Regional Scale Inverse Modeling of North American Carbon Fluxes

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Geostatistical inverse modeling is a numerical technique that can be used to infer finely-resolved patterns of biosphere-atmosphere exchange from atmospheric mixing ratio data. In this study we employed this technique in a regional framework to characterize the spatial and temporal information about biospheric carbon fluxes that can be extracted from continuous mixing ratio data simulated at six tall tower locations (3 existing, 3 planned) across the United States. We inferred the monthly average net ecosystem exchange (NEE) and the monthly-mean diurnal cycle of NEE predicted by the Simple Biosphere Model-2 (SiB-2) biogeochemical model for the month of September at the spatial scale of 1ºx1º, using four measurements per day from each tower. The Stochastic Time-Inverted Lagrangian Transport (STILT) model was used to generate the simulated time series of CO_2 at the towers and the transport information used in the inversion. We also used the geostatistical technique to infer the monthly average sensitivity of NEE to solar radiation and temperature in a very simple NEE model. The results show that the spatial pattern of the flux is accurately retrieved near the towers and that the aggregated monthly NEE is accurately retrieved up to 1000 km from the towers (a total area of ~10 million km^2), with a substantial reduction in the uncertainty of the aggregated flux.

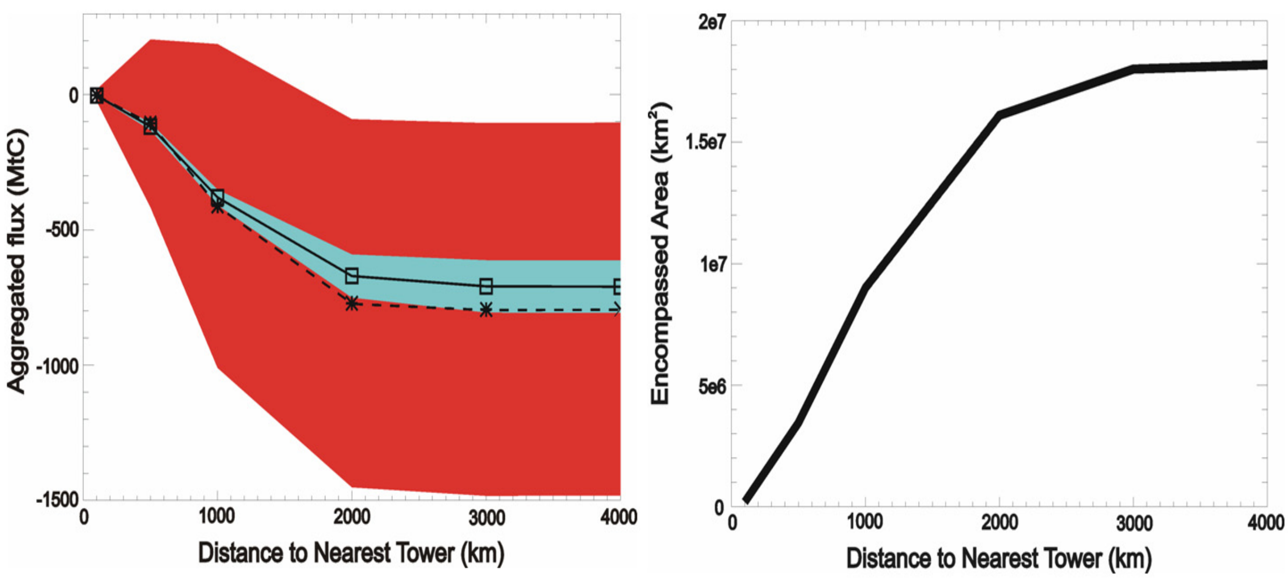

Figure 1. Left panel shows a comparison between the aggregated prescribed flux (dashed line and red ± 1□ uncertainty bounds) and aggregated inferred flux (solid line and blue uncertainty bounds), in millions of tons of carbon for the month of September. The aggregation was performed by adding the flux from all grid cells within 100, 500, 1000 (etc.) of the 6 tall tower locations. The right panel shows the area encompassed within the different distances, in square kilometers.