

Got a video or model you want to analyze? Awesome! Here's how to get data from it.

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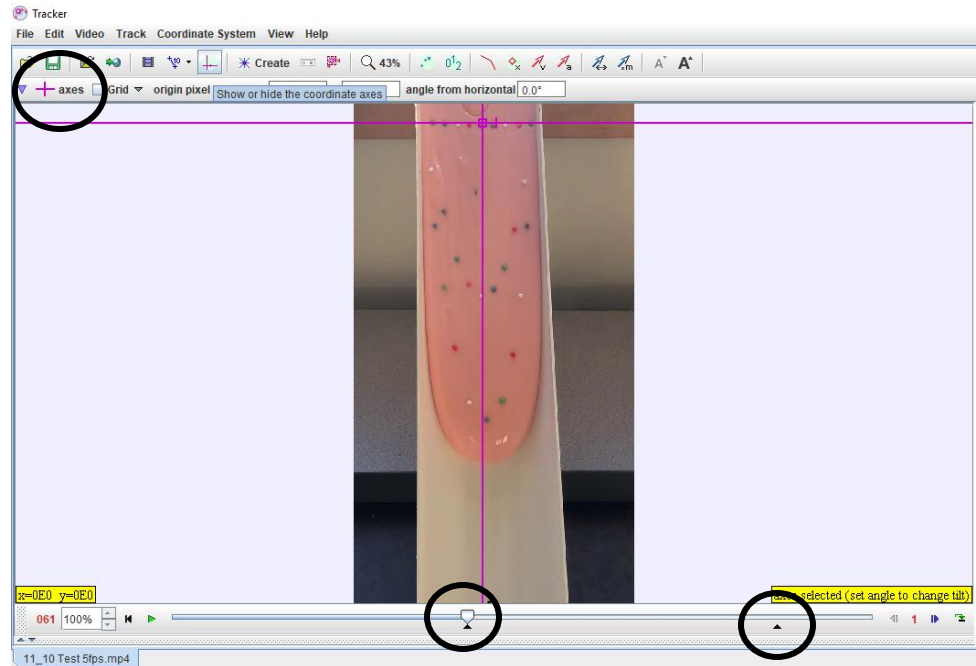
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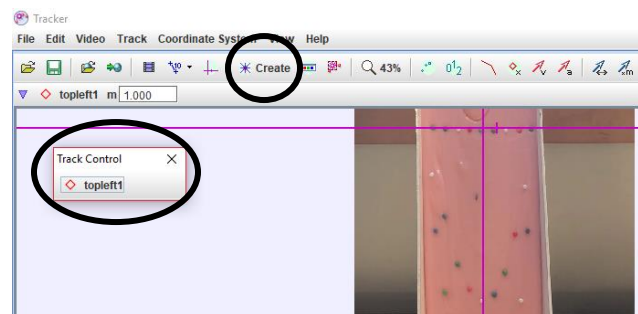
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## Tracking Points from a Movie in Tracker

- 1) Download Tracker: <https://physlets.org/tracker/>
- 2) Open the video in Tracker
- 3) You can select a specific starting point for the video using the small black triangle under the time bar. I would suggest starting somewhere in the middle where there are few frame breaks, glares, bubbles, etc. You can choose an ending point the same way.
- 4) Set coordinate axes for your points to be based off (the icon with the two intersecting pink lines). I like to set the axes for the center and top of the glacier, but you can choose what makes the most sense for representing your data.



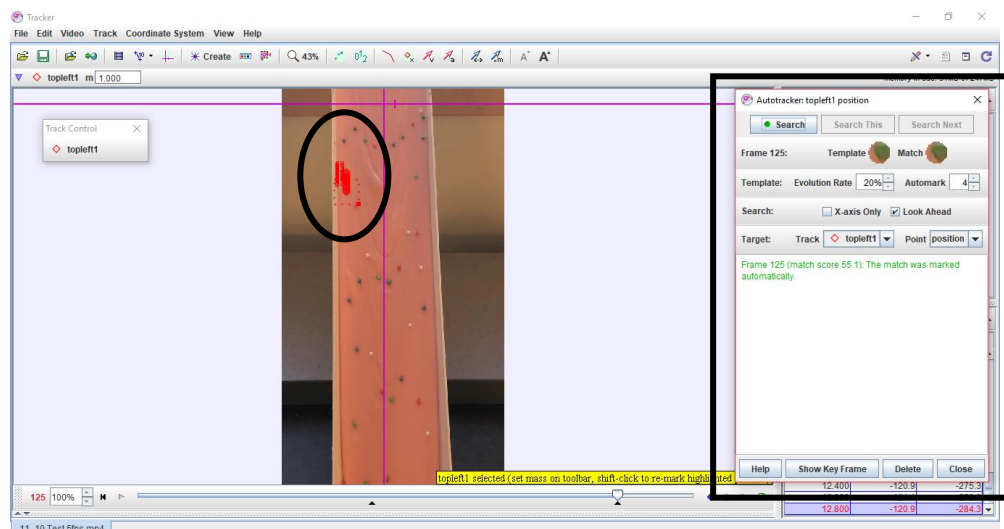
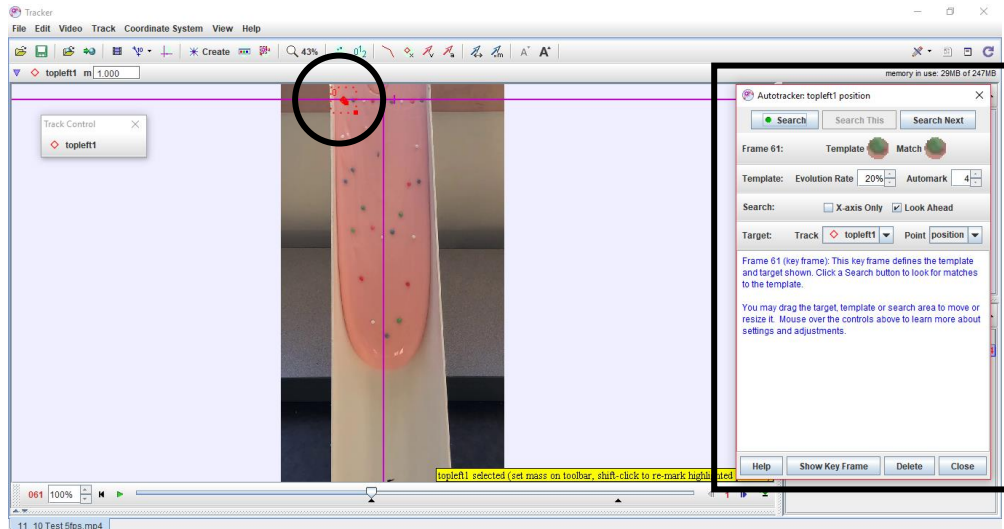
- 5) Choose what points you want to auto-track. I would suggest all the top row and several from the bottom of the frame as well to get a robust dataset from all along the glacier. To create these tracks:
  - a) Create > Point Mass, then a box should come up with an icon labeled mass A. I would rename this so you have an idea of what/where all your points are. Right click on the mass A label to rename. Here I've labeled it topleft1.



- b) There are two kinds of tracking you can do, manual tracking and autotracking. The difference between these two in terms of selection is all in your keyboard controls. **Note:**

I used this program in Windows, the keyboard controls may be different for Mac or Linux.

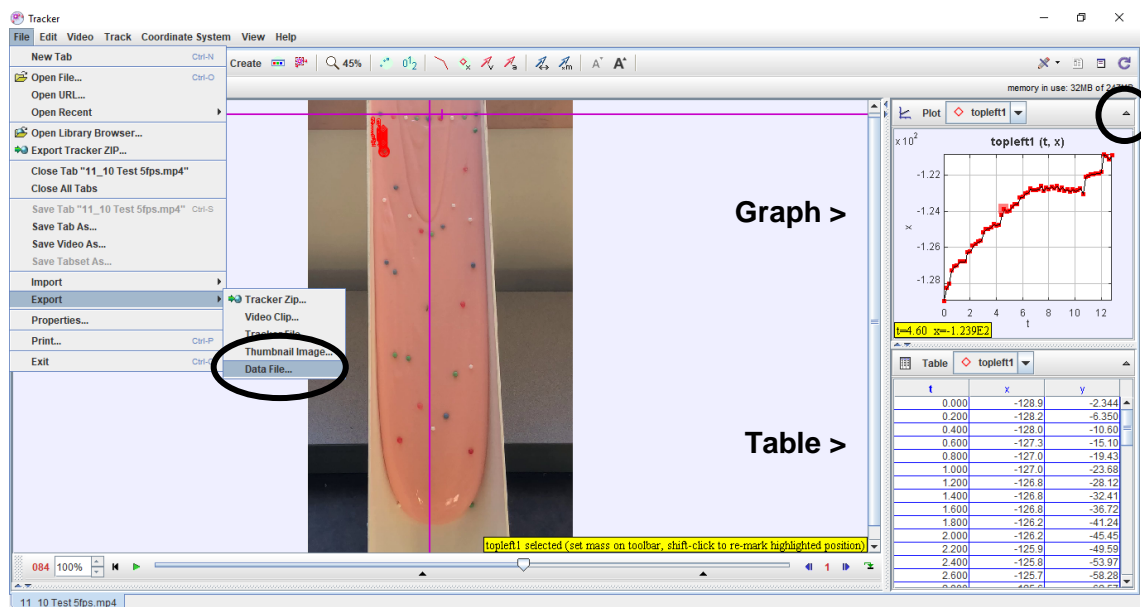
- i) **Manual tracking:** Hold down the **shift key** as you **select a point** on the video. Your mouse cursor should turn into a square to highlight the dot you want to measure throughout the video. With manual tracking, you can select a first point in time, then skip ahead multiple frames to get another position for that same point.
- ii) **Autotracking:** This will generate a large dataset for any points you want and the program does the heavy lifting. Hold down **control and shift** as you **select a starting point** on the video. Your mouse cursor should be a circle now. The autotracker toolbox will automatically pop up with the “template” of the image you selected with your cursor and whether it can find another match or not. On the video, you can see the point outlined by a red dotted box labeled “0” meaning it is the first frame. As you go through the video, each new coordinate pair will be labeled with a consecutive number. If you are satisfied with the starting point you chose, then click the “Search” button and it will track that point through the portion of the video you originally selected.



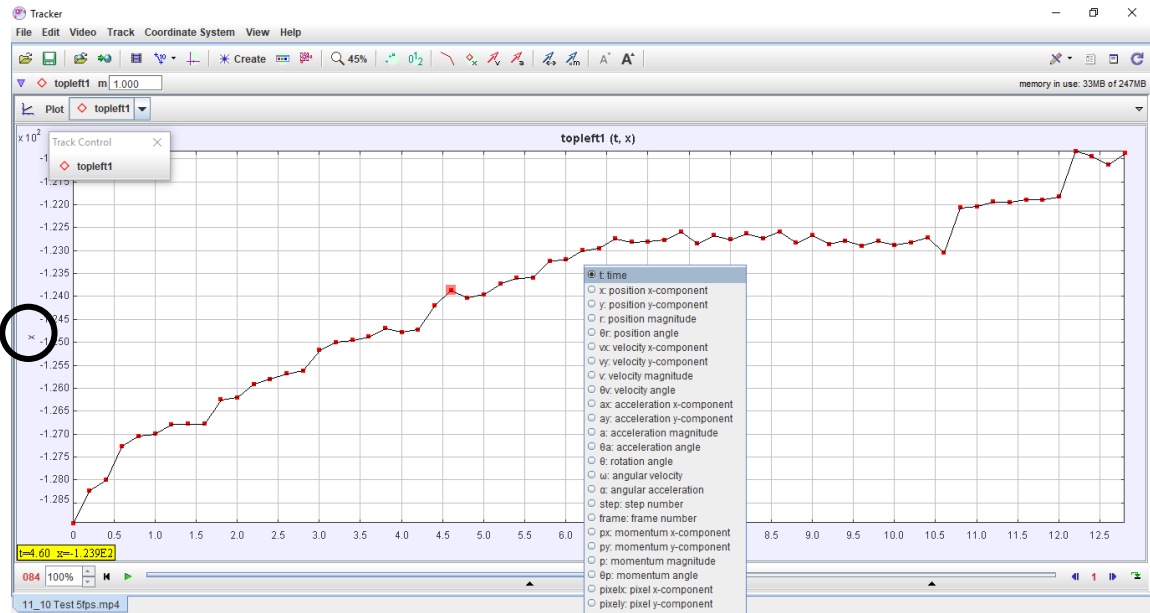
If there are ever any frames where it can't find a match, an error message will pop up in the text part of the Autotracker toolbox asking you whether you would like to accept the match or skip it. Usually, if it gets confused it will be trying to select a point that is on the other side of the video, so I skip it and just make sure to look at that time signal when I am calculating velocities later. You can also manually choose a point for that frame if you want to keep that frame in the dataset.

If you are satisfied with your results, you can exit the autotracker toolbox.

- 6) To the right of your screen you now have two forms of data: your graph and your table. The table has the raw data which you will want to save to an Excel file for analysis in Surfer if that is your route.
  - a) **Saving Data:** File > Export > Data File... > Save As. Make sure you change "cells" from "selected cells" to "all cells" otherwise you will probably only get one data point. This will give you positions and times of a track.
  - b) In Excel, you can combine multiple tracks together to get more data points and divide the change in distance by the change in time between two points to get velocity.



- 7) With the graph, you can expand it by clicking on the triangle in the right corner. In the graph, you can change either axis by clicking on their labels. The default is position versus time, but the software gives you many options to choose from (like velocity and acceleration) and even lets you create your own.



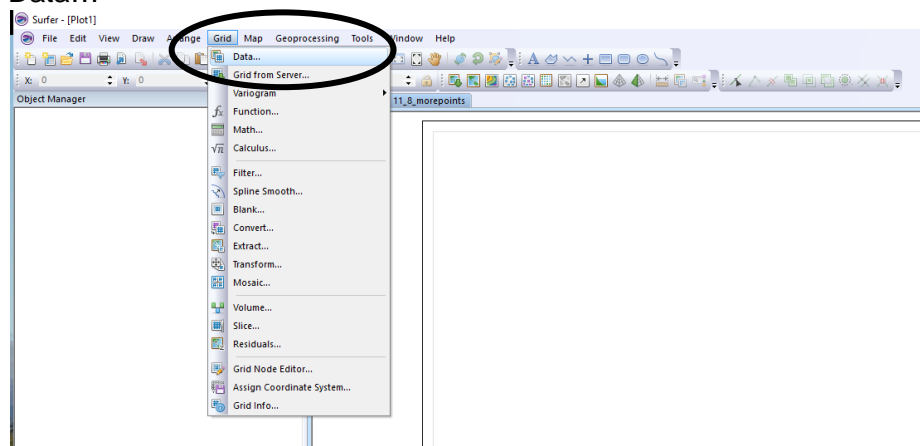
- 8) Make sure you repeat steps 5 and 6 for more data points so you can get velocity across the whole glacier.

## Getting Strain Rates in Surfer 13

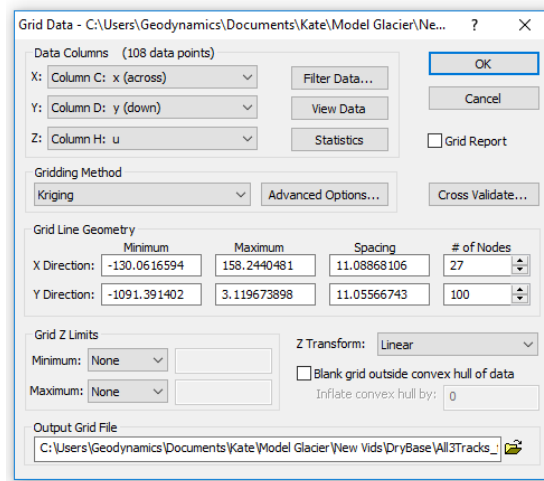
- 1) Use tracker to put an excel file together of the initial positions and velocities

## 2) Gridding Data

- a) Grid > Data...



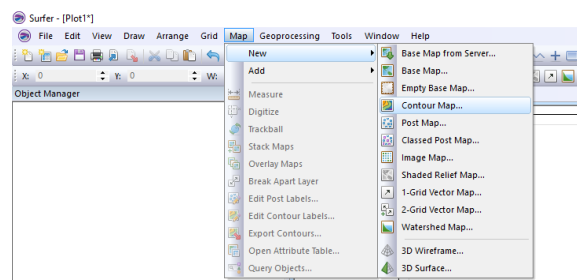
- b) Select the file you are using (your Tracker Excel file), then a box will pop up where you will describe what your grid file will look like.



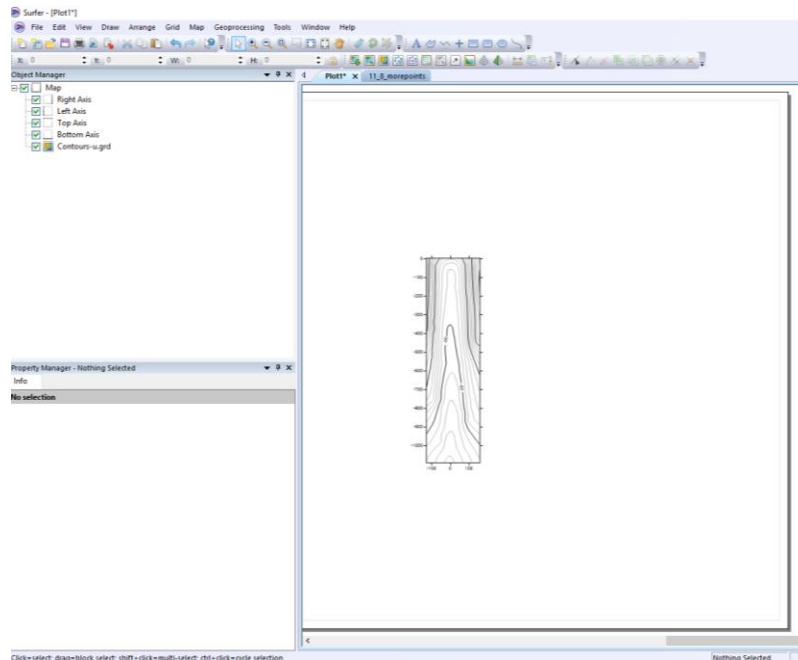
- c) In the Data Columns spot, make sure the x and y pull-down menus match what you want on the two axes. Note: If you are using a glacial coordinate system, it can be a little counterintuitive if we are talking about a glacier flowing from the top of the image to the bottom of the image (“x” glacier flow is actually the y axis and “y” flow is actually the x axis).
- d) Choose Kriging for the Gridding Method
- e) Set the Grid Line Geometry to a little outside your farthest points
- f) # of nodes and spacing depends on how many data points you have. If you only have 5 data points, but select 50 nodes then your generated map will have a fine resolution but all the points in between will just be extrapolated by the program, not actual data (similar to accuracy versus precision).
- g) Make sure to specify the output file name and location so you don’t accidentally write over any previous grids.
- h) Do this for all your velocities (x, y, z). Make sure they all have the same Grid Line Geometry and spacing/nodes or you will not be able to compare the files. I usually screenshot the first Grid Data box before I click ok so I have all the number I input and can use those same number for the next grids.

### 3) Creating Contour Maps

- a) Map>new>contour map>select any of your velocity grids



b) It comes out looking like this

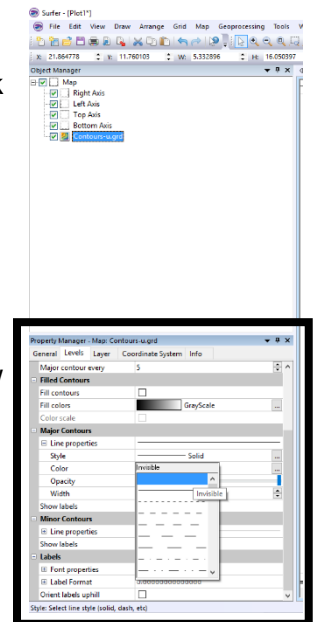


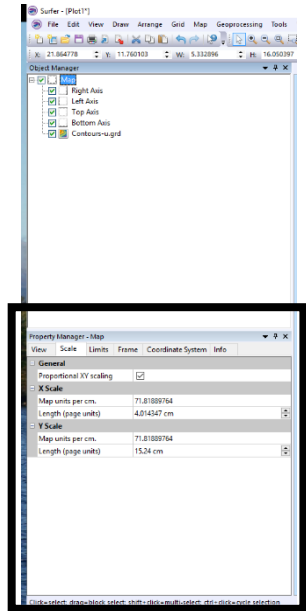
c) To make it more than just a bunch of lines in a rectangle:

i) In your object manager panel (left side), click on the contour map name so it's highlighted. Below the object manager there is the property manager panel, this is where you can change properties of the map.

ii) For color: Property manager>Levels>Filled Contours. Check the fill contours box. Then you can click on the box that shows the grayscale to change the color scheme you want. If you click on the "..." to the right of that you can change the bounds on the colors (making 0 white, changing the maximum and minimum to set multiple maps to the same scale, etc).

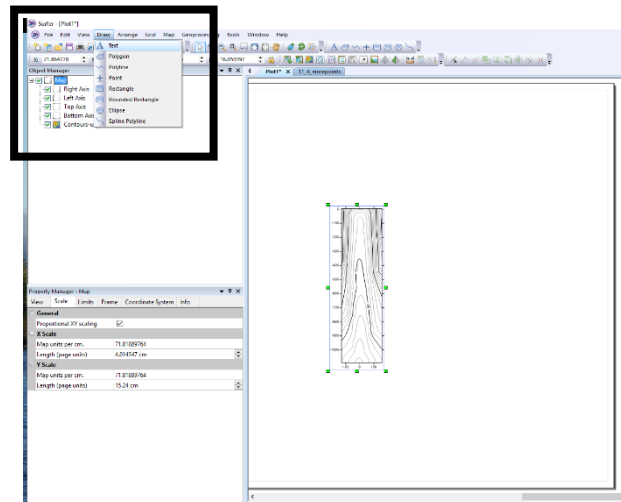
iii) If you just want colors, and don't want contour lines or labels, go to Major Contours and Minor Contours right below Filled Contours. You can uncheck the Show Labels box to get rid of the numbers on your contours. You can also click on the line to bring up a pull-down menu that allows you to change the line type.





iv) You can also change the size of the map while still scaling everything accurately (if you just drag the corner to make it bigger it warps the lettering and numbers on your axes or contour lines). In Object Manager, click on Map so it's highlighted then in the Property Manager click the Scale tab. Here you can change the X Scale and Y scale length. If you don't want it to change one when you change the other, uncheck the Proportional XY scaling box.

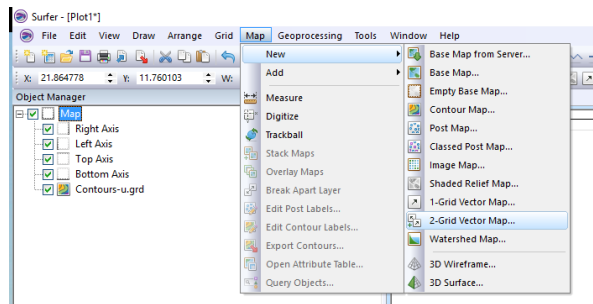
- v) To add text, Draw>Text
  - (1) The text doesn't always change size when you manipulate it in the box that comes up where you are typing the text. My tip is to write the text and then manipulate it with the Property Manager panel.
- vi) In the Draw tab you can also add squares for borders, shapes for legends, etc.



- vii) If you are layering maps and have axes that are in different units or the labels are getting thick, you can uncheck the Right/Left/Top/Bottom Axis boxes in the Object Manager to keep the initial contour (or other) image but not the axes.

#### 4) Creating Vector Maps

- a) Map>New>2-Grid-Vector-Map...

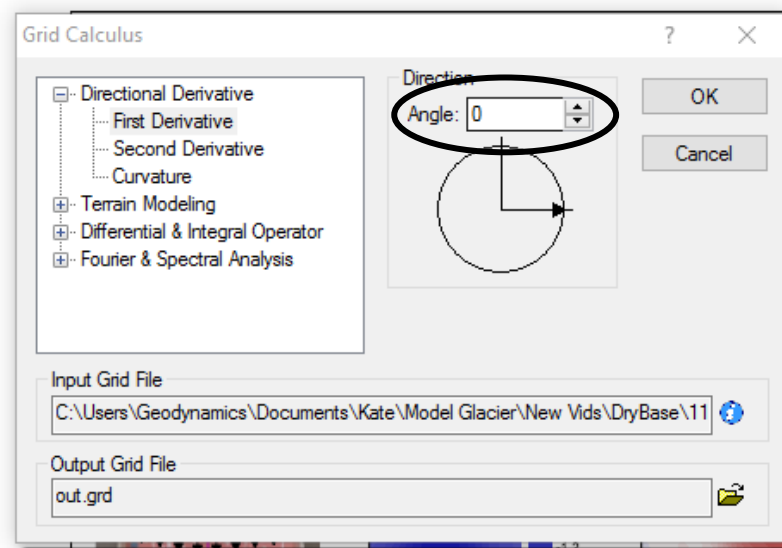




- b) Select your x velocity and your y velocity grids
- c) You will get a map with a bunch of arrows on it. If there are too many arrows to really see what is going on, you can change the frequency of the arrows. Click on the vector map label in the Object Manager and click on the Symbol tab. Under Symbol Properties you can increase the X frequency and the Y frequency. Counterintuitively, the higher the frequency the less arrows will be displayed on your map.
- 5) **Scale Bars:** For any of these maps, if you want a scale bar or reference vectors, you must check the “Color Scale” box in the Filled Contours Section for **Contour Maps**, or the “Show Scale Legend” in Scaling>General for **Vector Maps**.
- 6) **Post Maps:** To superimpose points on top of a contour map (for example GPS points on a velocity contour map) go to Map>New>Post Map and select the (x, y) coordinates you want displayed. In the Property Manager you can change how the icons for the points look.

## 7) Strain Rates

- a) Grid>Calculus> select the file you want to take the derivative of like your velocity grids. First select one then you will have to repeat this process again for the next.
- b) In Surfer, the direction determines what value you are taking the velocity derivatives with respect to. To take a derivative in the x direction (i.e.  $du/dx$ ) the direction angle should be set to 0. If you are taking a derivative in the y direction (i.e.  $du/dy$ ) the angle should be set to 90.



- c) Make sure to specify the output file name and location.
- d) For strain rates you will have 4 grid calculus files:  $du/dx$ ,  $du/dy$ ,  $dv/dx$ ,  $dv/dy$ 
  - i) Principles:  $du/dx$ ,  $dv/dy$

$$Dilation = \frac{1}{2} \left( \frac{du}{dx} + \frac{dv}{dy} \right)$$

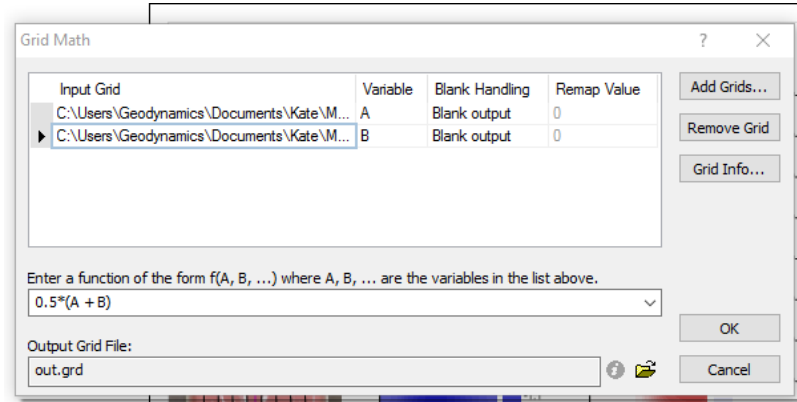
- ii) Shears:  $du/dy$ ,  $dv/dx$

$$Shear\ Strain\ Rate = \left( \frac{dv}{dx} + \frac{du}{dy} \right)$$

$$\text{Vorticity} = \frac{1}{2} \left( \frac{dv}{dx} - \frac{du}{dy} \right)$$

e) Once you have these files, type in the equation you want with those files.

i) Grid>Math



ii) Input the grids you are using

iii) In the function box, type: (A+B), 0.5\*(A-B), etc.

iv) Specify the output file name and location then click ok!

f) New>Contour Map>select the name of the math grid file you just created. The contour map will start out looking like your velocity contour map did, but you can manipulate it in the same way to give it color, change the size, etc. Now you should have a nice image of your strain rates!

