Design Interface: Interactive tools for editing and evaluating spatial designs.

Douglas Nychka and Eric Gilleland

Nancy Saltzman and J. Andrew Royle

Geophysical Statistics Project,
National Center for Atmospheric Research
`www.cgd.ucar.edu/stats`

- The problem
- Spatial models for air quality
- Di Toolbar
- An Example: 8-hour average ozone in NC

National Center for Atmospheric Research

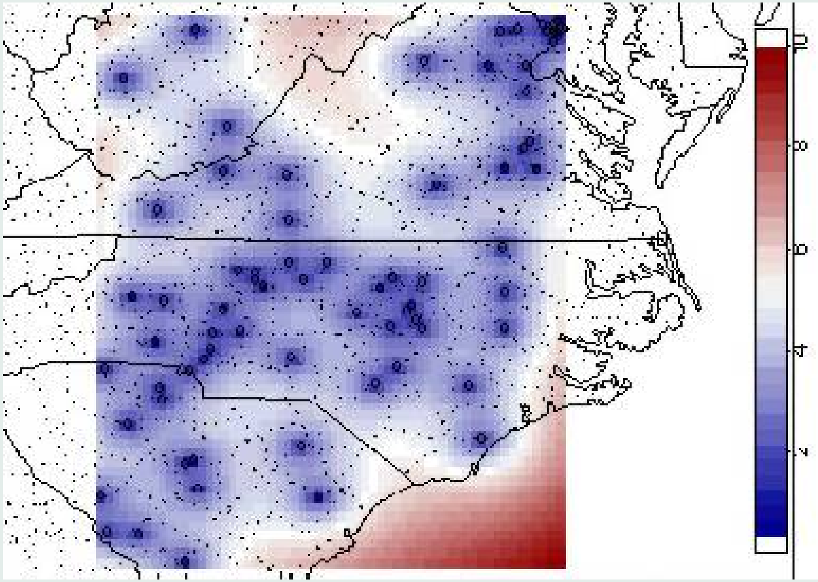
≈ 1000 people total, several hundred PH D (physical) scientists,
half the budget (≈ 60M) is a single grant from NSF-ATM

Research on nearly every aspect related to the atmosphere Climate, Weather, the Sun, Ocean/atmosphere, Ecosystems, Economic impacts, Air quality, Instrumentation, Scientific computing and ...

Statistical methods for the geosciences

Translating monitoring measurements into informative spatial information.

Spatial statistics can provide extensive information about the spatial characteristics of a pollutant and also the precision of a monitoring network.



Design Interface was proposed as a means to make this statistical information readily available to nonstatisticians.

- What is a best estimate of a pollutant at an unmonitored location?
- What is the estimate of an air quality standard?
- What is the uncertainty in the spatial predictions?
- What is the effect of increasing or decreasing the monitoring locations on spatial prediction?

Basic premises:

- Measurements made at a point location have some relevance for an area surrounding the site.
- Correlations among locations are roughly consistent over time.

The first assumption suggests using spatial statistics to predict pollutants at unmonitored locations.

The second allows for modeling the spatial structure using data at more than one time.

Spatial Models

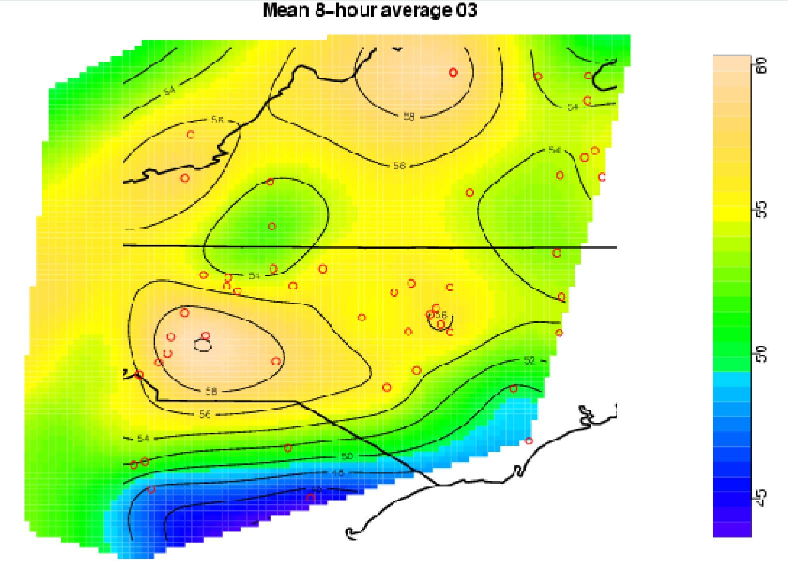
Starting points for a spatial model

- Measurement is normally distributed or can be transformed (e.g. square root) to be normal $z(\mathbf{x})$.
- Each location has an associated mean level and variance
- The correlation among any two locations is specified.

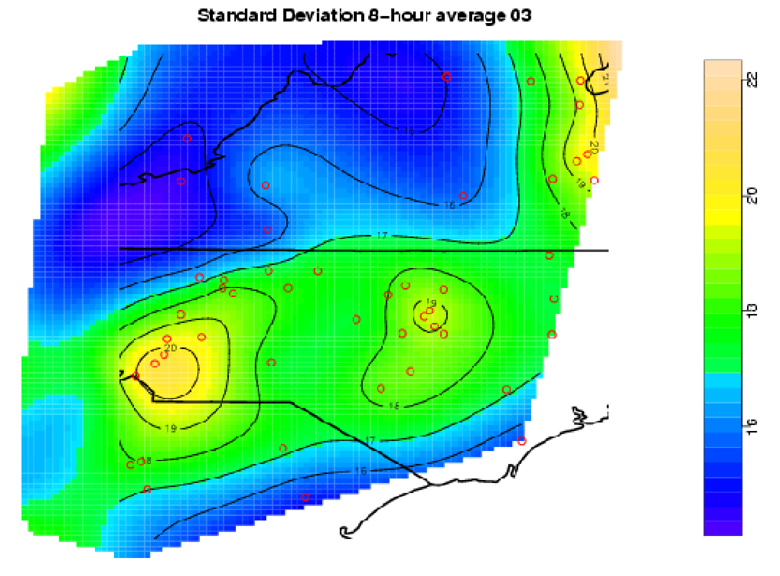
Each of these items can slowly vary over time or depend on seasonality.

Ingredients for a spatial model

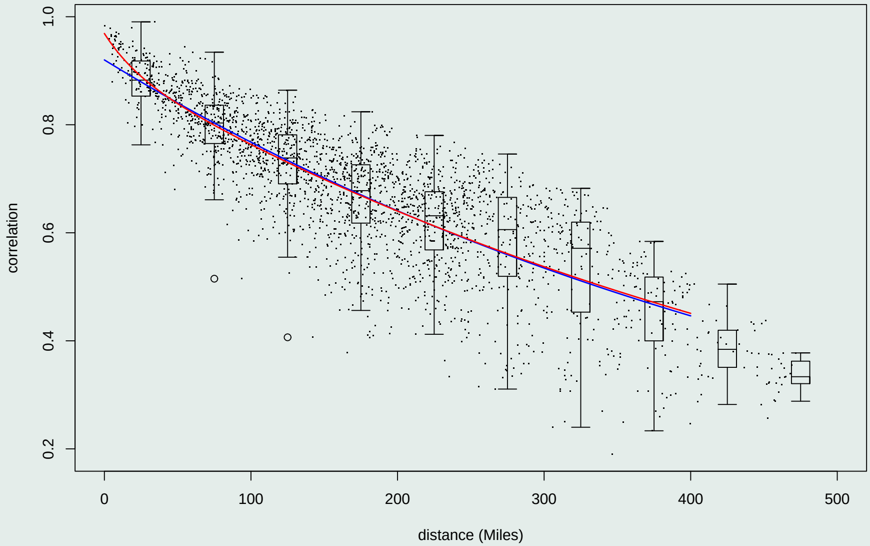
Mean field



Variance field



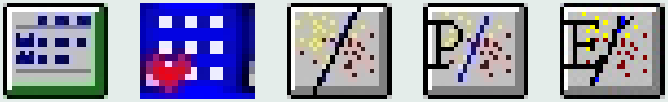
Spatial dependence



DI functions

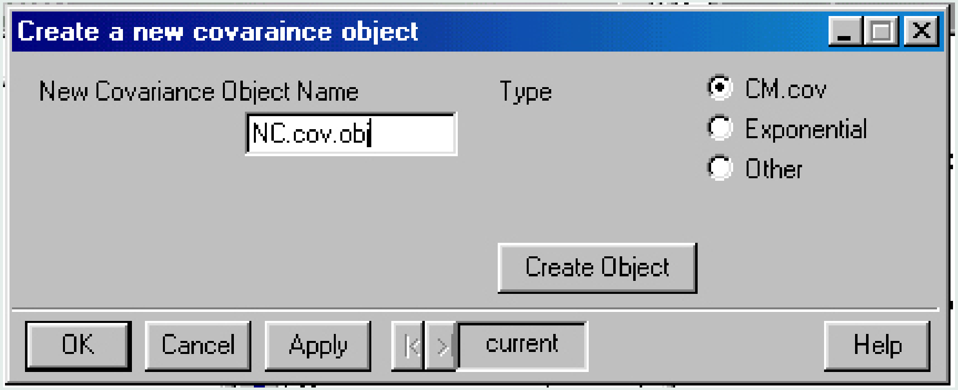
How DI works: Creates, modifies and displays a network object using the **S** statistical environment. The initial version assumes that the basic data has been read into **S**.

The Tool Bar



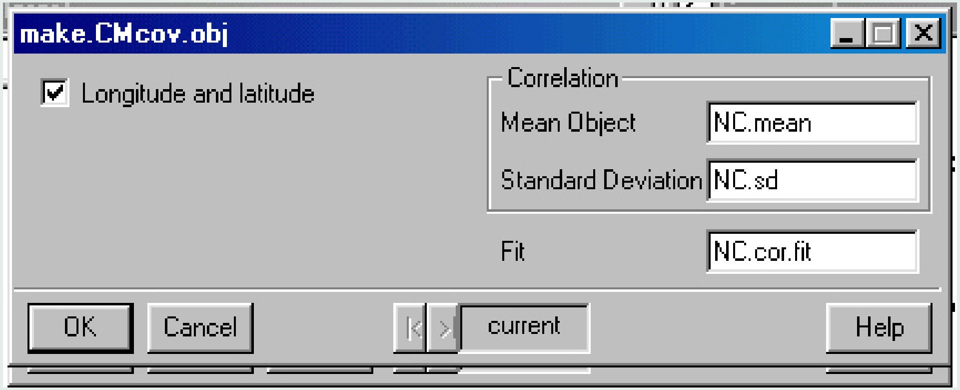
- Define a covariance
- Create a network: locations, covariance and Data (optional)
- Network summary plot
- Spatial prediction plot
- Editing a network

Defining a covariance



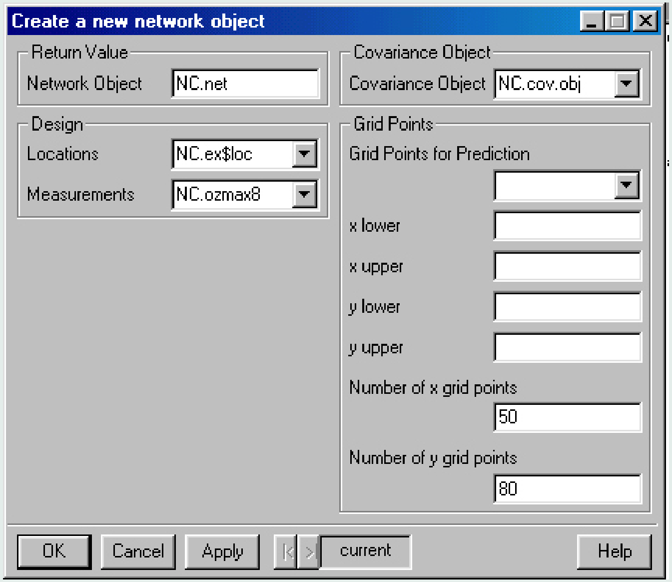
`CM.cov` Correlation model

Adding some details:

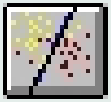


`NC.mean` and `NC.sd` are the mean and standard deviation surfaces.
`NC.cor.fit` is correlation as a function of distance.

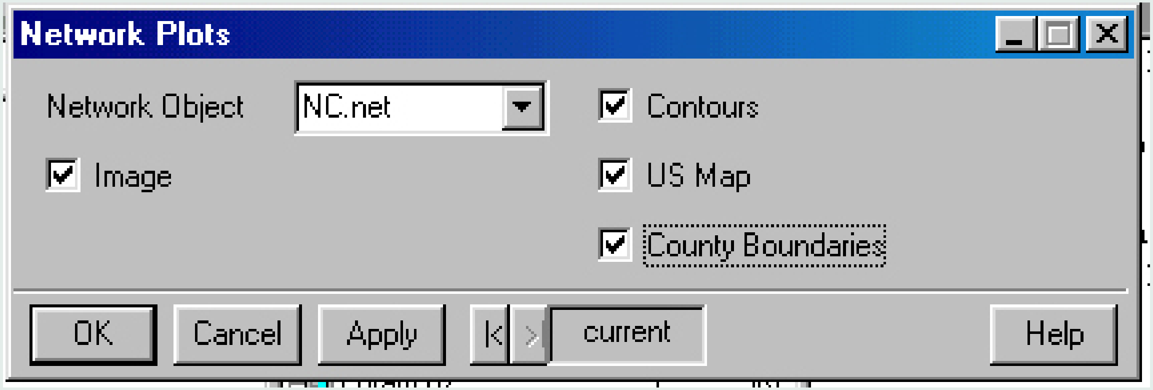
Creating a network object



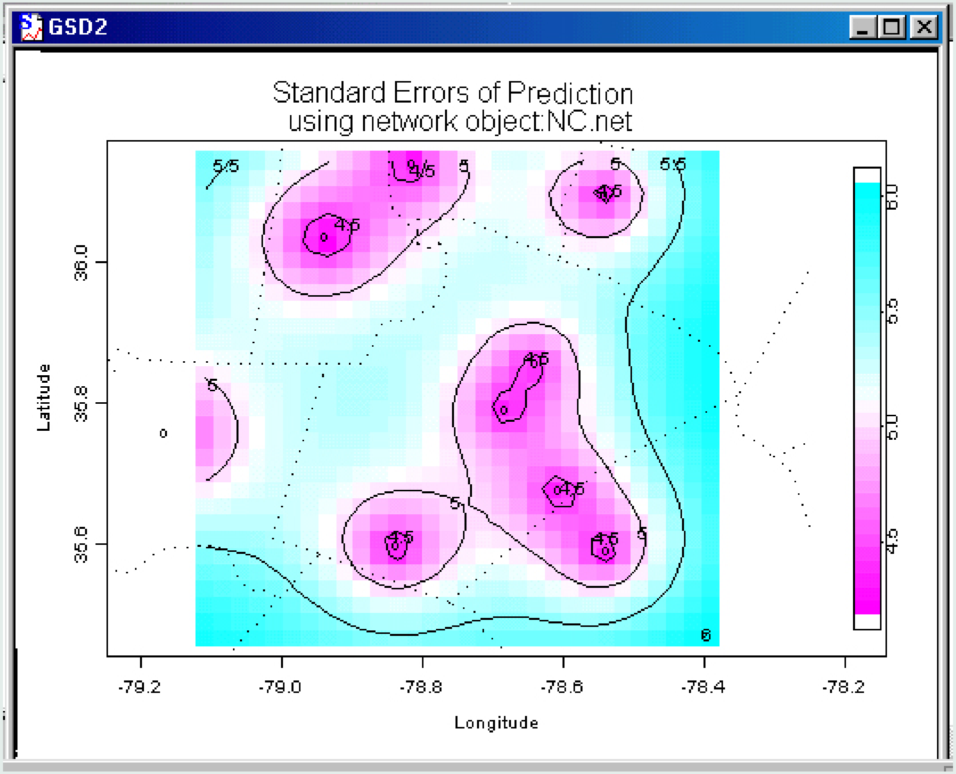
We used the covariance `NC.cov.obj` from previous step.
Location (lon/lat) information is `NC.ex$loc`
Data matrix is `NC.ozmax8`.

 Graphical summary of network

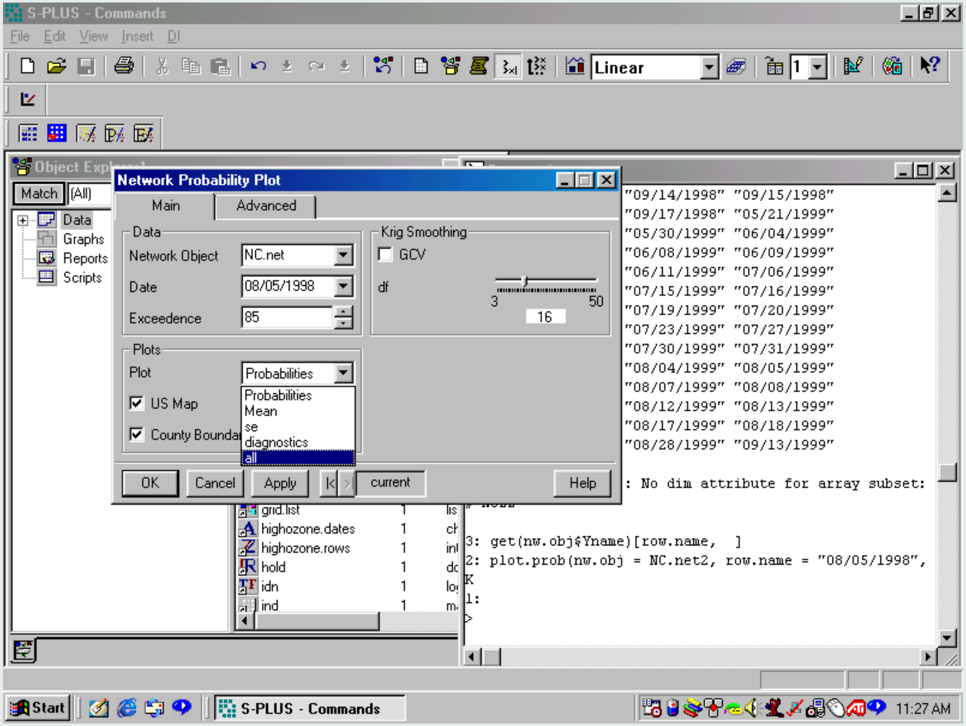
Now it's easy!



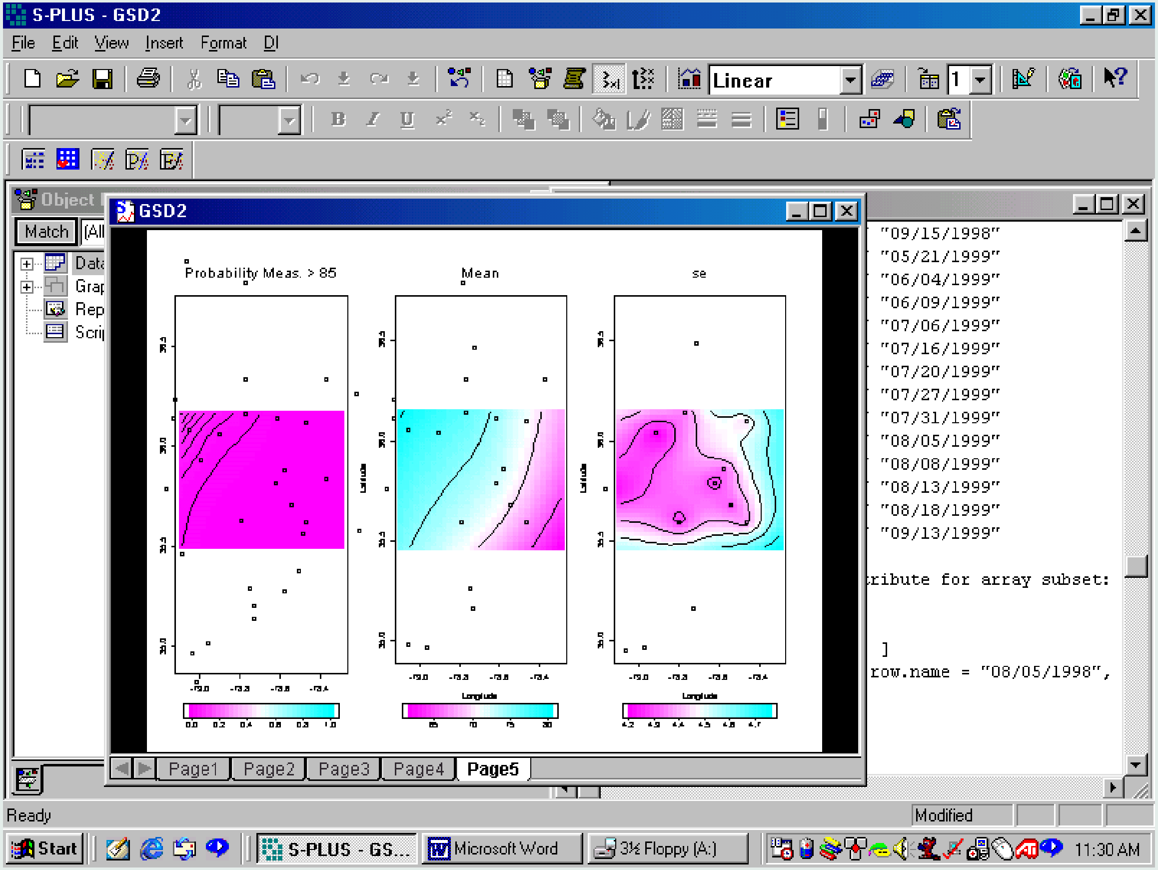
Standard errors of prediction within RTP, NC.



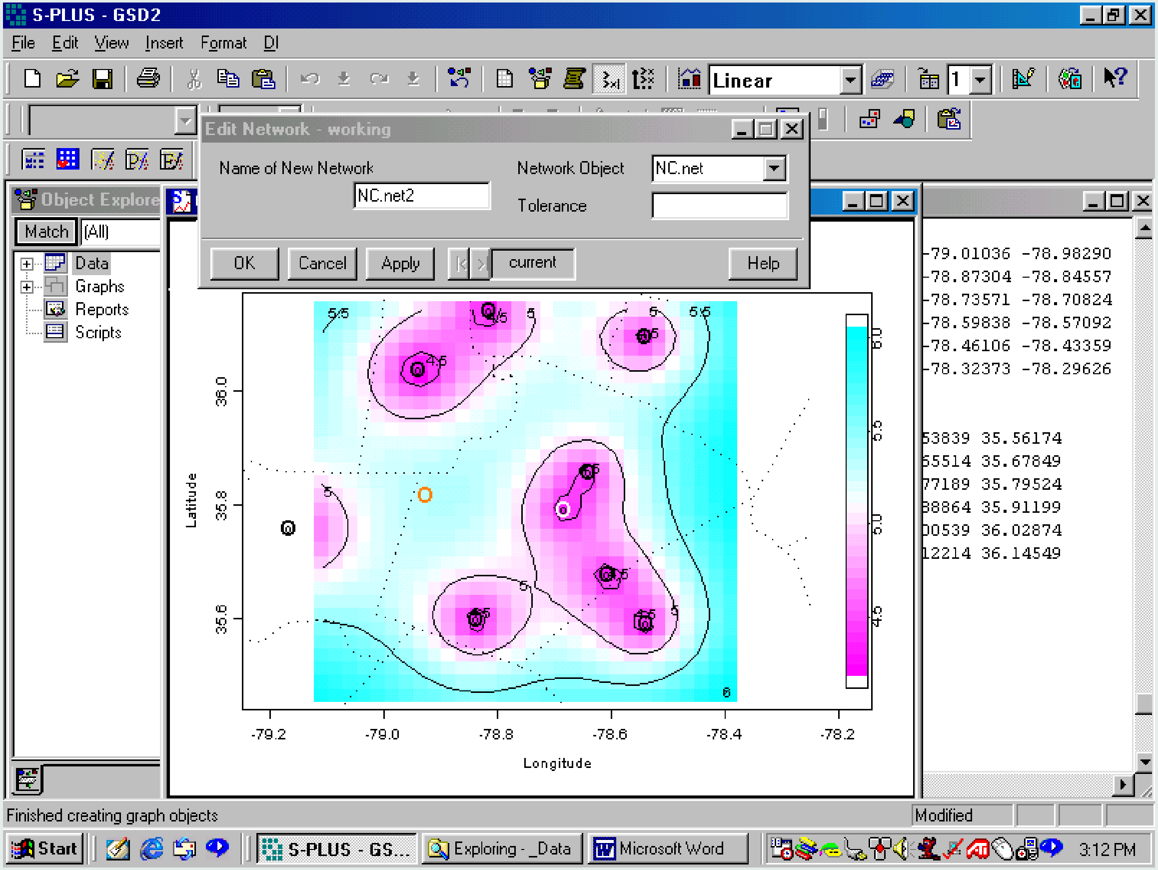
Analyzing observed data



Summary plot probability of exceedence, mean and standard error.



Editing a network



Future work

- GUI support for simple I/O to common formats.
- Tutorial on identifying spatial models.
- Diagonostics for adequacy of spatial model.
- Spatial models for the ozone standard (third highest yearly 8 hour average)