Fine Spatial Resolution Global CO_2 Flux Estimates from Remote Sensing Derived Environmental Data within a Geostatistical Inverse Model

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This study applied a geostatistical approach to atmospheric inverse modeling to estimate carbon fluxes on a monthly gridscale from 1997 to 2001, focusing on the effect of using remote-sensing derived auxiliary environmental data to help constrain flux estimates. The results of this study represent the first application of the geostatistical approach to inverse modeling using atmospheric data from the NOAA cooperative air sampling network, and the first implementation of the approach with auxiliary environmental data. The geostatistical approach uses observational CO_2 concentration data and an atmospheric transport model to update prior information about carbon fluxes. The prior information is represented in the form of a spatial and/or temporal covariance in the deviations of fluxes from mean behavior, and both the parameters of the covariance model and of the mean behavior can be inferred from observational data. The model of the mean is expanded through the addition of deterministic drift parameters known to affect carbon flux. This setup offers the opportunity to directly incorporate environmental data derived from remote sensing instruments, without assuming a priori the magnitude or statistical significance of the correlation of these data with the inferred carbon fluxes. In this study, global estimates of carbon fluxes were obtained at a 3.75° x 5° resolution, along with their estimated uncertainties. Auxiliary variables shown to be statistically significant were Leaf Area Index, Fraction of Photosynthetically Available Radiation, land cover, land temperature, and population density weighted gross domestic product. Results indicate that the proposed approach yields flux estimates with comparable precision to synthesis Bayesian approaches, without requiring pre-aggregation to large continental regions or prior assumptions about flux magnitudes.

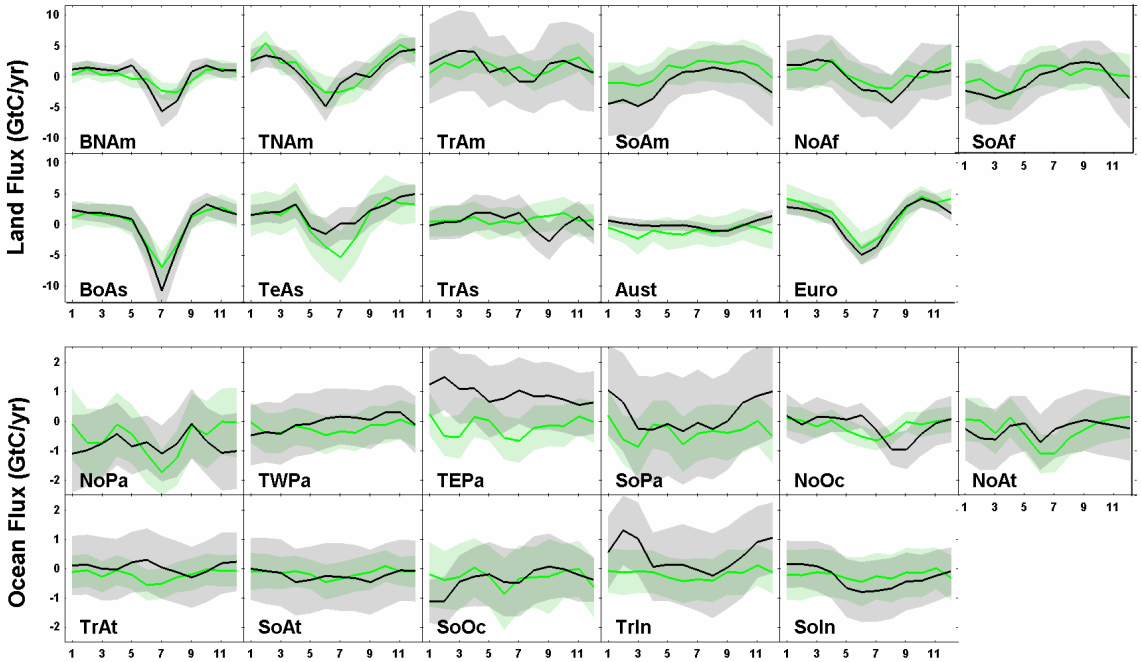

Figure 1. Year 2000 monthly fluxes and uncertainty bounds expressed as two standard deviations for variable trend best estimate aggregated to the 22 Transcom3 regions (in green) and Transcom estimates (Baker et al. 2006, in black).