

## Grid Operations (T25)

The Grid Operations tool enables you to perform the following operations on gridded datasets:

- Resample a grid to change its cell size and origin. The user can choose between four resampling methods.
- Smooth a grid using Minimum Curvature to improve its appearance.
- Rotate a grid about the grid origin.
- Decimate a grid (by half) and create an output grid with double the cell size.
- Extract single band grids from a multi-band grid.
- Insert single band grids into a multi-band grid.
- Detrend a grid using the 2D least squares technology from grid filter.
- Convert the internal grid values from Integer/Real to Double Precision.
- Export all non-null values from a grid to an INTREPID point dataset.
- Create GRF grids for your selected input grid. You must supply date of survey acquisition and survey flying height.
- Capture the grid outline into a shape or polygon file.
- Save the difference of a grid from the reference grid, without the requirement that the grids have the same origin and cell size.

### Tensor Grid Operations

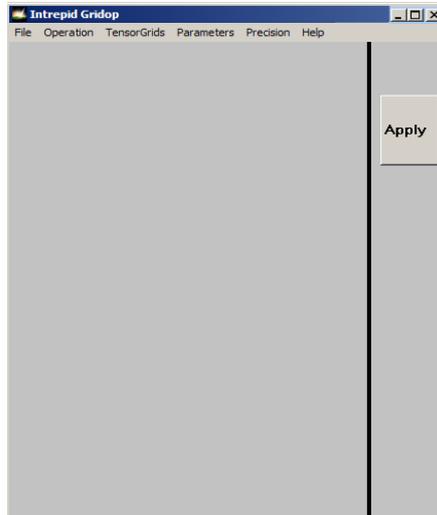
Both standard Full tensor grids and the Falcon variant are supported in this tool:

- Create a tensor grid from its component grids
- Deconstruct a tensor grid into its component grids.

## The Grid Operations tool

### >> *To use the Grid Operations tool*

- 1 Choose Grid Operations from the Grid menu of the Project Manager, or use the command `gridop.exe`. INTREPID will open the Grid Operations window.



- 2 If you have previously prepared file specifications and parameter settings for Grid Operations, load the corresponding task specification file using Load Options from the File menu. (See [Specifying input and output files](#) for detailed instructions.) If all of the specifications are correct in this file, go to step 6. If you wish to modify any settings, carry out the following steps as required.
- 3 Specify the input, reference and output datasets for the operation. Specify the reference dataset for resampling or smoothing, if required. (See [Specifying input and output files](#) for detailed instructions.)
- 4 If you are resampling, specify the cell size required for your resampled grid, and select the resampling process you wish to use. (See [Resampling a grid](#) for details.)
- 5 If you are smoothing your grid, specify the number of iterations required and the maximum residual difference for the minimum curvature smoothing process. (See [Smoothing a grid](#) for details.)
- 6 Choose Apply. INTREPID will process the input grid and create an output grid.
- 7 If you wish to save the parameters for this process in a task specification (.job) file in order to repeat a similar task later or for some other reason, use Save Options from the File menu. (See [Specifying input and output files](#) for detailed instructions.)
- 8 To exit from Grid Operations, choose Quit from the File menu.

You can view Help information by choosing options from the Help menu (See [Help](#)).

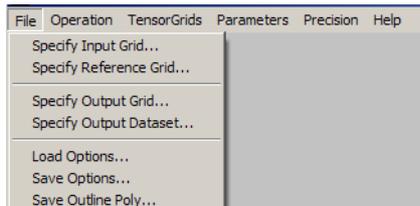
You can execute Grid Operations as a batch task using a task specification file (.job) file that you have previously prepared. See [Using task specification files](#) for details.

## Specifying input and output files

For resampling, specify the original grid as the input grid. The origin of the new grid can be set to that of an existing grid by selecting the existing grid as the reference grid at the file selection stage. (See [Preparing grids to avoid Grid Merge tool resampling](#) for an example of a situation where you would wish to change the origin). Specify a name for the output grid (the resampled grid).

For other operations, specify input and output grids.

Choose the corresponding options from the File menu to specify the datasets as described above.



In each case INTREPID displays an Open dialog box. Use the directory and file selector to locate the file you require. (See [“Specifying input and output files” in Introduction to INTREPID \(R02\)](#) for information about specifying files).

**Specify Input Grid** Select the name of the grid dataset to be processed.

**Specify Reference Grid** The reference grid serves a distinctly different role depending on whether you are resampling or smoothing your dataset.

If you are resampling a grid and wish to change the origin, use this to specify the name of the existing grid you want to align with. (See [Preparing grids to avoid Grid Merge tool resampling](#) for an example of a situation where you would wish to change the origin).

If you are smoothing a grid, use this to specify the name of the input dataset which contains the original values for honouring by the minimum curvature smoothing process.

If you do not specify a reference grid, INTREPID uses the input grid as the reference grid.

**Specify Output Grid** Specify the name of the new grid dataset you are creating with this grid operation.

**Load Options** Select a Grdop task specification file to preload the interactive session with all the required file and parameter settings. (See [Using task specification files](#) for information about task specification files).

**Save Options** Save the current Grid Operations file specifications and parameter settings as a task specification file. (See Section [Using task specification files](#) for more information).

**Save Outline Poly** Save the outline of the current Grid to a shape file of polygon dataset.

## Resampling a grid

The Resampling option creates a new grid with a specified cell size and an origin based on a specified reference grid. If you do not specify a reference grid, INTREPID uses the origin of the input grid. It uses an interpolation process to calculate the value for each output cell. The output cell size may be larger or smaller than the input grid cell size. The output cell size does not need to be an exact multiple of the input grid cell size.

Each cell value in the output grid is derived from a single input grid cell or a group of neighbouring input grid cells. There are four resampling methods available to interpolate values for the output cells. They are Newton 4th Order, Cubic Spline, Minimum Curvature or Cubic Polynomial.

**Newton 4th Order** is our recommended general purpose method. It works well for a wide range of datasets. It is the best method to use for radiometric or electromagnetic data. It computes quickly on large grids, and honours the original values faithfully.

**Cubic Spline** is best suited to datasets with small amplitude changes between cells (ie; not radiometric or electromagnetic data). It is slower to compute than Newton 4th order.

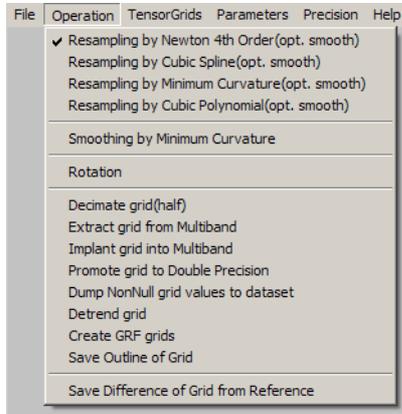
**Minimum Curvature** is especially suited to potential field data. It is our recommended method for magnetic or gravity datasets. It also computes quickly on large grids, and honours original values well.

**Cubic Polynomial** is especially suited to potential field data. This method ensures the highest quality local estimates of a field that is Laplacian. It provides genuinely 2-dimensional interpolation, rather than one-dimensional interpolation applied in orthogonal directions.

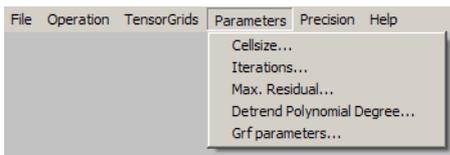
The default behavior of the Gridop tool is to resample the grid and then apply Minimum Curvature smoothing to the output grid. The smoothing stage is optional and can be turned off by setting the number of smoothing iterations to zero.

>> **To specify the resampling process**

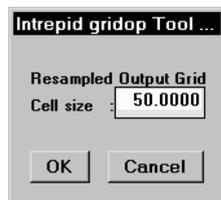
- 1 Specify input, reference and output grids (See [Specifying input and output files](#) for detailed instructions).
- 2 Choose the method required from the Resampling menu (See below for process descriptions).



- 3 Specify the grid cell size required for the resampling process. Choose Cellsize from the Parameters menu.



INTREPID displays the Resampled Output Grid Cell Size dialog box.



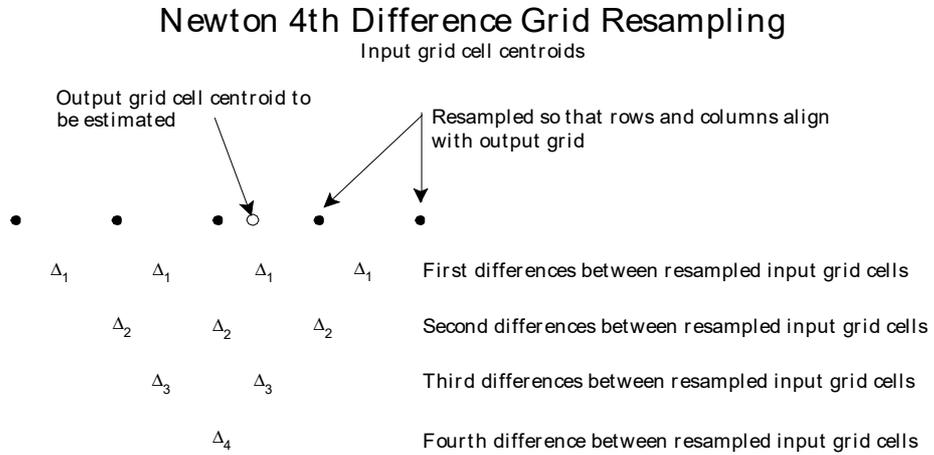
You must specify the cell size before resampling the dataset. (The Cell Size text box may not contain the cell size of the input dataset.) Specify the required cell size for the output dataset (in the distance units of the dataset<sup>1</sup>) and choose OK.

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1. In particular, if your dataset is geodetic (latitude and longitude) you need to specify the Grid Cell Size in degrees.

## Resampling—Newton 4th Difference

This method calculates the value for the new cell from the values of the 5 nearest non-Null cell values. INTREPID adjusts the new value using the 4th difference to allow for the gradient in that neighbourhood. The following diagram illustrates the process.



INTREPID calculates the value for new cell by linear interpolation from the adjacent cells, then modifies it using the 4th difference  $\Delta_4$ . This allows for the influence of the gradient near the new cell.

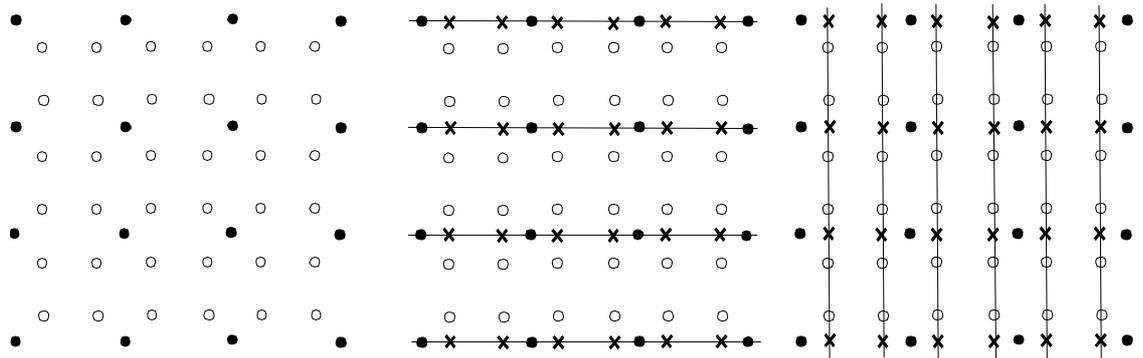
## Resampling—Cubic Spline

This method involves two passes.

In the first pass, INTREPID uses spline curves along the rows to calculate values that will correspond to the columns in the resampled grid.

In the second pass, INTREPID uses the column values obtained in the first pass (and original data values wherever the column coincides with a column from the original dataset) to calculate a spline curve along each resampled column. The following diagram illustrates the process.

Bi-cubic spline resampling of a grid to change origin and cell size.



**Input and output grid cell centroids**

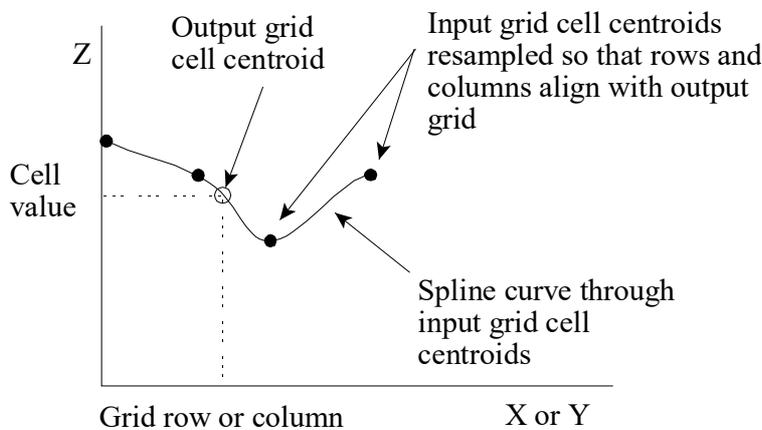
- Input grid cell centroid
- Output grid cell centroid
- ✕ Interpolated value in line with output grid cell centroids

**First pass along rows:** INTREPID interpolates values in line with output grid cell centroids.

**Second pass down columns:** INTREPID interpolates values for output grid using interpolated values from first pass.

INTREPID uses a spline curve to calculate the value for each new cell centroid in each column as illustrated in the following diagram.

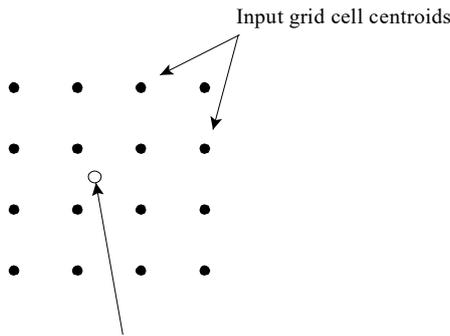
## Bi-Cubic Spline Grid Resampling



## Resampling—Minimum Curvature

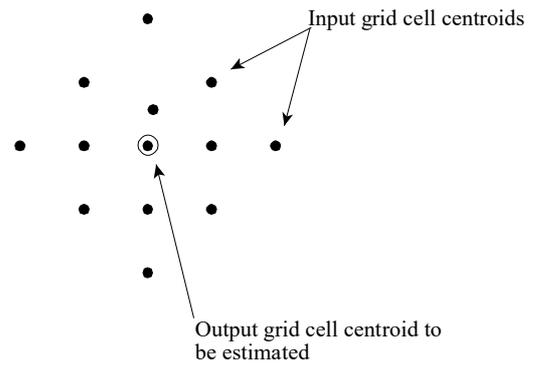
INTREPID calculates the value of the new cell centroid using a weighted combination of surrounding original cell values in one pass. The Minimum Curvature resampling process uses values from the current original grid row, and from the two grid rows either side of the current grid row. This method is an inverse of the Honour Original Data method (See “[Minimum Curvature](#)” in [Gridding \(T22a\)](#)). The following diagrams illustrate the process.

Minimum Curvature Grid Resampling



Output grid cell centroid to be estimated. INTREPID bases the value on a weighted combination of surrounding input cell values, honouring the exact location of the output cell.

Minimum Curvature Grid Resampling (ideal case of aligned cell centroids)



Output grid cell centroid to be estimated

## Resampling—Cubic Polynomial

The Cubic Polynomial method is applicable to resampling within a grid cell, where the values of the field at the corners and also the gradients, are known quantities. An analytic function is used locally to calculate the field value at the required point. This method is often used in contouring as well, to ensure high quality local estimates of a field that is Laplacian.

## Smoothing a grid

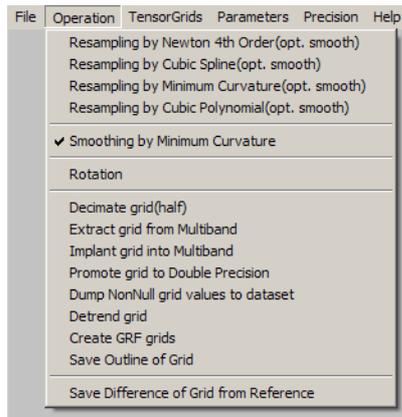
After resampling is completed, the resampled grid may appear pixelated or “coarse-grained”. Intrepid will automatically apply Minimum Curvature smoothing to the resampled grid. You can control the amount of smoothing by changing the number of smoothing iterations, or turn it off completely by setting the number of iterations to zero.

Smoothing can also be run as a separate operation on its own. You may have a grid which for some reason or other appears pixelated. You can improve its appearance by smoothing it. Specify your grid as the input grid. If you do not specify a reference grid, INTREPID uses the cell values in the input dataset you have specified.

INTREPID uses a minimum curvature smoothing process. INTREPID will perform several iterations through the grid, progressively examining and adjusting each cell in the input grid according to the values of the cells in the corresponding region of the reference grid. INTREPID will repeat the process until it has either completed the number of specified iterations, or the maximum residual change for all interpolated cells is less than the specified value.

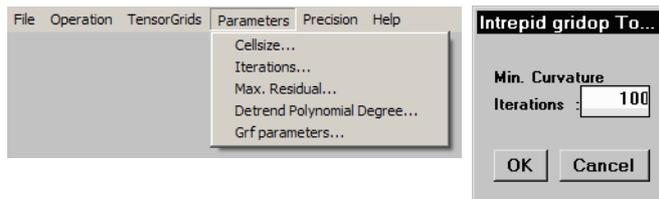
>> *To specify the smoothing process*

- 1 Choose Minimum Curvature from the Operation menu.

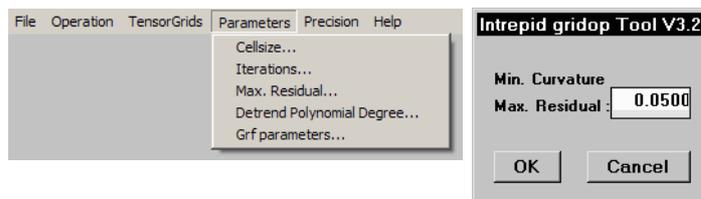


- 2 Choose Iterations from the Parameters menu. INTREPID displays the Minimum Curvature Iterations dialog box.

Use this box to specify the number of times that INTREPID may scan through the grid (number of iterations) during the Minimum Curvature smoothing process.



- 3 Choose Max Residual from the Parameters menu. INTREPID displays the Minimum Curvature Maximum Residual dialog box.



- 4 Each time INTREPID scans in its attempt to smooth the grid, it may cause a change in the value of each interpolated cell. As it completes each scan, the change in each cell becomes smaller—the interpolated values are becoming settled.

If all cell changes in a minimum curvature pass are less than the Maximum Residual, the process will terminate. Specify the Maximum Residual in the cell data units.

In this way you can specify the stage at which you consider that the cell values are sufficiently settled.

## Rotating a grid

The Grid Operations tool can rotate a grid dataset. When a grid is rotated the result is a change in the orientation of the grid rows and columns.

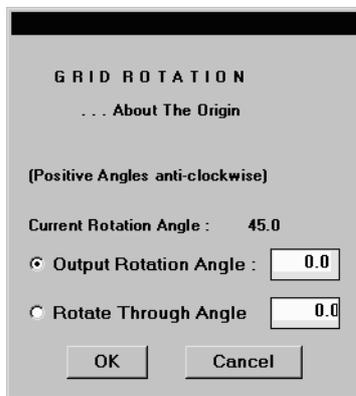
Grid rotation is performed around the grid origin. Positive angles are anti-clockwise. You may declare the rotation angle parameter in either of two ways – either by specifying the **output** grid rotation angle, or as a rotation **through** the specified angle.

### How to rotate a grid

>> *To specify rotation for a grid dataset*

- 1 Ensure that you have correctly specified an input and output dataset.
- 2 Choose Rotation from the Operation menu.

INTREPID displays the Grid Rotation dialog box which reports the current rotation of the grid.



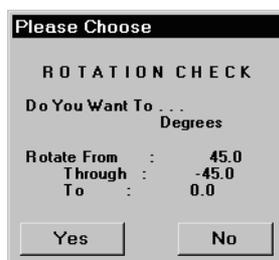
- 3 Specify the angle to or by which you wish to rotate the grid. Do this by either:
  - a) Selecting the target angle (Output Rotation Angle)

**OR**

- b) the amount of rotation (Rotate Through Angle).

Then specify the angle in degrees (positive angles are anticlockwise) in the text box corresponding to the selected option.

- 4 Choose OK. INTREPID displays the Rotation Check dialog box which reports the existing and proposed rotation settings for the grid.



- 5 Choose Yes if the settings correspond to your requirements.
- 6 Choose Apply in the main window.

## Reasons for rotating a grid

When you are using INTREPID there are two situations where you may wish to rotate a grid.

- 1 The INTREPID Bicubic Spline algorithm creates a rotated grid if the survey lines were not acquired in a North–South or East–West direction. In this case you would use the Gridop tool to unrotate the grid back to a rotation angle of zero.
- 2 If you want to use the INTREPID Decorrugation tool, this tool requires that the input grid have rows and columns with North–South or East–West orientation. However the INTREPID Minimum Curvature gridding algorithm creates grid columns which run parallel to the survey lines. For survey lines which were not acquired in a North–South or East–West direction, the grid rows and columns will not have North–South or East–West orientation. In this case you will need to use Gridop to rotate the grid such that the input grid for Decorrugation has the correct orientation.

## Extract grid from Multiband

This option enables you extract a new single band grid from an existing multiband grid. To extract a single band grid:

- 1 Choose **File > Specify Input Grid** and select and open your existing multiband grid.
- 2 From the **Select Band** dialog box select the band name and choose **OK**.
- 3 Choose **File > Specify Output**, specify the single band grid file name and choose **OK**.
- 4 Choose **Operation > Extract grid from Multiband**.
- 5 Choose **Apply**.
- 6 The **Enter band number** dialog box appears. Leave the entry as the default of **1/1**.  
**Note:** you cannot create a multiband grid using this prompt. Choose **OK**.  
A message box appears **Finished OK**. Choose **OK**.

## Implant grid into Multiband

This option enables you to combine existing single band grids into a new multiband grid. To create a multiband grid in this way:

- 1 Choose **File > Specify Input Grid** and select your first single band grid.
- 2 Choose **File > Specify Output** and specify the multiband grid to be created.
- 3 Choose **Operation > Implant grid into Multiband**
- 4 Choose **Apply**.
- 5 In the **Enter band number** dialog box, enter the number of bands to be in your multiband grid and the band number of the grid you specified in step 1.  
For example, for a 3 band K-U-Th radiometric grid, if you have just specified band 1, enter **3/1** in the pop-up box.
- 6 Choose **OK** and dismiss the message box that tells you the operation is complete.
- 7 Choose **File > Specify Input Grid**. Select your next single band grid.
- 8 Choose **Apply**. Enter the band number for this grid.
- 9 Repeat steps 7–8 until you have populated each band of your multiband grid.

## Preparing grids to avoid Grid Merge tool resampling

In some situations you may wish to combine a pair of grids with minimal Grid Stitch tool resampling. Using Grid Operations you can specify an origin and cell size for the resampled grid so it fits neatly with the grid to which you intend to stitch it. This will reduce or eliminate the need for resampling during the Grid Merge process.

The INTREPID GridMerge tool incorporates a resampling scheme superior to the earlier GridStitch, reducing the need to perform resampling in Grid Operations.

### >> *To prepare grids for low resample merging*

If you wish to stitch grids A and B, and you will be resampling grid A to fit with grid B:

- 1 Specify grid A as the input grid and grid B as the reference grid.  
Specify a new grid cell size for the resampled dataset (A').  
For no resampling of A' by Grid Merge specify the cell size of A' equal to that of B.  
INTREPID produces a resampled dataset (A') whose origin is a whole number of reference grid cells away from the origin of the reference grid (B).
- 2 Smooth grid A' if necessary.

You can then use Grid Merge to stitch grids A' and B with minimal or no resampling.

Specify grid B as the grid to Calculate Geographic Reference From.

Specify the output cell size (Mesh Size) the same as that of grid B.

Grid Merge will still perform adjustment and feathering as specified by you.

See [GridMerge—merging multiple grids \(T24\)](#) for full instructions on the use of the Grid Merge tool.

## Create GRF grids

The **Create GRF grids** option creates three grids that cover the extents of the currently selected input grid. The grids created are the **amplitude**, **inclination** and **declination** of the Earth's magnetic field. They are calculated using the IGRF theoretical model. The calculation requires you to specify a survey flying height above the spheroid (GPS height) and the survey acquisition date. This is done in the **Parameters > GRF parameters** menu.

This feature can be useful for comparing trends in your supplied dataset with predicted theory. You may also wish to restore a regional trend back into your dataset. You can use the **Spreadsheet editor** tool to add this trend back into your input grid.

## Dump Non-Null grid values to dataset

This operation uses the non-null values in your input grid to create a standard INTREPID point dataset containing X,Y,Signal fields. This is a “reverse” gridding process that enables you to regain some of the original observations from a grid. This can be useful for 3D GeoModeller, as you sometimes need just a few points to indicate the observation of a contact. See also the Dataset Sampler tool for similar functionality: [Dataset Sampler \(T25a\)](#).

Note - when you Specify Output, you must include a database extension, eg: ..DIR, otherwise the program will assume an output grid is required.

## Detrend grid

This operation creates an output grid that is detrended using the same 2D polynomial technology used in the Spectral domain grid filters tool (GridFFT). The required degree of the detrending can be set in the **Parameters > Detrend Polynomial Degree** menu option.

## Constructing and deconstructing tensor grids

You can:

- Construct a tensor grid from a number of component grids
- Extract components of a tensor grid as independent grids.

### Constructing a tensor grid

**>> To construct a tensor grid from its components:**

- 1 Ensure that you have a set of six component grids:
  - With matching size, location and cell size
  - In *ERMapper* (.ers) or .semi format
- 2 Specify the output tensor grid. Choose **File > Specify Output Grid**.
- 3 Choose **TensorGrids > Create from parts**
- 4 Choose **Apply**. INTREPID displays **Open** dialog boxes for the component grids XX, XY, ZX, YY, YZ, ZZ
- 5 Specify the component grids. INTREPID creates the tensor grid.

## Extracting components from a tensor grid

You can extract grids of the following components and derived values from a tensor grid:

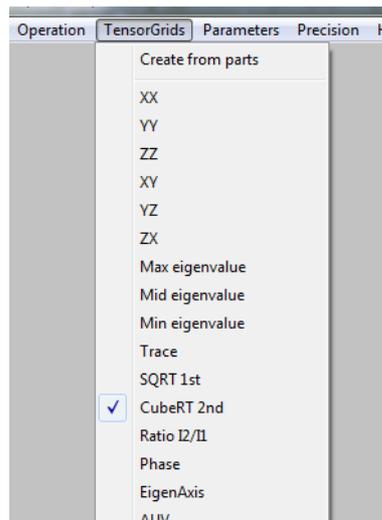
Component	Description
<b>Auv,Ane,Buv,Bne,Guv,Gne</b>	Falcon components
<b>XX, XY, ZX, YY, YZ, ZZ</b>	Normal Component gradients
<b>Max, Mid, Min eigenvalue</b>	Principal components
<b>Trace, SQRT 1st, CubeRT 2nd</b>	1st, 2nd, 3rd scaled invariants
<b>Ratio I2 / I1</b>	Ratio of second to first scaled invariant. This may help to tell if causative body has 2-dimensional characteristics. See:  Pedersen L.B., Rasmussen T.M., The Gradient Tensor of Potential Field Anomalies: Some Implications on Data Collection and Data Processing of Maps. <i>Geophysics</i> , 55, No 12, 1558–1566.
<b>Phase</b>	Independent rotational component of tensor curvature. We use this for enhancing subtle features and suppressing strong features
<b>Scalar Magnitude</b>	David Clarke's suggestion measure of invariant amplitude
<b>Curvature Gradient</b>	Falcon Hilbert pair magnitude ( $\sqrt{\text{Guv}^2 + \text{Gne}^2}$ )
<b>WormsTotalHorizontal Gradient</b>	For scalar and tensor grids ( $\sqrt{\text{Tzx}^2 + \text{Tyz}^2}$ )

>> *To extract a grid of a component or calculated value from a tensor grid:*

- 1 Specify the input tensor grid. Choose **File > Specify Input Grid**.

**Note:** Always specify the input grid before selecting the operation that you want to perform.

- 2 Choose the component or derived values that you want to extract. Choose the required option from the **TensorGrid** menu



- 3 Choose **Apply**. INTREPID displays a **Save As** dialog box for the component or derived values
- 4 Specify the output dataset name. INTREPID extracts and saves the component grid.

## Optimising processing performance for large grids

For large grids, INTREPID uses a tiling system. This involves processing the grid a section at a time. You can optimise the performance of your computer by adjusting the value of the INTREPID\_MEMORY system parameter.

Apart from this optimising adjustment, the tiling process and the decision to use it is automatic. See “[INTREPID Memory limits and tiling](#)” in [Configuring and using INTREPID \(R04\)](#) for information about INTREPID\_MEMORY.

## Apply

When you choose Apply, INTREPID performs the resampling or smoothing grid operation as specified by you, saving the grid

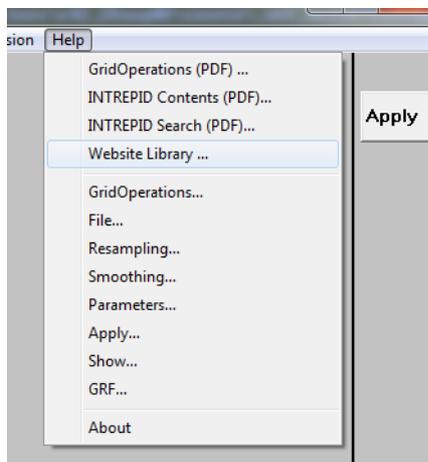
- When finished for a small grid or
- As it proceeds for a large grid where it is using the tiling process (See [Optimising processing performance for large grids](#) for details about small and large grids and tiling).

## Exit from Grid Operations

To exit from Grid Operations choose Quit from the File menu.

## Help

You can use the help menu to display help text on the topics shown in the menu illustration below.



## Using task specification files

You can store sets of file specifications and parameter settings for Grid Operations in task specification (`.job`) files. From version 5.0, a new syntax based on *Google* protobufs is also available..

### >> *To create a task specification file with the Grid Operations tool*

- 1 Specify all files and parameters.
- 2 If possible, execute the task (choose Apply) to ensure that it will work.
- 3 Choose Save Options from the File menu. Specify a task specification file (INTREPID will add the extension `.job`) INTREPID will create the file with the settings current at the time of the Save Options operation.

For full instructions on creating and editing task specification files see [INTREPID task, HISTORY, report and log files \(R06\)](#) files.

### >> *To use a task specification file in an interactive Grid Operations session*

Load the task specification (`.job`) file (File menu, Load Options), modify any settings as required, then choose Apply.

### >> *To use a task specification file for a batch mode Grid Operations task*

- 1 Type the command `gridop.exe` with the switch `-batch` followed by the name (and path if necessary) of the task specification file.

For example, if you had a task specification file called `surv_conv.job` in the current directory you would use the commands

```
gridop.exe -batch surv_conv.job
```

## Task specification file examples

Here is an example of an Grid Operations resampling task specification file.

```

Process Begin
  Name = gridop
  Input = /disk1/data/mlevel_grid
  Reference = /disk1/data/mlnext_grid
  Output = /disk1/data/mlevres_grid
  Parameters Begin
    Method = Newton_4th_Order
    Cellsize = 50.0
  Parameters End
Process End

```

Here is an example of an Grid Operations smoothing task specification file.

```

Process Begin
  Name = gridop
  Input = /disk1/data/mlevres_grid
  Reference = /disk1/data/mlevel_grid
  Output = /disk1/data/mlevsm_grid
  Parameters Begin
    Method = Smoothing
    MaxResidual = 0.04
    Iterations = 80
  Parameters End
Process End

```

Here is an example of an Grid Operations smoothing task specification file which shows the syntax for most of the current options.

```

Process Begin
  Name = gridop
  Input = /disk1/data/mlevres_grid
  Output = /disk1/data/grdop_grid
  Parameters Begin
# Method options are as follows:
# Cubic_Spline Newton_4th_Order Minimum_curvature Cubic Smoothing
# Rotate SubSample GetBand PutBand
    Method = Minimum_curvature
    Cellsize = 15.
    MaxResidual = 0.5
    Iterations = 100
    OutputPrecision = IEEE4ByteReal
    OutputRotation = 0.0
    # only used for getband method
    GetBand Begin
      Band = 1
    GetBand End
    # only used for putband method
    PutBand Begin
      Band = 1
      NBands = 1
    PutBand End
  Parameters End
Process End

```

```
# only used for subsample method
SubSample Begin
  SS = 0
  SL = 0
  NL = 100
  NS = 100
  SINC = 2 # sub sample increment
  LINC = 2 # line increment
SubSample End
Parameters End
Process End
```