

USING FFTFIL.EXE, PREP.EXE, and DE_PREP.EXE

FFTFIL - Program **FFTFIL** performs various two-dimensional filtering operations on standard USGS grids using fast Fourier transforms. **PREP.EXE** makes your data suitable for **FFTFIL** and **DE_PREP.EXE** undoes **PREP**'s contribution after you complete the filtering steps.

FFTFILT, with its various filtering operations, takes a lot of tinkering and fiddling. Basically you are recalculating your data to enhance residuals, or gain some ideas about the nature of regional anomalies. There is a list of options with which to experiment. Play with them enough, for each data set, to gain an understanding of the wavelength characteristics of your data. **FFTFIL** uses a fast Fourier transform, thus if your data have abrupt edges (for example the west and east edge don't smoothly match) you will need to smooth them to attenuate edge effects that will otherwise propagate into your data.

PREP adds rows and columns to your grid, using a cosine smoothing function, to help reduce edge effects. You should only increase your grid size by a few to several percent, otherwise you will be adding long wavelength contributions to your data. There is no exact procedure you can follow with **PREP** (or **FFTFIL** for that matter), you will have to experiment with various values and make a judgement as to which approach is best for any particular data set. Use **DE_PREP** after **FFTFIL** to remove the extra rows added by **PREP**.

FFTFIL uses a command file or runs interactively (sort of); from the **USGS Help File**:

1. Create a command file with the following structure - or get the DEMO file, FFTFIL.CMD out of C:\pf\test:

line 1: operator coded name (one of the following):

psdmag pseudo-magnetic transformation

psdgrv pseudo-gravity transformation

redpol reduction of total magnetic field intensity to the north pole (see program F_RTP for specialized filter for reduction to pole at low magnetic latitudes.

upcont upward continuation

dncont downward continuation

1stver 1st-vertical derivative of the input field

2ndver 2nd-vertical derivative of the input field

banpas bandpass filter

strike direcional filtering

vertot change vertical-component data to total-field

nofilt no filtering

(Note: If icoef=2, only Fourier coefficients are output; any operator can be entered since it has no effect)

line 2 : input file name.ext

line 3 : output file name.ext

line 4 : title (cols. 1-56)

line 5 : &parms

line 6 : namelist parameters (see below)

line 7 : &

NOTES:

Lines 1 thru 4 should begin in column 1.

Lines 5 thru 7, the parms file, must begin in column 2 and all alphanumeric parameters must be enclosed in single quotes (').

Command file example:

```
strike
infile.grd
outfile.grd
FILTERED MAP
&parms
iopt1=-1,iopt2=1,thet1=15.,thet2=90.,
&
```

Lines 1 through 4 can be blank, then **FFTFIL** will prompt for the information

2. Invoke the program by typing '**fftfil**' and respond with the command file name at the prompt. **FFTFIL** cycles to the beginning after each run. To exit from the program type 'ex' or carriage return. The following queries are asked after each filter operation has been completed:

- query 1 : additional filter to be applied? (y or n) - if 'y' the program asks queries 2 thru 6. if 'n' the program starts over by asking for the command file.
- query 2 : new operator? Format same as in line 1 response.
- query 3 : new datum level? Format same as in line 2 response.
- query 4 : new output file name.ext?
- query 5 : new title?
- query 6 : parameter change? (y or n) - If 'n' the filtering computations are started. If 'y' the user enters the parameters to be changed in a namelist (eg. &parms thet1=-90., thet2=0.,&)
(Note the following parameters cannot be changed: nadd,iopt2,idval,s,xo,yo).

NAMELIST PARAMETERS

- iopt1 = 0 no printed output (**USE** default: iopt1=0)
6 output printed on terminal
-1 output printed on disk.
- iopt2 = -1 no removal of mean from input array (**USE** default iopt2=-1)
0 remove mean using boundary values
1 remove mean and save grid, file name: CON.GRD.
- nadd = no. of rows or columns added to each side of grid to reduce the effects of Gibbs phenomenon (default nadd=0). **Use PREP/DE_PREP**; nadd=0.
- w1,w2,w3,w4 - wavelengths used in bandpass filtering. Data are passed in the tetrahedral-shaped region starting at w1, ramping up to w2, and ramping down from w3 to w4. No data are passed with wavelengths less than w1 or greater than w4. Data are passed unchanged between w2 and w3, and are increasingly suppressed from w2 toward w1 and from w3 toward w4. $w1 \leq w2 \leq w3 \leq w4$. (default w1=w2=0, w3=w4=1.0e+30, i.e. all pass)
- density contrast, gm/cc (default den=1.).
- bmag magnetization contrast, e.g. suscept*field strength for induced mag (default bmag=1.)
- dec, xinc - declination and inclination of earth's field,degrees. (default dec=0. xinc=90.)
- bdec, binc - declination and inclination of magnetization vector. (default bdec=0. binc=90.)
- idval = 0 no flagged grid points in input data (default idval=0)
1 flagged grid points in input data
-1 flagged values removed and locations in file FLAG.LOC.
- Note: it's best to plug the dval areas first, before running fftfil, in which case idval=0.
- icoef =2 output only Fourier coeff's of input grid in file FFTFIL.COF; no filter operation is performed (location of flagged values stored in file FLAG.LOC in users area.)
1 Save Fourier coefficients in file FFTFIL.COF for later use but perform designated

filter operation. (Note: If data contains flagged values a file named FLAG.LOC containing their locations is also created in users disk area.) The saved fftfil.cof file has not been operated on by the designated filter. Normally icoef=1 is associated with operation "nofilt".

- 0 Fourier coefficients not saved (default icoef=0).
- 1 Fourier coefficients in file FFTFIL.COF are used as input. note that if flagged values are present in the data, file FLAG.LOC is required and 'idval' must be equal to -1. In addition, the parameter 'nadd' must be identical to its assigned value when the Fourier coefficients were saved.
- z continuation distance, in grid units. $z > 0$ for downward continuation and $z < 0$ for upward continuation (default $z = 0$). **GRID UNITS, like km, meters, etc.**
- thet1, thet2 -angles from geographic north that form a pie-slice filter for directional filtering ($-90.\text{ge.thet1}.\text{le.}+90.;\text{thet2}.\text{gt.thet1}$). Default thet1=0. thet2=90, i.e., all pass
- istr = -1 reject trends between thet1 and thet2. +1 pass (default istr=1).

The following parameters can be used if the spacing and origin of the output grid is to differ from that of the input grid.

- ddx - new grid spacing in the x direction, in grid units.
- ddy - new grid spacing in the y direction, in grid units.
- xo - new origin of rows, in grid units.
- yo - new origin of columns, in grid units.

REFERENCE: Hildenbrand, T.G., 1983, FFTFIL: A filtering program based on two dimensional Fourier analysis: U.S. Geological Survey Open- File Report 83-237, 31 p.

USGS info for PREP

To extend a grid, tilt, detrend, and cosine taper to reduce FFT wraparound, in preparation for use of program FFTFIL. After transforming, the new grid as output from FFTFIL can be untilted, retrended and trimmed back to the original by running program **DE_PREP**.

Dval areas, if present, should first be interpolated by program MEGAPLUG.

The new nrow, ncol should be chosen from the list of rich-in-factors-of-2 numbers that FFTFIL likes. The program checks that the new nrow and ncol will not be increased by FFTFIL.

It is necessary to extend the grid and taper the edges to get a well-behaved FFT, but too much extension increases the area of phony data to the point of contaminating the spectrum. Five or maybe up to ten percent increase in ncol and nrow should be ok.

If the new ncol or nrow isn't in the following list FFTFIL will choose something else. Do not proceed if **PREP** indicates that the grid would be extended by FFTFIL.

In program **PREP** the grid is detrended, then linearly tilted so that the northwest and southeast corners are equal, then extrapolated into the region north and east of the data by a cosine taper so that the new east- most column is (almost) equal to column 1 and the new northern-most row is (almost) equal to row 1. (See the code.) The tilting operation avoids anisotropy in the treatment of the new area in the northeast corner.

When running FFTFIL, be sure to set parameter nadd=0.

Program **PREP** put out an ascii file PREP.REC, which contains coefficients needed by program **DE_PREP** to untilt, retrend, etc. **Run program DE_PREP after FFTFIL.**

DE_PREP.EXE

To be used on output of FFTFIL when original data grid has been extended, detrended and tilted by program **PREP**. This program untilts (i.e., adds back in the datum shift and linear trend removed by **PREP**, and trims the border back to the original size. Requires file PREP.REC which was output automatically from program **PREP**.

Note that adding back the linear trend may not be appropriate, as in the case of, for example, derivatives, pseudo-gravity, or other cases where the units of the output grid differ from those of the original grid. Adding back the linear trend is therefore provided as an option.