A Bayesian spatial statistical approach to the evaluation of CMAQ

Jenise Swall (NOAA/EPA) and Jerry Davis (EPA)

Brief Description:

This research focuses on the application of spatial statistical techniques for the evaluation of the Community Multiscale Air Quality (CMAQ) model. The upcoming release version of the CMAQ model was run for the calendar year 2001 and is in the process of being evaluated by EPA and NOAA scientists and other interested parties. As part of this evaluation, a Bayesian hierarchical approach is taken for evaluating the air concentration of SO4. We evaluate the model against monitoring observations for two different 4-week periods, one in mid-winter and one in mid-summer, for various subregions in the eastern U.S. The observed data come from the U.S. EPA's CASTNet (Clean Air Status and Trends Network) and STN (Speciated Trends Network) monitoring networks.

Exploratory data analysis (EDA) techniques are used to explore the nature of the spatial correlation between observations collected at the various monitoring sites and the model predictions made for the grid cells. Bayesian kriging is then used to interpolate between the given input values in a statistically justifiable manner, taking into account the overall spatial trends in the input values and the potential measurement error. The interpolated field is then compared with other sets of monitoring data and model output fields for evaluation purposes, using the uncertainty measures and distributional information provided by the technique. A number of critical statistical issues are addressed in this work. For instance, we show how to account for the change of support problem, which arises from the fact that the observed data are point measurements, while the model output fields are based on grid cell averages. Bayesian hierarchical models can also be extended to treat related problems in air pollution prediction and model evaluation. For example, statistical methods similar to those used here to address the change of support issue could prove useful in combining several disparate sources of information to provide an improved estimate for a spatially-varying quantity of interest.

The research presented here was performed under the Memorandum of Understanding between the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and under agreement number DW13921548. Although it has been reviewed by EPA and NOAA and approved for publication, it does not necessarily reflect their policies or views.