append r to include all records (default omits records where navigation errors were detected).

            −**Dd** output differences between cruise and grid data. Requires −**G** option. Output columns include:

            lat lon dist cruiseZ gridZ diff [cruiseZ2 gridZ2 diff2 ...]

            Note: grid values are subtracted from cruise data so a positive difference implies cruise > grid. For multiple grid comparison, *cruiseZ gridZ diff* are repeated for each grid comparison in command line order.

            −**De** output E77 error classification format. Error output is divided into (1) a header containing

information globally applicable to the cruise and (2) individual error records summarizing all errors encountered in each cruise record. mgd77sniffer writes E77 directly to <ngdc_id.e77> file handle. See **E77 ERROR FORMAT** below for additional details.

−DE Same as **−De** but no regression tests will be carried out.

−Df output delta Z (change in geophysical field) column and delta S (change in distance) for each geophysical field. Distance between observations often differ for different fields depending on instrument sampling rate, so ds is included for each geophysical observation. Output columns include:

d[twt] ds d[depth] ds d[mtf1] ds d[mtf2] ds d[mag] ds d[diur] ds d[msd] ds d[gobs] ds d[eot] ds d[faa] ds

−Dl display mgd77sniffer limits. Customize this output to create a custom limits file for the **−L** option. No additional arguments are required. Output columns include:

fieldabbrev min max maxSlope maxArea

−Dm output MGD77 format records in Y2K-compliant MGD77 format

−Dn output distance to coast for each record. Requires **−Gnav** or **−gnav** option. Output columns include:

lat lon dist distToCoast

−Ds output calculated gradients for speed and geophysical fields. Gradients correspond to the gradient type selected in the **−S** option (spatial derivatives by default). Output columns include:

speed d[twt] d[depth] d[mtf1] d[mtf2] d[mag] d[diur] d[msd] d[gobs] d[eot] d[faa]

See **MGD77 FIELD INFO** below for field and abbreviations descriptions.

−Dv display values for the twelve position and geophysical fields for each MGD77 data record (in this order):

lat lon twt depth mtf1 mtf2 mag diur msens gobs eot faa

See below for **MGD77 FIELD INFO**.

−g   Compare cruise data to the specified grid in Sandwell/Smith Mercator format. Requires a valid MGD77 field abbreviation (see **MGD77 FIELD INFO** below) followed by a comma, the path (if not in current directory) and grid filename, a scale to multiply the data (1 or 0.1), and mode which stand for the following: (0) Img files with no constraint code, returns data at all points, (1) Img file with constraints coded, return data at all points, (2) Img file with constraints coded, return data only at constrained points and NaN elsewhere, and (3) Img file with constraints coded, return 1 at constraints and 0 elsewhere.

−G   Compare cruise data to the specified grid. Requires a valid MGD77 field abbreviation (see **MGD77 FIELD INFO** below) followed by a comma, then the path (if not in current directory) and grid filename. Multiple grid comparison is supported by using separate **−g** or **−G** calls for each grid. See **GRID FILE INFO** below.

Grid comparison activates several additional error checks. (1) Re-weighted Least Squares Regression of ship versus grid data determines slope and DC shift, which when differing from expected 1 and 0, respectively, may indicate incorrectly scaled ship data, including incorrect units or

instrument drift as well as erroneous gravity tie-in. (2) Accumulated ship grid offsets are computed along-track and excessive offsets are flagged according to *maxArea* threshold (use **−L** option to adjust *maxArea*). Warning: predicted bathymetry grids are constrained by cruise data so grids and cruise data are not always independent. Comparison of cruise bathymetry with predicted bathymetry grids also activates a "navigation crossing over land" check.

−H   (with **−G|g** only) disable (or force) decimation during RLS analysis of ship and gridded data. By default mgd77sniffer analyses both the full and decimated data sets then reports RLS statistics for the higher correlation regression.

   −Hb analyze both (default), report better of two.

   −Hd to disable data decimation (equivalent to -H with no argument).

   −Hf to force data decimation.

−I   Append a field abbreviation and the first and last record in a range of records that should be flagged as bad (and set to NaN prior to the analysis). Repeat as many times as needed. May not be used for multiple cruises.

−K   Reverse navigation quality flags (good to bad and vice versa). May be necessary when a majority of navigation fixes are erroneously flagged bad, which can happen when a cruise's first navigation fix is extremely erroneous. Caution! This will affect sniffer output and should only be attempted after careful manual navigation review.

−L   Override mgd77sniffer default error detection limits. Supply path and filename to the custom limits file. Rows not beginning with a valid MGD77 field abbreviation are ignored. Field abbreviations are listed below in exact form under MGD77 FIELD INFO. Multiple field limits may be modified using one default file, one field per line. Field min, max, max slope and max area may be changed for each field. Max slope pertains to the gradient type selected using the **−S** option. Max area is used by the **−G** option as the threshold for flagging excessive offsets from the specified grid. Dump defaults **−Dl** to view syntax or to quickly create an editable custom limits file.

   Example custom default file contents (see below for units):
   # abbrev min   max   maxSlope   maxArea
   twt   0   15   1   0
   depth 0   11000 500   5000
   mag   -800   800   -   -
   faa   -300   300   100   2500

   Use a dash '-' to retain a default limit. Hint: to test your custom limits, try: mgd77sniffer **−Dl** **−L**<yourlimitsfile>

−N   Use nautical units.

−P   Flag regression statistics that are outside the specified confidence level. (i.e., -P5 flags coefficients m, b, rms, and r that fall outside 95%.)

−Q   Quick mode, use bilinear rather than bicubic interpolation [Default]. Alternatively, select the interpolation mode by adding **b** for B-spline smoothing, **c** for bicubic interpolation, **l** for bilinear interpolation or **n** for nearest-neighbor value. Optionally, append *threshold* in the range [0,1]. This parameter controls how close to nodes with NaN values the interpolation will go. E.g., a *threshold* of 0.5 will interpolate about half way from a non-NaN to a NaN node, whereas 0.1 will go about 90% of the way, etc. [Default is 1, which means none of the (4 or 16) nearby nodes may be NaN]. **−Q0** will just return the value of the nearest node instead of interpolating. This is the same as using **−Qn**.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−S   Specify gradient type for along-track excessive slope checking.
         −Sd Calculate change in z values along track (dz). Output is given in geophysical units, e.g. mGal.
         −Ss Calculate spatial gradients (dz/ds). Output is given in geophysical units per km along the survey track, e.g. mGal/km.
         −St Calculate time gradients (dz/dt) [default]. Output is given in geophysical units per second along the survey track, e.g. mGal/sec.

−T   Adjusts mgd77sniffer gap handling. By default, data gaps greater than 5 km are skipped. Set to zero to de-activate gap skipping.

−W   Print out only certain warning types for verbose error messages. Comma delimit any combination of **c|g|o|s|t|v|x**: where (**c**) type code warnings, (**g**)radient out of range, (**o**)ffsets from grid (requires **−G|g**), (**s**)peed out of range, (**t**)ime warnings, (**v**)alue out of range, (**x**) warning summaries. By default ALL warning messages are printed.Not compatible with any **−D** options.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−b   output binary data for **−D**d|f|s|v option. Append **s** for single and **d for double precision [Default is double].**

MGD77 FIELD INFO

Field	Abbreviation	Units
Two-way Travel Time	twt	sec
Corrected Depth	depth	m
Mag Total Field1	mtf1	nT
Mag Total Field2	mtf2	nT
Residual Magnetic	mag	nT
Diurnal Correction	diur	nT
Mag Sensor Depth/Alt	msens	m
Observed Gravity	gobs	mGal
Eotvos Correction	eot	mGal
Free Air Anomaly	faa	mGal

GRID FILE INFO

For **−g** the grids must be in the format used by Sandwell & Smith, which is a spherical Mercator 2-byte grid with no header. For **−G** the grid files can be of any grid type supported by GMT and therefore must contain a GMT header. A correctly formatted *.i2 grid file can be generated using grdraster as shown below.

gmtset GRIDFILE_SHORTHAND TRUE

Create/edit .gmt_io file to include the following rows:
GMT I/O shorthand file
suffix   format_id scale offset   NaN
grd   0   -   -   -
i2   2   -   -   32767

grdraster 1 -R0/359:55/-90/90 -Getopo5_hdr.i2

The new grid, etopo5_hdr.i2 in this example, contains a GMT header and can be used in the **−G** option to compare cruise depth with grid values.

E77 ERROR FORMAT

Header

Information pertaining to an entire cruise, such as NGDC and survey institution identification codes, cruise examination time, two-way travel time corrector information, data precision warnings, as well as systematic scales, DC shifts and correlation coefficients from global grid comparisons are reported as E77 header information.

Sample

\# Cruise 08010039 ID 74010908 MGD77 FILE VERSION: 19801230 N_RECS: 3066
\# Examined: Wed Oct 3 16:30:13 2007 by mtchandl
\# Arguments: -De -Gdepth,/data/GRIDS/etopo5_hdr.i2
N Errata table verification status
\# mgd77manage applies corrections if the errata table is verified (toggle 'N' above to 'Y' after review)
\# For instructions on E77 format and usage, see http://gmt.soest.hawaii.edu/mgd77/errata.php
\# Verified by:
\# Comments:
\# Errata: Header
Y-E-08010039-H13-02: Invalid Magnetics Sampling Rate: (99) [ ]
Y-W-08010039-H13-10: Survey year (1975) outside magnetic reference field IGRF 1965 time range (1965-1970)
Y-I-08010039-depth-00: RLS m: 1.00053 b: 0 rms: 127.851 r: 0.973422 significant: 1 decimation: 0
Y-W-08010039-twt-09: More recent bathymetry correction table available
Y-W-08010039-mtf1-10: Integer precision
Y-W-08010039-mag-10: Integer precision

Error Record

Individual error records have strict format. Included is a time or distance column followed by record number, a formatted error code string, and finally a verbose description of errors detected in the record. Three error classes are encoded into the error code string with different alphabetic characters representing unique error types. See below for error code format description.

Format

<time/distance> <record number> <error code string> <description>

Sample

\# Errata: Data
Y   08010039   1975-05-10T22:16:05.88   74   C-0-0   NAV: excessive speed

Error Code Description

Each of the three error classes is separated by a dash '-' and described by a combination of alphabetic characters or 0 signifying no detected problems.

Error classes: NAV-VAL-GRAD

Error Class Descriptions
NAV (navigation):
0 - fine
A - time out of range
B - time decreasing
C - excessive speed
D - above sea level
E - lat undefined

F - lon undefined

VAL (value):
0 - fine
K - twt invalid
L - depth invalid
O - mtf1 invalid
etc.

GRAD (gradient):
0 - fine
K - d[twt] excessive
L - d[depth] excessive
O - d[mtf1] excessive
etc.

The NAV error class has unique cases while VAL and GRAD classes are described by alphabetic characters for each of the 24 numeric fields in MGD77 format order.

```
  MGD77 bit-pattern w/ E77 alpha characters
|--------------------------------------------|----------|
| X W V U T S R Q P O N M L K J I H G F E D C B A | E77 Code |
| - - - - - - - - - - - - - - - - - - - - - - | - - - - - |
|n f e g m d m m m m b b d t p l l m h d m y t d|F I   |
|q a o o s i s a t t t c e w t o a i o a o e z r|i D   |
|c a t b d u e g f f c c p t c n t n u y n a t|e     |
|    s  r n 2 1  t      r  t r  |l     |
|       s     h        h  |d     |
| - - - - - - - - - - - - - - - - - - - - - - | - - - - - |
| 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | Bit place|
| - G C G C C - G G G - - G G - - - T T T T T - - | Bit type |
|--------------------------------------------|----------|
  Bit types: (G)eophysical, (C)orrection, (T)ime
```

EXAMPLES

To scan for excessive values or gradients, try

mgd77sniffer 08010001

To dump cruise gradients, try

mgd77sniffer 08010001 -Ds

To compare cruise depth with ETOPO5 bathymetry and gravity with Sandwell/Smith 2 min gravity version 11, try

mgd77sniffer 08010001 −**G**depth,/data/GRIDS/etopo5_hdr.i2 −**g**faa,/data/GRIDS/grav.11.2.img,0.1,1

SEE ALSO

mgd77list(1), *mgd77track*(1) *x2sys_init*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

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The Marine Geophysical Data Exchange Format - "MGD77", see *http://www.ngdc.noaa.gov/mgg/dat/geodas/docs/mgd77.txt*

NAME

        mgd77track – A shiptrack plotting program

SYNOPSIS

        mgd77track *NGDC-ids* **−R**west/east/south/north[**r**] **−J**parameters [**−A**[**c**][*size*][,*spacing*]] [
        −B[**p**|**s**]*parameters*] [**−C**|**g**|**e**] [**−Da**startdate] [**−Db**stopdate] [**−F**] [**−Gd**|**t**gap] [**−I**ignore] [**−K**] [
        −Ltrackticks] [**−O**] [**−P**] [**−Sa**startdist[**u**]] [**−Sb**stopdist[**u**]] [**−TT**|**t**|**d**ms,mc,mfs,mf,mfc] [
        −U[*just*/*dx*/*dy*/][**c**|*label*]] [**−V**] [**−W**pen] [**−X**[**a**|**c**|**r**][*x-shift*[**u**]]] [**−Y**[**a**|**c**|**r**][*y-shift*[**u**]]] [**−c**copies]

DESCRIPTION

        mgd77track reads NGDC MGD77 cruises and creates *PostScript* code that will plot one or more ship
        tracks on a map using the specified projection. The *PostScript* code is written to standard output.

        NGDC-ids

                Can be one or more of five kinds of specifiers:
                1) 8-character NGDC IDs, e.g., 01010083, JA010010etc., etc.
                2) 2-character <agency> codes which will return all cruises from each agency.
                3) 4-character <agency><vessel> codes, which will return all cruises from those vessels.
                4) =<list>, where <list> is a table with NGDC IDs, one per line.
                5) If nothing is specified we return all cruises in the data base.
                (See mgd77info **−L** for agency and vessel codes). The ".mgd77" or ".nc" extensions will automat-
                ically be appended, if needed (use **−I** to ignore certain file types). Cruise files will be looked for
                first in the current directory and second in all directories listed in
                $MGD77_HOME**/mgd77_paths.txt [If **$MGD77_HOME is not set it will default to
                $GMT_SHAREDIR/mgd77].

        −J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modi-
                fier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but
                this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value.
                When central meridian is optional, default is center of longitude range on **−R** option. Default stan-
                dard parallel is the equator. For map height, max dimension, or min dimension, append **h**, +, or **-**
                to the width, respectively.
                More details can be found in the **psbasemap** man pages.

                CYLINDRICAL PROJECTIONS:

                −Jclon0/lat0/scale (Cassini)
                −Jcyl_stere/[lon0/[lat0/]]scale (Cylindrical Stereographic)
                −Jj[lon0/]scale (Miller)
                −Jm[lon0/[lat0/]]scale (Mercator)
                −Jmlon0/lat0/scale (Mercator - Give meridian and standard parallel)
                −Jo[**a**]lon0/lat0/azimuth/scale (Oblique Mercator - point and azimuth)
                −Jo[**b**]lon0/lat0/lon1/lat1/scale (Oblique Mercator - two points)
                −Joclon0/lat0/lonp/latp/scale (Oblique Mercator - point and pole)
                −Jq[lon0/[lat0/]]scale (Cylindrical Equidistant)
                −Jtlon0/[lat0/]scale (TM - Transverse Mercator)
                −Juzone/scale (UTM - Universal Transverse Mercator)
                −Jy[lon0/[lat0/]]scale (Cylindrical Equal-Area)

                CONIC PROJECTIONS:

                −Jblon0/lat0/lat1/lat2/scale (Albers)
                −Jdlon0/lat0/lat1/lat2/scale (Conic Equidistant)
                −Jllon0/lat0/lat1/lat2/scale (Lambert Conic Conformal)
                −Jpoly[lon0/[lat0/]]scale ((American) Polyconic)

                AZIMUTHAL PROJECTIONS:

−Ja*lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
−Je*lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
−Jf*lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
−Jg*lon0/lat0*[*/horizon*]*/scale* (Orthographic)
−Jg*lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
−Js*lon0/lat0/*[*/horizon*]*/scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−Jh[*lon0/*]*scale* (Hammer)
−Ji[*lon0/*]*scale* (Sinusoidal)
−Jkf[*lon0/*]*scale* (Eckert IV)
−Jk[**s**][*lon0/*]*scale* (Eckert IV)
−Jn[*lon0/*]*scale* (Robinson)
−Jr[*lon0/*]*scale* (Winkel Tripel)
−Jv[*lon0/*]*scale* (Van der Grinten)
−Jw[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
−Jx*x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

OPTIONS
No space between the option flag and the associated arguments.

−A   Append **c** to annotate using the MGD77 cruise ID [Default uses the filename prefix]. Optional *size* is the font size in points. The leg annotation font is controlled by **LABEL_FONT**. By default, each leg is annotated every time it enters the map region. Alternatively, append ,*spacing* to place this label every *spacing* units apart along the track. Append one of the units **k** (km), **n** (nautical mile), **d** (day), or **h** (hour).

−B   Sets map boundary annotation and tickmark intervals; see the **psbasemap** man page for all the details.

−C   Select procedure for along-track distance calculation:
        f Flat Earth distances.
        g Great circle distances [Default].
        e Geodesic distances on current GMT ellipsoid.

−Da   Do not plot data collected before *startdate* (yyyy-mm-dd**T**[hh:mm:ss]) [Default is first day].

−Db   Do not plot data collected after *stopdate* (yyyy-mm-dd**T**[hh:mm:ss]). [Default is last day].

−F   Do not apply the error bit flags if present in a MGD77+ file [Default will apply these flags upon reading the data].

−G   Let successive point separations exceeding **d***gap* (km) or **t***gap* (minutes) indicate a break in the track where we should not draw a line [no gaps recognized]. Repeat to use both types of gap checking.

−I   Ignore certain data file formats from consideration. Append **a**|**c**|**t** to ignore MGD77 ASCII, MGD77+ netCDF, or plain table files, respectively. The option may be repeated to ignore more

than one format. [Default ignores none].

−K   More *PostScript* code will be appended later [Default terminates the plot system].

−L   To put time/distance log-marks on the track. E.g. **a**500**ka**24**ht**6**h** means (**a**)nnotate every 500 km (**k**) and 24 **h**(ours), with (**t**)ickmarks every 500 km and 6 hours. Alternatively you may use the modifiers **d** (days) and **n** (nautical miles).

−O   Selects Overlay plot mode [Default initializes a new plot system].

−P   Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

−Sa   Do not plot data that are less than *startdist* meter along track from port of departure. Append **k** for km, **m** for miles, or **n** for nautical miles [Default is 0 meters].

−Sb   Do not plot data that are more than *stopdist* meter along track from port of departure. Append **k** for km, **m** for miles, or **n** for nautical miles [Default is end of track].

−T   Controls the attributes of the three kinds of markers (**T** for the first time marker in a new day, **t** for additional time markers in the same day, and **d** for distance markers). For each of these you can specify the 5 comma-separated attributes *markersize*, *markercolor*, *markerfontsize*, *markerfont*, and *markerfontcolor*. Repeat the **−T** option for each marker type.

−U   Draw Unix System time stamp on plot. By adding *just/dx/dy/*, the user may specify the justification of the stamp and where the stamp should fall on the page relative to lower left corner of the plot. For example, BL/0/0 will align the lower left corner of the time stamp with the lower left corner of the plot. Optionally, append a *label*, or **c** (which will plot the command string.). The **GMT** parameters **UNIX_TIME**, **UNIX_TIME_POS**, and **UNIX_TIME_FORMAT** can affect the appearance; see the **gmtdefaults** man page for details. The time string will be in the locale set by the environment variable **TZ** (generally local time).

−W   Append *pen* used for the trackline. [Default is 0.25p,black]. [Default is solid].

−X −Y   Shift plot origin relative to the current origin by (*x-shift,y-shift*) and optionally append the length unit (**c**, **i**, **m**, **p**). You can prepend **a** to shift the origin back to the original position after plotting, or prepend **r** [Default] to reset the current origin to the new location. If **−O** is used then the default (*x-shift,y-shift*) is (0,0), otherwise it is (r1i, r1i) or (r2.5c, r2.5c). Alternatively, give **c** to align the center coordinate (x or y) of the plot with the center of the page based on current page size.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−c   Specifies the number of plot copies. [Default is 1].

EXAMPLES

To generate a Mercator plot of the track of the cruise 01010007 in the area 70W to 20E, 40S to 20N, using a Mercator scale of 0.1inch/degree, label the tracks with 10 points characters, annotate the boundaries every 10 degrees, draw gridlines every 5 degrees, and mark the track every day and 1000 km, with ticks every 6 hours and 250 km, and send the plot to the default printer, enter the following command:

mgd77track 01010007 **−R**70W/20E/40S/20N **−Jm**0.1 **−B**10g5 **−A**10 **−L**a1da1000kf6hf250k | lpr

SEE ALSO

mgd77info(1), *psbasemap*(1) *mgd77list*(1)

REFERENCES

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The Marine Geophysical Data Exchange Format - "MGD77", see *http://www.ngdc.noaa.gov/mgg/dat/geo-das/docs/mgd77.txt*

NAME

binlegs – Maintain the **GMT** index files for mgg supplement

SYNOPSIS

binlegs *leglistfile* **[−R] [−D] [−P***path* **] [−V]**

DESCRIPTION

binlegs will make changes to the **mgg** supplement data base files *gmt_legs.d* and *gmt_index.b* for the legs listed in the *leglistfile*. Normally, only the data archivist will need to be concerned with these operations.

leglistfile
> Contains the list of legs to be worked on.

OPTIONS

No space between the option flag and the associated arguments

−R   Replace the current information if a leg already is in the system. [Default is append].

−D   Delete information for these legs from the system index files.

−P   Set the path to where the *gmt_legs.d* and *gmt_index.b* files reside. [Default is the **$GMT_SHAREDIR**/mgg directory].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

To add new cruises to the system:

binlegs *newlegs.lis* **−V −P***/usr/lib/gmt*

To remove bad legs from the system:

binlegs *badlegs.lis* **−D −V −P***/usr/lib/gmt*

SEE ALSO

GMT(1), *gmtlegs*(1), *gmt2bin*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.
Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.
Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.
Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.
Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME
> dat2gmt – Convert an ASCII file to a binary gmt file

SYNOPSIS
> **dat2gmt** *gmtfile*

DESCRIPTION
> **dat2gmt** reads an ASCII version of a gmt file (made by **gmt2dat**) from standard input and creates a binary gmt file.

EXAMPLES
> To create a gmt file from the ASCII file c2104_fixed.ascii, run
>
> **dat2gmt** c2104.gmt < c2104_fixed.ascii

SEE ALSO
> *gmt2dat*(1), *GMT*(1)

REFERENCES
> Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.
>
> Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.
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> Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.
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> Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.
>
> Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME
gmt2bin – Create bin-index files from gmt files

SYNOPSIS
gmt2bin *listfile* [**−P***path*] [**−V**]

DESCRIPTION
gmt2bin reads a file with a list of leg ids, opens each gmt file, and creates a bin-index file for each leg called <legid>.bix. These are used by **binlegs** to update the system files read by **gmtlegs**. Normally, only the data archivist will need to be concerned with these operations.

listfile   This is a one column ASCII file with one leg id pr line.

OPTIONS
−P   Sets full path to directory with gmtfiles. [Default is current directory].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

SEE ALSO
binlegs(1), *dat2gmt*(1), *GMT*(1)

REFERENCES
Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.

Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME
gmt2dat – Convert a binary gmt file to an ASCII file

SYNOPSIS
gmt2dat *gmtfile*

DESCRIPTION
gmt2dat reads a <legid>.gmt file and converts it to a regular ASCII text file that can be edited using the text editor. The ASCII text is sent to standard output and can be redirected to a file/program/printer, etc.

EXAMPLES
To convert c2104.gmt to ASCII:

gmt2dat c2104.gmt > c2104.ascii

SEE ALSO
dat2gmt(1), *GMT*(1)

REFERENCES
Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.

Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME
gmtinfo – Get information about individual cruises

SYNOPSIS
gmtinfo *leg-ids*

DESCRIPTION
gmtinfo reports the minimum/maximum coordinates, year of the cruise, leg id, number of records, the number of gravity, magnetics, and bathymetry points found, and the start/stop dates for the leg. All the information is written to standard output on one line so that it is easy to use **awk** to add up numbers etc.

leg-ids   Can be one or more gmtleg-names, like c2610. Use 'cat list_of_legs' to pass all the legnames in the file list_of_legs.

EXAMPLES
To obtain information about cruises c2603 and v2819, run

gmtinfo   c2603 v2819 > info_file

SEE ALSO
GMT (1)

REFERENCES
Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.
Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.
Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.
Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.
Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME

gmtlegs − Find cruises in a given region

SYNOPSIS

gmtlegs −R*west*/*east*/*south*/*north*[**r**] [**−G**] [**−M**] [**−T**] [**−L**] [**−V**]

DESCRIPTION

gmtlegs will report the name of all the cruises that happened to be wholly or partially inside the specified region. As an option, only those cruises that collected a certain type of data can be reported.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

OPTIONS

No space between the option flag and the associated arguments

−G   Report cruises that collected Gravity data. [Default is any data].

−M   Report cruises that collected Magnetics. [Default is any data].

−T   Report cruises that collected Topography. [Default is any data].

−L   Long output, i.e. cruisenames and data types available. [Default is cruisenames only].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

To find all cruises around Hawaii that collected gravity and topography:

gmtlegs −R-162/-152/18/25 **−G −T** > hawaii_gt.legs

To find all cruises with magnetics:

gmtlegs −R0/360/-90/90 **−M** > all_m.legs

SEE ALSO

GMT(1), *gmt2bin*(1), *binlegs*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.

Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME

   gmtlist − A data-extractor for <legid>.gmt files

SYNOPSIS

   gmtlist *leg-ids* [**−C***correctionfile*] [**−Da***startdate*] [**−Db***stopdate*] [**−F***flags*] [**−G**] [**−H**[**i**][*nrec*]] [
   −R*west*/*east*/*south*/*north*[**r**]] [**−Sa***startdist*] [**−Sb***stopdist*] [**−V**] [**−W***weight*] [
   −bo[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1*/...]]]]

DESCRIPTION

   gmtlist reads <legid>.gmt files and produces an ASCII [or binary] table. The <legid>.gmt files contain
   time(**s**), latitude(**y**), longitude(**x**), gravity(**g/G**), magnetics(**m/M**), and bathymetry(**t/T**), and the user may
   extract any combination of these 6 parameters + distance(**d**), heading (**h**), velocity (**v**), and weight (**w**, see
   −W). A sub-section can be specified by passing time- or distance-intervals along track or by selecting a
   region.

   leg-ids Can be one or more cruisenames. To give a list of names, use 'cat list_of_legs'.

OPTIONS

   No space between the option flag and the associated arguments

   −C   Apply crossover Corrections to the data. If no correction file is given, gmtlist reads the default cor-
      rection file. (See **XSYSTEM** for how to set up your own correction file).

   −Da Do not list data collected before *startdate* (mm/dd/yyyy/hh:mm) [Default is first day].

   −Db Do not list data collected after *stopdate* (mm/dd/yyyy/hh:mm). [Default is last day].

   −F   Can be any combination of **syxgmtdhv** to indicate the desired output data. The data will appear in
      the order indicated by flags. If **G**, **M**, or **T** is substituted for **g**, **m**, **t**, only records that have that
      combination of data are written out. If **s** is followed by **c** (calendar), then yyyy/mm/dd/hh/mm/ss is
      written out, if **s** is followed by **j** (julian), then yyyy/jd/hh/mm/ss is written out. Default is seconds
      from start of year.

   −G   Force Geographical longitudes (-180/+180) rather than geodetic (0-360) [Default].

   −H   Issue a header record with names for each data field.

   −R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
      degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map
      coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global
      domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively,
      specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are
      copied from the grid.

   −Sa Do not list data that are less than *startdist* km along track from port of departure. [Default is 0].

   −Sb Do not list data that are more than *stopdist* km along track from port of departure. [Default is
      length of track].

   −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

   −W   Set the weight for these data. Weight output option must be set in **−F**. This is useful if the data
      are to be processed with the weighted averaging techniques offered by **blockmean**, **blockmedian**,
      and **blockmode**.

   −b   Selects binary output mode (in double precision) [Default is ASCII]. **−H** is ignored if **−b** is
      selected. Julian and calendar dates are not supported for binary time output (i.e., you get seconds
      from start of year).

EXAMPLES

   To get a (distance, heading, crossover-corrected gravity, bathymetry) listing from c2104.gmt, starting at
   June 3 1971 20:45 and ending at distance = 5000 km, use the following command:

   gmtlist c2104 **−Da**6/3/1971/20:45 **−Sb**5000 **−F**dhgt **−C** > myfile

To make input for **blockmean** and **surface** using all the cruises listed in the file gmt.list, but only the data that are inside the specified area, and make output binary:

gmtlist 'cat gmt.list' **−F**xyg **−R**-40/-30/25/35 **−b** > allgrav.xyg

SEE ALSO

GMT(1), *x_system*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.

Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME
gmtpath – Get full pathname for gmt files

SYNOPSIS
gmtpath *leg-ids*

DESCRIPTION
gmtpath returns the full pathname to one or more gmt-files. The pathname returned for a given cruise may change with time due to reshuffling of disks/subdirectories.

leg-ids Can be one or more gmtleg-names, like c2610. Use 'cat list_of_legs' to pass all the legnames in the file list_of_legs.

EXAMPLES
To obtain pathnames for cruises c2603 and v2819, run

gmtpath c2603 v2819

SEE ALSO
GMT(1)

REFERENCES
Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.
Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.
Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.
Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.
Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME
>   gmttrack – A shiptrack plotting program

SYNOPSIS
>   **gmttrack** *leg-ids* **−R***west/east/south/north*[**r**] **−J***parameters* [**−B**[**p**|**s**]*parameters*] [**−M***trackticks*] [
>   **−W***pen*[*red/green/blue*][**OA**]] [**−A**[*size*]] [**−K**] [**−O**] [**−P**] [**−U**[*just/dx/dy/*][**c**|*label*]] [**−V**] [
>   **−X**[**a**|**c**|**r**][*x-shift*[**u**]]] [**−Y**[**a**|**c**|**r**][*y-shift*[**u**]]] [**−c***copies*]

DESCRIPTION
>   **gmttrack** reads gmt cruises and creates *PostScript* code that will plot one or more ship tracks on a map
>   using the specified projection. The *PostScript* code is written to standard output.
>
>   *leg-ids* Can be one or more gmtleg-names, like c2104 v3206 etc.
>
>   **−J**   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modi-
>   fier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but
>   this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value.
>   When central meridian is optional, default is center of longitude range on **−R** option. Default stan-
>   dard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-**
>   to the width, respectively.
>   More details can be found in the **psbasemap** man pages.
>
>   **CYLINDRICAL PROJECTIONS:**
>
>   **−Jc***lon0/lat0/scale* (Cassini)
>   **−Jcyl_stere**/[*lon0/*[*lat0/*]]*scale* (Cylindrical Stereographic)
>   **−Jj**[*lon0/*]*scale* (Miller)
>   **−Jm**[*lon0/*[*lat0/*]]*scale* (Mercator)
>   **−Jm***lon0/lat0/scale* (Mercator - Give meridian and standard parallel)
>   **−Jo**[**a**]*lon0/lat0/azimuth/scale* (Oblique Mercator - point and azimuth)
>   **−Jo**[**b**]*lon0/lat0/lon1/lat1/scale* (Oblique Mercator - two points)
>   **−Joc***lon0/lat0/lonp/latp/scale* (Oblique Mercator - point and pole)
>   **−Jq**[*lon0/*[*lat0/*]]*scale* (Cylindrical Equidistant)
>   **−Jt***lon0/*[*lat0/*]*scale* (TM - Transverse Mercator)
>   **−Ju***zone/scale* (UTM - Universal Transverse Mercator)
>   **−Jy**[*lon0/*[*lat0/*]]*scale* (Cylindrical Equal-Area)
>
>   **CONIC PROJECTIONS:**
>
>   **−Jb***lon0/lat0/lat1/lat2/scale* (Albers)
>   **−Jd***lon0/lat0/lat1/lat2/scale* (Conic Equidistant)
>   **−Jl***lon0/lat0/lat1/lat2/scale* (Lambert Conic Conformal)
>   **−Jpoly**[*lon0/*[*lat0/*]]*scale* ((American) Polyconic)
>
>   **AZIMUTHAL PROJECTIONS:**
>
>   **−Ja***lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
>   **−Je***lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
>   **−Jf***lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
>   **−Jg***lon0/lat0*[*/horizon*]*/scale* (Orthographic)
>   **−Jg***lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
>   **−Js***lon0/lat0*[*/horizon*]*/scale* (General Stereographic)
>
>   **MISCELLANEOUS PROJECTIONS:**
>
>   **−Jh**[*lon0/*]*scale* (Hammer)
>   **−Ji**[*lon0/*]*scale* (Sinusoidal)

        −Jkf[*lon0/*]*scale* (Eckert IV)
        −Jk[**s**][*lon0/*]*scale* (Eckert IV)
        −Jn[*lon0/*]*scale* (Robinson)
        −Jr[*lon0/*]*scale* (Winkel Tripel)
        −Jv[*lon0/*]*scale* (Van der Grinten)
        −Jw[*lon0/*]*scale* (Mollweide)

        NON-GEOGRAPHICAL PROJECTIONS:

        −Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
        −Jx*x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

OPTIONS

No space between the option flag and the associated arguments.

−B   Sets map boundary annotation and tickmark intervals; see the **psbasemap** man page for all the details.

−A   Annotate each leg every time it enters the plot. Optional *size* is character size in points.

−Da   Do not plot data collected before *startdate* (mm/dd/yyyy/hh:mm) [Default is first day].

−Db   Do not plot data collected after *stopdate* (mm/dd/yyyy/hh:mm). [Default is last day].

−K   More *PostScript* code will be appended later [Default terminates the plot system].

−M   To put time/distance Marks on the track. E.g. **a500ka24ht6h** means (**a**)nnotate every 500 km (**k**) and 24 **h**(ours), with (**t**)ickmarks every 500 km and 6 hours.

−O   Selects Overlay plot mode [Default initializes a new plot system].

−P   Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

−Sa   Do not plot data that are less than *startdist* km along track from port of departure. [Default is 0].

−Sb   Do not plot data that are more than *stopdist* km along track from port of departure. [Default is length of track].

−U   Draw Unix System time stamp on plot. By adding *just/dx/dy/*, the user may specify the justification of the stamp and where the stamp should fall on the page relative to lower left corner of the plot. For example, BL/0/0 will align the lower left corner of the time stamp with the lower left corner of the plot. Optionally, append a *label*, or **c** (which will plot the command string.). The **GMT** parameters **UNIX_TIME**, **UNIX_TIME_POS**, and **UNIX_TIME_FORMAT** can affect the appearance; see the **gmtdefaults** man page for details. The time string will be in the locale set by the environment variable **TZ** (generally local time).

−W   *pen* is thickness of the trackline. [Default is 1]. Optionally, specify the rgb combination to obtain a colored trackline [Default is black]. Append **o** for d**o**tted line, **a** for d**a**shed. [Default is solid].

−X −Y Shift plot origin relative to the current origin by (*x-shift,y-shift*) and optionally append the length unit (**c**, **i**, **m**, **p**). You can prepend **a** to shift the origin back to the original position after plotting, or prepend **r** [Default] to reset the current origin to the new location. If **−O** is used then the default (*x-shift,y-shift*) is (0,0), otherwise it is (r1i, r1i) or (r2.5c, r2.5c). Alternatively, give **c** to align the center coordinate (x or y) of the plot with the center of the page based on current page size.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−c   Specifies the number of plot copies. [Default is 1].

EXAMPLES

To generate a Mercator plot of the track of cruises C2610 and V1512 in the area 150E to 154E, 18N to 23N, using a Mercator scale of 1.5inch/degree, label the tracks with 10 points characters, annotate the boundaries every degree, and draw gridlines every 30 minutes, and send the plot to the default printer, enter the following command:

gmttrack c2610 v1512 **−R**150/154/18/23 **−Jm**1.5 **−B**1**g**30**m −A**10 | lpr

SEE ALSO

GMT (1), *psbasemap*(1)

REFERENCES

Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.

Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.

Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, http://www.agu.org/eos_elec/95154e.html, Copyright 1995 by the American Geophysical Union.

Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72 (41), p. 441.

NAME
mgd77togmt – Convert an MGD-77 ASCII file to a binary gmt file

SYNOPSIS
mgd77togmt [**−L***list*] [*mgd77file*] **−F***legid* **−Y***start_year* [**−A***information*] [**−I***time_increment*] [**−T**[*<offset>*]] [**−W**[*<cable_length>*]] [**−V**]

DESCRIPTION
mgd77togmt reads an ASCII MGD-77 format file [or standard input] and creates a binary gmt file. The 16 header records specified in the MGD-77 documentation may or may not be present. If two-way travel times are available, **mgd77togmt** will convert those to corrected depths using the Carter tables. Both old and new (Y2K-compliant) MGD-77 files are supported.

−L   Name of file with several records of the format *mgd77file legid start_year*. For multiple files, use this option rather than the **−F −Y** combination.

−Y   The year of the first data point in the file. If not provided and -L option not used, it tries to get it from a header file. The header file must be in the same directory of the main file and must have a name equal to the main but with a .h77 extension.

OPTIONS
No space between the option flag and the associated arguments.

−A   Set an optional 10 character information string to be stored in the header [Default is blank].

−F   Leg id that will be used in file name (*legid*.gmt). If not given, it will be constructed from the mgd77file name plus the .gmt extension.

−I   Used for files where time is missing. The increment is used to calculate fake times.

−T   Extracts Total field instead of anomaly. Since F does not hold in a 2 byte signed variable we subtract a constant [default = 40000] but you can provide another value in *<offset>*.

−W   Take into account that the magnetometer is not at ship's position. *<cable>* is magnetometer tow distance [default = 200 meters]. If **−W** only is given (e.g. no <cable>) and like with the **−Y** option, we try to get the tow distance from the header file. Failing, defaults to 200 meters. Note that this option will throw away the first points whose accumulated. distance since the start of magnetic acquisition is less than cable. length, and likewise for the end of the mag profile.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES
To create a gmt file from the ASCII file c2104.mgd77, run

mgd77togmt c2104.mgd77 **−Y**1977

To create new gmt files from all the mgd77 files listed in *list.d*:

mgd77togmt −Llist.d **−V**

SEE ALSO
dat2gmt(1), *GMT*(1)

REFERENCES
Wessel, P., and W. H. F. Smith, 2009, The Generic Mapping Tools (GMT) version 4.5.0 Technical Reference & Cookbook, SOEST/NOAA.
Wessel, P., and W. H. F. Smith, 1998, New, Improved Version of Generic Mapping Tools Released, EOS Trans., AGU, 79 (47), p. 579.
Wessel, P., and W. H. F. Smith, 1995, New Version of the Generic Mapping Tools Released, EOS Trans., AGU, 76 (33), p. 329.
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Wessel, P., and W. H. F. Smith, 1991, Free Software Helps Map and Display Data, EOS Trans., AGU, 72

(41), p. 441.

MGD77 Task Group, 1977, The Marine Geophysical Data Exchange Format - MGD77, Key to Geophysical Records documentation No. 10, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO.

Carter, D. J. T., *Echo Sounding Correction Tables: Formerly Matthews' Tables*, 150 pp, Hydrographic Department, Ministry of Defense, Taunton, Somerset, England, 1980.

NAME
dimfilter – Directional filtering of 2-D gridded files in the space (or time) domain

SYNOPSIS
dimfilter *input_file.grd* **−D***distance_flag* **−F**<*filtertype*><*width*>[*mode*] **−G***output_file.grd* **−N**<*filtertype*><*n_sectors*> **−Q***cols* [**−I***xinc*[*unit*][=|+][/*yinc*[*unit*][=|+]]] [**−R***west/east/south/north*[**r**]] [**−T**] [**−V**]

DESCRIPTION
dimfilter will filter a *.grd* file in the space (or time) domain by dividing the given filter circle into *n_sectors*, applying one of the selected primary convolution or non-convolution filters to each sector, and choosing the final outcome according to the selected secondary filter. It computes distances using Cartesian or Spherical geometries. The output *.grd* file can optionally be generated as a sub-**R**egion of the input and/or with a new **−I**ncrement. In this way, one may have "extra space" in the input data so that the edges will not be used and the output can be within one-half-width of the input edges. If the filter is low-pass, then the output may be less frequently sampled than the input. **-Q** is for the error analysis mode and only requires the total number of columns in the input file, which contains the filtered depths. Finally, one should know that **dimfilter** will not produce a smooth output as other spatial filters do because it returns a minimum median out of *N* medians of *N* sectors. The output can be edgy unless the input data is noise-free. Thus, an additional filtering (e.g., Gaussian) to the DiM-filtered data is generally recommended.

input_file.grd
    The file of points to be filtered.

−D   Distance *flag* tells how grid (x,y) relates to filter *width* as follows:

    flag = 0: grid (x,y) same units as *width*, Cartesian distances.
    flag = 1: grid (x,y) in degrees, *width* in kilometers, Cartesian distances.
    flag = 2: grid (x,y) in degrees, *width* in km, dx scaled by cos(middle y), Cartesian distances.

    The above options are fastest because they allow weight matrix to be computed only once. The next three options are slower because they recompute weights for each latitude.

    flag = 3: grid (x,y) in degrees, *width* in km, dx scaled by cosine(y), Cartesian distance calculation.
    flag = 4: grid (x,y) in degrees, *width* in km, Spherical distance calculation.

−F   Sets the primary filter type. Choose among convolution and non-convolution filters. Append the filter code followed by the full diameter *width*. Available convolution filters are:
    (**b**) Boxcar: All weights are equal.
    (**c**) Cosine Arch: Weights follow a cosine arch curve.
    (**g**) Gaussian: Weights are given by the Gaussian function.
    Non-convolution filters are:
    (**m**) Median: Returns median value.
    (**p**) Maximum likelihood probability (a mode estimator): Return modal value. If more than one mode is found we return their average value. Append - or + to the filter width if you rather want to return the smallest or largest of the modal values.

−N   Sets the secondary filter type and the number of bow-tie sectors. *n_sectors* must be integer and larger than 0. When *n_sectors* is set to 1, the secondary filter is not effective. Available secondary filters are:
    (**l**) Lower: Return the minimum of all filtered values.
    (**u**) Upper: Return the maximum of all filtered values.
    (**a**) Average: Return the mean of all filtered values.
    (**m**) Median: Return the median of all filtered values.
    (**p**) Mode: Return the mode of all filtered values.

−G   *output_file.grd* is the output of the filter.

OPTIONS

−I   *x_inc* [and optionally *y_inc*] is the output Increment. Append **m** to indicate minutes, or **c** to indi-
cate seconds. If the new *x_inc, y_inc* are NOT integer multiples of the old ones (in the input
data), filtering will be considerably slower. [Default: Same as input.]

−R   *west, east, south,* and *north* defines the Region of the output points. [Default: Same as input.]

−T   Toggle the node registration for the output grid so as to become the opposite of the input grid
[Default gives the same registration as the input grid].

−Q   *cols* is the total number of columns in the input file. For this mode, it expects to read depths con-
sisted of several columns. Each column represents a filtered grid with a filter width, which can be
obtained by 'grd2xyz -Z'. The outcome will be median, MAD, and mean. So, the column with the
medians is used to generate the regional component and the column with the MADs to conduct the
error analysis.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

GRID FILE FORMATS

By default **GMT** writes out grid as single precision floats in a COARDS-complaint netCDF file format.
However, **GMT** is able to produce grid files in many other commonly used grid file formats and also facili-
tates so called "packing" of grids, writing out floating point data as 2- or 4-byte integers. To specify the pre-
cision, scale and offset, the user should add the suffix *=id*[*/scale/offset*[*/nan*]], where *id* is a two-letter iden-
tifier of the grid type and precision, and *scale* and *offset* are optional scale factor and offset to be applied to
all grid values, and *nan* is the value used to indicate missing data. When reading grids, the format is gener-
ally automatically recognized. If not, the same suffix can be added to input grid file names. See **grdrefor-
mat**(1) and Section 4.17 of the GMT Technical Reference and Cookbook for more information.

When reading a netCDF file that contains multiple grids, **GMT** will read, by default, the first 2-dimensional
grid that can find in that file. To coax **GMT** into reading another multi-dimensional variable in the grid file,
append **?***varname* to the file name, where *varname* is the name of the variable. Note that you may need to
escape the special meaning of **?** in your shell program by putting a backslash in front of it, or by placing the
filename and suffix between quotes or double quotes. The **?***varname* suffix can also be used for output
grids to specify a variable name different from the default: "z". See **grdreformat**(1) and Section 4.18 of
the GMT Technical Reference and Cookbook for more information, particularly on how to read splices of
3-, 4-, or 5-dimensional grids.

GEOGRAPHICAL AND TIME COORDINATES

When the output grid type is netCDF, the coordinates will be labeled "longitude", "latitude", or "time"
based on the attributes of the input data or grid (if any) or on the **−f** or **−R** options. For example, both **−f0x**
−f1t and **−R**90w/90e/0t/3t will result in a longitude/time grid. When the x, y, or z coordinate is time, it will
be stored in the grid as relative time since epoch as specified by **TIME_UNIT** and **TIME_EPOCH** in the
.gmtdefaults file or on the command line. In addition, the **unit** attribute of the time variable will indicate
both this unit and epoch.

EXAMPLES

Suppose that north_pacific_dbdb5.grd is a file of 5 minute bathymetry from 140E to 260E and 0N to 50N,
and you want to find the medians of values within a 300km radius (600km full width) of the output points,
which you choose to be from 150E to 250E and 10N to 40N, and you want the output values every 0.5
degree. To prevent the medians from being biased by the sloping plane, you want to divide the filter circle
into 6 sectors and to choose the lowest value among 6 medians. Using spherical distance calculations, you
need:

dimfilter north_pacific_dbdb5.grd **−G**filtered_pacific.grd **−Fm**600 **−D**4 **−N**l6 **−R**150/250/10/40 **−I**0.5 **−V**

Suppose that cape_verde.grd is a file of 0.5 minute bathymetry from 32W to 15W and 8N to 25N, and you
want to remove small-length-scale features in order to define a swell in an area extending from 27.5W to
20.5W and 12.5N to 19.5N, and you want the output value every 2 minute. Using cartesian distance calcu-
lations, you need:

dimfilter cape_verde.grd **−G**t.grd **−Fm**220 **−Nl**8 **−D**2 **−R**-27.5/-20.5/12.5/19.5 **−I**2m **−V**
grdfilter t.grd **−G**cape_swell.grd **−Fg**50 **−D**2 **−V**

Suppose that you found a range of filter widths for a given area, and you filtered the given bathymetric data using the range of filter widths (e.g., *f100.grd f110.grd f120.grd f130.grd*), and you want to define a regional trend using the range of filter widths, and you want to obtain median absolute deviation (MAD) estimates at each data point, you need:

grd2xyz f100.grd **-Z** > f100.d
grd2xyz f110.grd **-Z** > f110.d
grd2xyz f120.grd **-Z** > f120.d
grd2xyz f130.grd **-Z** > f130.d
paste f100.d f110.d f120.d f130.d > depths.d
dimfilter depths.d **-Q**4 > output.z

LIMITATIONS

When working with geographic (lat, lon) grids, all three convolution filters (boxcar, cosine arch, and gaussian) will properly normalize the filter weights for the variation in gridbox size with latitude, and correctly determine which nodes are needed for the convolution when the filter "circle" crosses a periodic (0-360) boundary or contains a geographic pole. However, the spatial filters, such as median and mode filters, do not use weights and thus should only be used on Cartesian grids (or at very low latitudes) only. If you want to apply such spatial filters you should project your data to an equal-area projection and run dimfilter on the resulting Cartesian grid.

SCRIPT TEMPLATE

The dim.template.sh is a skeleton shell script that can be used to set up a complete DiM analysis, including the MAD analysis.

REFERENCE

Kim, S.-S., and Wessel, P. (2008), Directional Median Filtering for Regional-Residual Separation of Bathymetry, *Geochem. Geophys. Geosyst., 9(Q03005)*, doi:10.1029/2007GC001850.

SEE ALSO

GMT(1), *grdfilter*(1)

NAME

      gmt2kml – Convert GMT data tables to KML files for Google Earth

SYNOPSIS

      gmt2kml [*infile(s)*] [**−Aa**|**g**|**s**[*alt*|**x***scale*]] [**−C***cpt*] [**−D***descriptfile*] [**−E**[*altitude*]] [**−Fe**|**s**[*cpt*]|**t**|**l**|**p**] [
      −Gf|**n***fill*] [**−H**[**i**]*nrec*]] [**−I***icon*] [**−K**] [**−L***col1:name1,col2:name2,...*] [**−N**[**+**|*name_template*|*name*]]
      [**−O**] [**−Q**[**s**|**l**|**p**]*transparency*] [**−Ra**|*w/e/s/n*] [**−Sc**|**n***scale*] [**−T***title*[*/foldername*]] [**−V**] [**−W**-|*pen*] [
      −Z*args*] [**−:**[**i**|**o**]] [**−bi**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−f**[**i**|**o**]*colinfo*] [**−m**[**i**|**o**][*flag*]] [> *output.kml*]

DESCRIPTION

      gmt2kml reads one or more GMT table file and converts them to a single output file using Google Earth's
      KML format. Data may represent points, lines, or polygons, and you may specify additional attributes such
      as title, altitude mode, colors, pen widths, transparency, regions, and data descriptions. You may also
      extend the feature down to ground level (assuming it is above it) and use custom icons for point symbols.

      The input file should contain the following columns:
      lon lat [*alt*] [*timestart* [*timestop*]]
      where *lon* and *lat* are required for all features, *alt* is optional for all features (see also **−A** and **−C**), and
      timestart and *timestop* apply to events and timespan features.

      infile(s) ASCII (or binary, see **−bi**) data file(s) to be operated on. If not given, standard input will be read.

OPTIONS

      No space between the option flag and the associated arguments.

      −A   Select one of three altitude modes recognized by Google Earth that determines the altitude (in m)
              of the feature: **a** absolute altitude, **g** altitude relative to sea surface or ground, **s** altitude relative to
              seafloor or ground. To plot the features at a fixed altitude, append a *alt* (in m). Use 0 to clamp the
              features to the chosen reference surface. Append **x***scale* to scale the altitude from the input file by
              that factor. If no value is appended, the altitude (in m) is read from the 3rd column of the input
              file. [By default the features are clamped to the sea surface or ground].

      −C   Use color palette for assigning colors to the symbol, event, or timespan icons, based on the value
              in the 3rd column of the input file. Ignored when plotting lines or polygons.

      −D   File with HTML snippets that will be included as part of the description content for the KML file
              [no description].

      −E   Extrude feature down to ground level. [no extrusion].

      −F   Sets the feature mode. Choose from points (**e**vent, **s**ymbol, or **t**imespan), **l**ine, or **p**olygon. [sym-
              bol]. The first two columns of the input file should contain (*lon, lat*). When the altitude or value
              is use (i.e., no *altitude* value is given with **−A**, or **−C** is used), the third column needs to contain
              the *altitude* (in m). The event (**−Fe**) is a symbol that should only be active at a particular *time*,
              given in the next column. Timespan (**−Ft**) is a symbol that should only be active during a particu-
              lar time period indicated by the next two columns (*timestart, timestop*). Use NaN to indicate
              unbounded time limits. If used, times should be in ISO format yyyy-mm-ddThh:mm:ss[.xxx] or in
              GMT relative time format (see **−f**).

      −G   Set fill color for symbols, extrusions and polygons (**−Gf**) [Default is lightorange] or text labels
              (**−Gn**) [Default is white]. Optionally, use **−Gf-** to turn off polygon fill, and **−Gn-** to disable labels.
              (See SPECIFYING FILL below).

      −H   Input file(s) has header record(s). If used, the default number of header records is
              N_HEADER_RECS. Use **−Hi** if only input data should have header records [Default will write
              out header records if the input data have them]. Blank lines and lines starting with # are always
              skipped.

      −I   Specify the URL to an alternative icon used for the symbol [Default is a Google Earth circle]. If
              the URL starts with + then we will prepend http://maps.google.com/mapfiles/kml/ to the name.
              [Default is a local icon with no directory path].

−K   Allow more KML code to be appended to the output later [finalize the KML file].

−L   Extended data given. Append one or more strings of the form *col*:*name* separated by commas. We will expect the listed data columns to exist in the input and will be encoded in the KML file as Extended Data sets, whose attributes will be available in the Google Earth balloon when the item is selected.

−N   By default, if multisegment headers contain a **−L**"label string" then we use that for the name of the KML feature (linesegment or set of symbols). Default names for these segments are "Line %d" and "Point Set %d", depending on the feature, where %d is a sequence number of linesegments within a file. Each point within a linesegment will be named after the linesegment plus a sequence number. Default is simply "Point %d".
Alternatively, select one of these options: (1) append + to supply individual symbol labels directly at the end of the data record, (2) append a string that may include %d or a similar integer format to assign unique name IDs for each feature, with the segment number (for lines and polygons) or point number (symbols) appearing where %d is placed, (3) give no arguments to turn symbol labeling off, linesegments will still be named.

−O   Appended KML code to an existing KML file [initialize new KML file].

−Q   Set the transparency level for the selected feature (**e**, **s**, **t**, **l**, or **p**, plus **n** for name labels). Transparency goes from 0 (fully transparent) to 1 (opaque) [0.75 for polygons, 1 for symbols, lines, and labels].

−R   Issue a single Region tag. Append *w/e/s/n* to set a particular region (will ignore points outside the region), or append **a** to determine and use the actual domain of the data (single file only) [no region tags issued].

−S   Scale icons or labels. Here, **−Sc** sets a scale for the symbol icon, whereas **−Sn** sets a scale for the name labels [1 for both].

−T   Sets the document title [GMT Data Document]. Optionally, append /*FolderName*; this allows you, with **−O**, **−K**, to group features into folders within the KML document. [The default folder name is "*Name* Features", where *Name* is Point, Event, Timespan, Line, or Polygon].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−W   Set pen attributes for lines or polygon outlines. Append pen attributes to use [Defaults: width = 1, color = black, texture = solid]. Optionally, use **−W-** to turn off polygon outline (See SPECIFYING PENS below).

−Z   Set one or more attributes of the Document and Region tags. Append +a*alt_min/alt_max* to specify limits on visibility based on altitude. Append +l*lod_min/lod_max* to specify limits on visibility based on Level Of Detail, where *lod_max* == -1 means it is visible to infinite size. Append +f*fade_min/fade_max* to fade in and out over a ramp [abrupt]. Append +v to make a feature *not* visible when loaded [visible]. Append +o to open a folder or document in the sidebar when loaded [closed].

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/*... to specify the variables to be read. [Default is 2 input columns].

−f   Special formatting of input and/or output columns (time or geographical data). Specify **i** or **o** to make this apply only to input or output [Default applies to both]. Give one or more columns (or column ranges) separated by commas. Append **T** (absolute calendar time), **t** (relative time in chosen **TIME_UNIT** since **TIME_EPOCH**), **x** (longitude), **y** (latitude), or **f** (floating point) to each column or column range item. Shorthand **−f[i|o]g** means **−f[i|o]0x,1y** (geographic coordinates).

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output. The **−m** option make sure that segment headers in the input files are copied to output, but it has no effect on the data selection. Selection is always done point by point, not by segment.

SPECIFYING PENS

pen   The attributes of lines and symbol outlines as defined by *pen* is a comma delimetered list of *width*, *color* and *texture*, each of which is optional. *width* can be indicated as a measure (points, centimeters, inches) or as **faint**, **thin[ner|nest]**, **thick[er|est]**, **fat[ter|test]**, or **obese**. *color* specifies a gray shade or color (see SPECIFYING COLOR below). *texture* is a combination of dashes '-' and dots '.'.

SPECIFYING COLOR

color   The *color* of lines, areas and patterns can be specified by a valid color name; by a gray shade (in the range 0−255); by a decimal color code (r/g/b, each in range 0−255; h-s-v, ranges 0−360, 0−1, 0−1; or c/m/y/k, each in range 0−1); or by a hexadecimal color code (#rrggbb, as used in HTML). See the **gmtcolors** manpage for more information and a full list of color names.

EXAMPLES

To convert a file with point locations (lon, lat) into a KML file with red circle symbols, try

gmt2kml mypoints.txt **−G**red **−Fs** > mypoints.kml

To convert a multisegment file with lines (lon, lat) separated by multisegment headers that contain a **−L**labelstring with the feature name, selecting a thick white pen, and title the document, try

gmt2kml mylines.txt **−W**thick,white **−Fl** **−T**"Lines from here to there" > mylines.kml

To convert a multisegment file with polygons (lon, lat) separated by multisegment headers that contain a **−L**labelstring with the feature name, selecting a thick black pen and semi-transparent yellow fill, giving a title to the document, and prescribing a particular region limit, try

gmt2kml mypolygons.txt **−G**yellow **−Qp**0.5 **−Fp** **−T**"My polygons" **−L**30/90/-20/40 > mypolygons.kml

To convert a file with point locations (lon, lat, time) into a KML file with green circle symbols that will go active at the specified time and stay active going forward, try

awk '{print $1, $2, $3, "NaN"}' mypoints.txt | gmt2kml **−G**green **−Ft** > mytimepoints.kml

LIMITATIONS

Google Earth has trouble displaying filled polygons across the Dateline. For now you must manually break any polygon crossing the dateline into a west and east polygon and plot them separately.

MAKING KMZ FILES

Using the KMZ format is preferred as it takes less space. KMZ is simply a KML file and any data files, icons, or images referenced by the KML, contained in a zip archive. One way to organize large data sets is to split them into groups called Folders. A Document can contain any number of folders. Using scripts you can create a composite KML file using the **−K**, **−O** options just like you do with GMT plots. See **−T** for switching between folders and documents.

KML HIERARCHY

GMT stores the different features in a hierarchical folders, by feature type (when using **−O**, **−K** or **−T**/*foldername*) by input file (if not standard input), and by line segment (using the name from the segment header, or **−N**). This makes it more easy in Google Earth to switch on or off parts of the contents of the Document. The following is a crude example:

```
<Document><name>GMT Data Document</name>
  <Folder><name>Point Features</name>
    <!--This level of folder is inserted only when using -O, -K>
    <Folder><name>file1.dat</name>
      <!--One folder for each input file (not when standard input)>
      <Folder><name>Point Set 0</name>
      <!--One folder per linesegment>
      <!--Points from the first line segment in file file1.dat go here>
      <Folder><name>Point Set 1</name>
      <!--Points from the second line segment in file file1.dat go here>
    </Folder>
  </Folder>
  <Folder><name>Line Features</name>
    <Folder><name>file1.dat</name>
      <!--One folder for each input file (not when standard input)>
      <Placemark><name>Line 0</name>
        <!--Here goes the first line segment>
      </Placemark>
      <Placemark><name>Line 1</name>
        <!--Here goes the second line segment>
      </Placemark>
    </Folder>
  <Folder>
</Document>
```

SEE ALSO

gmtdefaults(1), *GMT*(1), *img2google*(1), *kml2gmt*(1), *ps2raster*(1)

NAME

gmtdigitize – Digitizing and Inverse map transformation of map x/y coordinates

SYNOPSIS

gmtdigitize **−J**_parameters_ **−R**_west_/_east_/_south_/_north_[**r**] [**−A**] [**−C**_device_] [**−D**_limit_] [**−F**] [**−H**[**i**][_nrec_]]
[**−L**_lpi_] [**−N**_namestem_] [**−S**] [**−V**] [**−Zk**|**v**] [**−bo**[**s**|**S**|**d**|**D**[_ncol_]|**c**[_var1/..._]]] [**−m**[_flag_]] [> output.d]

DESCRIPTION

gmtdigitize digitizes points from a digitizer via a serial line connection and computes map coordinates
using the specified map projection. The program is interactive and will take you through the setup proce-
dure and how you will digitize points. The program will determine the actual map scale as well as rotation
of the paper that is taped to the digitizer table. By default the output will go to stdout.

No space between the option flag and the associated arguments. Use upper case for the option
flags and lower case for modifiers.

−J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modi-
        fier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but
        this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value.
        When central meridian is optional, default is center of longitude range on **−R** option. Default stan-
        dard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-**
        to the width, respectively.
        More details can be found in the **psbasemap** man pages.

CYLINDRICAL PROJECTIONS:

−Jc_lon0/lat0/scale_ (Cassini)
−Jcyl_stere/[_lon0/[lat0/]_]_scale_ (Cylindrical Stereographic)
−Jj[_lon0/_]_scale_ (Miller)
−Jm[_lon0/[lat0/]_]_scale_ (Mercator)
−Jm_lon0/lat0/scale_ (Mercator - Give meridian and standard parallel)
−Jo[**a**]_lon0/lat0/azimuth/scale_ (Oblique Mercator - point and azimuth)
−Jo[**b**]_lon0/lat0/lon1/lat1/scale_ (Oblique Mercator - two points)
−Joc_lon0/lat0/lonp/latp/scale_ (Oblique Mercator - point and pole)
−Jq[_lon0/[lat0/]_]_scale_ (Cylindrical Equidistant)
−Jt_lon0/[lat0/]scale_ (TM - Transverse Mercator)
−Ju_zone/scale_ (UTM - Universal Transverse Mercator)
−Jy[_lon0/[lat0/]_]_scale_ (Cylindrical Equal-Area)

CONIC PROJECTIONS:

−Jb_lon0/lat0/lat1/lat2/scale_ (Albers)
−Jd_lon0/lat0/lat1/lat2/scale_ (Conic Equidistant)
−Jl_lon0/lat0/lat1/lat2/scale_ (Lambert Conic Conformal)
−Jpoly[_lon0/[lat0/]_]_scale_ ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−Ja_lon0/lat0[/horizon]/scale_ (Lambert Azimuthal Equal-Area)
−Je_lon0/lat0[/horizon]/scale_ (Azimuthal Equidistant)
−Jf_lon0/lat0[/horizon]/scale_ (Gnomonic)
−Jg_lon0/lat0[/horizon]/scale_ (Orthographic)
−Jg_lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale_ (General Perspective).
−Js_lon0/lat0[/horizon]/scale_ (General Stereographic)

MISCELLANEOUS PROJECTIONS:

            −Jh[*lon0/*]*scale* (Hammer)
            −Ji[*lon0/*]*scale* (Sinusoidal)
            −Jkf[*lon0/*]*scale* (Eckert IV)
            −Jk[**s**][*lon0/*]*scale* (Eckert IV)
            −Jn[*lon0/*]*scale* (Robinson)
            −Jr[*lon0/*]*scale* (Winkel Tripel)
            −Jv[*lon0/*]*scale* (Van der Grinten)
            −Jw[*lon0/*]*scale* (Mollweide)

            NON-GEOGRAPHICAL PROJECTIONS:

            −Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
            −Jxx-scale[**d**|**l**|**p**pow|**t**|**T**][*/y-scale*[**d**|**l**|**p**pow|**t**|**T**]] (Linear, log, and power scaling)
            For geographic projections you can give 1 as the scale will be solved for anyway.

−R   *xmin*, *xmax*, *ymin*, and *ymax* specify the Region of interest. For geographic regions, these limits correspond to *west, east, south,* and *north* and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid. For calendar time coordinates you may either give (a) relative time (relative to the selected **TIME_EPOCH** and in the selected **TIME_UNIT**; append **t** to **−JX**|**x**), or (b) absolute time of the form [*date*]**T**[*clock*] (append **T** to **−JX**|**x**). At least one of *date* and *clock* must be present; the **T** is always required. The *date* string must be of the form [-]yyyy[-mm[-dd]] (Gregorian calendar) or yyyy[-Www[-d]] (ISO week calendar), while the *clock* string must be of the form hh:mm:ss[.xxx]. The use of delimiters and their type and positions must be exactly as indicated (however, input, output and plot formats are customizable; see **gmtdefaults**).

OPTIONS
−A   Give an audible signal each time the digitizer mouse/puck is clicked [Default is silent].

−C   Specify the device (port) to read from [Default is /dev/ttyS0].

−D   Only output a point if it is further than *limit* units from the previous point. Append **c, i, m, p** for cm, inch, meter, or point, respectively [Default is no limit].

−F   Force the program to ask for 4 arbitrary calibration points [Default is to use the 4 corners of the map, if possible].

−H   This option allows you to write out any number of header records to the beginning of the output file. Each record will automatically start with a #-character to indicate comment. Headers are not written if multiple output files are selected with **−N −m**.

−L   Set the digitizer table resolution in lines per inch [2540].

−N   Set name for output file(s). If a regular filename is given, then all digitized data will be written to that file. If the file contains a C-format for an integer (i.e., %d) then the file is used as a format statement to create unique filenames based on the current segment number (e.g., line_%d.d will yield files line_0.d, line_1.d, etc). By default, all output is written to stdout. Multiple segment files requires specifying the **−m** option.

−S   Suppress points that fall outside the specified map region [Default outputs all points].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"]. The program will also duplicate data output to stderr for monitoring.

−Z   Append **v** to prompt for a *z*-value and output it as a third data column. Append **k** to output the button key as the final data column. Both **−Zk** and **−Zv** can be specified. [Default is just 2 column x,y output].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file.

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

EXAMPLES

To digitize lines from a mercator map made for a given region, and save each line segment in individual files called segment_000.xy, segment_001.xy etc, try

gmtdigitize **−R**20/50/12/25 **−Jm**1:1 **−m −N**segment_%3.3d.xy

To digitize seismically defined interfaces from a multichannel seismic section, with horizontal distances from 130 to 970, and vertical times from 0 to 10 seconds, write out the button code, and save all line segment to a single multisegment file, and beep at each click, try

gmtdigitize **−R**130/970/0/10 **−Jx**1/-1 **−m −A −Z** > interfaces.d

SYSTEM SETUP

This applies to the Calcomp DrawingBoard III hooked up to a RedHat Linux workstation. We use /dev/ttyS0 as the serial port and change permissions so that it is world read/write-able. Then, stty -F /dev/ttyS0 evenp will set the terminal settings, which can be checked with stty -F /dev/ttyS0 -a. Setup of digitizer: We use the CalComp 2000 ASCII (Save 3) setup, which has:
Mode: Point
Baud Rate: 9600
Data Bits: 7
Parity: Even
Data Rate: 125 pps
Resolution: 200 lpi
Output Format: Format 0
Emulation: CalComp 2000 ASCII
(A)We need to make a slight modification to the Preset No 3 settings: (1) 2450 LPI instead of 200, and (2) None instead of yes for added CR. These modifications can be changed and saved to Preset 3 on the digitizer but a power outage may reset in back to the factory defaults, necessitating a manual reset of those two settings. (B) Setup tty port. stty -F /dev/ttyS0 evenp (C) Run gmtdigitize. Map scale does not matter; it is computed from the region and plot size.

SEE ALSO

gmtdefaults(l), *GMT*(l), *gmtstitch*(l), *mapproject*(l), *project*(l)

NAME

gmtdp – Line reduction using the Douglas-Peucker algorithm

SYNOPSIS

gmtdp *infiles* **−T***tolerance* [**−H**[**i**][*nrec*]] [**−V**] [**−:**[**i**|**o**]] [**−b**[**i**|**o**][**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−bo**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−m**[**i**|**o**][*flag*]]

DESCRIPTION

gmtdp reads one or more data files (which may be multisegment files; see **−m**) and apply the Douglas-Peucker line simplification algorithm. The method recursively subdivides a polygon until a run of points can be replaced by a straight line segment, with no point in that run deviating from the straight line by more than the tolerance. Have a look at this site to get a visual insight on how the algorithm works http://geometryalgorithms.com/Archive/algorithm_0205/algorithm_0205.htm WARNING: currently this program should be used only with geographical coordinates.

file(s)   One of more data files. If none are supplied then we read standard input.

OPTIONS

−T   Specifies the maximum mismatch tolerance in km.

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 2 input columns].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default is same as input].

−f   Special formatting of input and/or output columns (time or geographical data). Specify **i** or **o** to make this apply only to input or output [Default applies to both]. Give one or more columns (or column ranges) separated by commas. Append **T** (absolute calendar time), **t** (relative time in chosen **TIME_UNIT** since **TIME_EPOCH**), **x** (longitude), **y** (latitude), or **f** (floating point) to each column or column range item. Shorthand **−f**[**i**|**o**]**g** means **−f**[**i**|**o**]**0x,1y** (geographic coordinates).

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

ASCII FORMAT PRECISION

The ASCII output formats of numerical data are controlled by parameters in your .gmtdefaults4 file. Longitude and latitude are formatted according to **OUTPUT_DEGREE_FORMAT**, whereas other values are formatted according to **D_FORMAT**. Be aware that the format in effect can lead to loss of precision in the output, which can lead to various problems downstream. If you find the output is not written with enough precision, consider switching to binary output (**−bo** if available) or specify more decimals using the **D_FORMAT** setting.

EXAMPLE

To reduce the line segment.d using a tolerance of 2 km, run

gmtdp segment.d **−T**2 > new_segment.d

REFERENCES

Douglas, D. H., and T. K. Peucker, Algorithms for the reduction of the number of points required to represent a digitized line of its caricature, *Can. Cartogr., 10*, 112-122, 1973.

This implementation of the algorithm has been kindly provided by Dr. Gary J. Robinson, Environmental Systems Science Centre, University of Reading, Reading, UK (gazza@mail.nerc-essc.ac.uk); his subroutine forms the basis for this program.

SEE ALSO

GMT (1)

NAME
        gmtstitch – Join line segments whose end points match within tolerance

SYNOPSIS
        gmtstitch [*infiles*] [**−C**[*closed*]] [**−D**[*template*]] [**−H**[**i**][*nrec*]] [**−L**[*linkfile*]] [**−Q**[*template*]] [
        −T*cutoff*[**m**|**c**|**e**|**E**|**k**|**K**][/*nn_dist*]] [**−V**] [**−:**[**i**|**o**]] [**−b**[**i**|**o**][**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [
        −bo[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−m**[**i**|**o**][*flag*]]

DESCRIPTION
        gmtstitch reads one or more data files (which may be multisegment files; see **−m**) and examines the coordi-
        nates of the end points of all line segments. If a pair of end points are identical or closer to each other than
        the specified separation tolerance then the two line segments are joined into a single segment. The process
        repeats until all the remaining endpoints no longer pass the tolerance test; the resulting segments are then
        written out to standard output. It it is not clear what the separation tolerance should be then use **−L** to get a
        list of all separation distances and analyze them to determine a suitable cutoff.

        file(s)   One of more data files. If none are supplied then we read standard input.

OPTIONS
        −C   Write all the closed polygons to *closed* [gmtstitch_closed.d] and all other segments as they are to
                    stdout. No stitching takes place. Use **−T***cutoff* to set a minimum separation [0], and if *cutoff* is >
                    0 then we also close the polygons on output.

        −D   For multiple segment data, dump each segment to a separate output file [Default writes a multiple
                    segment file to stdout]. Append a format template for the individual file names; this template
                    must contain a C format specifier that can format an integer argument (the segment number); this
                    is usually %d but could be %8.8d which gives leading zeros, etc. Optionally, it may also contain
                    the format %c *before* the integer; this will then be replaced by C (closed) or O (open) to indicate
                    segment type. [Default is gmtstitch_segment_%d.d]. Note that segment headers will be written in
                    either case. For composite segments, a generic segment header will be written and the segment
                    headers of individual pieces will be written out as comments to make it possible to identify where
                    the stitched pieces came from.

        −H   Input file(s) has header record(s). If used, the default number of header records is
                    N_HEADER_RECS. Use **−Hi** if only input data should have header records [Default will write
                    out header records if the input data have them]. Blank lines and lines starting with # are always
                    skipped.

        −L   Writes the link information to the specified file [links.d]. For each segment we write the original
                    segment id, and for the beginning and end point of the segment we report the id of the closest seg-
                    ment, whether it is the beginning (B) or end (E) point that is closest, and the distance between
                    those points in units determined by **−T**.

        −Q   Used with **−D** to a list file with the names of the individual output files. Optionally, append a file-
                    name template for the individual file names; this template **may** contain a C format specifier that
                    can format an character (C or O for closed or open, respectively). [Default is gmtstitch_list.d].

        −T   Specifies the separation tolerance in the data coordinate units [0]. Append **m** or **c** for minutes or
                    seconds, or **e** or **k** for meters or km (implies **−fg** using use flat Earth approximation. Use **E** or **K**
                    for exact geodesic distances; however. if the current ELLIPSOID is Sphere then spherical great
                    circle distances are used. If two lines has endpoints that are closer than this cutoff they will be
                    joined. Optionally, append /*nn_dist* which adds the requirement that a link will only be made if
                    the second closest connection exceeds the *nn_dist*. The latter distance is assumed to be in the
                    same units as *cutoff*.

        −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

        −:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (lon-
                    gitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

        −bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will
                    force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if

it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 2 input columns].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default is same as input].

−f   Special formatting of input and/or output columns (time or geographical data). Specify **i** or **o** to make this apply only to input or output [Default applies to both]. Give one or more columns (or column ranges) separated by commas. Append **T** (absolute calendar time), **t** (relative time in chosen **TIME_UNIT** since **TIME_EPOCH**), **x** (longitude), **y** (latitude), or **f** (floating point) to each column or column range item. Shorthand **−f[i|o]g** means **−f[i|o]0x,1y** (geographic coordinates).

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

ASCII FORMAT PRECISION

The ASCII output formats of numerical data are controlled by parameters in your .gmtdefaults4 file. Longitude and latitude are formatted according to **OUTPUT_DEGREE_FORMAT**, whereas other values are formatted according to **D_FORMAT**. Be aware that the format in effect can lead to loss of precision in the output, which can lead to various problems downstream. If you find the output is not written with enough precision, consider switching to binary output (**−bo** if available) or specify more decimals using the **D_FORMAT** setting.

EXAMPLES

To combine the digitized multisegment lines segment_*.d (whose coordinates are in cm) into as few complete lines as possible, assuming the end points slop could be up to 0.1 mm, run

gmtstitch segment_*.d **−Tf**0.1 **−m** > new_segments.d

To combine the digitized segments in the multisegment file my_lines.d (whose coordinates are in lon,lat) into as few complete lines as possible, assuming the end points slop could be up to 150 m, and write the complete segments to separate files called Map_segment_0001.dat, Map_segment_0002.dat, etc., run

gmtstitch my_lines.d **−Tf**0.15k **−m −D**Map_segment_%4.4d.dat

SEE ALSO

GMT(1), *mapproject*(1)

NAME
kml2gmt – Extract GMT table data from Google Earth KML files

SYNOPSIS
kml2gmt [*infile*] [−**V**] [−**Z**] [−**:**[**i**|**o**]] [−**bo**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]]

DESCRIPTION
kml2gmt reads a Google Earth KML file and outputs a GMT table file. Only KML files that contain points, lines, or polygons can be processed. This is a bare-bones operation that aims to extract coordinates and the name of the features. The main use is to capture coordinates modified in Google Earth and then reinsert the modified data into the original GMT data file.

infile   Name of the KML file to work on. If not given, standard input is read.

OPTIONS
No space between the option flag and the associated arguments.

−**Z**   Output the altitude coordinates as GMT z coordinates [Default will output just longitude and latitude].

−**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−**:**   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−**bo**   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file.

EXAMPLES
SEE ALSO
gmtdefaults(1), *GMT*(1), *img2google*(1), *ps2raster*(1) *gmt2kml*(1)

NAME
makepattern − make GMT color pattern from b/w pattern or icon

SYNOPSIS
makepattern *1bit.ras | iconfile* **−Cf***r/g/b* **−Cb***r/g/b*

DESCRIPTION
makepattern reads either a Sun 1-bit rasterfile OR a Sun icon file. It then accepts color choices for the foreground and background pixels and colorizes the pattern, writing it as a 8-bit Sun rasterfile on stdout. These patterns may then be used in **GMT** (3.1 or later) **−Gp** settings or by **psimage**.

1bit.ras | iconfile
　　Either a 1-bit Sun rasterfile (standard format, no RLE) or a Sun icon file (as used in **GMT** 3.0).

−Cf　　Sets the color for the foreground pixels (the ones) [black].

−Cb　　Sets the color for the background pixels (the zeros) [white].

WIN32 fix
Since binary redirection under WIN32 does not work, you must specify the output file with **−G***newfile.ras*. This option is only available under WIN32.

EXAMPLES
To create a colorized red/blue 8-bit Sun rasterfile pattern from the old 3.0-style iconpattern stored in file custom.icon, run

makepattern custom.icon **−Cf**red **−Cb**blue > custom.ras

To create a green/blue 8-bit Sun rasterfile pattern from a 1-bit Sun raster called bits.ras, run

makepattern bits.ras **−Cf**green **−Cb**blue > colorbits.ras

SEE ALSO
GMT(1), *psimage*(1)

NAME

nc2xy – Converting netCDF column file(s) to ASCII xy data

SYNOPSIS

nc2xy *files* [**−F***var1/var2/...*] [**−S[r]**] [**−V**] [**−f***colinfo*] [**−bo**]

DESCRIPTION

nc2xy reads one or more netCDF files with column data and writes out those columns in ASCII format to standard output, so that they can be used by **psxy**, **psxyz**, or **xyz2grd**. Modify the precision of the ASCII output format by editing the **D_FORMAT** parameter in your .gmtdefaults4 file or use **−−D_FOR-MAT**=*value* on the command line.

files   Names of netCDF files to be converted.

OPTIONS

−F   Specify up to 10 names of the variables (separated by slashes) to be printed out. All variables to be 1-dimensional and be of equal length. When omited, the first two variables in the netCDF file will be printed.

−S   Suppress output for records with one or more NaN values [Default outputs all nodes]. Append **r** to reverse the suppression, i.e., only output the records with at least one NaN value.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file.

−f   Special formatting of input and/or output columns (time or geographical data). Specify **i** or **o** to make this apply only to input or output [Default applies to both]. Give one or more columns (or column ranges) separated by commas. Append **T** (absolute calendar time), **t** (relative time in chosen **TIME_UNIT** since **TIME_EPOCH**), **x** (longitude), **y** (latitude), or **f** (floating point) to each column or column range item. Shorthand **−f[i|o]g** means **−f[i|o]0x,1y** (geographic coordinates). See also **TIME COORDINATES** below.

TIME COORDINATES

Time coordinates in netCDF files will be recognized as such. The variable's **unit** attribute is parsed to determine the unit and epoch of the time coordinate in the grid. Values are then converted to the internal time system specified by **TIME_UNIT** and **TIME_EPOCH** in the .gmtdefaults file or on the command line. The default output is relative time in that time system, or absolute time when using the option **−f0T**, **−f1T**, etc.

EXAMPLES

To print out latitude, longitude and height in a netCDF file as ASCII records, while suppressing all NaN values:

nc2xy −Flat/lon/height **−S** trackfile.nc > trackfile.xy

SEE ALSO

gmtdefaults(1), *GMT*(1), *psxy*(1), *psxyz*(1), *xyz2grd*(1)

NAME
psmegaplot – To create poster-size *PostScript* plots from page-size plot

SYNOPSIS
psmegaplot *plotfile* **−S***scale* [**−C**]

DESCRIPTION
psmegaplot reads a **GMT**-produced *PostScript* file and 'blows it up' by an arbitrary scale. The result is several plots that make up the pieces in a jigsaw puzzle. Cut and paste these pieces to make a 'megaplot'.

plotfile *PostScript* file as created by the **GMT** programs.

−S   Multiply the x- and y-dimension by *scale*. *scale* must be larger than 1.0.

OPTIONS
No space between the option flag and the associated arguments.

−C   Plot crop marks in each corner of every output page. [Default is no marks]

EXAMPLES
To magnify a contour-map PostScript file 3 times, giving a total of 9 output pages to be pasted together, use

psmegaplot hawaii_contour.ps **−S**3 **−C** > hawaii_contour_megaplot.ps

BUGS
This program is unlikely to work on non-**GMT**-produced *PostScript* files since it anticipates the structure of the file. It also assumes that the output media is Letter size.

SEE ALSO
GMT (1)

NAME
>   pssegy − Create imagemasked postscript from SEGY file

SYNOPSIS
>   **pssegy** *SEGYfile* **−J***parameters* **−R***west/east/south/north*[**r**] **−D***deviation* **−F**[*rgb*|*gray*]|**−W** [**−B***bias*] [
>   **−C***clip*] [**−E***error*] [**−I**] [**−K**] [**−L***nsamp*] [**−M***ntrace*] [**−N**] [**−O**] [**−P**] [**−S***header*] [**−T***filename*
>   ] [**−U***redvel*] [**−V**] [**−X***scale*] [**−Y***sample int*] [**−Z**]

DESCRIPTION
>   **pssegy** reads a native (IEEE) format SEGY file and produces a *PostScript* image of the seismic data. The
>   *imagemask* operator is used so that the seismic data are plotted as a 1-bit deep bitmap in a single (user-
>   specified) color or gray shade, with a transparent background. The bitmap resolution is taken from the cur-
>   rent **GMT** defaults. The seismic traces may be plotted at their true locations using information in the trace
>   headers (in which case order of the traces in the file is not significant). Standard **GMT** geometry routines
>   are used so that in principle any map projection may be used, however it is likely that the geographic pro-
>   jections will lead to unexpected results. Beware also that some parameters have non-standard meanings.
>   Note that the order of operations before the seismic data are plotted is deviation*[clip]([bias]+[normal-
>   ize](sample value)). Deviation determines how far *in the plot coordinates* a [normalized][biased][clipped]
>   sample value of 1 plots from the trace location. The SEGY file should be a disk image of the tape format
>   (ie 3200 byte text header, which is ignored, 400 byte binary reel header, and 240 byte header for each trace)
>   with samples as native real*4 (IEEE real on all the platforms to which I have access)

> *SEGYfile*
>>   Seismic data set to be imaged

> **−J**   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modi-
>>   fier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but
>>   this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value.
>>   When central meridian is optional, default is center of longitude range on **−R** option. Default stan-
>>   dard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-**
>>   to the width, respectively.
>>   More details can be found in the **psbasemap** man pages.

>>   **CYLINDRICAL PROJECTIONS:**

>>   **−Jc***lon0/lat0/scale* (Cassini)
>>   **−Jcyl_stere**/[*lon0/*[*lat0/*]]*scale* (Cylindrical Stereographic)
>>   **−Jj**[*lon0/*]*scale* (Miller)
>>   **−Jm**[*lon0/*[*lat0/*]]*scale* (Mercator)
>>   **−Jm***lon0/lat0/scale* (Mercator - Give meridian and standard parallel)
>>   **−Jo**[**a**]*lon0/lat0/azimuth/scale* (Oblique Mercator - point and azimuth)
>>   **−Jo**[**b**]*lon0/lat0/lon1/lat1/scale* (Oblique Mercator - two points)
>>   **−Joc***lon0/lat0/lonp/latp/scale* (Oblique Mercator - point and pole)
>>   **−Jq**[*lon0/*[*lat0/*]]*scale* (Cylindrical Equidistant)
>>   **−Jt***lon0/*[*lat0/*]*scale* (TM - Transverse Mercator)
>>   **−Ju***zone/scale* (UTM - Universal Transverse Mercator)
>>   **−Jy**[*lon0/*[*lat0/*]]*scale* (Cylindrical Equal-Area)

>>   **CONIC PROJECTIONS:**

>>   **−Jb***lon0/lat0/lat1/lat2/scale* (Albers)
>>   **−Jd***lon0/lat0/lat1/lat2/scale* (Conic Equidistant)
>>   **−Jl***lon0/lat0/lat1/lat2/scale* (Lambert Conic Conformal)
>>   **−Jpoly**[*lon0/*[*lat0/*]]*scale* ((American) Polyconic)

>>   **AZIMUTHAL PROJECTIONS:**

–**Ja***lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
–**Je***lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
–**Jf***lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
–**Jg***lon0/lat0*[*/horizon*]*/scale* (Orthographic)
–**Jg***lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
–**Js***lon0/lat0*[*/horizon*]*/scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

–**Jh**[*lon0/*]*scale* (Hammer)
–**Ji**[*lon0/*]*scale* (Sinusoidal)
–**Jkf**[*lon0/*]*scale* (Eckert IV)
–**Jk**[**s**][*lon0/*]*scale* (Eckert IV)
–**Jn**[*lon0/*]*scale* (Robinson)
–**Jr**[*lon0/*]*scale* (Winkel Tripel)
–**Jv**[*lon0/*]*scale* (Van der Grinten)
–**Jw**[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

–**Jp**[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
–**Jx***x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

–**R**   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands –**Rg** and –**Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the –**R** settings (and grid spacing, if applicable) are copied from the grid.

–**D**   gives the deviation in X units of the plot for 1.0 on the scaled trace.

–**F**[*rgb*|*gray*]
              Fill trace (variable area, defaults to filling positive). rgb or gray gives the color with which the imagemask is filled.

–**W**   Draw wiggle trace.

You *must* specify at least one of –**W** and –**F**.

OPTIONS
        No space between the option flag and the associated arguments.

–**B**   Bias to apply to data (added to sample values).

–**C**   Sample value at which to clip data (clipping is applied to both positive and negative values).

–**E**   Allow *error* difference between requested and actual trace locations when using **-T** option.

–**I**   Fill negative rather than positive excursions.

–**K**   More *PostScript* code will be appended later [Default terminates the plot system].

–**L**   Override number of samples per trace in reel header (program attempts to determine number of samples from each trace header if possible to allow for variable length traces).

–**M**   Override number of traces specified in reel header. Program detects end of file (relatively) gracefully, but this parameter limits number of traces that the program attempts to read.

–**N**   Normalize trace by dividing by rms amplitude over full trace length.

–**O**   Selects Overlay plot mode [Default initializes a new plot system].

−P   Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

−S   Read trace locations from trace headers: header is either c for CDP, o for offset, or b<num> to read a long starting at byte <num> in the header (first byte corresponds to num=0). Default has location given by trace number.

−T   Plot only traces whose location corresponds to a list given in *filename*. Order in which traces are listed is not significant - the entire space is checked for each trace.

−U   Apply reduction velocity by shifting traces *upwards* by redvel/|offset|. Negative velocity removes existing reduction. Units should be consistent with offset in trace header and sample interval.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−X   Multiply trace locations by scale before plotting.

−Y   Override sample interval in reel header.

−Z   Do not plot traces with zero rms amplitude.

EXAMPLES

To plot the SEGY file wa1.segy with normalized traces plotted at true offset locations, clipped at +-3 and with wiggle trace and positive variable area shading in black, use

pssegy wa1.segy **−JX**5/−5 **−R**0/100/0/10 **−D**1 **−C**3 **−N** **−S**o **−W** **−F**black > segy.ps

To plot the SEGY file wa1.segy with traces plotted at true cdp*0.1, clipped at +-3, with bias -1 and negative variable area shaded red, use

pssegy wa1.segy **−JX**5/−5 **−R**0/100/0/10 **−D**1 **−C**3 **−S**c **−X**0.1 **−F**red **−B**−1 **−I** > segy.ps

SEE ALSO

GMT(1), *pssegyz*(1)

NAME

      pssegyz − Create imagemasked postscript from SEGY file

SYNOPSIS

      pssegyz *SEGYfile* **−J***parameters* **−Jz**|**Z***parameters* **−R***west/east/south/north*[*/zmin/zmax*][**r**] **−D***deviation* **−F**[*rgb*|*gray*]|**−W** [**−B***bias*] [**−C***clip*] [**−E***azim/elev*[**+w***lon/lat*[*/z*]][**+v***x0/y0*]] [**−I**] [**−K**] [**−L***nsamp*] [**−M***ntrace*] [**−N**] [**−O**] [**−P**] [**−S***header_x/header_y*] [**−U***redvel*] [**−V**] [**−X***scale*] [**−Y***sample_int*] [**−Z**]

DESCRIPTION

      pssegyz reads a native (IEEE) format SEGY file and produces a *PostScript* image of the seismic data. The *imagemask* operator is used so that the seismic data are plotted as a 1-bit deep bitmap in a single (user-specified) color or gray shade, with a transparent background. The bitmap resolution is taken from the current **GMT** defaults. The seismic traces may be plotted at their true locations using information in the trace headers (in which case order of the traces in the file is not significant). Standard **GMT** geometry routines are used so that in principle any map projection may be used, however it is likely that the geographic projections will lead to unexpected results. Beware also that some parameters have non-standard meanings, and a couple of the options for **pssegy** are not available in **pssegyz**. Note that the order of operations before the seismic data are plotted is deviation*[clip]([bias]+[normalize](sample value)). Deviation determines how far *in the plot coordinates* a [normalized][biased][clipped] sample value of 1 plots from the trace location. The SEGY file should be a disk image of the tape format (ie 3200 byte text header, which is ignored, 400 byte binary reel header, and 240 byte header for each trace) with samples as native real*4 (IEEE real on all the platforms to which I have access)

      SEGYfile

           Seismic data set to be imaged

      −J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modifier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value. When central meridian is optional, default is center of longitude range on **−R** option. Default standard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-** to the width, respectively.

           More details can be found in the **psbasemap** man pages.

           CYLINDRICAL PROJECTIONS:

           −Jc*lon0/lat0/scale* (Cassini)
           −Jcyl_stere/[*lon0/*[*lat0/*]]*scale* (Cylindrical Stereographic)
           −Jj[*lon0/*]*scale* (Miller)
           −Jm[*lon0/*[*lat0/*]]*scale* (Mercator)
           −Jm*lon0/lat0/scale* (Mercator - Give meridian and standard parallel)
           −Jo[**a**]*lon0/lat0/azimuth/scale* (Oblique Mercator - point and azimuth)
           −Jo[**b**]*lon0/lat0/lon1/lat1/scale* (Oblique Mercator - two points)
           −Joc*lon0/lat0/lonp/latp/scale* (Oblique Mercator - point and pole)
           −Jq[*lon0/*[*lat0/*]]*scale* (Cylindrical Equidistant)
           −Jt*lon0/*[*lat0/*]*scale* (TM - Transverse Mercator)
           −Ju*zone/scale* (UTM - Universal Transverse Mercator)
           −Jy[*lon0/*[*lat0/*]]*scale* (Cylindrical Equal-Area)

           CONIC PROJECTIONS:

           −Jb*lon0/lat0/lat1/lat2/scale* (Albers)
           −Jd*lon0/lat0/lat1/lat2/scale* (Conic Equidistant)
           −Jl*lon0/lat0/lat1/lat2/scale* (Lambert Conic Conformal)
           −Jpoly[*lon0/*[*lat0/*]]*scale* ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−Ja_lon0/lat0[/horizon]/scale_ (Lambert Azimuthal Equal-Area)
−Je_lon0/lat0[/horizon]/scale_ (Azimuthal Equidistant)
−Jf_lon0/lat0[/horizon]/scale_ (Gnomonic)
−Jg_lon0/lat0[/horizon]/scale_ (Orthographic)
−Jg_lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale_ (General Perspective).
−Js_lon0/lat0[/horizon]/scale_ (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−Jh[_lon0/_]_scale_ (Hammer)
−Ji[_lon0/_]_scale_ (Sinusoidal)
−Jkf[_lon0/_]_scale_ (Eckert IV)
−Jk[**s**][_lon0/_]_scale_ (Eckert IV)
−Jn[_lon0/_]_scale_ (Robinson)
−Jr[_lon0/_]_scale_ (Winkel Tripel)
−Jv[_lon0/_]_scale_ (Van der Grinten)
−Jw[_lon0/_]_scale_ (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−Jp[**a**]_scale_[_/origin_][**r**|**z**] (Polar coordinates (theta,r))
−Jx_x-scale_[**d**|**l**|**p**_pow_|**t**|**T**][_/y-scale_[**d**|**l**|**p**_pow_|**t**|**T**]] (Linear, log, and power scaling)

−R   _west, east, south,_ and _north_ specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−D   gives the deviation in X units of the plot for 1.0 on the scaled trace, This may be a single number (applied equally in X and Y directions) or devX/devY

−E   Sets the viewpoint's azimuth and elevation (for perspective view) [180/90]. For frames used for animation, you may want to append + to fix the center of your data domain (or specify a particular world coordinate point with +**w**_lon0/lat_[_/z_]) which will project to the center of your page size (or specify the coordinates of the projected veiw point with +**v**_x0/y0_).

−F_[rgb/gray]_
         Fill trace (variable area, defaults to filling positive). rgb or gray gives the color with which the imagemask is filled.

−W   Draw wiggle trace.

You _must_ specify at least one of **−W** and **−F**.

OPTIONS
No space between the option flag and the associated arguments.

−B   Bias to apply to data (added to sample values).

−C   Sample value at which to clip data (clipping is applied to both positive and negative values).

−I   Fill negative rather than positive excursions.

−K   More _PostScript_ code will be appended later [Default terminates the plot system].

−L   Override number of samples per trace in reel header (program attempts to determine number of samples from each trace header if possible to allow for variable length traces).

    −M   Override number of traces specified in reel header. Program detects end of file (relatively) grace-fully, but this parameter limits number of traces that the program attempts to read.

    −N   Normalize trace by dividing by rms amplitude over full trace length.

    −O   Selects Overlay plot mode [Default initializes a new plot system].

    −P   Selects Portrait plotting mode [Default is Landscape, see **gmtdefaults** to change this].

    −S   Read trace locations from trace headers: header is either c for CDP, o for offset, b<num> to read a long starting at byte <num> in the header (first byte corresponds to num=0), or a number to fix the location.
            First parameter for x, second for y. Default has X and Y given by trace number.

    −U   Apply reduction velocity by shifting traces *upwards* by redvel/|offset|. Negative velocity removes existing reduction. Units should be consistent with offset in trace header and sample interval.

    −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

    −X   Multiply trace locations by scale before plotting.

    −Y   Override sample interval in reel header.

    −Z   Do not plot traces with zero rms amplitude.

EXAMPLES

To plot the SEGY file wa1.segy with normalized traces plotted at true offset locations, clipped at +-3 and with wiggle trace and positive variable area shading in black, use

pssegyz wa1.segy **−JX**5/−5 **−D**1 **−Jz**0.05 **−E**180/5 **−R**0/100/0/10/0/10 **−C**3 **−N** **−S**o **−W** **−F**black > segy.ps

BUGS

Variable area involves filling four-sided figures of distressing generality. I *know* that some of the more complex degenerate cases are not dealt with correctly or at all; the incidence of such cases increases as viewing angles become more oblique, and particularly as the viewing elevation increases. Wiggle-trace plotting is not affected.

SEE ALSO

GMT(1), *pssegy*(1)

NAME

    segy2grd – Converting SEGY file to grid file format

SYNOPSIS

    segy2grd *segyfile* **−G***grdfile* **−I***xinc*[*unit*][**=**|**+**][**/***yinc*[*unit*][**=**|**+**]] **−R***west/east/south/north*[**r**] [**−A**[**n**|**z**]] [**−D***xname/yname/zname/scale/offset/title/remark*] [**−F**] [**−N***nodata*] [**−S**[*zfile*]] [**−V**] [**−Z**[*flags*]] [**−:**[**i**|**o**]] [**−bi**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]]

DESCRIPTION

    segy2grd reads an IEEE SEGY file and creates a binary grid file. Either a simple mapping (equivalent to xyz2grd -Z) or a more complicated averaging where a particular grid cell includes values from more than one sample in the SEGY file can be done. **segy2grd** will report if some of the nodes are not filled in with data. Such unconstrained nodes are set to a value specified by the user [Default is NaN]. Nodes with more than one value will be set to the average value.

    segyfile   ASCII [or binary] file holding z or (x,y,z) values. xyz triplets do not have to be sorted (for binary triplets, see **−b**). 1-column z tables must be sorted and the **−Z** must be set).

    −G   *grdfile* is the name of the binary output grid file.

    −I   *x_inc* [and optionally *y_inc*] is the grid spacing. Append **m** to indicate minutes or **c** to indicate seconds.

    −R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

OPTIONS

    −A   Add up multiple values that belong to the same node (same as **−Az**). Append **n** to simply count the number of data points that were assigned to each node. [Default (no **−A** option) will calculate mean value]. Not used for simple mapping.

    −D   Give values for *xname, yname, zname, scale, offset, title,* and *remark*. To leave some of these values untouched, specify = as the value.

    −F   Force pixel registration [Default is grid registration].

    −N   No data. Set nodes with no input sample to this value [Default is NaN].

    −S   set variable spacing *header* is c for cdp, o for offset, b<number> for 4-byte float starting at byte number If -S not set, assumes even spacing of samples at the dx, dy supplied with -I

    −L   Override number of samples in each trace

    −X   applies scalar *x-scale* to coordinates in trace header to match the coordinates specified in -R

    −Y   Specifies sample interval as *s_int* if incorrect in the SEGY file

    −M   Fix number of traces to read in. Default tries to read 10000 traces. -M0 will read number in binary header, -Mn will attempt to read only n traces.

    −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

    To create a grid file from an even spaced SEGY file test.segy, try

    segy2grd test.segy **−I**0.1/0.1 **−G**test.grd **−R**198/208/18/25 **−V**

    Note that this will read in 18-25s (or km) on each trace, but the first trace will be assumed to be at X=198

To create a grid file from the SEGY file test.segy, locating traces according to the CDP number, where there are 10 CDPs per km and the sample interval is 0.1, try

segy2grd test.segy **−G**test.grd **−R**0/100/0/10 **−I**0.5/0.2 **−V** **−X**0.1 **−Y**0.1

Because the grid interval is larger than the SEGY file sampling, the individual samples will be averaged in bins

SEE ALSO

GMT(1), *grd2xyz*(1), *grdedit*(1), *pssegy*(1)

NAME

      sphdistance – Calculate nearest distances from Voronoi construction of spherical data

SYNOPSIS

      sphdistance *infiles* **–G***grdfile* [**–C**] [**–D**] [**–E**] [**–F**] [**–H**[**i**][*nrec*]] [**–I***xinc*[*unit*][**=**|**+**][**/***yinc*[*unit*][**=**|**+**]]
      ] [**–L***unit*] [**–Q***voronoi.d*] [**–R***west/east/south/north*[**r**]] [**–V**] [**–:**[**i**|**o**]] [
      –b[**i**|**o**][**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**–m**[**i**|**o**][*flag*]]

DESCRIPTION

      sphdistance reads one or more ASCII [or binary] files (or standard input) containing lon, lat and performs
      the construction of Voronoi polygons. These polygons are then processed to calculate the nearest distance
      to each node of the lattice and written to the specified grid. The Voronoi algorithm used is STRIPACK. As
      an option, you may provide pre-calculated Voronoi polygon file in the format written by **sphtriangulate**,
      thus bypassing the memory- and time-consuming triangularization.

      infiles   Data files with the point coordinates in ASCII (or binary; see **–b**). If no files are given the stan-
                   dard input is read.

OPTIONS

      –C   For large data set you can save some memory (at the expense of more processing) by only storing
             one form of location coordinates (geographic or Cartesian 3-D vectors) at any given time, translat-
             ing from one form to the other when necessary [Default keeps both arrays in memory]. Not appli-
             cable with **–Q**.

      –D   Used with **–m** to skip the last (repeated) input vertex at the end of a closed segment if it equals the
             first point in the segment. Requires **–m** [Default uses all points].

      –E   Instead of computing distances, return the ID numbers of the Voronoi polygons that each grid node
             is inside [Default computes distances].

      –H   Input file(s) has header record(s). If used, the default number of header records is
             N_HEADER_RECS. Use **–Hi** if only input data should have header records [Default will write
             out header records if the input data have them]. Blank lines and lines starting with # are always
             skipped.

      –I   *x_inc* [and optionally *y_inc*] is the grid spacing. Optionally, append a suffix modifier. **Geographi-**
             cal (degrees) coordinates: Append **m** to indicate arc minutes or **c** to indicate arc seconds. If one
             of the units **e**, **k**, **i**, or **n** is appended instead, the increment is assumed to be given in meter, km,
             miles, or nautical miles, respectively, and will be converted to the equivalent degrees longitude at
             the middle latitude of the region (the conversion depends on **ELLIPSOID**). If */y_inc* is given but
             set to 0 it will be reset equal to *x_inc*; otherwise it will be converted to degrees latitude. **All coor-**
             dinates: If = is appended then the corresponding max *x* (*east*) or *y* (*north*) may be slightly adjusted
             to fit exactly the given increment [by default the increment may be adjusted slightly to fit the given
             domain]. Finally, instead of giving an increment you may specify the *number of nodes* desired by
             appending + to the supplied integer argument; the increment is then recalculated from the number
             of nodes and the domain. The resulting increment value depends on whether you have selected a
             gridline-registered or pixel-registered grid; see Appendix B for details. Note: if **–R***grdfile* is used
             then grid spacing has already been initialized; use **–I** to override the values.

      –L   Specify the unit used for distance calculations. Choose among **e** (m), **k** (km), **m** (mile), **n** (nautical
             mile), or **d** (spherical degree). A spherical approximation is used unless **ELLIPSOID** is set to an
             actual ellipsoid. **–N** Read the information pertaining to each Voronoi polygon (the unique node
             lon, lat and polygon area) from a separate file [Default aquires this information from the ASCII
             segment headers of the output file]. Required if binary input via **–Q** is used.

      –Q   Append the name of a file with pre-calculated Voronoi polygons [Default performs the Voronoi
             construction on input data]. For binary data **–bi** you must specify the node information separately
             (via **–N**).

      –R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
             degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map

coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 2 input columns].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default is same as input].

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

ASCII FORMAT PRECISION

The ASCII output formats of numerical data are controlled by parameters in your .gmtdefaults4 file. Longitude and latitude are formatted according to **OUTPUT_DEGREE_FORMAT**, whereas other values are formatted according to **D_FORMAT**. Be aware that the format in effect can lead to loss of precision in the output, which can lead to various problems downstream. If you find the output is not written with enough precision, consider switching to binary output (**−bo** if available) or specify more decimals using the **D_FORMAT** setting.

GRID VALUES PRECISION

Regardless of the precision of the input data, GMT programs that create grid files will internally hold the grids in 4-byte floating point arrays. This is done to conserve memory and furthermore most if not all real data can be stored using 4-byte floating point values. Data with higher precision (i.e., double precision values) will lose that precision once GMT operates on the grid or writes out new grids. To limit loss of precision when processing data you should always consider normalizing the data prior to processing.

EXAMPLES

To construct Voronoi polygons from the points in the file testdata.txt and then calculate distances from the data to a global 1x1 degree grid, use

sphdistance testdata.txt **−Rg −I**1 **−G**globedist.grd

To generate the same grid in two steps using **sphtriangulate** separately, try

sphtriangulate testdata.txt **−Qv** > voronoi.d
sphdistance −Qvoronoi.d **−Rg −I**1 **−G**globedist.grd

SEE ALSO

GMT(1), *sphinterpolate*(1) *sphtriangulate*(1) *triangulate*(1)

REFERENCES

Renka, R, J., 1997, Algorithm 772: STRIPACK: Delaunay Triangulation and Voronoi Diagram on the Surface of a Sphere, *AMC Trans. Math. Software, 23* (3), 416–434.

NAME

sphtriangulate – Perform optimal Delauney triangulation or Voronoi construction of spherical data

SYNOPSIS

sphtriangulate *infiles* [−**A**] [−**C**] [−**D**] [−**H**[**i**][*nrec*]] [−**L***unit*] [−**N***nfile*] [−**Qd**|**v**] [−**T**] [−**V**] [−**:**[**i**|**o**]] [−**b**[**i**|**o**][**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/*...]]] [−**m**[**i**|**o**][*flag*]]

DESCRIPTION

sphtriangulate reads one or more ASCII [or binary] files (or standard input) containing lon, lat and performs a spherical Delauney triangulation, i.e., it find how the points should be connected to give the most equilateral triangulation possible on the sphere. Optionally, you may choose −**Qv** which will do further processing to obtain the Voronoi polygons. Normally, either set of polygons will be written as fillable multi-segment output; use −**T** to write unique arcs instead. As an option, compute the area of each triangle or polygon. The algorithm used is STRIPACK.

infiles   Data files with the point coordinates in ASCII (or binary; see −**b**). If no files are given the standard input is read.

OPTIONS

−**A**   Compute the area of the spherical triangles (−**Qd**) or polygons (−**Qv**) and write the areas (in chosen units; see −**L**) in the multisegment output headers [no areas calculated].

−**C**   For large data set you can save some memory (at the expense of more processing) by only storing one form of location coordinates (geographic or Cartesian 3-D vectors) at any given time, translating from one form to the other when necessary [Default keeps both arrays in memory].

−**D**   Used with −**m** to skip the last (repeated) input vertex at the end of a closed segment if it equals the first point in the segment. Requires −**m** [Default uses all points].

−**H**   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use −**Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−**L**   Specify the unit used for distance and area calculations. Choose among **e** (m), **k** (km), **m** (mile), **n** (nautical mile), or **d** (spherical degree). A spherical approximation is used unless **ELLIPSOID** is set to an actual ellipsoid. When degree is selected the areas are given in steradians.

−**N**   Write the information pertaining to each polygon (for Delauney: the three node number and the triangle area; for Voronoi the unique node lon, lat and polygon area) to a separate file [Default puts this information in the segment headers of the output file]. Required if binary output is needed.

−**T**   Write the unique arcs of the construction [Default writes fillable triangles or polygons]. When used with −**A** we store arc lenght in the segment header in chosen unit (see −**L**).

−**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−**:**   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−**bi**   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/*... to specify the variables to be read. [Default is 2 input columns].

−**bo**   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default is same as input].

−**m**   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and −**b** must set the number of output columns explicitly. By default the −**m** setting applies to both input and output. Use −**mi** and −**mo** to give separate settings to input and output.

ASCII FORMAT PRECISION

The ASCII output formats of numerical data are controlled by parameters in your .gmtdefaults4 file. Longitude and latitude are formatted according to **OUTPUT_DEGREE_FORMAT**, whereas other values are formatted according to **D_FORMAT**. Be aware that the format in effect can lead to loss of precision in the output, which can lead to various problems downstream. If you find the output is not written with enough precision, consider switching to binary output (**−bo** if available) or specify more decimals using the **D_FORMAT** setting.

GRID VALUES PRECISION

Regardless of the precision of the input data, GMT programs that create grid files will internally hold the grids in 4-byte floating point arrays. This is done to conserve memory and furthermore most if not all real data can be stored using 4-byte floating point values. Data with higher precision (i.e., double precision values) will lose that precision once GMT operates on the grid or writes out new grids. To limit loss of precision when processing data you should always consider normalizing the data prior to processing.

EXAMPLES

To triangulate the points in the file testdata.txt, and make a Voronoi diagram via **psxy**, use

sphtriangulate testdata.txt **−Qv** | psxy **−Rg −JG**30/30/6i **−M −L −P −W**1p **−B**0g30 | gv −

To compute the optimal Delauney triangulation network based on the multiple segment file globalnodes.d and save the area of each triangle in the header record, try

sphtriangulate globalnodes.d **−M −Qd −A** > global_tri.d

SEE ALSO

GMT (1), *triangulate*(1) *sphinterpolate*(1) *sphdistance*(1)

REFERENCES

Renka, R, J., 1997, Algorithm 772: STRIPACK: Delaunay Triangulation and Voronoi Diagram on the Surface of a Sphere, *AMC Trans. Math. Software, 23* (3), 416–434.

NAME

sphinterpolate – Gridding in tension of spherical data

SYNOPSIS

sphinterpolate *infiles* **−G***grdfile* [**−F**] [**−H**[**i**][*nrec*]] [**−I***xinc*[*unit*][=|+][/*yinc*[*unit*][=|+]]] [**−Q***mode*[/*options*]] [**−R***west/east/south/north*[**r**]] [**−V**] [**−Z**] [**−:**[**i**|**o**]] [**−b**[**i**|**o**][**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1*/...]]][**−m**[**i**|**o**][*flag*]]

DESCRIPTION

sphinterpolate reads one or more ASCII [or binary] files (or standard input) containing lon, lat, f and performs a Delaunay triangulation to set up a spherical interpolation in tension. The final grid is saved to the specified file. Several options may be used to affect the outcome, such as choosing local versus global gradient estimation or optimize the tension selection to satisfy one of four criteria.

infiles   Data files with the (lon, lat, f) coordinates in ASCII (or binary; see **−b**). If no files are given the standard input is read.

OPTIONS

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−I   *x_inc* [and optionally *y_inc*] is the grid spacing. Optionally, append a suffix modifier. **Geographical (degrees) coordinates**: Append **m** to indicate arc minutes or **c** to indicate arc seconds. If one of the units **e**, **k**, **i**, or **n** is appended instead, the increment is assumed to be given in meter, km, miles, or nautical miles, respectively, and will be converted to the equivalent degrees longitude at the middle latitude of the region (the conversion depends on **ELLIPSOID**). If /*y_inc* is given but set to 0 it will be reset equal to *x_inc*; otherwise it will be converted to degrees latitude. **All coordinates**: If = is appended then the corresponding max *x* (*east*) or *y* (*north*) may be slightly adjusted to fit exactly the given increment [by default the increment may be adjusted slightly to fit the given domain]. Finally, instead of giving an increment you may specify the *number of nodes* desired by appending + to the supplied integer argument; the increment is then recalculated from the number of nodes and the domain. The resulting increment value depends on whether you have selected a gridline-registered or pixel-registered grid; see Appendix B for details. Note: if **−R***grdfile* is used then grid spacing has already been initialized; use **−I** to override the values.

−Q   Specify one of four ways to calculate tension factors to preserve local shape properties or satisfy arc constraints [Default is no tension].

−Q0   Piecewise linear interpolation; no tension is applied.

−QQ1   Smooth interpolation with local gradient estimates.

−QQ2   Smooth interpolation with global gradient estimates. You may optionally append /*N/M/U*, where *N* is the number of iterations used to converge at solutions for gradients when variable tensions are selected (e.g., **−T** only) [3], *M* is the number of Gauss-Seidel iterations used when determining the global gradients [10], and *U* is the maximum change in a gradient at the last iteration [0.01].

−QQ3   Smoothing. Optionally append /*E/U* [/0/0], where *E* is Expected squared error in a typical (scaled) data value, and *U* is Upper bound on weighted sum of squares of deviations from data.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−T   Use variable tension (ignored with **−Q**0 [constant]

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−Z   Before interpolation, scale data by the maximum data range [no scaling].

−:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

−bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 3 input columns].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default is same as input].

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

ASCII FORMAT PRECISION

The ASCII output formats of numerical data are controlled by parameters in your .gmtdefaults4 file. Longitude and latitude are formatted according to **OUTPUT_DEGREE_FORMAT**, whereas other values are formatted according to **D_FORMAT**. Be aware that the format in effect can lead to loss of precision in the output, which can lead to various problems downstream. If you find the output is not written with enough precision, consider switching to binary output (**−bo** if available) or specify more decimals using the **D_FORMAT** setting.

GRID VALUES PRECISION

Regardless of the precision of the input data, GMT programs that create grid files will internally hold the grids in 4-byte floating point arrays. This is done to conserve memory and furthermore most if not all real data can be stored using 4-byte floating point values. Data with higher precision (i.e., double precision values) will lose that precision once GMT operates on the grid or writes out new grids. To limit loss of precision when processing data you should always consider normalizing the data prior to processing.

EXAMPLES

To interpolate the points in the file testdata.txt on a global 1x1 degree grid with no tension, use

sphinterpolate testdata.txt **−Rg −I**1 **−G**solution.grd

SEE ALSO

GMT(1), *greenspline*(1) *sphdistance*(1) *sphtriangulate*(1) *triangulate*(1)

REFERENCES

Renka, R, J., 1997, Algorithm 772: STRIPACK: Delaunay Triangulation and Voronoi Diagram on the Surface of a Sphere, *AMC Trans. Math. Software, 23* (3), 416–434.

Renka, R, J,, 1997, Algorithm 773: SSRFPACK: Interpolation of scattered data on the Surface of a Sphere with a surface under tension, *AMC Trans. Math. Software, 23* (3), 435-442.

NAME

backtracker – Reconstruct points, flowlines and hotspot tracks

SYNOPSIS

backtracker [*infile(s)*] **−E***rotations.txt* | **−e***lon/lat/angle* [**−A**[*young/old*]] [**−C**] [**−Df|b**] [**−H**[**i**][*nrec*]] [**−Lf|b***step*] [**−N***upper_age*] [**−Q***fixed_age*] [**−S***filestem*] [**−T***zero_age*] [**−V**] [**−W**[**a|t**]] [**−:**[**i|o**]] [**−b**[**i|o**][**s|S|d|D**[*ncol*]|**c**[*var1/...*]]] [**−m**[**i|o**][*flag*]]

DESCRIPTION

backtracker reads (longitude, latitude, age) positions from *infiles* [or standard input] and computes rotated (x,y,t) coordinates using the specified rotation parameters. It can either calculate final positions [Default] or create a sampled track (flowline or hotspot track) between the initial and final positions. The former mode allows additional data fields after the first 3 columns which must have (longitude,latitude,age). See option **−:** on how to read (latitude,longitude,age) files.

No space between the option flag and the associated arguments. Use upper case for the option flags and lower case for modifiers.

infile(s) Data file(s) to be projected. If not given, standard input is read.

−E Give file with rotation parameters. This file must contain one record for each rotation; each record must be of the following format:

lon lat tstart [tstop] angle [*khat a b c d e f g df*]

where *tstart* and *tstop* are in Myr and *lon lat angle* are in degrees. *tstart* and *tstop* are the ages of the old and young ends of a stage. If **−C** is set then a total reconstruction rotation is expected and *tstop* is implicitly set to 0 and should not be specified in the file. If a covariance matrix **C** for the rotation is available it must be specified in a format using the nine optional terms listed in brackets. Here, **C** = (*g/khat*)*[*a b d; b c e; d e f*] which shows **C** made up of three row vectors. If the degrees of freedom (*df*) in fitting the rotation is 0 or not given it is set to 10000. Blank lines and records whose first column contains # will be ignored.

−e Alternatively, specify the longitude, latitude, and opening angle (all in degrees and separated by /) for a single total reconstruction rotation that should be applied to all input points.

OPTIONS

−A Used in conjunction with **−Lb|f** to limit the track output to those sections whose predicted ages lie between the specified *young* and *old* limits. If **−LB|F** is used instead then the limits apply to the stage ids (id 1 is the youngest stage). If no limits are specified then individual limits for each record are expected in columns 4 and 5 of the input file.

−C Expect Total Reconstruction Rotations rather than Forward Stage Rotations [Default]. File format is similar to the stage pole format except that the *tstart* column is not present (assumed to be 0 Ma). Requires **−E**.

−D Set the direction to go: **−Df** will go backward in time (from younger to older positions), while **−Db** will go forward in time (from older to younger positions) [Default]. Note: For **−Db** you are specifying the age at the given location, whereas for **−Df** you are not; instead you specify the age at the reconstructed point.

−H Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−L Specify a sampled path between initial and final position: **−Lf** will draw particle flowlines, while **−Lb** will draw backtrack (hotspot track) paths. Append sampling interval in km. If *step* < 0 then only the rotation times will be returned. When **−LF** or **−LB** is used, the third output column will contain the stage id (1 is youngest) [Default is along-track predicted ages]. You can control the direction of the paths by using **−D**.

–N   Set the maximum age to extend the oldest stage rotation back in time [Default is no extension].

–Q   Assign a fixed age to all positions. Only lon, lat input is expected [Default expects longitude, latitude, age]. Useful when the input are points defining isochrons.

–S   When –L is set, the tracks are normally written to stdout as a multisegment file. Specify a *filestem* to have each track written to *filestem.#*, where # is the track number. The track number is also copied to the 4th output column.

–T   Set the current time [Default is 0 Ma].

–V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

–W   Rotates the given input (lon,lat,t) and calculates the confidence ellipse for the projected point. The input point *must* have a time coordinate that exactly matches a particular finite rotation time, otherwise the point will be skipped. Append **t** or **a** to output time or angle, respectively, after the projected lon, lat. After these 2-3 items, we write azimuth, major, minor (in km) for the 95% confidence ellipse. See –D for the direction of rotation.

–:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

–bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 3 input columns].

–bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default depends on settings].

–m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and –**b** must set the number of output columns explicitly. By default the –**m** setting applies to both input and output. Use –**mi** and –**mo** to give separate settings to input and output.

EXAMPLES

To backtrack the (x,y,t) points in the file seamounts.d to their origin (presumably the hotspot), using the DC85.d Euler poles, run

backtracker seamounts.d –**Db** –**E**DC85.d > newpos.d

To project flowlines forward from the (x,y,t) points stored in several 3-column, binary, double precision files, run

backtracker points.* –**Df** –**E**DC85.d –**L**f25 –**bo** –**bi***3* > lines.b

This file can then be plotted with **psxy** –**M**.

SEE ALSO

GMT(1), *project*(1), *mapproject*(1), *hotspotter*(1), *originator*(1)

REFERENCES

Wessel, P., 1999, "Hotspotting" tools released, EOS Trans. AGU, 80 (29), p. 319.

NAME

      hotspotter – Create CVA image from seamount flowlines

SYNOPSIS

      hotspotter   [*infile(s)*]   **−E***stage_file*   **−G***CVAgrid*   **−I***xinc*[*unit*][=|+][/*yinc*[*unit*][=|+]]
      −R*west*/*east*/*south*/*north*[**r**] [**−C**] [**−D***factor*] [**−F**] [**−H**[**i**][*nrec*]] [**−N***upper_age*] [**−S**] [**−T**] [**−V**] [
      −:[**i**|**o**]] [**−bi**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/*...]]]

DESCRIPTION

      hotspotter reads (longitude, latitude, amplitude, radius, age) records from *infiles* [or standard input] and
      calculates flowlines using the specified stage pole (Euler) rotations. These flowlines are convolved with the
      shape of the seamount (using a Gaussian shape given amplitude and radius = 6 sigma) and added up to give
      a Cumulative Volcano Amplitude grid (CVA). See option **−:** on how to read (latitude,longitude,...) files.

      No space between the option flag and the associated arguments. Use upper case for the option
      flags and lower case for modifiers.

    infile(s) Data file(s) to be processed. If not given, standard input is read.

    −E   Give file with rotation parameters. This file must contain one record for each rotation; each record
           must be of the following format:

                      lon lat tstart [tstop] angle [*khat a b c d e f g df*]

           where *tstart* and *tstop* are in Myr and *lon lat angle* are in degrees. *tstart* and *tstop* are the ages of
           the old and young ends of a stage. If **−C** is set then a total reconstruction rotation is expected and
           tstop is implicitly set to 0 and should not be specified in the file. If a covariance matrix **C** for the
           rotation is available it must be specified in a format using the nine optional terms listed in brack-
           ets. Here, **C** = (*g/khat*)*[*a b d; b c e; d e f*] which shows **C** made up of three row vectors. If the
           degrees of freedom (*df*) in fitting the rotation is 0 or not given it is set to 10000. Blank lines and
           records whose first column contains # will be ignored.

    −G   Specify name for output grid file.

    −I   *x_inc* [and optionally *y_inc*] is the grid spacing. Optionally, append a suffix modifier. **Geographi-**
           cal (degrees) coordinates: Append **m** to indicate arc minutes or **c** to indicate arc seconds. If one
           of the units **e**, **k**, **i**, or **n** is appended instead, the increment is assumed to be given in meter, km,
           miles, or nautical miles, respectively, and will be converted to the equivalent degrees longitude at
           the middle latitude of the region (the conversion depends on **ELLIPSOID**). If /*y_inc* is given but
           set to 0 it will be reset equal to *x_inc*; otherwise it will be converted to degrees latitude. **All coor-**
           dinates: If = is appended then the corresponding max *x* (*east*) or *y* (*north*) may be slightly adjusted
           to fit exactly the given increment [by default the increment may be adjusted slightly to fit the given
           domain]. Finally, instead of giving an increment you may specify the *number of nodes* desired by
           appending + to the supplied integer argument; the increment is then recalculated from the number
           of nodes and the domain. The resulting increment value depends on whether you have selected a
           gridline-registered or pixel-registered grid; see Appendix B for details. Note: if **−R***grdfile* is used
           then grid spacing has already been initialized; use **−I** to override the values.

    −R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
           degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map
           coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global
           domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively,
           specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are
           copied from the grid.

OPTIONS

    −C   Expect Total Reconstruction Rotations rather than Forward Stage Rotations [Default]. File format
           is similar to the stage pole format except that the *tstart* column is not present (assumed to be 0
           Ma).

–D   Modify the sampling interval along flowlines. Default [0.5] gives approximately 2 points within each grid box. Smaller factors gives higher resolutions at the expense of longer processing time.

–F   Force pixel registration [Default is grid registration].

–H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **–Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

–N   Set the upper age to assign seamounts whose crustal age is unknown (i.e. NaN) [no upper age].

–S   Normalize the resulting CVA grid to percentages of the CVA maximum.

–T   Truncate seamount ages exceeding the upper age set with **–N** [no truncation].

–V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

–:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (longitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

–bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 5 input columns].

EXAMPLES

To create a CVA image from the Pacific (x,y,z,r,t) data in the file seamounts.d, using the DC85.d Euler poles, run

hotspotter seamounts.d **–E**DC85.d **–G**CVA.grd **–R**130/260/-66/60 **–I**10**m** **–N**145 **–T** **–V**

This file can then be plotted with **grdimage**.

SEE ALSO

GMT(1), *grdimage*(1), *project*(1), *mapproject*(1), *backtracker*(1), *originator*(1)

REFERENCES

Wessel, P., 1999, "Hotspotting" tools released, EOS Trans. AGU, 80 (29), p. 319.

NAME

rotconverter – Manipulate finite and stage rotations

SYNOPSIS

rotconverter [+|-] *rotA* [+|- *rotB*] [+|- *rotC*] ... [−**C**[**a**|**t**]] [−**D**] [−**F***in/out*] [−**N**] [−**S**] [−**T**] [−**V**]

DESCRIPTION

rotconverter reads one or more plate motion models (rotations) stored in the given files. If more than one plate motion model is given we will add or subtract them in the order they were listed. The minus sign means we should first transpose the rotation and then add it to the previous rotation. The input files must all be of the same type (stage poles or finite rotations) which may differ from the desired output format; see −**F**. If a file cannot be opened we will attempt to decode the file name as a single rotation whose parameters are separated by slashes.

No space between the option flag and the associated arguments. Use upper case for the option flags and lower case for modifiers.

rotX   Name of a file with a plate motion model. Separate several files with desired operator (+ or -). The very first file may also have a leading minus to imply a transpose. If any of the specified rotation models cannot be opened as a file, we will try to decode the file name as *lon/lat/tstart*[*/tstop*]*/angle* for a single rotation given on the command line. The *tstop* argument is required for stage poles only. For a finite rotation without any time information, give *lon/lat/angle* only.

OPTIONS

−**C**   Write out a column header record identifying the various columns [Default is no header record]. Append **a** to indicate opening angles and **t** to indicate opening rates [Default].

−**D**   Report longitudes use the -180/+180 range [Default is 0/360].

−**F**   Specify both the input and output format for rotations. The *in* and *out* flags must be either **f** or **s** for finite or stage rotations, respectively. Note that both must be specified if −**F** is set [Default is −**Fff** (both input and output are finite rotations)].

−**N**   Place all output poles in the northern hemisphere [Default reports positive rotation angles].

−**S**   Place all output poles in the southern hemisphere [Default reports positive rotation angles].

−**T**   Transpose the final result, i.e., change the sign of the rotation angles.

−**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"]. Report statistics of extracted rotations.

EXAMPLES

To convert the finite rotations in the file model_finite.APM to stage poles, run

rotconverter model_finite.APM −**Ffs** > model_stages.APM

To obtain Nazca motion relative to Pacific hotspots by adding the motion of Nazca relative to a fixed Pacific to the Pacific-Hotspot reference model DC85_stages.d, and report the result as finite reconstruction poles in the northern hemisphere, try

rotconverter DC85_stages.APM + Pac_Naz_stages.RPM −**N** −**Fsf** > Naz_HS_finite.APM

To add the final rotations ROT(150.1, 70.5, -20.3) and ROT (145.0, 40.0, 11.4), try

rotconverter 150.1/70.5/-20.3 + 145/40/11.4

which prints out 157.32, -80.44, 11.97.

SEE ALSO

backtracker(1), *hotspotter*(1), *originator*(1)

NAME

grdrotater – Rotate a grid using a finite rotation

SYNOPSIS

grdrotate *ingrdfile* **−G***outgrdfile* **−T***plon/plat/omega* [**−F***polygonfile*] [**−H**[**i**][*nrec*]] [**−N**] [**−Q**[**b**|**c**|**l**|**n**][[**/**]*threshold*]] [**−R***west/east/south/north*[**r**]] [**−S**] [**−V**] [**−:**[**i**|**o**]] [**−b**[**i**|**o**][**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−m**[*flag*]]

DESCRIPTION

grdrotater reads a geographical grid and reconstructs it given a total reconstruction rotation. Optionally, the user may supply a clipping polygon in multiple-segment format; then, only the part of the grid inside the polygon is used to determine the return grid region. The outline of the projected region is returned on stdout.

No space between the option flag and the associated arguments. Use upper case for the option flags and lower case for modifiers.

ingrdfile
    Name of a grid file in geographical (lon, lat) coordinates.

−G   Name of output grid. This is the grid with the data reconstructed according to the specified rotation.

−T   Finite rotation. Specify the longitude and latitude of the rotation pole and the opening angle, all in degrees.

OPTIONS

−F   Specify a multi-segment closed polygon file that describes the inside area of the grid that should be projected [Default projects entire grid].

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−N   Do Not output the rotated polygon outline [Default will write it to stdout].

−Q   Quick mode, use bilinear rather than bicubic interpolation [Default]. Alternatively, select the interpolation mode by adding **b** for B-spline smoothing, **c** for bicubic interpolation, **l** for bilinear interpolation or **n** for nearest-neighbor value. Optionally, append *threshold* in the range [0,1]. This parameter controls how close to nodes with NaN values the interpolation will go. E.g., a *threshold* of 0.5 will interpolate about half way from a non-NaN to a NaN node, whereas 0.1 will go about 90% of the way, etc. [Default is 1, which means none of the (4 or 16) nearby nodes may be NaN]. **−Q0** will just return the value of the nearest node instead of interpolating. This is the same as using **−Qn**.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid.

−S   Skip the rotation of the grid, just rotate the polygon outline (requires **−F**).

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−:   Toggles between (longitude,latitude) and (latitude,longitude) input/output. [Default is (longitude,latitude)].

−bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append *var1/var2/...* to specify the variables to be read. [Default is 2 input columns].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file. [Default is same as input].

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

EXAMPLES

To rotate the data defined by grid topo.grd and the polygon outline clip_path.d, using a finite rotation with pole at (135.5, -33.0) and a rotation angle of 37.3 degrees and bicubic interpolation, try

grdrotater topo.grd **−T**135.5/-33/37.3 **−V −F**clip_path.d **−G**rot_topo.grd > rot_clip_path.d

To rotate the entire grid faa.grd using a finite rotation pole at (67:45W, 22:35S) and a rotation angle of 19.6 degrees using a bilinear interpolation, try

grdrotater faa.grd **−T**67:45W/22:35S/19.6 **−V −Q −G**rot_faa.grd > rot_faa_path.d

To just see how the outline of the grid large.grd will plot after the same rotation, try

grdrotater large.grd **−T**67:45W/22:35S/19.6 **−V −S** | psxy **−Rg −JH**180/6i **−B**30 **−m −W**0.5p | gv -

Let say you have rotated gridA.grd and gridB.grd, restricting each rotation to nodes inside polygons polyA.d and polyB.d, respectively, using rotation A = (123W,22S,16,4) and rotation B = (108W, 16S, -14.5), yielding rotated grids rot_gridA.grd and rot_gridB.grd. To determine the region of overlap between the rotated grids, we use grdmath:

grdmath 1 rot_gridA.grd ISNAN SUB 1 rot_gridB.grd ISNAN SUB 2 EQ = overlap.grd

The grid overlap.grd now has 1s in the regions of overlap and 0 elsewhere. You can use it as a mask or use grdcontour to extract a polygon (contour).

SEE ALSO

backtracker(1), *hotspotter*(1), *originator*(1) *rotconverter*(1)

NAME

grdspotter – Create CVA image directly from gravity or bathymetry grids

SYNOPSIS

grdspotter [*grdfile*] **−E***rotations_file* **−G***CVAgrid* **−I***xinc*[*unit*][=|+][/*yinc*[*unit*][=|+]]
−R*west/east/south/north*[**r**] [**−A***agegrid*] [**−B***n_try*] [**−C**] [**−D***DIgrid*] [**−F**] [**−M**] [**−N***upper_age*] [
−P*PAgrid*] [**−Q***IDinfo*] [**−S**] [**−T**] [**−U***fixed_val*] [**−V**] [**−Z***z_min*[/*z_max*[/*z_inc*]]]

DESCRIPTION

grdspotter reads a grid file with residual bathymetry or gravity and calculates flowlines from each node
that exceeds a minimum value using the specified rotations file. These flowlines are then convolved with
the volume of the prism represented by each grid node and added up to give a Cumulative Volcano Ampli-
tude grid (CVA).

No space between the option flag and the associated arguments. Use upper case for the option
flags and lower case for modifiers.

grdfile   Data grid to be processed, typically residual bathymetry or free-air anomalies.

−E   Give file with rotation parameters. This file must contain one record for each rotation; each record
must be of the following format:

lon lat tstart [tstop] angle [khat a b c d e f g df]

where *tstart* and *tstop* are in Myr and *lon lat angle* are in degrees. *tstart* and *tstop* are the ages of
the old and young ends of a stage. If **−C** is set then a total reconstruction rotation is expected and
tstop is implicitly set to 0 and should not be specified in the file. If a covariance matrix **C** for the
rotation is available it must be specified in a format using the nine optional terms listed in brack-
ets. Here, **C** = (*g/khat*)*[*a b d; b c e; d e f*] which shows **C** made up of three row vectors. If the
degrees of freedom (*df*) in fitting the rotation is 0 or not given it is set to 10000. Blank lines and
records whose first column contains # will be ignored.

−G   Specify name for output CVA grid file.

−I   *x_inc* [and optionally *y_inc*] is the grid spacing. Optionally, append a suffix modifier. **Geographi-
cal (degrees) coordinates**: Append **m** to indicate arc minutes or **c** to indicate arc seconds. If one
of the units **e**, **k**, **i**, or **n** is appended instead, the increment is assumed to be given in meter, km,
miles, or nautical miles, respectively, and will be converted to the equivalent degrees longitude at
the middle latitude of the region (the conversion depends on **ELLIPSOID**). If /*y_inc* is given but
set to 0 it will be reset equal to *x_inc*; otherwise it will be converted to degrees latitude. **All coor-
dinates**: If = is appended then the corresponding max *x* (*east*) or *y* (*north*) may be slightly adjusted
to fit exactly the given increment [by default the increment may be adjusted slightly to fit the given
domain]. Finally, instead of giving an increment you may specify the *number of nodes* desired by
appending + to the supplied integer argument; the increment is then recalculated from the number
of nodes and the domain. The resulting increment value depends on whether you have selected a
gridline-registered or pixel-registered grid; see Appendix B for details. Note: if **−R***grdfile* is used
then grid spacing has already been initialized; use **−I** to override the values.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map
coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global
domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively,
specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are
copied from the grid.

OPTIONS

−A   Supply a crustal age grid that is co-registered with the input data grid. These ages become the
upper ages to use when constructing flowlines [Default extend flowlines back to oldest age found
in the rotation file; but see **−N**].

−B   Get *n_try* bootstrap estimates of the maximum CVA location; the longitude and latitude results are written to stdout [Default is no bootstrapping]. Cannot be used with **−M**.

−C   Expect Total Reconstruction Rotations rather than Forward Stage Rotations [Default]. File format is similar to the stage pole format except that the *tstart* column is not present (assumed to be 0 Ma).

−D   Use flowlines to determine the maximum CVA encountered along each flowline and create a Data Importance (DI) grid with these values at the originating nodes.

−F   Force pixel registration [Default is grid registration].

−L   Supply a co-registered grid with seamount chain IDs for each node. This option requires that you also use **−Q**.

−M   Do not attempt to keep all flowlines in memory when using **−D** and/or **−P**. Should you run out of memory you can use this option to compute flowlines on-the-fly. It will be slower as we no longer can reuse the flowlines calculated for the CVA step. Cannot be used with **−B** or the multi-slice mode in **−Z**.

−N   Set the upper age to assign to nodes whose crustal age is unknown (i.e., NaN) [no upper age]. Also see **−A**.

−P   Use flowlines to determine the flowline age at the CVA maximum for each node and create a Predicted Age (PA) grid with these values at the originating nodes.

−Q   Either give (1) a single ID to use or (2) the name of a file with a list of IDs to use [Default uses all IDs]. Each line would be TAG ID [w e s n]. The *w/e/s/n* zoom box is optional; if specified it means we only trace the flowline if inside this region [Default uses region set by **−R**]. Requires **−L**.

−S   Normalize the resulting CVA grid to percentages of the CVA maximum. This also normalizes the DI grid (if requested).

−T   Truncate crustal ages given via the **−A** option that exceed the upper age set with **−N** [no truncation].

−U   After a node passes the test implied by **−Z**, use this *fixed_val* instead in the calculations. [Default uses individual node values].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−Z   Ignore nodes with z-values lower than *z_min* [0] and optionally larger than *z_max* [Inf]. Give *z_min/z_max/z_inc* to make separate CVA grids for each *z*-slice [Default makes one CVA grid]. Multi-slicing cannot be used with **−M**.

EXAMPLES

To create a CVA image from the Pacific topography grid Pac_res_topo.grd, using the DC85.d Euler poles, and only output a grid for the specified domain, run

grdspotter Pac_res_topo.grd **−E**DC85.d **−G**CVA.grd **−R**190/220/15/25 **−I**2m **−N**145 **−T** **−V**

This file can then be plotted with **grdimage**.

SEE ALSO

GMT(1), *grdimage*(1), *project*(1), *mapproject*(1), *backtracker*(1), *hotspotter*(1), *originator*(1)

REFERENCES

Wessel, P., 1999, "Hotspotting" tools released, EOS Trans. AGU, 80 (29), p. 319.

NAME
   originator – Associate seamounts with hotspot point sources

SYNOPSIS
originator [*infile(s)*] **−E***stage_file* **−F***hs_file* [**−C**] [**−D***d_km*] [**−H**[**i**][*nrec*]] [**−L**[**flag**] [**−N***upper_age*]
[**−Q***r/t*] [**−S**[*n_hs*]] [**−T**] [**−V**] **−W***maxdist*] [**−Z**] [**−:**[**i**|**o**]] [**−bi**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]]

DESCRIPTION
   originator reads (longitude, latitude, height, radius, crustal_age) records from *infiles* [or standard input]
   and uses the given Absolute Plate Motion (APM) stage poles and the list of hotspot locations to determine
   the most likely origin (hotspot) for each seamount. It does so by calculating flowlines back in time and
   determining the closest approach to all hotspots. The output consists of the input records with four addi-
   tional fields added for each of the *n_hs* closest hotspots. The four fields are the hotspot id (e.g., HWI), the
   stage id of the flowline segment that came closest, the pseudo-age of the seamount, and the closest distance
   to the hotspot (in km). See option **−:** on how to read (latitude, longitude,height, radius, crustal_age) files.

   No space between the option flag and the associated arguments. Use upper case for the option
   flags and lower case for modifiers.

infile(s)   Seamount data file(s) to be analyzed. If not given, standard input is read.

−E   Give file with rotation parameters. This file must contain one record for each rotation; each record
       must be of the following format:

   lon lat tstart [tstop] angle [*khat a b c d e f g df*]

       where *tstart* and *tstop* are in Myr and *lon lat angle* are in degrees. *tstart* and *tstop* are the ages of
       the old and young ends of a stage. If **−C** is set then a total reconstruction rotation is expected and
       tstop is implicitly set to 0 and should not be specified in the file. If a covariance matrix **C** for the
       rotation is available it must be specified in a format using the nine optional terms listed in brack-
       ets. Here, **C** = (*g/khat*)*[*a b d; b c e; d e f*] which shows **C** made up of three row vectors. If the
       degrees of freedom (*df*) in fitting the rotation is 0 or not given it is set to 10000. Blank lines and
       records whose first column contains # will be ignored.

−F   Give file with hotspot locations. This file must contain one record for each hotspot to be consid-
       ered; each record must be of the following format:

   lon lat hs_abbrev hs_id r t_off t_on create fit plot name

       E.g., for Hawaii this may look like

   205   20   HWI   1   25   0   90   Y   Y   Y   Hawaii

       Most applications only need the first 4 columns which thus represents the minimal hotspot infor-
       mation record type. The abbreviation may be maximum 3 characters long. The id must be an
       integer from 1-32. The positional uncertainty of the hotspot is given by r (in km). The t_off and
       t_on variables are used to indicate the active time-span of the hotspot. The create, fit, and plot
       indicators are either Y or N and are used by some programs to indicate if the hotspot is included in
       the ID-grids used to determine rotations, if the hotspot chain will be used to determine rotations,
       and if the hotspot should be included in various plots. The name is a 32-character maximum text
       string with the full hotspot name. Blank lines and records whose first column contains # will be
       ignored.

OPTIONS
−C   Expect Total Reconstruction Rotations rather than Forward Stage Rotations [Default]. File format
       is similar to the stage pole format except that the *tstart* column is not present (assumed to be 0
       Ma).

−D   Sets the flowline sampling interval in km. [Default is 5].

–H   Input file(s) has header record(s). If used, the default number of header records is
              N_HEADER_RECS. Use **–Hi** if only input data should have header records [Default will write
              out header records if the input data have them]. Blank lines and lines starting with # are always
              skipped.

–L   Output closest approach for nearest hotspot only (ignores **–S**). Choose **–Lt** for (*time, dist, z*)
              [Default], **–Lw** for (*omega, dist, z*), and **–Ll** for (lon, lat, time, dist, z). Normally, *dist* is in km;
              use upper case modifiers **TWL** to get *dist* in spherical degrees.

–N   Set the maximum age to extend the oldest stage back in time [no extension].

–Q

INput files only has (*x,y,z*); specify constant values for *r,t* that
              will be implied for each record. **–S** Set the number of closest hotspots to report [Default is 1].

–T   Truncate seamount ages exceeding the upper age set with **–N** [no truncation].

–V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

–W   Only report those seamounts whose flowlines came within *maxdist* to any hotspot [Default reports
              all seamounts].

–Z   Use the hotspot ID number rather than the name tag in output records.

–:   Toggles between (longitude,latitude) and (latitude,longitude) input and/or output. [Default is (lon-
              gitude,latitude)]. Append **i** to select input only or **o** to select output only. [Default affects both].

–bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will
              force byte-swapping. Optionally, append *ncol*, the number of columns in your binary input file if
              it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally,
              append *var1/var2/...* to specify the variables to be read. [Default is 5 input columns].

EXAMPLES

To find the likely (hotspot) origins of the seamounts represented by the (x,y,z,r,tc) points in the file
seamounts.d, using the DC85.d Euler poles and the pac_hs.d list of possible hotspots, and report the 2 most
likely hotspot candidates for each seamount, run

originator seamounts.d **–S**2 **–E**DC85.d **–F**pac_hs.d > origins.d

SEE ALSO

GMT(1), *project*(1), *mapproject*(1), *backtracker*(1), *hotspotter*(1)

REFERENCES

Wessel, P., 1999, "Hotspotting" tools released, EOS Trans. AGU, 80 (29), p. 319.

NAME

      x2sys_binlist − Create bin-index files from track data files

SYNOPSIS

      x2sys_binlist *track(s)* **−T***TAG* [**−D**] [**−E**] [**−V**]

DESCRIPTION

      x2sys_binlist reads one or more track data files and produces a multi-segment ASCII track bin-index file (tbf) with the track name in the header and one data record per bin crossed; these records contain *lon, lat, index, flags*[, *dist*], where *lon, lat* are the coordinates of the center of the bin, the *index* is the 1-D number of the bin, and *flags* is a bitflag that describes which data fields were available in this bin. The optional *dist* requires **−D**. The input files can be of any format, which must be described and passed with the **−T** option. The bin-index listing is a crude representation of where the track goes and is used by the data archivist to build an x2sys track data base for miscellaneous track queries, such as when needing to determine which tracks should be compared in a crossover analysis. You must run **x2ys_init** to initialize the tag before you can run the indexing.

      tracks   Can be one or more ASCII, native binary, or COARDS netCDF 1-D data files. To supply the data files via a text file with a list of tracks (one per record), specify the name of the track list after a leading equal-sign (e.g., =tracks.lis). If the names are missing their file extension we will append the suffix specified for this *TAG*. Track files will be searched for first in the current directory and second in all directories listed in **$X2SYS_HOME**/*TAG*/*TAG*_paths.txt (if it exists). [If **$X2SYS_HOME** is not set it will default to **$GMT_SHAREDIR**/x2sys]. (Note: MGD77 files will also be looked for via **MGD77_HOME**/mgd77_paths.txt and *.gmt files will be searched for via **$GMT_SHAREDIR**/mgg/gmtfile_paths).

      −T   Specify the x2sys *TAG* which tracks the attributes of this data type.

OPTIONS

      No space between the option flag and the associated arguments.

      −D   Calculate the length of trackline segments per bin [Default skips this step]. The length fragments are given as the 5th output column (after the *flags*). The length units are obtained via the TAB setting (see **x2sys_init**).

      −E   Convert geographic data to a cylindrical equal-area projection prior to binning. Basically, we apply the projection **−JY***lon0*/37:04:17.166076/360, where *lon0* is the mid-longitude of the region. Requires **−D**, geographical data, and a global region (e.g., **−Rg** or **−Rd**). This option is useful for statistics related to trackline density but should not be used when preparing bin-index files for the x2sys track data bases.

      −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

      To create a bin index file from the MGD77 file 01030061.mgd77 using the settings associated with the tag MGD77, do

      x2sys_binlist 01030061.mgd77 **−T**MGD77 > 01030061.tbf

      To create a track bin index file of all MGD77+ files residing in the current directory using the settings associated with the tag MGD77+ and calculate track distances, run

      x2sys_binlist *.nc **−T**MGD77+ **−D > all.tbf**

SEE ALSO

      x2sys_cross(1),   *x2sys_datalist*(1),   *x2sys_get*(1),   *x2sys_init*(1),   *x2sys_put*(1),   *x2sys_report*(1), *x2sys_solve*(1)

NAME

x2sys_datalist − A generic data-extractor for ASCII or binary files

SYNOPSIS

x2sys_datalist *track(s)* **−T***TAG* [**−A**] [**−F***name1,name2,...*] [**−H**[**i**][*nrec*]] [**−L**[*corrtable*]] [**−R***west*/*east*/*south*/*north*[**r**]] [**−S**] [**−V**] [**−bo**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/...*]]] [**−m**[*flag*]]

DESCRIPTION

x2sys_datalist reads one or more files and produces a single ASCII [or binary] table. The files can be of any format, which must be described and passed with the **−T** option. You may limit the output to a geographic region, and insist that the output from several files be separated by a multiple segment header. Only the named data fields will be output [Default selects all columns].

tracks   Can be one or more ASCII, native binary, or COARDS netCDF 1-D data files. To supply the data files via a text file with a list of tracks (one per record), specify the name of the track list after a leading equal-sign (e.g., =tracks.lis). If the names are missing their file extension we will append the suffix specified for this *TAG*. Track files will be searched for first in the current directory and second in all directories listed in **$X2SYS_HOME**/*TAG*/*TAG*_paths.txt (if it exists). [If **$X2SYS_HOME** is not set it will default to **$GMT_SHAREDIR**/x2sys]. (Note: MGD77 files will also be looked for via **MGD77_HOME**/mgd77_paths.txt and *.gmt files will be searched for via **$GMT_SHAREDIR**/mgg/gmtfile_paths).

−T   Specify the x2sys *TAG* which tracks the attributes of this data type.

OPTIONS

No space between the option flag and the associated arguments.

−A   Eliminate COEs by distributing the COE between the two tracks in proportion to track weight. These (dist, adjustment) spline knots files for each track and data column are called *track.column*.adj and are expected to be in the **$X2SYS_HOME**/*TAG* directory. The adjustments are only applied if the corresponding adjust file can be found [No residual adjustments]

−F   Give a comma-separated sub-set list of column names defined in the definition file. [Default selects all data columns].

−H   Input file(s) has header record(s). If used, the default number of header records is **N_HEADER_RECS**. Use **−Hi** if only input data should have header records [Default will write out header records if the input data have them]. Blank lines and lines starting with # are always skipped.

−L   Apply optimal corrections to columns where such corrections are available. Append the correction table to use [Default uses the correction table *TAG*_corrections.txt which is expected to reside in the **$X2SYS_HOME**/*TAG* directory]. For the format of this file, see CORRECTIONS below.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid. For Cartesian data just give *xmin/xmax/ymin/ymax*. This option limits the COEs to those that fall inside the specified domain.

−S   Suppress output records where all the data columns are NaN [Default will output all records].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file.

−m   Output a multisegment header between data from each track. Note this option does not imply anything about the input file; that information is conveyed via the system tag (**−T**).

EXAMPLES

To extract all data from the old-style MGG supplement file c2104.gmt, recognized by the tag GMT:

x2sys_datalist c2104.gmt **−T**GMT > myfile

To make lon,lat, and depth input for **blockmean** and **surface** using all the files listed in the file tracks.lis and define by the tag TRK, but only the data that are inside the specified area, and make output binary, run

x2sys_datalist =tracks.lis **−T**TRK **−F**lon,lat,depth **−R**-40/-30/25/35 **−bo** > alltopo_bin.xyz

CORRECTIONS

The correction table is an ASCII file with coefficients and parameters needed to carry out corrections. This table is usually produced by **x2sys_solve**. Comment records beginning with # are allowed. All correction records are of the form

trackID observation correction

where *trackID* is the track name, *observation* is one of the abbreviations for an observed field contained in files under this TAG, and *correction* consists of one or more white-space-separated *term*s that will be **subtracted** from the observation before output. Each *term* must have this exact syntax:

factor[*[*function*]([*scale*](*abbrev*[-*origin*]))[ˆ*power*]]

where terms in brackets are optional (the brackets themselves are not used but regular parentheses must be used exactly as indicated). No spaces are allowed except between *term*s. The *factor* is the amplitude of the basis function, while the optional *function* can be one of sin, cos, or exp. The optional *scale* and *origin* can be used to translate the argument (before giving it to the optional function). The argument *abbrev* is one of the abbreviations for columns known to this TAG. However, it can also be one of the three auxiliary terms **dist** (for along-track distances), **azim** for along-track azimuths, and **vel** (for along-track speed); these are all sensitive to the **−C** and **−N** settings used when defining the TAB; futhermore, **vel** requires **time** to be present in the data. If *origin* is given as **T** it means that we should replace it with the value of *abbrev* for the very first record in the file (this is usually only done for *time*). If the first data record entry is NaN we revert *origin* to zero. Optionally, raise the entire expression to the given *power*, before multiplying by *factor*. The following is an example of fictitious corrections to the track ABC, implying the **z** column should have a linear trend removed, the field **obs** should be corrected by a strange dependency on latitude, **weight** needs to have 1 added (hence correction is given as -1), and **fuel** should be reduced by a linear distance term:

```
ABC z   7.1      1e-4*((time-T))
ABC obs          0.5*exp(-1e-3(lat))^1.5
ABC weight       -1
ABC fuel 0.02*((dist))
```

SEE ALSO

blockmean(1), *GMT*(1), *surface*(1), *x2sys_init*(1), *x2sys_datalist*(1), *x2sys_get*(1), *x2sys_list*(1), *x2sys_put*(1), *x2sys_report*(1), *x2sys_solve*(1)

NAME
> x2sys_list – Output a subset of crossovers from data base

SYNOPSIS
> **x2sys_list** −**C**_column_ −**T**_TAG_ [_coedbase.txt_] [−**A**_asymm_max_] [−**F**_acdhiInNtTvxyz_] [−**I**[_list_] [−**L**[_cor-rtable_]] [−**N**_nx_min_] [−**Q**e|i] [−**R**_west/east/south/north_[**r**]] [−**S**_track_] [−**V**] [−**W**[_list_] [−**bo**[s|**S**|**d**|**D**[_ncol_]|**c**[_var1/..._]]] [−**m**[_flag_]]

DESCRIPTION
> **x2sys_list** will read the crossover ASCII data base _coedbase.txt_ (or _stdin_) and extract a subset of the crossovers based on the other arguments. The output may be ASCII or binary.

> −**C**   Specify which data column you want to process. Crossovers related to this column name must be present in the crossover data base.

> −**T**   Specify the x2sys _TAG_ which tracks the attributes of this data type.

OPTIONS
> No space between the option flag and the associated arguments.

> _coedbase.txt_
> The name of the input ASCII crossover error data base as produced by **x2sys_cross**. If not given we read standard input instead.

> −**A**   Specifies maximum asymmetry in the distribution of crossovers relative to the mid point in time (or distance, if not time is available). Asymmetry is computed as (n_right - n_left)/(n_right + n_left), referring the the number of crossovers that falls in the left or right half of the range. Symmetric distributions will have values close to zero. If specified, we exclude tracks whose asymmetry exceeds the specify cutoff in absolute value [1, i.e., include all].

> −**F**   Specify your desired output using any combination of _acdhiInNtTvwxyz_, in any order. Do not use space between the letters, and note your selection is case-sensitive. The output will be ASCII (or binary, see −**bo**) columns of values. Description of codes: **a** is the angle (< 90) defined by the crossing tracks, **c** is crossover value of chosen observation (see −**C**), **d** is distance along track, **h** is heading along track, **i** is the signed time interval between the visit at the crossover of the two tracks involved, **I** is same as **i** but is unsigned, **n** is the names of the two tracks, **N** is the id numbers of the two tracks, **t** is time along track in _date_**T**_clock_ format (NaN if not available), **T** is elapsed time since start of track along track (NaN if not available), **v** is speed along track, **w** is the composite weight, **x** is _x_-coordinate (or longitude), **y** is _y_-coordinate (or latitude), and **z** is observed value (see −**C**) along track. If −**S** is not specified then **d,h,n,N,t,T,v** results in two output columns each: first for track one and next for track two (in lexical order of track names); otherwise, they refer to the specified track only (except for **n,N** which then refers to the other track). The sign convention for **c,i** is track one minus track two (lexically sorted). Time intervals will be returned according to the **TIME_UNIT** GMT defaults setting.

> −**I**   Name of ASCII file with a list of track names (one per record) that should be excluded from consideration [Default includes all tracks].

> −**L**   Apply optimal corrections to the chosen observable. Append the correction table to use [Default uses the correction table _TAG__corrections.txt which is expected to reside in the **$X2SYS_HOME**/_TAG_ directory]. For the format of this file, see **x2sys_solve**.

> −**N**   Only report data from pairs that generated at least _nx_min_ crossovers between them [use all pairs].

> −**Q**   Append **e** for external crossovers or **i** for internal crossovers only [Default is all crossovers].

> −**R**   _west, east, south,_ and _north_ specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands −**Rg** and −**Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the −**R** settings (and grid spacing, if applicable) are copied from the grid. For Cartesian data just give _xmin/xmax/ymin/ymax_. This option limits the

COEs to those that fall inside the specified domain.

–S   Name of a single track. If given we restrict output to those crossovers involving this track [Default output is crossovers involving any track pair].

–V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

–W   Name of ASCII file with a list of track names and their relative weights (one track per record) that should be used to calculate the composite crossover weight (output code **w** above). [Default sets weights to 1].

–bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file.

–m   Multiple segment output format. Segments with crossovers for a single track pair are separated by a record whose first character is *flag* and contains the two track names. [Default is '>'].

EXAMPLES

To find all the magnetic crossovers associated with the tag MGD77 from the file COE_data.txt, restricted to occupy a certain region in the south Pacific, and return location, time, and crossover value, try

x2sys_list COE_data.txt **−V −T**MGD77 **−R**180/240/-60/-30 **−C**mag **−F**xytz > mag_coe.txt

To find all the faa crossovers globally that involves track 12345678 and output time since start of the year, using a binary double precision format, try

x2sys_list COE_data.txt **−V −T**MGD77 **−C**faa **−S**12345678 **−F**Tz **−bo**d > faa_coe.b

SEE ALSO

x2sys_binlist(1),   *x2sys_cross*(1),   *x2sys_datalist*(1),   *x2sys_get*(1),   *x2sys_init*(1),   *x2sys_put*(1), *x2sys_report*(1), *x2sys_solve*(1)

NAME

      x2sys_cross – Find and compute crossover errors

SYNOPSIS

      x2sys_cross *track(s)* **−T***TAG* [**−I**l|**a**|**c**] [**−J***parameters*] [**−K***combi.lis*] [**−L**] [**−Qe**|**i**] [**−S**l|**u**|**h***speed*] [**−V**][**−W***size*] [**−2**] [**−bo**[**s**|**S**|**d**|**D**[*ncol*]|**c**[*var1/*...]]]

DESCRIPTION

      x2sys_cross is used to determine all intersections between ("external cross-overs") or within ("internal cross-overs") tracks (Cartesian or geographic), and report the time, position, distance along track, heading and speed along each track segment, and the crossover error (COE) and mean values for all observables. The names of the tracks are passed on the command line. By default, **x2sys_cross** will look for both external and internal COEs. As an option, you may choose to project all data using one of the map-projections prior to calculating the COE.

      tracks   Can be one or more ASCII, native binary, or COARDS netCDF 1-D data files. To supply the data files via a text file with a list of tracks (one per record), specify the name of the track list after a leading equal-sign (e.g., =tracks.lis). If the names are missing their file extension we will append the suffix specified for this *TAG*. Track files will be searched for first in the current directory and second in all directories listed in **$X2SYS_HOME**/*TAG*/*TAG*_paths.txt (if it exists). [If **$X2SYS_HOME** is not set it will default to **$GMT_SHAREDIR**/x2sys]. (Note: MGD77 files will also be looked for via **MGD77_HOME**/mgd77_paths.txt and *.gmt files will be searched for via **$GMT_SHAREDIR**/mgg/gmtfile_paths).

      −T   Specify the x2sys *TAG* which tracks the attributes of this data type.

OPTIONS

      No space between the option flag and the associated arguments.

      −I   Sets the interpolation mode for estimating values at the crossover. Choose among:
             l Linear interpolation [Default].
             a Akima spline interpolation.
             c Cubic spline interpolation.

      −J   Selects the map projection. Scale is UNIT/degree, 1:xxxxx, or width in UNIT (upper case modifier). UNIT is cm, inch, or m, depending on the **MEASURE_UNIT** setting in .gmtdefaults4, but this can be overridden on the command line by appending **c**, **i**, or **m** to the scale/width value. When central meridian is optional, default is center of longitude range on **−R** option. Default standard parallel is the equator. For map height, max dimension, or min dimension, append **h**, **+**, or **-** to the width, respectively.
            More details can be found in the **psbasemap** man pages.

            CYLINDRICAL PROJECTIONS:

               −Jc*lon0/lat0/scale* (Cassini)
               −Jcyl_stere/[*lon0/*[*lat0/*]]*scale* (Cylindrical Stereographic)
               −Jj[*lon0/*]*scale* (Miller)
               −Jm[*lon0/*[*lat0/*]]*scale* (Mercator)
               −Jm*lon0/lat0/scale* (Mercator - Give meridian and standard parallel)
               −Jo[**a**]*lon0/lat0/azimuth/scale* (Oblique Mercator - point and azimuth)
               −Jo[**b**]*lon0/lat0/lon1/lat1/scale* (Oblique Mercator - two points)
               −Joc*lon0/lat0/lonp/latp/scale* (Oblique Mercator - point and pole)
               −Jq[*lon0/*[*lat0/*]]*scale* (Cylindrical Equidistant)
               −Jt*lon0/*[*lat0/*]*scale* (TM - Transverse Mercator)
               −Ju*zone/scale* (UTM - Universal Transverse Mercator)
               −Jy[*lon0/*[*lat0/*]]*scale* (Cylindrical Equal-Area)

            CONIC PROJECTIONS:

−Jb*lon0/lat0/lat1/lat2/scale* (Albers)
−Jd*lon0/lat0/lat1/lat2/scale* (Conic Equidistant)
−Jl*lon0/lat0/lat1/lat2/scale* (Lambert Conic Conformal)
−Jpoly[*lon0/*[*lat0/*]]*scale* ((American) Polyconic)

AZIMUTHAL PROJECTIONS:

−Ja*lon0/lat0*[*/horizon*]*/scale* (Lambert Azimuthal Equal-Area)
−Je*lon0/lat0*[*/horizon*]*/scale* (Azimuthal Equidistant)
−Jf*lon0/lat0*[*/horizon*]*/scale* (Gnomonic)
−Jg*lon0/lat0*[*/horizon*]*/scale* (Orthographic)
−Jg*lon0/lat0/altitude/azimuth/tilt/twist/Width/Height/scale* (General Perspective).
−Js*lon0/lat0*[*/horizon*]*/scale* (General Stereographic)

MISCELLANEOUS PROJECTIONS:

−Jh[*lon0/*]*scale* (Hammer)
−Ji[*lon0/*]*scale* (Sinusoidal)
−Jkf[*lon0/*]*scale* (Eckert IV)
−Jk[**s**][*lon0/*]*scale* (Eckert IV)
−Jn[*lon0/*]*scale* (Robinson)
−Jr[*lon0/*]*scale* (Winkel Tripel)
−Jv[*lon0/*]*scale* (Van der Grinten)
−Jw[*lon0/*]*scale* (Mollweide)

NON-GEOGRAPHICAL PROJECTIONS:

−Jp[**a**]*scale*[*/origin*][**r**|**z**] (Polar coordinates (theta,r))
−Jx*x-scale*[**d**|**l**|**p***pow*|**t**|**T**][*/y-scale*[**d**|**l**|**p***pow*|**t**|**T**]] (Linear, log, and power scaling)

−K Only process the pair-combinations found in the file *combi.lis* [Default process all possible combinations among the specified files].

−L Output results using the old XOVER format [Default is x2sys format]. This option should only be used with *.gmt-formatted MGD77 files. See the GMT mgg supplement for file description; see *Wessel* [1989] for details on the XOVER format.

−Q Append **e** for external COEs only, and **i** for internal COEs only [Default is all COEs].

−R *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid. For Cartesian data just give *xmin/xmax/ymin/ymax*. This option limits the COEs to those that fall inside the specified domain.

−S Defines window of track speeds. If speeds are outside this window we do not calculate a COE. Specify
    −Sl sets lower speed [Default is 0].
    −Su sets upper speed [Default is Infinity].
    −Sh does not limit the speed but sets a lower speed below which headings will not be computed (i.e., set to NaN) [Default calculates headings regardless of speed].

−V Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

−W Give the maximum number of data points on either side of the crossover to use in the spline interpolation [3].

−2   Report the values of each track at the crossover [Default reports the crossover value and the mean value].

−bo   Selects binary output. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append *ncol*, the number of desired columns in your binary output file.

REMARKS

The COEs found are printed out to standard output in ASCII format (unless **−bo** is set). When ASCII is chosen, the output format depends on whether or not old-style XOVER output (**−L**) has been selected [See the **x_over** man page for more details]. If ASCII, then the first record contains the name of the tag used, the second records specifies the exact command line used for this run, and the third record contains the names of each column. For each track pair, there will be a multisegment header record containing the two file names and their start/stop/dist information (start/stop is absolute time or NaN if unavailable while dist is the total track length), whereas subsequent records have the data for each COE encountered. The fields written out are x, y, time along track #1 and #2, distance along track #1 and #2, heading along track #1 and #2, velocity along track #1 and #2, and then pairs of columns for each selected observable. These are either pairs of (COE, average value) for each data type (or track-values #1 and #2; see **−2**). It is recommended that the Akima spline is used instead of the natural cubic spline, since it is less sensitive to outliers that tend to introduce wild oscillations in the interpolation.

SIGN CONVENTION

If track_a and track_b are passed on the command line, then the COE value is Value (track_a) - Value (track_b).

PRECISION AND FORMAT

The output format of individual columns are controlled by **D_FORMAT** except for geographic coordinates (**OUTPUT_DEGREE_FORMAT**) and absolute calendar time (**OUTPUT_DATE_FORMAT**, **OUTPUT_CLOCK_FORMAT**). Make sure these are set to give you enough significant digits to achieve the desired precision.

EXAMPLES

To compute all internal crossovers in the gmt-formatted file c2104.gmt, and output in the old XOVER format, using the tag GMT, try

x2sys_cross c2104.gmt **−L −T**GMT > c2104.d

To find the crossover locations with bathymetry between the two MGD77 files A13232.mgd77 and A99938.mgd77, using the MGD77 tag, try

x2sys_cross A13232.mgd77 A99938.mgd77 **−Qe −T**MGD77 > crossovers.d

REFERENCES

Wessel, P. (1989), XOVER: A cross-over error detector for track data, *Computers and Geosciences, 15*(3), 333-346.

SEE ALSO

GMT(1), *x2sys_binlist*(1), *x2sys_init*(1), *x2sys_datalist*(1), *x2sys_get*(1), *x2sys_list*(1), *x2sys_put*(1), *x2sys_report*(1), *x2sys_solve*(1), *x_over*(1)

NAME

> x2sys_report – Report statistics from crossover data base

SYNOPSIS

> **x2sys_report** −**C***column* −**T***TAG* [*coedbase.txt*] −**A** [−**I**[*list*] [−**L**[*corrtable*]] [−**N***nx_min*] [−**Q**e|i] [
> −**R***west/east/south/north*[**r**]] [−**S***track*] [−**V**]

DESCRIPTION

> **x2sys_report** will read the input crossover ASCII data base *coedbase.txt* (or *stdin*) and report on the statis-
> tics of crossovers (*n, mean, stdev, rms, weight*) for each track. Options are available to let you exclude
> tracks and limit the output.

> −**C**   Specify which data column you want to process. Crossovers related to this column name must be
>   present in the crossover data base.

> −**T**   Specify the x2sys *TAG* which tracks the attributes of this data type.

OPTIONS

> No space between the option flag and the associated arguments.

> *coedbase.txt*
>   The name of the input ASCII crossover error data base as produced by **x2sys_cross**. If not given
>   we read standard input instead.

> −**A**   Eliminate COEs by distributing the COE between the two tracks in proportion to track weight and
>   producing (dist, adjustment) spline knots files for each track (for the selected *column*). Such
>   adjustments may be used by **x2sys_datalist**. The adjustment files are called *track.column*.adj and
>   are placed in the **$X2SYS_HOME**/*TAG* directory. For background information on how these
>   adjustments are designed, see *Mittal* [1984].

> −**I**   Name of ASCII file with a list of track names (one per record) that should be excluded from con-
>   sideration [Default includes all tracks].

> −**L**   Apply optimal corrections to the chosen observable. Append the correction table to use [Default
>   uses the correction table *TAG*_corrections.txt which is expected to reside in the
>   **$X2SYS_HOME**/*TAG* directory]. For the format of this file, see **x2sys_solve**.

> −**N**   Only report data from tracks involved in at least *nx_min* crossovers [all tracks].

> −**Q**   Append **e** for external crossovers or **i** for internal crossovers only [Default is external].

> −**R**   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal
>   degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map
>   coordinates are given instead of w/e/s/n. The two shorthands −**Rg** and −**Rd** stand for global
>   domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively,
>   specify the name of an existing grid file and the −**R** settings (and grid spacing, if applicable) are
>   copied from the grid. For Cartesian data just give *xmin/xmax/ymin/ymax*. This option bases the
>   statistics on those COE that fall inside the specified domain.

> −**S**   Name of a single track. If given we restrict output to those crossovers involving this track [Default
>   output is crossovers involving any track pair].

> −**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

> To report statistics of all the external magnetic crossovers associated with the tag MGD77 from the file
> COE_data.txt, restricted to occupy a certain region in the south Pacific, try

> **x2sys_report** COE_data.txt −**V** −**T**MGD77 −**R**180/240/-60/-30 −**C**mag > mag_report.txt

> To report on the faa crossovers globally that involves track 12345678, try

> **x2sys_report** COE_data.txt −**V** −**T**MGD77 −**C**faa −**S**12345678 > faa_report.txt

REFERENCES

Mittal, P. K. (1984), Algorithm for error adjustment of potential field data along a survey network, *Geophysics, 49*(4), 467-469.

SEE ALSO

x2sys_binlist(1) *x2sys_cross*(1) *x2sys_datalist*(1) *x2sys_get*(1) *x2sys_init*(1) *x2sys_list*(1) *x2sys_put*(1) *x2sys_solve*(1)

NAME

      x2sys_solve − Determine systematic corrections from crossovers

SYNOPSIS

      x2sys_solve −C_column_ **−T**_TAG_ **−E**_mode_ [_COE_list.d_] [**−V**] [**−W**] [**−bi**[**s**|**S**|**d**|**D**[_ncol_]|**c**[_var1/..._]]]

DESCRIPTION

      x2sys_solve will use the supplied crossover information to solve for systematic corrections that can then be applied per track to improve data quality. Several systematic corrections can be solved for using a least-squares approach. Note: Only one data column can be processed at the time.

      −T   Specify the x2sys _TAG_ which tracks the attributes of this data type.

      −C   Specify which data column you want to process. Needed for proper formatting of the output correction table and must match the same option used in **x2sys_list** when preparing the input data.

      −E   The correction type you wish to model. Choose among the following functions $f(p)$, where p are the m parameters per track that we will fit simultaneously using a least squares approach:
            c will fit $f(p) = a$ (a constant offset); records must contain cruise ID1, ID2, COE.
            d will fit $f(p) = a + b * d$ (linear drift; d is distance; records must contain cruise ID1, ID2, d1, d2, COE.
            g will fit $f(p) = a + b \sin(y)^2$ (1980-1930 gravity correction); records must contain cruise ID1, ID2, latitude y, COE.
            h will fit $f(p) = a + b \cos(H) + c \cos(2H) + d \sin(H) + e \sin(2H)$ (magnetic heading correction); records must contain cruise ID1, ID2, heading H, COE.
            s will fit $f(p) = a * z$ (a unit scale correction); records must contain cruise ID1, ID2, z1, z2.
            t will fit $f(p) = a + b * (t - t0)$ (linear drift; $t0$ is the start time of the track); records must contain cruise ID1, ID2, t1-t0, t2-t0, COE.

OPTIONS

      No space between the option flag and the associated arguments.

      _COE_list.d_
            Name of file with the required crossover columns as produced by **x2sys_list**. NOTE: If **−bi** is used then the first two columns are expected to hold the integer track IDs; otherwise we expect those columns to hold the text string names of the two tracks.

      −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

      −W   Means that each input records has an extra column with the composite weight for each crossover record. These are used to obtain a weighted least squares solution [no weights].

      −bi   Selects binary input. Append **s** for single precision [Default is **d** (double)]. Uppercase **S** or **D** will force byte-swapping. Optionally, append _ncol_, the number of columns in your binary input file if it exceeds the columns needed by the program. Or append **c** if the input file is netCDF. Optionally, append _var1/var2/..._ to specify the variables to be read.

EXAMPLES

      To fit a simple bias offset to faa for all tracks under the MGD77 tag, try

      x2sys_list COE_data.txt **−V −T**MGD77 **−C**faa **−F**nc > faa_coe.txt
      x2sys_solve faa_coe.txt **−V −T**MGD77 **−C**faa **−E**c > coe_table.txt

      To fit a faa linear drift with time instead, try

      x2sys_list COE_data.txt **−V −T**MGD77 **−C**faa **−F**nTc > faa_coe.txt
      x2sys_solve faa_coe.txt **−V −T**MGD77 **−C**faa **−E**t > coe_table.txt

      To estimate heading corrections based on magnetic crossovers associated with the tag MGD77 from the file COE_data.txt, try

      x2sys_list COE_data.txt **−V −T**MGD77 **−C**mag **−F**nhc > mag_coe.txt
      x2sys_solve mag_coe.txt **−V −T**MGD77 **−C**mag **−E**h > coe_table.txt

      To estimate unit scale corrections based on bathymetry crossovers, try

      x2sys_list COE_data.txt **−V −T**MGD77 **−C**depth **−F**nz > depth_coe.txt
      x2sys_solve depth_coe.txt **−V −T**MGD77 **−C**depth **−E**s > coe_table.txt

SEE ALSO
      x2sys_binlist(1), *x2sys_cross*(1), *x2sys_datalist*(1), *x2sys_get*(1), *x2sys_init*(1), *x2sys_list*(1), *x2sys_put*(1), *x2sys_report*(1)

NAME

x2sys_get – Get track listing from the x2sys track index databases

SYNOPSIS

x2sys_get **−T***TAG* [**−C**] [**−F***flags*] [**−L**[*list*] [**−N***flags*] [**−R***west/east/south/north*[**r**]] [**−V**]]

DESCRIPTION

x2sys_get will return the names of the track data files in the x2sys data base for this TAG that match the given requirements. You may choose a specific region and optionally ask only for tracks that meet certain data criteria. Finally, you may select an option to list all possible pairs that might generate crossovers.

−T   Specify the x2sys *TAG* which tracks the attributes of this data type.

OPTIONS

No space between the option flag and the associated arguments.

−C   Instead of reporting the track names, just output the coordinates of the center of each bin that has at least one track with the specified data.

−F   Give a comma-separated list of column names (as described in the definition file) that should be present. [Default selects all data columns].

−L   Crossover mode. Return a list of track pairs that should be checked for possible crossovers. The list is determined from the bin-index data base on the assumption that tracks occupying the same bin are very likely to intersect. By default we return all possible pairs in the data base. Append the name of a file with a list of tracks if you want to limit the output to those pairs that involve at least one of the track names in your list. The output is suitable for the **−K** option in **x2sys_cross**.

−N   Give a comma-separated list of column names (as described in the definition file) that must be absent.

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are copied from the grid. For Cartesian data just give *xmin/xmax/ymin/ymax*. This option limits the tracks to those that fall at least partly inside the specified domain.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

To find all the tracks associated with the tag MGD77, restricted to occupy a certain region in the south Pacific, and have at least free air anomalies and bathymetry, try

x2sys_get **−V** **−T**MGD77 **−R**180/240/-60/-30 **−F**faa,depth

To find all the tracks associated with the tag MGD77 that have depth but not twt, try

x2sys_get **−V** **−T**MGD77 **−F**depth **−N**twt

To find all the pairs associated with the tag MGD77 that might intersect each other, but only those pairs which involves tracks in your list new.lis, try

x2sys_get **−V** **−T**MGD77 **−L**new.lis > xpairs.lis

SEE ALSO

x2sys_binlist(1),   *x2sys_cross*(1),   *x2sys_datalist*(1),   *x2sys_init*(1),   *x2sys_list*(1),   *x2sys_put*(1), *x2sys_report*(1), *x2sys_solve*(1)

NAME

x2sys_init – Initialize x2sys data base for track data files

SYNOPSIS

x2sys_init *TAG* **−D***deffile* [**−Cc**|**f**|**g**|**e**] [**−E***suffix*] [**−F**] [**−Gd**|**g**] [**−I***dx*[*/dy*]] [**−Nd**|**s***unit*] [**−R***west*/*east*/*south*/*north*[**r**]] [**−V**] [**−Wt**|**d***gap*] [**−m**[**i**|**o**][*flag*]]

DESCRIPTION

x2sys_init is the starting point for anyone wishing to use x2sys; it initializes a set of data bases that are particular to one kind of track data. These data, their associated data bases, and key parameters are given a short-hand notation called an x2sys TAG. The TAG keeps track of settings such as file format, whether the data are geographic or not, and the binning resolution for track indices. Running **x2sys_init** is a prerequisite to running any of the other x2sys programs, such as **x2sys_binlist**, which will create a crude representation of where each data track go within the domain and which observations are available; this information serves as input to **x2sys_put** which updates the track data base. Then, **x2sys_get** can be used to find which tracks and data are available inside a given region. With that list of tracks you can use **x2sys_cross** to calculate track crossovers, use **x2sys_report** to report crossover statistics or **x2sys_list** to pull out selected crossover information that **x2sys_solve** can use to determine track-specific systematic corrections. These corrections may be used with **x2sys_datalist** to extract corrected data values for use in subsequent work.

TAG   The unique name of this data type x2sys TAG.

−C   Select procedure for along-track distance calculation when needed by other programs:
c Cartesian distances [Default, unless **−G** is set].
f Flat Earth distances.
g Great circle distances [Default if **−G** is set].
e Geodesic distances on current **GMT** ellipsoid.

−D   Definition file prefix for this data set [See DEFINITION FILES below for more information]. Specify full path if the file is not in the current directory.

OPTIONS

No space between the option flag and the associated arguments.

−E   Specifies the file extension (suffix) for these data files. If not given we use the definition file prefix as the suffix (see **−D**).

−F   Force creating new files if old ones are present [Default will abort if old TAG files are found].

−G   Selects geographical coordinates. Append **d** for discontinuity at the Dateline (makes longitude go from -180 to + 180) or **g** for discontinuity at Greenwich (makes longitude go from 0 to 360 [Default]). If not given we assume the data are Cartesian.

−I   *x_inc* [and optionally *y_inc*] is the grid spacing. Append **m** to indicate minutes or **c** to indicate seconds for geographic data. These spacings refer to the binning used in the track bin-index data base.

−m   Multiple segment file(s). Segments are separated by a special record. For ASCII files the first character must be *flag* [Default is '>']. For binary files all fields must be NaN and **−b** must set the number of output columns explicitly. By default the **−m** setting applies to both input and output. Use **−mi** and **−mo** to give separate settings to input and output.

−N   Sets the units used for distance and speed when requested by other programs. Append **d** for distance or **s** for speed, then give the desired *unit* as **c** (Cartesian userdist or userdist/usertime), **e** (meter or m/s), **k** (km or km/hr), **m** (miles or miles/hr), or **n** (nautical miles or knots). [Default is **−Ndk −Nse** (km and m/s) if **−G** is set and **−Ndc** and **−Nsc** otherwise (Cartesian units)].

−R   *west, east, south,* and *north* specify the Region of interest, and you may specify them in decimal degrees or in [+-]dd:mm[:ss.xxx][W|E|S|N] format. Append **r** if lower left and upper right map coordinates are given instead of w/e/s/n. The two shorthands **−Rg** and **−Rd** stand for global domain (0/360 and -180/+180 in longitude respectively, with -90/+90 in latitude). Alternatively, specify the name of an existing grid file and the **−R** settings (and grid spacing, if applicable) are

copied from the grid. For Cartesian data just give *xin/xmax/ymin/ymax*. This sets the complete domain for the relevant track data set.

–V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

–W   Give **t** or **d** and append the corresponding maximum time gap (in user units; this is typically seconds [Infinity]), or distance (for units, see **–N**) gap [Infinity]) allowed between the two data points immediately on either side of a crossover. If these limits are exceeded then a data gap is assumed and no COE will be determined.

DEFINITION FILES

These *.def files contain information about the data file format and have two sections: (1) header information and (2) column information. All header information starts with the character # in the first column, immediately followed by an upper-case directive. If the directive takes an argument it is separated by white-space. You may append a trailing # comments. Five directives are recognized:

ASCII states that the data files are in ASCII format.
BINARY states that the data files are native binary files.
NETCDF states that the data files are COARDS-compliant 1-D netCDF files.
SKIP takes an integer argument which is either the number of lines to skip (when reading ASCII files) or the number of bytes to skip (when reading native binary files). Not used with netCDF files.
GEO indicates that these files are geographic data sets, with periodicities in the *x*-coordinate (longitudes). Alternatively, use **–G**.
MULTISEG means each track consists of multiple segments separated by a **GMT** multisegment header (alternatively, use **–m** when defining the system TAG). Not used with netCDF files.

The column information consists of one line per column in the order the columns appear in the data file. For each column you must provide seven attributes:

name type NaN NaN-proxy scale offset oformat

name is the name of the column variable. It is expected that you will use the special names *lon* (or *x* if Cartesian) and *lat* (or *y*) for the two required coordinate columns, and *time* when optional time data are present.
type is always **a** for ASCII representations of numbers, whereas for binary files you may choose among **c** for signed 1-byte character (-127,+128), **u** for unsigned byte (0-255), **h** for signed 2-byte integers (-32768,+32767), **i** for signed 4-byte integers (-2,147,483,648,+2,147,483,647), **f** for 4-byte floating points and **d** for 8-byte double precision floating points. For netCDF, simply use **d** as netCDF will automatically handle type-conversions during reading.
NaN is Y if certain values (e.g, -9999) are to be replaced by NAN, and N otherwise.
NaN-proxy is that special value (e.g., -9999).
scale is used to multiply the data after reading.
offset is used to add to the scaled data.
oformat is a C-style format string used to print values from this column.

If you give - as the *oformat* then **GMT**'s formatting machinery will be used instead (i.e., **D_FORMAT**, **PLOT_DEGREE_FORMAT**, **PLOT_DATE_FORMAT**, **PLOT_CLOCK_FORMAT**). Some file formats already have definition files premade. These include mgd77 (for plain ASCII MGD77 data files), mgd77+ (for enhanced MGD77+ netCDF files), gmt (for old mgg supplement binary files), xy (for plain ASCII x, y tables), xyz (same, with one z-column), geo (for plain ASCII longitude, latitude files), and geoz (same, with one z-column).

EXAMPLES

If you have a large set of track data files you can organize them using the x2sys tools. Here we will outline the steps. Let us assume that your track data file format consist of 2 header records with text information followed by any number of identically formatted data records with 6 columns (lat, lon, time, obs1, obs2, obs3) and that files are called *.trk. We will call this the "line" format. First, we create the line.def file:

```
# Define file for the line format
#ASCII              # File is ASCII
#SKIP 2             # Skip 2 header records
#GEO                # Data are geographic
#name   type   NaN   NaN-proxy      scale offset oformat
lat     a      N     0          1      0      %9.5f
lon     a      N     0          1      0      %10.5f
time    a      N     0          1      0      %7.1f
obs1    a      N     0          1      0      %7.2f
obs2    a      N     0          1      0      %7.2f
obs3    a      N     0          1      0      %7.2f
```

Next we create the TAG and the TAG directory with the databases for these line track files. Assuming these contain geographic data and that we want to keep track of the data distribution at a 1 x 1 degree resolution, with distances in km calculated along geodesics and with speeds given in knots, we may run

x2sys_init LINE **−V −G −D**line **−Rg −Ce −Ndk −NsN −I**1/1 **−E**trk

where we have selected LINE to be our x2sys tag. When x2sys tools try to read your line data files they will first look in the current directory and second look in the file *TAG*_paths.txt for a list of additional directories to examine. Therefore, create such a file (here LINE_paths.txt) and stick the full paths to your data directories there. All TAG-related files (definition files, tag files, and track data bases created) will be expected to be in the directory pointed to by **$X2SYS_HOME**/*TAG* (in our case **$X2SYS_HOME**/LINE). Note that the argument to **−D** must contain the full path if the *.def file is not in the current directory. **x2sys_init** will copy this file to the **$X2SYS_HOME**/*TAG* directory where all other x2sys tools will expect to find it.

Create tbf file(s):
Once the (empty) TAG databases have been initialized we go through a two-step process to populate them. First we run **x2sys_binlist** on all our track files to create one (or more) multi-segment track bin-index files (tbf). These contain information on which 1 x 1 degree bins (or any other blocksize; see **−I**) each track has visited and which observations (in your case obs1, obs2, obs3) were actually observed (not all tracks may have all three kinds of observations everywhere). For instance, if your tracks are listed in the file tracks.lis we may run this command:

x2sys_binlist −V −TLINE :tracks.lis > tracks.tbf

Update index data base:
Next, the track bin-index files are fed to **x2sys_put** which will insert the information into the TAG databases:

x2sys_put −V −TLINE tracks.tbf

Search for data:
You may now use **x2sys_get** to find all the tracks within a certain sub-region, and optionally limit the search to those tracks that have a particular combination of observables. E.g., to find all the tracks which has both obs1 and obs3 inside the specified region, run

x2sys_get −V −TLINE **−R**20/40/-40/-20 **−F**obs1,obs3 > tracks.tbf

MGD77[+] or GMT:
Definition files already exist for MGD77 files (both standard ASCII and enhanced netCDF-based MGD77+ files) and the old *.gmt files manipulated by the mgg supplements; for these data sets the **−C** and **−N** will default to great circle distance calculation in km and speed in m/s. There are also definition files for plain x,y[,z] and lon,lat[,z] tracks. To initiate new track databases to be used with MGD77 data from NGDC, try

x2sys_init MGD77 **−V −D**mgd77 **−E**mgd77 **−Rd −Gd −Nsn −I**1/1 **−Wt**900 **−Wd**5

where we have chosen a 15 minute (900 sec) or 5 km threshold to indicate a data gap and selected knots as the speed; the other steps are similar.

Binary files:

Let us pretend that your line files actually are binary files with a 128-byte header structure (to be skipped) followed by the data records and where *lon*, *lat*, *time* are double precision numbers while the three observations are 2-byte integers which must be multiplied by 0.1. Finally, the first two observations may be -32768 which means there is no data available. All that is needed is a different line.def file:

```
# Define file for the binary line format
#BINARY          # File is now binary
#SKIP 128        # Skip 128 bytes
#GEO             # Data are geographic
#name   type    NaN?   NaN-proxy       scale offset oformat
lon     d       N      0       1       0       %10.5f
lat     d       N      0       1       0       %9.5f
time    d       N      0       1       0       %7.1f
obs1    h       Y      -32768  0.1     0       %6.1f
obs2    h       Y      -32768  0.1     0       %6.1f
obs3    h       N      0       0.1     0       %6.1f
```

The rest of the steps are identical.

COARDS 1-D netCDF files:

Finally, suppose that your line files actually are netCDF files that conform to the COARDS convention, with data columns named *lon*, *lat*, *time*, *obs1*, *obs2*, and *obs3*. All that is needed is a different line.def file:

```
# Define file for the netCDF COARDS line format
#NETCDF          # File is now netCDF
#GEO             # Data are geographic
#name   type    NaN?   NaN-proxy       scale offset oformat
lon     d       N      0       1       0       %10.5f
lat     d       N      0       1       0       %9.5f
time    d       N      0       1       0       %7.1f
obs1    d       N      0       1       0       %6.1f
obs2    d       N      0       1       0       %6.1f
obs3    d       N      0       1       0       %6.1f
```

Note we use no scaling or NAN proxies since those issues are usually handled internally in the netCDF format description.

SEE ALSO

x2sys_binlist(1),   *x2sys_datalist*(1),   *x2sys_get*(1),   *x2sys_list*(1),   *x2sys_put*(1),   *x2sys_report*(1), *x2sys_solve*(1)

NAME

      x2sys_put – Update x2sys track data bases

SYNOPSIS

      x2sys_put [*info.tbf*] **−T***TAG* [**−D**] [**−F**] [**−V**]

DESCRIPTION

      x2sys_put accepts a track bin-index file created by **x2sys_binlist** and adds this information about the data tracks to the relevant data base. You may chose to overwrite existing data with new information for older tracks (**−F**) and even completely remove information for certain tracks (**−D**). The x2sys *TAG* must match the tag encoded in the *info.tbf* file. To inquire about tracks in the data base, use **x2sys_get**.

      −T   Specify the x2sys *TAG* which tracks the attributes of this data type.

OPTIONS

      No space between the option flag and the associated arguments.

      info.tbf Name of a single track bin file. If not given, stdin will be read.

      −D   Delete all tracks found in the track bin file [Default will try to add them as new track entries].

      −F   Replace any existing database information for these tracks with the new information in the track bin file [Default refuses to process tracks already in the database].

      −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

EXAMPLES

      To add the information stored in the track bin-index file latest.tbf to the track data bases associated with the tag MGD77, and replace any exiting information for these tracks, try

      x2sys_put latest.tbf **−F −V −T**MGD77

X2SYS DATABASES

      The **x2sys_put** utility adds new information to the x2sys data bases. These consists of two files: The first file contains a listing of all the tracks that have been added to the system; it is named *TAG*_tracks.d and is in ASCII format. The second file is named *TAG*_index.b and is in native binary format. It contains information on which tracks cross each of the bins, and what data sets were observed while crossing the bin. The bins are defined by the **−R** and **−I** options passed to **x2sys_init** when the *TAG* was first initiated. Both data base files are stored in the **$X2SYS_HOME**/*TAG* directory. Do not attempt to edit these files by hand.

SEE ALSO

      x2sys_binlist(1), *x2sys_get*(1)

NAME

      x2sys_merge − Merge an updated COEs tables

SYNOPSIS

      x2sys_merge −A*main_COElist.d* **−M***new_COElist.d*

DESCRIPTION

      x2sys_merge will read two crossovers data base and output the contents of the main one updated with the COEs in the second one. The second file should only contain updated COEs relatively to the first one. That is, it MUST NOT contain any new two tracks intersections (This point is NOT checked in the code). This program is useful when, for any good reason like file editing NAV correction or whatever, one had to recompute only the COEs between the edited files and the rest of the database.

      −A   Specify the file *main_COElist.d* with the main crossover error data base.

      −M   Specify the file *new_COElist.d* with the newly computed crossover error data base.

OPTIONS

      No space between the option flag and the associated arguments.

      EXAMPLES

            To update the main COE_data.txt with the new COEs estimations saved in the smaller COE_fresh.txt, try

            x2sys_merge −ACOE_data.txt **−M**COE_fresh.txt > COE_updated.txt

SEE ALSO

      x2sys_binlist(1), *x2sys_cross*(1), *x2sys_datalist*(1), *x2sys_get*(1), *x2sys_init*(1), *x2sys_list*(1), *x2sys_put*(1), *x2sys_report*(1)

NAME

x_edit − convert between binary and ASCII crossover correction tables.

SYNOPSIS

x_edit **−A**|**X**[*name*] **−O**[*outname*]

DESCRIPTION

The purpose of **x_edit** is to convert between ASCII and binary versions of the crossover correction tables.

−A   Name of ASCII correction table [stdin], write binary table to file given by **−O** [stdout].

−X   Name of binary correction table [stdin], write ASCII table to file given by **−O** [stdout].

−O   Name of output correction table [stdout].

EXAMPLES

To convert the binary file crossover_corr.b to ASCII and write to stdout, run

x_edit −Xcrossover_corr.b > corrections.d

SEE ALSO

GMT(1), *x_system*(1)

REFERENCES

Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

NAME
x_init – Initialization of Cross-Over Data Bases.

SYNOPSIS
x_init –I

DESCRIPTION
The purpose of **x_init** is to create two key files that will be holding all the cross-over information for all the cruises tested. These files are called *xx_base.b* and *xx_legs.b*, and they will contain data for each cross-over and totals for each leg, respectively. **x_init** will create these two files in the current directory, and write out the fileheader with a 1 as the next record number in the case of xx_base.b. NB! Any previous files with the same names in the current directory will be erased, so use with caution.

–I   Must be present form initialization to take effect.

BEWARE
Both files are binary and have fixed record lengths. The formats of the files are as follows:

xx_base.b:
> Record length = 40 bytes.
> Rec # 1:   fileheader
> Rec # 2:   pairheader
> Next n recs: crossover-structure
> Rec # n+3:   pairheader etc.

The fileheader is a 40 byte character string where the last 10 bytes contains the record number of the last record in the file. The pairheader is a 40 byte character string which contains the names of the two legs in question and the number of COEs generated between them. The crossover-structure contains all the information for one COE, that is lat, lon, time along leg values of gravity, magnetics, and bathymetry at the cross-over point, the heading of track #1, and the heading of track #2. See program listing for more details on formats. The file is sequential in that new data are appended at the end of the file.

xx_legs.b:
> Record length = 204 bytes.

Each record contains the complete information for each leg that has been checked. The leg-structure contains fields like year of cruise, number of internal/external COEs for gravity, magnetics, and bathymetry, their means and standard deviations, and the best fitting regression lines, i.e. the dc-shifts and drift-rates computed from the time/error data points. See program listing for complete description of record format.

SEE ALSO
GMT(1), *x_system*(1)

REFERENCES
Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

NAME

      x_list – Extract Cross-Over Information from the Data Base.

SYNOPSIS

      x_list [*leg1*] [*leg2*] [*−dataflags*] [*−R**west/east/south/north*] [*−X**xbase*] [*−H*] [*−I*] [*−V*] [*−C**cor-rfile*] [*−Z**ignorefile*]

DESCRIPTION

      x_list will allow the user to extract information from the xx_base.b and xx_legs.b files. Several options can be passed on the command line in order to specify which parameters to extract. They are:

      leg1 leg2

            If two legs are specified, the cross-overs they have in common are returned. If one leg is specified, all the external cross-overs involving this leg are returned, OR only its internal cross-overs if –I is selected. If no legs are given, all the external (or internal with –I) cross-overs are returned. This program is useful if one wants to look at, say, gravity COEs versus time from port for a particular leg, etc.

      dataflags

            This is a string of any combination of the following:

                  l means list both legnames.
                  t means list time.
                  x means list longitude.
                  y means list latitude.
                  g means list gravity COEs.
                  m means list magnetics COEs.
                  b means list bathymetry COEs.
                  G means list average gravity at cross-over.
                  M means list average magnetic anomaly at cross-over.
                  B means list average bathymetry at cross-over.
                  h means list heading of ship at cross-over.

            The components are written out in the order they appear in *dataflags*. The default output is **−txygmbGMBhl**. When internal COEs are desired, the time reported is the elapsed time since the ship first occupied the cross-over point. For external COEs the time means time from the start of the year in seconds.

      −R   Only return cross-overs inside the specified region *west, east, south,* and *north*. [Default is world].

      −X   Indicate alternate *xx_base.b* file.

      −H   Issue one header record on output.

      −I   Report on internal COEs [Default is external COEs].

      −C   Apply cross-over correction to the data (i.e. reports the cross-over value after the best-fitting corrections have been applied to both legs). If no *corrfile* is given, the default correction file is assumed.

      −Z   Ignore those legs that appear in the *ignorefile*.

      −V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

SEE ALSO

      GMT(1), *x_system*(1)

REFERENCES

      Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

NAME

x_over – Find and compute Cross-Over Errors

SYNOPSIS

x_over *leg_1* [*leg_2*] [**−A**] [**−C**] [**−L**] [**−V**] [**−W***timegap*] [**−G***fact*] [**−M***fact*] [**−T***fact*] [**−N***np_int*]

DESCRIPTION

x_over is used to inspect two cruises to see if they intersect, and if so report the time, position, discrepancies in gravity/magnetics/bathymetry, heading for each track segment, and the average values of the geophysical observables at the cross-over point. The names of the legs are passed on the command line. If they are identical or only one name is passed, then **x_over** looks for internal cross-overs. The optional parameters are:

−A   Use an Akima spline to interpolate the geophysical field at the cross-over point.

−C   Use a Natural Cubic spline function instead.

−L   Use a linear interpolant [Default].

−W   Do not compute cross-overs if the 2 nearest points are more than *timegap* minutes apart.

−G   Scale gravity by *fact* [Default is 0.1 since gmt-files store gravity in g.u.]

−M   Scale magnetic anomaly by *fact* [1.0].

−T   Scale bathymetry by *fact* [1.0].

−N   Specify how many points to use in the interpolation [Default is 6].

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"]. Report the number of cross-overs for this pair of legs.

BEWARE

The COEs found are printed out to standard output in ASCII format. The first record contains the leg names and their start year, whereas subsequent records have the data for each COE encountered. The fields written out are lat, lon, time along track #1, time along track #2, x_gravity, x_magnetics, x_bathymetry, average gravity, average magnetics, average bathymetry, heading along track #1, and heading along track #2. Sign convention: If lega and legb are passed on the command line, then the COE value is Value (lega) - Value (legb). It is recommended that the Akima spline is used instead of the natural cubic spline, since it is less sensitive to outliers that tend to introduce wild oscillations in the interpolation.

SEE ALSO

GMT(1), *x_system*(1)

REFERENCES

Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

NAME
>   **x_remove** − Remove COEs for Selected Cruises from the Data Base

SYNOPSIS
>   **x_remove** *removefile* [−**X***xbase*] [−**L***legbase*] [−**V**]

DESCRIPTION
>   **x_remove** will read a list of 'bad' cruises, read the **XSYSTEM** data base files, and write out new **XSYS-TEM** files that do not include any COEs generated by the bad cruises. This is useful if certain cruises turn out to have systematic errors (e.g. the topography values were inadvertently given as fathoms instead of meters), and we would like to re-run **x_over/x_update** after the systematic errors have been rectified. The new file names will consist of the old file names with the suffix _new appended.

>   −**X**   Indicates alternate xbase file [Default is *xx_base.b*].

>   −**L**   Indicates alternate legbase file [Default is *xx_legs.b*].

>   −**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

SEE ALSO
>   *GMT*(1), *x_system*(1)

REFERENCES
>   Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

NAME
x_report − Report Cross-Over Error Statistics for Cruises

SYNOPSIS
x_report [*leg*] [**−X***legbase*] [**−G**] [**−M**] [**−T**]

DESCRIPTION
x_report reads the x_system data base file and prints out statistics for each leg. The statistics are the number of, means, and standard deviations of COEs for both the internal and external cases. One or more data types (GMT) may be specified.

leg   Report on *leg* only. [Default is all legs].

−X   Specify alternate leg data base [Default is *xx_legs.b*].

−G   Give information for Gravity cross-overs only. [Default is G, M, and T].

−M   Give information for Magnetics cross-overs only. [Default is G, M, and T].

−T   Give information for Topography cross-overs only. [Default is G, M, and T].

SEE ALSO
GMT(1), *x_system*(1)

REFERENCES
Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

NAME

x_setup − Determine Pairs of Legs that need Cross-Over Checking

SYNOPSIS

x_setup [**−L***legfile*] [**−R***west/east/south/north*]

DESCRIPTION

x_setup scans the *gmtindex.b* file that contains information on which legs occupy each 1 by 1 degree bin and reports all the pairs of legs that may overlap. Each pair is only reported once, even if the two legs involved are found in other bins also.

−L　　　　Only report pairs where at least one of the legs are present in the *legfile*.

−R　　　　The region of interest. [Default is world]

BEWARE

The **−L** option is useful when one wants to check out a handful of new cruises. Obviously we only need to compute COEs for the pairs that involve one or two of the new cruises, since all the other combinations have already been done.

SEE ALSO

GMT(1), *x_system*(1)

REFERENCES

Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

NAME
   x_solve_dc_drift – Find Best-fitting D.C.-shift and Drift Estimates

SYNOPSIS
   x_solve_dc_drift [−**X**_xbase_] [−**L**_lbase_] [−**I**_ignorefile_] [−**S**] [−**C**_iteration_] [−**M**_min_nx_] [
   −**R**_west/east/south/north_] [−**U**_uselegsfile_] [−**V**] [−**B**_binfile_] [−**A**_ASCIIfile_]

DESCRIPTION
   x_solve_dc_drift will read the database files and, by iterating, find the best-fitting regression line to the
   <time,COE> points for each leg that minimizes the overall standard deviation of the data set in a least
   squares sense. Finally, correction file(s) are created.

   −**X**   Indicate an alternate database to read. [Default is _xx_base.b_].

   −**L**   Indicate an alternate legbase to read. [Default is _xx_legs.b_].

   −**I**   Ignore information for certain legs (that might be bad, etc).

   −**S**   Reset the old d.c.-shift and drift estimates to zero before iterating.

   −**C**   Specify how many iterations to do. Default is interactive session.

   −**M**   Solve for drift only if the leg has more than _min_nx_ cross-overs.

   −**R**   Only take COEs inside this region into account. [Default is world].

   −**U**   Solve for corrections involving COEs from legs in the _uselegsfile_ only.

   −**B**   Create a binary correction file (which can be read by **x_list** and **gmtlist**).

   −**A**   Create an ASCII correction table. At least one of −**A** and −**B** must be specified.

   −**V**   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"].

BEWARE
   The reason for the −**M** option is that if the COEs are few, then a stable estimate of the slope may not be
   obtained (e.g. when most of the COEs occur midway between ports). However, in most cases the bulk of
   the COEs do occur near the ports so that a drift estimate can be computed. Conventional wisdom recom-
   mends plotting the time-series and the computed regression line to see if it makes sense.

SEE ALSO
   GMT(1), _x_system_(1)

REFERENCES
   Wessel, P. XOVER: A Cross-over Error Detector for Track Data, _Computers & Geosciences, 15_, 333-346.

NAME

      x_system – A Cross-Over Error Analysis Tool

INTRODUCTION

      The **x_system** was developed to aid in the task of gridding geophysical track data, e.g. gravity, magnetics, or bathymetry. It has long been recognized that although the data quality along track may be quite good, one usually finds discrepancies at the points where two tracks intersect. These cross-over errors (COE) can be large enough to cause artificial features in the final gridded dataset, which would render geological interpretations of such a map questionable. Also, notoriously bad cruises will generate high COEs along their tracks, and should ideally be removed from the data base before gridding is attempted. The reasons why COEs arise are many and will not be dealt with here. Although originally intended to be used for marine gravity data only, **x_system** has been designed to handle magnetics and bathymetry as well. (For an overview of gravity COEs, see Wessel and Watts [1988]). In most cases, marine gravity COEs can be explained by a simple model having only 2 parameters. These are a d.c.-shift and a drift-rate that apply for the duration of the cruise. The goal of the COE analysis is thus to determine the dc-shifts and drift-rates for each leg that will minimize the COEs in a least squares sense, and at the same time flag cruises that exhibit unreasonably high COEs (even after correction for d.c.-shift/drift). Furthermore, we can also assign a 'quality index' for each cruise by looking at the standard deviation of the COEs. The d.c.-shift/drift rate model may not be as meaningful for magnetics and bathymetry as it is for gravity. However, looking for high COEs is still one of the best ways of identifying systematic errors in the magnetic/bathymetric data sets.

x_system PHILOSOPHY

      Since the d.c.-shift/drift corrections for a given cruise depend entirely on the values of the COEs generated at intersections with other cruises, there is no such thing as a 'final correction' as long as we keep on adding data to the data base. This means that the system must be able to incorporate new data and compute a new set of d.c.-shifts/drift-rates that takes the new COEs into account. **x_system** is made modular so that one program computes the actual COEs, one program archives the COE information, and the remaining programs do various tasks like reporting statistics (to flag bad cruises), extracting a subset of the COE database, and solving for the best fitting d.c.-shift/drift corrections. This way only the new COEs generated need to be computed and added to the database before a new correction solution is sought.

      All the 8 programs that make up the **x_system** package have been written in the C programming language and are intended to be run on a UNIX machine. Thus, it is assumed that the user has access to UNIX tools like *awk, grep*, and *sort*, and that the operating system provides a means for redirecting input/output. Likewise, it is assumed that all the geophysical data are stored in the GMT-format as outlined in the **GMT** MGG supplements man pages, and that the 1 by 1 degree bin information files (gmtindex.b and gmtlegs.b) have been created and are being maintained by the database librarian.

HOW TO DO IT

      To illustrate how one would set things up, we will go through the necessary steps and point out usage, useful tricks, and pitfalls. (A more complete description of what exactly each program does can be found in the man pages for each program). We will assume that we initially have N cruises in our GMT data bank, and that we just have received the **x_system** package. The first thing to do is to run **x_init** which will create an empty data base system. This will normally be done only once. With N cruises on our hands we will in the worst case have to compare the N*(N+1)/2 possible pairs. This is where **x_setup** comes in handy. It will read the 1 by 1 degree bin information files and print out a list of pairs that need to be checked. The two cruises that make up a pair will at least once occupy the same 1 by 1 degree bin, and may thus intersect. Those combinations which do not have any bins in common obviously don't have to be checked. Let's call this list of pairs xpairs.lis.

      x_over is the main program in the package as it is responsible for locating and computing the COEs For details on algorithm, see Wessel [1989]. It takes two cruise names as arguments and writes out all the COEs generated between them (if any). Since xpairs.lis may contain quite a few pairs, the most efficient way of running **x_over** is to create an executable command (batch) file that starts **x_over** for each pair. Using awk to do this, we would say:

            pratt% awk '{ printf "x_over -<options> %s %s\n", $1, $2}' xpairs.lis > xjob
            pratt% chmod +x xjob   (make it executable)

pratt% xjob > xjob.d &

and relax while xjob is crunching the numbers. This is the time-consuming part of the COE analysis, and on a SUN-3 computer with Floating Point Accelerator installed we average about 10,000 pairs of cruises/day. It may pay off to split a huge xjob file into smaller parts, and call the output files xjob.d1, xjob.d2 etc. Most of the run-time is taken up by reading the GMT files; when in memory the actual computations are remarkably fast. The output file xjob.d will now have all the COE information in ASCII form. For each pair of legs there will be a header record stating the names of the cruises and their starting years. The following records up to the next header record (or End-Of-File) will contain lat, lon, time, value, etc. for each COE found. This is a temporary file, but it is wise to back it up to tape just in case.

When the **x_over** part is done, time has come to archive the data more efficiently than ASCII files. This is done by **x_update** which rearranges the data and updates the binary data base system. After this step the xjob.d files can be deleted (presuming they have been backed up to tape). At this stage we have several options available. We can list some of the COEs by running **x_list**, which will extract COEs that match the options we pass, e.g. we might ask for all the internal COEs for cruise c2104, and only print out time and gravity COE. See the man pages for more details. **x_report** can be run, and will output statistics for separate cruises, i.e. mean and standard deviation of the COEs for different data sets (gravity/magnetics/bathymetry). To solve for the best fitting corrections we would run **x_solve_dc_drift**. This program will solve for the d.c.-shift/drift-rates for all cruises, update that information in the data base system, and create correction tables (ASCII and/or binary). We have now completed the COE analysis for our initial GMT data bank.

At some later time, however, we will get a new batch of cruises. We will then follow the the same recipe and go back and run **x_setup**, but this time we will use the **−L** option so that only the pairs involving new cruises are returned. Then we would run the remaining programs exactly as described above.

SEE ALSO

GMT (1),

AUTHOR

Paul Wessel, Dept. of Geology and Geophysics, SOEST, University of Hawaii at Manoa. Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.

Wessel, P. and A. B. Watts, On the Accuracy of Marine Gravity Measurements, *J. Geophys. Res., 93*, 393-413, 1988.

NAME

x_update – Archiving of Cross-Over Information

SYNOPSIS

x_update *cross-overfile* [**−X***xbase*] [**−L***legbase*] [**−V**] [**−W***max*]

DESCRIPTION

x_update reads the ASCII file produced by **x_over** and writes the information to the database files *xx_base.b* and *xx_legs.b* (unless other filenames are specified on the command line) using a compact, binary format. The options recognized are:

−X   Indicate alternate *xx_base.b* file.

−L   Indicate alternate *xx_legs.b* file.

−V   Selects verbose mode, which will send progress reports to stderr [Default runs "silently"]. Reports the pair currently being processed.

−W   Prints a warning if the number of COEs generated by any pair of legs exceed *max*.

BEWARE

For security reasons the *xx_legs.b* are first renamed to *xx_legs.b_old*, to prevent loss of information if a black-out or system crash should occur during writing of the new *xx_legs.b* file. It is recommended that the old file is left on the disk in case of other disasters. Note that **x_update** does not check if a pair of legs already exist in the *xx_base.b* file. It is the user's responsibility to ensure that duplication of information does not occur. Should some pairs already in the database need to be re-examined, then run **x_remove** which will wipe out all traces of the specified cruises from the x_system data base files. Now we can pass the pairs that need to be redone through **x_over/x_update** again.

SEE ALSO

GMT(1), *x_system*(1)

REFERENCES

Wessel, P. XOVER: A Cross-over Error Detector for Track Data, *Computers & Geosciences, 15*, 333-346.