Digital Optimization of Grid Systems
DOGS 1.5.0 Beta

NOTE: In this release of DOGS, on-line help is not available through the help menu, and the **Help** buttons in the dialog boxes are not enabled. This document is the main source of information about DOGS.

Contents

Introduction

DOGS is used to analyze and order bathymetric data obtained from the National Ocean Service (NOS). Bathymetry files may contain tens to hundreds of thousands of data points collected from various surveys, so it is usually necessary that a subset of data be selected for use in NOAA's ocean current analysis tool, CATS. A small subset of data may well describe the ocean topology in the region of interest within a specified error criterion. This subset of data can then be saved and used in subsequent current analysis.

Program Input

DOGS reads bathymetry data in several file formats, and shoreline data in one file format. All files are opened using the **Open** item in the **File** menu, except when reading bathymetry data directory off an NOS Hydrographic Surveys CD, in which case the **Import NOS Hydrographic Data** menu item is used.

- DOGS files

    This is a text format defined by DOGS. The file starts with a number of header lines, indicated by a keyword in square brackets. The following table shows some of the pre-defined header line types. A star indicates that a line of the given type is required in all DOGS files.

header entry type	format / meaning	example
[VERS] *	floating point / the file format version number (currently 2.00)	2.00
[NOBJ] *	integer / number of bathymetry point records in file	1000
[UNIT] *	units for the bathymetry depth values	meters
[BNDS] *	decimal latitude/longitude coordinates that bound the points in the file (high-lat, low-long, low-lat, high-long)	59.789847, -151.499917, 59.500197, -151.002453
[NTRI]	number of triangles at bottom of file	
[CRIT]	string / criterion used to pick next point in triangulation * required if [NTRI] is provided	absolute volume
[FPNT]	string / criterion used to pick first point in triangulation * required if [NTRI] is provided	relative height

The header lines are followed by the records, one per line. Each line has the following format:

index, longitude, latitude, depth, error, epsilon, survey, NOS-cartographic-code

field	format / meaning	example
index	integer (line number from NOS file)	12345
longitude	decimal degrees (west negative)	-122.123456
latitude	decimal degrees (south negative)	47.123456
depth	decimal meters	2.123456
error	decimal / meaning depends on criterion used at time of triangulation	123.458932

epsilon	decimal / maximum height delta at time of recording error	12.034423
survey	string /survey from which this bathymetry point was taken	H10082
NOS-code	cartographic code specifying how depth value is stored in NOS file	127

Here is a sample DOGS file:

```
[NOBJ] 4670
[VERS] 2.00
[UNIT] Meters
[BNDS] 59.794491, -151.499924, 59.500198, -151.000229
[NOTE] this is a note
[NOTE] and this is another
137234,-151.458038,59.561684,168.981125,-1.000000,-1.000000,9877,125
136808,-151.416306,59.555695,2.377440,-1.000000,-1.000000,9877,125
138284,-151.420120,59.570305,151.607513,-1.000000,-1.000000,9877,125
136415,-151.361572,59.559326,1.280160,-1.000000,-1.000000,9877,125
.
.
.
```

NOTE: Versions of DOGS previous to version 1.0ß used the same format, but without the final NOS-cartographic-code field. Thus each record had the following format:

index, longitude, latitude, depth, error, epsilon, survey

DOGS can read files with or without the NOS-cartographic-code field.

• HYD93 files

DOGS can read bathymetry data taken from the NOS Hydrographic Surveys CDs. This is a database of NOS surveys distributed on two CDs (see below for ordering information). DOGS can read bathymetry data directly off these CDs, or you can use the GEODAS software (Windows only) included on the CD to export CD data into an ".a93" file, which can then be read by DOGS. These two options are described below:

• To read data directly from the CD, use the polygon trace tool (see below) to indicate the area of interest. Then use the **Import NOS Hydrographic Data** item in the **File** menu. In order to read data from the NOS CD, DOGS needs to have the file HYDNOS.IDX in its folder (directory). This file is distributed with DOGS, but it if gets lost or becomes out of date, DOGS will recreate it. In order to do this, DOGS will need to access the HYDNOS.INV file, which is located on the GEODAS Setup CD (one of the two CDs in the NOS Hydrographic Surveys set).

• Alternatively, you can install and use the Geophysical Data System (GEODAS) software (Windows only) included on the CD to export CD

data into an ".a93" file, which can then be read by DOGS. Specifically, do a search with GEODAS and choose to download the found points in the HYD93 ASCII format (".a93" suffix). Then use the **Open** menu item in DOGS to read the ".a93" file.

For more information on ordering the GEODAS CD set contact:

> Robin Warnken
> NOAA/NGDC Mail
> Code E/GC3
> 325 Broadway
> Boulder, CO 80303
> phone: (303) 497-6338
> fax: (303) 497-6513
> Internet: rwarnken@ngdc.noaa.gov
>
> You can visit GEODAS on-line at:
> http://www.ngdc.noaa.gov/mgg/geodas/geodas.html

• NOTE: In addition to the DOGS and HYD93 formats, DOGS accepts two other formats for compatibility with previous versions of DOGS. These are (1) a BNA format similar to the format used for shoreline data (see below), but modified for bathymetry point data, and (2) data read from old NOS bathymetry tapes, which comes as fixed 40 byte records or 51 byte records with tabs inserted as field delimiters (these files were referred to as NOS files in previous versions of DOGS).

• BNA shoreline files

> DOGS reads shoreline information files in BNA format. These text files specify a list of polygons. Each polygon starts with a header line that gives the name, the type ("1" means land), and the number of points. The points follow, one per line. The beginning of a sample file is shown below:

```
"1175","1",4
-151.212686,59.596410
-151.228942,59.596014
-151.228505,59.600576
-151.219024,59.602352
.
.
.
```

Bathymetry Analysis/Optimization

DOGS analyzes bathymetry by iteratively selecting bathymetry points and adding them to a growing mesh of triangles. These triangles, interpreted as connected plane regions, form a topological map of the ocean terrain called a "geodesic dome." As points are added and the number of triangles increases, the topological accuracy of the geodesic dome increases.

Preparing the analysis

DOGS performs its triangle analysis when you use the **Generate Triangles** item in the **Analysis** menu. Before using this item, however, you need to load a prepare your depth points and, if appropriate, your shoreline.

The triangle analysis takes place within a given region or *domain*. This domain can be defined either by a selected shoreline polygon, or by simply using the rectangular "hyper-box" that bounds the point data. If you want to use a shoreline polygon as your domain boundary, you must pick the polygon to be used using the **Exclusive Water Domain** item in the **Shoreline** menu. This item shows a dialog box where you can scan through the loaded polygons and pick the one you want. (Note: If you forget to use **Exclusive Water Domain** before using **Generate Triangles**, DOGS will ask you later to specify the boundary polygon.)

It is necessary for DOGS to assign a depth to each vertex point defining the domain. In the case of a hyper-box domain, the depths for the four corner points are computed automatically by a weighted average of the depths of the surrounding data points. When using a shoreline polygon as the domain boundary, you must specify the default depth to assign to each shoreline point. You have the option of marking certain shoreline points (using the shoreline mark tool, described below) to indicate that they should not take the default depth value, but should be assigned a depth value by DOGS based of the depth of the closest bathymetry point. This will maintain the topology for shoreline domains that cut across waterways.

Once you have loaded your files and marked any shoreline points as necessary, select **Generate Triangles** to bring up the **Triangle Analysis Parameters** dialog box. The various options in the dialog are described fully in the Reference section below.

The triangle analysis

The section describes the steps DOGS goes through after you click OK in the **Triangle Analysis Parameters** dialog box.

If you are using a shoreline polygon as your domain boundary, the first step is to create a triangle mesh out of the polygon's points. For a hyper-box domain, a single data point is selected and, by connecting the point to each corner, four triangles are made. (This first point is chosen either by taking the data point closest to center, or

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by deriving the three-dimensional surface shape function that passes through the hyper-box corners, and selecting the data point with the largest depth delta from this surface.)

In either case, DOGS now has a mesh of triangles. The procedure is then to add the bathymetry points one by one to the mesh. As each point is added, it falls within a given existing triangle. This triangle is broken into three smaller triangles, with the added point as their common vertex. At each step, the next point chosen to be added to the mesh is that point which is furthest away from the geodesic dome as it has been defined so far. The exact meaning of "furthest away" is dependent on the convergence criterion you choose in the **Triangle Analysis Parameters** dialog box.

The points are added one by one until all of the points have been exhausted, or until the convergence error or absolute height cutoff value has been reached.

Note: DOGS uses *Delauney triangulation* to aid in creating triangles that are as close to equilateral as possible. When a new vertex is determined, the "parent" triangle which contains this point is split into three triangles using this vertex as the common point. When this happens, it is not guaranteed that the resulting triangles will be as equilateral as possible. DOGS looks at the parent's neighboring triangles to determine if a better triangle might be made by re-defining the triangle side to share its neighbors opposite vertex. If a more equilateral triangle can be made, the split happens. This process continues until all sides of the parent triangle have been considered.

Analysis outcome

When the analysis is completed the result is an ordered list of bathymetry points which define the terrain with increasing accuracy. For example, using the first 100 vertex points, the terrain might be resolved to within an error of 50 meters. However, using the first 300 points might resolve the terrain to within an error of 1 meter. Depending on the topological accuracy required for current analysis, the user can determine how many points are needed to meet this requirement. A plot of the vertex errors (i.e., the maximum error still existing after each data point was added) may be viewed using the **Error Plot** item in the **Analysis** menu.

When you are satisfied with the triangle analysis, you can output the ordered points in various ways using the **Save As** item in the **File** menu.

Tools and Special Functions

 Bathymetry selection tool

The selection tool is used to select individual bathymetry points. Selected points are indicated with four small highlight dots at their corners.

Special: Drag with the arrow tool to define a rectangle; when you release the mouse button, all points within the rectangle are selected. Hold the SHIFT key down while dragging the mouse to select multiple regions, or to deselect a set of previously selected points.

 Zoom/scroll tools
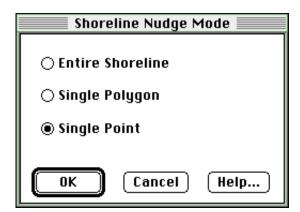
Use the magnifying glasses to zoom in and out. Use the hand to shift the map without zooming.

 Shoreline nudge tool

This tool may be used to shift the entire shoreline, a single polygon, or a single shoreline point. This tool is useful when the shoreline is not an exact match to the bathymetry due to instrument or NAD datum differences.

Special: Double-clicking on this tool allows you to select the nudge mode.

Special: In some cases, you may want to merge one shoreline polygon with another in order, for instance, to "close off" a very small channel that is causing problems during the analysis. To do this, drag a point from one polygon within the boundary of the other polygon. DOGS will prompt you to confirm the merge.

Once the shoreline has been edited in any way, these edits cannot be "undone." However, you can use the **Revert Shoreline** item in the **File** menu to reload the shoreline from the file, thus restoring all points to their last-saved positions.

Polygon tool

The polygon tool is used to define a polygon referred to as the "filter polygon" or "trace polygon." This polygon can be used to limit a set of incoming points or to crop a shoreline boundary to the given area.

> • You can use the polygon to read from a bathymetry file only those points that fall within the polygon. To do this, create the polygon and, when using the **Open** menu item, check the box labeled **Clip Bathymetry to Traced Polygon**. When reading bathymetry directly from the NOS CD (using **Import NOS Hydrographic Data**), you must first create the polygon to indicate which data is to be loaded.

> • The polygon tool can also be used to "cut out" a given section of shoreline. To do this, create the polygon and use the **Cookie Cut** item in the **Shoreline** menu. (Note that you can also do a cookie cut without defining a polygon by using the hyper-box of the depth data as the bounding box.)

Special: Hold down the SHIFT key when you use the polygon tool to create a rectangular polygon.

Special: Hold down the SHIFT key and click with no movement of the mouse to remove the polygon. (The polygon may also be removed using the **Dispose Items** item in the **File** menu.)

Special: Double-click on this tool to enter the rectangular coordinates of the (rectangular) polygon manually.

Shoreline mark tool

As explained above, it is sometimes necessary to mark certain points of the domain boundary shoreline polygon so that their depth values are computed from the closest depth data point, instead of the default depth you provide in the **Triangle Analysis Parameters** dialog box. This occurs when part of the boundary polygon crosses the water, as in the case of a channel. For these points, it is necessary for DOGS to use actual depths in that region to conserve the topology and avoid a "shelving" effect that would close the waterway. The Shoreline Mark Tool is used to indicate which points of the water polygon should be assigned the depth of the closest bathymetry point. Click on points with this tool to mark and unmark them

in the direction the cursor arrow indicates. Click and drag to mark or unmark several points in a row. A "marked" point is indicated by a small circle drawn around the point.
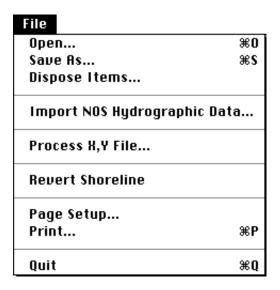
Special: Hold down the OPTION key and click to reverse the direction in which points will be selected.

Histogram bin check boxes

You can click on the small gray box to the left of a given line in the histogram to highlight all points of that color on the map. Highlighted points are drawn as large dots to make them more visible. Note that highlighted points are not the same as selected points, which are framed with four small dots. You can select the highlighted points using the **Select Highlighted Points** item in the **Analysis** menu.

Note that you must be showing bathymetry points in order to highlight points.

Reference: Menus and Dialogs

```
File
Open...                           ⌘O
Save As...                        ⌘S
Dispose Items...

Import NOS Hydrographic Data...

Process X,Y File...

Revert Shoreline

Page Setup...
Print...                          ⌘P

Quit                              ⌘Q
```
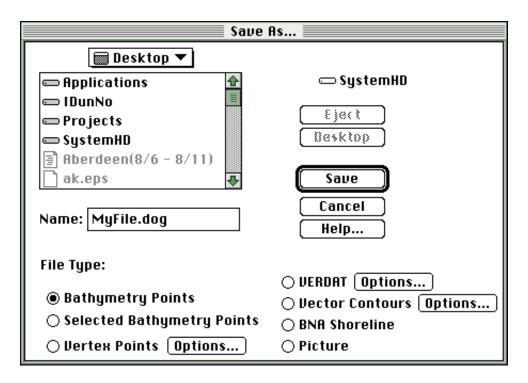
Open...
> Opens bathymetry and shoreline files. Multiple files may be opened in a single DOGS window. If you open more that one file of a given type, DOGS will confirm that you want to append the new data to the data that is already loaded.

Save As...
> Lets you save the loaded bathymetry or shoreline data in various formats.

Bathymetry Points
Saves the entire set of bathymetry points to a specified file in DOGS format.

Selected Bathymetry Points
Saves the currently selected bathymetry points to a specified file in DOGS format.

BNA Shoreline
Saves the current shoreline data in BNA format.
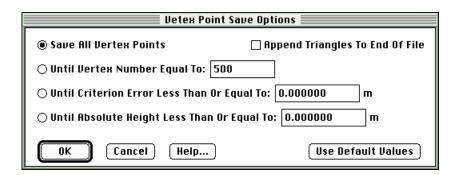
Picture
Saves the current map window as a picture file.

Vertex Points
Saves the ordered set of bathymetry points (vertex points resulting from a triangle analysis) in DOGS format according to the vertex save options.
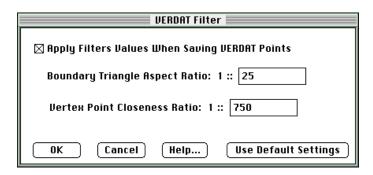
You can choose to save all of the points, or only those points up to a certain vertex number, or error criterion. The triangle set may be appended to the vertex point file to avoid having to recalculate triangles when the file is loaded back into DOGS.

VERDAT
Saves the boundary points and ordered vertex points to a specified file for use with CATS, according to the VERDAT filtering options.
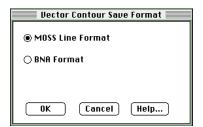
```
┌─────────────── VERDAT Filter ───────────────┐
│                                             │
│  ⊠ Apply Filters Values When Saving VERDAT Points │
│                                             │
│   Boundary Triangle Aspect Ratio: 1 :: │ 25    │  │
│                                             │
│   Vertex Point Closeness Ratio: 1 :: │ 750    │  │
│                                             │
│  ┌────┐  ┌────────┐  ┌─────┐  ┌──────────────────┐ │
│  │ OK │  │ Cancel │  │Help…│  │ Use Default Settings │ │
│  └────┘  └────────┘  └─────┘  └──────────────────┘ │
└─────────────────────────────────────────────┘
```

The VERDAT filter averages vertex points that are too close to each other using the specified Vertex Point Closeness Ratio and removes vertex points that are too close to an individual boundary point. The closeness ratio used is (1 / ratio) of the distance of the longest bounding rectangle side. For example, if the horizontal bounding side is 20,000 meters, the vertical bounding side is 10,000 meters, and the ratio is 1::750, vertex points may not be closer than 20,000/750 meters or 26.67 meters. The filter also removes vertex points that lie too close to a boundary segment using the Boundary Triangle Aspect Ratio. This is the minimum ratio of the distance of the point to the segment, to the length of the segment.

Vector Contours
Saves the vector (topological) contours that have been calculated for this triangle optimization.

```
┌──────── Vector Contour Save Format ────────┐
│                                            │
│  ⦿ MOSS Line Format                        │
│                                            │
│  ○ BNA Format                              │
│                                            │
│                                            │
│   ┌────┐  ┌────────┐  ┌─────┐              │
│   │ OK │  │ Cancel │  │Help…│              │
│   └────┘  └────────┘  └─────┘              │
└────────────────────────────────────────────┘
```
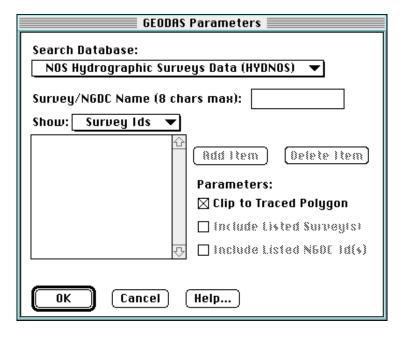
These can be saved in one of two formats, MOSS Line or BNA. The BNA format is described above. The MOSS Line format is compatible with the Map Overlay Statistical System, and can be read by programs such as ArcInfo.

Dispose Items...

As shown in the dialog above, you can dispose a number of different items (only items that are currently loaded in your DOGS system are available in this dialog box). Disposing items is useful if you are working with multiple large files or in a low-memory situation.

Import NOS Hydrographic Data...

Use this menu item to read bathymetry data directly from the NOS Hydrographic Surveys and GEODAS Trackline CDs. To limit a search to an area, use the polygon trace tool to indicate the area of interest. Then select **Import NOS Hydrographic Data**. You can also limit a search to a specified list of survey ids or NGDC ids.

In order to read data from the NOS and Trackline CDs, DOGS needs to have the files HYDNOS.IDX and TRKDAS.IDX in its folder (directory). These files are distributed with DOGS, but if they get lost or become out of date, DOGS will recreate them. In order to do this, DOGS will need to access the HYDNOS.INV file and the TRKDAS.INV file, which are located on the GEODAS Setup CD.

Process XY File...

```
┌──────────────── Process XY File Options ────────────────┐
│ ┌─Input Parameters ─────────────────────────────────┐   │
│ │                                                   │   │
│ │ Longitude Field Number:  [1    ]                  │   │
│ │                                                   │   │
│ │ Latitude Field Number:   [2    ]                  │   │
│ │                                                   │   │
│ │ Depth Field Number:      [     ]                  │   │
│ │                                                   │   │
│ │ Field Delimiter:  [ Comma    ▼ ]                  │   │
│ │                                                   │   │
│ │ ☐ West Longitudes Positive                        │   │
│ └───────────────────────────────────────────────────┘   │
│                    ┌─────────────────────────────────┐  │
│ Output Option:     │ ✓Place Z At End Of Record       │  │
│                    │  Insert Z Into Specified Field   │  │
│                    │  Save XYZ Only                   │  │
│                    └─────────────────────────────────┘  │
│  ( OK )    ( Cancel )   ( Help... )                      │
└─────────────────────────────────────────────────────────┘
```
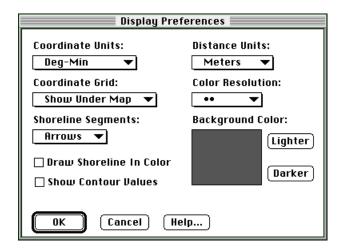
Once a triangle set has been calculated, this function can be used to "sift" a file of x,y points through the triangle list to calculate a depth (z) value for each point. This dialog box lets you specify the format of the X,Y file, and how the z value should be output. After filling in the values in this dialog box, you are prompted for the X,Y file to be processed. The depth values are saved in meters.

Revert Shoreline...

Use this menu item after performing shoreline edits to reload the shoreline from the file, thus restoring all points to their last-saved positions.

Display

Settings...	⌘D
Histogram...	⌘H
Fit To Window	⌘F
Unhighlight All Points	
Bathymetry Points	
Triangles	
Vertex Points	
Vector Contours	
Geodesic Color Contours	
Raster Contours	
Shoreline	

Settings...

Display Preferences

Coordinate Units:
Deg-Min ▼

Distance Units:
Meters ▼

Coordinate Grid:
Show Under Map ▼

Color Resolution:
•• ▼

Shoreline Segments:
Arrows ▼

Background Color:
[Lighter]
[Darker]

☐ Draw Shoreline In Color
☐ Show Contour Values

[OK]   [Cancel]   [Help...]
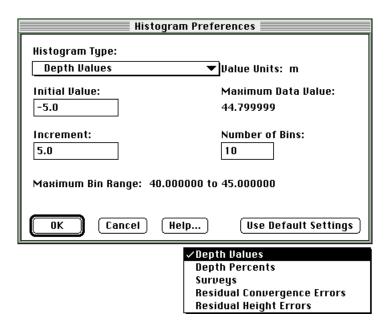
This dialog box lets you make general settings affecting the DOGS display. The options include: the format for lat/long data, whether and how the coordinate grid should be shown, the distance units, how shoreline segments should be drawn, whether the shoreline should be in color, whether values of vector contours should be displayed on the map, the resolution for raster contours, and the darkness of the map background.

Histogram...

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The **Histogram Preferences** dialog enables the histogram to represent one of several distributions including: Depth Values, Depth Percents, Surveys, Residual Criterion Errors, and Residual Height Errors. The Max Bin Range values change as the minimum value, number of bins, and bin increment change. The default values for the distribution may be entered by clicking **Use Default Values**.

Fit To Window...

This menu item changes the map view to show just the area enclosing the loaded data.

Unhighlight All Points...

This menu item unchecks all checked histogram boxes and redraws the map with no bathymetry points highlighted.
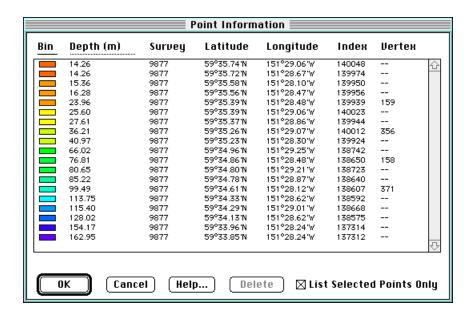
Bathymetry Points
Triangles
Vertex Points
Vector Contours
Geodesic Color Contours
Raster Contours
Shoreline

These menu items toggle to hide and show the selected item.
(Geodesic Color Contours are the same as Vector Contours.)

Special: Hold down the CONTROL key (OPTION key on the Macintosh) to show only the selected item.

Point Information...

This menu item and dialog box are used to view longitude, latitude, depth, index number, survey number, and depth code information for some or all of the loaded bathymetry points. This dialog also allows you to delete individual data points (for instance, data points with obviously bad values).
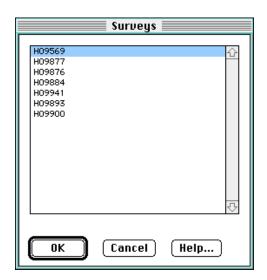
Click on a column header to sort the list by that header (indicated by an underline). SHIFT-click to set a secondary sort key (indicated by a dotted underline).

Survey Information...

Use this menu item to view information about a selected survey. The information displayed is read from the "HYDNOS.INV" and "TRKDAS.INV" files supplied on the "GEODAS Setup" CD.

Select Points From Survey...
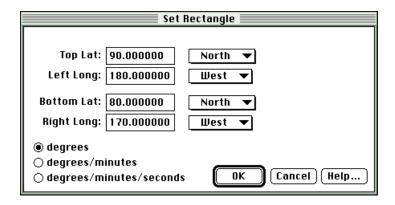
Selects the bathymetry points recorded from the chosen survey number.

Select Highlighted Points...

Bathymetry points associated with a specific histogram bin (line) may be highlighted (drawn in large dots for easy visibility) by checking the gray button to the left of the histogram bin. Once the points have been highlighted, choose **Select Highlighted Points** to select those points (the selected points are framed with small dots).

Select Bathymetry in Rectangle...

Lets you specify a rectangle using lat/long coordinates, and then selects all of the bathymetry points that fall within that rectangle.

Generate Triangles...

Use this menu item when you have loaded your bathymetry and, if appropriate, have loaded your shoreline, chosen the domain polygon, and marked any shoreline points as necessary.

A number of choices are possible as to how the triangle generation should proceed:

• Boundary Initialization:
  • you can use either a shoreline polygon or the bathymetry bounding box (hyper-box) as the starting framework for the triangle mesh
  • for a shoreline boundary, you must specify the depth to be assigned to all points except for those previously marked with the shoreline mark tool
  • for a hyper-box boundary, you can choose the method by which the first vertex point is chosen (with Data Center-Point, DOGS will use as its first vertex the bathymetry point closest to the center of the hyper-box; with Surface Deviation, DOGS calculates the three dimensional surface that passes through all four corners of the hyper-box, then takes as its first vertex the point farthest from that surface)

• Which point to add next:
  At each step when constructing the triangle mesh, DOGS adds the bathymetry point that has the poorest fit with the geodesic dome as it is defined so far. There are four ways that you can define what "poorest fit" means:
    • point with largest absolute volume
    • point with largest relative volume
    • point with largest absolute height
    • point with largest relative height

  The meaning of these four variables is given in the following box:

The depth delta, **delH**, is the absolute difference of the data depth and the triangle surface (geodesic dome) depth at the given coordinate. The triangle area, **a**, is derived using the two-dimensional projection of the triangle in the x-y plane. The centroid depth parameter, **c**, is the average of the three vertex depths. If the average of the three vertex depths is 0.0, then **c** is assigned the Minimum Centroid Depth from the **Triangle Analysis Parameters** dialog. This value is usually set to 1.0. The basin volume, **basinVol**, is the total volume of water contained within the boundary. Here are the four error definitions:

Absolute Volume = (**delH** * **a**) / 3.0;
Relative Volume = (**delH** * **a**) / (3.0 * **basinVol**);
Absolute Height = (**delH**);
Relative Height = (**delH** / **c**);
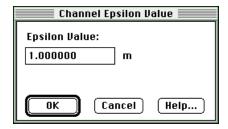
• When to stop adding points:
  • you can stop after a fixed number of points have been added

• you can stop after the absolute height variable becomes smaller than a given value
• you can stop after the variable specified as the convergence criterion (absolute volume, relative volume, absolute height, relative height) becomes smaller than a given value
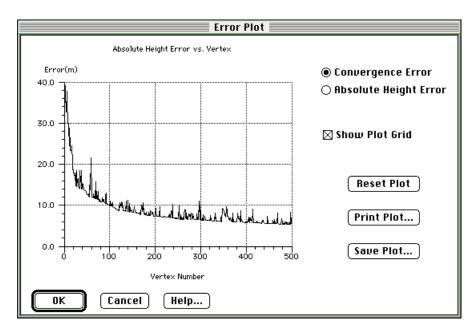
Resolve Channel Triangles...

If your shoreline domain contains narrow channels and there are not enough data points inside of these channels (often there are none), it is necessary to have DOGS insert fictitious depth values so that the shoreline points on opposite sides of the channel do not connect, in effect closing off the channel to water flow.

Using this menu item to add these channel points, specifying the depth to be assigned to the inserted points.

Error Plot...
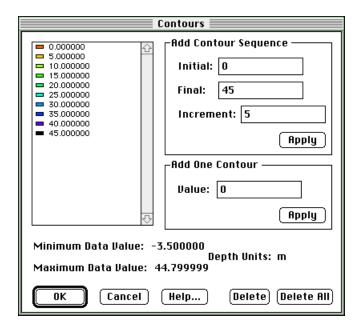
The error plot is used to evaluate the "Error vs. Vertex" curve when it is important to know how the error variable behaved during the optimization, or to know if the terrain was resolved beyond the desired

limit. This information may be used when saving a selected number of vertices to a file (see **Save As**).
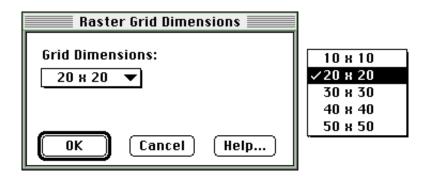
Special: Drag the mouse in the grid rectangle from one vertex to another to zoom into the given subrange of plot. Click **Reset Plot** to return to the full view.

Create Vector Contours...

This menu item and dialog box are used to create some number of topological contour lines based on the triangles you have generated. You can create a sequence of contours or a single contour.

Create Raster Contours...
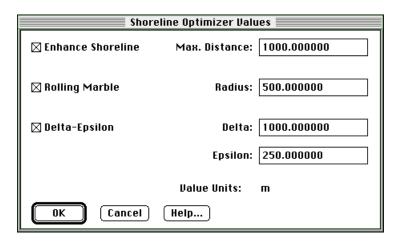
The raster contours are based on a 10x10, 20x20, 30x30, 40x40 or 50x50 grid that is set over the data. The depth at each grid vertex is assigned by taking the weighted average of the closest bathymetry points. Keep in mind that this contour analysis is simply a graphical representation

of the terrain and does not consider shoreline topology. However, it can be helpful in screening "outliers" in the data set before performing the triangle analysis.

Optimize...

The shoreline optimizer is able to perform three independent operations on the loaded shoreline data. If more than one optimization procedure is checked, the operations will be performed sequentially, in the order in which they appear in the dialog.
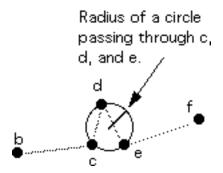
Enhance Shoreline: Points are added to the shoreline to ensure a maximum specified spacing between any two polygon points.

For example, if the **Distance**, **D**, is set to 1000.0 m, then if the distance between points **c** and **d** is greater than **D**, points will be added a distance **D** apart from each other until the distance between the last point added and point **d** is less than or equal to **D**. If the distance between points **c** and **d** is less than **2*D**, then a point is added at the midpoint of segment **cd**.

1000 m spacing between x's

Rolling Marble: The radius thinning algorithm attempts to remove a point by checking the radius of the circle that passes through it and its neighboring points.

For example, point **d** can be removed if the radius passing through points **c**, **d**, and **e** is less than the specified **Radius**.

Radius of a circle passing through c, d, and e.

If point **d** can be removed, the algorithm backs up and attempts to remove point **c** using points **b** and **e** as the bounding points. This process continues until the radius passing through any 3 points in question is equal to or greater than the specified radius, or the number of points defining the polygon is less than 3.

The other condition of the radius test is the acute angle test. This is used to smooth "spikes" in the shoreline that failed the radius test. If points **c**, **d**, and **e** form an acute angle, then if the perpendicular drawn from **c** to segment **de** or the perpendicular drawn from **e** to segment **cd** is less than the specified thinning radius, point **d** can be removed.
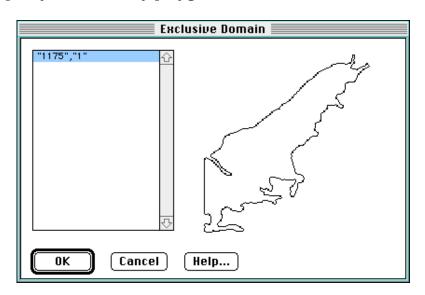
Delta-Epsilon: This test removes shoreline polygon points by checking the distance between polygon points and by checking the perpendicular distance of the middle point to the segment formed by the end points.

For example, if the distances between points **c** and **d**, and **d** and **e** are less than the specified distance, **Delta**, and the distance between points **c** and **e** that would result from removing **d** is less than **Delta**, and the perpendicular drawn from **d** to segment **ce** is less than the specified **Epsilon**, then **d** can be removed.

Select Exclusive Water Domain...

This item shows a dialog box where you can scan through the loaded polygons and pick the one you want to use as the domain boundary for generating triangles. (Note: If you forget to use **Exclusive Water Domain** before using **Generate Triangles**, DOGS will ask you later to specify the boundary polygon.)

| Water domain polygons are counter-clockwise and follow the left-hand rule: if you walk counter-clockwise along the polygon, your left hand points into the water. With land polygons, as you walk *clockwise* around the polygon, your left hand points into the domain (land). |

Deselect Exclusive Water Domain...
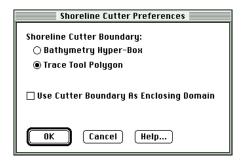
Deselects the previously chosen water domain polygon.

Delete Non-Domain Bathymetry...

Deletes all bathymetry data outside of the exclusive domain polygon.

Cookie Cut...
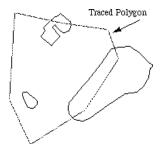
This menu item and dialog box are used to clip the loaded shoreline to a given polygon, which may be the hyper-box of the loaded bathymetry.

You can choose as your "cutter boundary" either the polygon you have defined with the polygon tool, or the hyper-box (enclosing rectangle) of the loaded bathymetry.
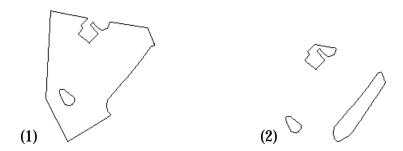
When performing the cut, you have the option to use the result as the domain boundary for a subsequent triangle analysis. If you check the box "Use Cutter Boundary As Enclosing Domain," the cut is defined to be the cutter boundary, minus the areas of any intersecting shoreline polygons. If you leave this box unchecked, the cut is defined to be the intersection of the cutter boundary with any intersecting shoreline polygons.

For example, consider the situation below, which shows three shoreline polygons and the user-defined polygon.

If we did this cut with "Use Cutter Boundary As Enclosing Domain" checked, the result, is as in figure (1) below: the cutter boundary minus the areas of the intersecting shoreline polygons.

If we did this cut with "Use Cutter Boundary As Enclosing Domain" unchecked, the result, is as in figure (2) below: the intersection of the cutter boundary with the intersecting shoreline polygons.

(1)   (2)

Check All Shoreline Crosses...
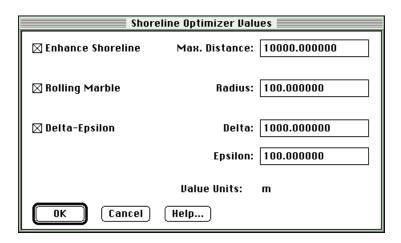
This menu item checks for any crossed polygon segments in the shoreline.

Guidelines for using DOGS efficiently
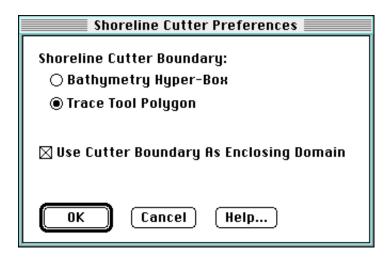
Preparing a Large Shoreline for use as a Domain Boundary

1. Load the large shoreline file into DOGS using **Open**.

2. Optimize the shoreline with the following values:
    Enhance with maximum distance of 10000.0 meters.
    Rolling Marble with radius of 100.0 meters.
    Delta-Epsilon with delta of 1000.0 meters and epsilon of 100.0 meters.

3. Once the shoreline has been optimized the first time through, zoom into the area
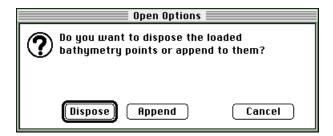
of interest on the map. Using the polygon tool, , roughly define the "cookie cutter" boundary to enclose the bathymetry set that you are working with. Use **Cookie Cut** to cut with the following options:

4. Use **Save As** to save the resulting shoreline to a separate file for later use.

Optimizing Bathymetry Files with More than 100,000 Points

1. Load the large bathymetry file into DOGS using **Open**.

2. Divide the large file into smaller files by selecting subsets of no more than 100,000 points each, then saving them with the "Selected Bathymetry Points" option. Be sure to name each one differently, using a systematic scheme.

3. When the large file has been subdivided, open the first subset file and click to dispose the larger data set.

4. Optimize each bathymetry subset using the values in the following dialog:

Note: 1000 vertex points reflects 1% of the bathymetry points if the subset contains 100,000 points. In general, optimize 1% to 2% of the data points for large data sets.

5. Save the vertex points to a separate file with the following options:

6. Load the next bathymetry subset file and optimize it with the values in step 4.

7. Once all the subset files have been optimized and saved, load each saved vertex file into DOGS by appending one to another. Be sure to dispose the last un-optimized bathymetry file before appending the vertex files.

8. Save the set of appended bathymetry points to a separate file.

How to Select the Convergence Error

Although DOGS supports four separate convergence error types, in almost all cases when optimizing a bathymetry set for use in hydrodynamic modeling, the convergence error that should be used is Absolute Volume.

When optimizing a bathymetry set to derive depth contours, it is most useful to set the convergence error to Absolute Height.

How Many Triangles (Vertex Points) to Create for CATS

In general, CATS works most efficiently when the total number of points is not more than 1000. This includes the points that define the shoreline boundary along with the points that define the interior (bathymetry). Typically, the number of points may be much smaller, e.g., 500 points.

Memory Requirements

(This section is mainly for Macintosh users, who can choose to allot more or less memory to DOGS depending on the size of the files they will be working with, and whether they need DOGS to run in parallel with other programs. On Windows, program memory allotment is handled automatically by the operating system.)

To work with a bathymetry or shoreline file of size N megabytes (as shown in the Finder or Explorer), you should allocate roughly 2N megabytes for DOGS. For instance, if you are working with a 3MB bathymetry file, and a 2MB shoreline file, you would want to have (3 * 2) * 2 = 10MB allocated for DOGS.