

## Relating Health Outcomes to Environmental Factors: Assessing Uncertainty in the Presence of Predicted Environmental Factors

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**Abstract.** Publicly available data from disparate sources are frequently combined for subsequent statistical analyses. Data from different sources are often measured or associated with different geographic or spatial units. Combining them for analysis usually requires prediction of one or more of the variables of interest. Here it is assumed that health outcomes and related covariates are measured at residences (points) and that environmental exposure is measured at monitors (a different set of points). To assess the association between the health outcome and environmental exposure, adjusting for covariates, the environmental exposure is predicted for the points for which health outcomes are observed.

When exposure is predicted using a smoothing method, such as kriging, Berkson error arises in the estimation of the parameter associated with environmental exposure in the

regression of health outcomes on predicted environmental exposure, adjusting for covariates. As a consequence, the parameter is estimated unbiasedly (unlike with classical measurement error), but the standard error is biased downwards. Previously suggested methods for improving the estimated standard error will be reviewed.

After aligning the health and environmental data sets using kriging, an iteratively reweighted generalized least squares approach is suggested for relating health outcomes and environmental exposure, adjusting for covariates. The properties of the method are discussed, and simulation results illustrate the performance of the proposed approach. Using the proposed methodology, the association between birth weight and air quality is explored, and the results contrasted to those obtained with other methods.

