A FLEXIBLE SPATIO-TEMPORAL MODEL FOR AIR POLLUTION WITH SPATIO-TEMPORAL COVARIATES

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Background and Aims: We developed a spatio-temporal model for predicting ambient air pollution that combines unbalanced monitoring data with deterministic air quality model output. This work is part of the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air) study, a prospective cohort study funded by the US EPA to investigate the relationship between chronic exposure to air pollution and cardiovascular disease.

Methods: The monitoring data includes three spatial “snapshots” at 174 locations; rotating monitors giving 2-3 measurements at 84 subject homes; and 25 time series of two-week averages at fixed and regulatory monitoring (AQS) sites. The data are unbalanced because at any given time measurements are available at only a subset of measurement sites. We also have geographic covariates and a spatio-temporal covariate based on the output from a source dispersion model for traffic-related air pollution (Caline3QHC; Wilton et al 2010).

We extended our unified hierarchical spatio-temporal model (Szpiro et al, 2010) to accommodate spatio-temporal covariates. We improved the estimation approach and developed several cross-validation strategies to make the fullest use of the available data. We assessed predicted NOx concentrations in Los Angeles.

Results: The model predicted well with cross-validated spatial $R^2$ of approximately 0.7 at subject homes. We successfully incorporated the source dispersion model output into the prediction model, but our implementation of Caline3QHC did not improve predictions in a model with road covariates. However, we found some evidence that Caline3QHC could replace the road covariates.

Conclusions: This spatio-temporal model for air pollution concentrations provides a flexible approach to combining irregularly sampled pollution monitoring data with geographic covariates and the output from deterministic air quality models. We successfully predicted long-term average NOx concentrations while taking full advantage of the unbalanced monitoring data available to the MESA Air study. This model has been implemented in an R-package, SpatioTemporal.

References:


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