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Visual comparison of Moving Window Kriging models

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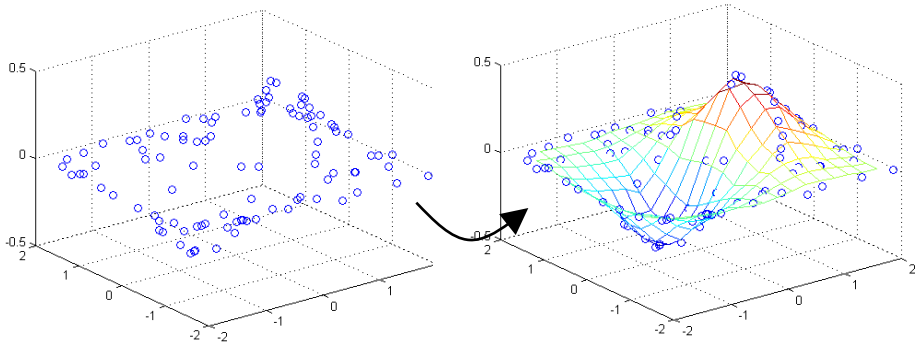
Moving Window Kriging (MWK)

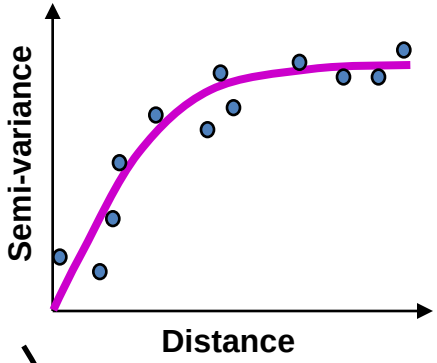
Kriging = geostatistical interpolation method

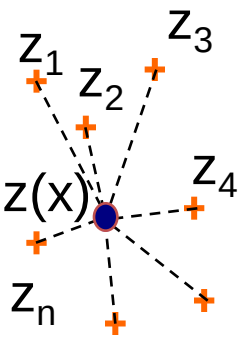


Estimate value at an unknown location

$$z(x)=\sum_{i=1}^{n} w_i z_i$$

Standard kriging = global variogram

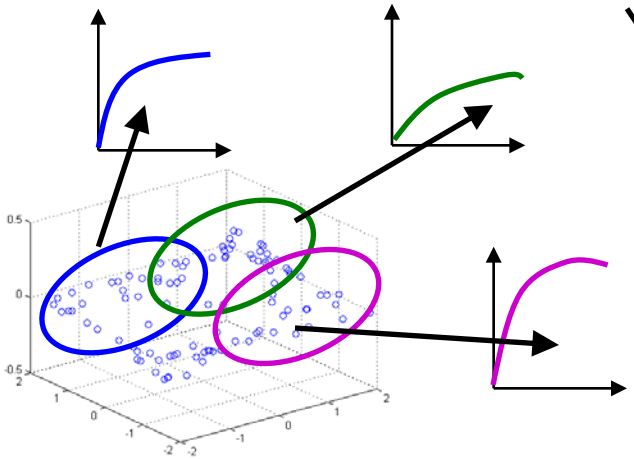




Weights w_i defined through variography

Interpolation results

Moving Window Kriging = simple kriging, variogram changes by location



Predicted value

These become dependent on **location**

Method parameters: kriging standard error & a set of other uncertainty measures

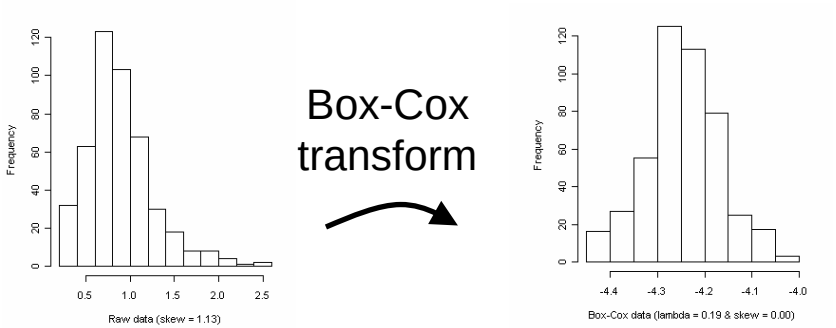
Multivariate spatial data set

Four MWK models – application of robustness

Model 1: MW-SK – not robust
Moving Window Kriging with Simple Kriging (SK)

Outliers in the data
↓
Violated assumptions
↓
Unreliable results

Use a **robust version** of the method: resistant to poor results produced by deviation from assumptions



Model 2: ROB1 - robust

1. globally Box-Cox transform the data
2. locally estimate and model robust (not basic) variograms using the transformed data
3. locally apply the four sub-stages of a robust form of SK
4. back-transform the robust SK results to the original data space.

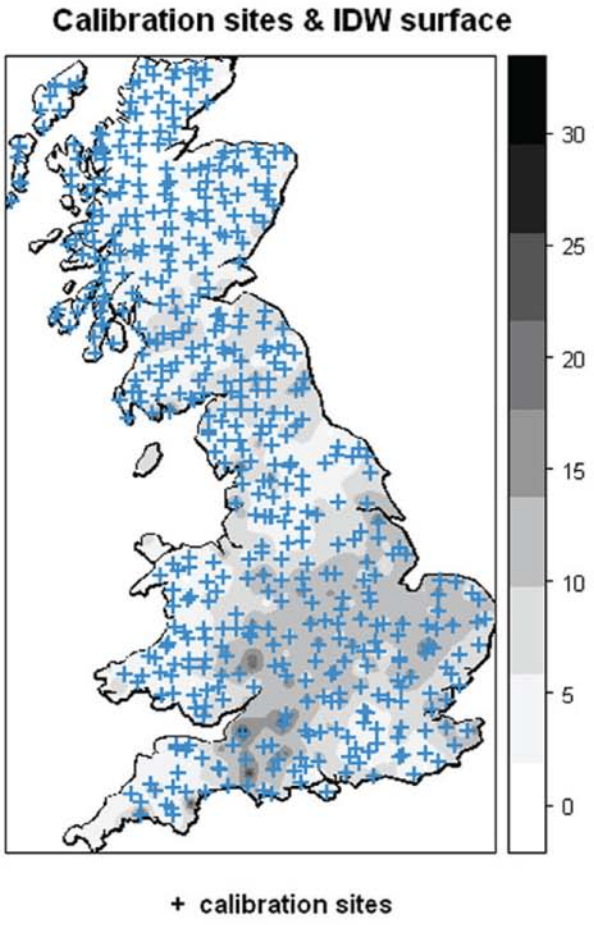
Model 3: ROB2 – robust, same as ROB1, except

1. locally Box-Cox transform the data

Model 4: ROB3 – hybrid between MW-SK and ROB2:
ROB2 in areas where aspatial outliers are present, MW-SK elsewhere.

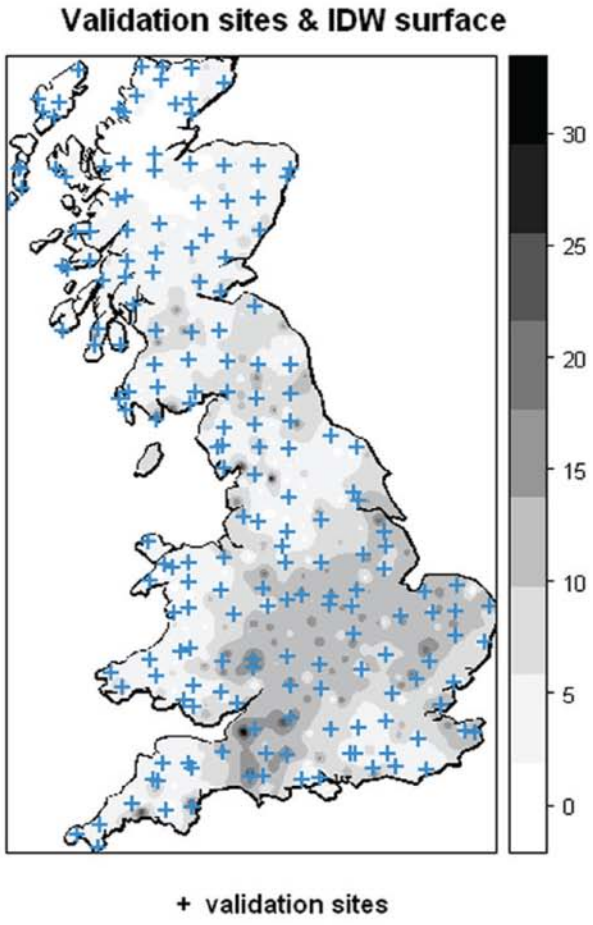
Data - Freshwater acidification critical load data set for GB

Calibration data
497 locations



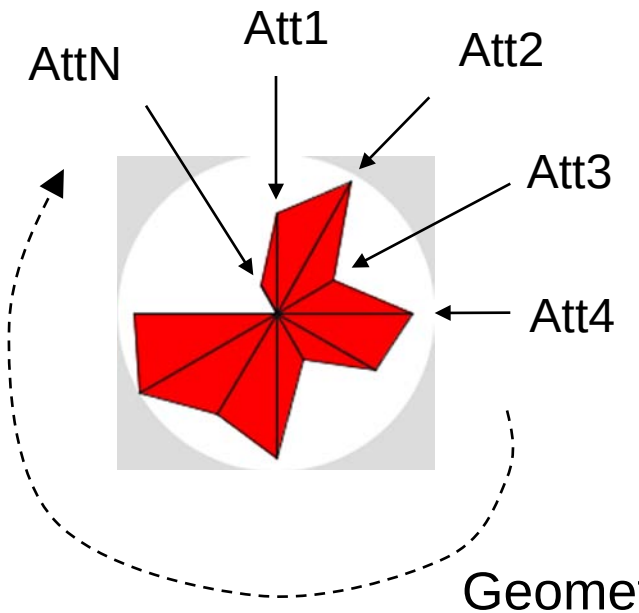
Model calibration

Validation data
189 locations



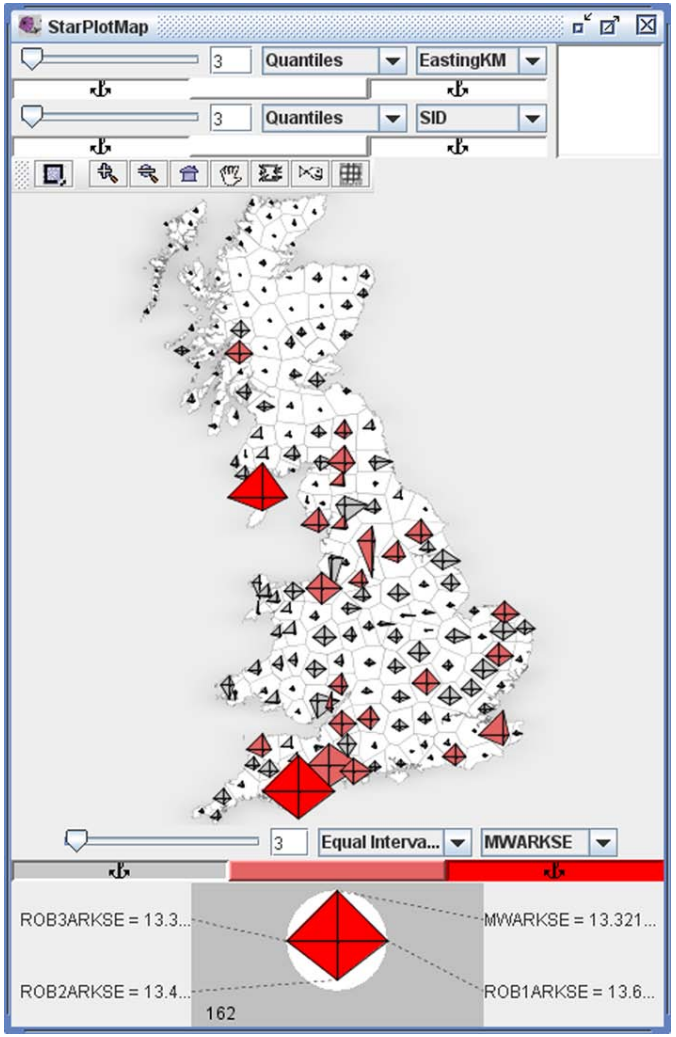
Model results & visualisation

Visualising model results – Star Icon Maps and Plots

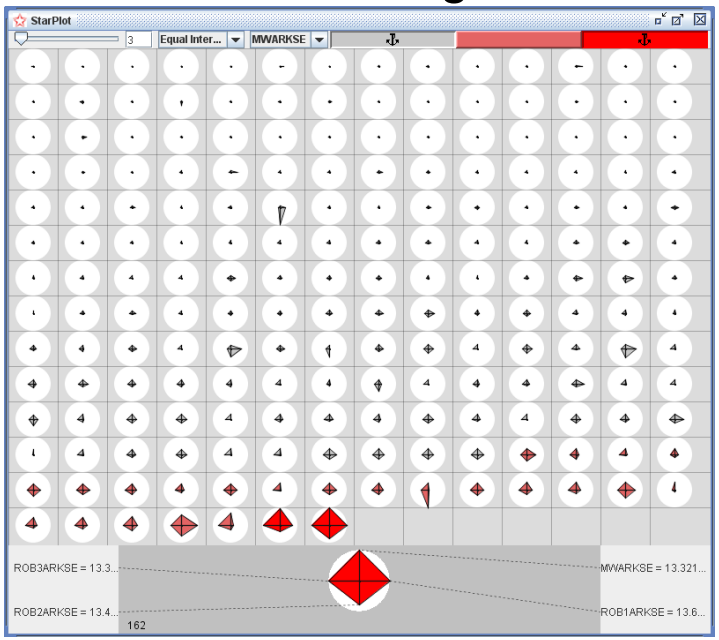


Star Icons:
Icon-based visualisation of multivariate data

Geographic positioning of icons: **StarPlotMap**



Geometric ordering: **StarPlot**



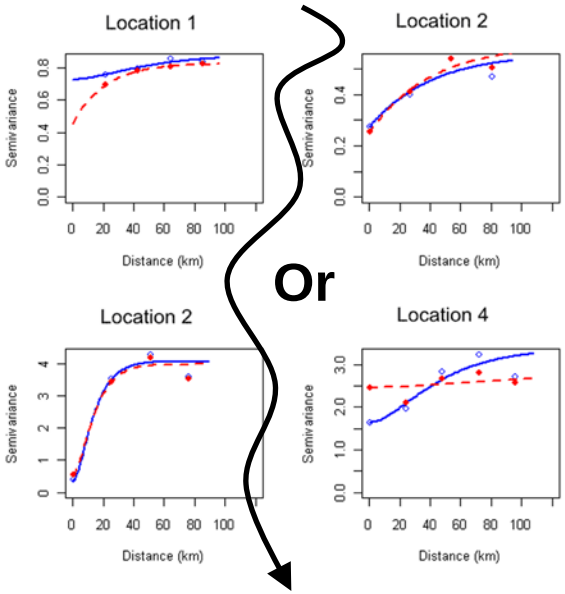
Geoviz Toolkit
Geovista Centre
Penn State University
MacEachren, Hardisty, Robinson

Model parametrisation – identifying local spatial structure

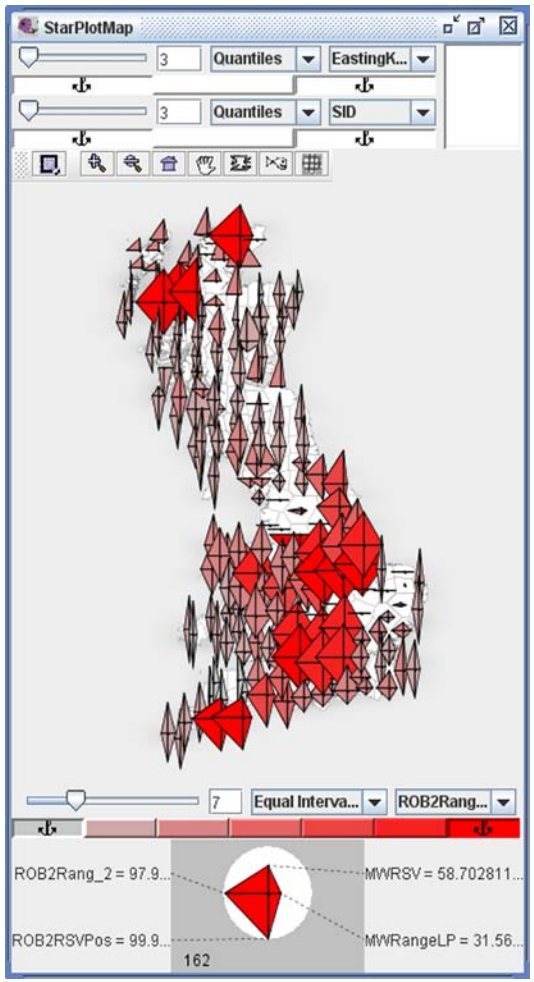
Task: identify areas where **local spatial autocorrelation** (LSA) changes with application of robustness

Measures of LSA in each model:
- Relative Structural Variability (RSV) –> ideally 100%
- Range -> ideally large

Manually compare variograms of two models at each validation location: MW-SK, ROB2

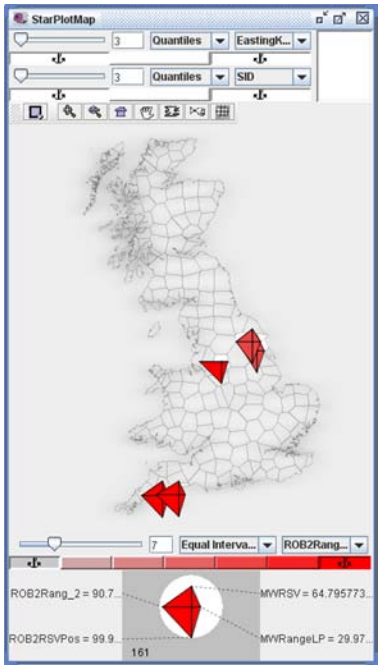


visualise Range and RSV values of both methods at all locations with star icons



MW-SK values larger than ROB2

MW-SK values smaller than ROB2

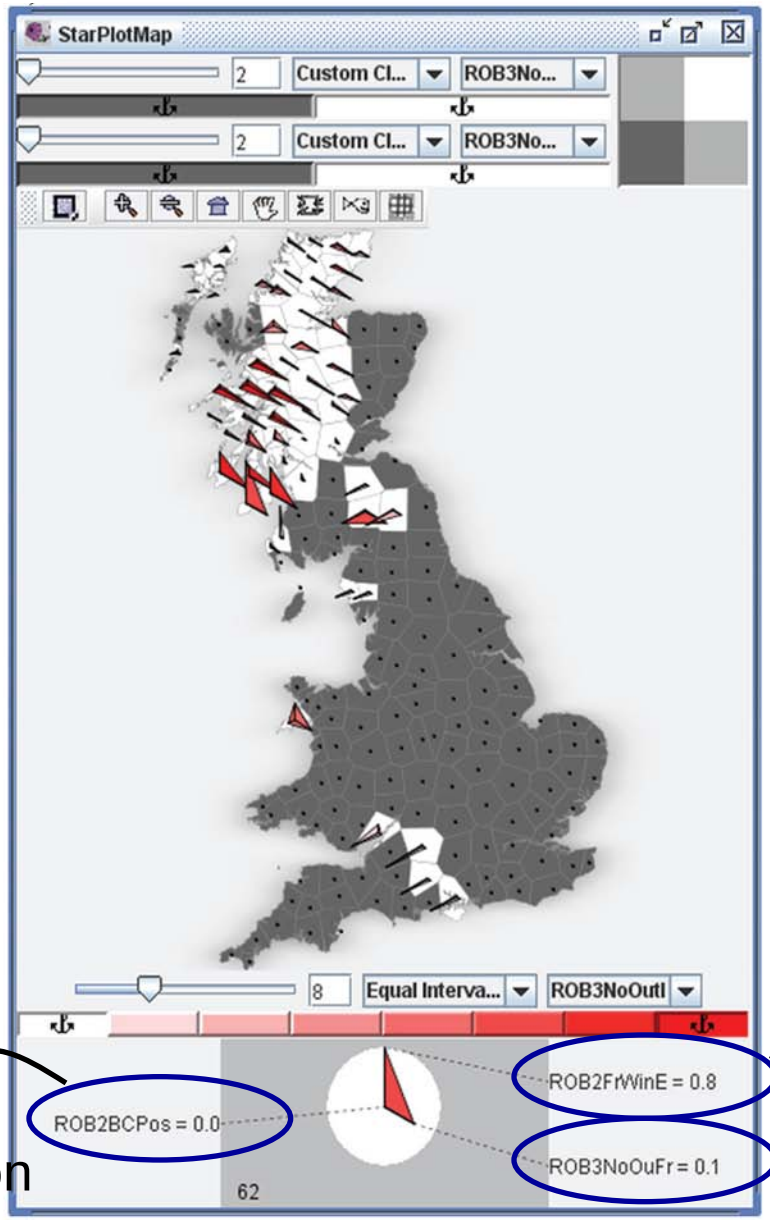


Model specification – appropriateness of robustness criterion

Task: is robustness justifiably applied everywhere?

Only areas where robustness was applied in ROB3:
ROB3NoOutl>0
presence of aspatial outliers

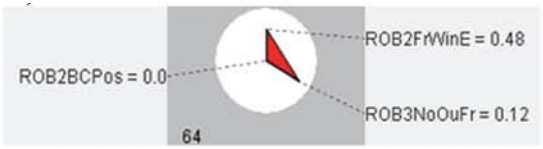
Visualising attributes that show **presence of outliers and data skew**



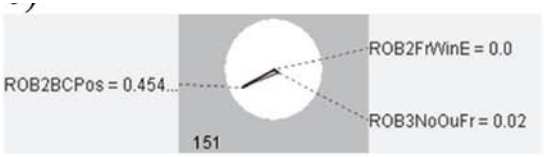
Skewness of data distribution

No. of spatial outliers

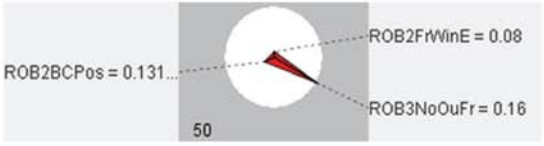
No. of aspatial outliers



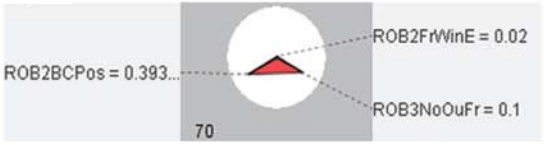
many spatial & aspatial outliers, no skew



no spatial & aspatial outliers, skewed data distribution



a few spatial & many aspatial outliers, a bit of skew



many aspatial outliers, skewed data distribution

Model performance – which of the models works best where?

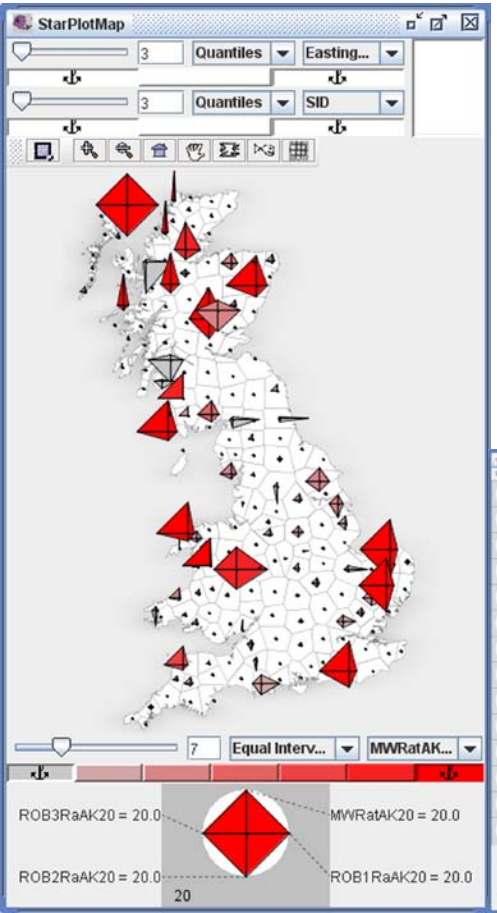
Task: compare how models perform vs. each other.

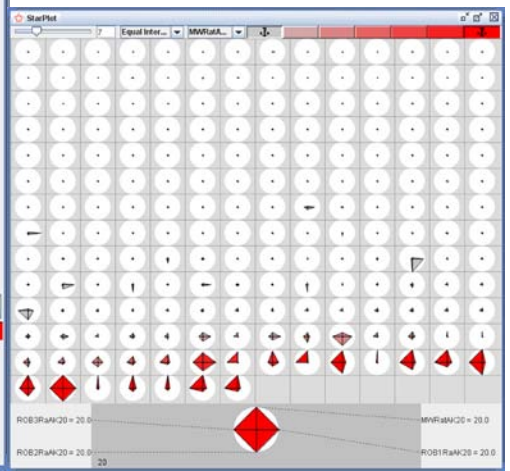
Measures of performance
- Absolute Residual (AR) –> prediction error
- Kriging Standard Error (KSE)

Manually calculate correlation between AR & KSE for each model

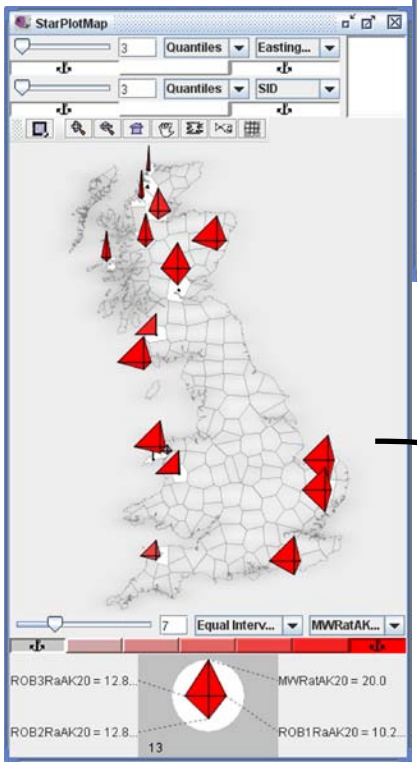
Or

visualise |(AR-KSE)/AR| For all four models simultaneously -> ideally 0 for all





MW-SK performs better than any robust model



At least one robust model performs better than MW-SK

Conclusions

Visual exploration of model parameters can help analyse parameterisation, specification and performance of basic and robust versions of the moving window kriging method.

Help with development of complex kriging models

Other multivariate visualisation methods?

Other local kriging models (e.g. GW kriging?)

Other model diagnostics?

Thank you!

Questions?