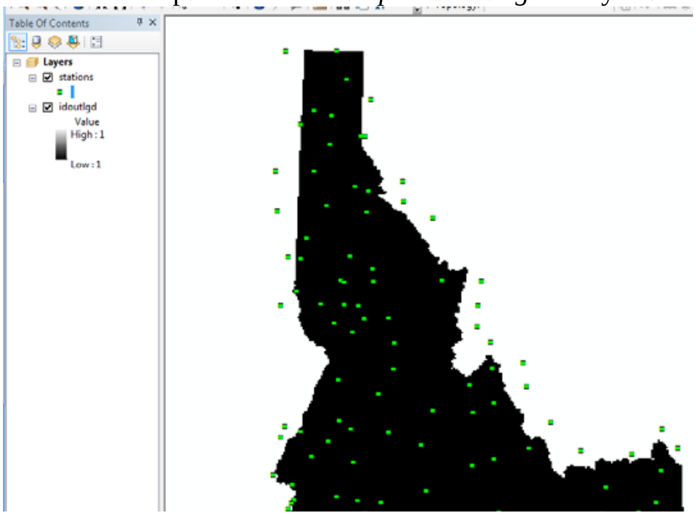
Demo 9: Spatial Interpolation
In this demo, you will learn how to perform 1. Trend Analysis; 2. Use three different methods to spatially interpolate the sample precipitation data in the state of Idaho. This demo is based on the Chapter 15 in the text book.

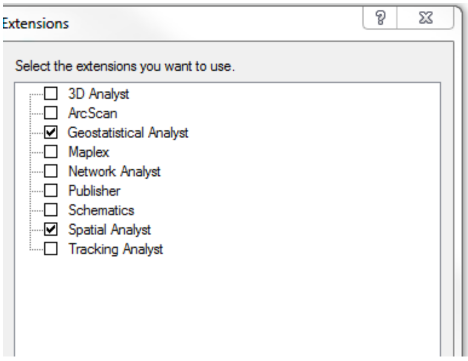
The applications section has five tasks. Task 1 Covers trend surface analysis. Task 2, 3, 4 deal with spatial interpolation. Task 5 covers spatial prediction error estimation using Kriging. You will use global polynomial interpolation, IDW, ordinary Kriging to spatially interpolate the sample precipitation data. You will see how cross-validation statistics such as the root mean square (RMS) error can help us to compare models.

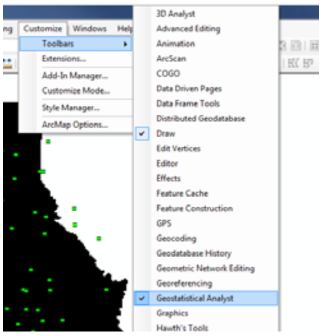
Task 1 Trend Analysis
In task 1, you will first explore the average annual precipitation data in *stations.shp*.

1. Launch ArcMap. Add *stations.shp* and *idoutlgd* to layers.

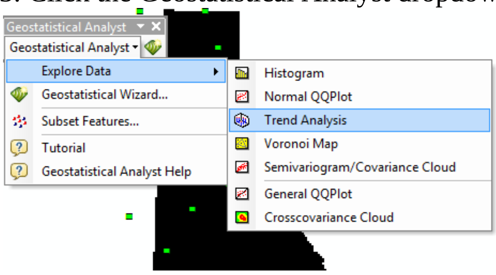


2. Make sure that both the Geostatistical Analyst and Spatial Analyst extensions are checked in Customize menu and the Geostatistical Analyst toolbar is check in the Customize menu.

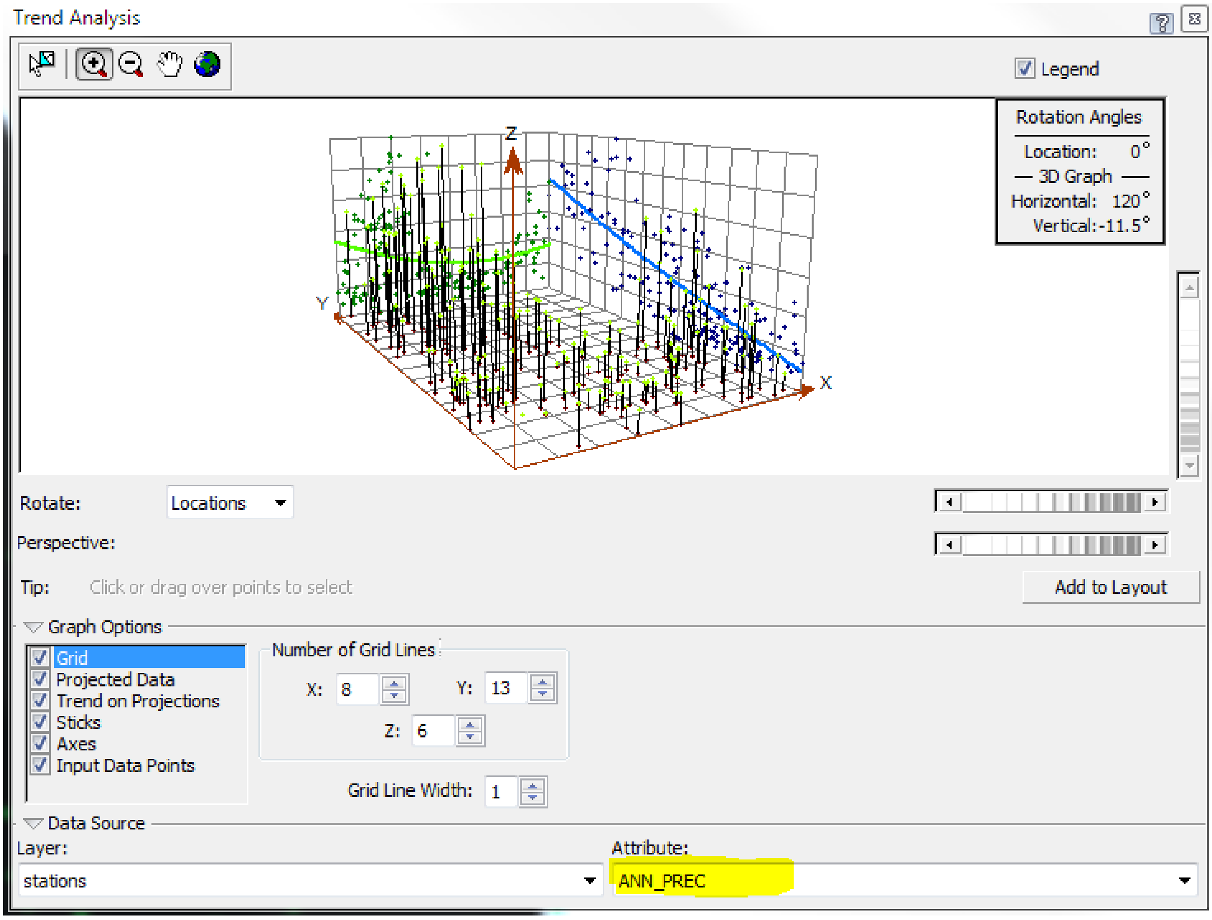




3. Click the Geostatistical Analyst dropdown arrow, point to Explore Data and select Trend Analysis.



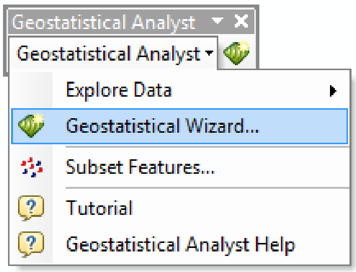
4. At the bottom of the Trend Analysis dialog, click the dropdown arrow to select stations for the layer and ANN_PREC for the attribute.



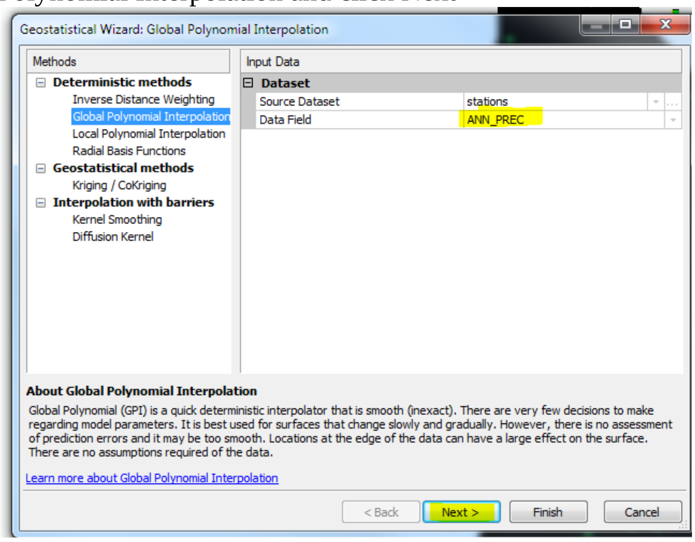
5. Maximize the Trend Analysis dialog. The 3-D diagram shows two trend projections: The YZ plane dips from north to south, and the XZ plane dips initially from west to east and then rises slightly. The north-south trend is much stronger than the east-west trend, suggesting that the general precipitation pattern in Idaho decreases from north to south. Close the dialog

Task 2 Use Global Polynomial Interpolation

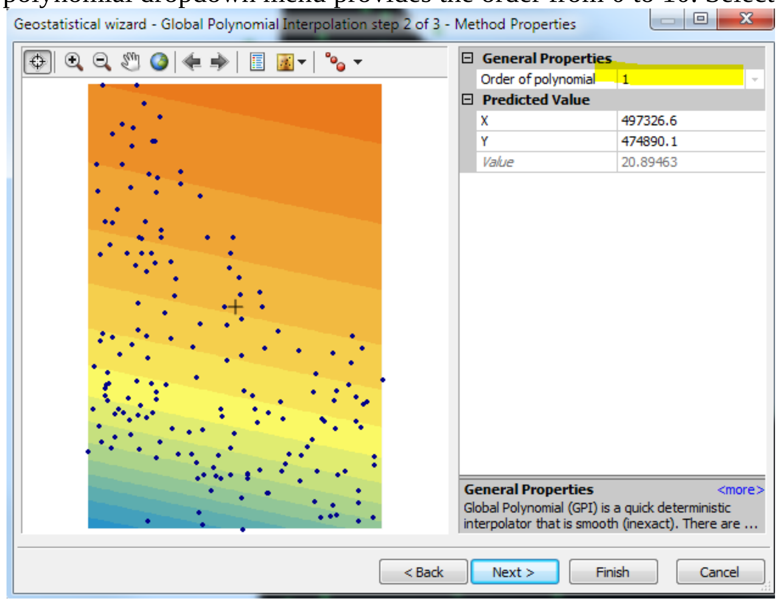
1. Click the Geostatistical Analyst drop down arrow and select Geostatistical Wizard.



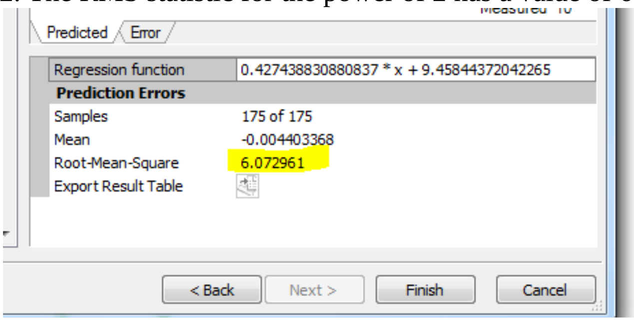
2. The opening panel lets you choose a geostatistical method. In the method frame, click Global Polynomial Interpolation and click Next

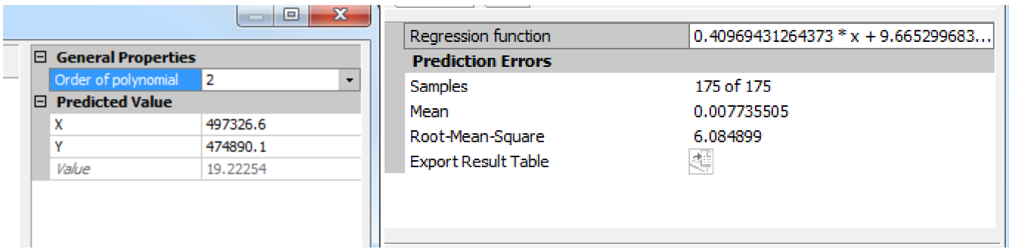


3. Step 2 of Global Polynomial Interpolation lets you choose the order of polynomial. The order of polynomial dropdown menu provides the order from 0 to 10. Select 1 for the order.

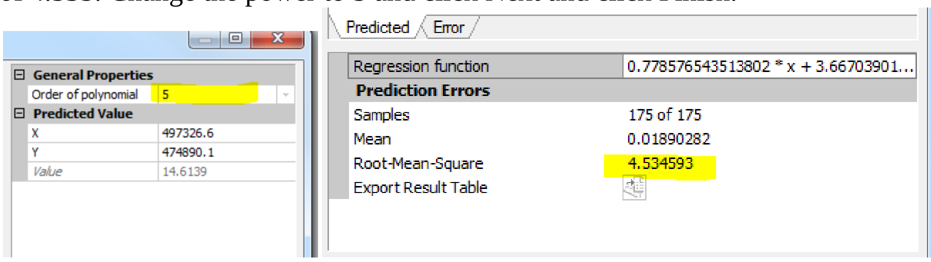


5. Step 3 shows scatter plots (Predicted versus Measured values, and Error versus Measured values) and statistics related to the first-order trend surface model. The RMS statistic measures the overall fit of the trend surface model. In this case, Root-Mean-Square error is 6.073. Click Back and change the power to 2. The RMS statistic for the power of 2 has a value of 6.085.



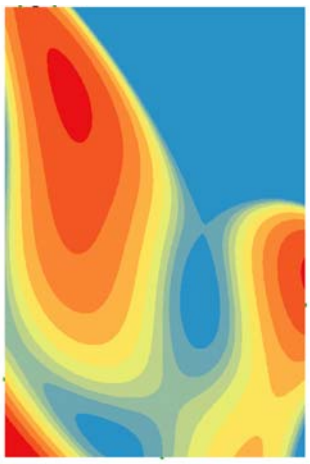


6. Repeat step 5 with other power numbers. The trend surface model with the lowest RMS statistic is the best overall model for this task. For ANN_PREC, the best overall model has the power of 5 with the RMS of 4.535. Change the power to 5 and click Next and click Finish.

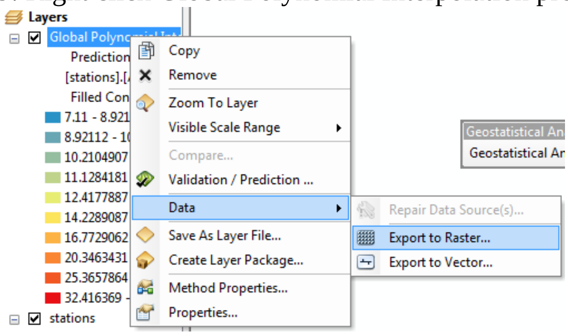


7. Click OK in the method summary dialog

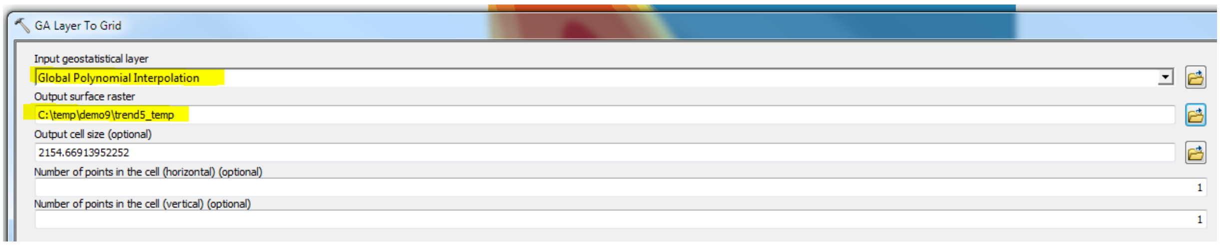
8. Global Polynomial Interpolation prediction map is a Geostatistical Analyst (GA) output layer and has the same extent as stations.



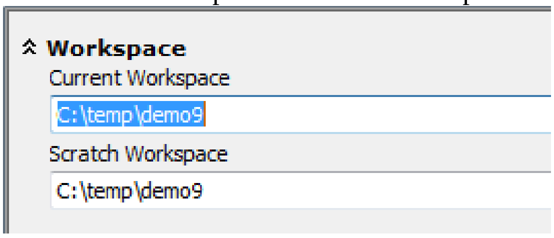
9. Right click Global Polynomial Interpolation prediction map, point to Data, and select Export to Raster



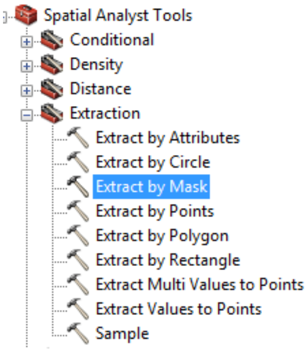
10. In the Export to Raster dialog, specify trend5_temp for the output surface raster. Click OK to export the dataset.



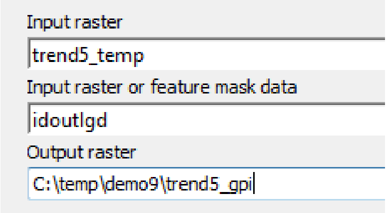
11. Click ArcToolbox window to open it.
12. Set the C:\temp\demo9 as the workspace.



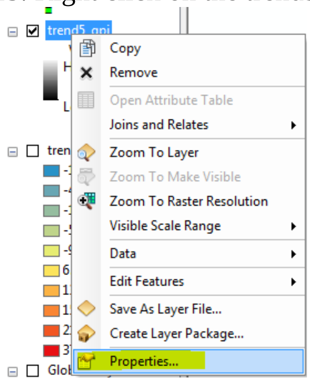
13. Double-click the Extract by Mask tool in the Spatial Analyst Tools>Extraction tool set.



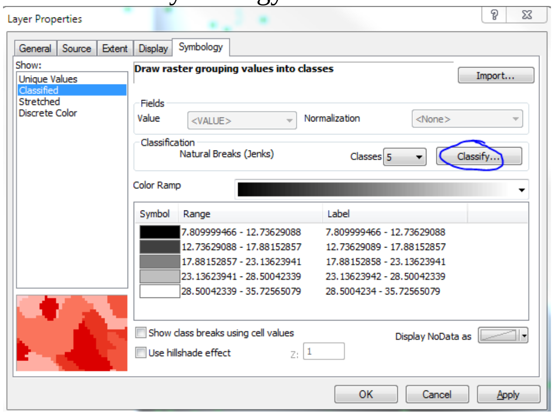
14. Select *trend5_temp* for the input raster, select *idoutlgd* for the feature mask data, specify *trend5_gpi* for the output raster, and click OK.



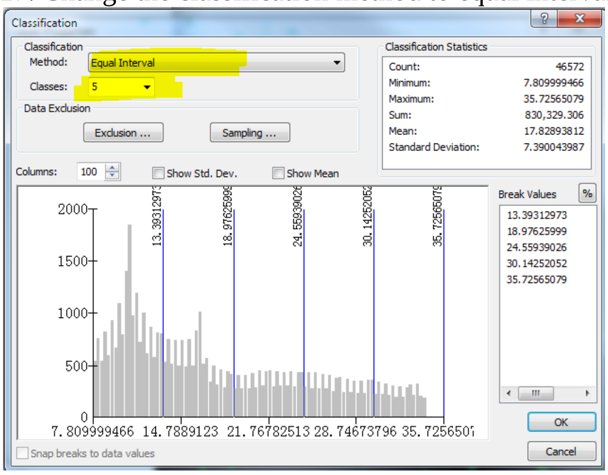
15. Right click on the trend5_gpi and select Properties.



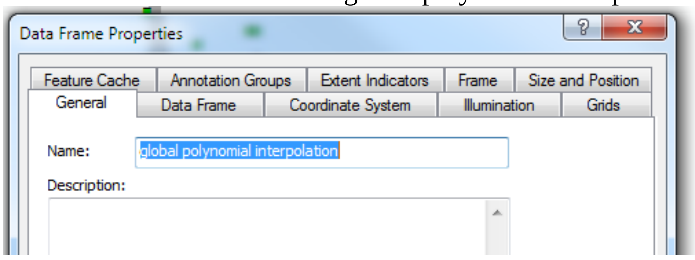
16. Click the Symbology tab and select classified and Click classify



17. Change the classification method to equal interval and click OK at the bottom.



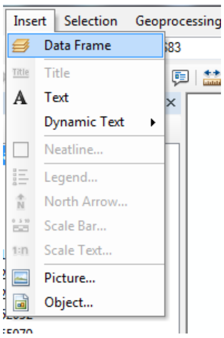
18. Rename the data frame as global polynomial interpolation



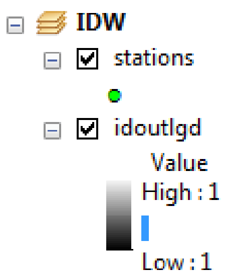
Task 3. Use IDW for Interpolation

You can also use IDW to create a precipitation raster.

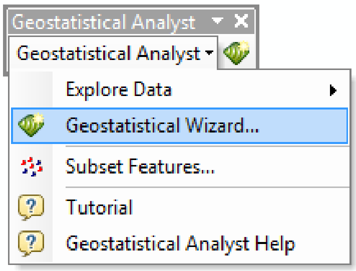
1. Insert a new data frame in ArcMap and rename it IDW



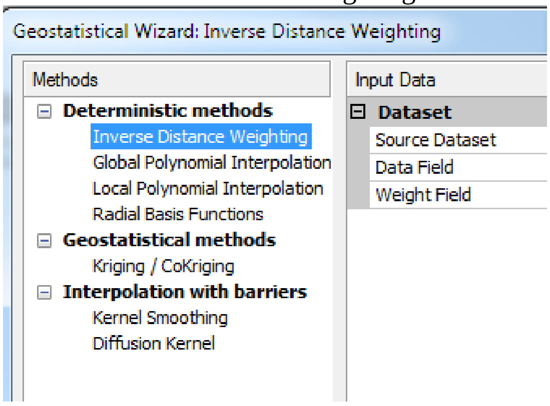
2. Add *stations.shp* and *idoutlgd* to IDW



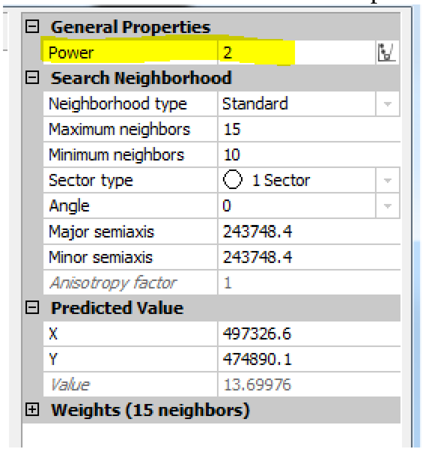
3. Click the Geostatistical Analyst dropdown arrow and select Geostatistical Wizard.



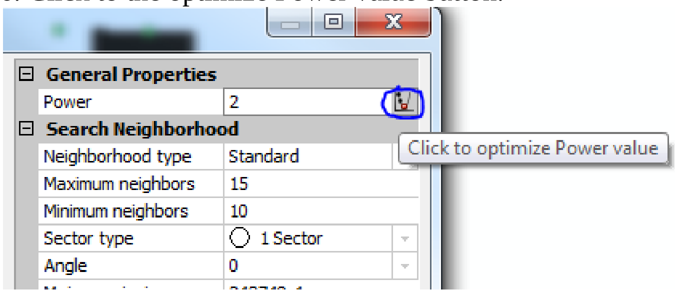
4. Click Inverse Distance Weighting in the Methods frame and click Next



5. The Step 2 Panel of IDW includes a graphic frame and a method frame for specifying IDW parameters. The default IDW method uses a power of 2.

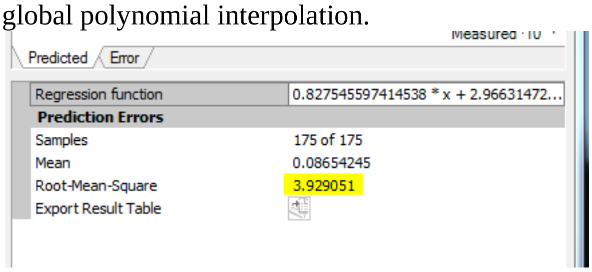


6. Click to the optimize Power value button.



Because a change of the power value will change the estimate value at a point location, you can click the button and ask Geostatistical Wizard to find the optimal power value while holding other parameters constant. Geostatistical Wizard employs the cross-validation technique to find the optimal value.
In this case, the optimal power value is **3.191**.

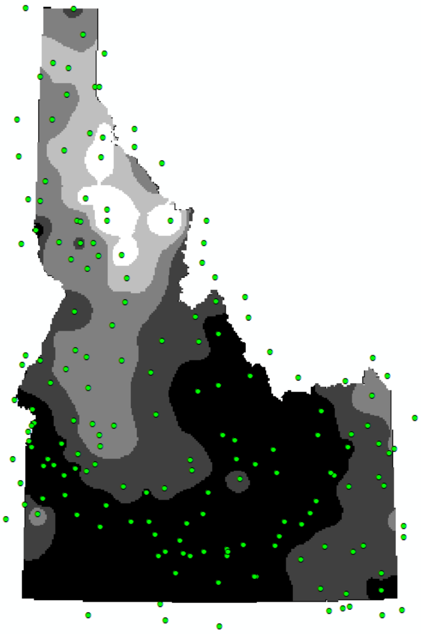
7. Click Next and you will find that the Root-Mean-Square (error) is 3.929 that is much smaller than the global polynomial interpolation.



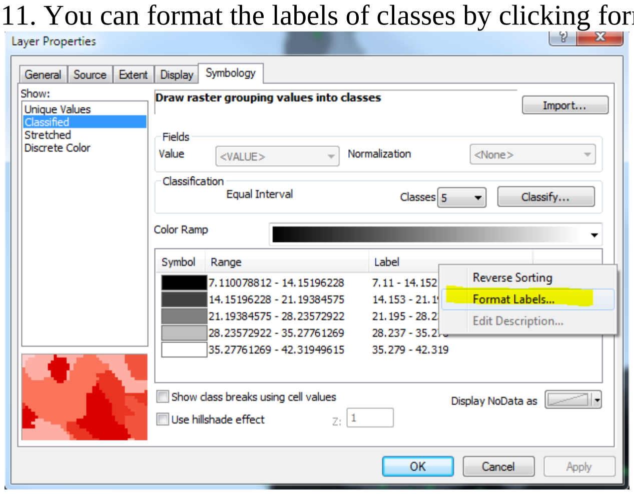
8. Click Finish and click OK in the Method Summary dialog

9. Follow the same steps as in Task 2 to convert Inverse Distance Weighting Prediction Map to a raster and clip the raster using idoutlgd as the analysis mask. Specify the final IDW out as *Trend_IDW*

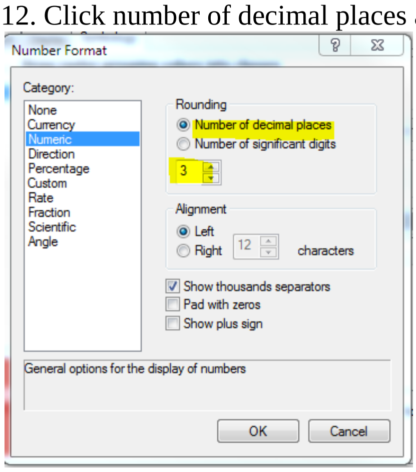
10. Change the symbology of the resulting raster as below

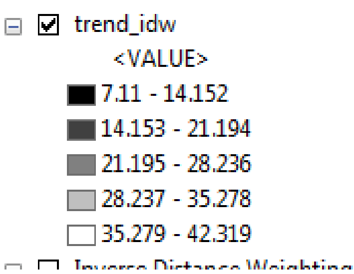


11. You can format the labels of classes by clicking format labels



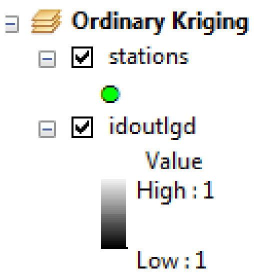
12. Click number of decimal places and change to 3



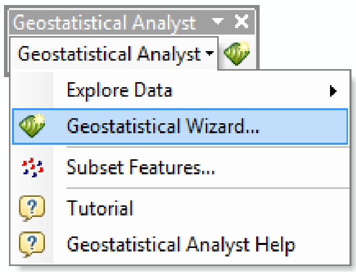


Task 4 Use Ordinary Kriging for Interpolation

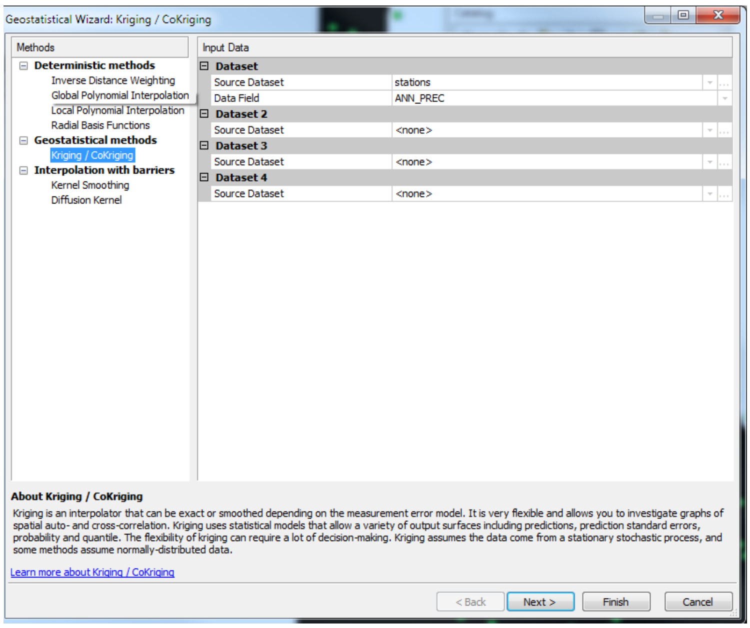
1. Select Data Frame and from the Insert menu in ArcMap. Rename the new data frame as Ordinary Kriging.
2. Add stations.shp and idoutlgd to Ordinary Kriging.



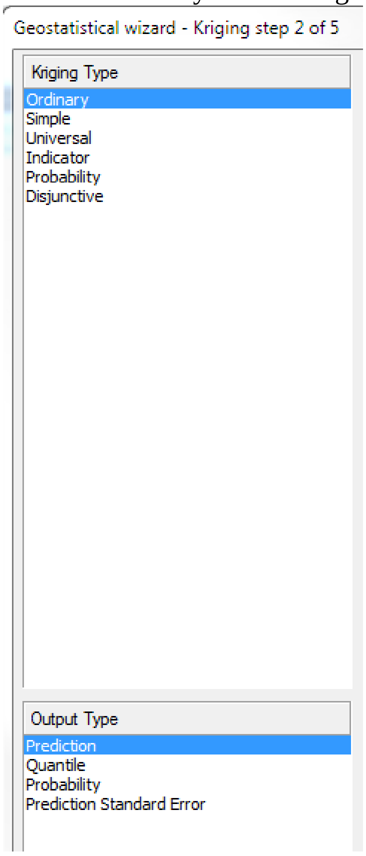
3. Select Geostatistical Wizard from the Geostatistical Analyst Menu.



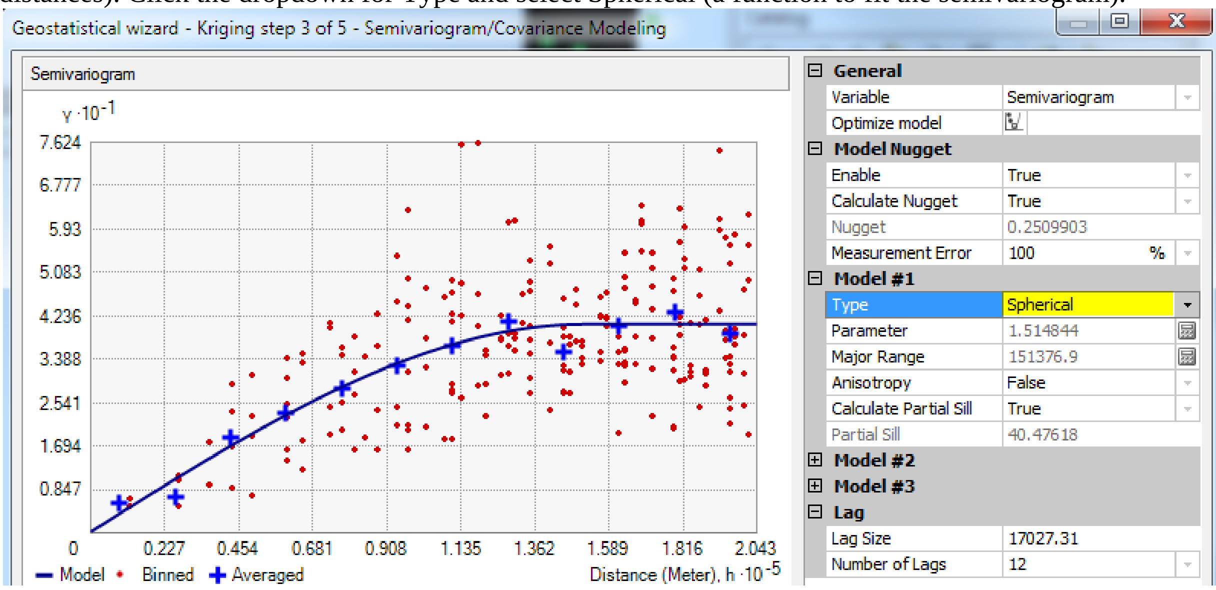
4. Make sure the source dataset is stations and the data field is ANN_PREC. Click Kriging/CoKriging in the Methods frame and click Next



5. Select Ordinary for the Kriging Type and Prediction for the Output type and click Next

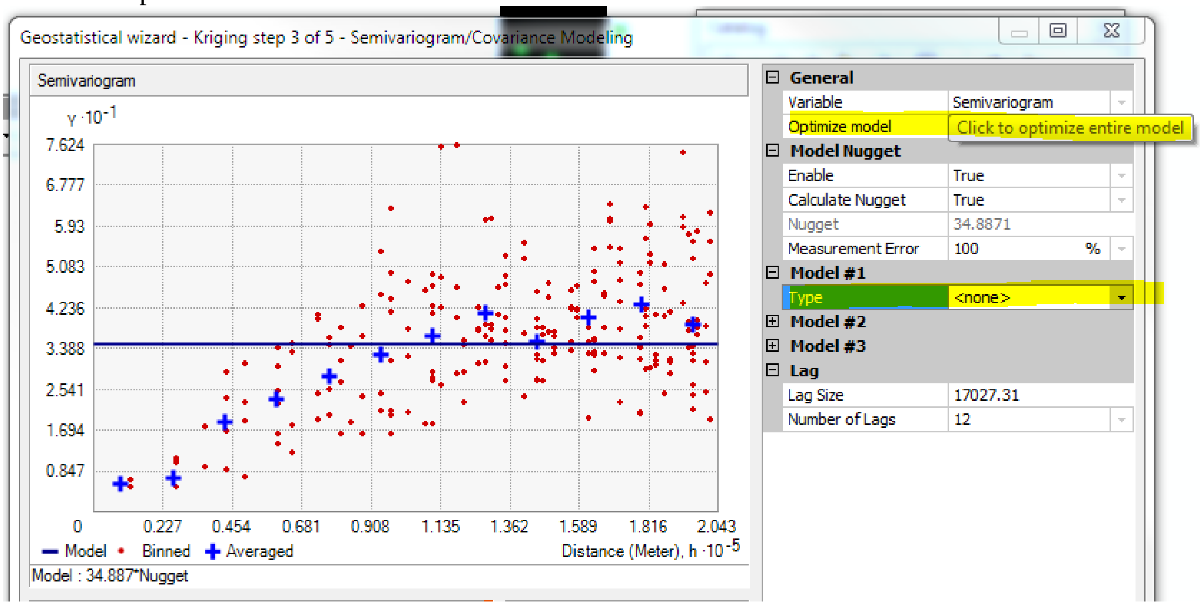


6. Step 3 panel shows a binned semivariogram (spatial dependence of the dataset given specific distances). Click the dropdown for Type and select Spherical (a function to fit the semivariogram).

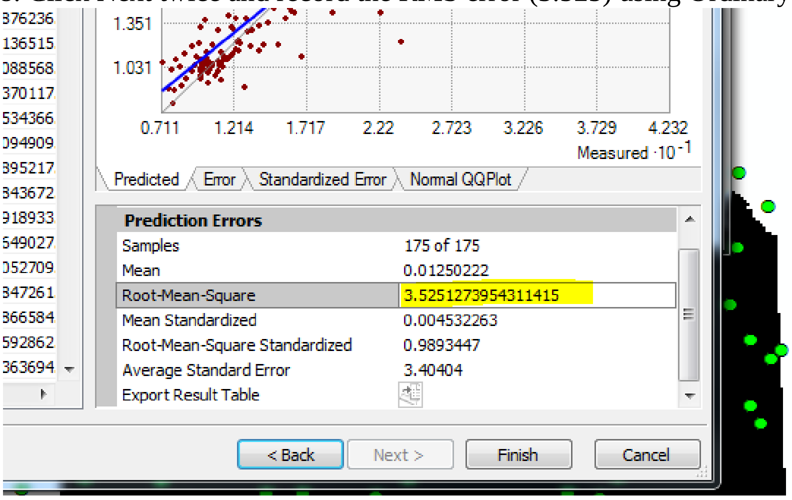


This diagram shows a progressive decrease of spatial dependence until some distance, beyond which spatial dependence level off.

7. Select none for Type under Model #1 and then click the “click to optimize entire model” button and click OK to proceed.



8. Click Next twice and record the RMS error (3.525) using Ordinary Kriging.



9. Click Finish and click OK. Ordinary Kriging Prediction Map is added to the ArcMap.

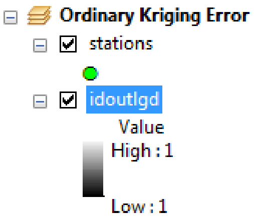
10. Different from other local interpolation methods, **Kriging can assess the prediction errors in every location based on the spatial variability of an attribute.**

11. Follow the same steps as in Task 2 to convert Inverse Distance Weighting Prediction Map to a raster and clip the raster using *idoutlgd* as the analysis mask. Specify the final output as *Trend_Okg*

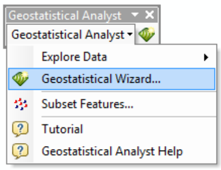
12. Follow the same steps as in Task 3 to change the Symbology

Task 5. Use Kriging to estimate Spatial Prediction Error

1. Insert a new data frame named Ordinary Kriging Error and add stations.shp and idoutlgd

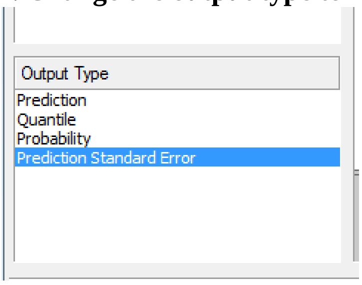


2. Start Geostatistical Wizard again

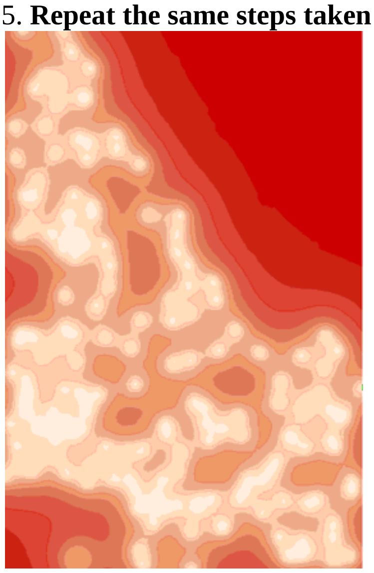


3. Select Kriging/CoKriging and click Next

4. **Change the output type to Prediction Standard Error**



5. **Repeat the same steps taken in Task 4 to produce the prediction map**

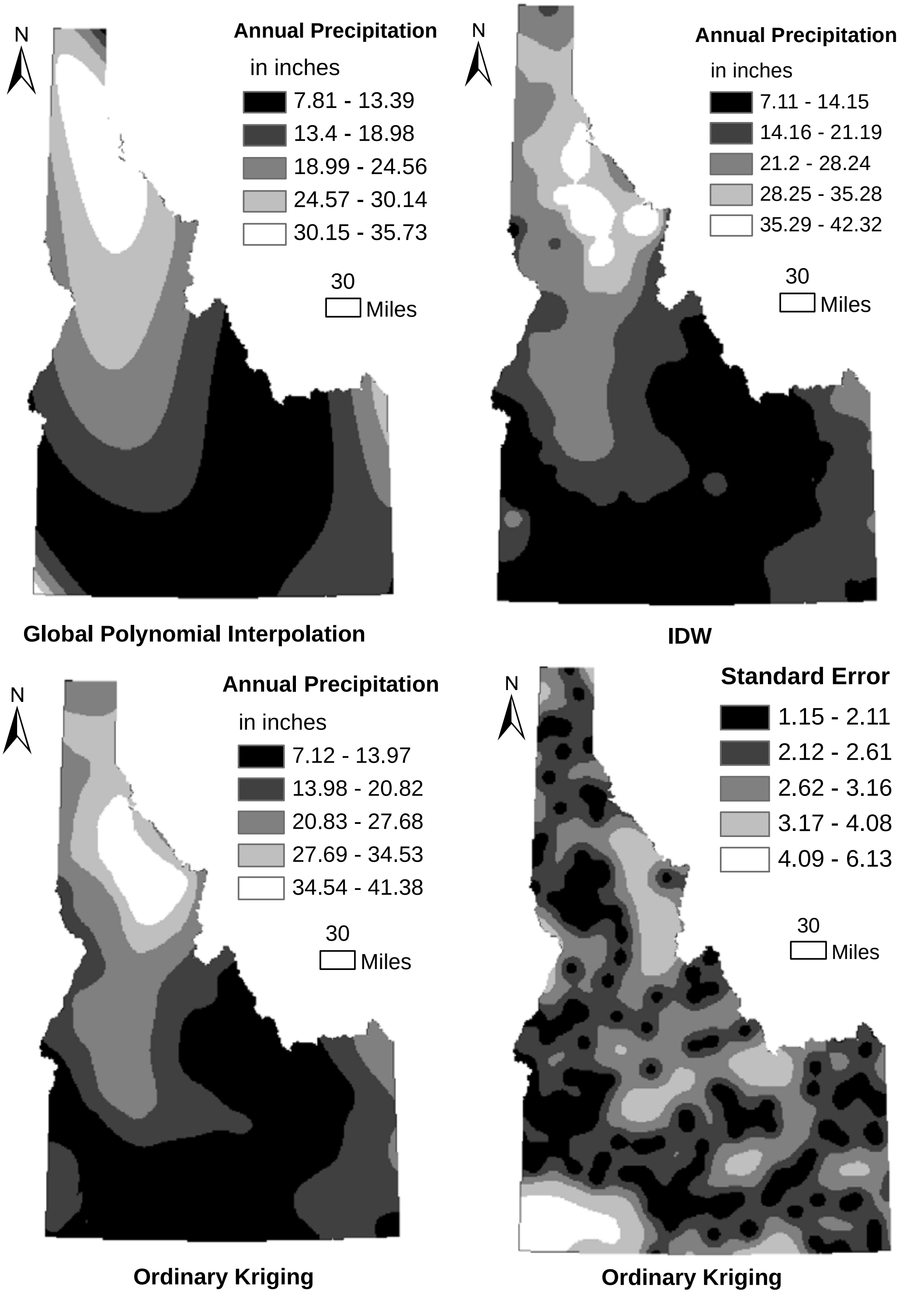


15. Follow the same steps as in Task 2 to convert Ordinary Kriging Prediction Error layer to raster and clip the raster using *idoutlgd* as the analysis mask. Specify the final prediction error surface as *ErrorOkg*

16. Follow the same steps as in Task 3 to change the symbology

Your final map and summary table should be like this.

Figure 1. Annual Precipitation Surface by Different Spatial Interpolation Methods



Date: Apr 3, 2012
Catographer: Felix
Data Source: National Climatic Data Center

Table 1. Spatial Interpolation Methods and Root-Mean-Square Errors

Method	Root-Mean-Square Errors	Order of Polynomial Function/ Optimal Power Value for IDW
Global Polynomial Interpolation	4.535	5
IDW	3.929	3.191
Ordinary Kriging	3.525	N.A.