Geostatistical Analyst: An Introduction

Steve Lynch and Eric Krause

Redlands, CA.

SEE WHAT OTHERS CAN'T

Outline

- What is geostatistics?
- What is Geostatistical Analyst?
- Spatial autocorrelation
- Geostatistical Wizard and geoprocessing tools
- Where is it used?
- Demonstrations
- Tips and Tricks
- Conclusion
- Questions

Sessions of note…

Tuesday

- Interpolating Surfaces in ArcGIS (1:00-2:00 SDCC Rm33C)
- Kriging: An Introduction to Concepts and Applications (2:30-3:30 SDCC Rm33C)
- **Geostatistical Analyst: An Introduction (4:00-5:00 SDCC Rm30C)**

Wednesday

- Surface Interpolation in ArcGIS (11:15-12:00 SDCC Demo Theater 10)
- Empirical Bayesian Kriging and EBK Regression Prediction in ArcGIS (2:30-3:15 SDCC Demo Theater 10)

Thursday

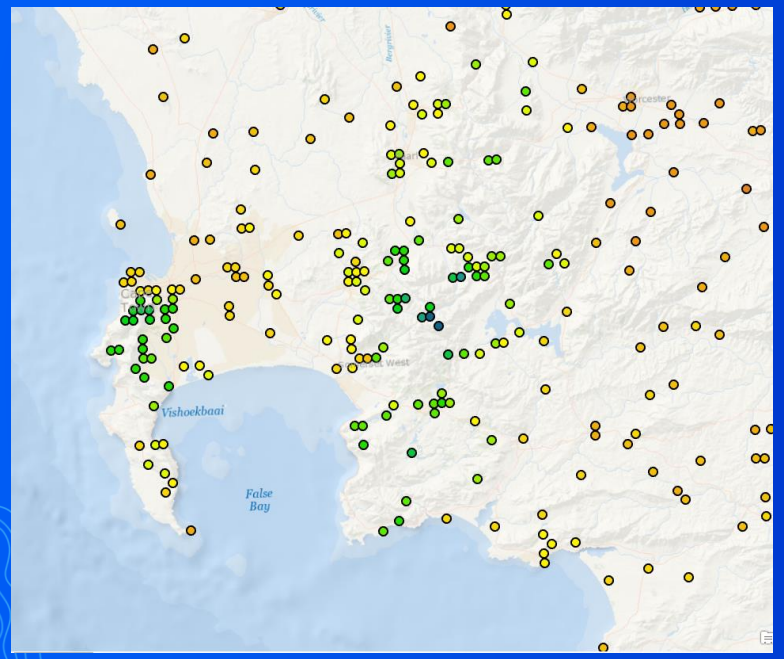
- Geostatistics in Practice: Learning Interpolation Through Examples (8:30-9:30 SDCC Rm30A)
- Polygon-to-Polygon Predictions Using Areal Interpolation (11:15-12:00 SDCC Demo Theater 10)
- **Geostatistical Analyst: An Introduction (1:00-2:00 SDCC Rm30A)**
- Using Living Atlas Data and ArcGIS Pro for 3D Interpolation (2:30-3:30 SDCC Rm 30C)
- Interpolating Surfaces in ArcGIS (4:00-5:00 SDCC Rm15A)
- Kriging: An Introduction to Concepts and Applications (4:00-5:00 SDCC Rm15B)

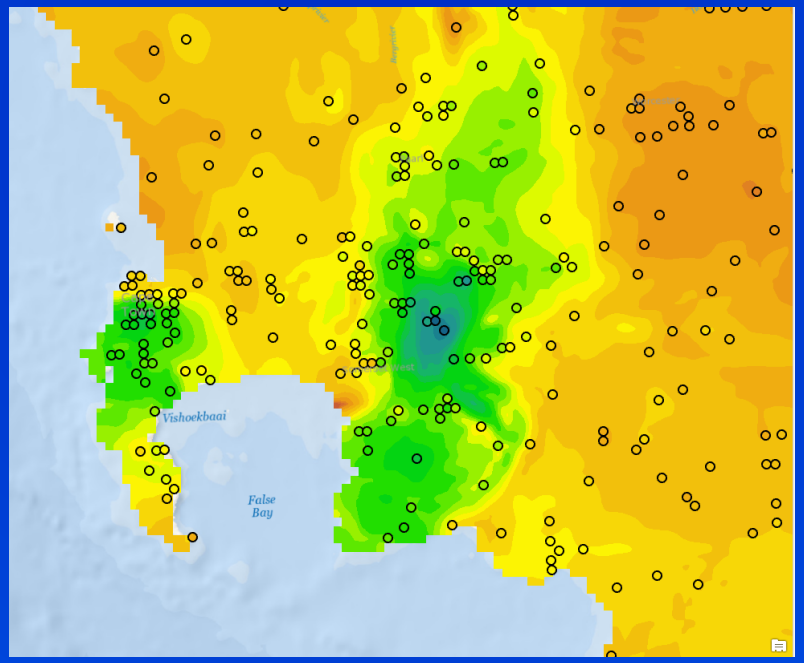
What is geostatistics?

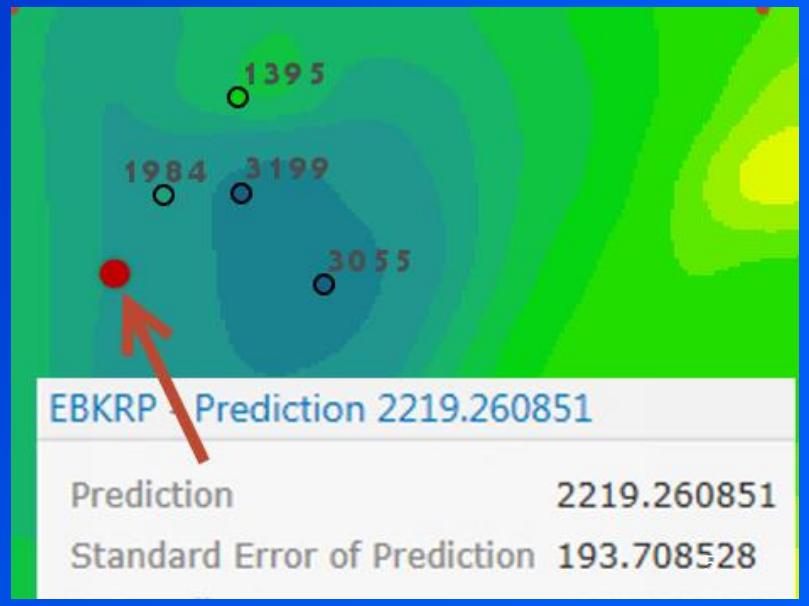
- is a class of statistics used to analyze and predict values associated with spatial phenomena.
- it incorporates the spatial coordinates of the data
- Has evolved to not only provide
  - interpolated values, but also
  - measures of uncertainty

ArcGIS for Geostatistical Analyst

Too expensive to measure everywhere, however, we want to know values everywhere.

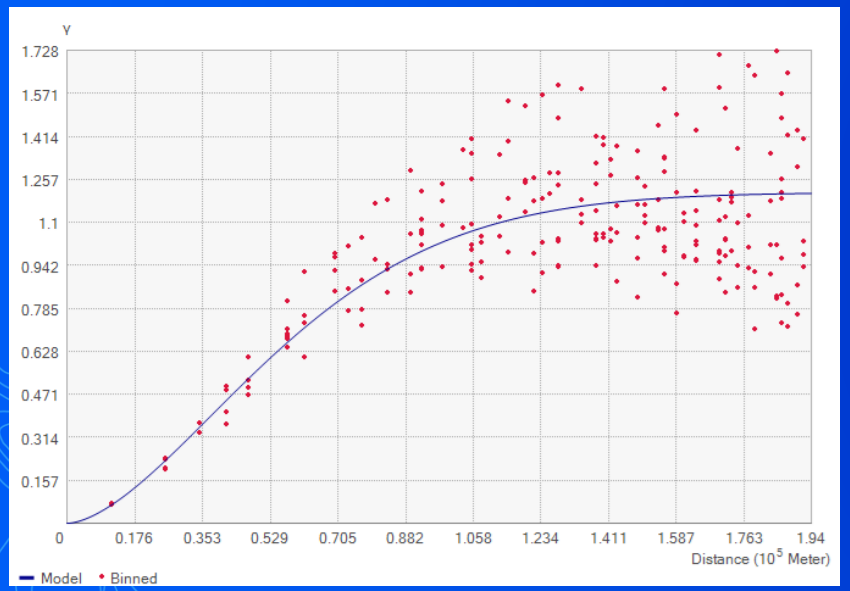


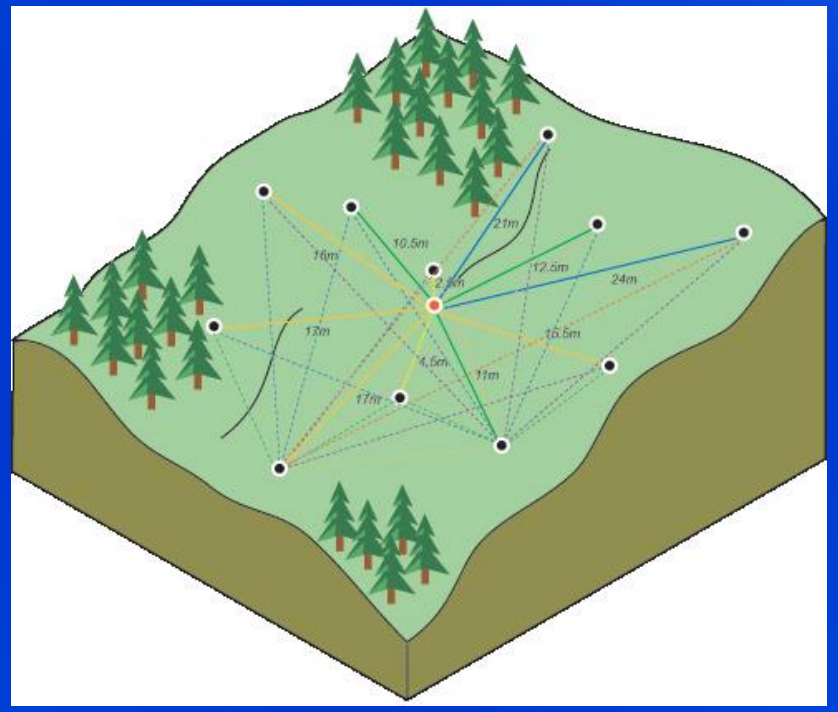


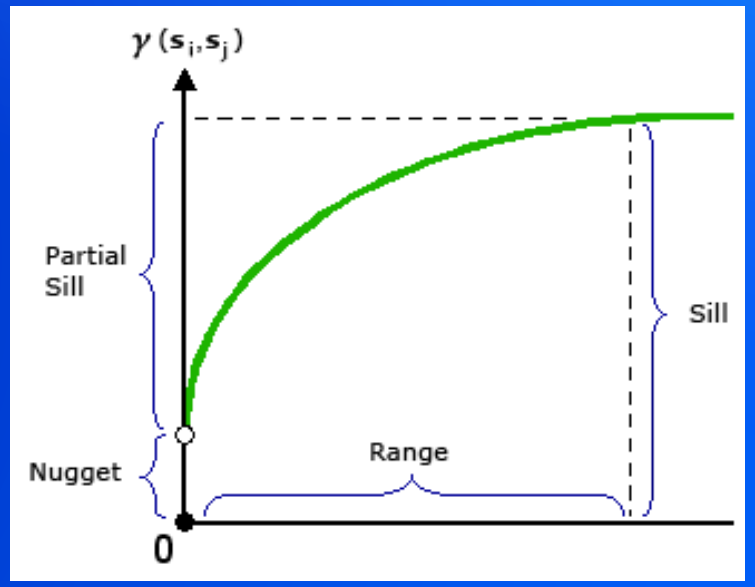


What is a semivariogram?

Semivariogram(distance h) = 0.5 * average [$(\text{value}_i - \text{value}_j)^2$]

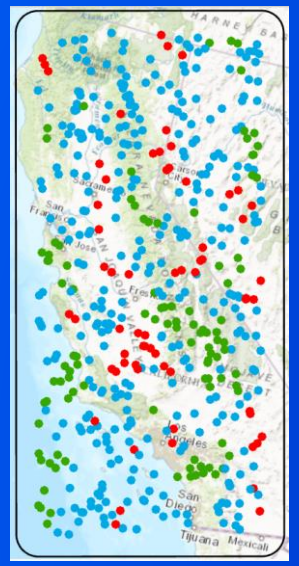


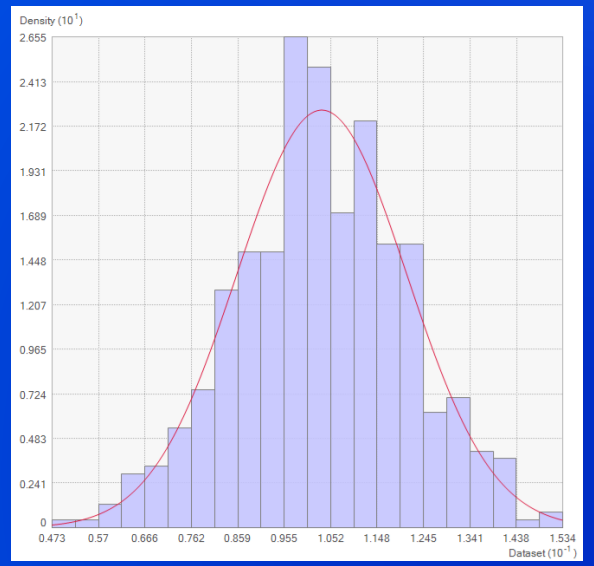


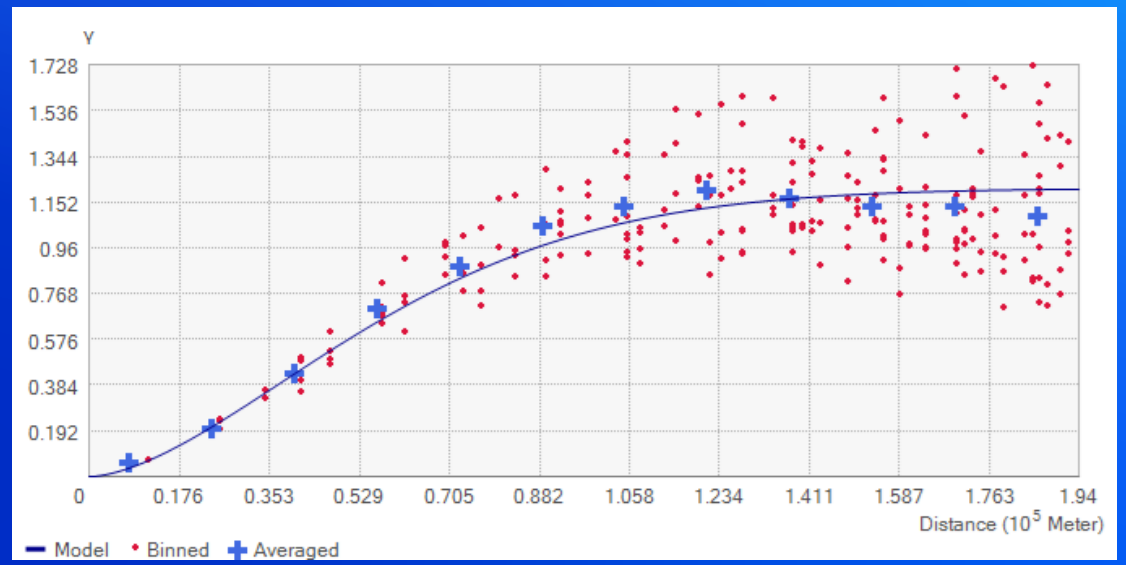


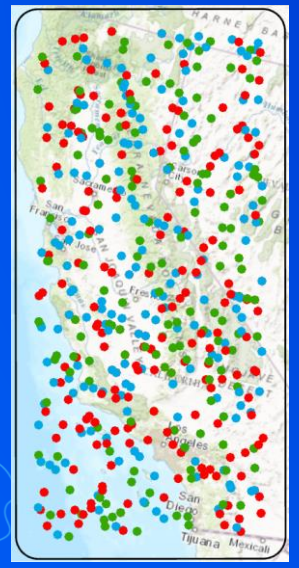
- Range = separation distance between pairs
- Sill = plateau the variogram reaches at the range
- Nugget = sampling error and short scale variability

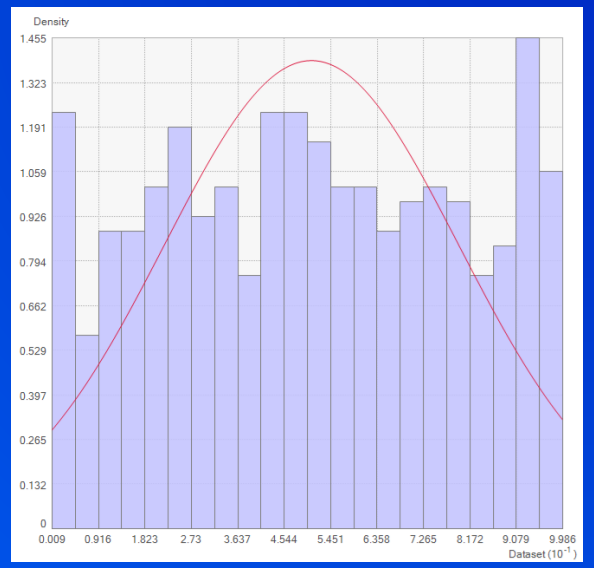
Spatial autocorrelation

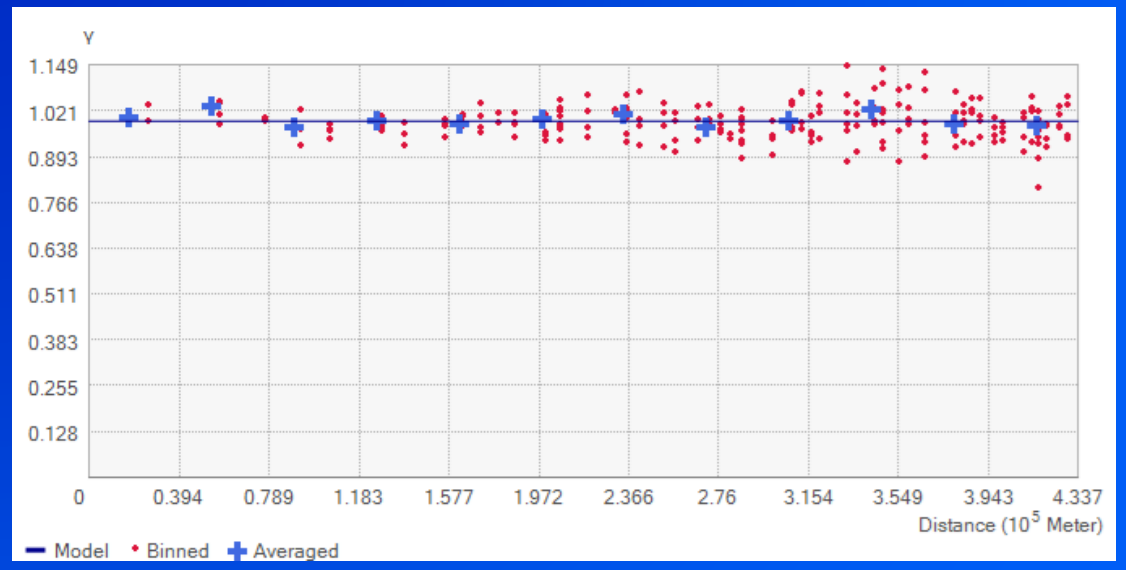








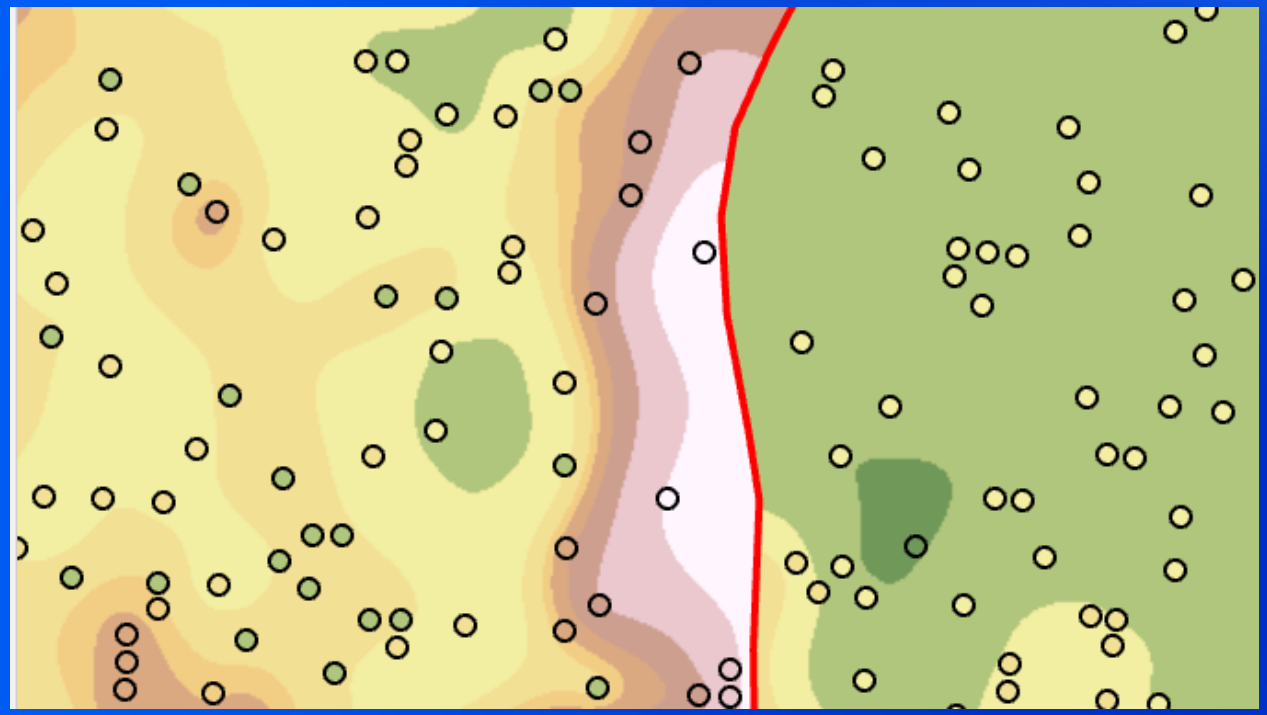




Geostatistical Analyst – What is it?

Provides a complete set of spatial analytical tools that range from techniques to explore the original data to post-processing evaluation of data and predictions uncertainties.

- Geoprocessing tools
  - Use within ArcMap / Pro / Server
  - Modelbuilder
  - Scripting



GP tool

Kernel Interpolation with Barriers

Eric Krause

Geostatistical Analyst – Geoprocessing tools

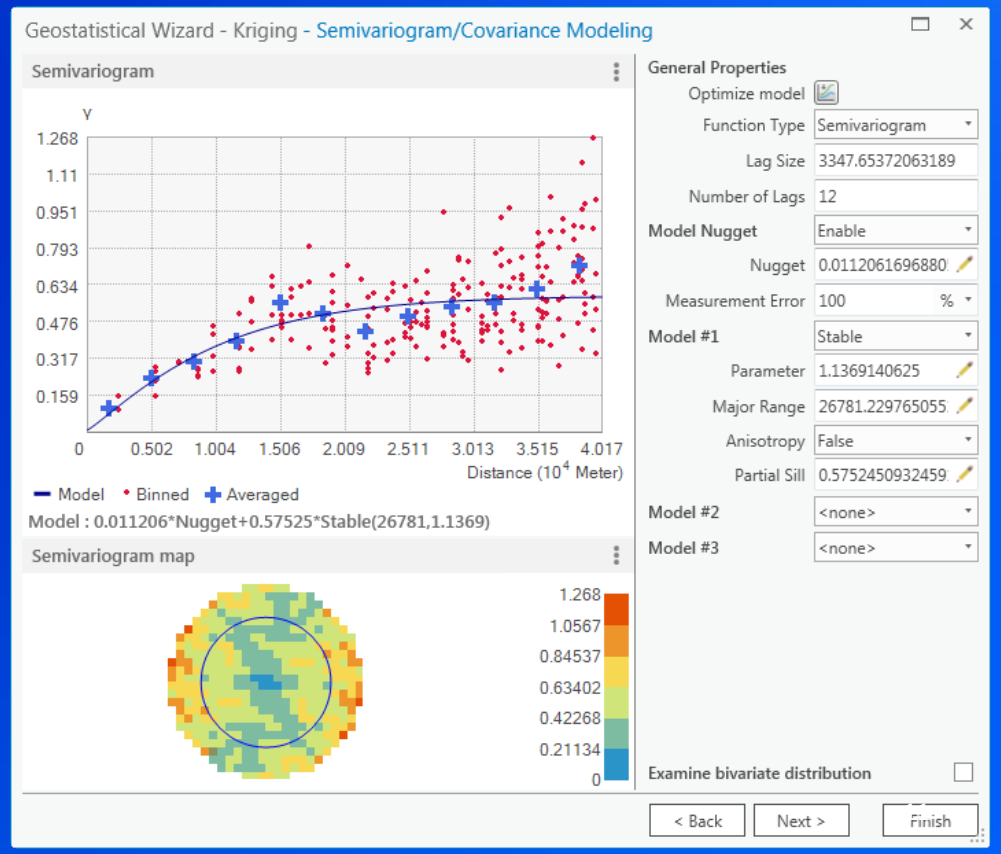
- Geostatistical Analyst Tools
  - Interpolation
    - Diffusion Interpolation With Barriers
    - EBK Regression Prediction
    - Empirical Bayesian Kriging
    - Empirical Bayesian Kriging 3D
    - Global Polynomial Interpolation
    - IDW
    - Kernel Interpolation With Barriers
    - Local Polynomial Interpolation
    - Moving Window Kriging
    - Radial Basis Functions
  - Sampling Network Design
    - Create Spatially Balanced Points
    - Densify Sampling Network
  - Simulation
    - Extract Values To Table
    - Gaussian Geostatistical Simulation
  - Utilities
    - Cross Validation
    - Neighborhood Selection
    - Semivariogram Sensitivity
    - Subset Features
  - Working with Geostatistical Layers
    - Areal Interpolation Layer To Polygons
    - Calculate Z-value
    - Create Geostatistical Layer
    - GA Layer To Contour
    - GA Layer To Grid
    - GA Layer To Points
    - GA Layer To Rasters
    - Get Model Parameter
    - Set Model Parameter

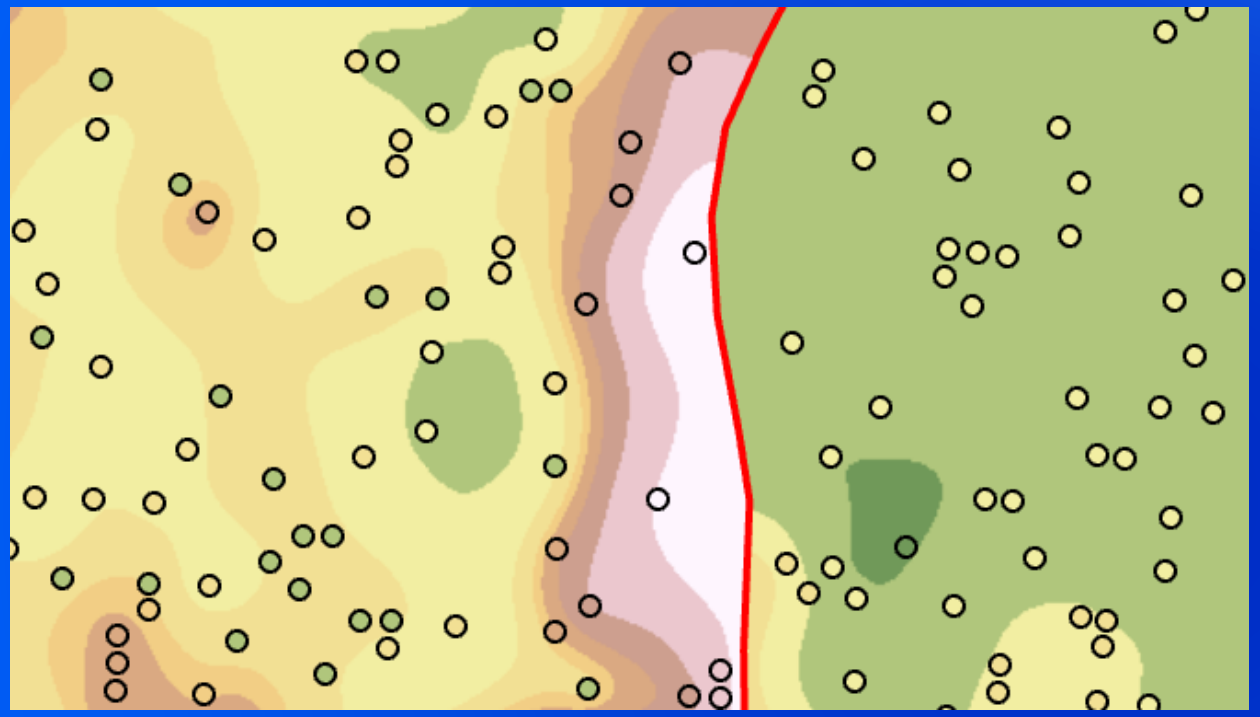
2.3

Geostatistical Analyst – What is it?

Provides a complete set of spatial analytical tools that range from techniques to explore the original data to post-processing evaluation of data and predictions uncertainties.

- Wizard
  - is a dynamic set of pages that is designed to guide you through the process of constructing and evaluating the performance of an interpolation model.





Geostatistical Wizard

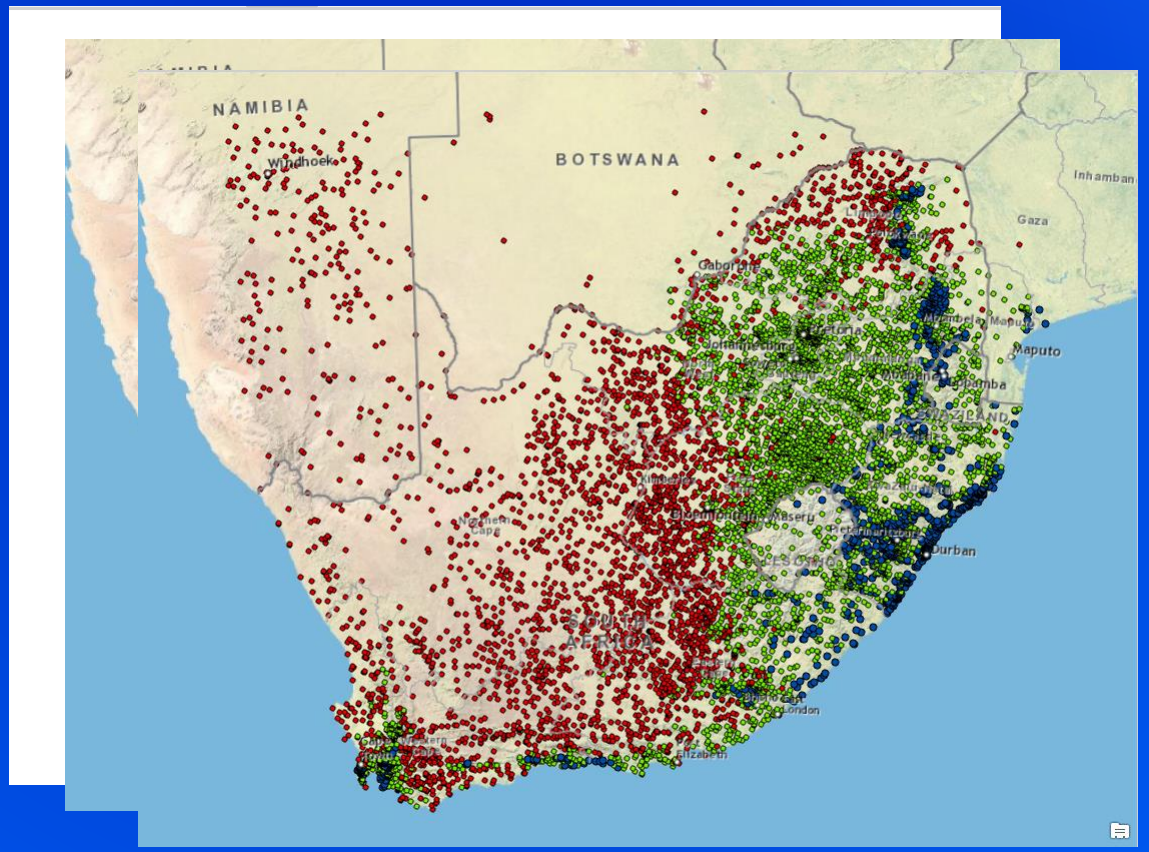
Kernel Interpolation with Barriers

Eric Krause

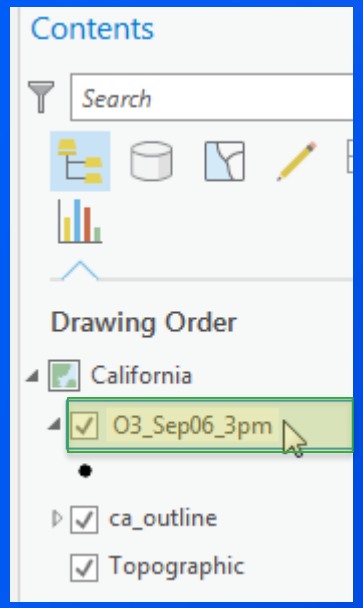
ESDA

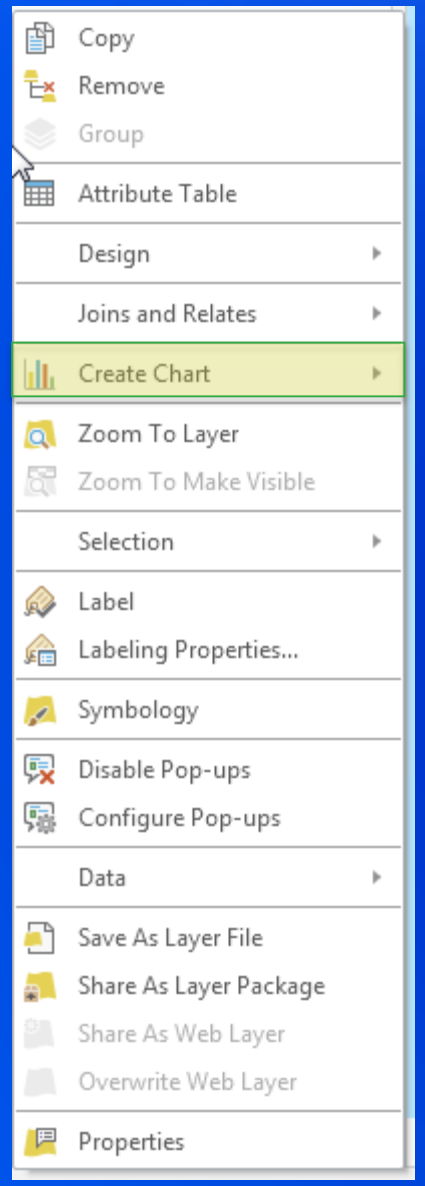
Exploratory Spatial Data Analysis

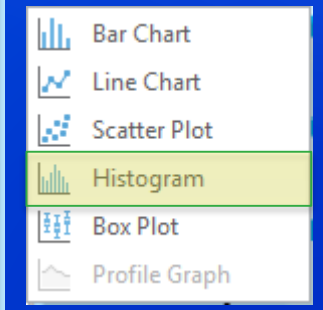
- Where is the data located?
- What are the values at the data points?
- How does the location of a point relate to its value?

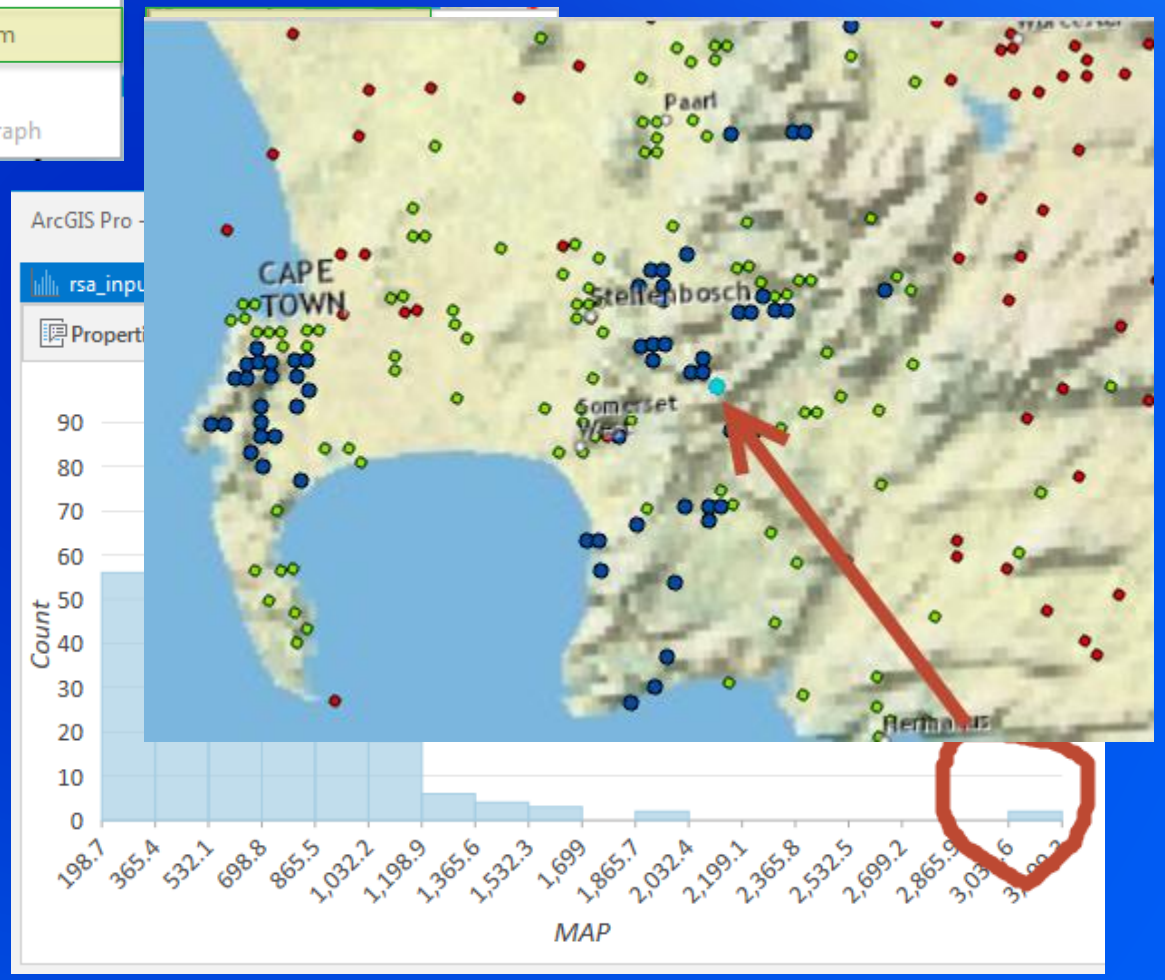


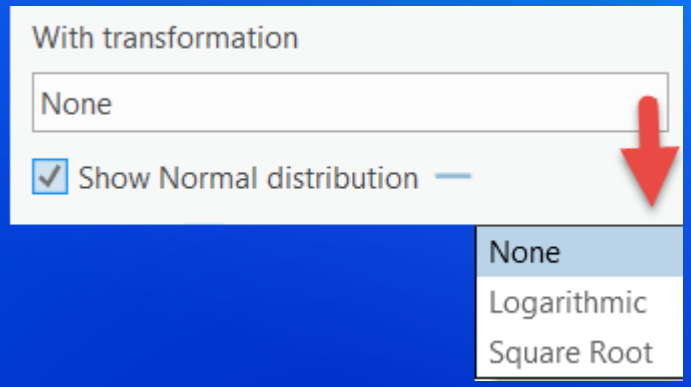
Exploratory Spatial Data Analysis (ESDA)

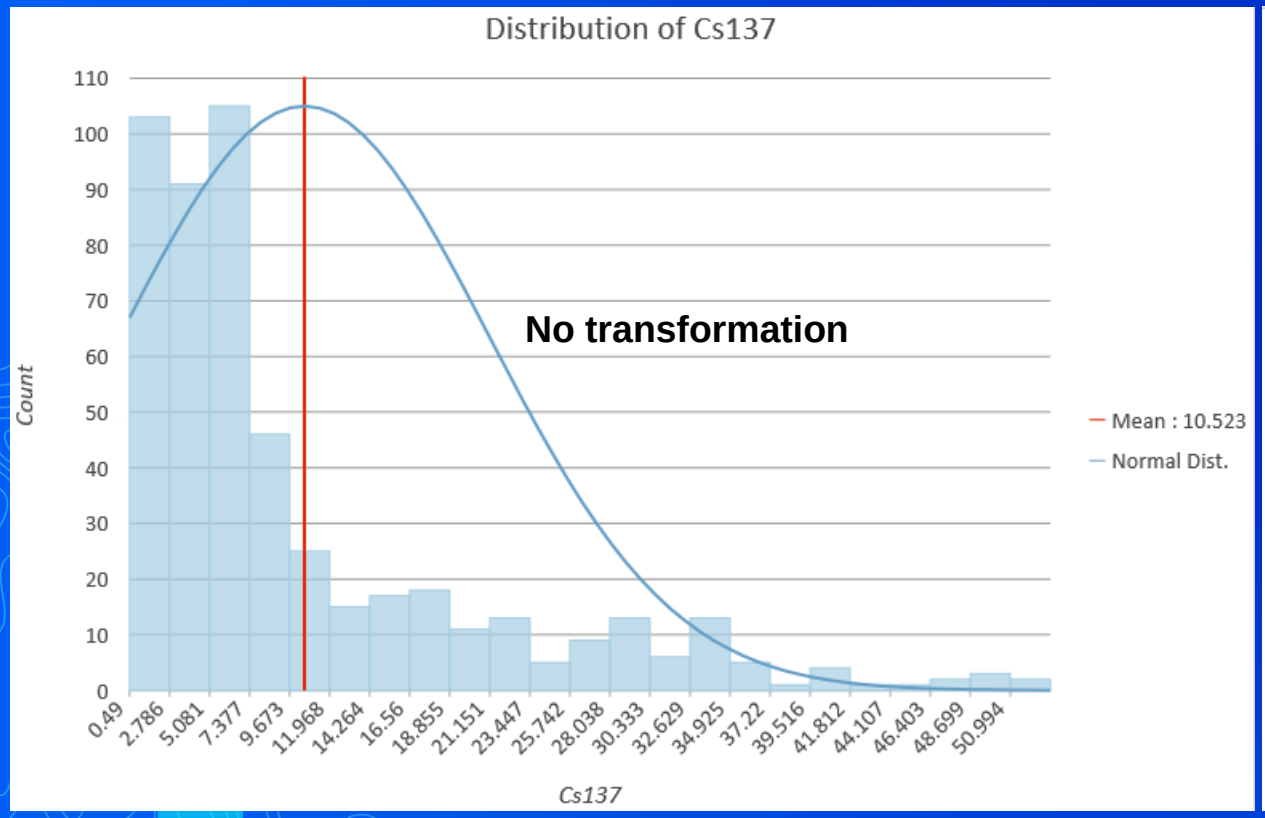


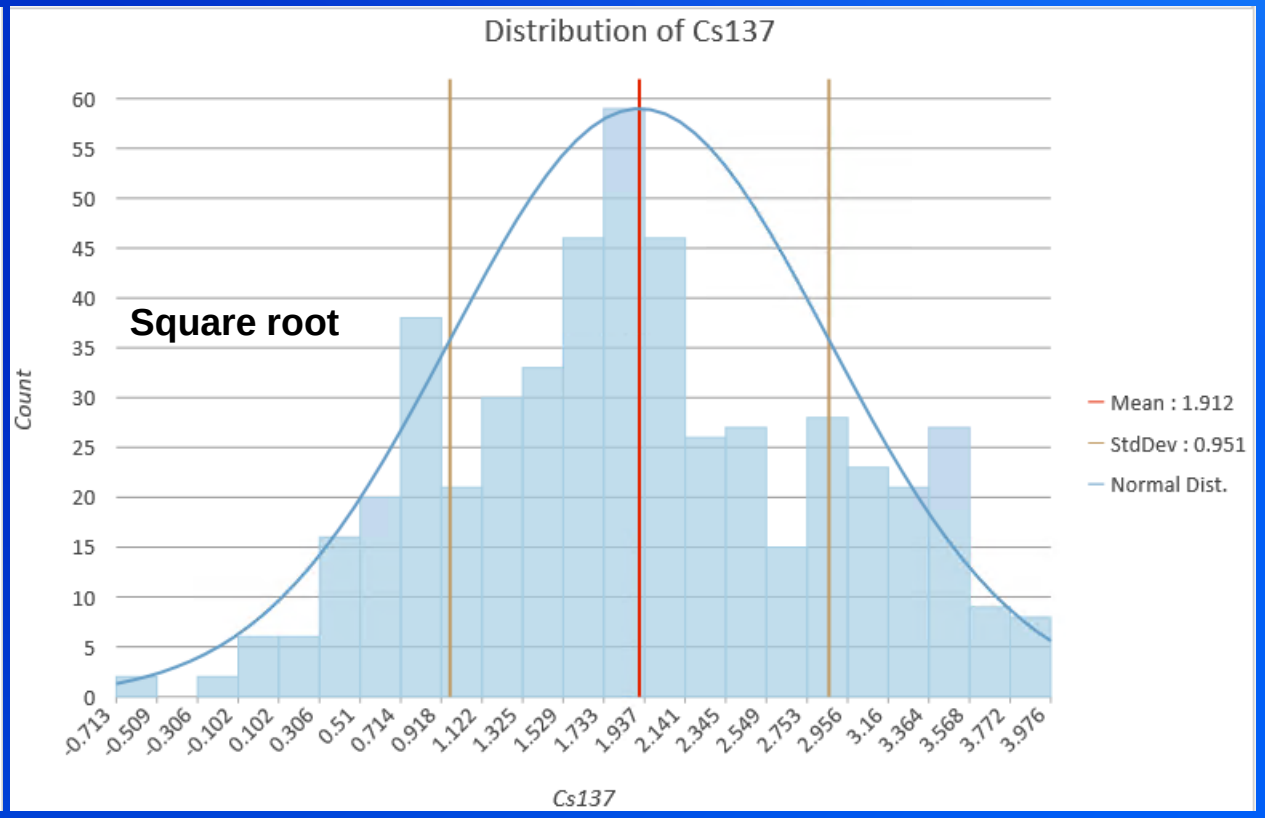







With transformation
None
Show Normal distribution
None
Logarithmic
Square Root


Distribution of Cs137
No transformation
Count
Cs137
Mean : 10.523
Normal Dist.


Distribution of Cs137
Square root
Count
Cs137
Mean : 1.912
StdDev : 0.951
Normal Dist.

What is kriging?

Tuesday

- Kriging: An Introduction to Concepts and Applications (2:30-3:30 SDCC Rm33C)

Wednesday

- Empirical Bayesian Kriging and EBK Regression Prediction in ArcGIS (2:30-3:15 SDCC Demo Theater 10)

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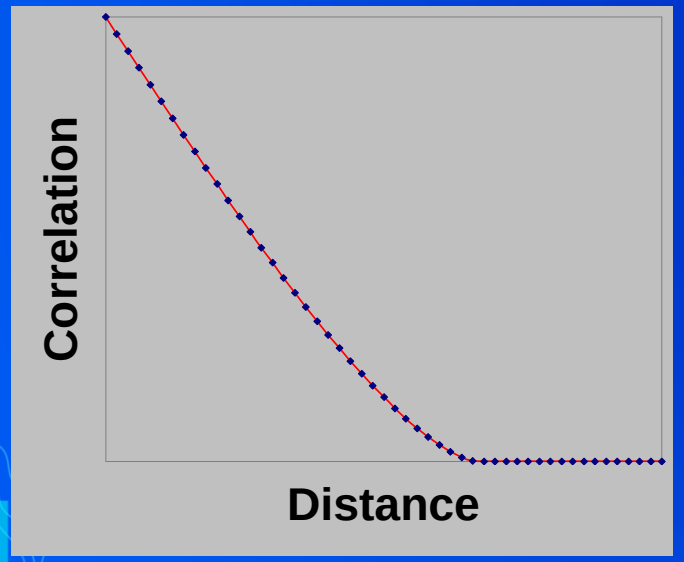
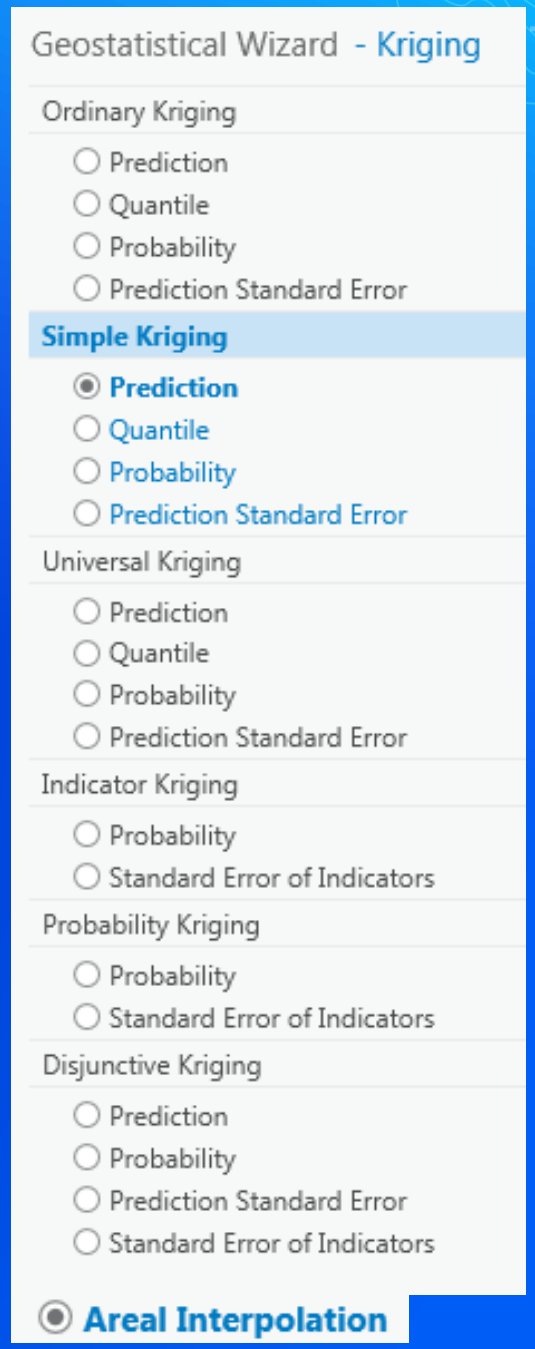
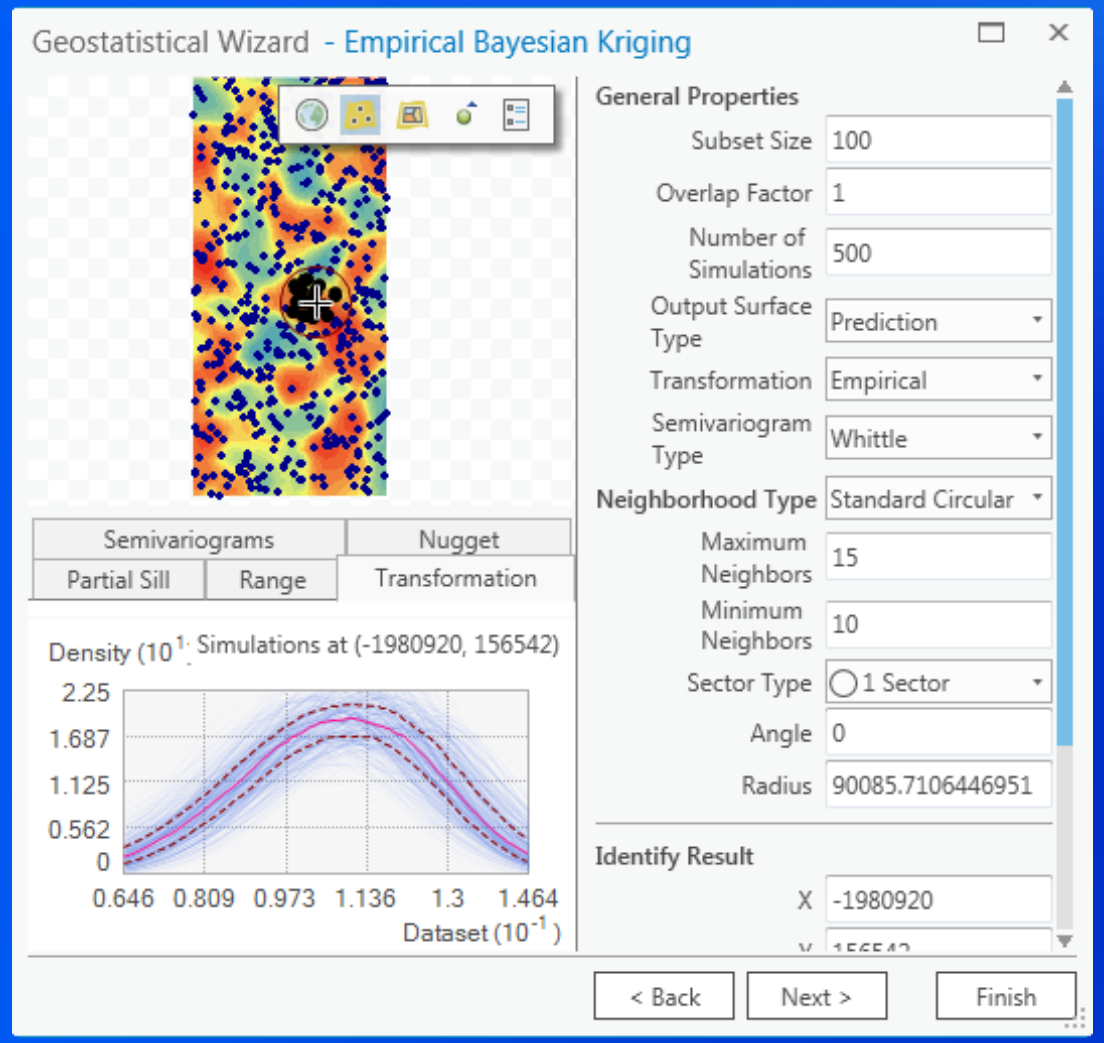
What is kriging?

- It is a geostatistical interpolation technique
- that models the spatial correlation of point measurements
- to estimate values at unmeasured locations.
- Associates uncertainty with the predictions







Geostatistical Wizard

Eric Krause

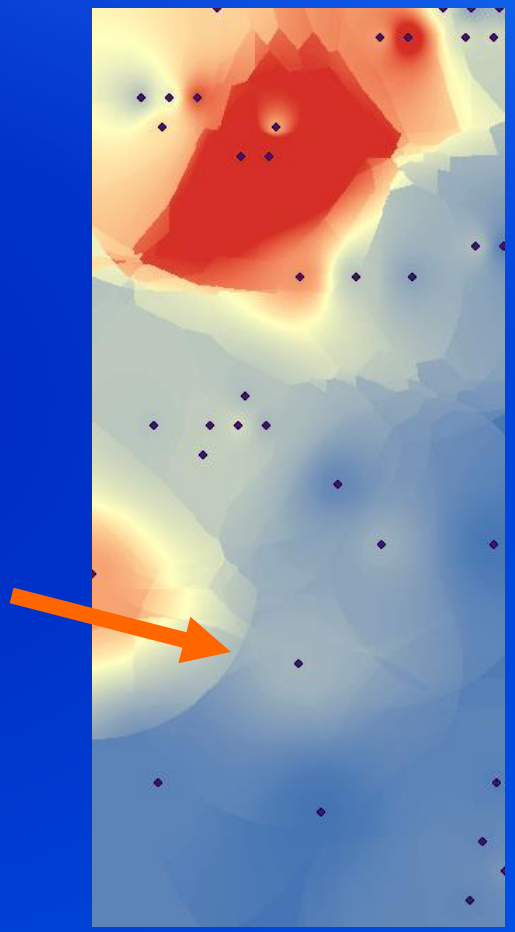
Interpolation workflow

- ESDA
- Interpolate
- Goodness of fit

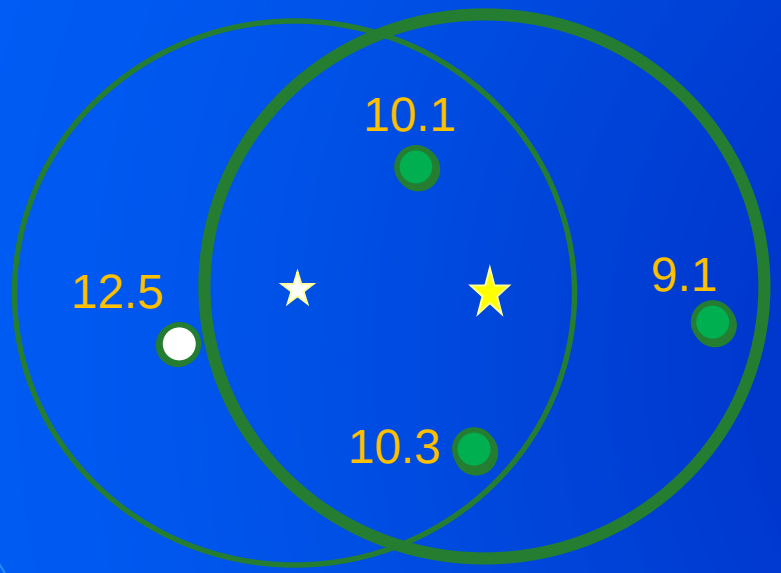
Why use ESRI's Geostatistical Analyst?

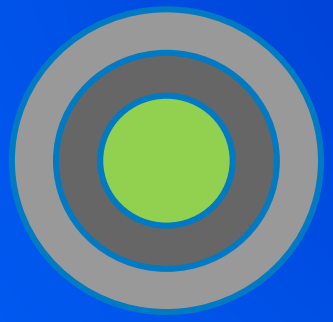
- Search neighborhood
  - Sectors
  - Smooth
- Chordal distance
- Cross validation
- Error maps
- Interactive Variography
- Barriers
- Simulations
- 3D interpolation

Search neighborhood - Smooth

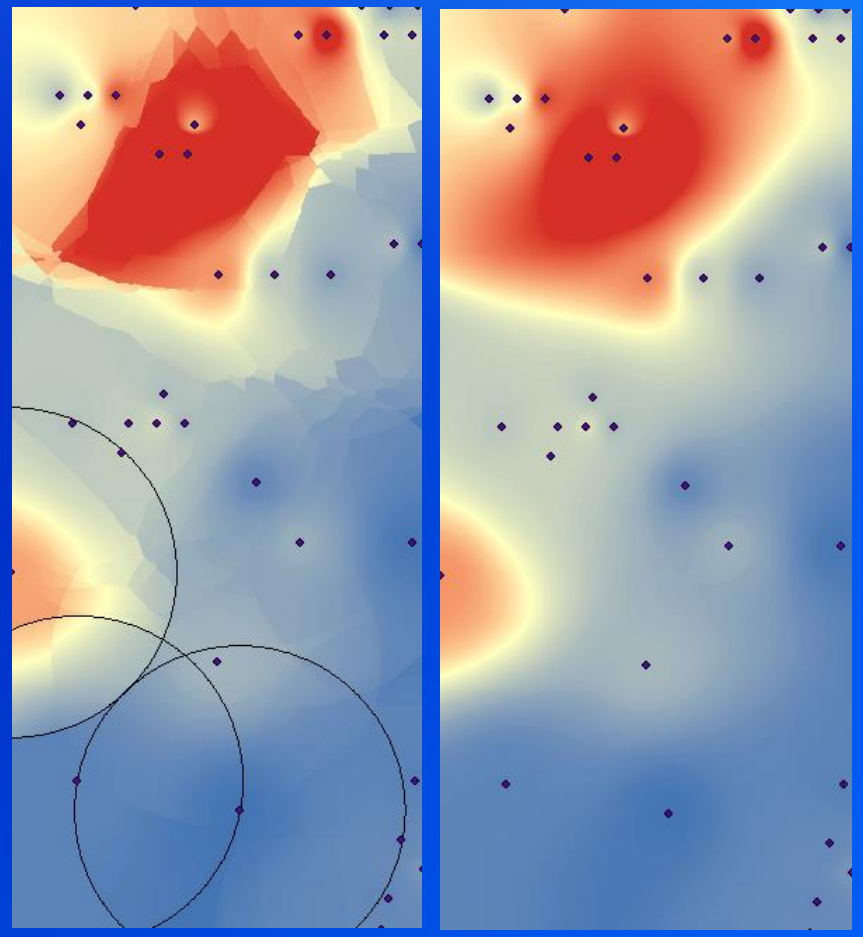


Search neighborhood - Smooth

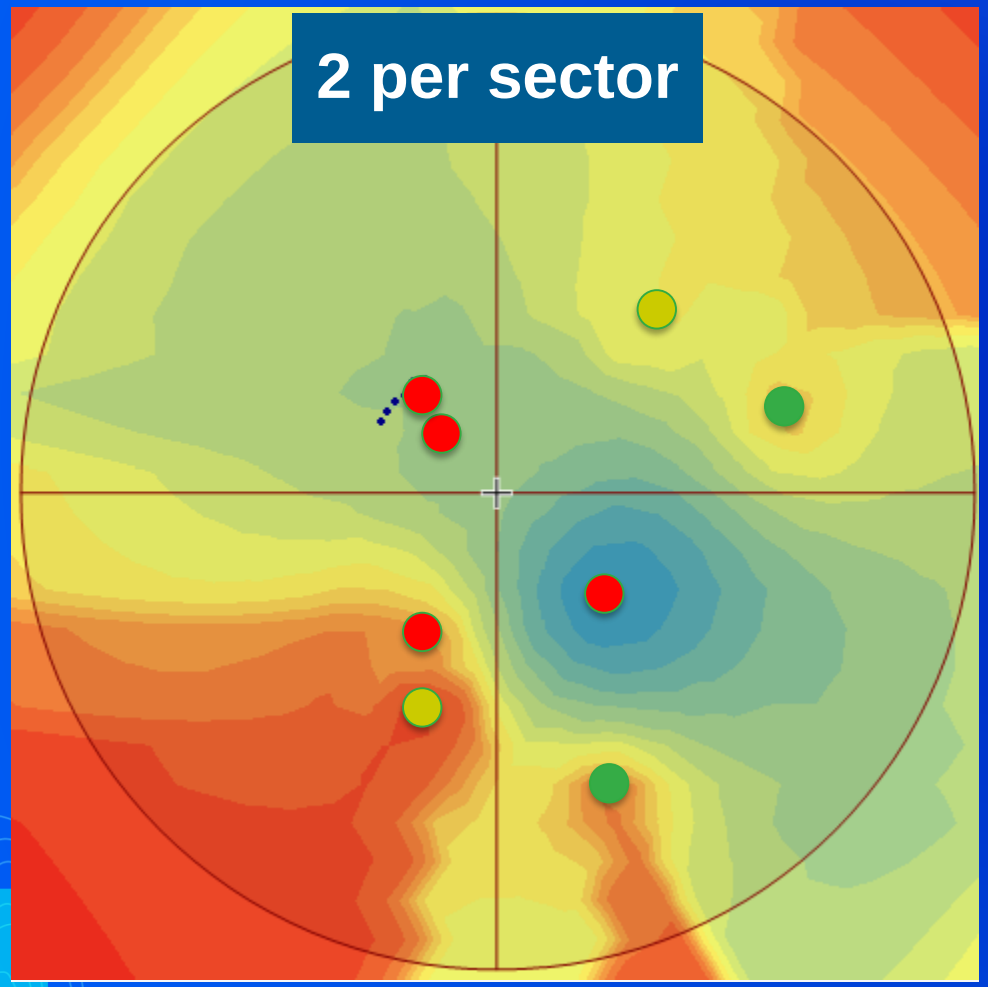


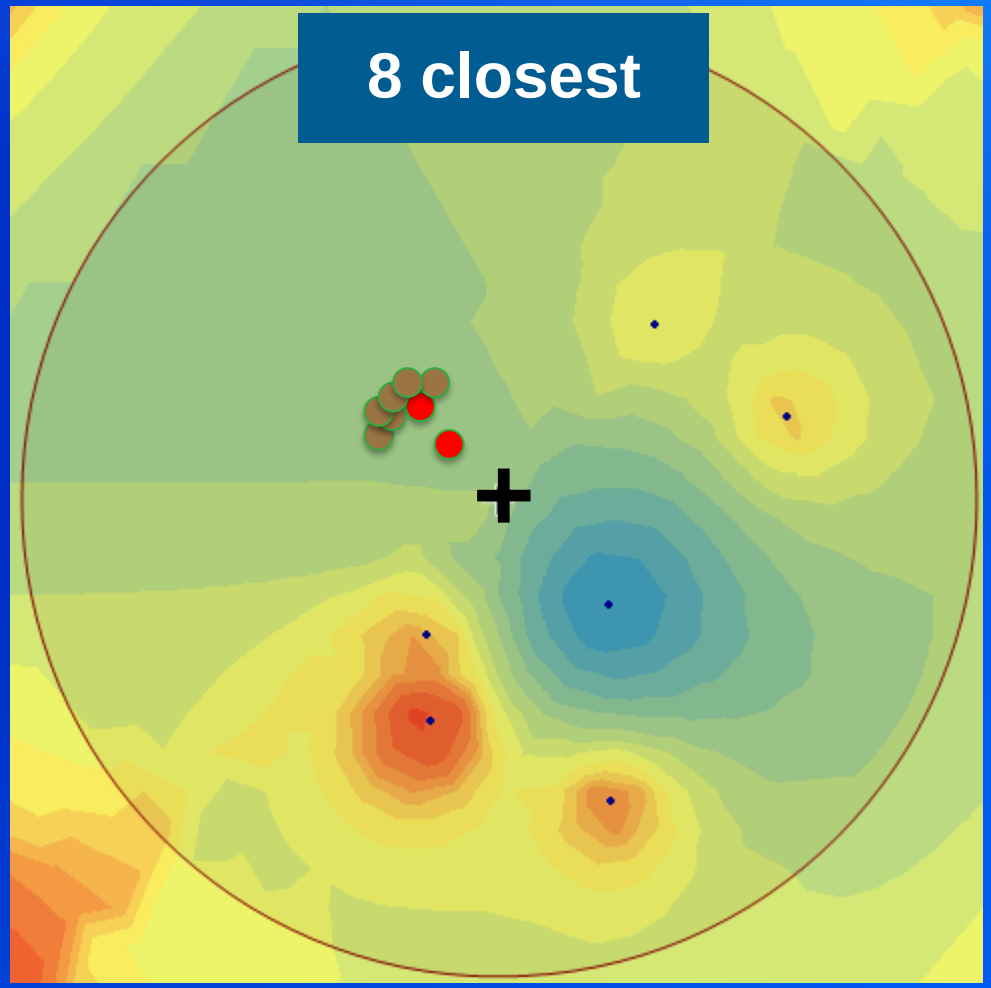


Unlike smoothing the output,
this method modifies the weights



Search neighborhood - Standard





Chordal distances

Only for EBK and EBK Regression Prediction

- Automatically kicks in when data are in GCS
- The chordal distance between any two points is the straight-line distance that connects the two points.
- This line will go through the earth rather than along its surface.

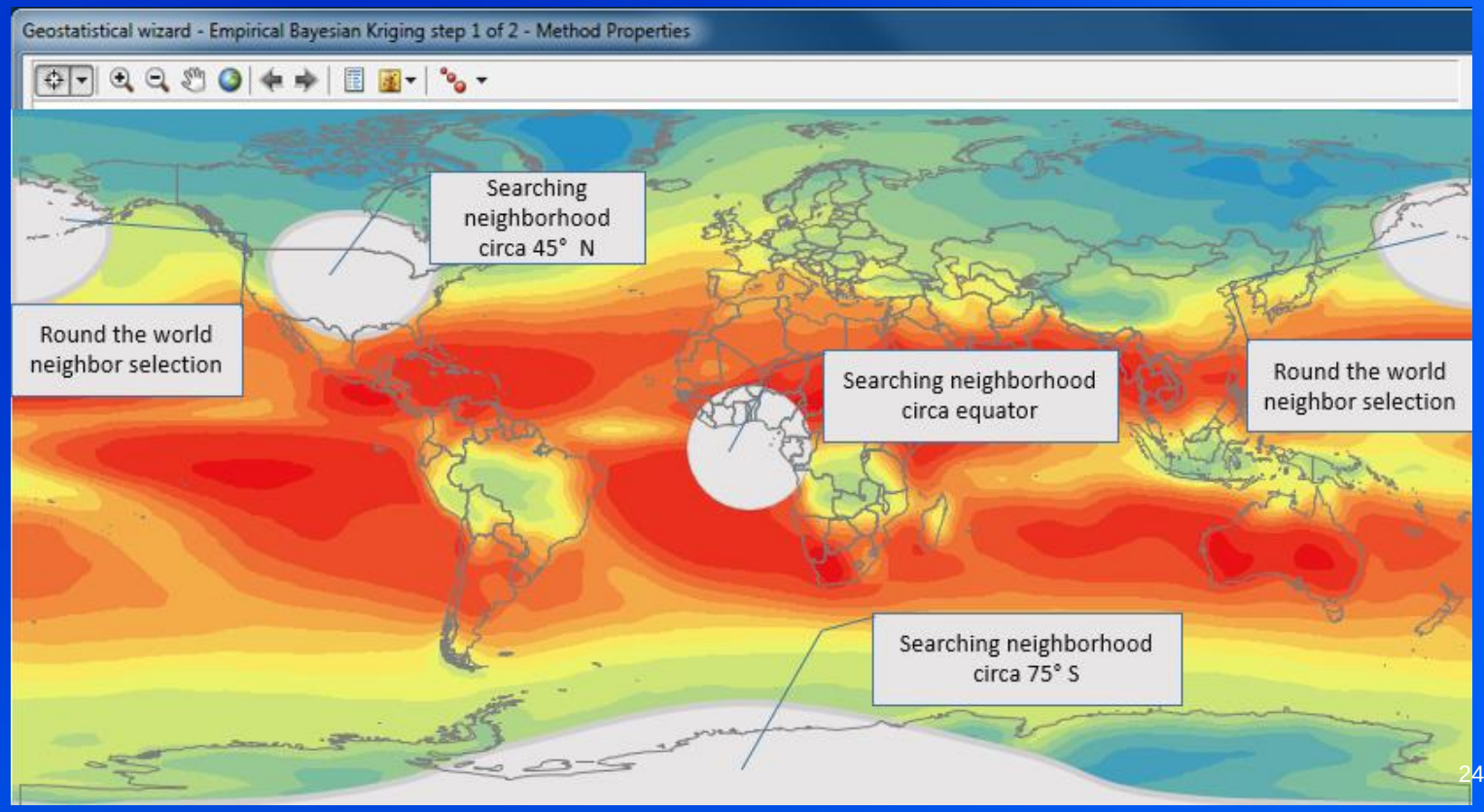
Distance between LA and New York

Geodesic = 3,939.1 km

Chordal = 3,877.0 km

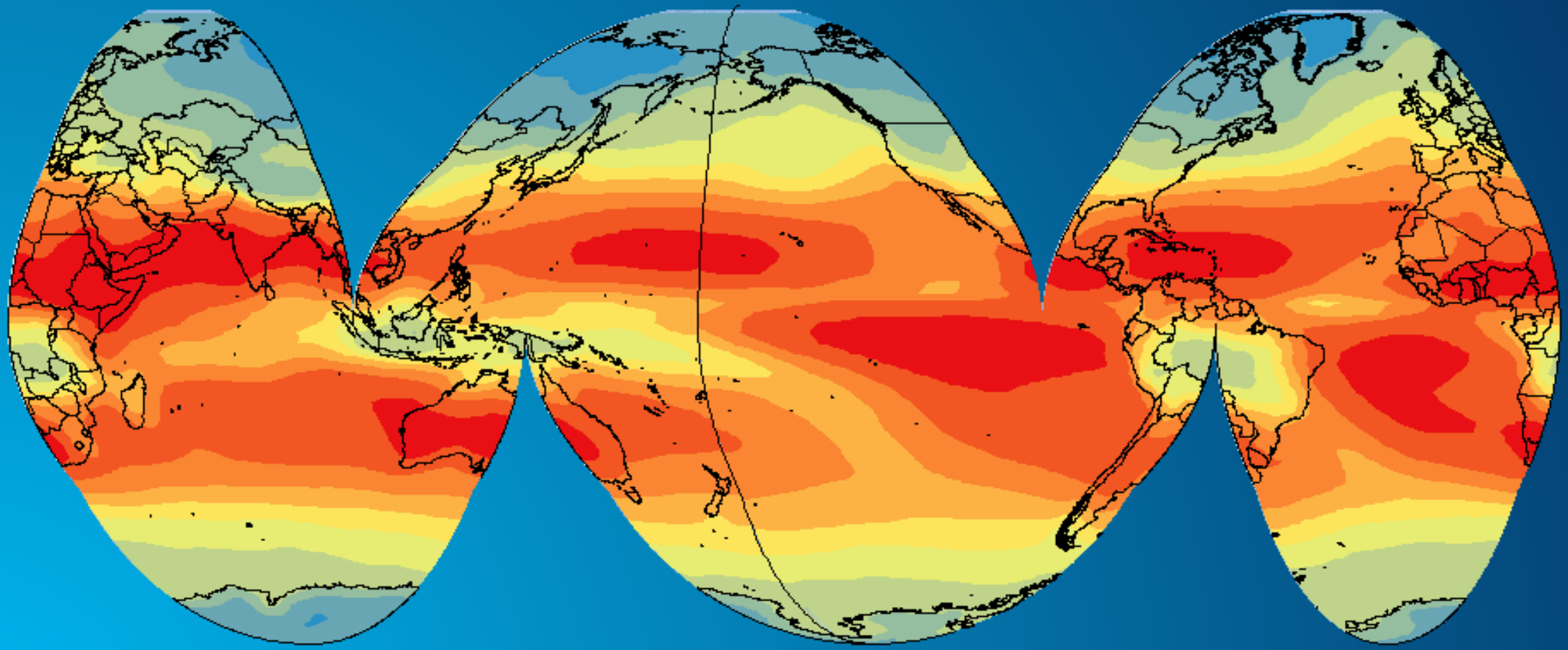
Difference = 62.1 km (1.5%)

Speed!

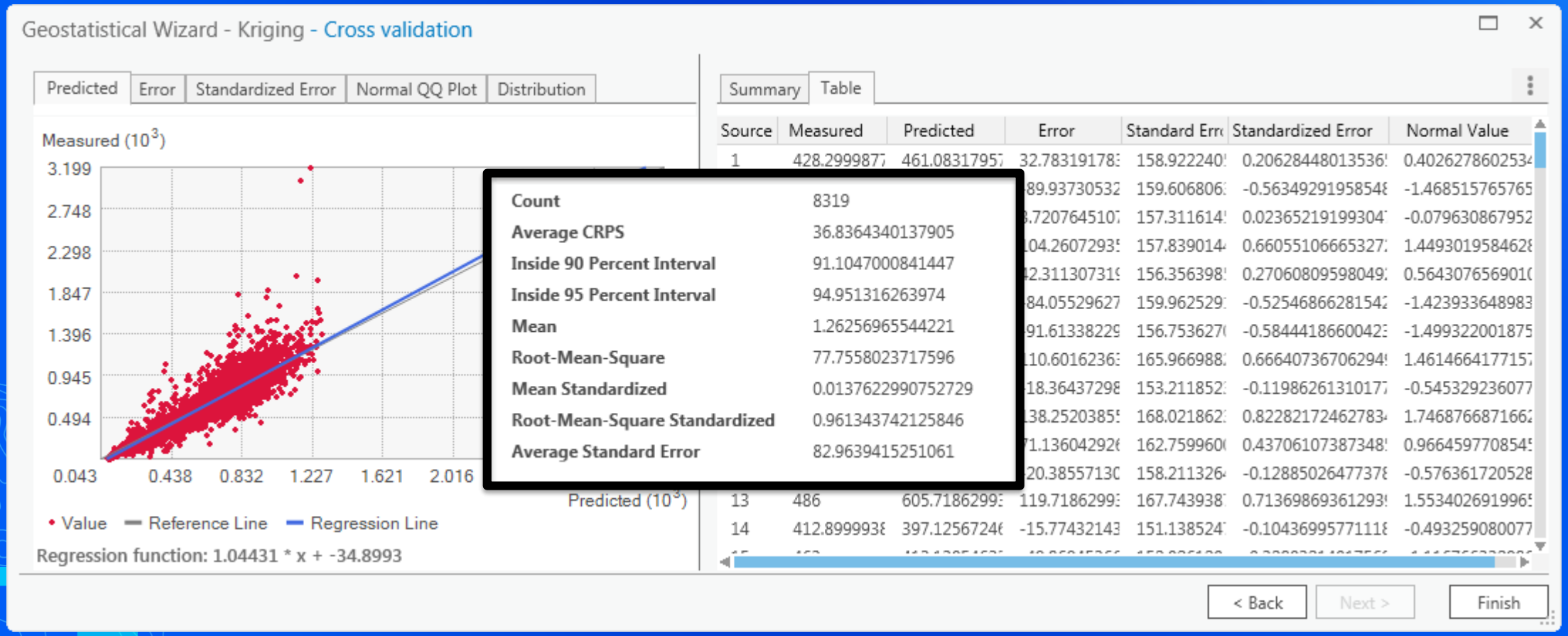


Chordal distances

Only for EBK and EBK Regression Prediction

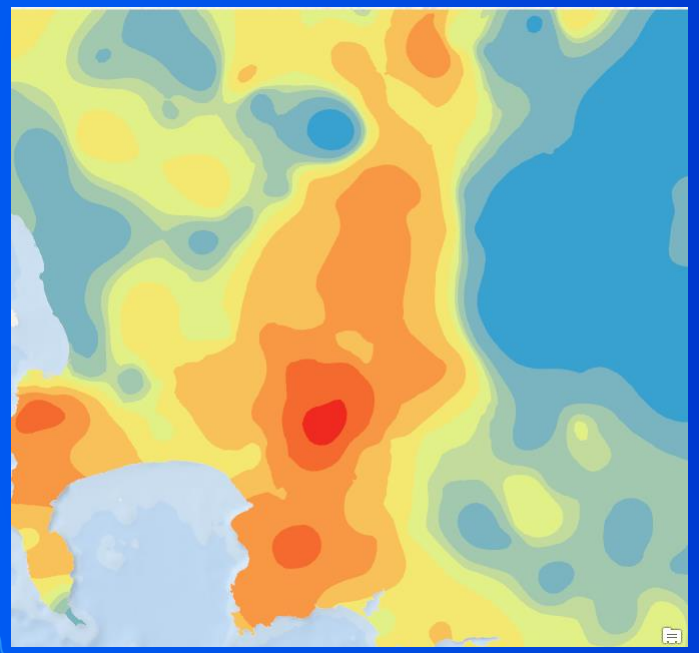


Cross validation / Validation

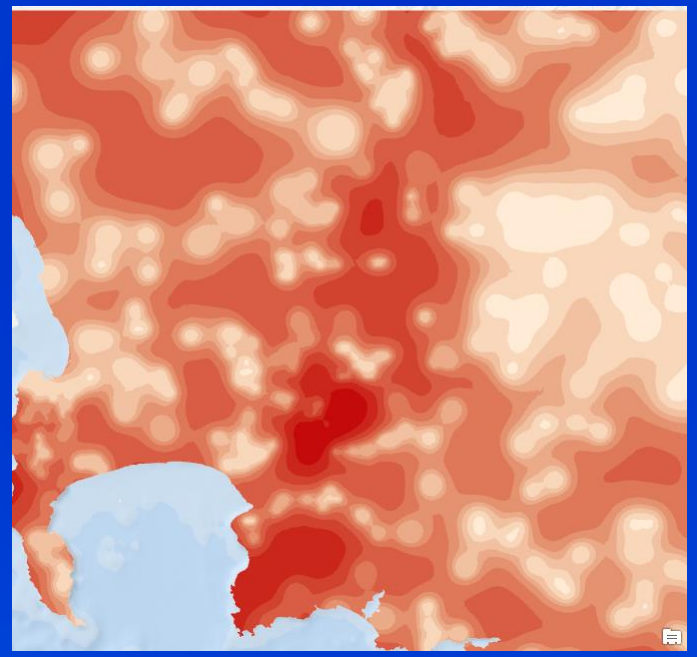


Output surfaces

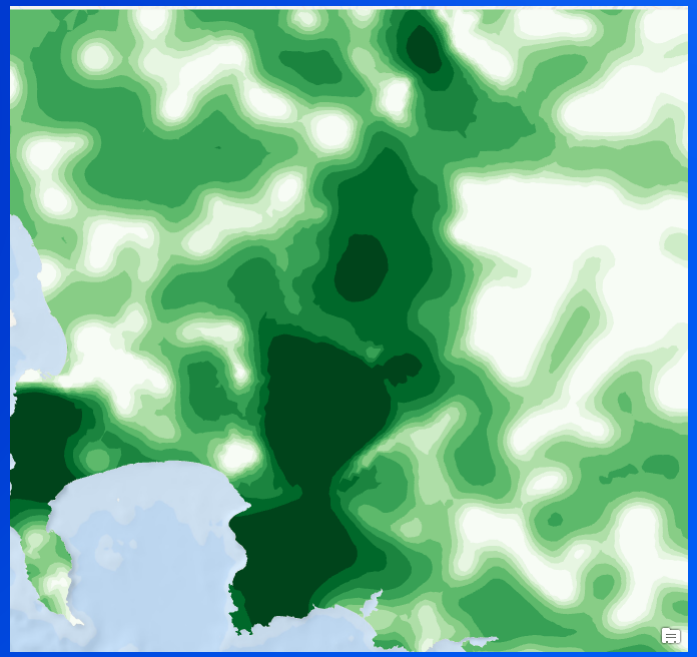
Prediction



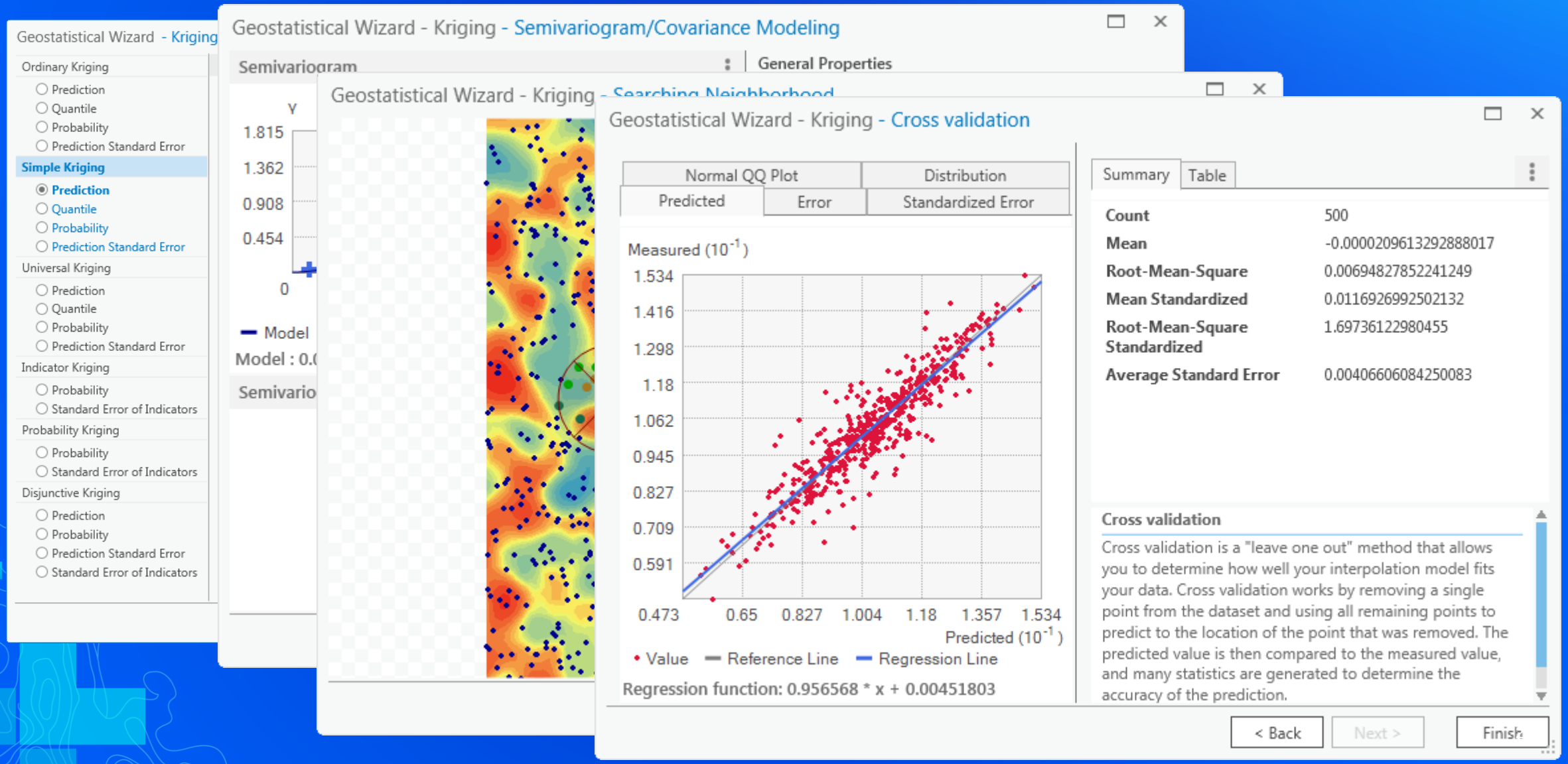
Standard error of prediction



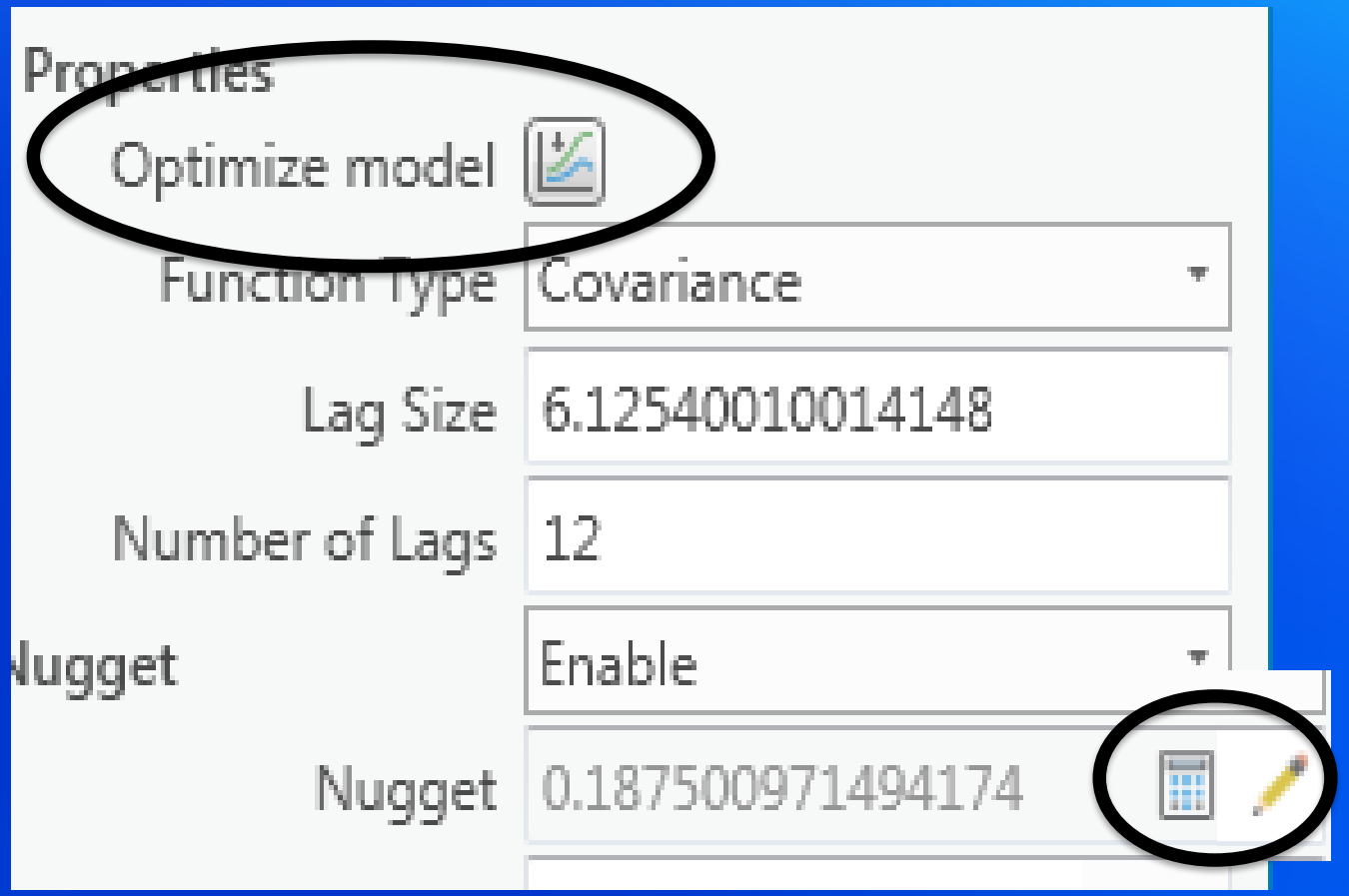
Probability that rainfall exceeds 900mm



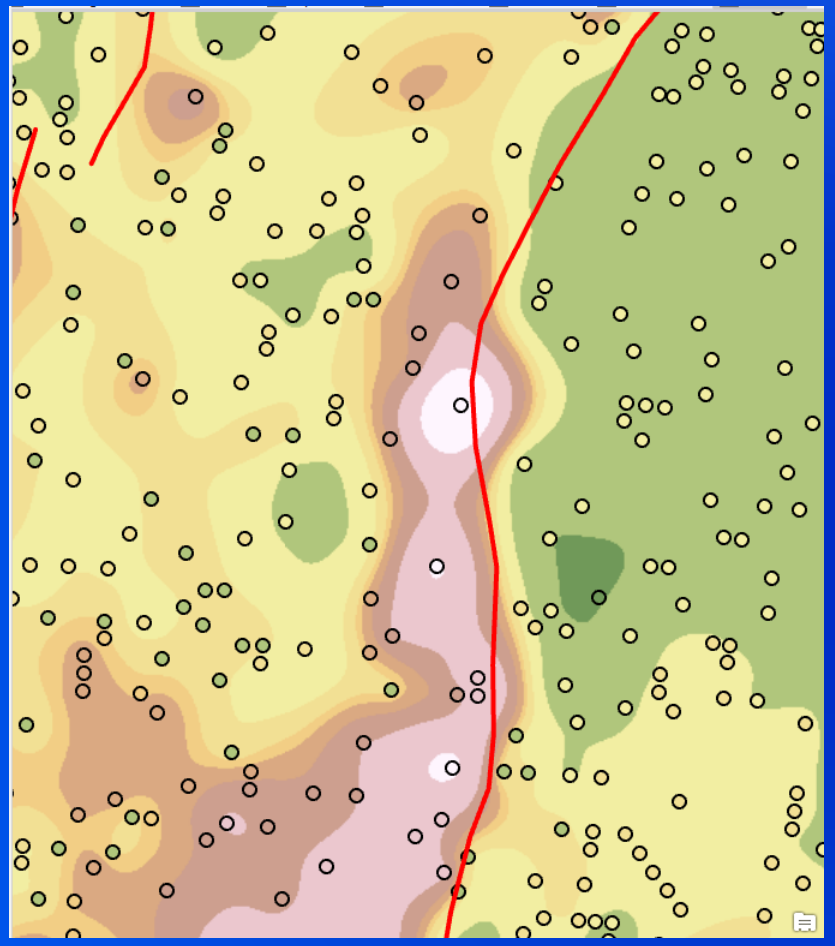
Interactive Wizard

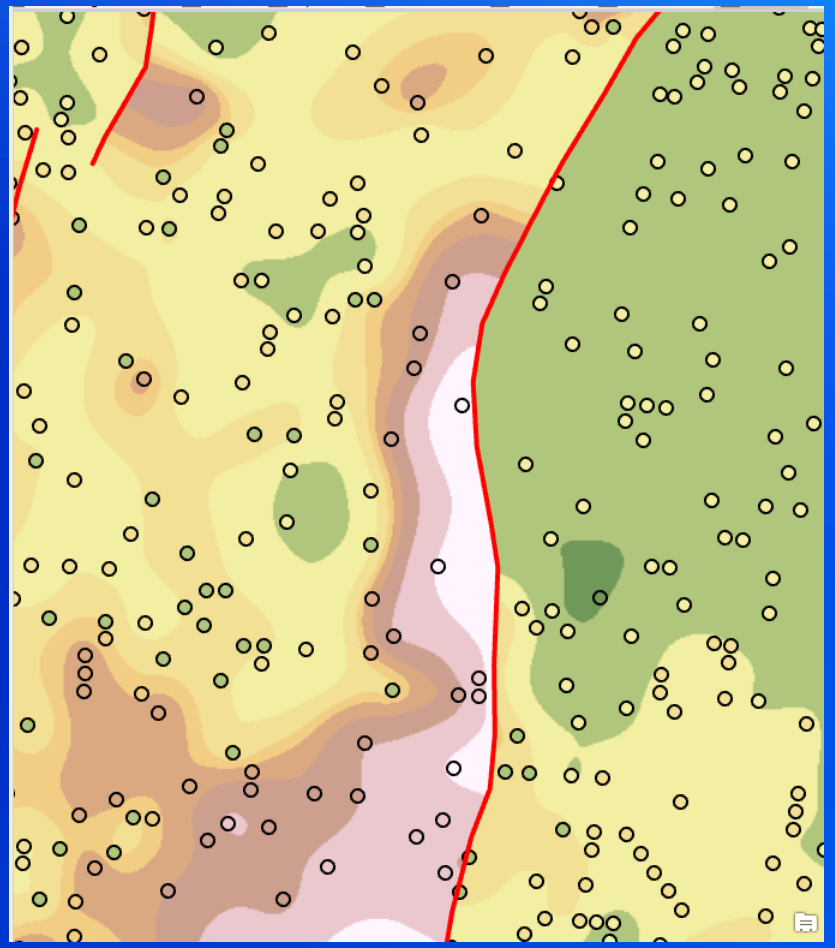


Interactive Wizard



Barriers

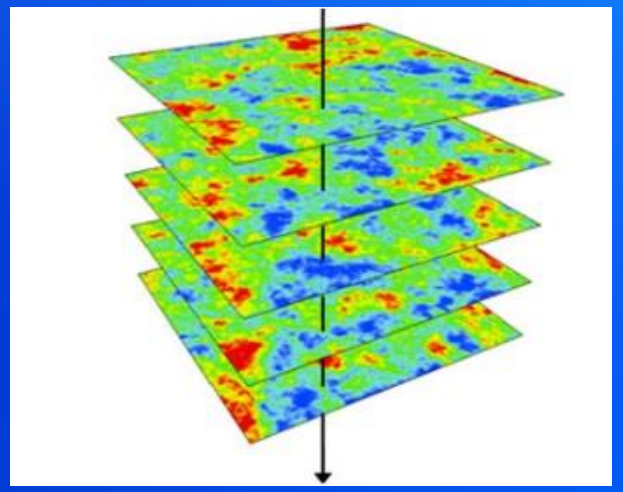


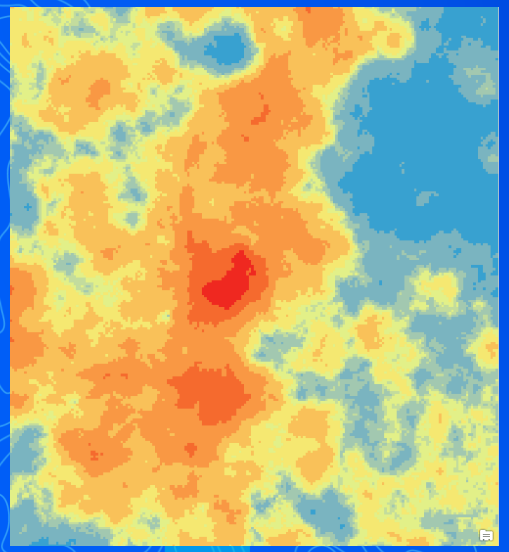


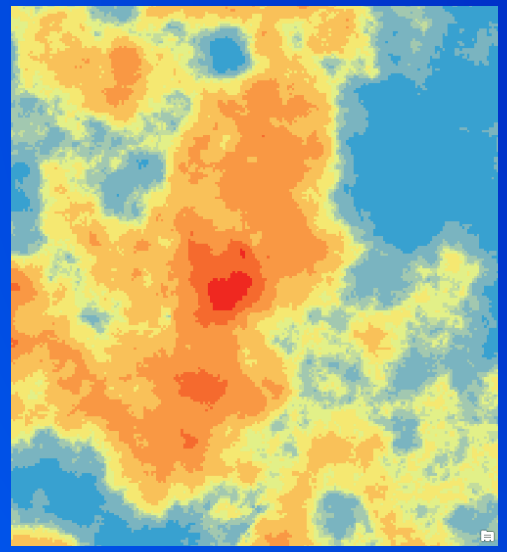
Gaussian Geostatistical Simulations

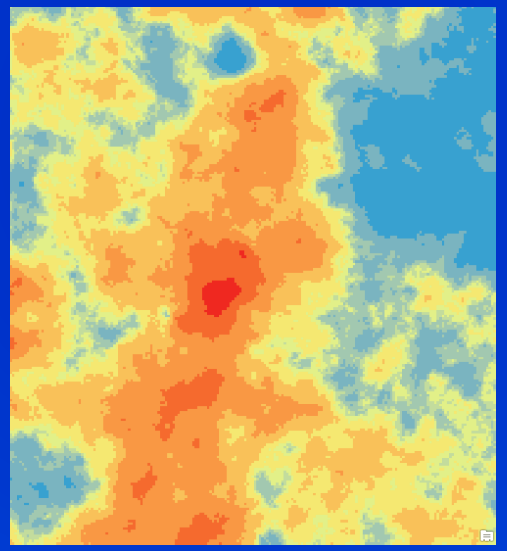
Create multiple versions (realizations) of a surface to perform risk analysis.

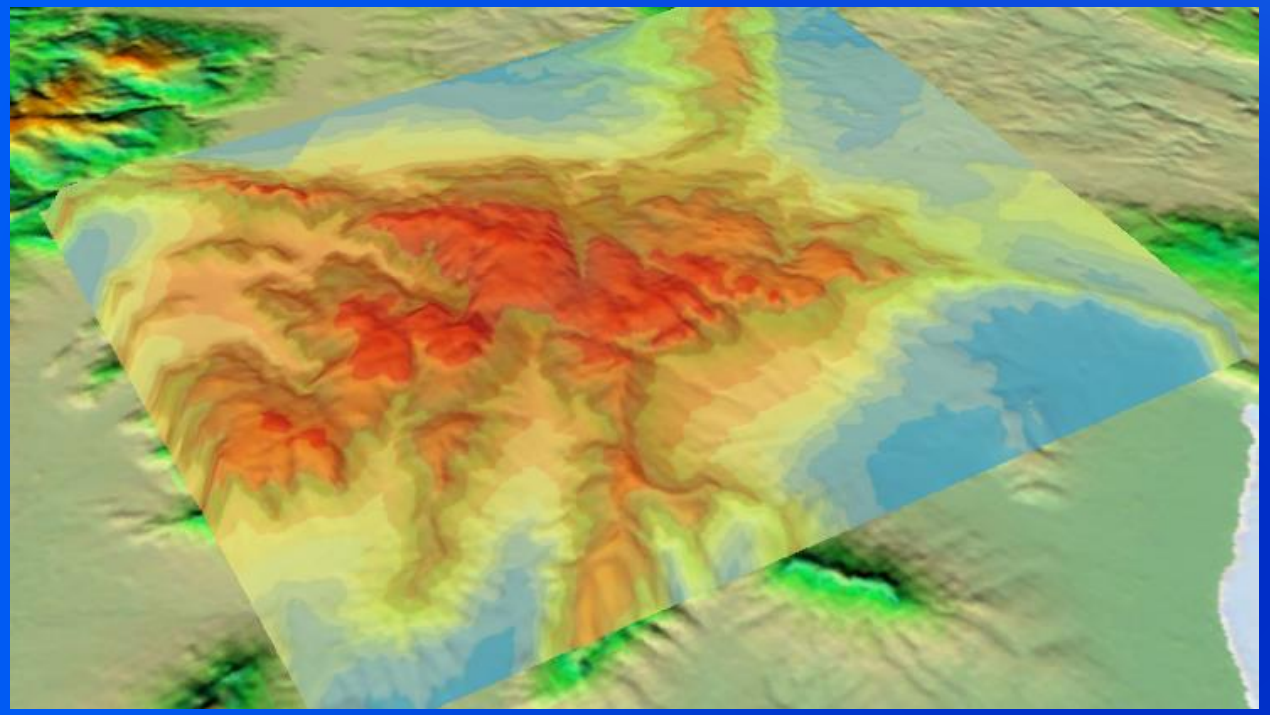
- Any realization might be the “real” thing!





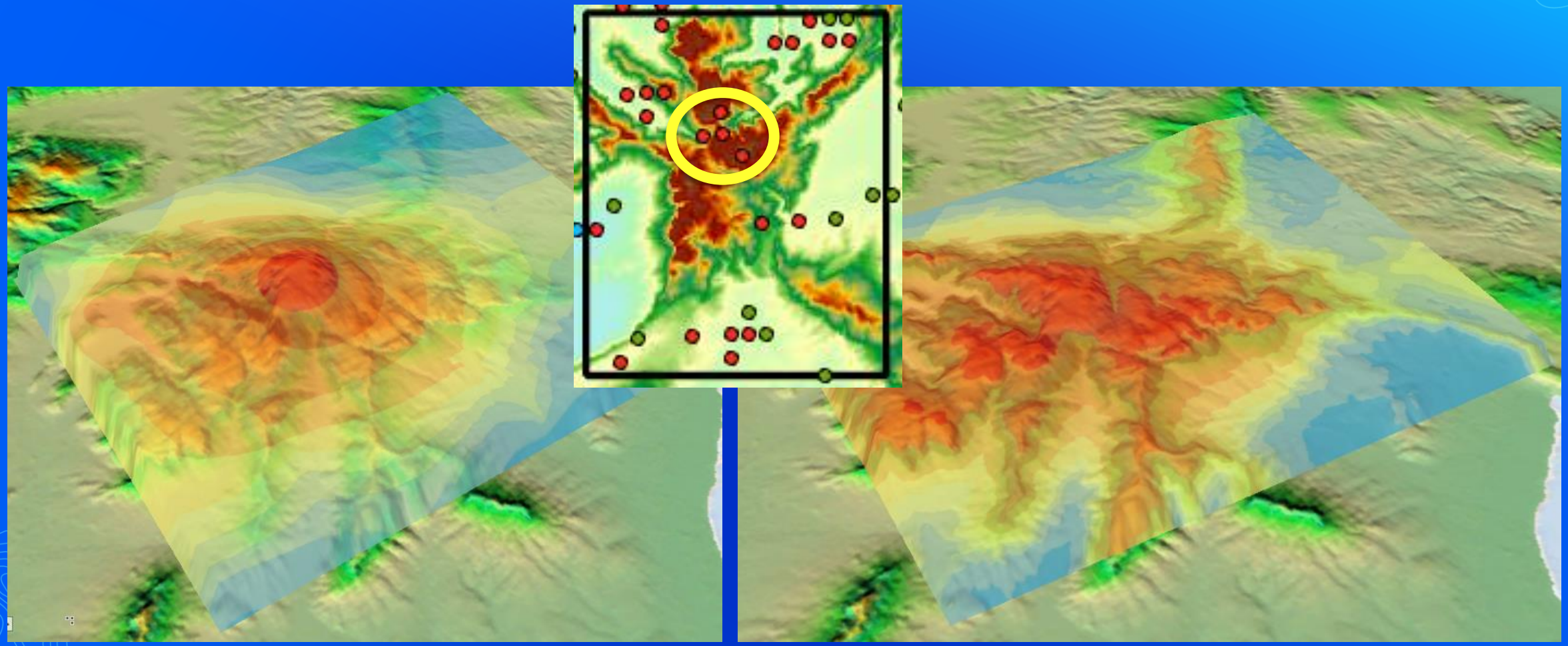






EBK Regression Prediction

Eric Krause

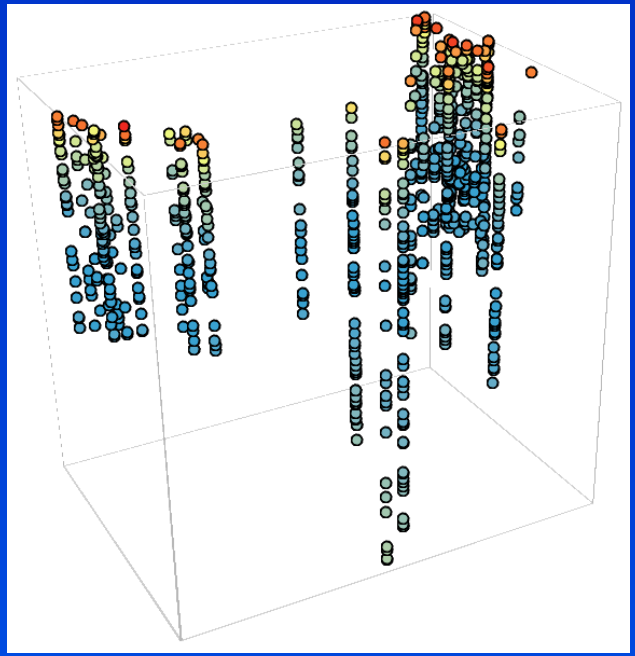


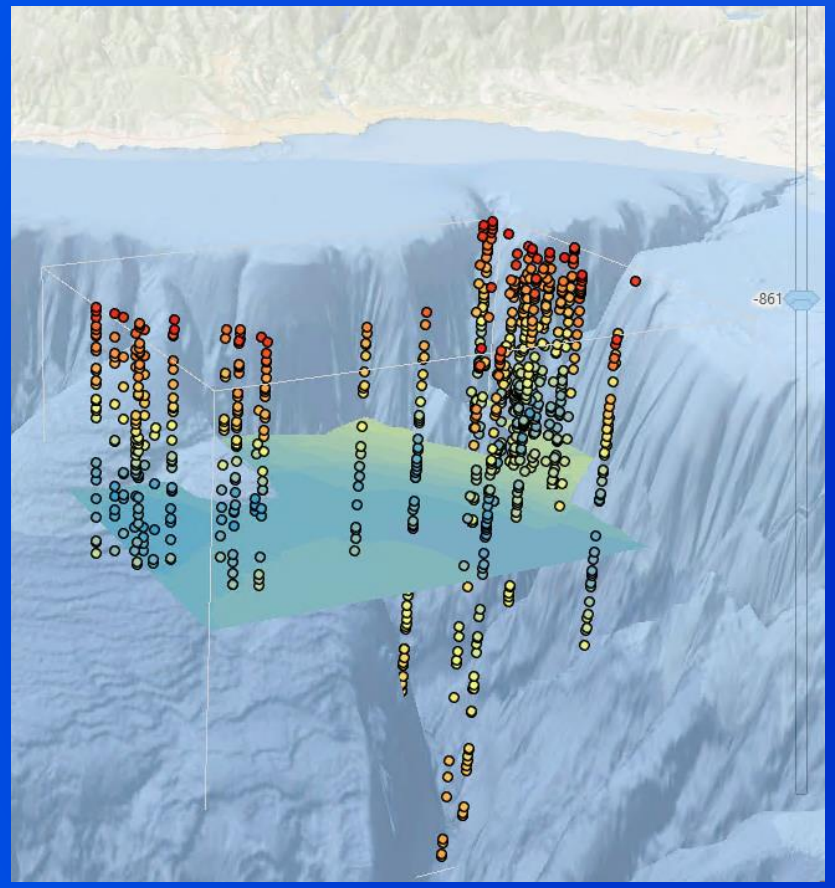
EBK Regression Prediction

Empirical Bayesian Kriging 3D

- Uses EBK
- (x,y,z) and a measured field to interpolate
- z is usually height or depth

For example, dissolved oxygen measured at different (x,y) locations and at different depths.





EBK 3D

Eric Krause

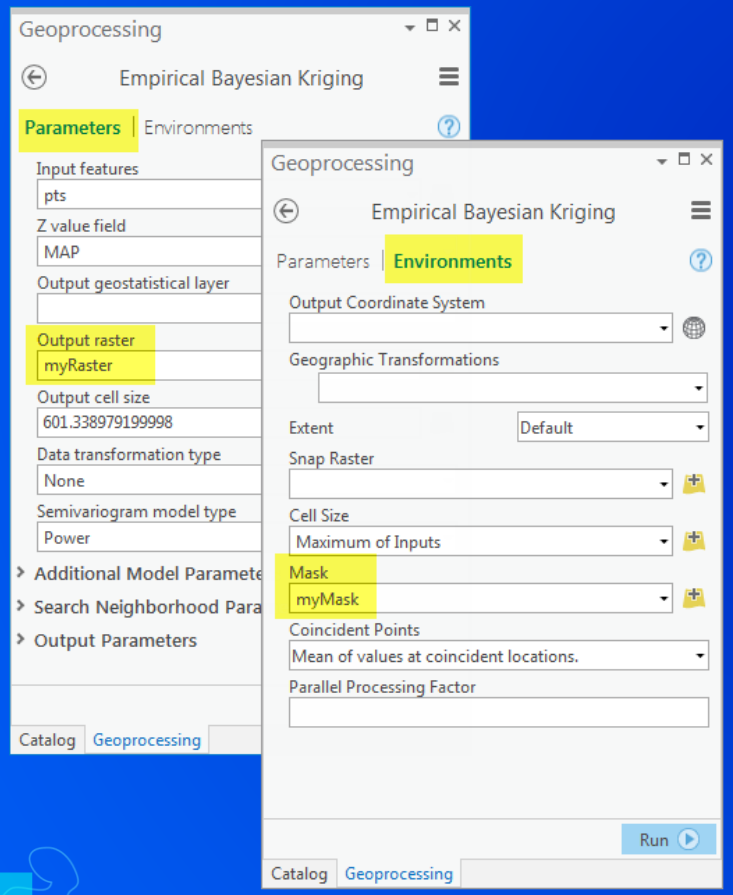
Where is GA used?

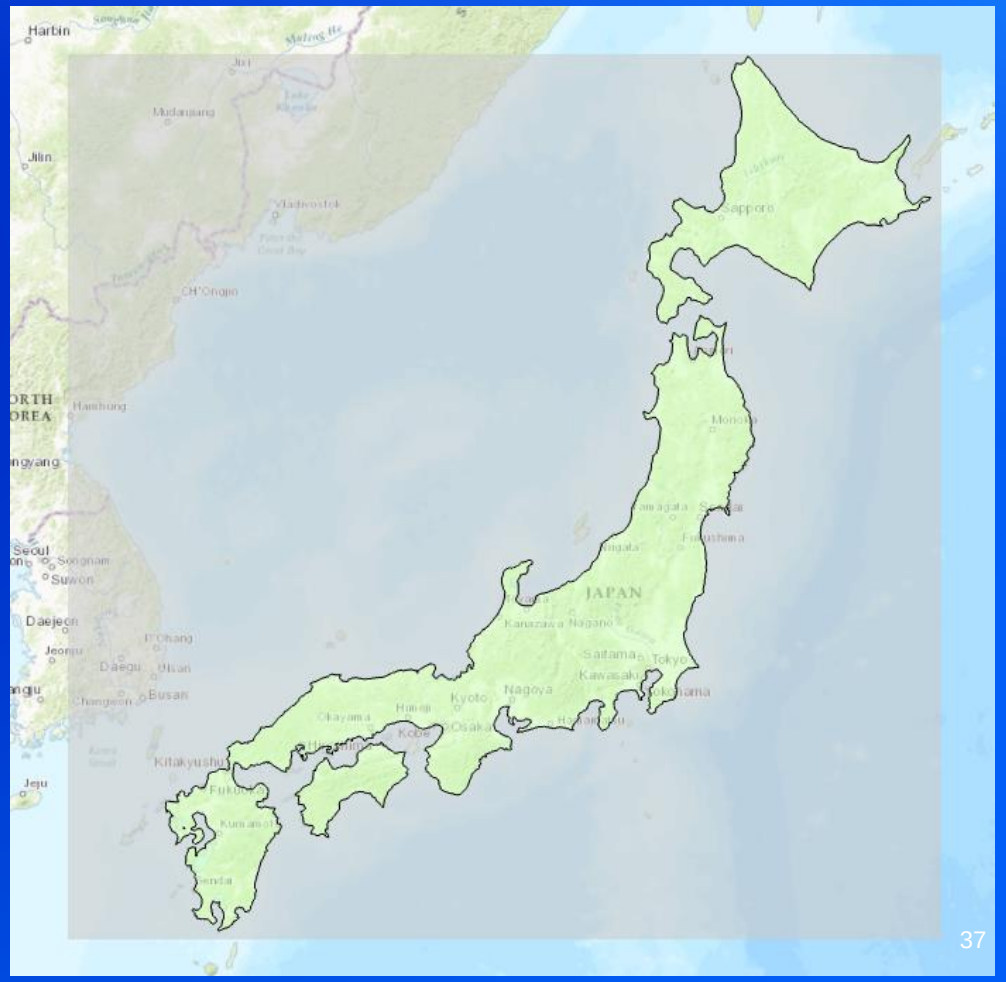
- Anyone who needs to statistically explore data and create surfaces for a number of variables will benefit from this statistical software package.

- Some of the various fields that use ArcGIS Geostatistical Analyst include:
  - agriculture,
  - geology,
  - meteorology,
  - hydrology,
  - archaeology,
  - forestry,
  - oceanography,
  - fishery,
  - health care, and
  - environmental studies.

Tips & Tricks

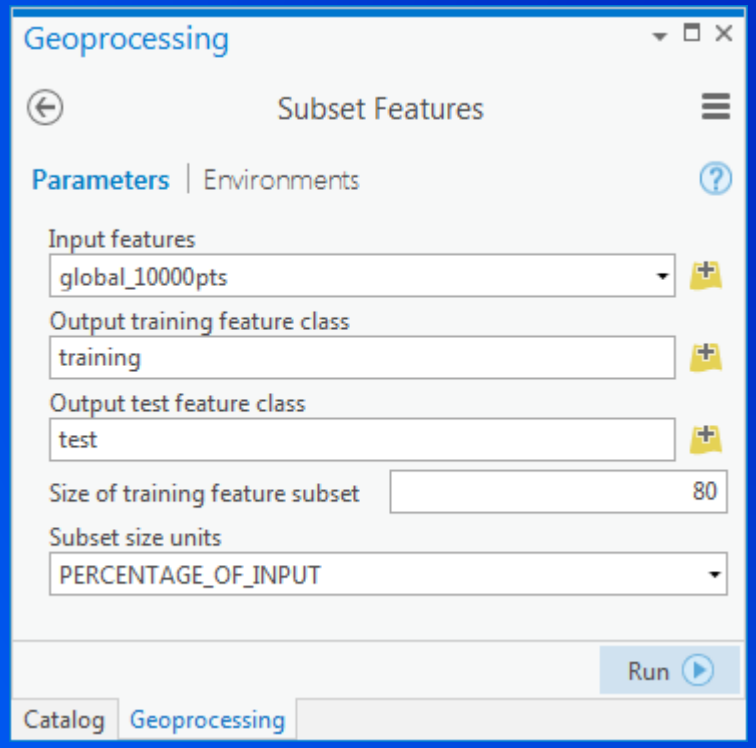
- Use Mask when creating a raster
  - 8700 pixels inside (55,000 outside) Japan (6 ½ times)

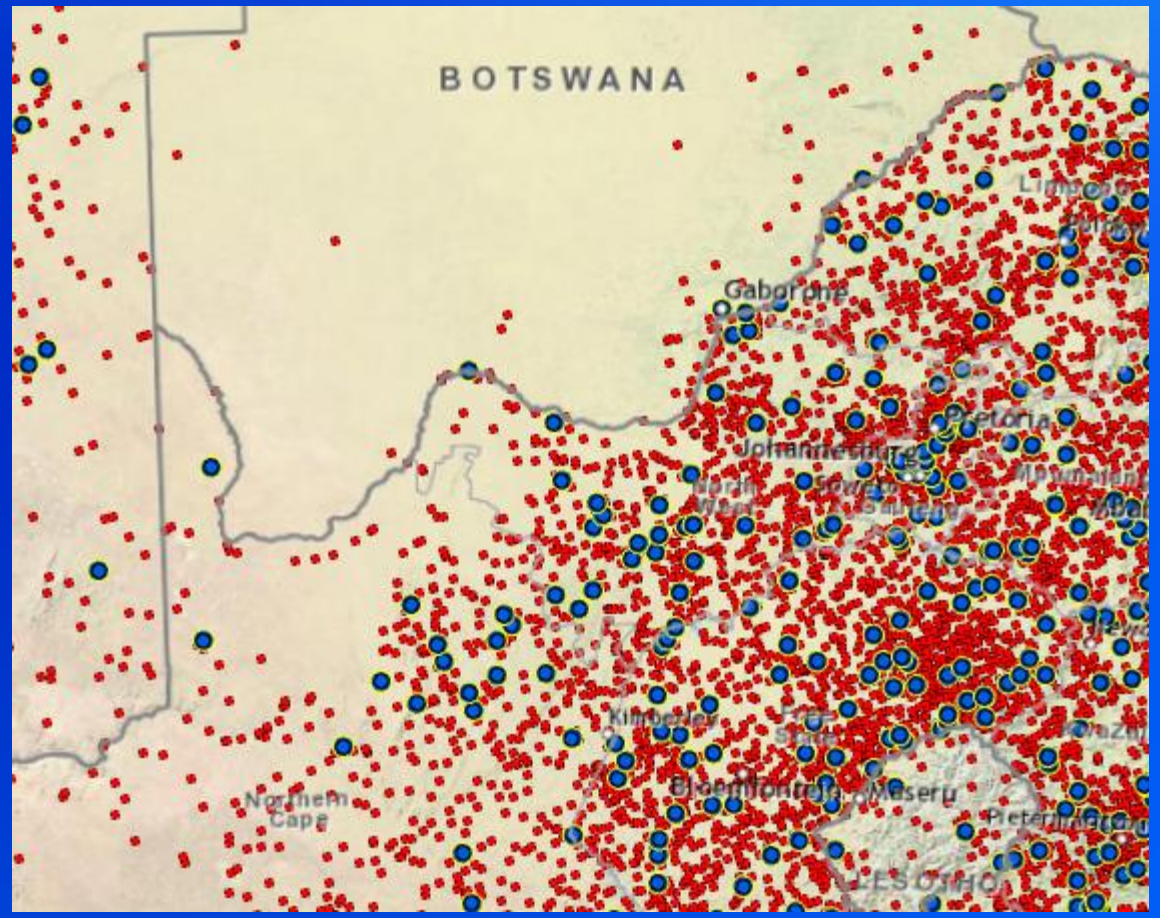




Tips & Tricks

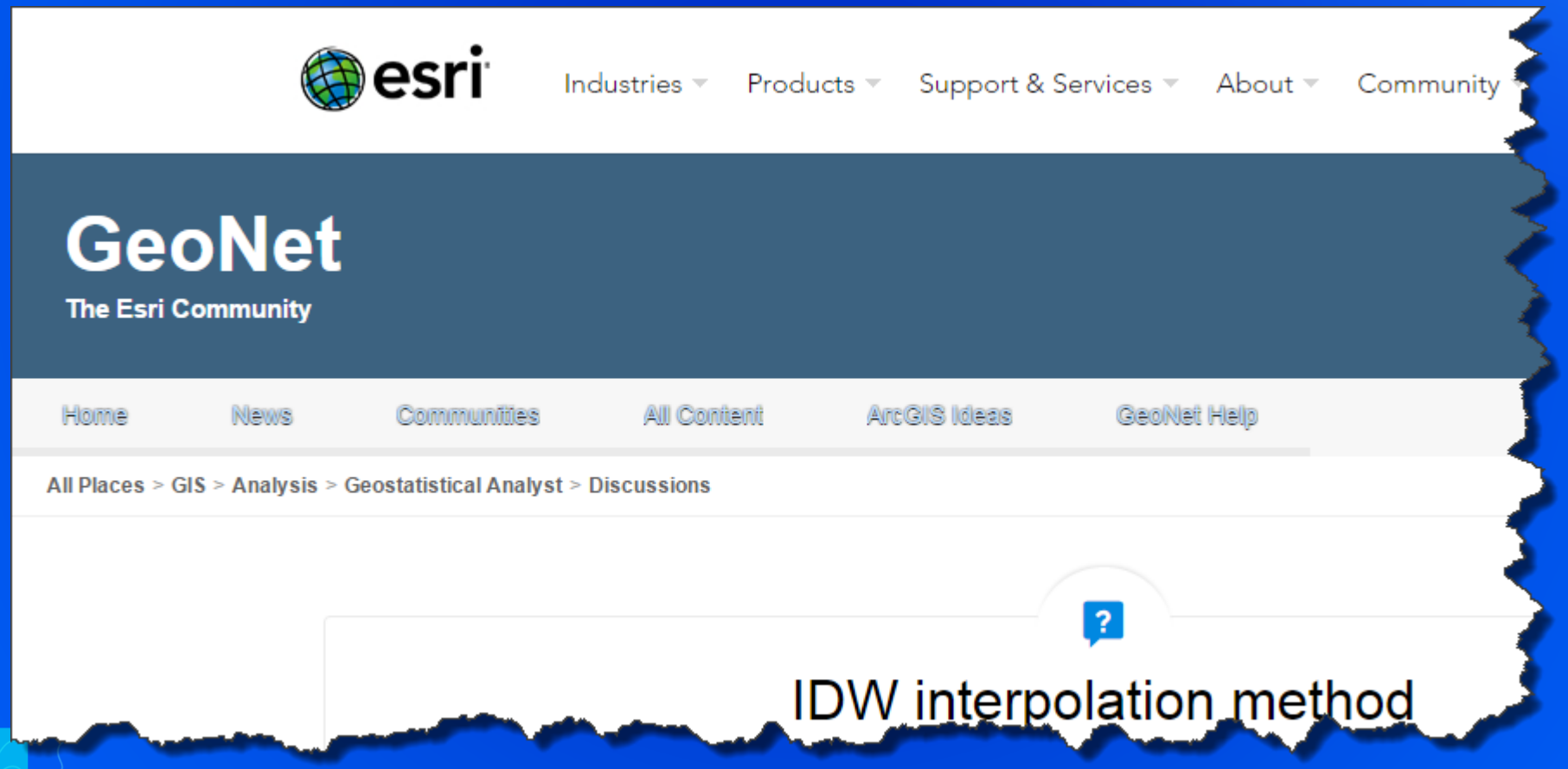
- Subset of the data
  - SubsetFeatures GP tool
  - Selection





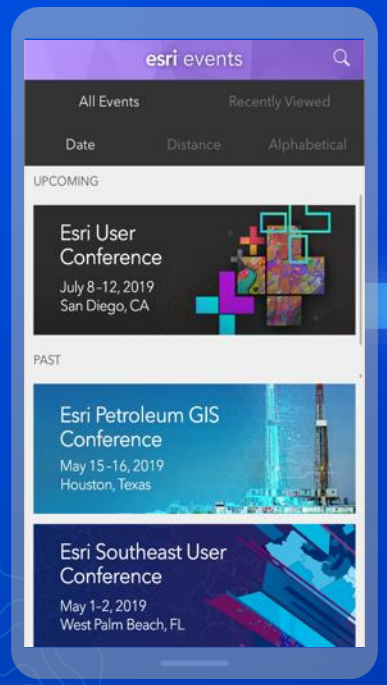
Conclusions

https://geonet.esri.com/

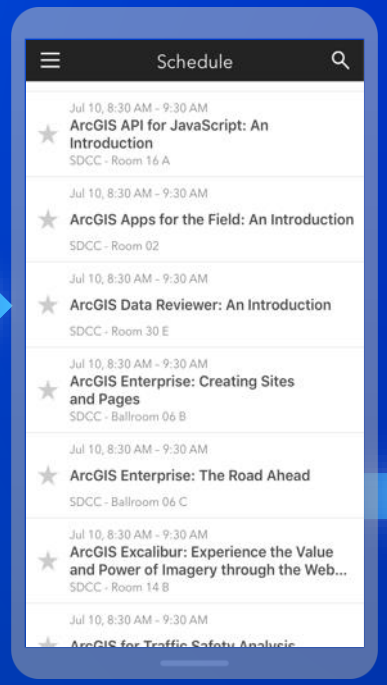


Please Share Your Feedback in the App

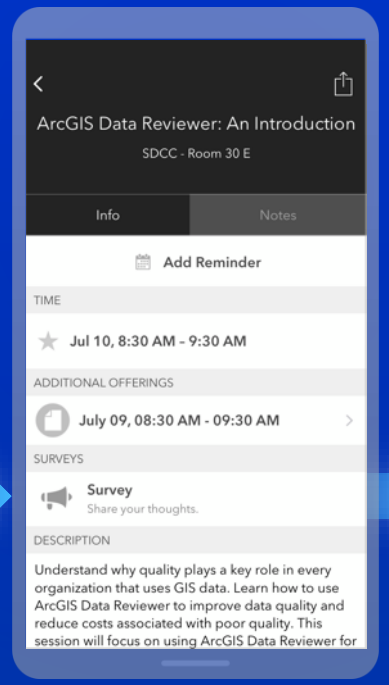
Download the Esri Events app and find your event



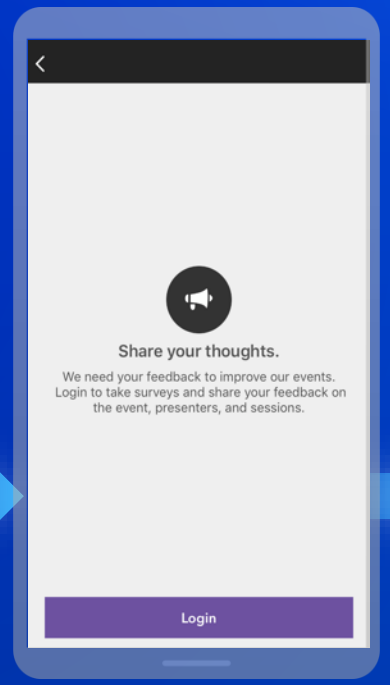
Select the session you attended



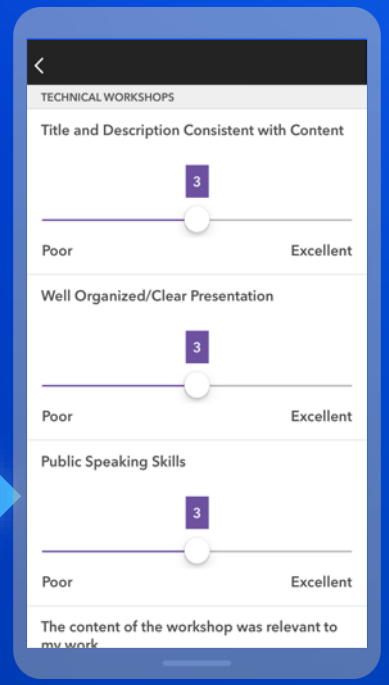
Scroll down to "Survey"



Log in to access the survey



Complete the survey and select "Submit"



esri | THE SCIENCE OF WHERE

http://esriurl.com/GeostatGetStarted

Find optimal script

```
iterationsList = [30, 100, 500, 1000]
subsetSizeList = [100, 200, 500]
overlapList = [1,3,5]
semivariogram_List =  [['POWER','NONE'], ['LINEAR','NONE'], ['THIN_PLATE_SPLINE','NONE'],
                       ['EXPONENTIAL_DETRENDED','EMPIRICAL'], ['EXPONENTIAL','EMPIRICAL'],
                       ['K_BESSEL_DETRENDED','EMPIRICAL'], ['K_BESSEL','EMPIRICAL'],
                       ['WHITTLE','EMPIRICAL'], ['WHITTLE_DETRENDED','EMPIRICAL']]

try:
    for iterations in iterationsList:
        for i in range(0, len(semivariogram_List)):
            for subsetSize in subsetSizeList:
                for overlap in overlapList:
                    svg = semivariogram_List[i][0]
                    transf=semivariogram_List[i][1]
                    t1 = time.time()
                    result = arcpy.EmpiricalBayesianKriging_ga(inFC, inField, outLyr, outRas, cellsize,
                                                               transf, subsetSize, overlap, iterations,
                                                               sn, 'PREDICTION', '', '', '', svg)
                    t2 = time.time()
                    tebk = t2-t1
                    cv = arcpy.CrossValidation_ga(outLyr)
                    rmseValue = cv.rootMeanSquare
                    rmsStd = cv.rootMeanSquareStandardized
                    toWriteList = [rmseValue, rmsStd, svg, transf, tebk, subsetSize, overlap, iterations]
                    outFile.writerow(toWriteList)
                    arcpy.Delete_management(outLyr)

except:
    print ('Tool execution FAILED')
    print (arcpy.GetMessages())
```