Estimating Monthly Gridscale CO_2 Fluxes Using a Geostatistical Inverse Modeling Approach

A.M. Michalak[1,2], L. Bruhwiler[2], A. Hirsch[2,3], W. Peters[2,3], J.B. Miller[2,3], and P.P. Tans[2]

[1]University Corporation for Atmospheric Research (UCAR), Visiting Scientist Program, P.O. Box 3000, FL-4/VSP, Suite 2200, Boulder, CO 80307; 303-497-4568, Fax: 303-497-5590, E-mail: Anna.Michalak@noaa.gov
[2]NOAA Climate Monitoring and Diagnostics Laboratory, Boulder, CO 80305
[3]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder 80309

A geostatistical inversion algorithm is applied to the recovery of gridscale CO_2 fluxes using data from the CMDL Cooperative Air Sampling Network. The geostatistical approach to inverse modeling is a Bayesian approach in which the prior probability density function is specified based on an assumed form for the spatial and/or temporal correlation of the surface fluxes to be estimated. This differs from the more common traditional Bayesian approaches, where the prior information is in the form of initial surface flux estimates for given regions or grid cells. In geostatistical inverse modeling, the degree to which surface fluxes at two points are expected to be correlated is defined as a function of the separation distance in space or in time between the two points. Flux estimates obtained in this manner are not subject to some of the limitations associated with traditional Bayesian inversions, such as potential biases created by the choice of prior fluxes and aggregation error resulting from the use of large regions with prescribed flux patterns. In essence, they shed light on the information contained in the measurements themselves. Inversion results are presented for 1997 through 2001 (Figure 1). Because the inversion does not incorporate prior estimates of fluxes, the results are indicative of the degree to which the CMDL Cooperative Air Sampling Network can itself constrain fluxes at various scales.

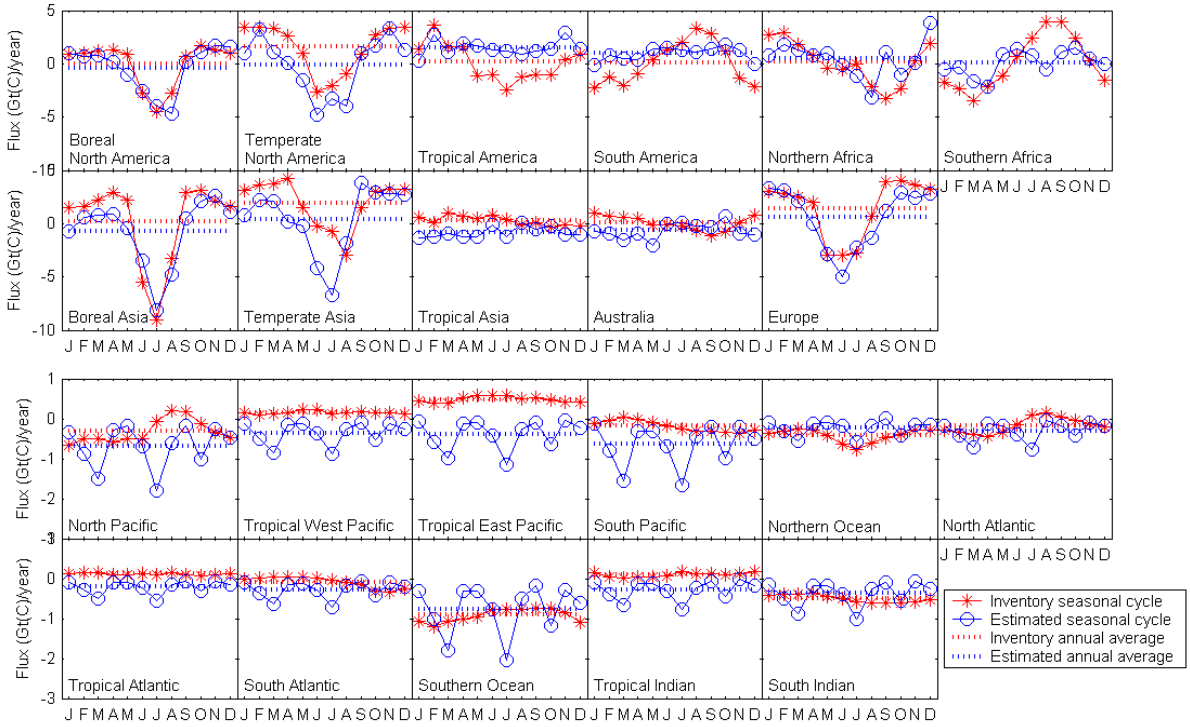

Figure 1. Gridscale flux estimates for 2000, aggregated to the 22 TransCom3 regions. Blue circles represent aggregated posterior best estimates. Red stars represent aggregated fluxes from net ecosystem exchange and oceanic exchange inventory data. Certain regions, such as Boreal North America and Boreal Asia, show pronounced seasonality that is very similar to that suggested by inventory data. Other regions, such as South America, are clearly not well constrained by the flask data. Finally, regions such as Temperate Asia show variability that is distinctly different from that of the inventory data.