Tutorial 9 – Spatial Interpolation

This tutorial is designed to introduce you to a basic set of interpolation techniques and surface comparisons including:

- Inverse Distance Weighting
- Splines
- Kriging
- Advanced kriging using the Geostatistical Analyst extension
- Setting the extent of an interpolated surface to a shapefile (a.k.a. visual clipping)
- Using the raster calculator to perform mathematical functions between/among whole raster grids (example - subtracting grids).

Before beginning the tutorial, please map the \\geogsv01\classspace\G245S11\LabData and \\geogsv01\classspace\G245S11\L245a or L245b\yourname server folders. The LabData folder contains a folder called L09. In it, you will find an archive called Lab09.zip that contains the data that are needed for this tutorial and exercise 9. COPY the Lab09 archive to your server folder and unpack it.

New York Winter Temperature
The data for this tutorial are average winter temperatures for a series of weather stations in New York State. These data are contained in a shapefile called NYtempsites.

Launch ArcMap and open the NYtempsites map. You might also want to overlay a map of NY State for visual reference and change the projection to something more appropriate (Fig. 1). The attribute table for NYtempsites contains a variable called AveWinT which contains the average winter temperature values (Fig. 2).

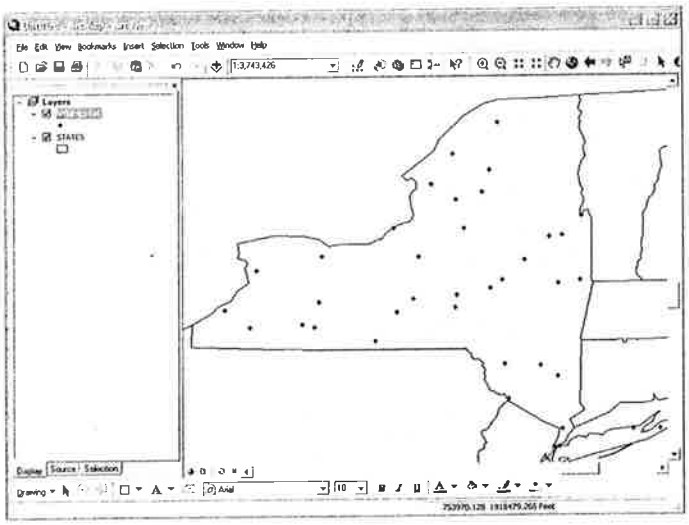
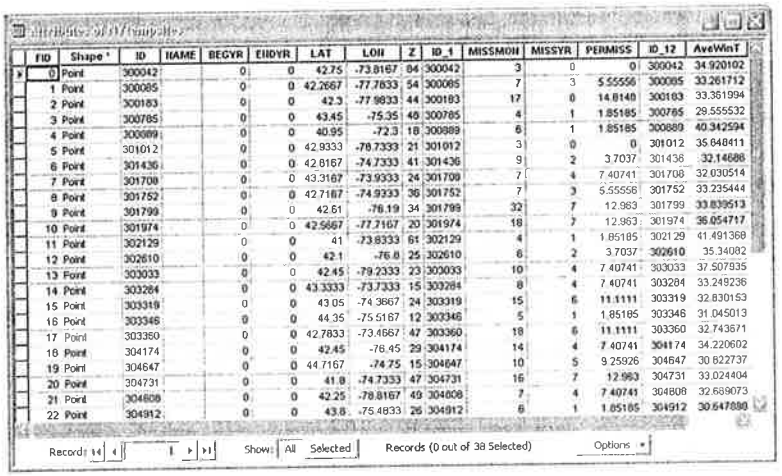


Fig 1

1. Inverse Distance Weighting

Although there are a number of places in ArcMap where interpolation and geostatistical tools are found, we will be relying primarily on the Spatial Analyst dropdown menu. Before starting, make sure you adjust the spatial extent of the spatial analysis output to equal the extent of NYstate. Otherwise, the resulting grid will only cover as far east/west/north/south as the weather data points. To limit the extent to only NY State, you must first create a new shapefile of just New York State (you should know how to do this). With the shapefile of NY in the view, select Spatial Analyst -> Options -> Extent and set to the same as your NY shapefile. Your output will now extend to the east/west/north/south extent of NY.

The inverse distance weighting (IDW) window is accessed using the Spatial Analyst Dropdown -> Interpolate to Raster -> Inverse Distance Weighting (Fig. 3). The IDW window (Fig. 4) gives you options for selecting the variable to interpolate (AveWinT in this case), the distance weighting, and the search options for the sample points. In my example, I used distance squared with the 8 nearest points. I also retained the default grid size. Keep in mind that if you plan to keep the resulting grid you should save it somewhere other than in the temporary space. Fig. 5 shows the resulting IDW grid.



FID	Shape *	ID	NAME	BEGYR	ENDYR	LAT	LON	Z	ID_1	MISSMON	MISSYR	PERMISS	ID_12	AveWinT
0	Point	300042		0	0	42.75	-73.8167	84	300042	3	0	0	300042	34.920102
1	Point	300085		0	0	42.2667	-77.7833	54	300085	7	3	5.55556	300085	33.261712
2	Point	300183		0	0	42.3	-77.9833	44	300183	17	0	14.8148	300183	33.361994
3	Point	300765		0	0	43.45	-75.35	46	300765	4	1	1.85185	300765	29.555532
4	Point	300889		0	0	40.95	-72.3	18	300889	6	1	1.85185	300889	40.342594
5	Point	301012		0	0	42.9333	-78.7333	21	301012	3	0	0	301012	35.648411
6	Point	301436		0	0	42.8167	-74.7333	41	301436	9	2	3.7037	301436	32.14688
7	Point	301708		0	0	43.3167	-73.9333	24	301709	7	4	7.40741	301708	32.030514
8	Point	301752		0	0	42.7167	-74.9333	36	301752	7	3	5.55556	301752	33.235444
9	Point	301799		0	0	42.61	-76.19	34	301799	32	7	12.963	301799	33.839513
10	Point	301974		0	0	42.5667	-77.7167	20	301974	18	7	12.963	301974	36.054717
11	Point	302129		0	0	41	-73.8333	61	302129	4	1	1.85185	302129	41.491368
12	Point	302610		0	0	42.1	-76.8	25	302610	6	2	3.7037	302610	35.34082
13	Point	303033		0	0	42.45	-78.2333	23	303033	10	4	7.40741	303033	37.507935
14	Point	303284		0	0	43.3333	-73.7333	15	303284	8	4	7.40741	303284	33.249236
15	Point	303319		0	0	43.05	-74.3667	24	303319	15	6	11.1111	303319	32.830153
16	Point	303346		0	0	44.35	-75.5167	12	303346	5	1	1.85185	303346	31.045013
17	Point	303360		0	0	42.7833	-73.4667	47	303360	18	6	11.1111	303360	32.743671
18	Point	304174		0	0	42.45	-76.45	29	304174	14	4	7.40741	304174	34.220602
19	Point	304647		0	0	44.7167	-74.75	15	304647	10	5	9.25926	304647	30.822737
20	Point	304731		0	0	41.8	-74.7333	47	304731	16	7	12.963	304731	33.024404
21	Point	304808		0	0	42.25	-78.8167	49	304808	7	4	7.40741	304808	32.689073
22	Point	304912		0	0	43.8	-75.4833	26	304912	6	1	1.85185	304912	30.647888

Record: 14 1 Show: All Selected Records (0 out of 38 Selected) Options

Fig 2

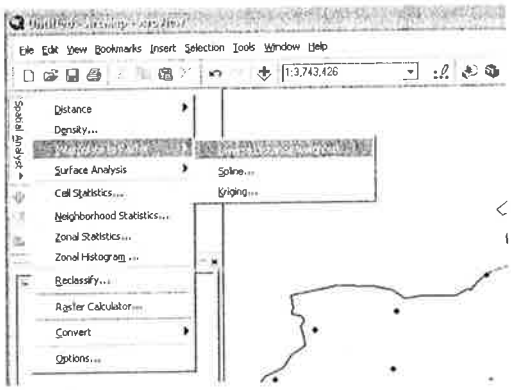


Fig. 3

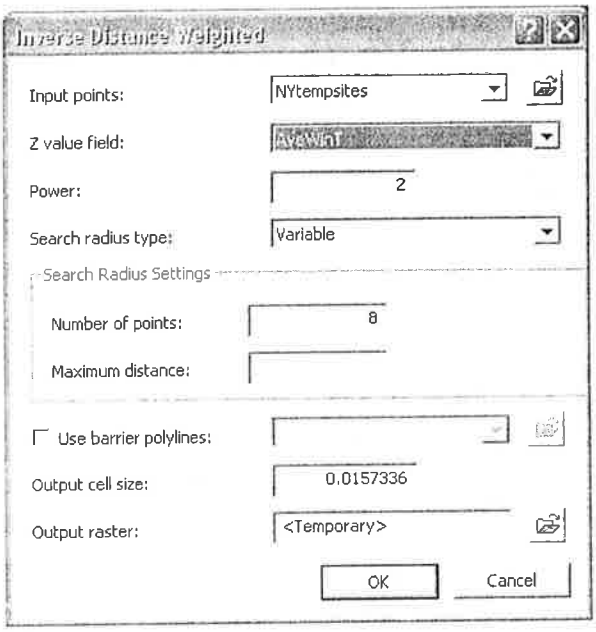

Inverse Distance Weighted
Input points:
NYtempsites
Z value field:
AveWinT
Power:
2
Search radius type:
Variable
Search Radius Settings
Number of points:
8
Maximum distance:
Use barrier polylines:
Output cell size:
0.0157336
Output raster:
<Temporary>
OK
Cancel

Fig. 4

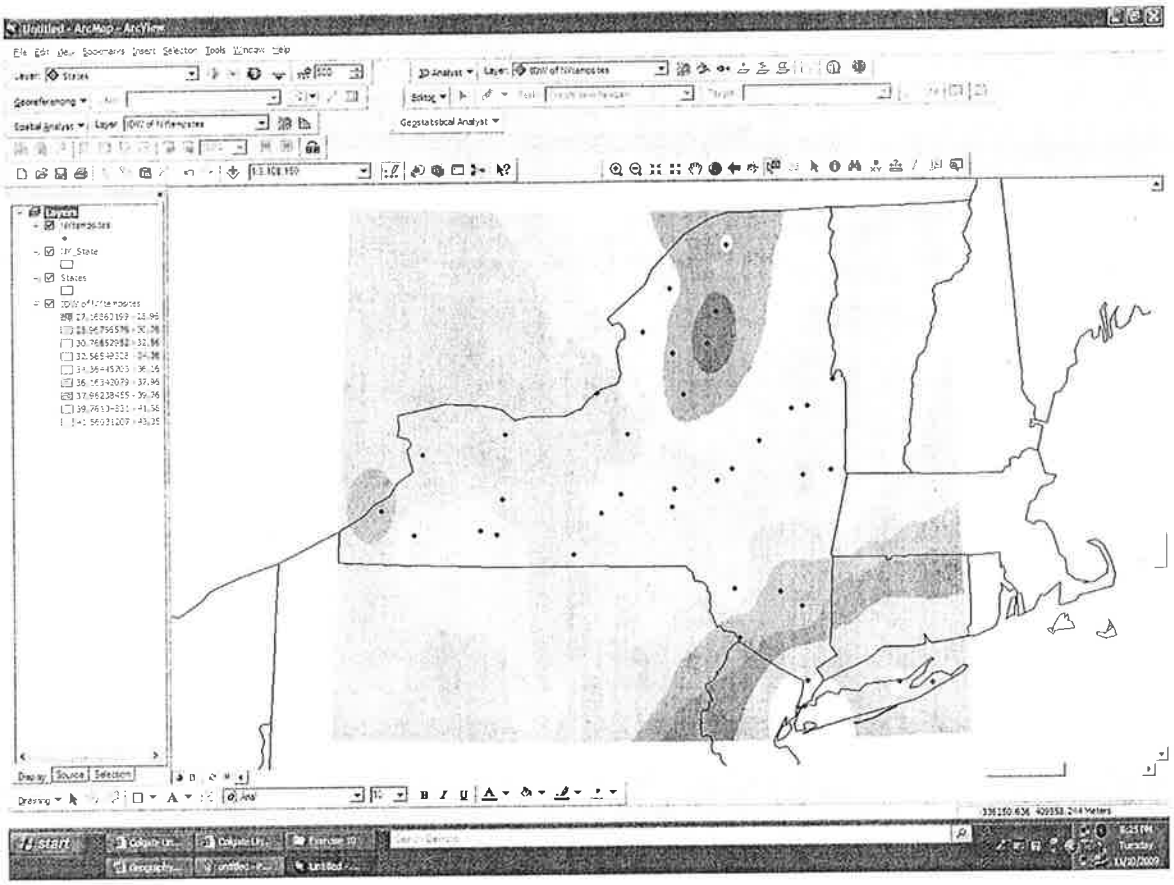


Fig. 5

2. Splines

Selecting the spline interpolation option produces a window like Fig 6. Again, you must identify the variable to be interpolated. You must also select the spline type (regularized or tension), the weight, and the number of points. The results for my example are shown in Fig 7.

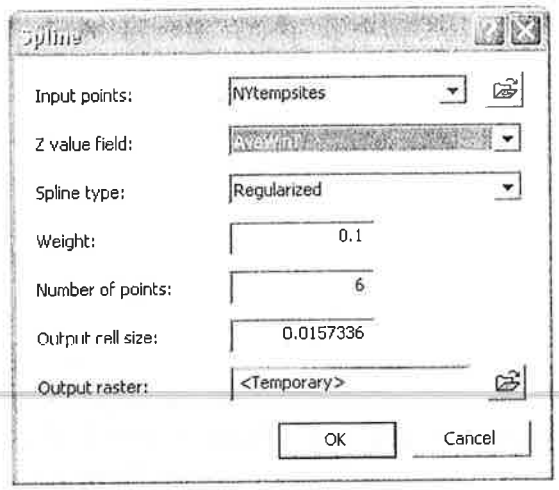


Fig. 6

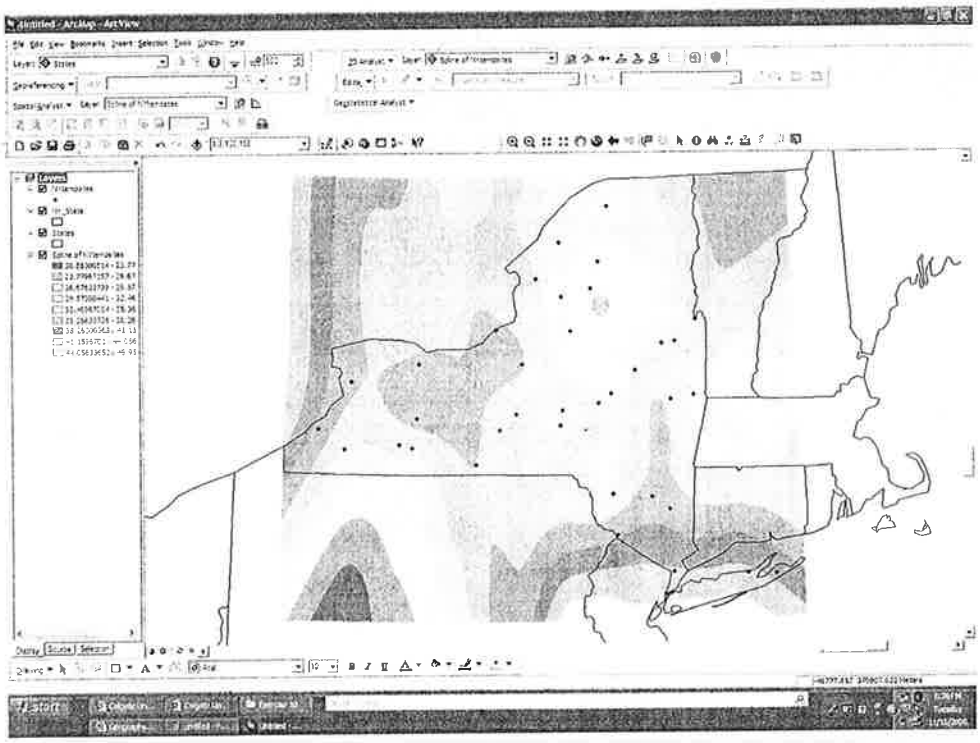


Fig. 7

3. Kriging

The kriging option within spatial analyst provides basic kriging functions (Fig. 8). Select the appropriate variable to interpolate, the semivariogram model (I suggest spherical for beginners), and search radius settings. The options in Fig. 8 produce the map shown in Fig. 9.

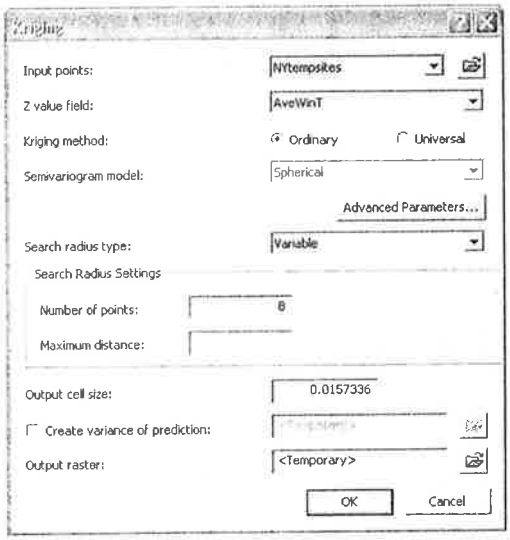


Fig. 8

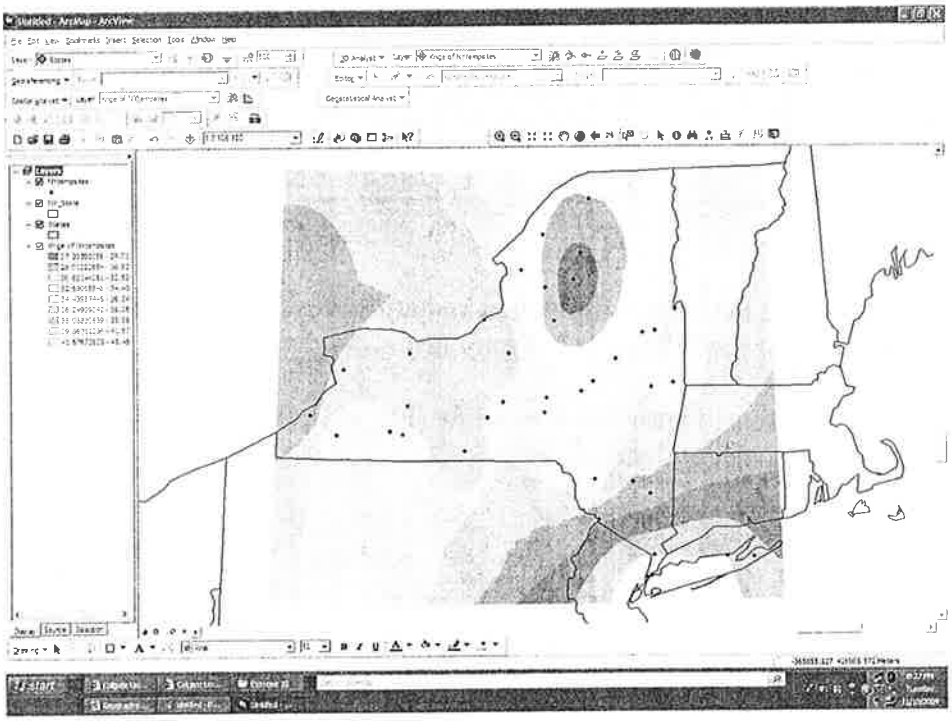


Fig. 9

4. Advanced Kriging

More advanced kriging options are available within the Geostatistical Analyst extension. To utilize these tools you will need to turn on the extension and add the toolbar to your view (you should know how to do this). Select Geostatistical Wizard option from the geostatistical pulldown menu. This first window is used to select the interpolation method and the variable to be interpolated (Fig 10).

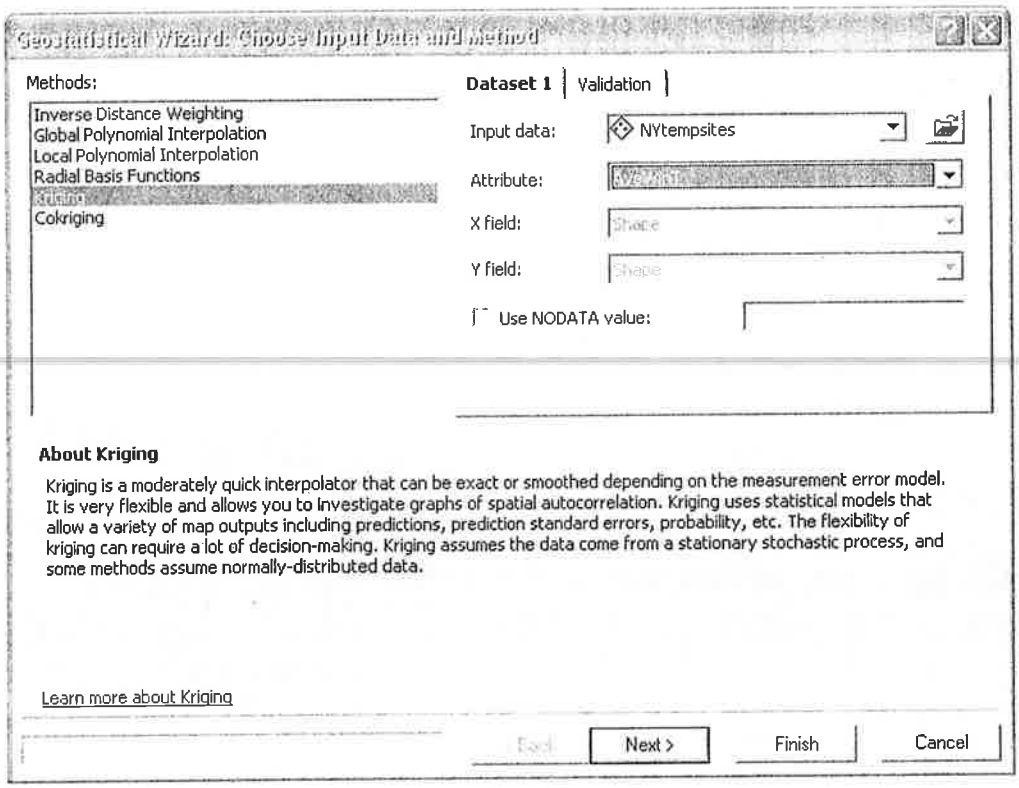


Fig 10

Make sure you select 'Kriging' and the correct input data and attribute. We are interested in kriging the AveWinT attribute of the NYTempsites map layers.

When you click next, you will presented with a new window (Fig 11) offering several different kriging methods. I've chosen ordinary kriging.

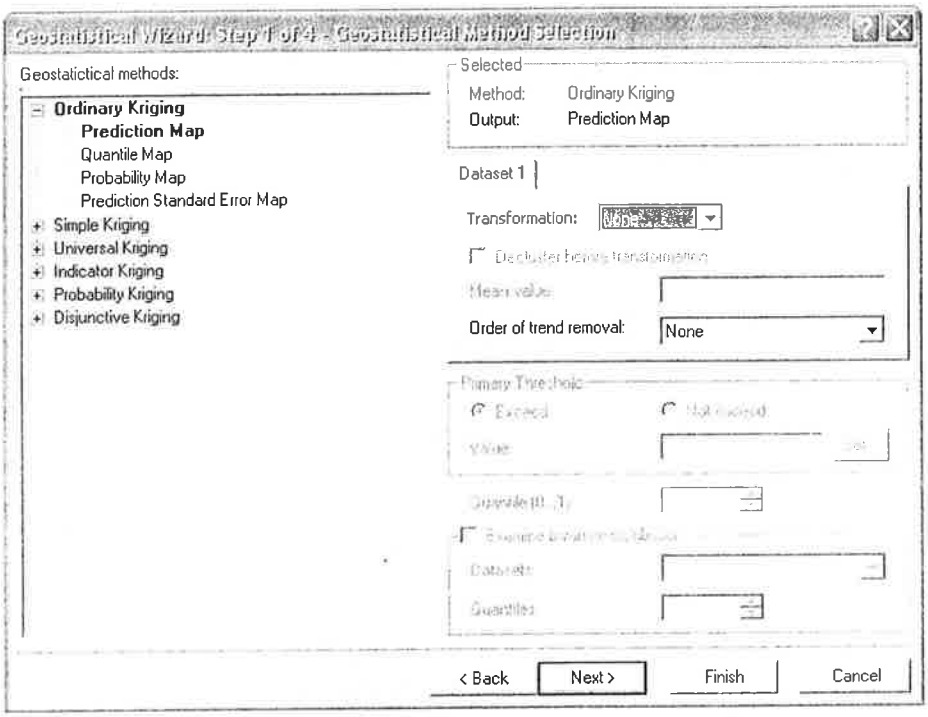


Fig 11

The next window provides a method of analyzing the semivariogram (Fig. 12). Again, I selected the spherical model. Click on a few options and note the changing shape of the model line on the semivariogram.

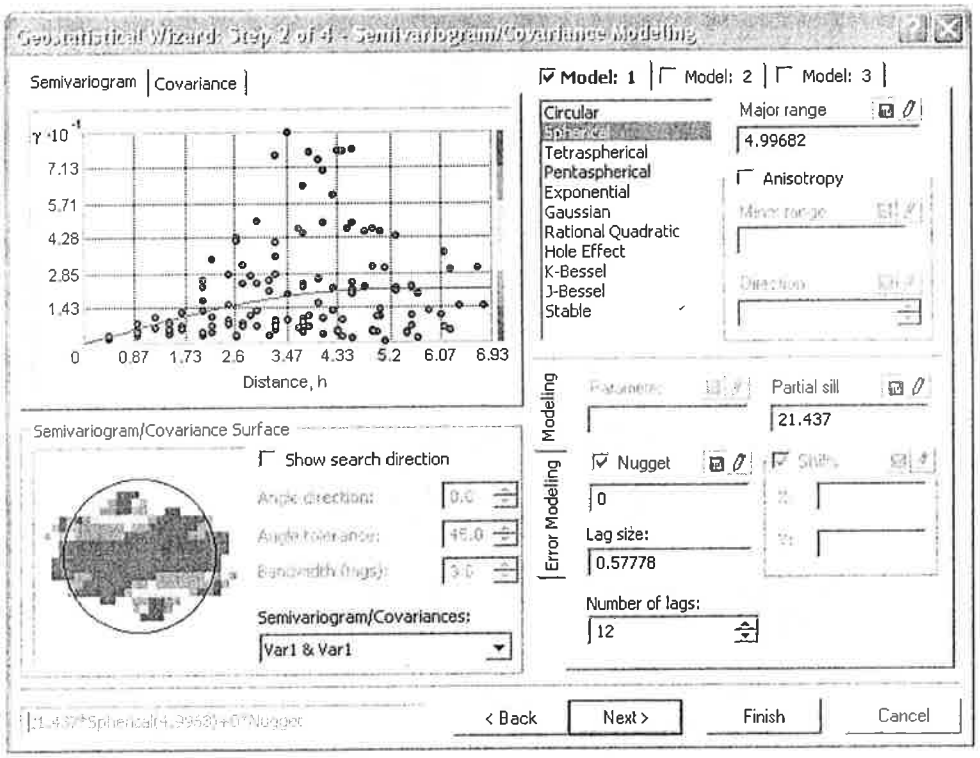


Fig. 12

After clicking next, you will given options for the search neighborhood (Fig. 13).

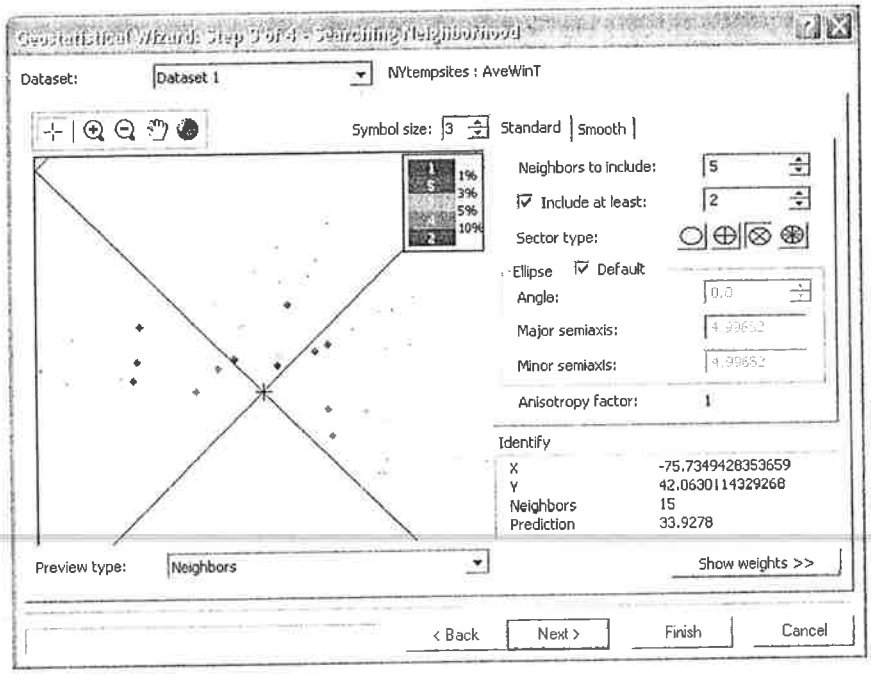


Fig. 13

You are then presented with an error analysis window (Fig. 14)

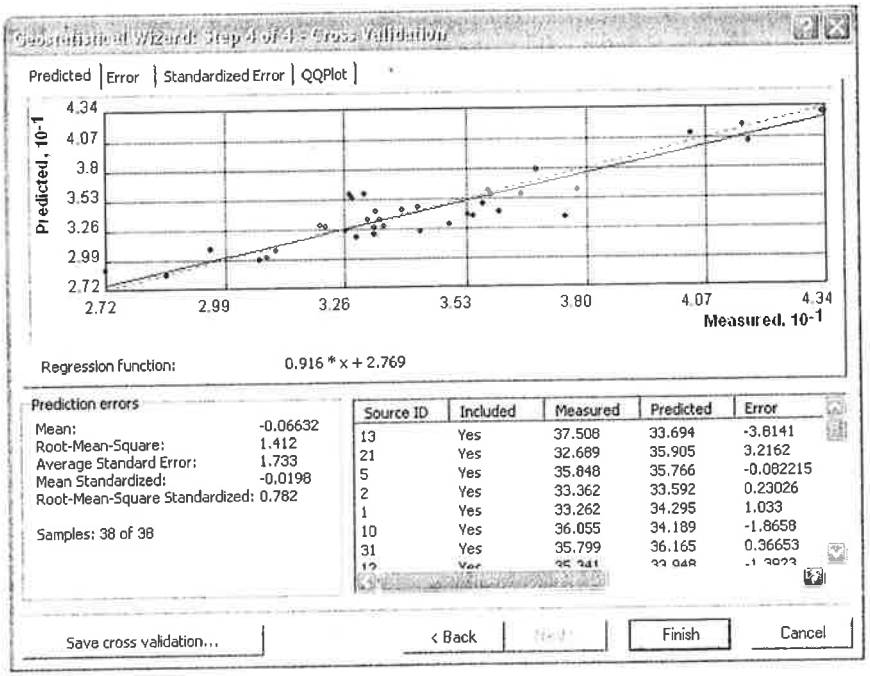


Fig. 14

The final result is shown in Fig. 15

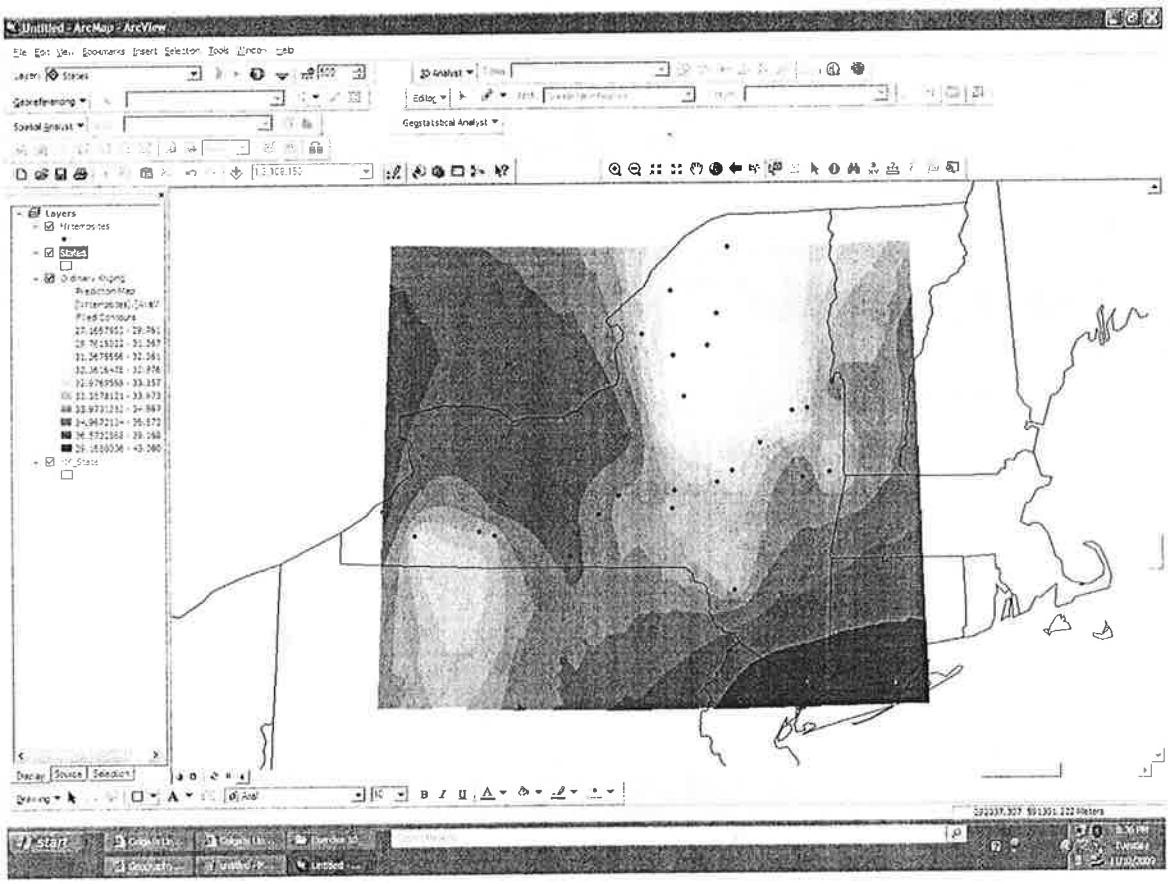


Fig. 15

Note how the Geostatistical Wizard defaults to the extent of the temperature data points. You can change the extent of surfaces created through the geostatistical analyst by modifying their properties via right clicking on data layer in the table of contents.

5. Comparing interpolated surfaces

Often times it is useful to compare the output of different interpolated results. To do this we will subtract one of our interpolated surfaces from one another. This will highlight the differences between the two interpolations.

To begin, remove everything from your view except the temperature points and the NY State map. Under the spatial analyst pulldown menu select Options (see Fig. 16 below). Under the 'extent' tab select 'Same as Layer 'NY'.

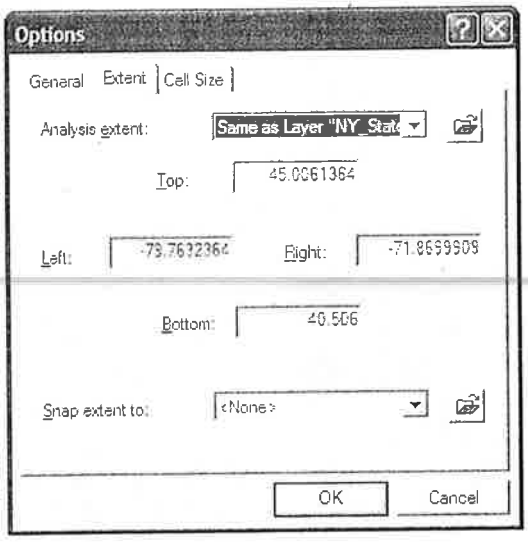


Fig. 16

Now create another IDW surface for the AveWinT variable. You should see output that extents to the entire state (see Figure 17).

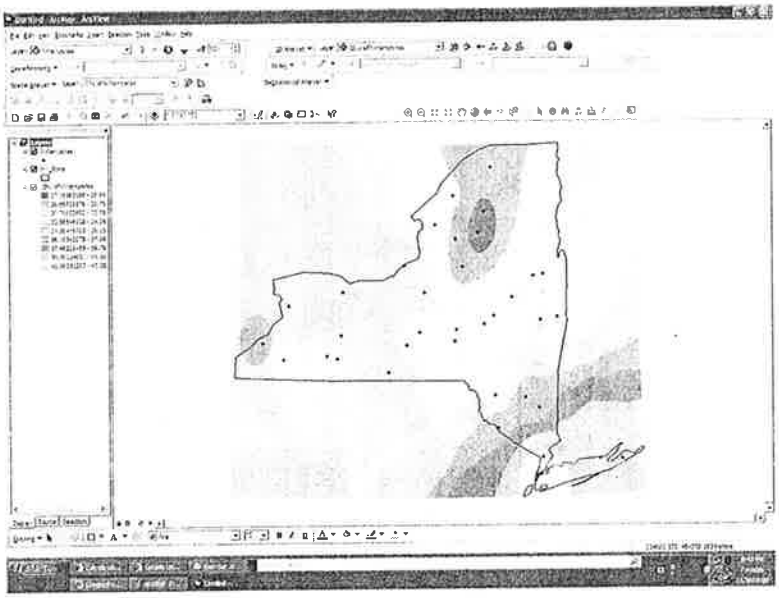


Figure 17

We can further focus our analysis by clipping the view of the dataframe to exclude areas outside of NY. In our case this makes sense since we have no data from outside the state. In other words, our interpolated surface is extrapolated into these areas. To do this right click on the dataframe and select the DataFrame Properties tab (Figure 18).

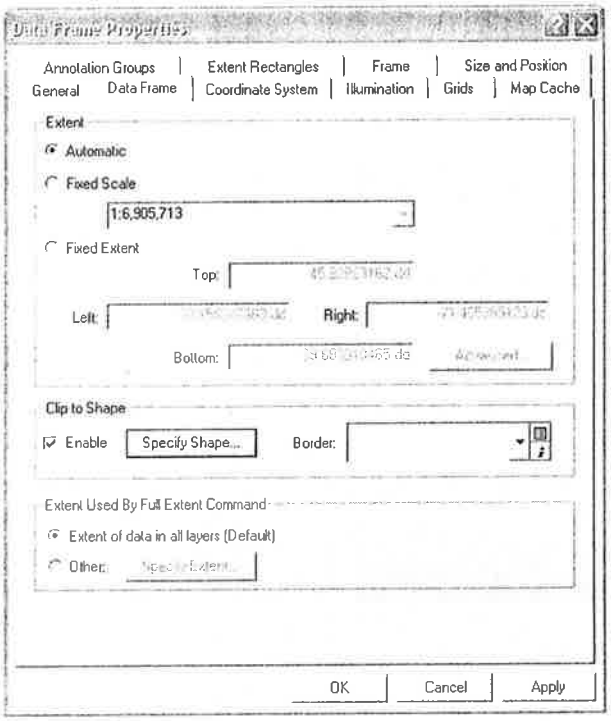


Figure 18

Enable the 'Clip to Shape' feature and specify the 'Outline of Features' in your NY State shapfile (see Figure 19).

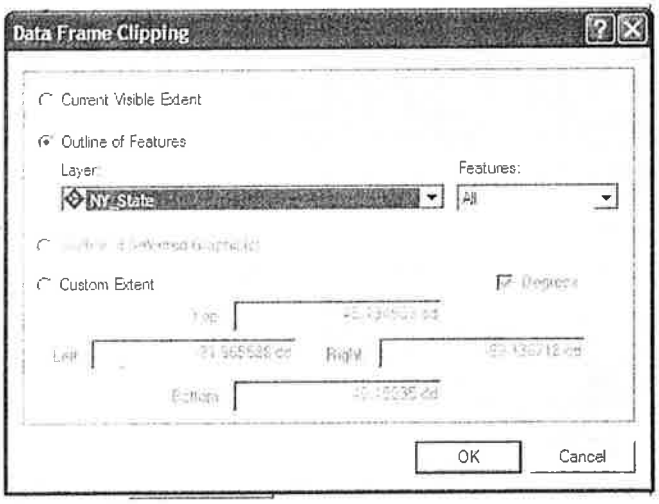


Figure 19

After clicking 'OK' in both windows your IDW surface should look like the one in Figure 20. **WARNING - This procedure simply hides the grid cells that are outside the NY boundary. They still enter into any analytical procedures you might perform on this raster so be careful.**

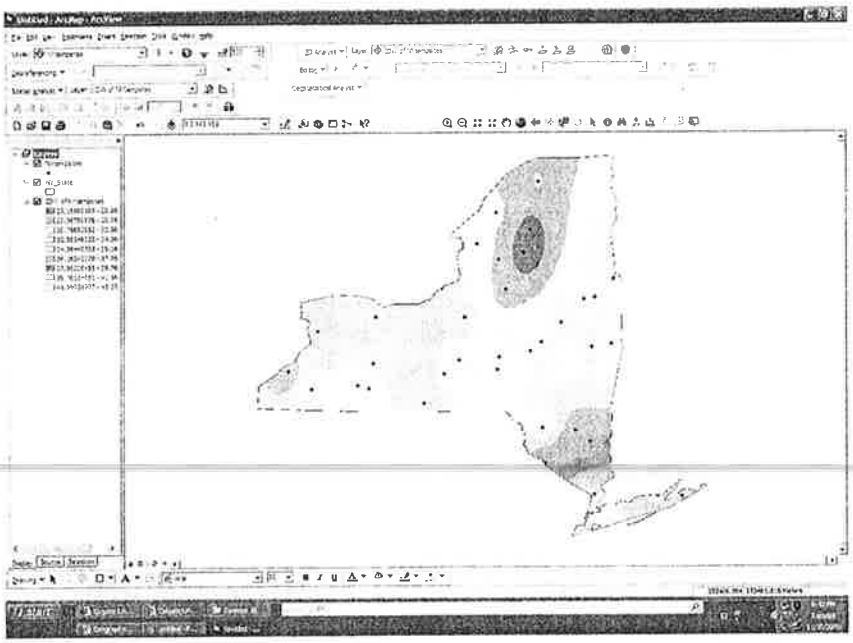


Figure 20

Now, create an ordinary kriging surface similar to the one you created above. Your surface should look similar to the one in Figure 21. Note the subtle differences between the two surfaces, for example the low, green values do not extend to the Canadian border.

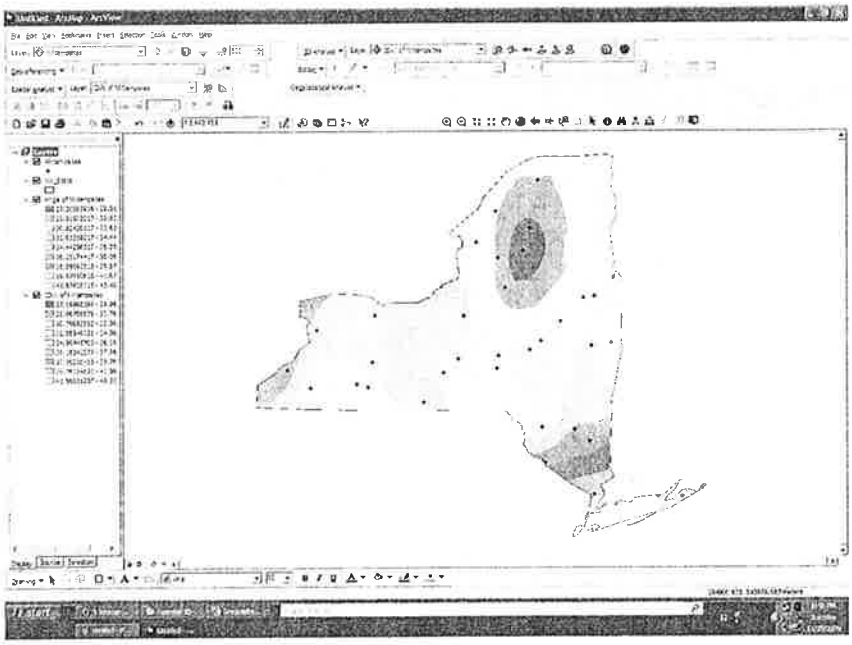


Figure 21

We can further compare these surfaces by subtracting one from the other. If we subtract the kriged surface from the IDW surface the positive values will be locations where the IDW provided a greater estimate than kriging and vice-versa.

Open the raster calculator to perform the subtraction. Your expression should look like Figure 22.

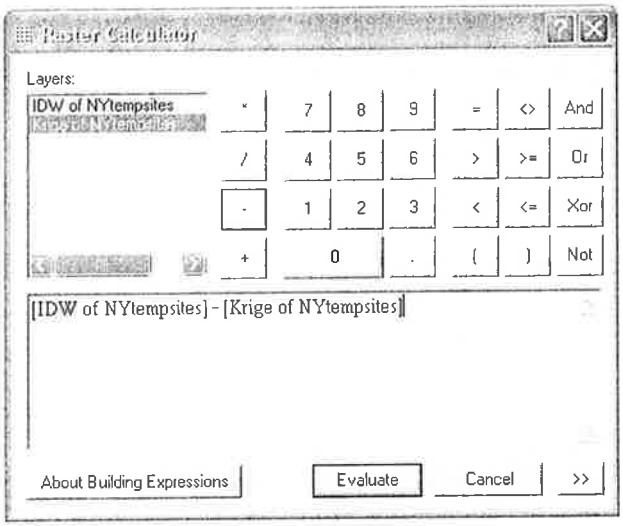


Fig. 22

Once you click 'Evaluate' the output is added to your map (Figure 23).


Figure 23

Here, the white areas are high values (IDW > Krige) and the black areas are negative values (IDW < Krige). You can also see that the biggest difference between the two is negative 2.39 degrees. To best illustrate you could change the symbology to display the negatives and positive values in different hues, similar to tutorial three.