Geostatistical Analysis

ISTANBUL**TECHNICAL**UNIVERSITY

Sp. Anly. and Alg. in GIS
Week 10

Res. Assist. Ömer AKIN

Introduction & Aim of the Study

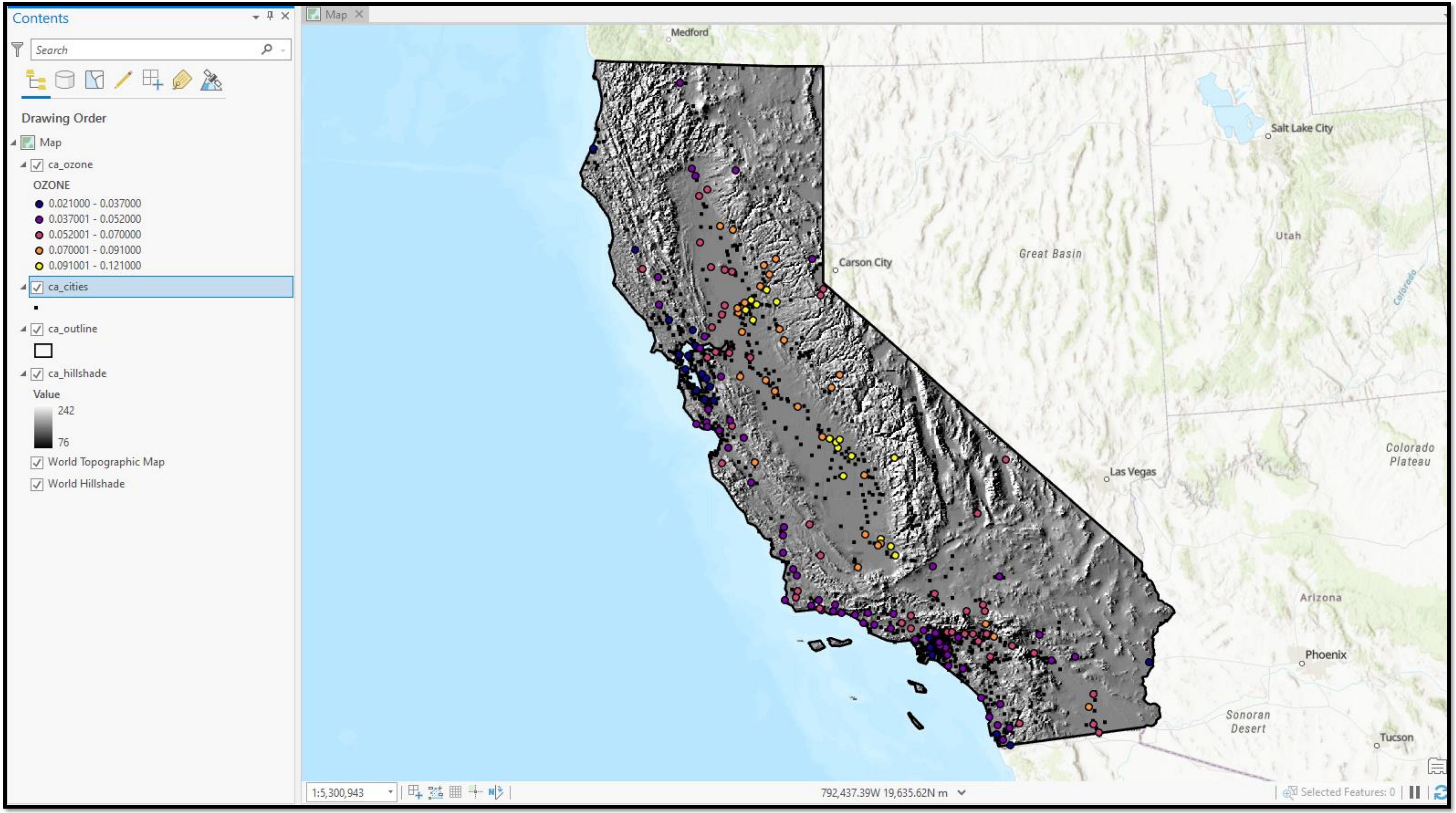
Aim of the Study:

- *Ozone concentration is measured at monitoring stations throughout the state of California. The locations of monitoring stations and concentration levels of ozone are known for all the stations, but the ozone values for other (unmonitored) locations in California are also of interest.*

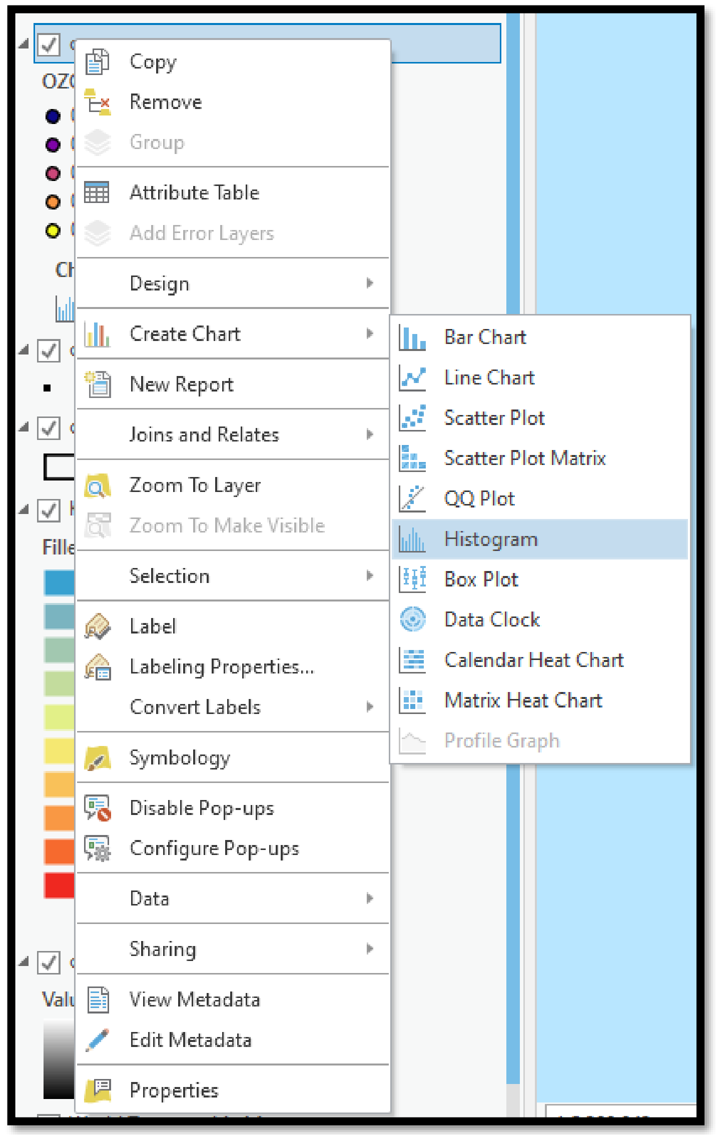
Input Data:

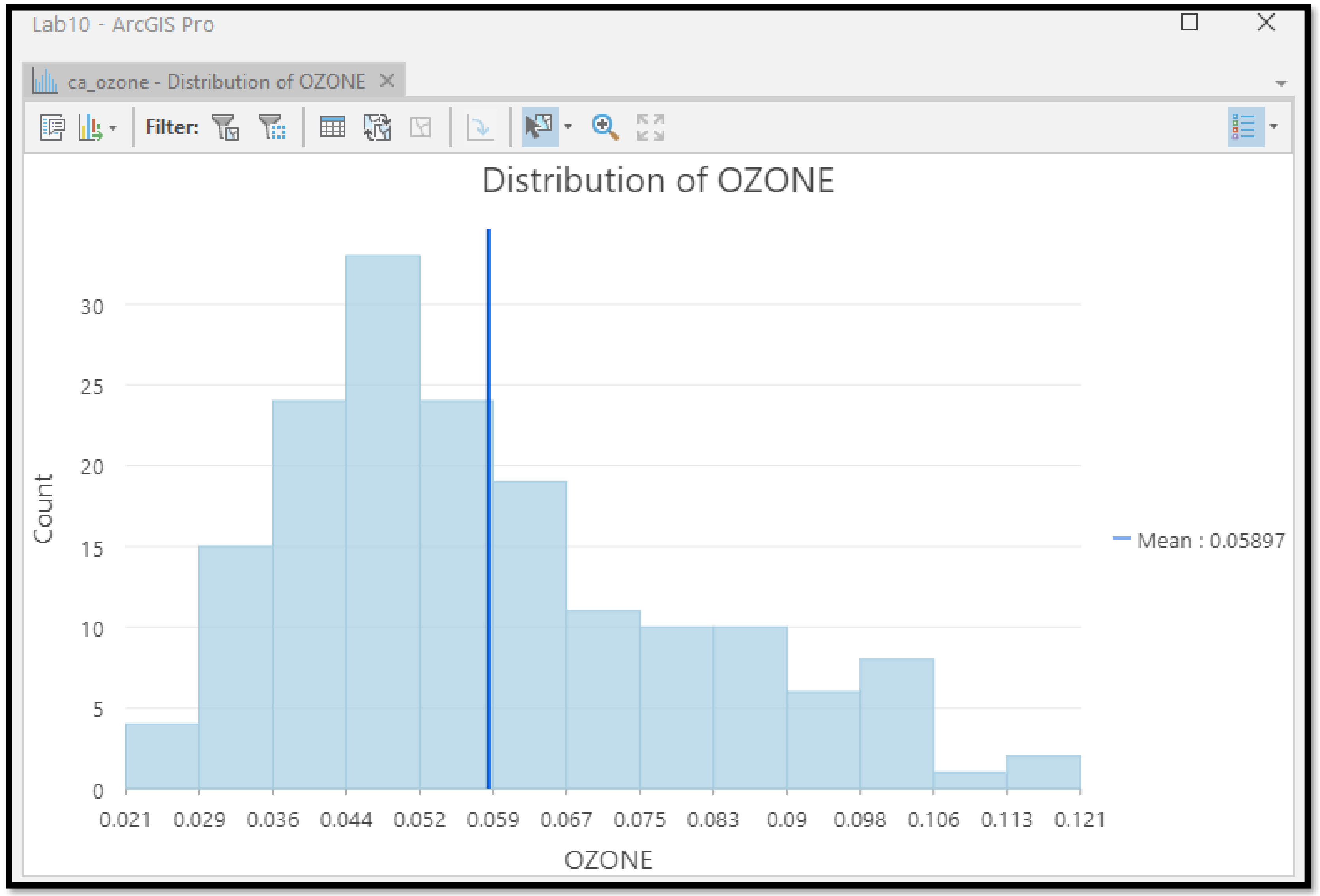
- *Ozone Concentration (measured on September 6, 2007 between 3:00 and 4:00 p.m.) (Vector-Point)*
- *City Centers (Vector-Point)*
- *Border of California (Vector-Polygon)*
- *Hillshade (Raster)*

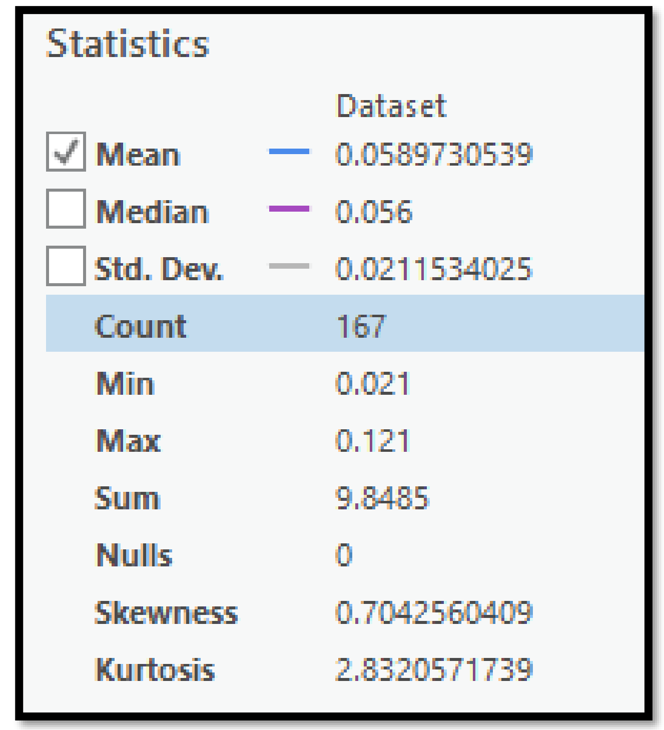
Study Area & Data



Explore Data Statistics



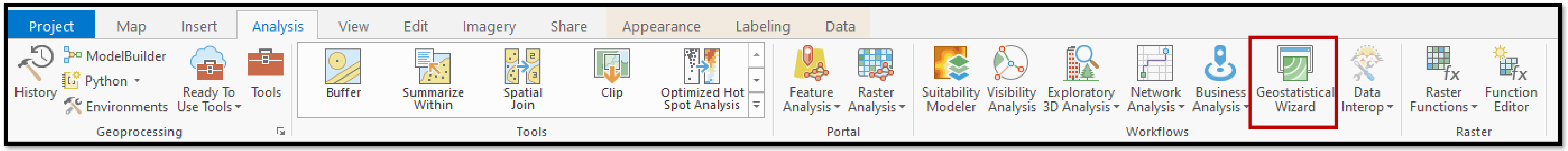


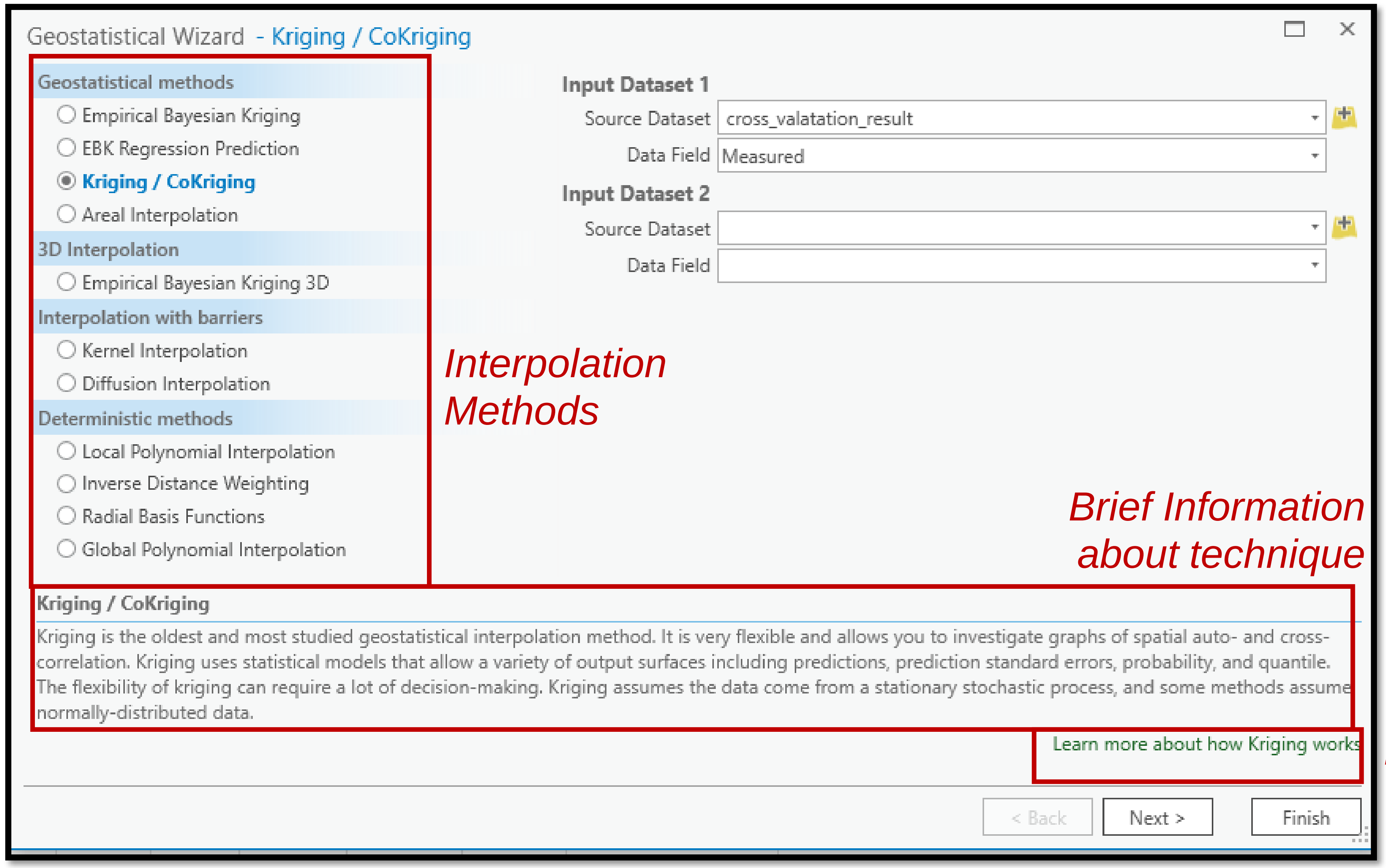


- As a quick check, if the mean and the median are approximately the same value, you have one piece of evidence that the data may be normally distributed.
- The ozone data histogram indicates that the data is unimodal (one hump) and skewed right. The right tail of the distribution indicates the presence of a relatively small number of sample points with large ozone concentration values. It seems that the data is not close to a normal distribution.

Geostatistical Analyst

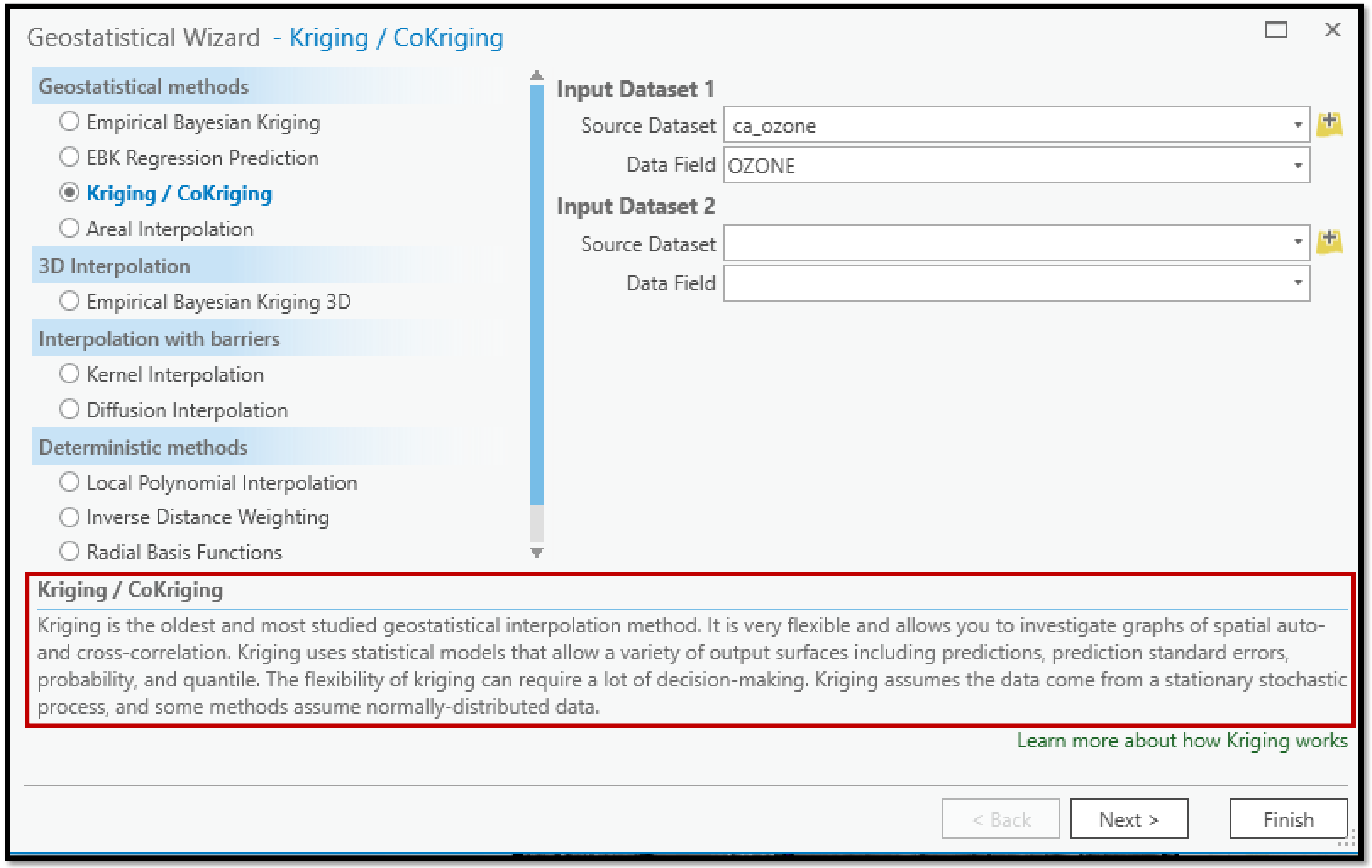
Geostatistical Analyst provides tools that make optimal predictions possible by examining the relationships between all the sample points and producing a continuous surface of ozone concentration, standard errors (uncertainty) of predictions, and probabilities that critical values are exceeded.

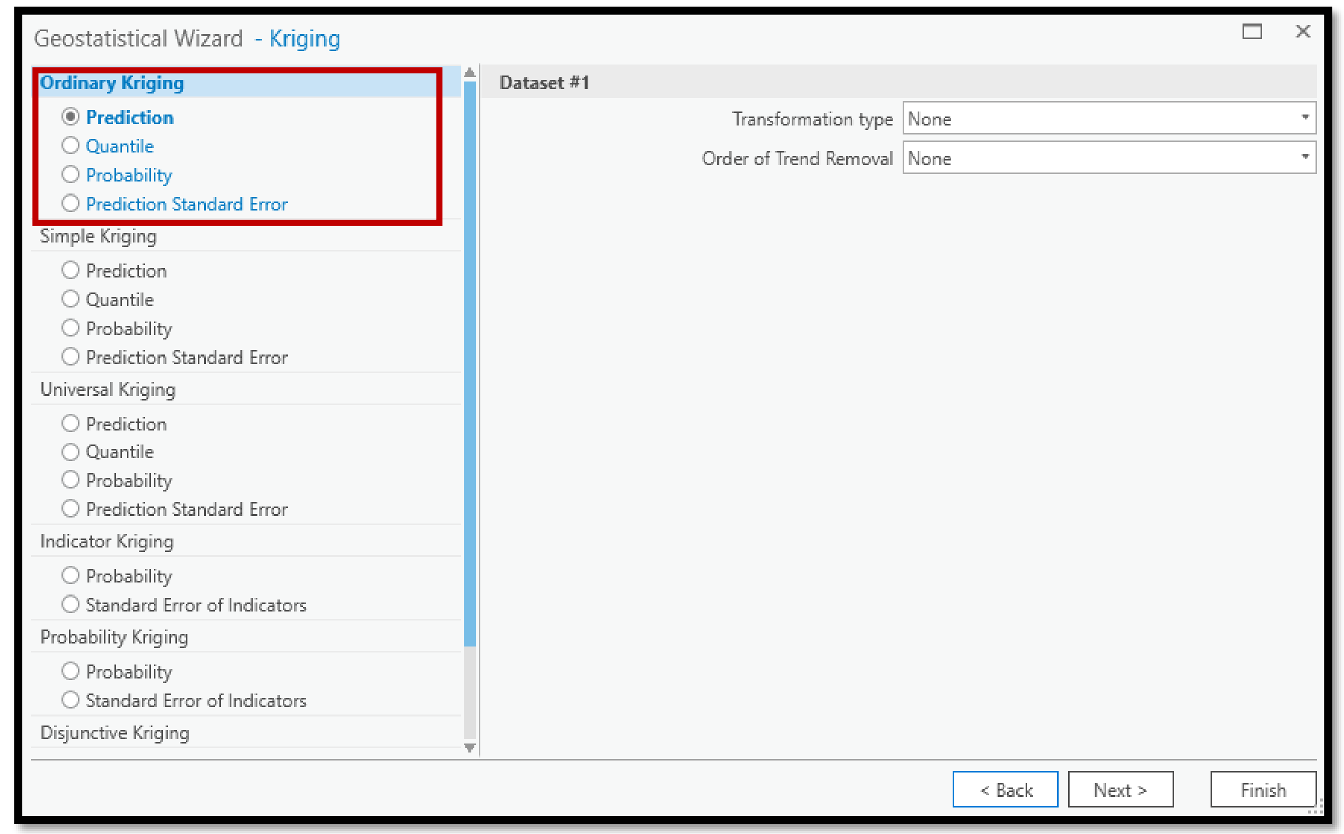




Detailed Information links

Kriging Methods / Ordinary Kriging

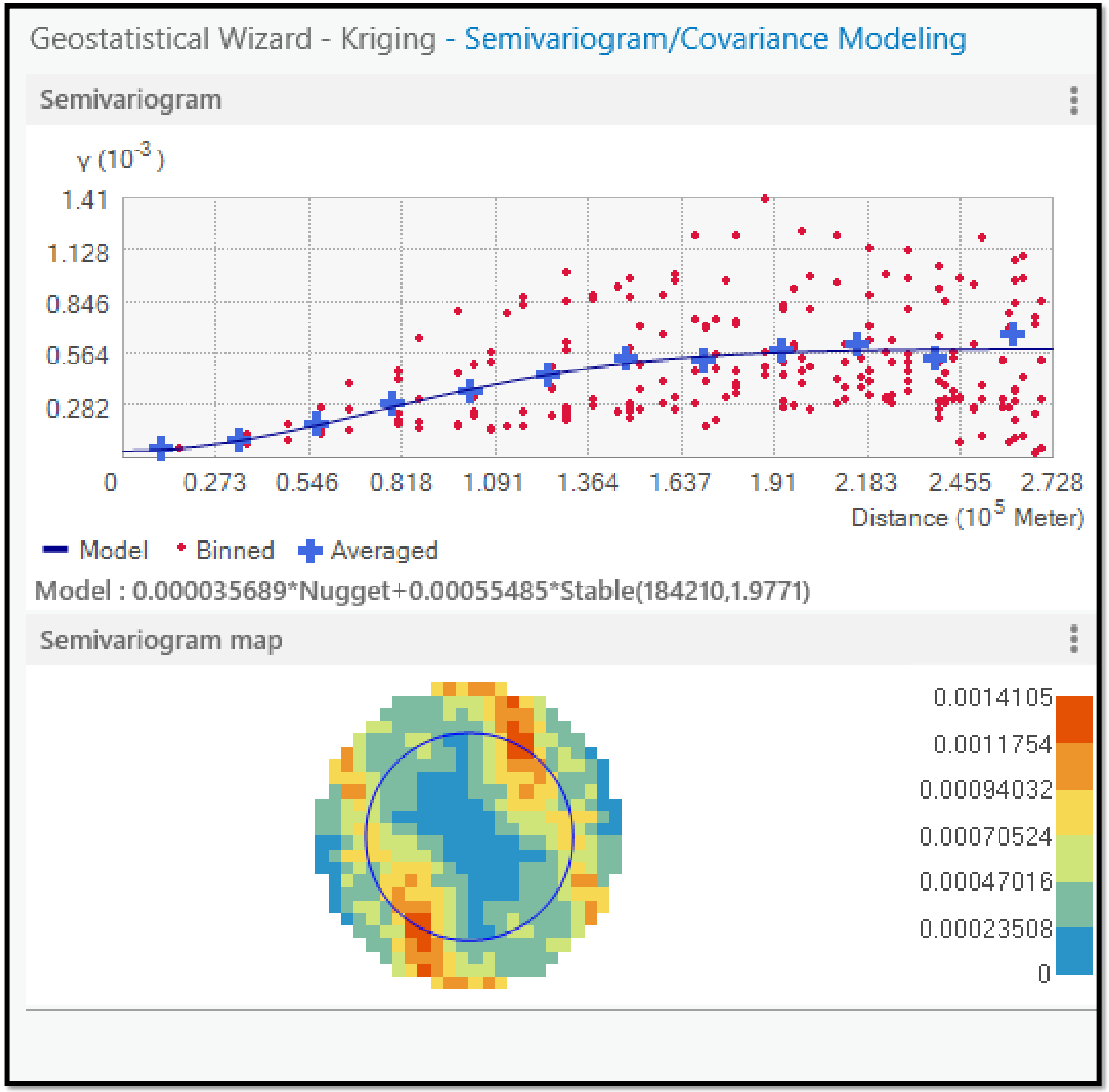




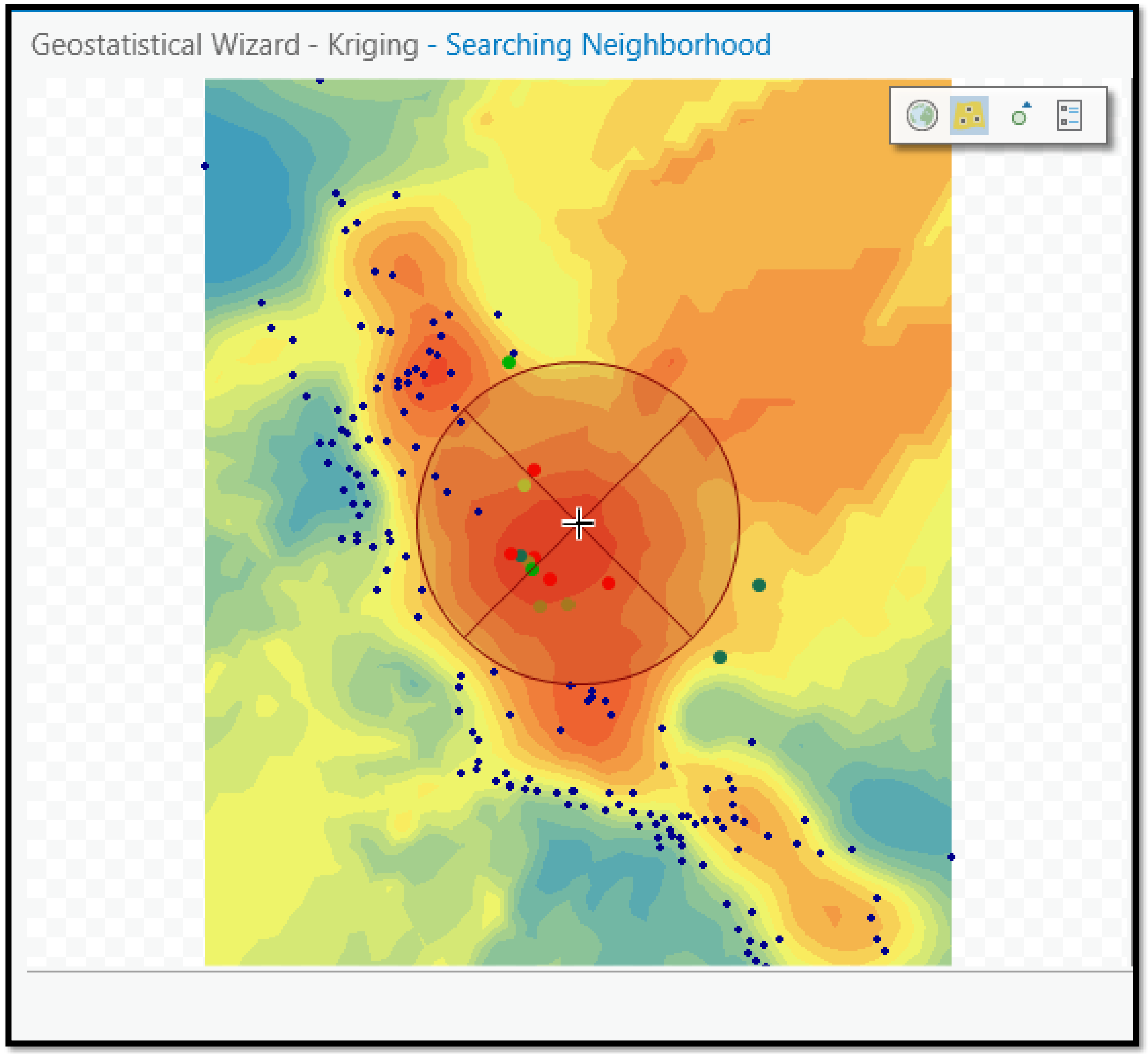
*To get more information about kriging techniques please visit:
https://pro.arcgis.com/en/pro-app/2.7/help/analysis/geostatistical-analyst/what-are-the-different-kriging-models-.htm

Semivariogram/Covariance Model

- The semivariogram/covariance model is displayed, allowing you to examine spatial relationships between measured points.
- You can assume that things that are closer together are more alike than things that are farther apart. The semivariogram allows you to explore this assumption.
- The process of fitting a semivariogram model to capture the spatial relationships in the data is known as variography.



Prediction Surface

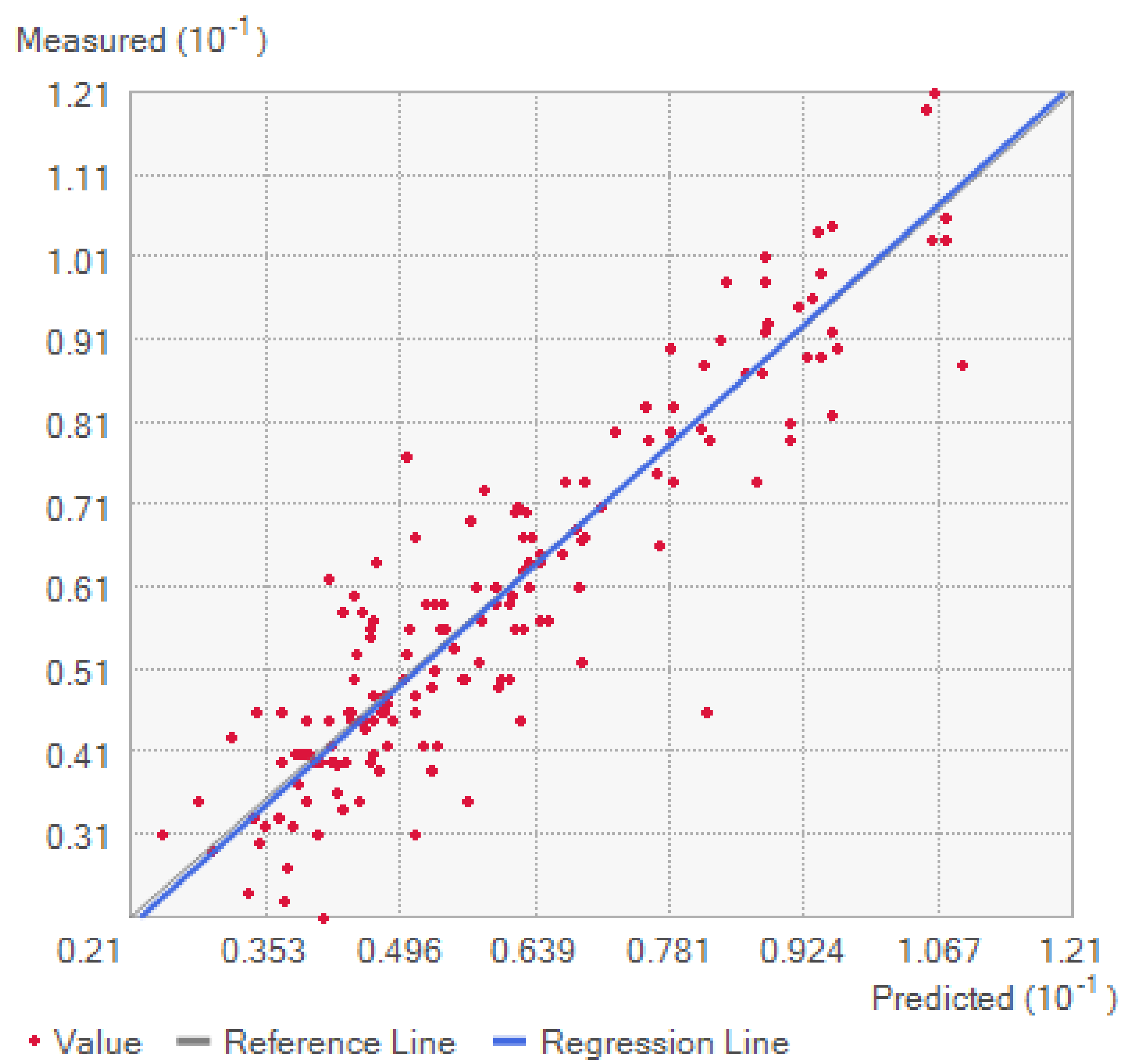


- As shown, the values of the closest measured locations are most alike to the value of the unmeasured location that you are trying to predict.
- The red points in the image below are going to be weighted (or influence the unknown value) more than the green points since they are closer to the location you are predicting.
- Using the surrounding points and the semivariogram/covariance model fitted previously, you can predict values for the unmeasured location.

Cross Validation

Geostatistical Wizard - Kriging - Cross validation

Predicted | Error | Standardized Error | Normal QQ Plot | Distribution



Regression function: 1.0194142312805 * x + -0.00148887548712402

Summary | Table

Count	167
Mean	0.000396454268027537
Root-Mean-Square	0.00862302755801119
Mean Standardized	0.0167857622534953
Root-Mean-Square Standardized	1.06511274997349
Average Standard Error	0.00860248117409058

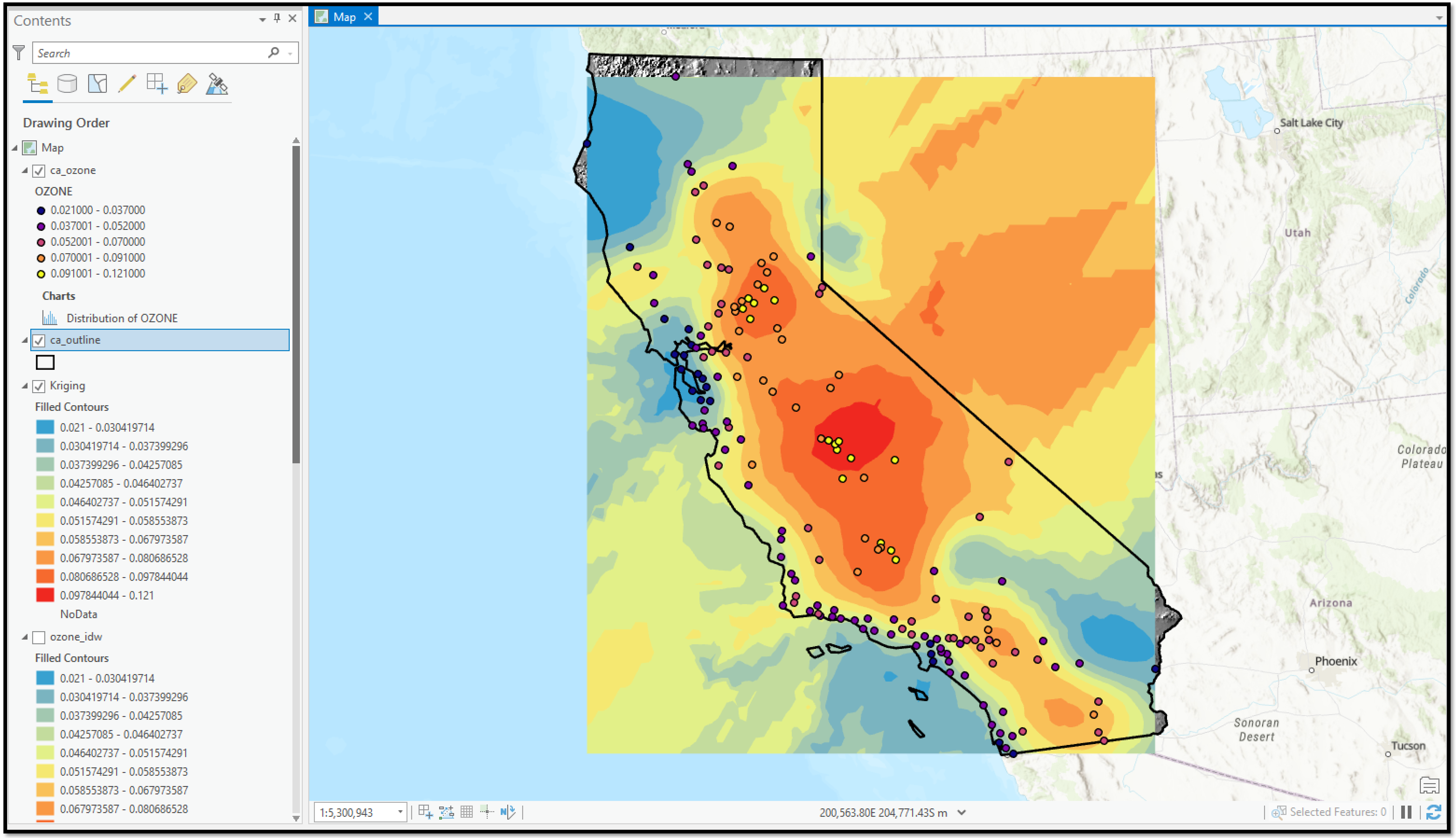
Cross validation

Cross validation is a "leave one out" method that allows you to determine how well your interpolation model fits your data. Cross validation works by removing a single point from the dataset and using all remaining points to predict to the location of the point that was removed. The predicted value is then compared to the measured value, and many statistics are generated to determine the accuracy of the prediction.

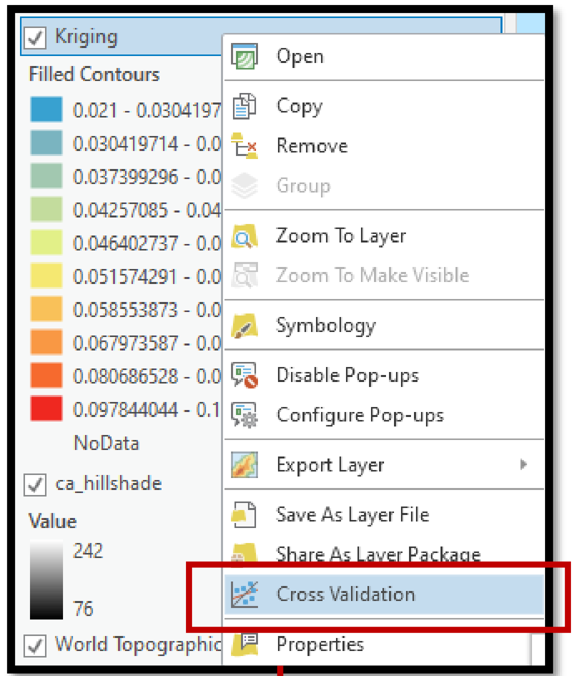
Learn more about cross validation

< Back | Next > | Finish

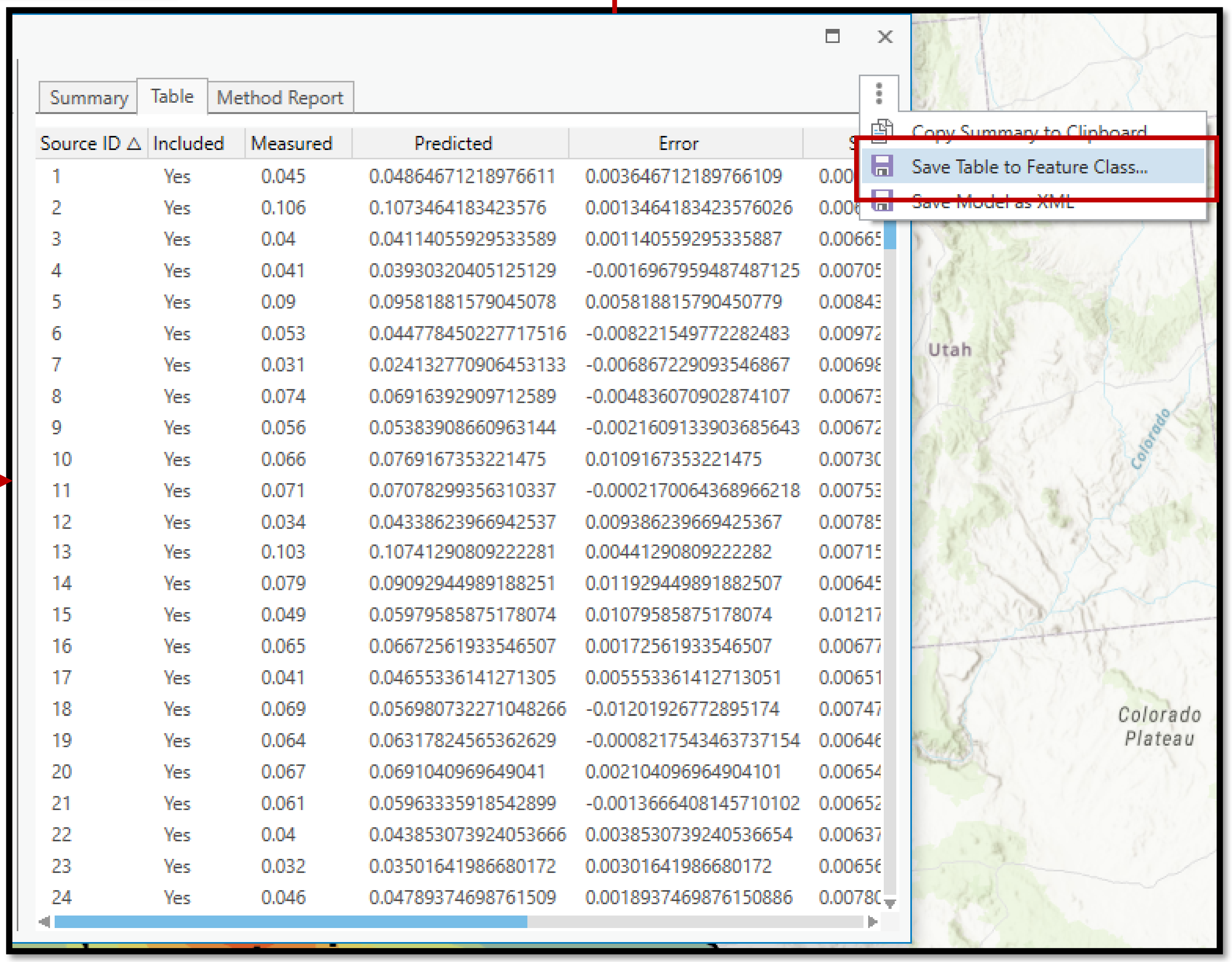
Result of Ordinary Kriging



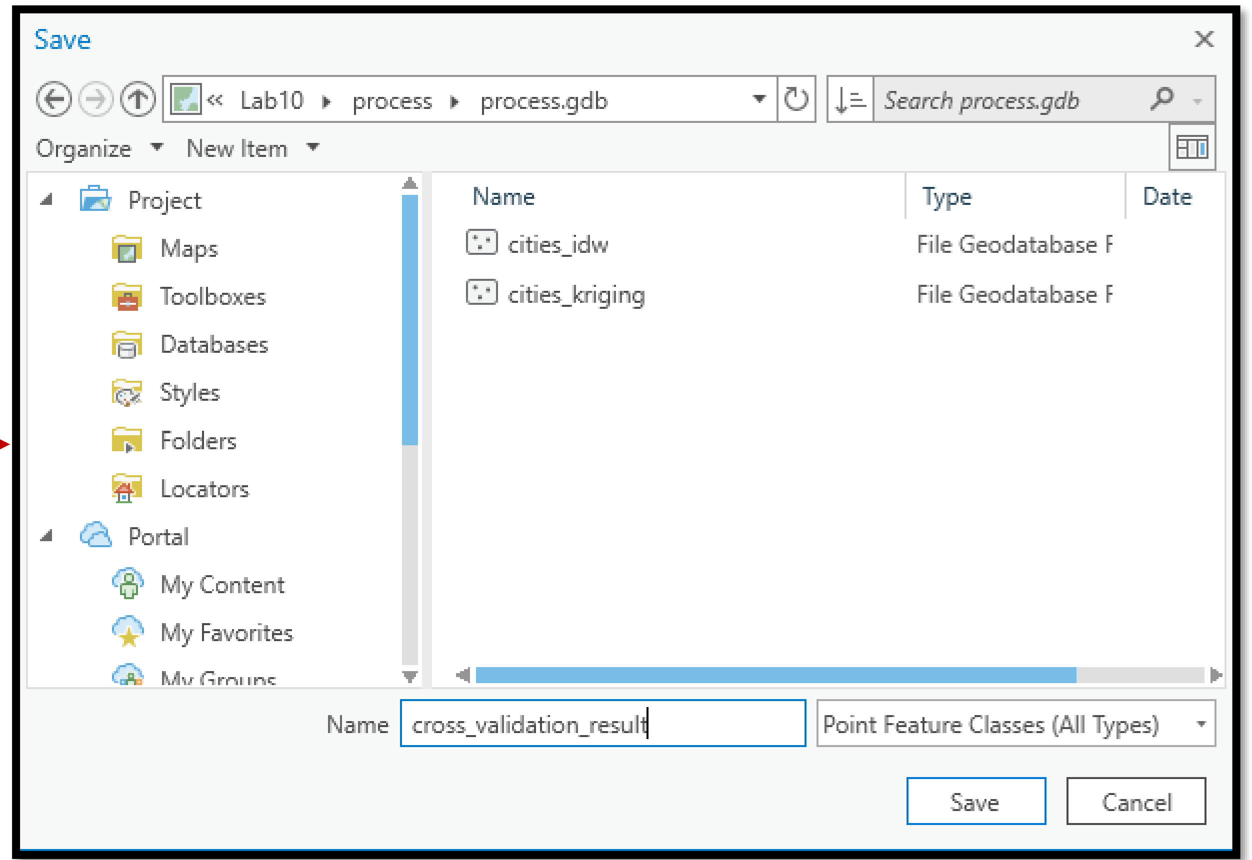
Get Cross Validation Results as Feature

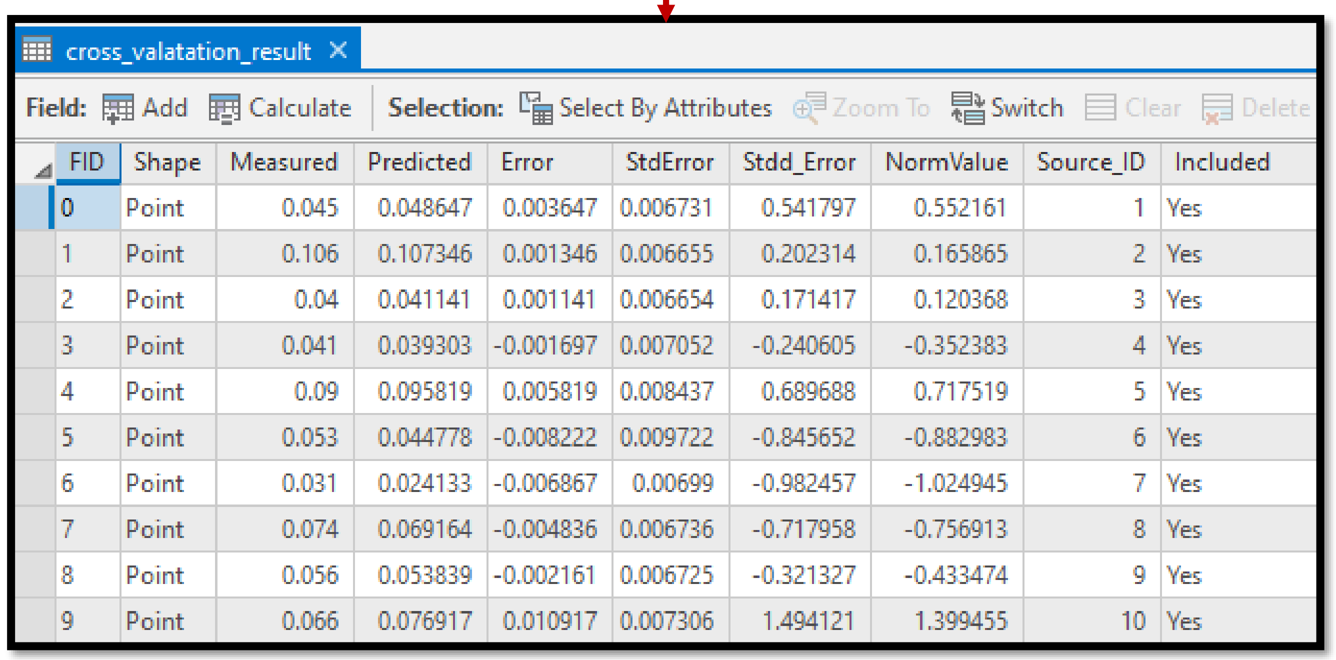


Export table as a feature



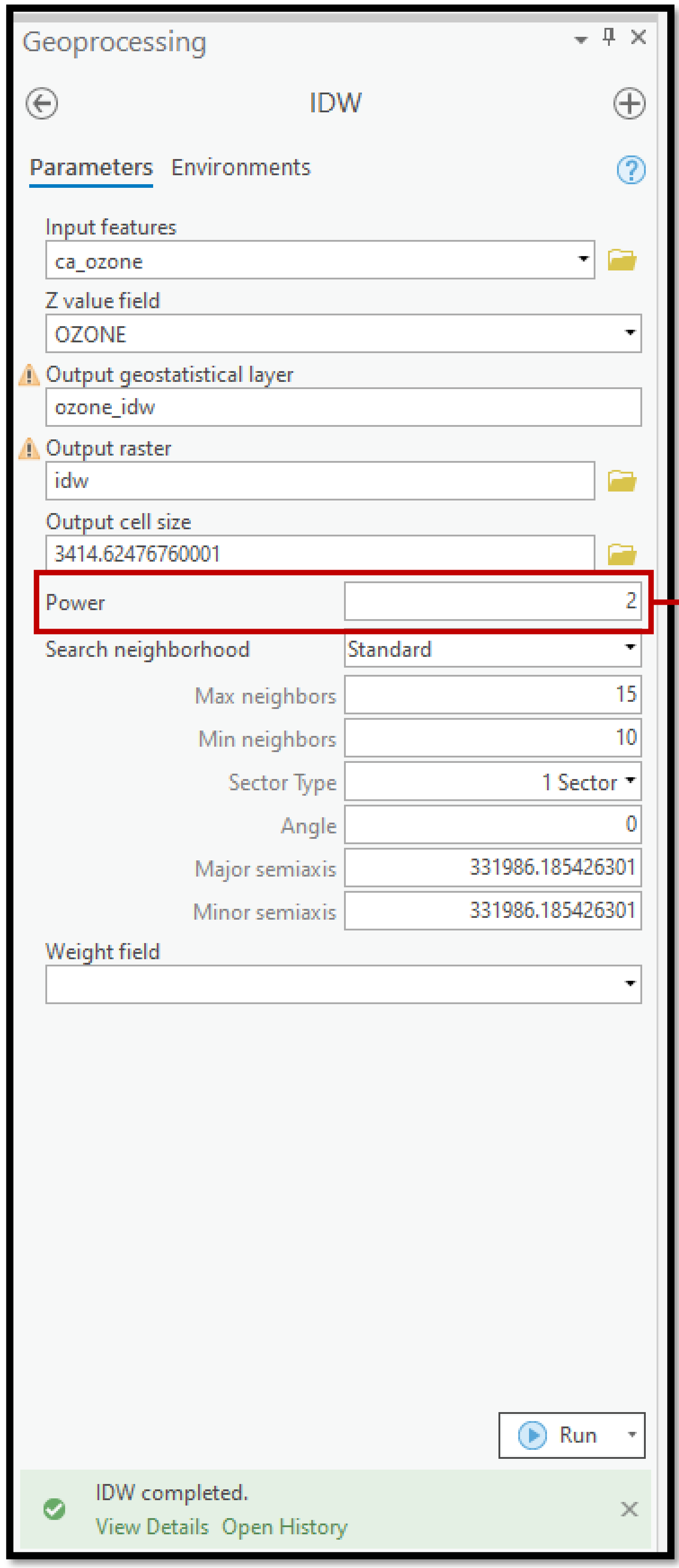
Source ID △	Included	Measured	Predicted	Error	
1	Yes	0.045	0.04864671218976611	0.003646712189766109	0.00
2	Yes	0.106	0.1073464183423576	0.0013464183423576026	0.00
3	Yes	0.04	0.04114055929533589	0.001140559295335887	0.00665
4	Yes	0.041	0.03930320405125129	-0.0016967959487487125	0.00705
5	Yes	0.09	0.09581881579045078	0.005818815790450779	0.00843
6	Yes	0.053	0.044778450227717516	-0.008221549772282483	0.00972
7	Yes	0.031	0.024132770906453133	-0.006867229093546867	0.00698
8	Yes	0.074	0.06916392909712589	-0.004836070902874107	0.00673
9	Yes	0.056	0.05383908660963144	-0.0021609133903685643	0.00672
10	Yes	0.066	0.0769167353221475	0.0109167353221475	0.00730
11	Yes	0.071	0.07078299356310337	-0.0002170064368966218	0.00753
12	Yes	0.034	0.04338623966942537	0.009386239669425367	0.00785
13	Yes	0.103	0.10741290809222281	0.00441290809222282	0.00715
14	Yes	0.079	0.09092944989188251	0.011929449891882507	0.00645
15	Yes	0.049	0.05979585875178074	0.01079585875178074	0.01217
16	Yes	0.065	0.06672561933546507	0.00172561933546507	0.00677
17	Yes	0.041	0.04655336141271305	0.005553361412713051	0.00651
18	Yes	0.069	0.056980732271048266	-0.01201926772895174	0.00747
19	Yes	0.064	0.06317824565362629	-0.0008217543463737154	0.00646
20	Yes	0.067	0.0691040969649041	0.002104096964904101	0.00654
21	Yes	0.061	0.05963335918542899	-0.0013666408145710102	0.00652
22	Yes	0.04	0.043853073924053666	0.0038530739240536654	0.00637
23	Yes	0.032	0.03501641986680172	0.003016419866680172	0.00656
24	Yes	0.046	0.04789374698761509	0.0018937469876150886	0.00780





FID	Shape	Measured	Predicted	Error	StdError	Stdd_Error	NormValue	Source_ID	Included
0	Point	0.045	0.048647	0.003647	0.006731	0.541797	0.552161	1	Yes
1	Point	0.106	0.107346	0.001346	0.006655	0.202314	0.165865	2	Yes
2	Point	0.04	0.041141	0.001141	0.006654	0.171417	0.120368	3	Yes
3	Point	0.041	0.039303	-0.001697	0.007052	-0.240605	-0.352383	4	Yes
4	Point	0.09	0.095819	0.005819	0.008437	0.689688	0.717519	5	Yes
5	Point	0.053	0.044778	-0.008222	0.009722	-0.845652	-0.882983	6	Yes
6	Point	0.031	0.024133	-0.006867	0.00699	-0.982457	-1.024945	7	Yes
7	Point	0.074	0.069164	-0.004836	0.006736	-0.717958	-0.756913	8	Yes
8	Point	0.056	0.053839	-0.002161	0.006725	-0.321327	-0.433474	9	Yes
9	Point	0.066	0.076917	0.010917	0.007306	1.494121	1.399455	10	Yes

Inverse Distance Weighted (IDW)



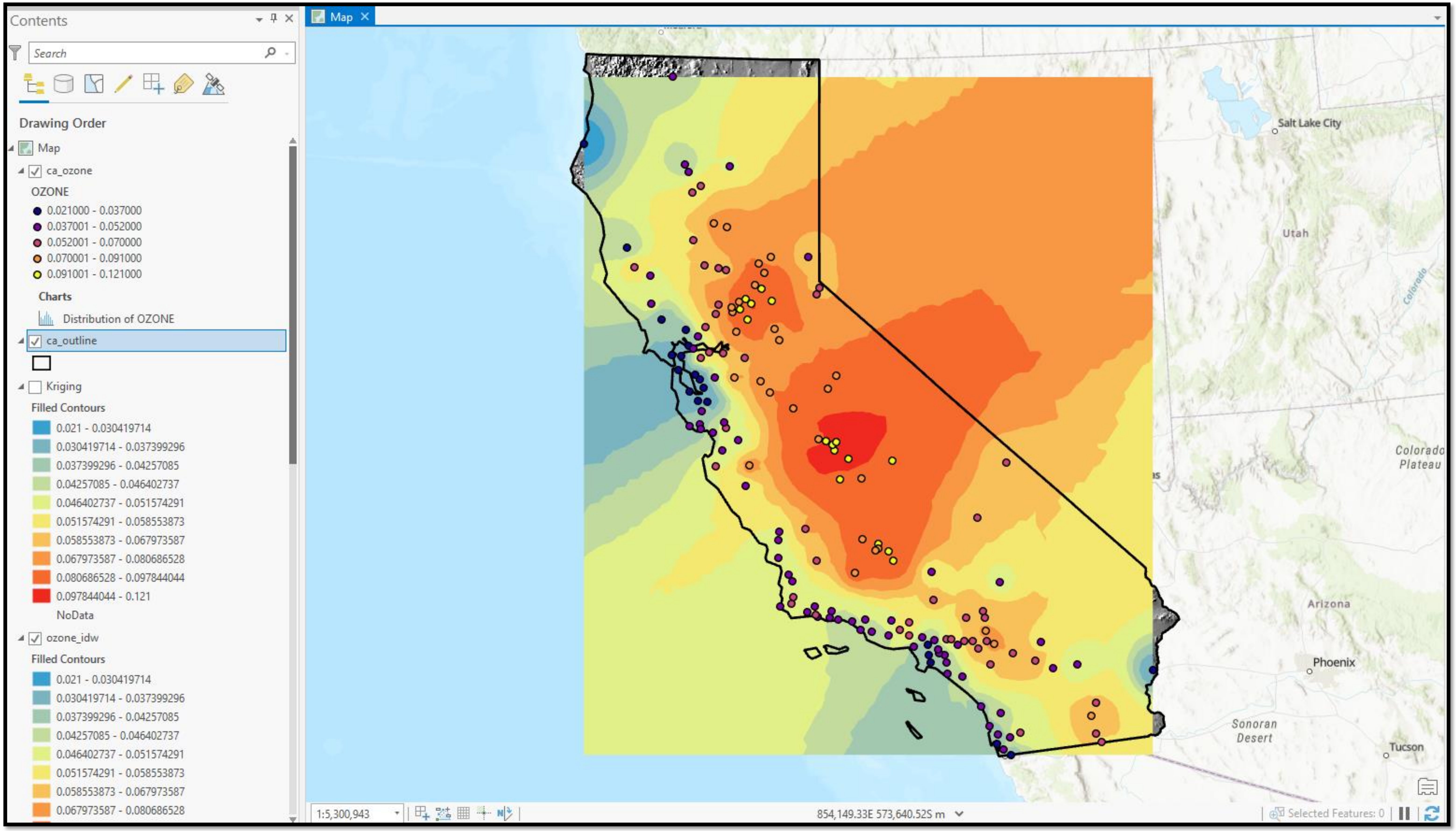
- Inverse distance weighted (IDW) interpolation explicitly makes the assumption that things that are close to one another are more alike than those that are farther apart.

- To predict a value for any unmeasured location, IDW uses the measured values surrounding the prediction location.

- IDW assumes that each measured point has a local influence that diminishes with distance. It gives greater weights to points closest to the prediction location, and the weights diminish as a function of distance, hence the name inverse distance weighted.

- Weights are proportional to the inverse of the distance (between the data point and the prediction location) raised to the power value *p*. As a result, as the distance increases, the weights decrease rapidly.

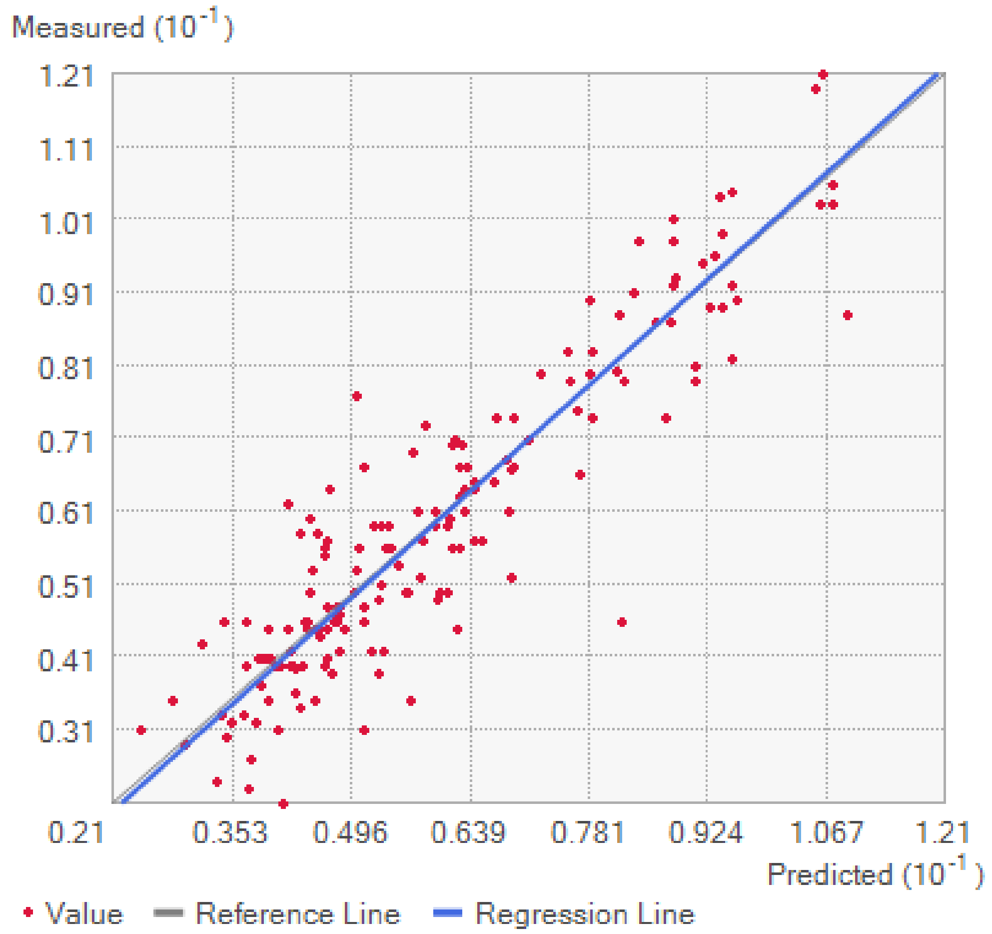
Result of IDW



Comparing Cross-Validation Results

Geostatistical Wizard - Kriging - Cross validation

Predicted | Error | Standardized Error | Normal QQ Plot | Distribution



Regression function: 1.0194142312805 * x + -0.00148887548712402

Summary | Table

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Mean	0.000396454268027537
Root-Mean-Square	0.00862302755801119
Mean Standardized	0.0167857622534953
Root-Mean-Square Standardized	1.06511274997349
Average Standard Error	0.00860248117409058

Ordinary Kriging

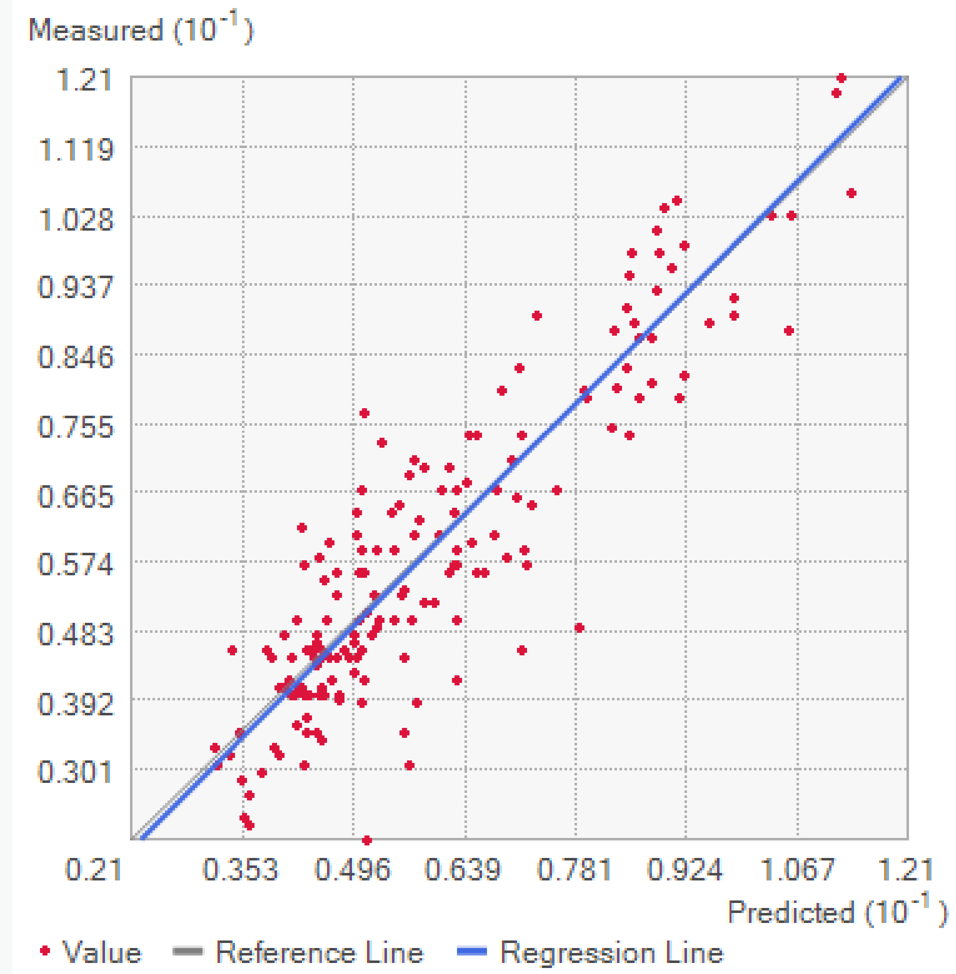
IDW

Summary | Table | Method Report

Count	167
Mean	0.000943651150445797
Root-Mean-Square	0.00944019656139528

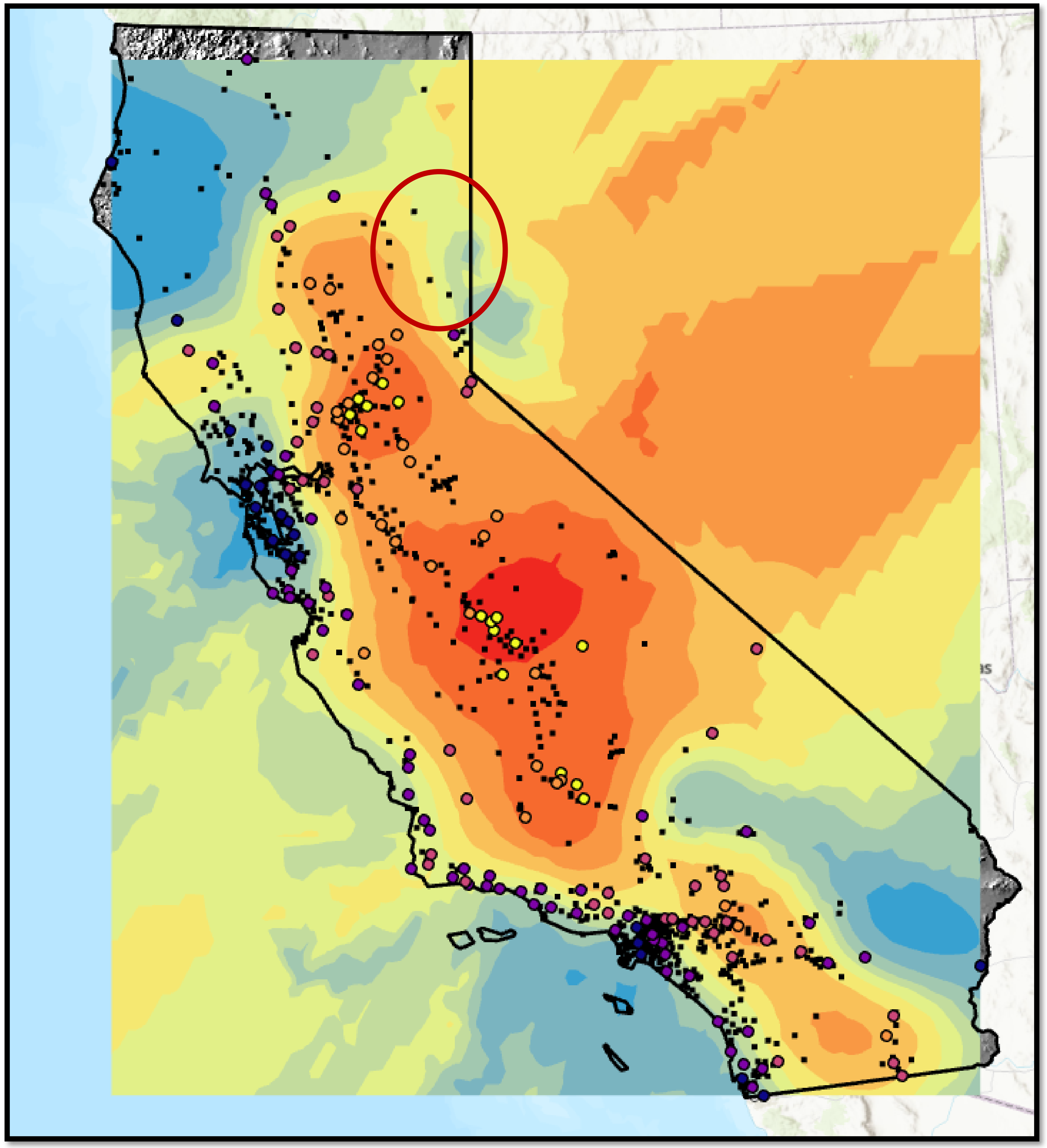
Cross validation - Map/ozone_idw

Predicted | Error | Distribution



Regression function: 1.02150814283688 * x + -0.001718233011913

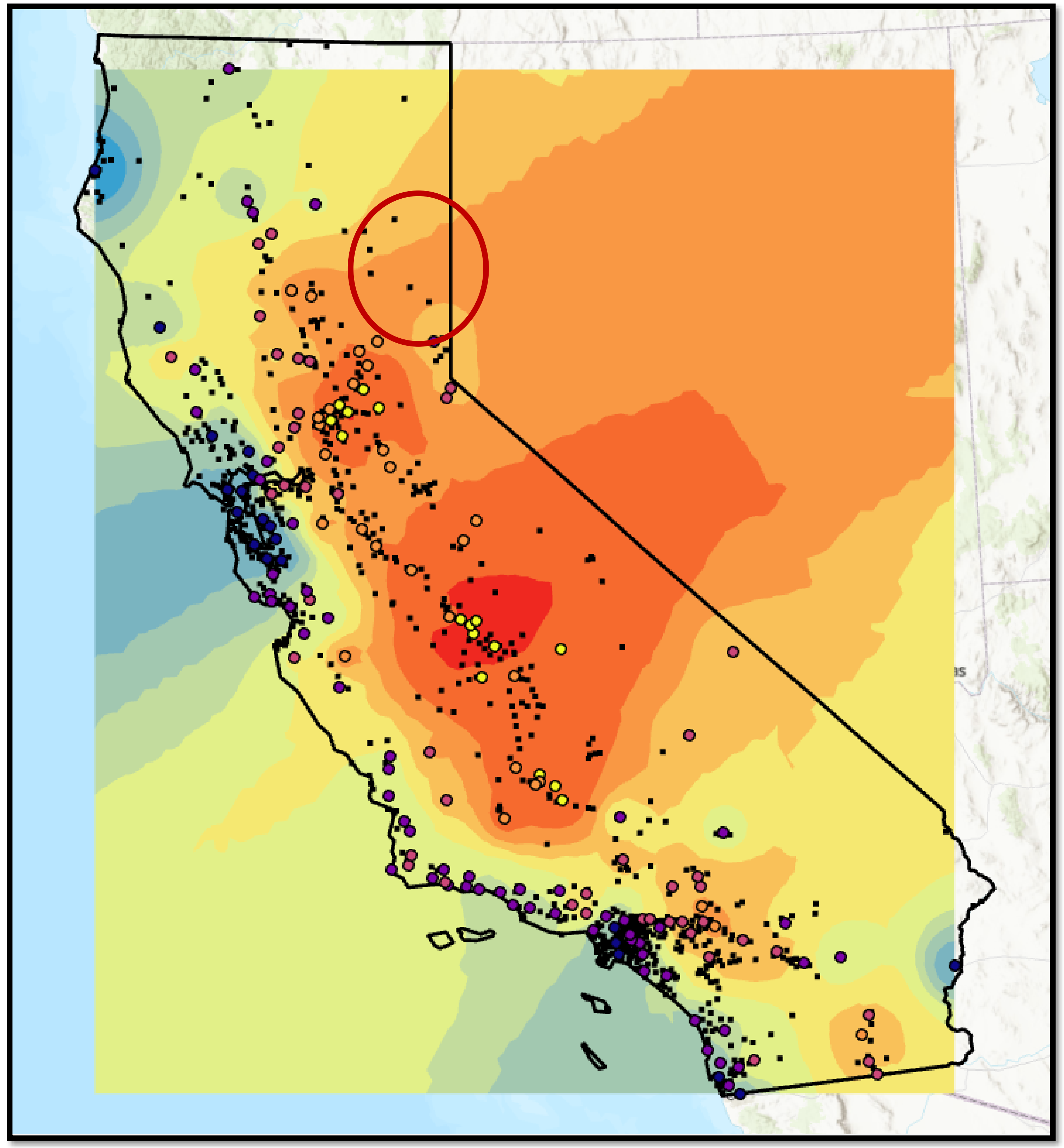
Comparing Results



Ordinary Kriging

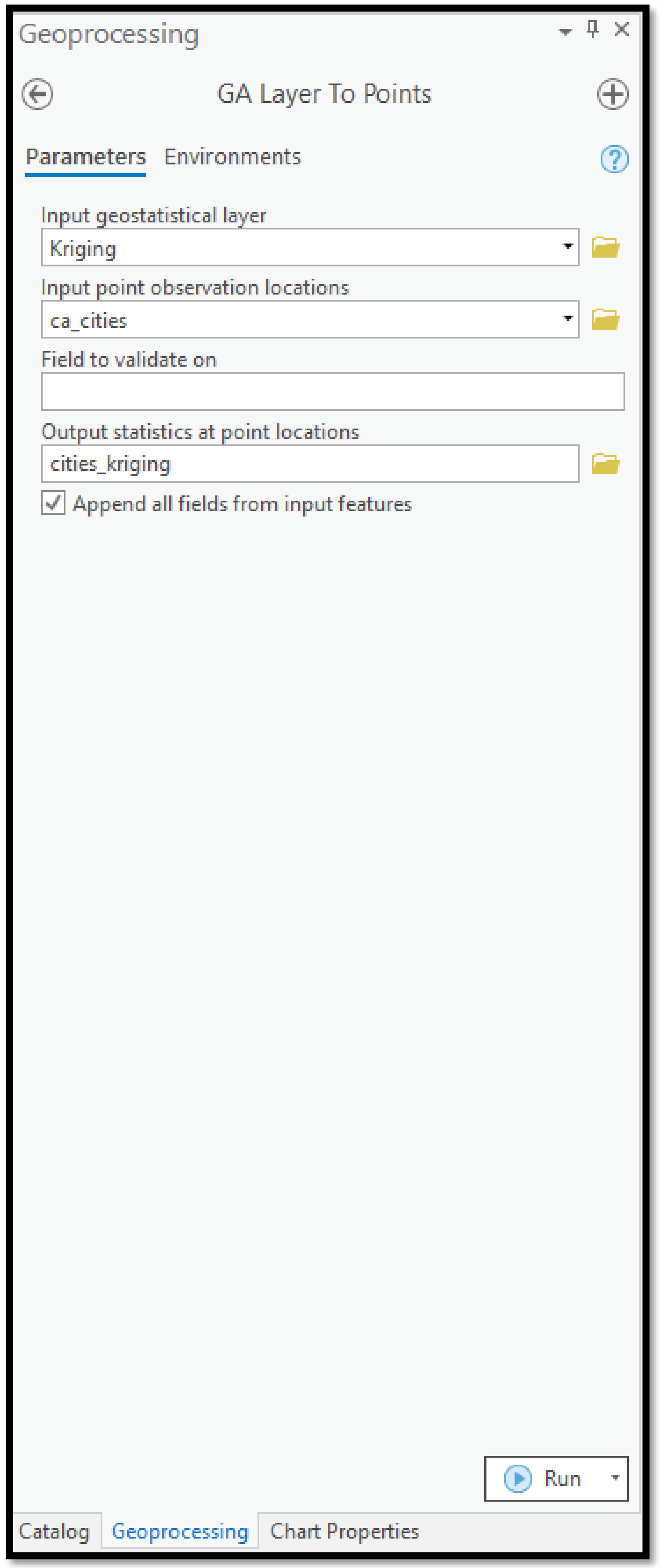
Kriging captured local variations better than IDW.

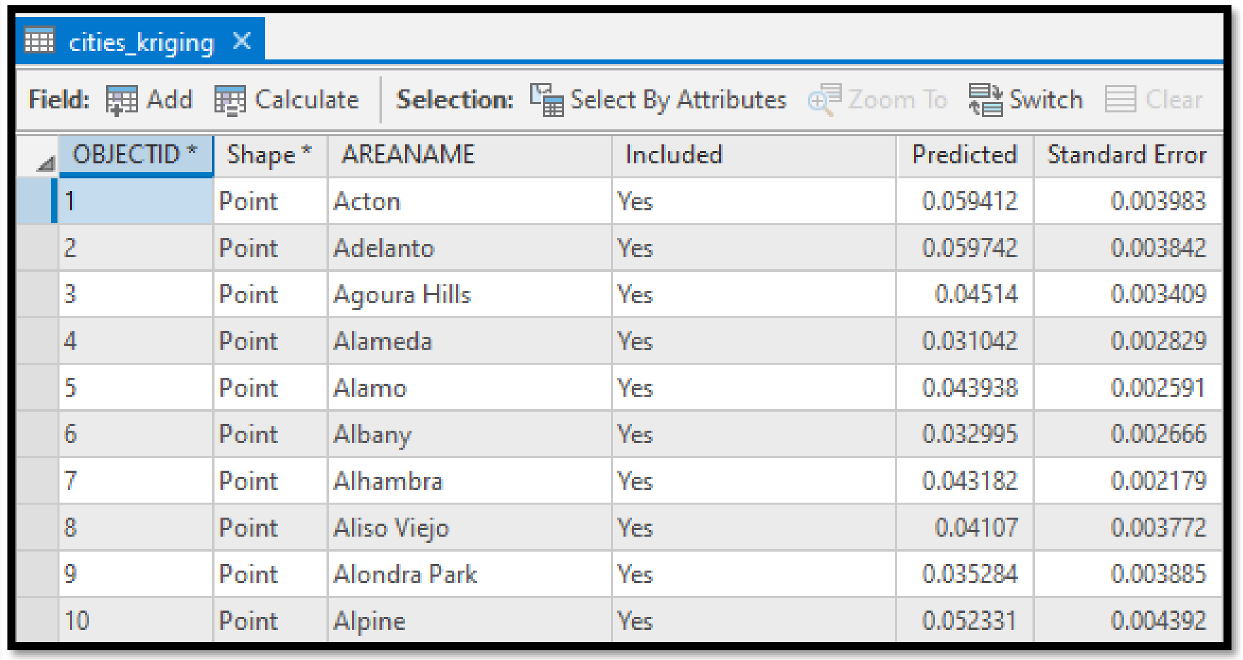
Inverse Distance Weighted



Using Geostatistical Layer

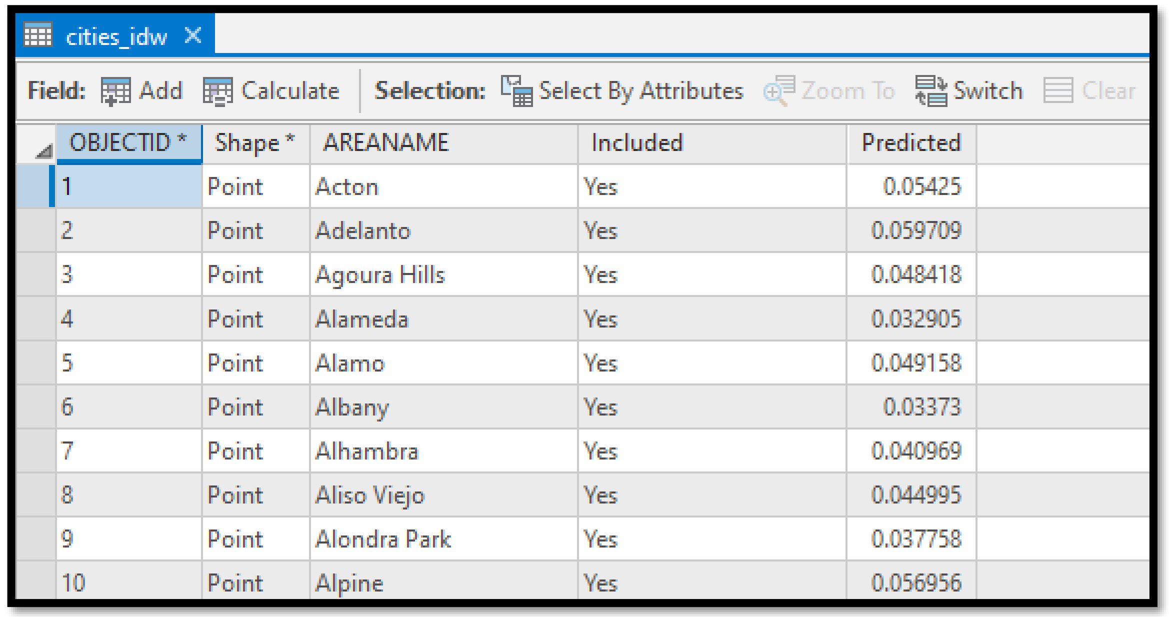
Find the ozone concentration of cities by using geostatistical surfaces created by Kriging and IDW





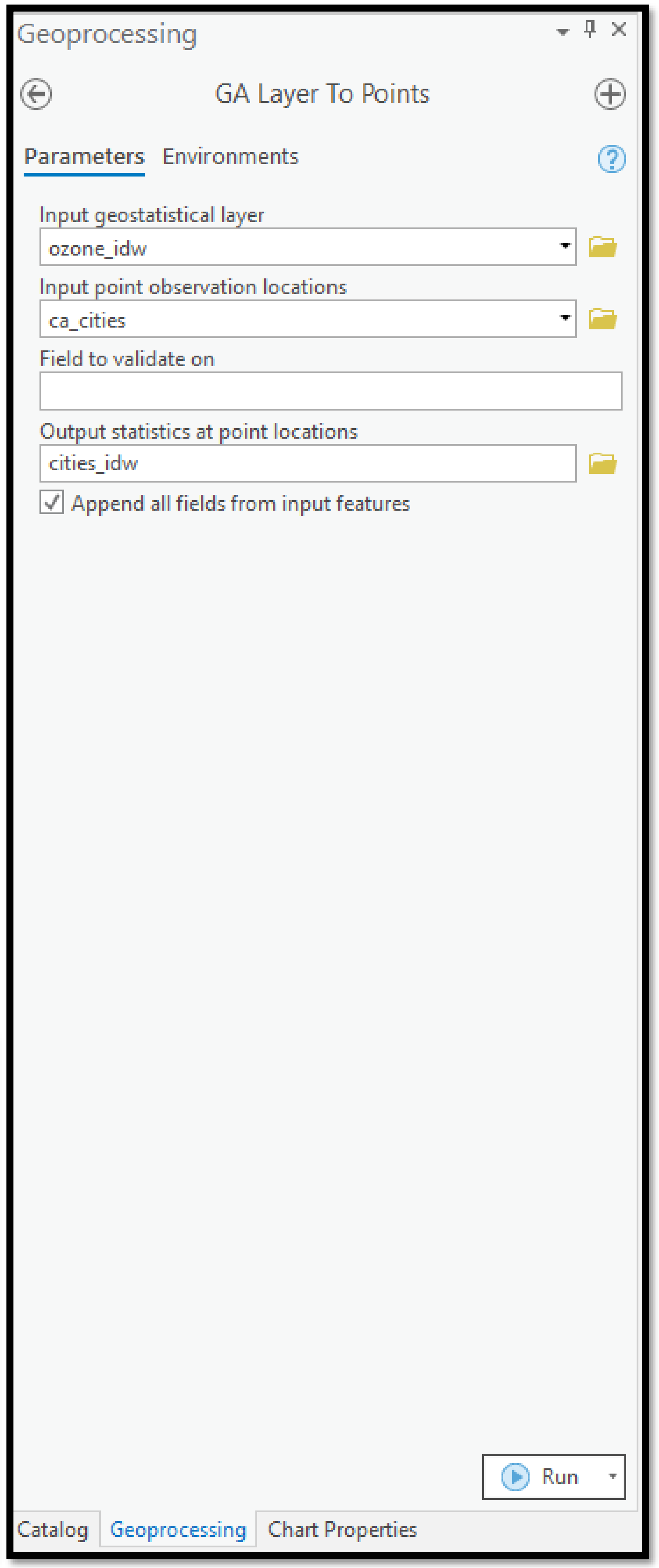
cities_kriging

OBJECTID *	Shape *	AREANAME	Included	Predicted	Standard Error
1	Point	Acton	Yes	0.059412	0.003983
2	Point	Adelanto	Yes	0.059742	0.003842
3	Point	Agoura Hills	Yes	0.04514	0.003409
4	Point	Alameda	Yes	0.031042	0.002829
5	Point	Alamo	Yes	0.043938	0.002591
6	Point	Albany	Yes	0.032995	0.002666
7	Point	Alhambra	Yes	0.043182	0.002179
8	Point	Aliso Viejo	Yes	0.04107	0.003772
9	Point	Alondra Park	Yes	0.035284	0.003885
10	Point	Alpine	Yes	0.052331	0.004392

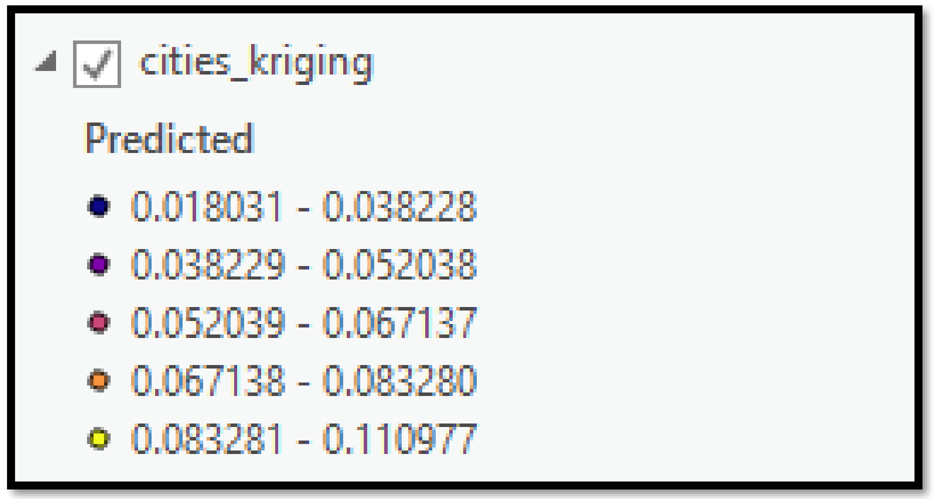


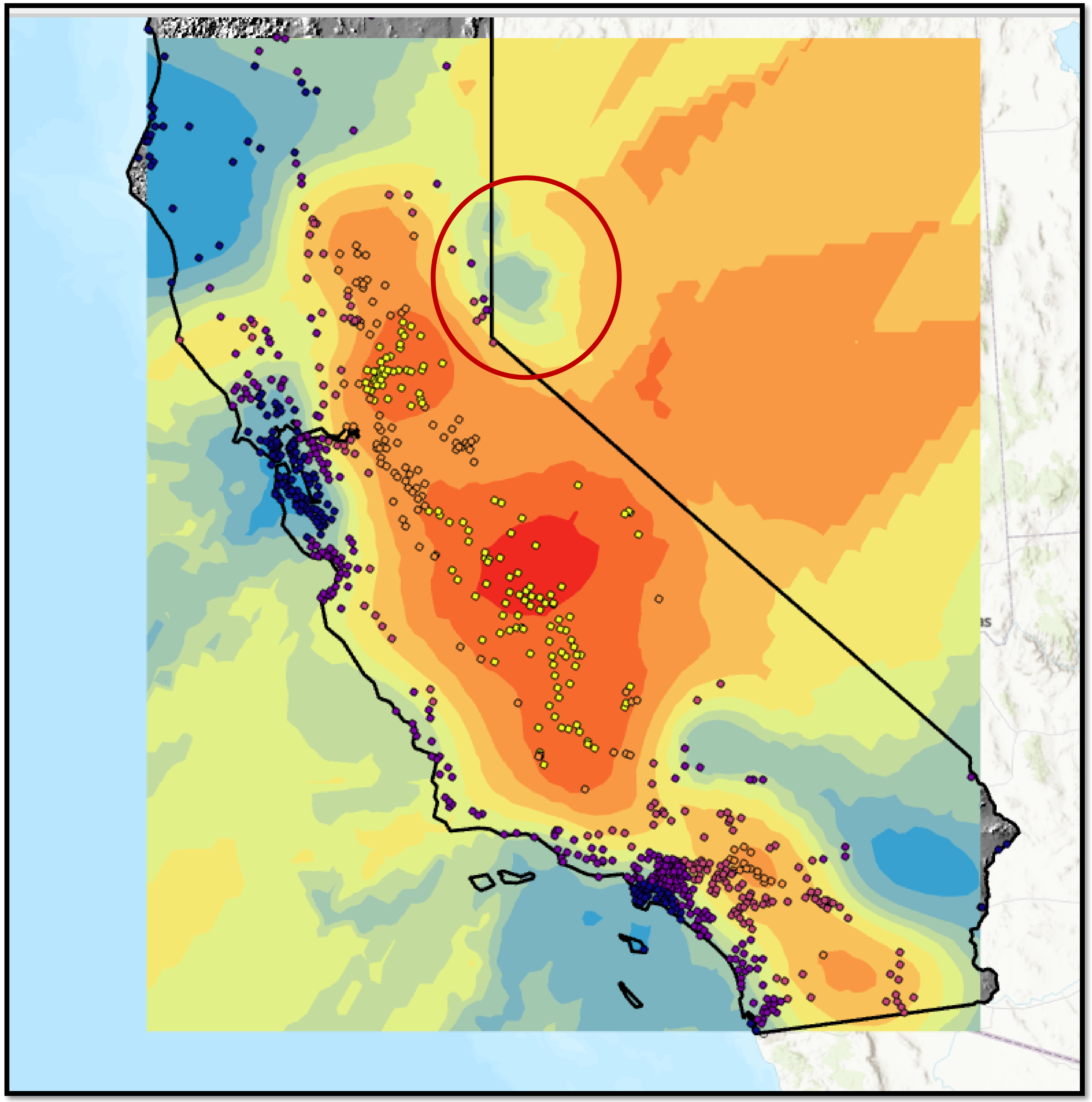
cities_idw

OBJECTID *	Shape *	AREANAME	Included	Predicted
1	Point	Acton	Yes	0.05425
2	Point	Adelanto	Yes	0.059709
3	Point	Agoura Hills	Yes	0.048418
4	Point	Alameda	Yes	0.032905
5	Point	Alamo	Yes	0.049158
6	Point	Albany	Yes	0.03373
7	Point	Alhambra	Yes	0.040969
8	Point	Aliso Viejo	Yes	0.044995
9	Point	Alondra Park	Yes	0.037758
10	Point	Alpine	Yes	0.056956

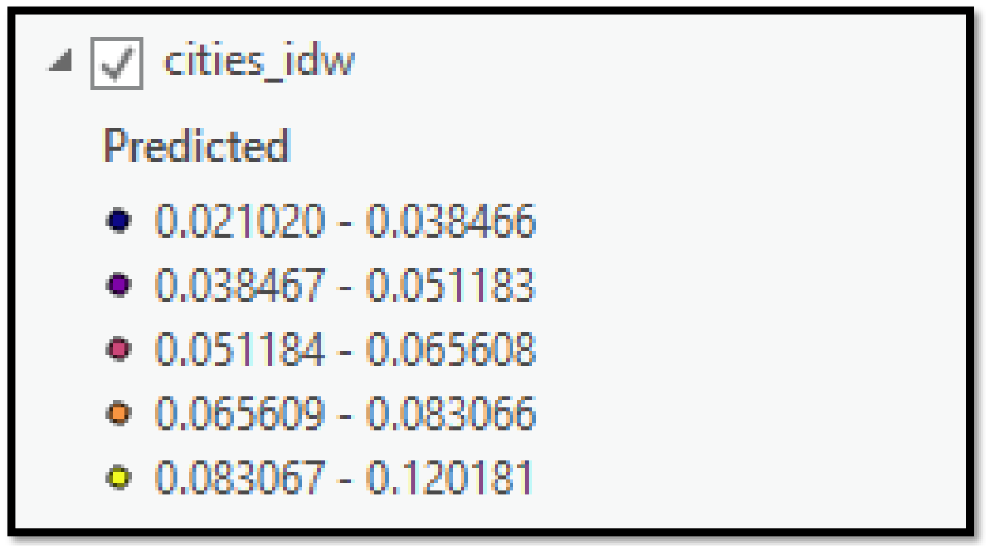


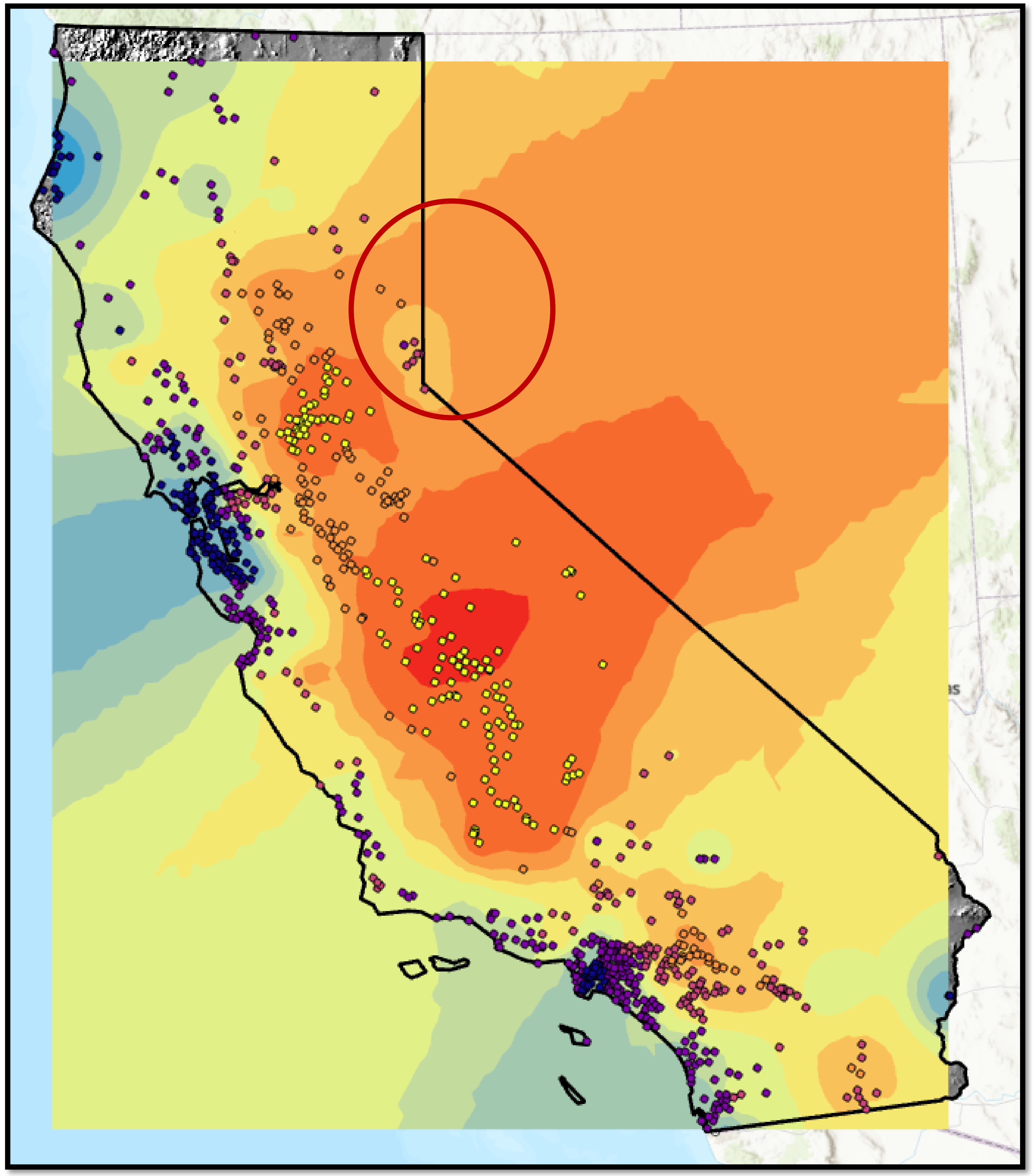
Ozone Concentration of Cities
Ordinary Kriging





Ozone Concentration of Cities
IDW





Comparing Values

Compare the results for the area represented as circle in previous slides

cities_kriging

OBJECTID *	Shape *	AREANAME	Included	Predicted
209	Point	Dollar Point	Yes	0.054139
300	Point	Glenshire-Devonshire	Yes	0.047254
378	Point	Kings Beach	Yes	0.048796
458	Point	Loyalton	Yes	0.04727
616	Point	Portola	Yes	0.053769
745	Point	South Lake Tahoe	Yes	0.059933
764	Point	Sunnyside-Tahoe City	Yes	0.058212
772	Point	Tahoe Vista	Yes	0.049889
792	Point	Truckee	Yes	0.052265

cities_idw

OBJECTID *	Shape *	AREANAME	Included	Predicted
209	Point	Dollar Point	Yes	0.060467
300	Point	Glenshire-Devonshire	Yes	0.052592
378	Point	Kings Beach	Yes	0.059347
458	Point	Loyalton	Yes	0.069461
616	Point	Portola	Yes	0.072397
745	Point	South Lake Tahoe	Yes	0.058046
764	Point	Sunnyside-Tahoe City	Yes	0.063709
772	Point	Tahoe Vista	Yes	0.057692
792	Point	Truckee	Yes	0.049161

Results

Aim of the Study:

- *Ozone concentration is measured at monitoring stations throughout the state of California. The locations of monitoring stations and concentration levels of ozone are known for all the stations, but the ozone values for other (unmonitored) locations in California are also of interest.*

Output Data:

- *Results of Kriging and IDW (Raster)*
- *Cities having Ozone Concentration for Kriging and IDW (Vector-Point)*
- *Cross-validation results of Kriging and IDW (Vector-Point)*

Contact:

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