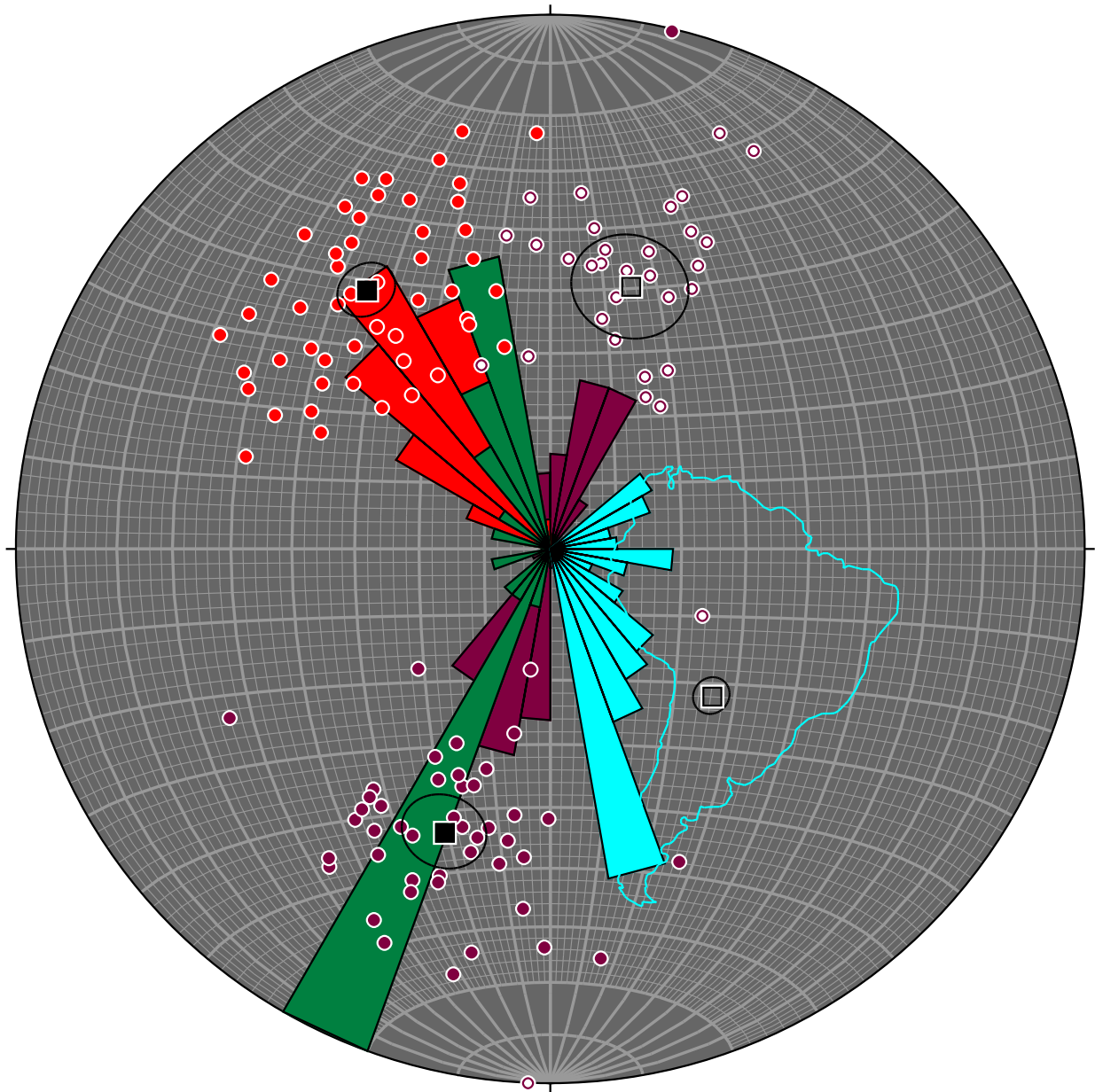
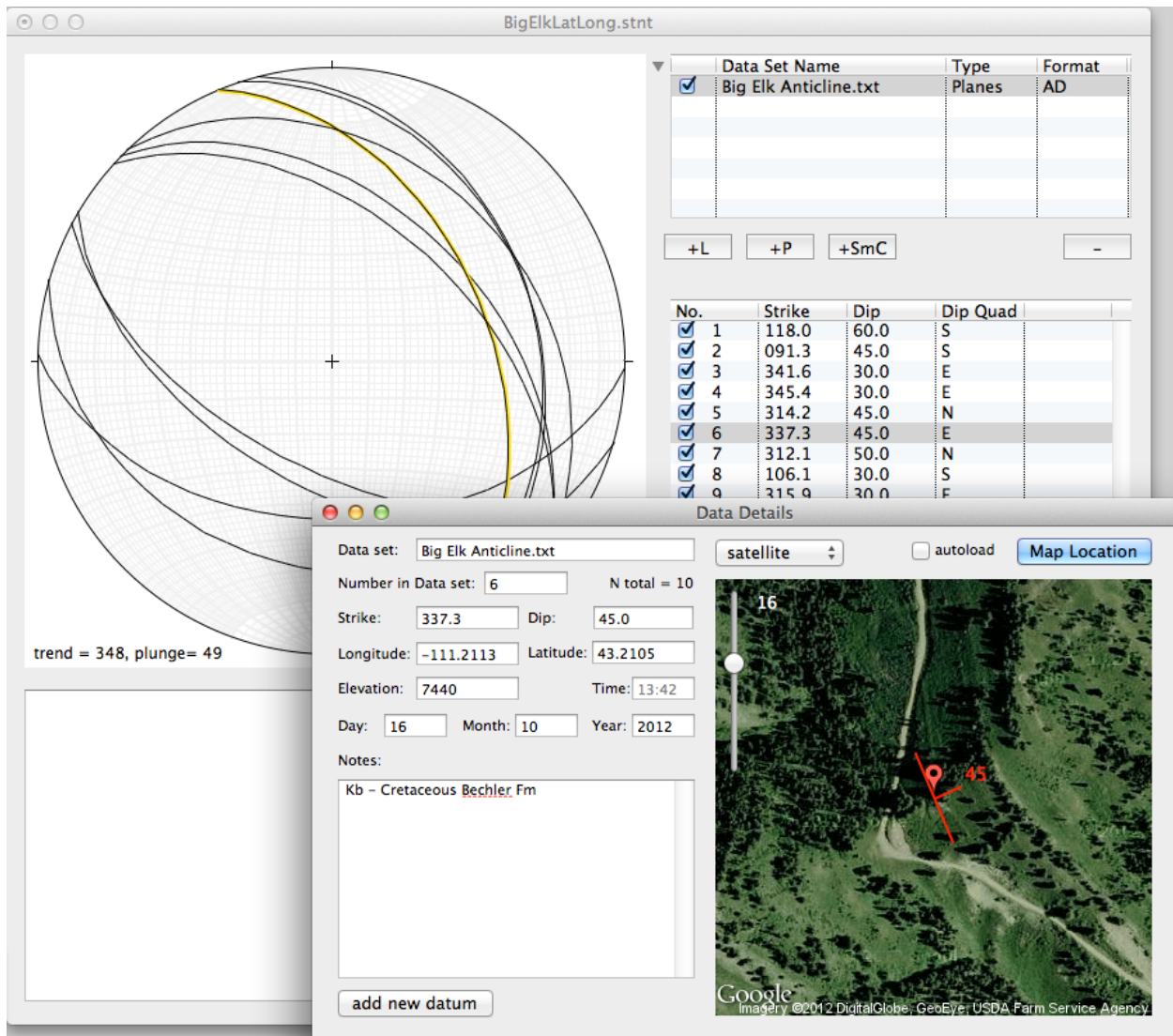


# Stereonet 9.5



Richard W. Allmendinger © 2011-2016



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## Disclaimer

Stereonet 9.5 is distributed on an "as is" basis without any warranty, explicit or implicit. The author will not be liable for direct, indirect, incidental, or consequential damages resulting from any defect in this software or this user's manual, even if he has been previously made aware of the defect. Furthermore, I make no systematic effort to inform all users of either bug fixes or upgrades. This program may not be sold or offered as an inducement to buy any other product.

## Referencing this Program

The science behind the algorithms in Stereonet 9.5 can be found in the following references:

Allmendinger, R. W., Cardozo, N., and Fisher, D., 2012, Structural geology algorithms: Vectors and tensors in structural geology: Cambridge University Press (book to be published in early 2012).

Cardozo, N., and Allmendinger, R.W., 2013, Spherical projections with OSXStereonet: Computers & Geosciences, v. 51, p. 193 – 205, doi:10.1016/j.cageo.2012.07.021.

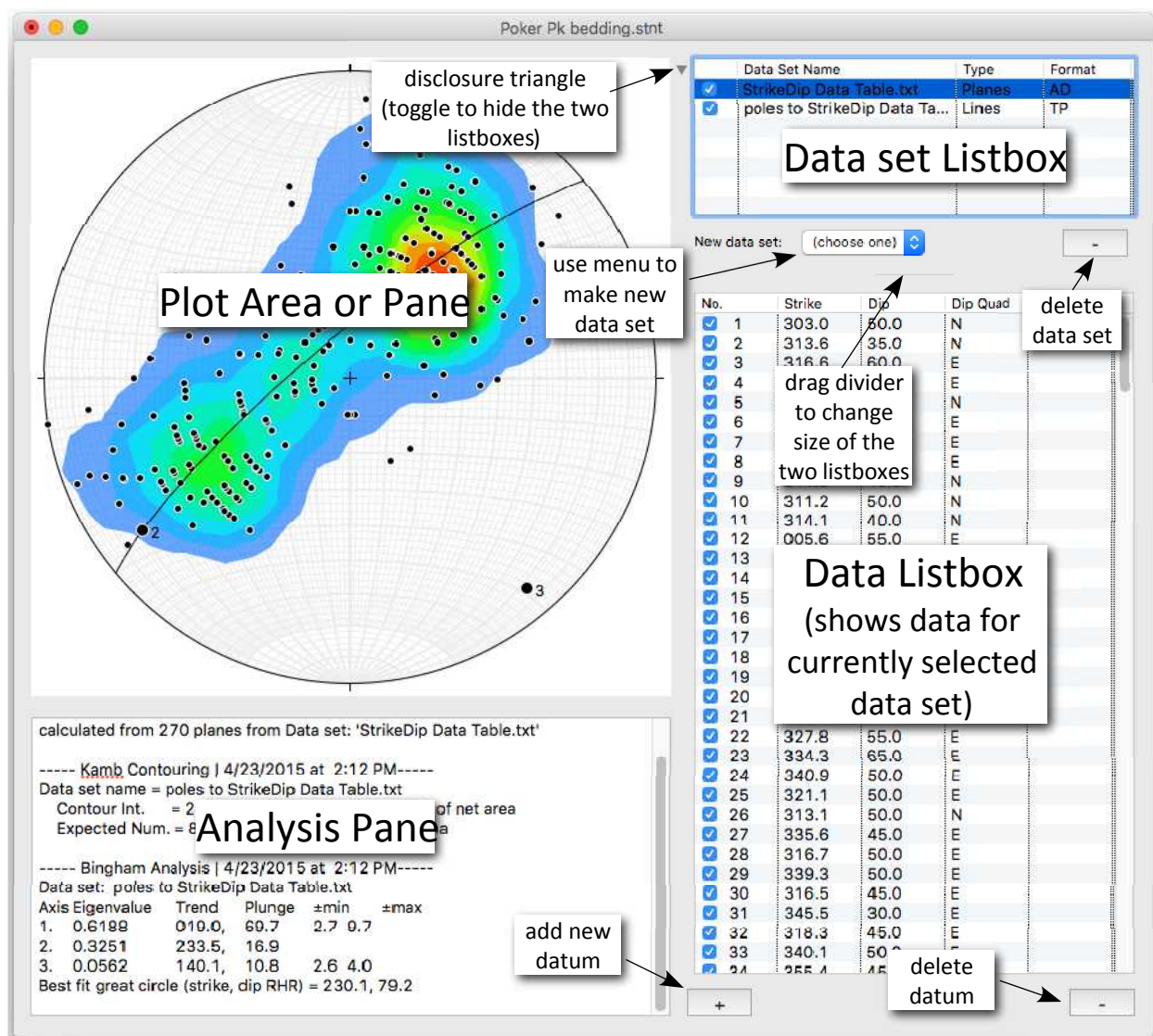
Please refer to this publication in any study or presentation that result from the use of this program.

## Credits

Stereonet 9.5 was written by Richard W. Allmendinger; the interface for the program is modeled after Stereonet3D by Néstor Cardozo and Richard Allmendinger. The rotation algorithm has been completely rewritten from one originally written by Randy Marrett. The contouring algorithm used is "conrec" by Paul Bourke (1987). The eigenvalue and eigenvector routines have been modified from the book *Numerical Recipes*. The PDF classes included in this program are from pdfFile by Toby W. Rush Copyright © 2004. I am particularly grateful to comments and advice from Néstor Cardozo during the development of this program and for sharing many other programming adventures. Finally, to all of you who have taken time to report bugs or, better still, just written to say thank you, I really appreciated it!

## Introduction

Stereonet 9.5 is a complete rewrite of my venerable, but aging, stereonet plotting program for Windows, originally called "StereoWin". The program has a revamped, and vastly improved, user interface, includes all of the scientific functionality of the older versions, and will work just fine on modern operating systems such as Mac OS X



and Windows 7 and higher. The functionality and interface of the program has been modeled after Stereonet3D by Néstor Cardozo and Richard W. Allmendinger. The only difference is that Stereonet3D uses an interface with a main window and two drawer windows that can be opened and closed at will, whereas Stereonet 9.5 version uses a single window with several different panes for different interface elements (Fig. 1)<sup>1</sup>.

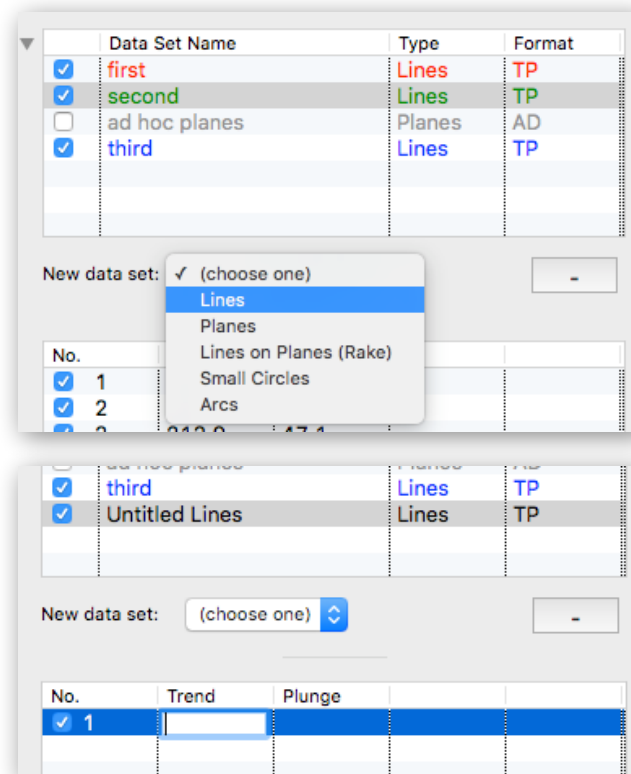
<sup>1</sup> The figures throughout this manual are from the Macintosh version of the program but Windows and Linux version are functionally identical.



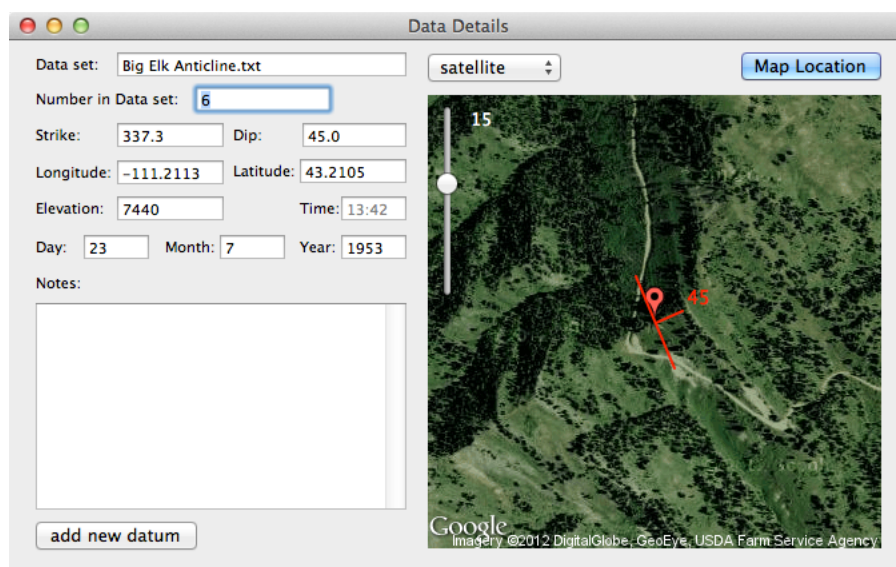
## Entering and Saving Data

### Entering new data

To enter a new data set into the program, use the pull-down menu next to the label “New data set” or use the selections in the Data>New Data Set> submenu. Stereonet supports five different data types as shown in the figure to the right. As soon as you release the menu, a new data set of the highlighted type will be created and the first datum in the data set will also be created and selected ready for you to type in the orientation. In the example shown in the figure one would first type the trend measurement, then press the tab key to move to the plunge column to enter the plunge measurement. After entering the plunge, if you press the Return Key, a second line will be added automatically to enter another line of data. Alternatively, you can click the “+” button beneath the data listing pane to add a new line of data.

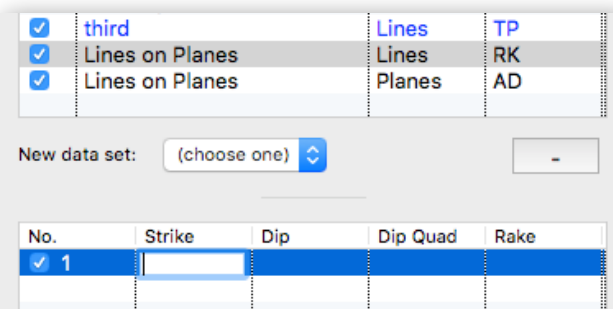


If you need to enter more details about your data — latitude, longitude, elevation, date, time, and free form notes — you can open Window>Data Details and enter



lines and planes in that dialog box. This dialog box can only accommodate planes data in right-hand-rule format, but has the obvious advantage that you can see exactly where the datum is located by clicking “Map Location” to show the datum in Google Satellite, terrain, or roadmap view.

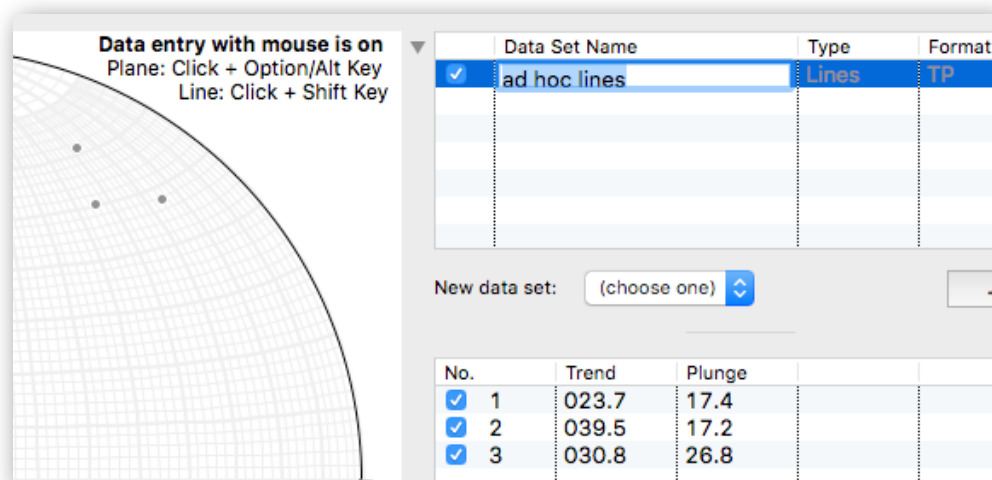
If you are entering rakes of lines on planes, Stereonet 9.5 will create both a lines data set and a planes data set (figure to the right). These two data sets must be given the same name. If you delete the planes data set (or change its name), you will still be able to show the lines data, but you will not be able to display it using the rake (RK) format.



The name of the data set can be edited at any time by clicking on the name (e.g., “Untitled Lines”) and then typing in whatever you want. It is useful to give the data sets sensible names because those are used in various operations (e.g., poles to planes, rotations) and are saved as part of the binary file. Note that you can set the default format for newly entered data by selecting Preferences.

### Entering New Data with Mouse

You can also *add data by clicking the mouse* inside the primitive of the stereonet. To enable this option, select “Enter with mouse” from the Data Menu. A message will appear explaining how to plot lines and planes (Figure below). Anytime “Enter with mouse” is checked, you can enter a new line by holding down the **Shift Key** while clicking, or enter a new plane by holding down the **Option** or **Alt Key**. In both cases, the datum is entered when you release the mouse, not when you click the mouse. When choosing a new plane this way, the place that you click the mouse becomes the pole to

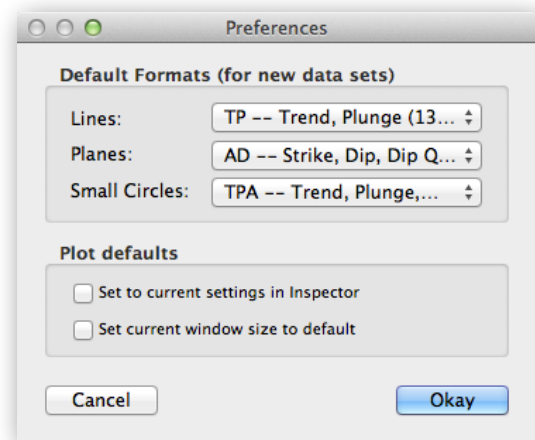




the plane; as you drag to move the pole around, the corresponding great circle is displayed. The first time you enter data with the mouse, it will be placed in a special data set named “ad hoc lines” or “ad hoc planes”. Any subsequent lines or planes added with the mouse will be added to the same ad hoc data set, rather than creating a new data set. As long as Stereonet 9.5 finds either of those two data sets listed, data entered with the mouse will be added to the existing data set. You can, of course, change the name of the data set to whatever you want; however, when you do so the program will then create a new “ad hoc lines” or “ad hoc planes” data set for any subsequent lines or planes entered with the mouse. In practice, these ad hoc data sets will most likely be used for temporary constructions. You can turn them off with the appropriate checkboxes or delete them entirely once you are done. They are saved with the binary file.

### Setting Data Format Preferences

From the Preferences menu choice under the Windows Menu (Windows) or Application Menu (Mac OS X) you can select the default formats for new data sets. To set default colors, styles, line weights, point sizes, etc., set all of those features in the Inspector, then check the box, “Set to current settings in Inspector” before clicking Okay in the Preferences dialog. You can also set the default window size on startup.



### Deleting Data

You can delete an individual datum by selecting the line of data in the data list pane and then pressing the “–” button located beneath the data list pane in the bottom right corner of the window. The datum will be deleted and the remaining lines beneath the datum will be shifted upwards. If you have a multiple selection in the data list pane, only the first line of data will be deleted.

To delete an entire data set, selected in the Data Set pane and then press the “–” button located beneath the data set pane (i.e., to the right of the add data drop-down menu). The data set and all of its associated data will be deleted.

*No warning is given when you press the “–” for either data sets or individual lines of data!!* They are simply deleted.

## Opening a Data File

### Importing text files with Stereonet formatting code

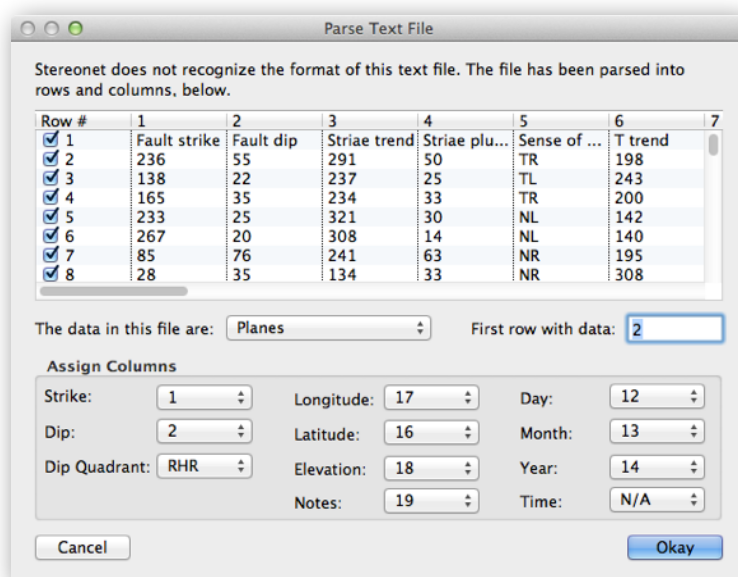
Using the “Import Text File” command under the File Menu, you can read in a text file that has a two letter header on the first line of the text file. These were the only sorts of files that could be used with StereoWin and versions of Stereonet for Mac versions 6 and earlier. The following table has a description of the two letter codes that Stereonet 9.5 recognizes:

<i>Data Type</i>	<i>Code</i>	<i>Example</i>	<i>Description</i>
Lines	TP	277, 42	The trend value appears first, followed by the plunge. A negative plunge indicates a vector pointing into the upper hemisphere.
	PT	42, 277	The plunge value appears first, followed by the trend.
	PQ	42 N 83 W	The plunge value appears first, followed by the trend, given in quadrant format. The trend must contain a letter (N, E, S, W), a number between 0 and 90, and another letter (N, E, S, W).
	LL	41, -76	The latitude of the point appears first, followed by the Longitude. South latitude and west longitude are given as negative numbers.
	RK	123 23 E 45	Lines are specified as a rake (pitch) in a plane. The plane orientation is given first in AD format, followed by the rake from the given strike azimuth.
Planes	AD	320 25 W	Strike azimuth between 0 and 360° is given first, followed by the dip magnitude, and then a letter specifying the quadrant (N, E, S, W) of the dip direction.
	AZ	140 25	This format assumes that the dip azimuth is located clockwise from the strike azimuth. In other words, if you give a strike of 137, Stereonet will assume that the dip azimuth is 227 (to the southwest). In this example, if your dip is to the northeast then you should specify a strike azimuth of 317. This is the format that Stereonet uses for all of its internal calculations, even if you don't enter it that way.
	QD	N 40 W 25 W	In this format, you can report any bearing with respect to N, S, E, or W. For example, the program will correctly interpret W 50 N the same as N 40 W. Only the first letter is significant for the compass directions (SW is interpreted as S).
	DD	25, 230	A format more commonly used in Europe. Note that the dip magnitude (vertical angle) comes before the dip azimuth.

Following the two line header, there were any number of lines, each with only one datum (e.g., trend and plunge, or strike and dip) followed by a return character. The values on the line can be separated by a comma, space, tab or any combination.

### Opening column formatted text files (e.g., from spreadsheet programs)

Stereonet 9.5 can also parse any text file that has been formatted into columns using a separator character. The program parses the columns automatically: if tab characters are present they will be used as a separator; if tabs are absent, commas will be used and if commas are absent, spaces will be used. In the latter case, the program assumes that contiguous spaces are a single separator, so this is clearly the least desirable option for such files. The Parse Text File dialog box is shown, below



The labels and numbers of popup menus for columns changes depending on what is selected in the popup menu "The data in this file are:". Simply chose the column in which each data type appears and Stereonet 9.5 will read in the column. You can skip specific rows of data by deselecting the checkbox on the left side. For many people, this will be the most convenient way to enter details such as location information, etc.

### Opening Column-formatted Text on the Clipboard

You can also enter or add column formatted data from the system Clipboard. If you want to add data to an existing data set, select the data set in the data set list box; if instead you want to create a new data set, make sure that no data sets are selected in the data set list box. Then choose Edit>Paste into Data Set. The same dialog box as you see above will appear allowing you to identify the different columns of data. Make your elections and when you click Okay then data will be added to the program.

## **Moving Data from One Data Set to Another**

You can combine data from two existing data sets by selecting the data that you want to move in the data list box (non-contiguous selections are okay) and choosing Edit>Copy All Data. Then, select the data set the you wish to add the data to in the Data Set List Box and select Edit>Paste into Data Set. The selected data from the first data set will be added to the second data set; the first data set will remain unmodified. If you want to keep both data sets unmodified, create a new blank data set of the appropriate type, first, and then Copy all Data from both old data sets and paste into the new data set. Note that you cannot use the normal copy and paste commands because they will not capture all of the data.

## **Opening Stereonet 9.5 Native Files**

Stereonet 9.5 introduces a new binary file format that, in a single file, contains not only all of the data sets entered, but also all of the settings at the time the file was saved. This includes all of the formatting you have applied to the stereonet (e.g., colors, grid spacing, projection, etc.), the data (e.g., colors, symbols, line weights, etc.), the plot itself, and the contents of the Analysis pane. Opening a Stereonet 9.5 native file is just like picking up exactly where you left off when you last saved the file. Stereonet 9.5 can read Stereonet 7 binary files, but Stereonet 7 cannot read Stereonet 9.5 binaries! Older version of the program cannot read binary files created by newer versions of the program.

## ***Saving Data Files***

Likewise, Stereonet 9.5 can save data files in two formats:

### **Exporting Text Files**

You can export text files in two flavors: if you want to save a text file with a two line header, just like older version of Stereonet/StereoWin, choose Stereonet 6 Format. Lines are only saved with the TP (trend, plunge) format and planes are saved only with the AD (Azimuth Dip, i.e., right hand rule) format. Use export text file if you want to exchange data with Stereonet3D or with older versions of Stereonet/StereoWin.

Always save your precious field data as text files, even if you also save them using the binary file format. The text files should be useable by virtually any program for the foreseeable future whereas the binary format files can only be read by recent versions of Stereonet!

You can also save text files in Table format. In this flavor, you get a one line header with column labels and you save all of the location information (longitude, latitude, elevation, notes) as well as the orientation data. These file can be read back in to Stereonet 9.5 using the Parse Text File option, above.

In either case, only the selected data set is saved.

## Save Stereonet 9.5 Native (Binary) File

The “Save As...” command under the file menu saves a Stereonet 9.5 native (binary) file with the file suffix “.stnt”, which can only be read by Stereonet 9.5. As described above, these files contain an exact copy of the state of the program and data at the time that you save the file. The Stereonet 9.5 native file cannot be read by any previous version of Stereonet. Stereonet 9.5 (but not earlier versions) can also save a binary file in the Stereonet v. 8.8 format, providing some backwards compatibility. To do so, hold down the Shift Key and the Option (Mac) or Alt (Windows) Keys while choosing File>Save As...

## Choosing which data to plot or analyze

Stereonet 9.5 will only plot or analyze data that are checked in the Data Set and Data List panes to the right of the plot. The program makes it easy to link data in the plot to the table in the data list box by highlighting selected points and planes in yellow, an effect I call the “selection halo”. If you click on a point in the plot, the row will be selected in the table, and clicking on a row provides a selection halo in the Plot Window. You can make multiple, non-contiguous selections in the table of the Data List pane by command clicking the rows of interest. From the Data Menu, or equivalent popup menu in the Data Drawer accessed by right-clicking, you can toggle on or off selected data.

The Toggle On and Off commands in the Data Menu can be very powerful when combined with the ability to sort rows by clicking on a column in the table of the data list pane. The first time you click a column heading all the rows will sort ascending, the next click will sort descending according to the value in the column clicked. To return to the original sorting, click the “No.” heading of the column farthest to the left. Once sorted by whatever criteria you want, you can then select the range of rows that fits your criteria and Toggle Off the rest of the data set.

Stereonet 9.5 also allows you to search a single data set or all data sets for matching parameters by selecting Data>Search which will give you the dialog to the right. Here you can specify any combination of matching tag criteria by checking the checkbox to the left of the name. In the example shown to the right, pressing “select” will toggle on only those measurements in the currently selected data set that have trends between 350 and 010°, elevations between 800 and

Search

Scope of search

☒ current data set ☐ all data sets

☒ Trend:   ☐ Plunge:

☐ Day:   ☐ Latitude:

☐ Month:   ☐ Longitude:

☐ Year:   ☒ Elevation:

☒ Notes:

Click the appropriate criteria and enter the range of permissible values, then click the "Select" button, below, to perform your search. Note that you can sort the columns in the data pane to the right to select ranges.

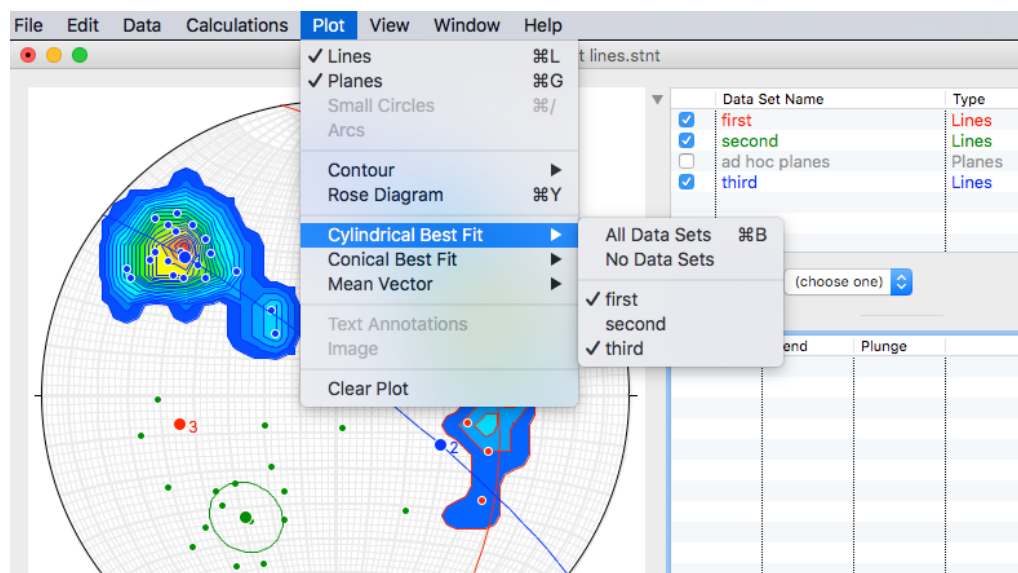
1200, and contain the phrase “Salar Grande” in the notes field. If you elect to search across all data sets, then the trend or the strike will be between 350 and 010°, etc. Click select opposite to toggle on those measurements which do NOT meet the entered criteria. Finally, the “Restore All” button will turn on all measurements in all data files.

### *Plotting Your Data*

Stereonet 9.5 will plot whatever options are checked in the Plot menu. Select a plot type once to turn it on and a second time to turn it off; the plot will automatically change to reflect your selections. If a plot option is checked at the time of data entry, the points (or great or small circles) will appear interactively as you enter each datum. The same plotting options are applied to all checked date sets in the Data Set pane. For example, turning on scatter will make a scatter plot for all lines data sets. If you do not want a data set to appear in a plot, then turn it off by unchecking it in the Data Set pane. As described above, only data that are checked in the Data List Pane will be plotted.

Plotting is specific to data set type. For example, you cannot contour a Planes data set. To produce a contour diagram of poles to planes, you must first make a Lines data set containing the poles, which you do by choosing “Poles” from the Calculation Menu.

Several plot types are specific to lines, or vector, data. These include: **Contour**, **Cylindrical Best Fit**, **Conical Best Fit**, and **Mean Vector**. As of version 9.5 you can now choose to perform these plots/analyses on an individual data set basis by using the submenu options as shown in the following figure. The submenu for Cylindrical Best Fit is shown but appears exactly the same for the other three submenus. To turn on plotting for all data sets, select “All Data Sets” from the submenu. To turn off plotting for all data sets, choose “No Data Sets” or select “All Data Sets” a second time (to uncheck it).





Beneath those two options, the lines data sets are listed by their name in the Data Set Listbox. The checked data sets are the ones being plotted. You can make different choices for different types of analyses. The figure shows that contouring is turned on for data sets “first” and “third”, cylindrical best fit also for the same two data sets, but mean vector is turned on for only data set “second”.

Some of the options in the Plot menu write the results of the underlying analysis to the Analysis Pane. For example, if you choose Mean Vector from the Plot menu, the mean vector statistics will also be written to the Analysis pane. At any time, you can erase extraneous information that you don’t need from the Analysis pane by selecting it and pressing the delete key on the keyboard.

### *Changing the Appearance of Your Plot using the Inspector*

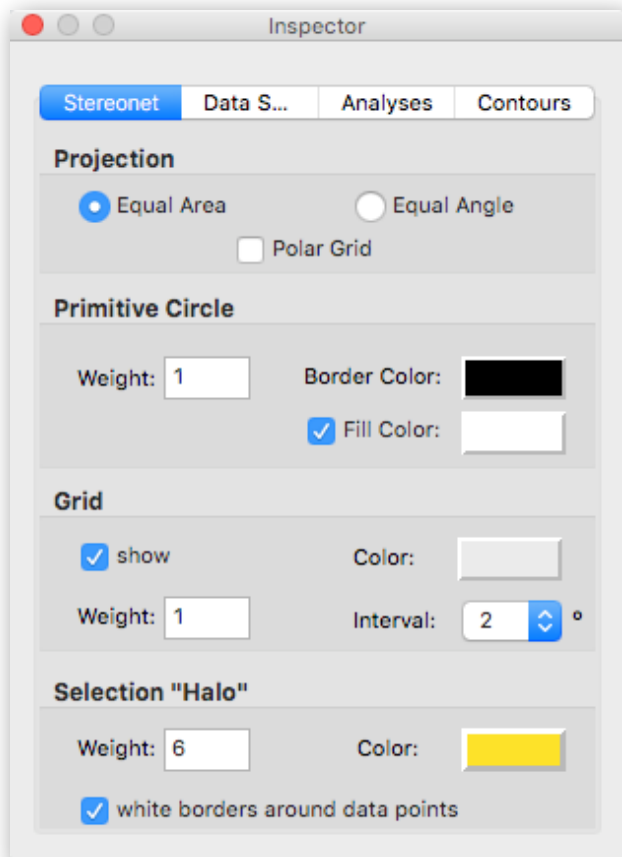
The appearance or formatting of your plot, including the type of projection (equal area or equal angle) is controlled by the **Inspector**, which is accessed from the View Menu. There are a large number of choices in the Inspector, thus giving you many options for formatting the plot to your liking. Any change that you make in the Inspector is immediately reflected in the plot.

#### **Stereonet Tab**

The first tab of the Inspector controls the appearance of the stereonet, itself. Here, you can set the projection, grid spacing, colors, etc. If you select “Polar Grid”, the small circles will be centered on the center of the projection; otherwise, they will be centered on the north and south poles of the projection. You can turn off the grid or the fill color for the stereonet. To change a color, click on the beveled color box to get the standard Windows or Mac color picker in order to chose a new color.

#### **Data Sets Tab**

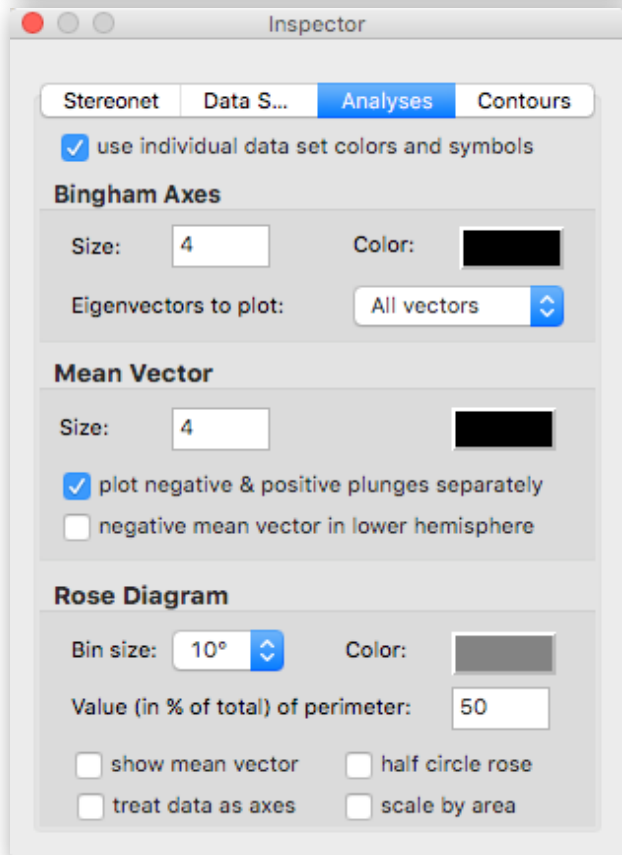
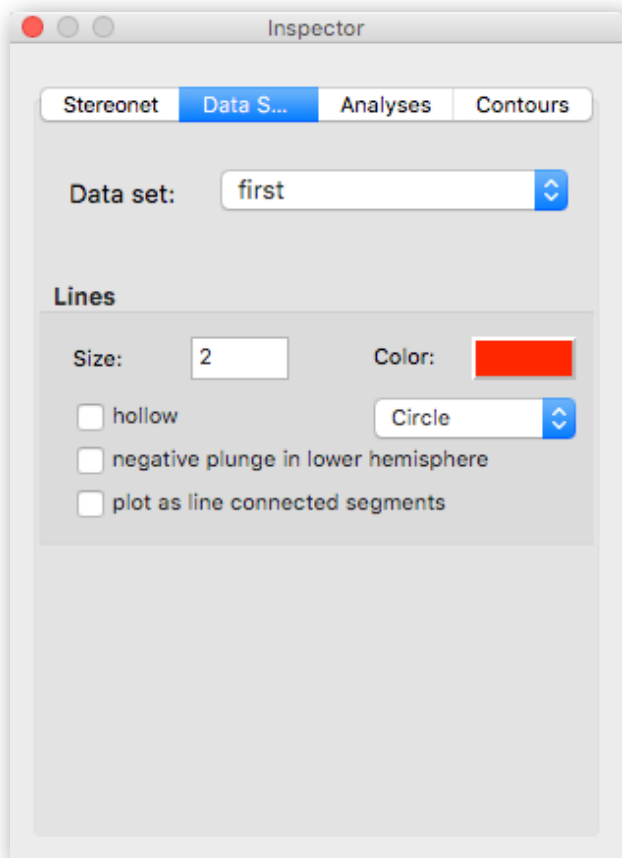
The second tab controls the appearance of individual data sets. The changes you make in this tab apply only to the data set that is selected in the Data Set Pane and/or using the pop-down menu next to the “Data set:” label in the



tab. If you have three lines data sets entered, only the one that is selected will acquire the properties that you enter. The appearance of this tab changes depending on which of the five data types are selected. Lines can be assigned one of four different symbol types, either hollow or solid, and can have any color. “Plot as connected line segments” only applies if you have entered a latitude-longitude data set (line format type “LL”). Lines can have either positive (lower hemisphere) or negative (upper hemisphere) plunges. Stereonet 9.5 always plots negative plunges with the same symbol and color, but opposite hollow-type than positive plunges. For example, if a single lines data set is set to use hollow triangles, any negative plunges will be plotted as solid triangles (or vice versa). You can choose to plot negative plunges in either the upper or the lower hemisphere, but they will still have the opposite hollow setting from the positive plunges in the data set. Small circles always break across the primitive, but you can select to plot the small circle entirely in the upper or the lower hemisphere.

### Analyses Tab

The third tab controls the appearance of various types of analyses that you can apply to your data such as Bingham Axes (Cylindrical Best Fit), the mean vector, and rose diagrams. If the “use individual data set colors and symbols” is used” the colors that you set here will be overridden by the existing colors which have been set for the individual lines and planes files. This is a global setting for all



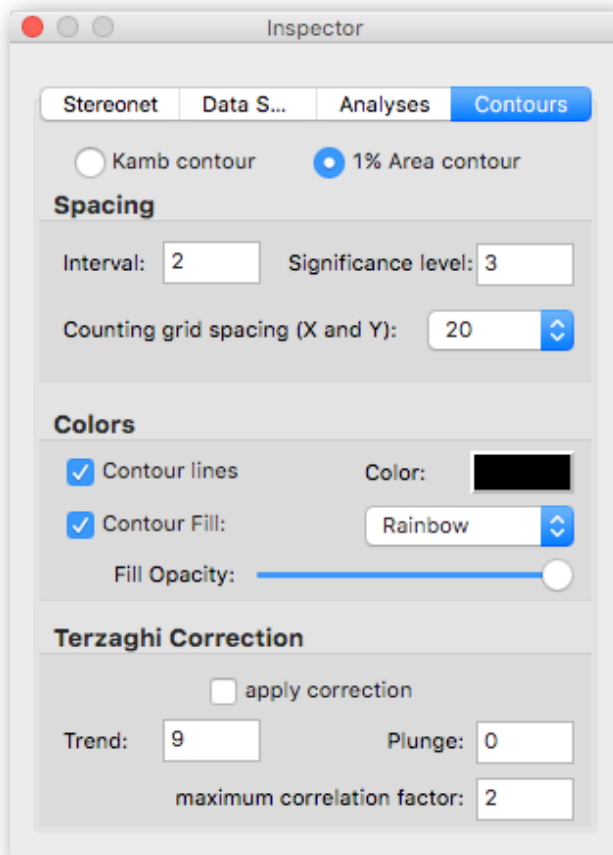
analyses on this tab.

If your data set has both positive and negative plunges, as is common with paleomagnetic data sets, you can choose to plot a separate mean vector for positive and negative populations, and chose to plot the negative mean vector in the lower hemisphere. Doing so would be equivalent to performing a paleomagnetic reversal test.

For the Rose Diagram, you would typically set the perimeter value to be slightly larger than the scale of the largest petal, but you can set any value here, which allows you to compare different data sets. Statistically, it is more valid to scale the petals by area rather than length, though the majority of published diagrams are scaled by length because the concentrations look more impressive (than they really are!). Stereonet uses **scale by area** if checked; otherwise it scales by length. You can also treat the data as axes with no directional significance rather than as vectors. If treated as axes, Krumbein's mean vector is calculated rather than the standard mean vector.

### Contour Tab

The fourth tab is where you specify whether you want Kamb or 1% area contouring and control the appearance of your contour plots. Like the items on the Analyses Tab, changes in the Contours Tab apply to all lines data sets. If you want to plot the contour lines with the same color as used for the different lines data sets, make sure that "Use individual data set colors and symbols" at the top of the Analyses Tab is checked. The contour interval is appropriate to both Kamb and 1% area contouring, but the significance is only pertinent to the former. The resolution of the counting grid is controlled by the pop-down menu, with choices of 20, 30, or 40. Note that a higher resolution grid takes more time and, especially with smaller data sets can introduce insignificant detail when smoothing is actually called for. You can turn on or off contour lines with the checkbox of that name. Color sets the color for the contour lines (for all data sets) assuming that it is not overridden by the "Use individual data sets colors..." checkbox. The Contour fill checkbox determines whether the contoured regions are filled or empty. Finally, four different



contour color ramps are available from the pop-down menu: Rainbow, monochrome (gray scale), blue scale or red scale. The opacity of the fill is controlled with the slider.

The Terzaghi Correction is intended for data that you sample along a 1-D linear transect (borehole, etc.), which can be biased by the fact that you are very unlikely to sample a representative number of structures that trend sub-parallel or parallel to your sampling line. As Randy Marrett explained it to me, to apply the Terzaghi correction for this bias, you just multiply the value at each counting node times  $1/\cos(\text{angle between the sample line and the counting node})$ . The trend and plunge that you enter in the Inspector's Contours Tab gives the orientation of the sampling line or transect. Counting nodes that are parallel to the sample line should have a value of infinity, but that would result in an awful lot of contours, so you must specify some upper maximum value, the default value being 10.

### *Changing the View Direction of Your Plot*

Structural geologists are accustomed to viewing the stereonet as a lower hemisphere projection, as if one were looking vertically downward. However, there are many times when a different frame of reference is better. For example, you may want to plot data in the plane of a cross section (a view direction which is horizontal and perpendicular to the azimuth of the cross section), or in the profile plane (down plunge view) of a cylindrical fold (a view direction parallel to the fold axis). Of course, you can do this by rotating all your data, but it can be a bit tedious, and you don't have and visualization aids. Stereonet allows you to set any view direction without having to rotate all of your data.

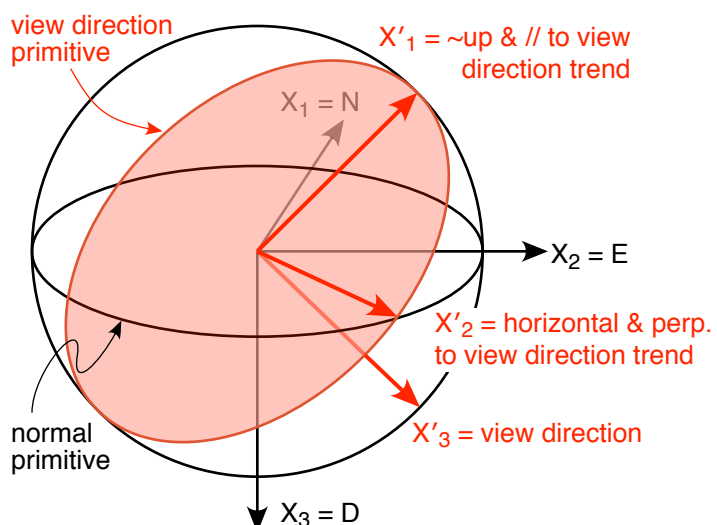
When you choose "Set View Direction..." under the plot menu, the dialog box will appear to the right. The trend and plunge that you enter in this dialog will become the new center of the projec-

**Set View Direction**

Enter the direction of view. The default view is straight down and N at the top, a view direction of 000, 90.

Trend = 
Plunge =

Cancel
Default view
Okay



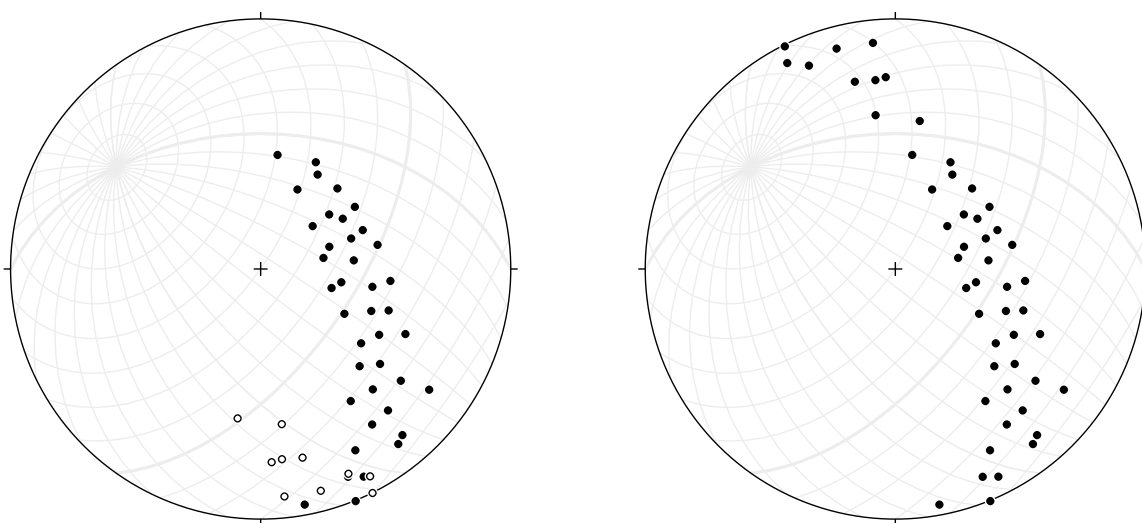
tion and the primitive plane perpendicular to that direction. You can easily return to the default view of North-East-Down by clicking the “Default View” button in the set view dialog box. You do not need to enter any values first. The following diagram shows the relationship between the Cartesian coordinates of a normal geographic stereographic projection (in black) and those of the new view (in red).

The new view coordinate system axes are plotted at the same position as the old axes. For example, the new  $X'_3$  is plotted in the center of the net at the same place as the old  $X_3$ . Stereonet does not modify your data in any way; you will see no change in the orientations in the Data List box.

To maintain a sense of orientation, I highly recommend that you have “Show Grid” turned on in Preferences; Stereonet will then plot the rotated grid, with the great circles intersecting at the north or south pole. This essentially lets you see both coordinate systems at once. For the values shown in the above dialog, the rotated grid with the new and old coordinate systems, is shown below. Note that for the entered values,  $X_1$ ,  $X_2$ , and  $X_3$  are all positive, but other view directions can result in negative axes being plotted.

When you click and hold down the mouse on the stereonet, the orientation that you see is in geographic coordinates. That is, if you click on the pole in the above diagram, the trend and plunge will show “T&P = 0, 0”, or perhaps “T&P = 360, 0”. This is the fastest way to determine whether or not the pole showing is north or south (the latter, of course, will have a trend of  $180^\circ$ ). Clicking on points above the horizon will show negative plunges, because these points are plunging upwards into the upper hemisphere, negative by standard structural convention. If you hold down the shift key while you click on the stereonet, you will see the trend and plunge of the clicked point in the new view coordinate system. It is unlikely that you will need this very often!

One potentially confusing aspect of this new capability is the concept of “upper” and “lower” hemispheres. Once you set the view direction, the upper hemisphere is the one in the direction opposite to the direction in which you are looking. Lines that plunge downward geographically (and thus have positive plunges) may well end up in the “upper” hemisphere of the new view. When you choose Scatter or Mean Vector, Stereonet will ask you how you want to handle these “upper” hemisphere lines. The figure below shows the same data set plotted in geographic coordinates (left) and with a view direction of  $045^\circ$ , 37. Note that some of the lines in the left hand graphic have become “upper” hemisphere (to the new view direction) because of the coordinate transformation. In the right, “Plot negative plunges in lower hemisphere has been selected. Note that contouring always occurs in the lower hemisphere of the current projection.



## Calculations and Data Analyses

### *Pole to Planes, Planes from Poles*

These two options produce new data sets. In the case of Poles to Planes (if a planes data set is selected in the Data Set Listbox) or Planes from Poles (if a lines data set is selected), a new data set is always created with a name taken from the original data set preceded by “poles to...” or “planes from...” but you can change the name afterwards if you want. Note that, *to contour poles to planes, or calculate cylindrical best fit, there must actually be a Lines data file which contains the poles to the planes.*

### *Rotations*

#### **Rotate Data**

Your data can be rotated about an axis of any orientation. Rotation magnitudes are positive if they are clockwise looking in the direction of the given azimuth and plunge of the rotation axis, and negative if they are counter-clockwise. The data are always rotated as vectors: If the rotation produces a line with a negative plunge (pointing into the upper hemisphere), it will not be converted into a lower hemisphere line.

As shown in the rotation dialog box to the right, you have the choice of

**Rotate Data**

---

**Parameters**

Azimuth of rotation axis =

Plunge of rotation axis =

Magnitude of rotation =

(a positive rotation is clockwise looking in the direction of the given azimuth and plunge)

**What to rotate**

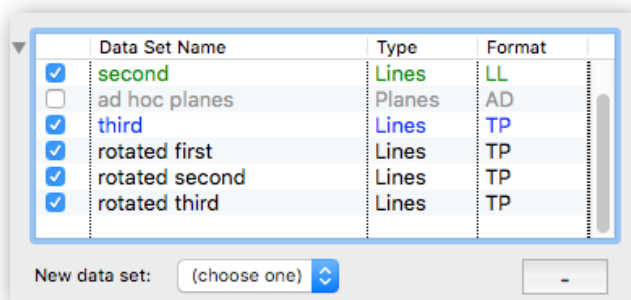
☐ Selected data set    ☒ All checked data sets

**Where to put the results**

☒ Create new dataset    ☐ Overwrite current dataset

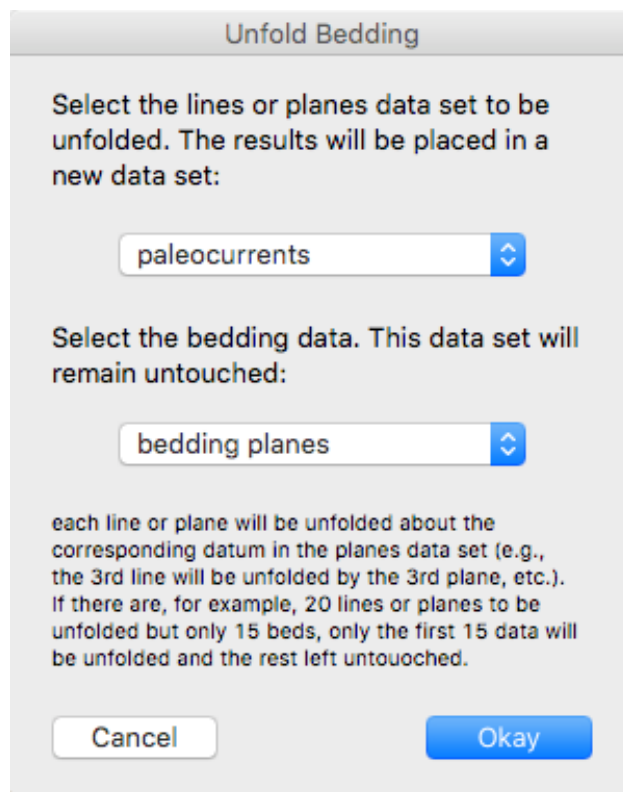


rotating just the selected data set or all of the data sets in the Data Sets Pane. Additionally, you can specify that the rotation replace the existing data sets or that new data sets be created. The screen capture to the right shows the results of rotating all entered data and placing them in new data sets.



### Unfold Bedding

While Rotate Data rotates an entire data set by the same amount, that is not what you want to do if, say, you have a group of paleocurrent measurements and the bedding orientations where they were collected and you want to unfold them because the rotation of each paleocurrent measurement depends on the local bedding orientation. You can address this situation with Unfold Bedding, which gives you the dialog box to the right. In the first pop-down menu, choose the lines or planes data that you want to rotate; in the second choose the bedding data set to be rotated back to horizontal. A new data set will be created with the rotated lines or planes.



### Statistical Analyses

I highly recommend that you do not use these statistical analyses blindly but instead actually learn what they mean and when they are appropriate. This section is not intended to instruct the user on these techniques, only list some of the key equations. Please read the books by Davis (2002), Fisher et al. (1987), Butler (1992), Allmendinger et al. (2012), etc. These statistical analyses accessed from the Calculations Menu are carried out on the selected lines file in the Data Set Pane and the results written to the Analyses Pane. No data sets are modified in any way.

### Fisher Vector Distribution

This is the standard mean vector calculation: the direction cosines of all of the individual unit vectors are simply added up. The mean length reported is just the length

of the resultant vector,  $R$ , divided by the number of vectors summed,  $N$ . The reported trend and plunge are derived from the resultant vector normalized to a unit vector. The uncertainty intervals are calculated from the following equation:

$$\cos \delta \alpha_p = 1 - \left( \frac{N - R}{R} \right) \left[ \left( \frac{1}{1 - p} \right)^{\frac{1}{N-1}} - 1 \right]$$

Where  $p$  is the probability,  $N$  is the number of observations, and  $R$  is the resultant vector length. Kappa,  $\kappa$ , the dispersion or concentration factor, is estimated from one of the following calculations:

$$\begin{aligned} \kappa &\approx \left( \frac{N}{(N - R)} \right) \left( 1 - \left( \frac{1}{N} \right) \right)^2 && \text{for } N < 16 \\ \kappa &\approx \frac{(N - 1)}{(N - R)} && \text{for } N \geq 16 \end{aligned}$$

For the lower equation, one can find the in literature either  $(N - 1)$  or  $(N - 2)$  in the numerator. Stereonet uses  $(N - 1)$  following following Fisher's original estimation but you should be aware that some authors and programs use  $(N - 2)$  (e.g., Davis, 2002).

### Bingham Axial Distribution

The Bingham axial distribution is used where the data are axes rather than lines. Its most common use is in the cylindrical best fit determination of the fold axes. The routine works by calculating the orientation tensor:

$$\mathbf{T} = \begin{bmatrix} \sum \cos^2 \alpha_{[i]} & \sum \cos \alpha_{[i]} \cos \beta_{[i]} & \sum \cos \alpha_{[i]} \cos \gamma_{[i]} \\ \sum \cos \beta_{[i]} \cos \alpha_{[i]} & \sum \cos^2 \beta_{[i]} & \sum \cos \beta_{[i]} \cos \gamma_{[i]} \\ \sum \cos \gamma_{[i]} \cos \alpha_{[i]} & \sum \cos \gamma_{[i]} \cos \beta_{[i]} & \sum \cos^2 \gamma_{[i]} \end{bmatrix}$$

from the direction cosines of the individual measurements and then calculating the eigenvalues and eigenvectors to get the principal axes of the tensor. The first axis corresponds to the greatest concentration of points, the second to the intermediate and the

third to the smallest concentration; the third axis is usually interpreted as the cylindrical fold axis. For more than 25 points, Stereonet calculates the semi-major and minor axes of the error ellipses around each principal axis following the procedure outlined in Fisher et al. (1987).

### von Mises Distribution

The von Mises Circular Distribution is similar to the mean vector calculation. It corresponds to the sum of the two horizontal direction cosines of horizontal vectors, producing a two dimensional horizontal mean vector. the circular variance is given by:

$$\sigma^2 = \frac{(N - R)}{N}$$

And the concentration factor,  $\kappa$ , estimated using lookup tables (Davis, 2002). The error on the mean direction is the standard error given by:

$$\sigma_e = \frac{1}{\sqrt{N\bar{R}\kappa}}$$

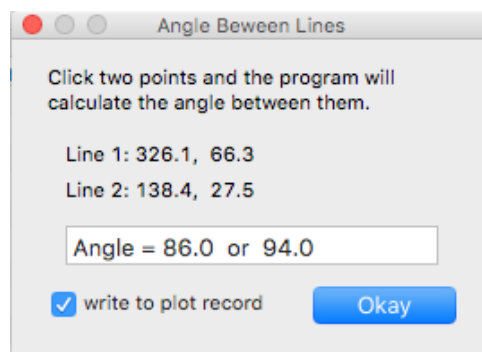
Where  $\bar{R}$  is the length of the resultant vector divided by the number of measurements.

*Angle between...*

### Selected Lines, Selected Planes

If two lines are selected in a data set you can choose to calculate the angle between them, which is essentially the angle in the plane that contains both lines. Both the angle and the two lines selected will be recorded in the Analysis pane.

If two planes are selected in the same data set, the program will calculate not only the angle between the two planes but the line of intersection as well. The result will be written to the Analysis pane:



```
-----Angle between Lines | 8/10/2011 at 10:18 PM-----
Angle = 27.1° or 152.9°
Line of intersection = 016.7, 12.4
Planes selected (RHR): 347.0°, 24.0° and 259.0°, 14.0°
```

Finally, you can also use the mouse to click on two points inside the stereonet and the angle between those two points will be displayed in a dialog box and you will be given the option of writing the results to the Analysis Pane.

### *Apparent Dip Calculator*

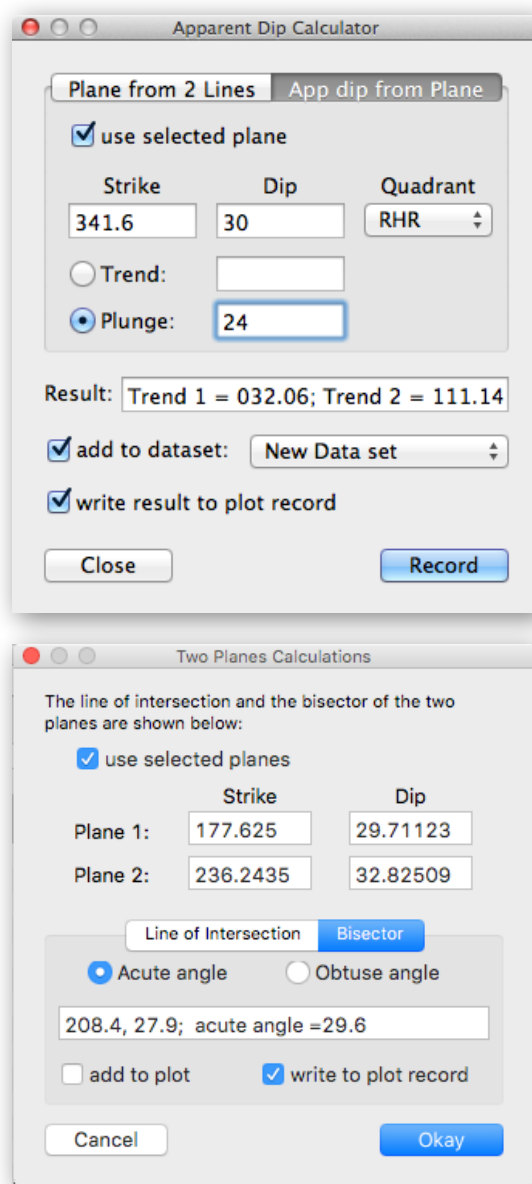
You can rapidly calculate apparent dip problems by selecting Calculations>Apparent Dips. Two different options are available by clicking the tabs at the top. In the first, you provide two lines and the program will calculate the plane that contains them. In the second, you provide the plane and the program will calculate the apparent dip in the direction of the given trend, or the two trends that have a given plunge in the plane of bedding. The results can be written to either a new or existing data set for plotting, and can also be written to the plot record. The apparent dip calculator is a floating window that will stay open until you close it.

### *Two Planes Calculations*

Stereonet can perform an number of calculations on two planes including the acute and obtuse bisector, the line of intersection, etc. The result of any of these calculations can be written to the Analysis pane and can also be added to the plot by selecting the appropriate check boxes. The two planes can be entered manually, or you can select any two planes within a single data set.

### *Axial Plane Finder*

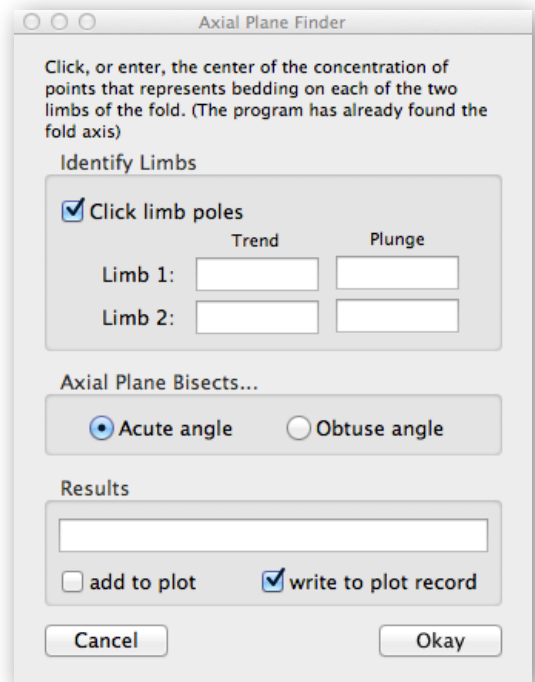
Stereonet 9.5 can also do some basic fold analysis with Calculations>Axial Plane Finder. To use this function, you must select a lines data set that contains the poles to bedding before choosing this menu option. Furthermore, this analysis only works if your folds have relatively planar limbs and sharp hinges such that the bedding poles cluster in two distinct groups, one for each limb. Click on the two limb clusters and tell the program whether the axial plane bisects the acute or obtuse angles between the



limbs. Remember that an obtuse angle between the limbs produces an acute angle between the poles to the limbs! The program will then calculate and report the trend and plunge of the fold axis, the strike and dip of the axial plane, and the interlimb angle:

```
----- Pick Axial Plane | 10/13/2012 at 10:16 PM-----
Axial plane of dataset:      poles to Big Elk Anticline
Trend & plunge of fold axis: 124.9, 16.0
Strike & dip of axial plane: 307.2, 82.0 N
Interlimb angle:            99.7°
```

The Axial Plane finder window is a floating window which will stay open until you close it. While it is open, all clicks in the stereonet will be assumed to be clicks on clusters of pole for one limb or the other.



### *Convert to Lower Hemisphere*

If you prefer to deal with axes and not vectors, you can select this command to convert all your measurements to the lower hemisphere. Practically, this is only useful if your data set has negative plunges or dips. This operation only works on the selected data set and, for safety's sake, creates a new data set rather than overwriting the old. Once you have completed the operation, you can delete the old data set if you (really) want.

### *Direction Cosines*

This command will write out the direction cosines of any selected lines, or the poles to any selected planes, to the Analysis Window. The entries are tab separated, making it easy to copy the results from the Analysis pane and paste them into a spreadsheet or other document:

```

----- Direction Cosines | 8/10/2011 at 10:38 PM-----
Data set: Corral Quemado Paleomag
Datum      Trend    Plunge    North      East      Down
15         024.9    -46.7     0.622     0.289    -0.728
29         212.2     37.9    -0.668    -0.42     0.614
52         339.3    -59.7     0.472    -0.178    -0.863
59         200.      45.7    -0.656    -0.239     0.716

----- Direction Cosines | 8/10/2011 at 10:39 PM-----
Data set: BreeCreekNWBdg.txt
Datum      Strike   Dip      North      East      Down
1          201.   49.     -0.27     0.705     0.656
3          340.   25.     -0.145    -0.397     0.906
15         199.   49.     -0.246     0.714     0.656
[direction cosines are for the poles to the planes]

```

## Copying, saving and printing your plot

Once you have the plot just as you like it, you can save it as a PDF file for import into other programs. The PDFs produced should be of publication quality and should appear identical to, but higher resolution than, the plot window itself. The size of the pdf is controlled by the size of the Plot tab in the Main window.

Alternatively, Stereonet 9.5 can save plots as scalable vector graphics (.svg), an open, high resolution vector format that can be read by all major web browsers and most modern vector graphics programs (e.g., Illustrator, EazyDraw, etc.). *SVG has many desirable characteristics and is the best one to use if your graphics program supports this format.* Note that all modern web browsers can open SVG files and most can then export them as PDFs in case you do not have a SVG-capable graphics program.

Finally, you can save your plot in an older vector format by choosing “Save Plot as PICT/EMF” which will save the plot as an enhanced metafile format in Windows. PDF and SVG output is superior to PICT/EMF and is thus highly recommended<sup>2</sup>.

Stereonet 9.5 also supports the clipboard. If any text is selected in either the Data List or the Analysis Pane, that editable text will be copied to the clipboard. Otherwise the Graphic in the Main Window will be copied as vector objects to the clipboard for pasting into another application. The application into which you paste the graphic will determine the format in which it appears. In Mac OS X, Cocoa applications, it will usually appear as a Tiff image, whereas Carbon apps will recognize the vectors. The clipboard uses .EMF quality graphics and thus should not be used for final production work if you can help it.

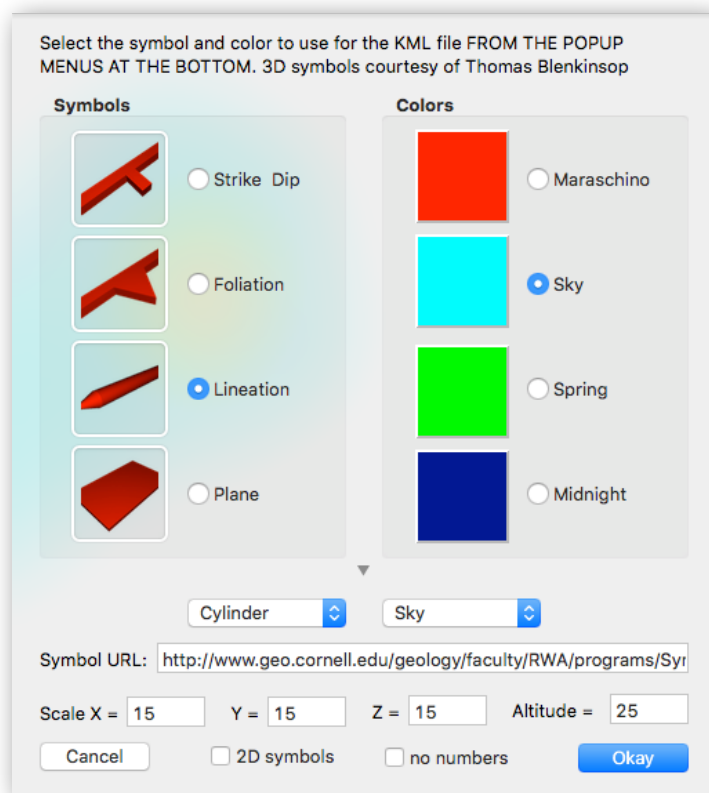
---

<sup>2</sup> I have had reports that PDF output does not work on German systems. If that is the case, just switch your system to US English for long enough to save the plot as a PDF.



### *KML output*

Stereonet can export a KML file of geographically registered 3D strike and dip and lineation symbols for plotting in Google Earth (thanks to Tom Blenkinsop and Nestor Cardozo for the idea). To do so, select File>Export Text File>KML File..... The dialog box below shows the basic options for symbols and colors; more can be chosen if you toggle the disclosure triangle at the bottom of the initial window. Only the selected data set will be saved as KML. Once saved, the file can be opened in Google Earth simply by double clicking on the file.



The 3D symbols are excellent for teaching purposes. As the screen capture in Google Earth, above, shows, plotting in 3D is excellent for understanding the relationship between the measurement and the 3D geology depicted in Google Earth. It is also useful for identifying anomalous strikes and dips — that 70° dip looks suspect to me!

If you use this option, *please reference Blenkinsop, T.G., 2012. Visualizing structural geology: From Excel to Google Earth. Computers & Geosciences 45, 52–56.*

### *Printing*

Stereonet 9.5 has a very basic printing routine which will print the graphics in the Plot pane, again using .EMF quality graphics. At present, the graphic is printed at the size it appears on the screen unless it is larger than 7 inches, in which case it is shrunk to fit the screen. The default size of the graphics window produces a stereonet that just fits on one page. The text in the Analysis Window / Pane is automatically added beneath the stereonet. On the Mac OS X, you can print to PDF as you can in other programs, however, the pdf that is produced by the save plot as pdf command is higher quality than that saved from the print window.

## **Interactive Features**

- Whenever the mouse moves over the stereonet, the trend and plunge at the tip of the cursor is displayed in the lower left corner
- Clicking and dragging the mouse inside the stereonet temporarily displays a great circle whose pole coincides with the tip of the cursor.
- When “Enter with mouse” is checked under the Data Menu, you can enter data by clicking and dragging the mouse inside the stereonet. Hold down the Shift Key to enter Lines; hold down the Alt Key to enter Planes.
- Clicking on a data point in the stereonet selects the corresponding row in the data table and vice versa. Multiple, noncontiguous selections are possible
- Changes made in the Inspector are instantly reflected in the plot

## **Version History**

Version 9.5.0 — 2016.01.03 (Happy New Year!)

- Major new feature: Plotting applied to lines — contouring, cylindrical best fit, continual best fit and mean vectors — can now be turned on or off on a per data set basis. For example, in a file with three lines data sets, you can now choose to contour only the second set, while continuing to display

scatter plots of the other data sets. In the plot menu, the contouring, cylindrical best fit, continual best fit and mean vector menu choices all now have submenus where you can choose: All data sets (to turn on the, say, mean vector of all data sets), no data set (turn off plotting mean vector for all sets), and a separate menu entry to toggle on or off each individual data set depicting the same name as is shown in the Data Sets list box. The All Data Sets submenu choice functions exactly as the main menu choice in previous versions of Stereonet and has the same key command assigned to it.

- New binary file format — to accommodate the new plotting granularity, I had to implement a new binary file format. The new version of the program can read old file formats, but old versions cannot read the new format. However, Stereonet can now save a binary file in the previous version (back to v. 8.8) for those of you who need backwards compatibility with colleagues/students who have not yet updated. To do so, hold down the Shift and Option (Mac) or Alt (Windows) Keys while choosing File>Save...
- The choice of Kamb or 1% Area contouring has been moved to the top of the Contours tab of the Inspector palette. This was necessary to make the submenus in the Plot menu consistent. A benefit of this move is that your contouring preference is now saved when you set the Preferences for the app.
- Printing from the File menu now correctly scales the plot for the page so that none of the symbols are distorted. Note that, although you can use File>Print to save a PDF, the File>Save as PDF will produce a higher quality graphic. The most versatile vector graphic format is File>Save as SVG, if your graphics program supports scaleable vector graphics (all web browsers support SVG and from the web browser you can export PDF if you need to do so). Click [here](#) to see an SVG file rendered in your browser.
- Several bugs fixed. Probably lots of new bugs introduced with the above changes. I breathlessly await your reports

Version 9.3.3 — 2015.11.28

- Fixed obscure crashing bug that would happen when a lines data set had no points checked.
- PDF and SVG files now follow the specifications set in the Inspector regarding the symbol and color used for the mean vector and Bingham axes (thanks, Alex!)

Version 9.3.2 — 2015.09.03

- Fixed a bug that would cause a crash when you chose Edit>Copy All Data and then chose Edit>Paste Into Data Set

Version 9.3.1 — 2015.06.03

- Corrected a bug where small circle data would not display correctly
- The mean vector arrow on rose diagrams is always drawn using the rose diagram color (not the data set color) set in the Inspector.

Version 9.3.0 — 2015.05.13

- Major improvements to the Rose diagram functionality, including:
  - Scale the petals by either length or area (new). Only length was possible before
  - Calculation of the mean direction for axial data (i.e., data with no directional significance). this is sometimes referred to as Krumbein's (1939) mean
  - Half circle rose diagrams always show Krumbein's mean; full circle diagrams can either depict vector azimuths or, if "treat data as axes" is checked in the Inspector, the full circle diagrams will be symmetric (this has been a highly requested feature that I've resisted until now!)
- Addition of a Von Mises Distribution option to the Calculations menu which displays the same 2D azimuthal statistics as the Rose diagram displays. The program now calculates the circular variance, kappa, and 1 sigma standard error for azimuthal data.
- Plots with polar grids can now be saved as .pdf and .svg files
- Fixed a bug that occurred when planes were being entered in "DD" format and the data details window was opened.

Version 9.2.3 — 2015.02.16

- Corrected a bug that where the equator of the stereonet grid (EW line) would not be drawn in pdf and svg files if the grid was set to 10°.

Version 9.2.2 — 2015.01.31

- Corrected a bug that would cause Stereonet to crash if a data set required more than 100 contour levels (Thanks to Al L.)

Version 9.2.1 — 2015.01.18

- Corrected a bug in reading the notes fields when importing a "Lines & Planes" text file

- Corrected a bug in saving data that were imported using "Lines & Planes" (Thanks to Gordon W. For helping me track this down)

Version 9.2.0 — 2014.08.18

- View>Hide Unchecked Values removes the unchecked values in the data listbox from view.
- The Search Window remembers your last search and automatically selects the same box.
- File>Save Plot as PICT/EMF has been disabled (again) because of a still unfixed bug in the compiler I use. The only workaround is to use PDF or SVG format output (these are higher quality than PICT/EMF, anyway...)
- Bug fixes...

Version 9.1.1 — 2014.07.19

- Data>Batch Annotate now has a Find and Replace panel so you can batch replace any text in the Notes field for multiple observations
- Rose diagrams now show the number of observations. Also cosmetic changes to rose diagram
- Stereonet now remembers selected search criteria between searches
- Corrected a bug that occurred when pasting data into a data set where the copied data had return characters in the notes field (those are now replaced with semicolons)
- Fixed a rare crashing bug when changing the contour interval in the Inspector (e.g., completely erasing the old interval value before entering a new value)

Version 9.1.0 — 2014.05.29

- New Data>Batch Annotate command for adding the same annotation to the Notes field of multiple observations all at once
- Text file and clipboard parsing dialog now allows one to add multiple columns to the Notes field by adding comma or space separated column numbers to the new combo box for the notes field. Each column added to the notes field is put on a separate line of the notes field.
- The Search dialog now permits you to add the found matches to the existing checked data so you can sequentially add two subsets together.
- Stereonet now correctly reads numbers entered in non-U.S. formats. It will use the number format specified in the user's system preferences.

- A minor crashing bug — when the user tried to quit the program when there were no open windows — has been fixed
- Fixed a bug in reading the old Stereonet v. 6 rake format text files ("RK")
- Fixed cosmetic issues with reading in the text record from a stereonet binary file.

Version 9.0.6 — 2014.04.18

- A few bugs associated with deleting data sets squashed (hopefully).
- Stereonet now checks the screen size and forces the window to be smaller than the maximum screen size, even if a larger window size has been saved with preferences

Version 9.0.4 — 2014.03.18

- The Parse Clipboard text dialog no longer appears when Using Edit>Copy All Data and then Edit>Paste into Data Set to move data from one data set to another within the program
- In the Data Details window, up-down arrows have been added next to the datum number text box, allowing one to step easily through a data set, one datum at a time.
- A bug changing scale in the extended KML export dialog box has been fixed with other minor cosmetic fixes as well.
- The ability to import Stereonet v. 6 files in the old "PQ" format (lines in quadrant format, e.g., 45 N 27 W) has been restored.

Version 9.0.3 — 2014.02.11

- Several small cosmetic bugs related to deleting a data set while contouring is turned on have been quashed.
- Choosing Data>Enter with Mouse will display a small notification in the upper right hand corner of the Plot canvas. This notification also includes a reminder about what key to press when clicking the mouse to get lines or planes. This notification is NOT saved with the plot.
- The angle between two clicked points window now displays the line and, if you are working on the second line, the angle between lines as you drag the mouse around. This is particularly useful in conjunction with Enter data with mouse: you can, for example, click one point along a great circle then click and drag the mouse the exact angular distance along the great circle and when you release the mouse, if you are holding the shift key



down, the program will plot the second point the specified distance from the first.

Version 9.0.1 — 2014.02.06; 9.0.2 — 2014.03.05

- Corrected a bug that would cause Stereonet to crash under certain contouring conditions. Thanks to Mario Sánchez Gómez for help tracking down the bug.
- Corrected a bug reading the Preferences file in versions 8.9.5 and higher. Stereonet 9.0.2 will write a brand new preferences file called "Stereonet9Prefs.txt" to the appropriate location the first time you run it. If you have made changes to the default Preferences, you will need to set them again and save them via the preferences dialog. Thanks to Myra Keep for helping to track this one down.

Version 9.0.0— 2014.01.28

- Added two new color contouring options to choose from
- Corrected numerous cosmetic bugs that reared their ugly heads when a contoured diagram had the size of the stereonet changed.
- Contouring now works correctly when the view direction is changed from the default

Version 8.9.5, 8.9.6— 2014.01.24

- Happy New Year update — only one new feature but it is a big one...
- Contour Fill! Contours can now be filled with either a monochrome or a rainbow set of colors and plotted with or without contour lines. The contour fill can be made partially transparent and multiple datasets can be plotted on the same diagram. You can still plot just contour lines.
- some menu items have been disabled at start up if there are no data sets entered as selecting them in that condition could cause a crash.
- copyright updated to 2014 :-)
- v. 8.9.6 corrects some screen refresh issues related to the new functionality

Version 8.9.2— 2013.11.24

- Added a new planes format: "DR" which allows one to specify planes as Dip Azimuth and dip (e.g., 242/56) in addition to the already existing "DD" format (e.g., 56/242)
- If you specify either DD or DR formats, the Data Details window will now show your planes orientations in those formats rather than in Strike and Dip.

- Added a checkbox to the Inspector to specify a polar grid using either equal area or equal angle (without changing the view direction)
- Fixed a bug that caused crashes when using two planes calculations.
- Fixed a bug that caused the “Set Stereonet Radius” (under the View Menu) to work incorrectly.
- The trend and plunge display in the plot pane was not showing the correct values when the view plunge was not vertical; this has been fixed
- Disabled the Save Plot as PICT/EMF command as several functions that were used have been deprecated and cause crashes on modern systems. It may or may not be reinstated in the future...

Version 8.9.1— 2013.11.14

- Stereonet’s help file is now accessible from the new Help menu
- The Mac version of Stereonet is now code-signed with my own developer certificate from Apple which means that the first time you run it, you no longer have to go through the process of right-clicking on it as described in the text in the upper left of this page.

Version 8.9.0— 2013.10.21

- You can now import old Stereonet v. 6 format files that used the QD format (e.g., N 60 W 45 N). Stereonet does not save data in this format, but this should help people with legacy files
- The zoom slider for the Google satellite view in the data details window has now been moved to one side, allowing Windows users to see it, perhaps for the first time! Windows users still do not see the strike and dip (or trend and plunge symbol) that is seen on Mac versions of the program. Sorry...
- You can click the label for the elevation field in the data details window to retrieve the elevation of the datum from the MapQuest elevation server and will overwrite whatever is already in the elevation field. Any previous values are written to the Notes text area of the Data details window.

Version 8.8.9 — 2013.08.28

- Kml symbols can now be output as 2D symbols, which of course, are only useful if you are looking straight down in Google Earth
- More bug fixes

Version 8.8.8 — 2013.08.06

- More bugs related to reading old Stereonet v. 6 format files corrected. Other bugs also squashed.

Version 8.8.7 — 2013.07.27

- Corrects a bug reading a data file in AD format using commas as delimiters where the quadrant was given as two letters (e.g., "SE") rather than just one ("S").
- Corrects a bug that would cause a crash when reading more than one Stereonet v. 6 format data files.

Version 8.8.6 — 2013.07.04

- Added a horizontal splitter between the data sets and the data list boxes on the right hand side of the Window so that you can resize their heights
- Fixed a bug that occurred when deleting a data set
- Fixed a bug where lines entered as rakes could not be selected by clicking on them in the stereonet
- Cleaned up some of the code which could, of course, introduce interesting new bugs!

Version 8.8.5 — 2013.06.25, rev. 2013.06.27

- cosmetic glitch with the Windows splash screen fixed -- not worth changing the version number so download it again if you downloaded in the last few days.
- A recently introduced version broke the import of Stereonet 6 text files. This has now been fixed
- Stereonet now quits correctly on Windows when you close the last remaining open Window
- Tabbing order through dialog boxes has been improved

Version 8.8.4 — 2013.05.13

- corrected a bug in the Edit>Paste into data set routine that was introduced by the new compiler
- corrected a bug in the expanded KML save dialog box that you get when you hold down the shift key while choosing that option. Also added more options for using your own kml symbols.
- Changed the splash screen

Version 8.8.3 — 2013.05.13

- Option-dragging on a text annotation will duplicate the annotation

- Compiled in a new compiler with minor interface changes
- Corrected another crashing bug related to Calculations>Poles and Calculations>Planes from Poles that occurred when no other lines (or planes) data sets were present

Version 8.8.2 — 2013.05.13

- Corrects a crashing bug in Calculations>Poles and Calculations>Planes from Poles that was introduced in v. 8.7.5. If you have downloaded v. 8.7.5 or 8.8.1 please replace them with this version.

Version 8.8.1 — 2013.05.30

- Text annotations — Select Edit>Annotate Plot, click on the plot where you want the text to begin, enter your text and specify color and size if you want and your done. You can reposition existing text annotations simply by clicking and dragging then in the plot pane. Handles occur on either side of the annotation during the drag operation. Viewing annotations can be toggled on or off with Plot>Text Annotations, and annotations can be deleted with Edit>Delete All Annotations. Annotations can be up to 64 characters long. When you right- or control-click on an annotation, you will get a contextual menu which will allow you to edit or delete just that annotation.
- New binary file format — the addition of text annotations has required a new binary file format. Stereonet 8.8 can read all older binary files; older versions will NOT be able to read Stereonet 8.8 binary files. Sorry...
- Menu options pertaining to particular types of data sets are only enabled if that type of data actually exists. For example, if there are no Lines data sets, Plot>Lines will be grayed out and you will not be able to select it.
- The usual bug fixes...

Version 8.7.5 — 2013.05.16

- Drag to reorder the data sets in the Data Sets list box (upper right corner)
- Improvements to text parsing (via files or the clipboard) so that Stereonet will work better with files generated by GeoID iPhone app
- You can now copy complete data sets to a new or different document by selecting the dataset in the first document, choosing Edit>copy all data then pasting it into the second document with Edit>Paste into data set
- Fixed bug in parsing comma separated values.

Version 8.7.0 — 2013.05.01

- Half circle rose diagrams now work. Use the checkbox in the Analysis tab of the Inspector
- New menu option to clear the plot: Plot>Clear Plot
- Cosmetic improvement to drawing 2° grids
- Fixed some glitches writing the Rose diagram results to the text analysis area.

Version 8.6.6 — 2013.04.11

- Two planes calculations — line of intersection, acute and obtuse bisectors, and angle between planes
- Convert to Lower hemisphere — new command to force all data to be in the lower hemisphere. To protect you from yourself, this command creates a new data set rather than overwriting the old one
- You can now see the data for an unchecked, but selected, data set.
- Several graphical glitches concerning the plotting of mean vectors have been fixed
- Rose diagrams are only plotted when the traditional view direction is used (looking straight down on the lower hemisphere)
- The four add data sets buttons ("L", "P", etc.) were getting out of hand so they have been replaced with a single drop-down menu.
- v. 8.6.6 corrects a minor bug in the convert to lower hemisphere routine that was introduced in the short lived v. 8.6.5

Version 8.6.0 — 2013.03.24

- Lasso selection now works (but only for lines). You can have it select either those points inside or outside the lasso.
- New data type: Arcs. Arcs are segments of great circles that are drawn between a starting point and an ending point that you define by entering the trends and plunges of the corresponding lines. Arcs can cross the primitive and you can choose whether to plot the acute or obtuse angle. You can also specify that the program should draw an arrow head at either the start or the end of the arc (or both)
- Redesign of the Data Sets tab of the Inspector. Now you only see data pertinent to the selected data set. You can select the data set from the popup menu in the Inspector or by clicking on it in the Data sets list box.

- Fixed (hopefully) a bug with copy and paste on Windows version of the program

Version 8.5.1, 8.5.2 — 2013.03.06

- Stereonet is now "document based" meaning that you can open as many different windows with different plots in them as you want.
- When you start up the program, the About box is now displayed; you should select either the new blank file button or the open file if you want to open a Stereonet binary file. At any time, you can choose File>New and a new blank window will appear; likewise, file>open allows you to open another file while leaving the first one open as well.
- You can now copy and paste data! Select some rows in one data set and paste them to a different data set in the same window or to a dataset in a completely different window. You can also copy any tab delimited data from any text file (Including an Excel spreadsheet).
- if stereonet doesn't recognize the format of data on the Clipboard, it will present you with a dialog box so you can tell it how to parse the clipboard data. Use Edit>Copy all data to include the data that only shows up in the Data Details Window. To paste into an existing data set, you have to use Edit>Paste into Data Set.
- KML export of geographically registered 3D strike and dip and lineation symbols for plotting in Google Earth (thanks to Tom Blenkinsop and Nestor Cardozo for the idea). Click [here](#) for an example. If you use this option, please reference Blenkinsop, T.G., 2012. Visualizing structural geology: From Excel to Google Earth. Computers & Geosciences 45, 52–56.
- Bug fixes related to not saving the conical best fit with the plot

Version 8.0.4 — 2013.02.14

- Data entry by mouse was broken and is now fixed
- Conical best fit now uses the approach outlined in Mulchrone et al. (2013) so that it now works more reliably in the lower hemisphere [oops, not exactly, I'm still working on this.]
- Other bug fixes and improvements

Version 8.0.2 — 2013.01.24

- Fixed various issues related to rake format ("RK") and rake preferences selection, including a rotation bug



- Fixed window rewriting problems when setting the stereonet size from View>Set Stereonet Size.
- Details window now has a "2x" checkbox that will enable you to double the size of the satellite image/ map

Version 8.0.1 — 2012.11.23 (counter reset)

- Corrected a crashing bug in the Analysis tab of the Inspector when only planes were entered
- Added a character count to the Notes field in the Details Window so you can tell when you are getting close to the 512 character limit for that field. Character count turns red when you exceed 512 characters

Version 8.0.0 — 2012.10.20

- Major feature: Plotting lines or planes on Google satellite, terrain, or roadmap imagery by choosing Window>Data Details
- New native data (binary) format now includes location information plus free form notes field where you can write anything about a datum in 512 characters or less.
- Ability to parse any column oriented text file — particularly useful for entering location data.
- Axial plane finder in Calculations menu provides basic fold geometry analysis.
- Angle between clicked points now shows trend and plunge while clicking.
- Fixed a bug in adding new data to existing data sets.

Version 7.3.6 — 2012.09.23

- The Mac OS X version of the program is now a native Cocoa app with a more modern interface rather than the Carbon app as previously.
- Corrected a bug in the angle between two planes routine
- Corrected a bug introduced in previous version related to saving a new default window size from preferences
- Disclosure triangle/ arrows now behave in a more "standard" manner

Version 7.3.5 — 2012.09.18

- Scans can now be repositioned by dragging them within the plot window by selecting Edit>Drag Image
- Return of the Apparent Dip Calculator! You can use lines or a plane selected in an existing data set, or you can enter new values directly into the di-

alog box. The results can be written to an existing data file or a new data file for plotting. The Apparent Dip Calculator is a floating window that you can keep open if you have a lot of calculations to do.

- Default height of the main window has been reduced to 640 pixels to accommodate users who prefer to keep their screen resolutions at low values (e.g., to increase the size of text on their screens). This will hopefully avoid the artifact that cause the text box to overwrite the bottom of the plot area. You can still resize the window to larger sizes once the program has been opened.
- To compensate for the smaller initial main window size, a new check box in the Preferences dialog, "Set current window size to default", will allow you to have set the initial size of the window to whatever you want.
- Removed Plot Planes as Poles option. It was confusing too many people, particularly when they couldn't do a cylindrical best fit. Now, if you have entered planes and want to plot poles, you will have to choose Calculations>Poles first (which was the original behavior of the old Stereonet. If it turns out that LOTS of people loved plotting planes as poles without calculating poles first, I'll consider reinstating it.

#### Version 7.3.0

- New Feature — import scans of existing stereonet plots, and overlay beneath the live stereonet in the program. You can use this to compare your data to published data or, in combination with Data>Enter with Mouse, you can extract digital values from published stereonets. Scans can be imported as pdf, tiff, png, or jpeg formats. New Plot menu option allows you to show or hide a scan.
- New Feature — SVG (scalable vector graphics) output option for your plots. .svg is an open, high resolution graphics format that can be read by most modern graphics programs. Unlike other graphics output options in Stereonet, .svg saves small and great circles as open polygons rather than separate line segments for ease in touching up plots in graphics programs. Both .svg and .pdf options are higher resolution than the emf/pict format.
- Bug fixes related to window display.

#### Version 7.2.4 — 2012.02.21

- Mac version of Stereonet 7 posted for those who need a Carbon program that works on Mac OS X operating systems older than 10.6 or for those who need compatibility with the Stereonet 7 for Windows binary file format. For Mac users who have Mac OS X 10.6 or higher installed, I still rec-

commend [OSXStereonet](#). Also posted the Linux version of the program as I have had a few requests for one of those.

- Corrected bugs related to deleting a data set or an individual datum from a data set
- Fixed the default setting for Bingham axes to plot all three axes plus the great circle. (The program was defaulting to plotting only the largest principal axis)
- Deactivated the maximize button in the main window as it was not stretching the window elements correctly. You can still resize the window to whatever you want by dragging the edge/corner of the window.
- When no data sets are selected in the data sets listbox, no data will be displayed in the data listbox.
- Added several informational dialogs:
  - If a user tries to delete a data set, they are warned that it is undoable and they have the option of canceling
  - If a user tries to do a cylindrical best fit when only planes have been entered they are now advised that they must calculate the poles first as cylindrical best fit only works on lines data sets. Users have been confused because of the option to plot planes as poles.
  - If a user tries to rotate a "selected" data set but no data set is selected in the data sets list box.

Version 7.2.3 — 2012.01.11

- Now uses GDI+ for anti-aliased (i.e., smoother) drawing to the screen.
- Copyright updated to 2012 :-)

Version 7.2.1 — 2011.11.18

- Variable rotation by unfolding beds. Choose a lines or planes data set, then select the data set that contains bedding where the observations were made, and click Okay. each datum will be unfolded by rotating the corresponding bedding back to horizontal.
- Rose diagrams for planes: If the planes format is "AD" or "AZ" the rose diagram will be based on the strikes of the planes; if the format is "DD" the rose diagram will be based on the dip azimuth rather than the strike azimuth.

Version 7.2.0 — 2011.11.07

- Major new features: enter data with mouse by clicking and dragging inside the stereonet.
- Fixed bug where window not resized correctly when reading in a binary file
- Fixed bug where program tried to draw error cone even when normalized mean vector length was  $<0.65$

Version 7.1.6 & 7.1.7 — 2011.10.26

- Planes can now be drawn as either solid or dashed lines
- If only rose diagrams are showing, the equal area angle grid is not displayed. Instead equally spaced concentric circles, at either 5 or 10 percentage intervals, and spokes at  $10^\circ$  intervals are drawn and labeled as a scale for the rose diagram. This happens automatically and only when rose diagrams and nothing else are displayed. The value at the primitive is controlled by the entry in the Inspector Analysis tab.
- The outer edge of rose petals are now drawn as an arc rather than as a single straight line segment, which is much more attractive!
- Plot mean vector on rose diagrams has been enabled
- Fixed some interface bugs related to showing or hiding the data panels
- Significantly speeded up selecting tabs in the Inspector -- Yay!

Version 7.1.5 — 2011.09.12

- You can now hide the data set list and data list panes by toggling a disclosure triangle or from the Windows Menu. This makes the overall window narrower, which might be of help for people on small screens or if, for some reason, you want to hide the data.
- Various optimizations to improve performance selecting from the Data set list. The Inspector also appears more rapidly, though selecting tabs remains sluggish (sorry...)
- Fixed a bug where reading in a binary file that was saved with a view plunge of 90 degrees would be read in with a view plunge that wasn't exactly 90 degrees
- Fixed a bug associated with calculating poles from planes and planes from poles
- Planes can now be visualized as great circles and poles simultaneously

Version 7.1.2 — 2011.09.12

- Cylindrical best fit now draws the best fitting plane and writes its orientation to the Analysis text pane,
- When you add a new data set, the appropriate plot type is automatically selected so you see your data plotted as you enter it. E.g., if you select new lines, Scatter will be turned on in the Plot Menu, etc.
- Preferences dialog box has been added to allow the user to set their preferred default data format and stereonet format settings.

Version 7.1.1 — 2011.08.30

- Fixed a bug in the Dip, Dip Azimuth (DD) format for planes. Previous versions did not handle this format correctly
- Added uncertainty calculations to the cylindrical best fit/Bingham statistics
- Disabled pop up menu for planes style in Inspector because those options have not yet been implemented
- minor bug fixes

Version 7.1.0 — 2011.08.21

- Drawing contour lines has now been implemented. You can now do either Kamb or 1% area contouring by selecting one of those options in the Contour submenu of the Plot Menu.
- Contour lines are saved to PDF files and EMF files, they will print, and they are copied to the clipboard with the rest of the plot
- Contours do not yet have a fill pattern. Those options have been turned off in the Contour tab of the Inspector
- Lots of little bug fixes.

Version 7.0.4 — 2011.08.18

- Yet another new binary data format. Previous files will not read in correctly, so I hope that you have been exporting your data as text files!
- Stereonet can now handle input data of lines as rakes (pitches) on planes. To enter a new data set, hold down the shift key while clicking on the +L button. This will cause both a new lines and a new planes data set to be entered. These data sets should have the same name. The two letter format code for such data sets is "RK".
- The format code in the Data set list box has been changed to a two or three letter code, identical to that shown in the table in earlier int eh users manual and as used by earlier versions of Stereonet.

- Changing the format code in the Data set list box will now change the format of the data listing.

Version 7.0.3 — 2011.08.17

- New binary file format. It will read the old format with only minor glitches in the analysis text. Nonetheless, you should re-save all of your binary files.
- Interface for contouring has been put in place (e.g., the Inspector now has a Contours tab) but contouring itself still does not work.

Version 7.0.2 — 2011.08.16

- minor bug fixes and behavior changes
- more predictable Inspector behavior

Version 7.0.1 — 2011.08.15 -- Initial beta release!

Things that are known not to work in this release

- Contouring has not yet been implemented
- Set view direction does not work with latitude-longitude plots. This means that you are effectively limited to viewing continents in the Western Hemisphere
- Conical best fit has not yet been implemented
- Adding lines by their rake in a plane has not yet been programmed
- There is no way (yet) to combine data files, either by appending them to existing data sets or by or by copying and pasting between data sets
- Plotting small circle in the upper hemisphere is broken
- Variable rotation (e.g., by unfolding lines associated with bedding) has not yet been implemented
- Half circle rose diagrams and plotting mean directions for rose diagrams have not yet been implemented
- Refreshing the data listing does not always work. You may have to click on the data set again to refresh the data listing
- There is no way to control the format of the data listing at present
- There is currently no way to parse an unidentified text file that does not start with the standard two character header from earlier versions of Stereonet.



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