

Getting Started with montaj MAGMAP Filtering

This *Getting Started with montaj MAGMAP Filtering* How-To Guide describes how to get started using the [montaj MAGMAP Filtering](#) extension (MAGMAP hereon), an integrated software package that supports the application of common Fourier domain filters to gridded data, with particular emphasis on potential field data.

Systems Capabilities and Concepts

The system's Fast Fourier Transform filtering capabilities enable you to:

- ▶ Rapidly process gridded datasets by applying a wide range of common robust geophysical and mathematical filters.
- ▶ Define and apply your own filters.
- ▶ Apply multiple filters in one filtering run.

MAGMAP offers three approaches to help you meet your data filtering requirements:

- ▶ **MAGMAP 1-Step filtering**
- ▶ **Step-by-Step filtering**
- ▶ **Interactive filtering**

Furthermore, in order to design and refine the filter operator(s), a suite of calculation/visualization tools enables the inspection of the Energy Density Spectrum in the wave-number domain.

- ▶ Spectrum calculation and display

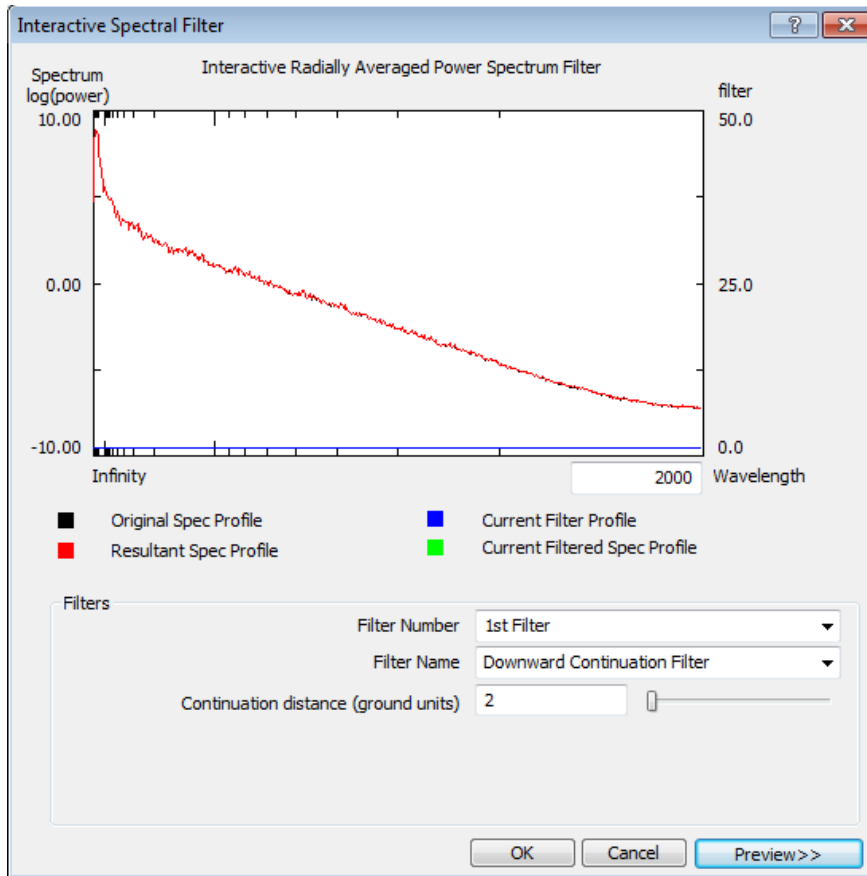
In the wave-number domain, the spatial dependency is abstracted and the data content is viewed in terms of its energy and frequency content - the very elements that the filters operate on.

The three filtering approaches only differ in your level of interaction with the system. The interactive filtering is the most granular level and allows you to visualize the waveform as well as the radially symmetrical filter operator. The step-by-step approach allows you to inspect the individual pre- and post-processing steps. The 1-Step filtering offers the highest level of interaction. All the defaults are appropriately set by the system and the sequential process is applied automatically.

Interactive Filtering

The Interactive Spectrum Filtering process enables you to display a radially averaged power spectrum of an FFT2 Transform image, a selected filter profile, and the resultant (filtered) power spectrum profile, in an interactive window. The filters can be selected from a subset dropdown list of symmetrical filters or from a predefined control file. Filter parameters can be interactively modified to obtain the best results.

The Interactive Spectral Filter dialog includes a profile window, a filter selection dropdown list, and filter-specific parameter fields.



Profile window

Filter selection dropdown list
Filter specific parameters

The profile pane displays:

- The radially averaged power spectrum profile from the original input spectrum file - in **black**
- The current filter profile - in **blue**
- The current filtered spectrum profile - in **green**
- The resultant (filtered) profile - in **red**

The values of the filter parameter fields can be entered interactively, by moving the associated slider, or by typing in the field boxes.

The radially symmetrical filters available through the Interactive Spectrum Filtering options are: Bandpass, Butterworth, Cosine Roll-off, Gaussian Regional/Residual, Upward Continuation, Downward Continuation, Derivative in the Z Direction, Vertical Integration and combination filters such as, General, Notch, Butterworth Notch, Butterworth Bandpass and Cosine Roll-off Bandpass.

The Interactive Filtering process includes the following procedures:



- Preparing grids for transformation
- Applying the forward Fast Fourier Transform

- Calculating the radial average spectrum
- Defining interactive spectrum filters
- Applying filters and the inverse transform

Creating a Project

In Oasis montaj you always start by creating a "Project". You can customize the setup of the project; select the desired menus and toolbars, along with their location in the Oasis montaj window. Projects are created with comprehensive defaults. The project inherently remembers its state; if you close and later reopen the project, it will recover all its elements in their latest state. All files manipulated in an open project are listed in the Project's Explorer pane and can be instantly invoked.

As you proceed with your processing exercise, and access files (databases, maps, and grids) anywhere in the file system, Oasis montaj will reference them in the Project Explorer pane, for easy access. Nonetheless, it always is a good strategy to carefully organize your data in an appropriate folder hierarchy before embarking on the processing activity.

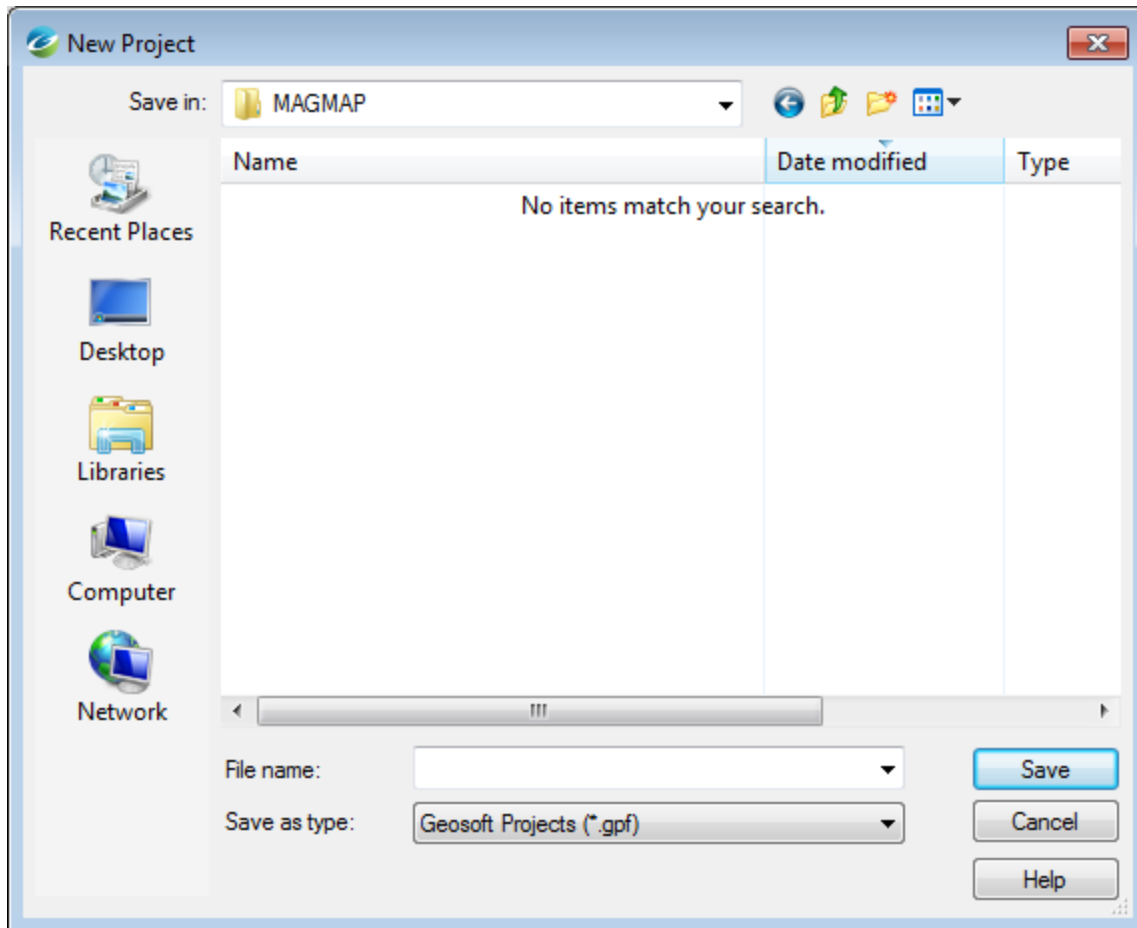
-  *A general rule to follow is never to work in the Geosoft installation folder.*
-  *Prior to starting an Oasis montaj project use your Windows Explorer tools to create a working folder, and populate it with all your starting files.*

Projects are generated with the extension (*.gpf). In the absence of an explicit folder path the system assumes that you are accessing files and saving files in the project working folder. To streamline your work, as well as keep it organized, you may wish to make sure that your project file is in the same folder as the other files you want to use. We recommend that each project you work on have its own project (*.gpf) file. If you use a number of applications or extension tools in Oasis montaj that have different menus, you can use the project to display only the menus you require.

To Create a Project

1. Create a folder for your project.
2. Start **Oasis montaj**.

From the *File* menu, select *Project* and then select **New**.
The *New Project* dialog appears.



3. Specify a *File name* and folder for the project.
4. Click **Save**. The system saves the project and indicates it is open by adding menus to the menu bar, adding buttons to the Standard Short-cut bar and by displaying the Project Explorer window. These visual clues indicate that you are ready to start working with the system.


Project Explorer Tool

The *Project Explorer* tool enables you to browse as well as open any data that has already been loaded into the project. The Project Explorer has two windows, the *Data* window that includes all data files included in the project and the *Tools* window that organizes and maintains the project tools. To access the Tools window click the **Tools** bar on the bottom of the Project Explorer. To return to the Data window, click the **Data** bar on the top the Project Explorer.

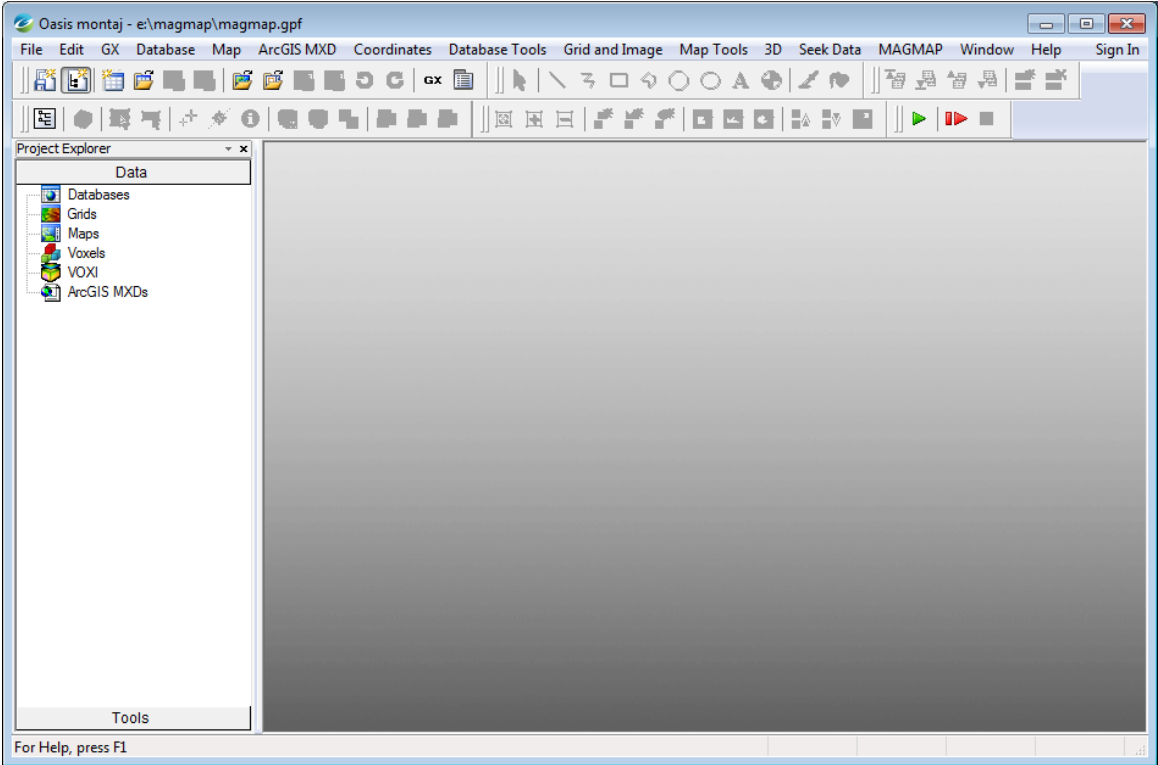
Loading the MAGMAP Menu

Before you can start working with the montaj MAGMAP Filtering extension, you have to load the MAGMAP menu in your project. For more information on setting menus, refer to the Oasis montaj Application Help system (Help | Help Topics).

To Load the MAGMAP Menu

- 1. From the GX menu, select **Load Menu** or click the Load Menu icon () on the toolbar. The *Load Menu* dialog appears.
- 2. From the list of menus, select *magmap.omn* and click **Open**.

The system displays the MAGMAP menu on the main Oasis montaj menu bar.



MAGMAP Menu and Processing System

The montaj MAGMAP Filtering extension (MAGMAP hereafter) is designed to provide you with an intuitive interface that guides you through the preparation, processing, analysis, and visualization of potential field data. This section describes the application menu and outlines the major steps in the processing sequence.

Navigating the MAGMAP Menu


The MAGMAP workflow is sequentially organize in the MAGMAP menu. When you select a menu item, the system runs a corresponding Geosoft eXecutable (GX), a programmed process that records your input values and implements a specific processing, analysis, or visualization task. The table below shows the MAGMAP menu items along with the corresponding GX names. You will notice that some GXs appear in more than one submenu; the underlain reason being that the menu system is designed to provide a natural workflow:

MAGMAP 1-Step Filtering...	MAGMAP1 GX	
Step-By-Step Filtering ▶	<div style="border: 1px solid black; padding: 5px;"> <p>Prepare Grid...</p> <p>Forward FFT...</p> <p>Define Filters...</p> <p>Apply Filter...</p> </div>	<p>FFT2PREP GX</p> <p>FFT2IN GX</p> <p>FFT2CON GX</p> <p>FFT2FLT GX</p>
Interactive Filtering ▶	<div style="border: 1px solid black; padding: 5px;"> <p>Prepare Grid...</p> <p>Forward FFT...</p> <p>Radial Average Spectrum...</p> <p>Interactive Spectrum Filters...</p> <p>Apply Filter...</p> </div>	<p>FFT2PREP GX</p> <p>FFT2IN GX</p> <p>FFT2RSPC GX</p> <p>FFT2SPCFLT GX</p> <p>FFT2FLT GX</p>
Spectrum Calculation and Display ▶	<div style="border: 1px solid black; padding: 5px;"> <p>Radial Average Spectrum...</p> <p>Display Spectrum...</p> <hr/> <p>2-D Power Spectrum...</p> </div>	<p>FFT2RSPC GX</p> <p>FFT2SMAP GX</p> <p>FFT2PSPC GX</p>
Generalised Derivative...	GENERALISED DERIVATIVE GX	
Analytic Signal...	GRIDASIG GX	
Tilt Derivative...	TILTDRV GX	

Understanding Processing Sequence

For the sake of mathematical simplicity and speed of operation, the MAGMAP extension applies filters in the Fourier (or wave-number) domain. This approach entails a number of consecutive steps, each of which is achieved by a separate GX in the workflow.

In the pre-processing stage the spatial data is conditioned to be conform with the fundamental maxims of the discrete wave-number domain processing. Next the spatial data is transformed to the wave-number domain, and filters are applied. Next the data is transformed back to the space domain. Post-processing involves the removal of the traits of the original precondition. These include restoring the original data coverage and when applicable introducing the effect of the regional trend. Each step is described in more detail below.

 You can either carry out each of these steps individually, using the MAGMAP step-by-step submenu, or execute the MAGMAP 1-step filtering option, that will take you through the entire sequence in one step. The latter will produce satisfactory results in most instances. However, if you experience artefacts such as ringing, edge distortions, unexplained regional influence or any other undesirable side effects, you must scrutinize the parameters involved in the pre-processing stage to address these potential issues.

Preparing Grid

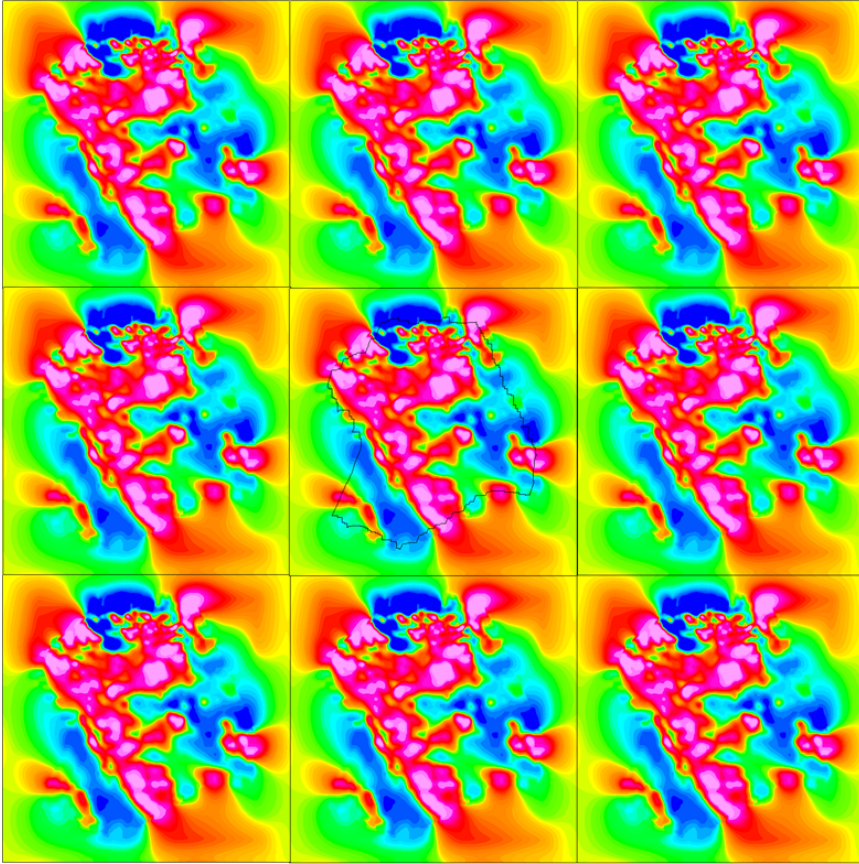
One of the maxims of the wave-number domain processing is that the signal must be periodic. In order to mimic periodicity, in the preprocessing stage, the grid is expanded and then extended at opposite ends to ensure continuity. To convey the notion, imagine repeating the preprocessed grid edge to edge and not seeing a seam. The preparation steps are listed below:

1. First the long wavelength-trend is removed from the data. The default is to remove a 1st order trend, but depending on the nature of the data you may opt for a different option, or simply opt out of it. It is recommended to remove a trend when the regional trend is pronounced.
2. Then the grid is expanded to a square (default) or rectangle of Winograd dimensions (*Winograd, S. On Computing the Discrete Fourier Transform, Mathematics of Computation, Vol. 32, No. 141, pp. 175-199, Jan. 1978.*). The expansion allows adequate space for ensuring smooth periodicity and continuity. Although it is possible to expand the grid to a rectangle, you are discouraged from doing so, because the difference in the X and Y dimension introduces aliasing in the processed grid.



Originally the preprocessing stage required that the data be expanded to a dimension of 2^n . For large grids this fundamental requirement increased unnecessarily the processing time. Subsequently Winograd altered the FFT algorithm to accept additional permissible dimensions.

3. Next, the expanded area is interpolated so that the filled grid is periodic along both coordinates.



Discontinuity in the transitions along opposite edges may reflect back in the filtered output data as ringing.

Applying Fourier Transform

The square periodic space domain grid is transformed to the wave-number domain . A radially averaged spectrum of the data is also produced for reference and analysis.

Specifying Filter

The desired filters are selected.

Using the Interactive filtering menu option, the radial filter can be visualized along with the energy spectrum. You can then adjust the filter parameters accordingly to produce the desired effect on the graph and save it.

Filtering


The defined filter(s) are applied to the wave-number domain data.

The filtered wave-number grid is transformed from the wave-number domain back to the space domain.

Post -processing

The processed space domain grid is reduced to its original size and masked to the original coverage.

If in the preparation stage a trend surface has been removed, and the absence of high-pass filters, the same trend is added back into the grid.

 Originally the preprocessing stage required that the data be expanded to a dimension of 2^n . For large grids this fundamental requirement increased unnecessarily the processing time. Subsequently Winograd altered the FFT algorithm to accept additional permissible dimensions.

How-To Guide Publication Date: 05/06/2014

Copyright 2014 Geosoft Inc. All rights reserved.