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# Estimation of Regional carbon exchanges from continuous variations of atmospheric mixing ratios of CO2

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Continuous variations of atmospheric mixing ratios of CO2 can be used to infer sources and sinks upstream. Timeseries of CO2 measurements from across North America in the summer of 2004 show repeated events in which meridional gradients advected into the domain from the Pacific were perturbed by synoptic weather systems. We simulated variations in surface fluxes over most of the North American continent for four months during 2004 using a mesoscale weather model (CSU-RAMS) coupled to a model of land-atmosphere exchanges of carbon, water, energy, and momentum (SiB2), and compared the results to observations made at a number of flask and tower sites. The model captures much of the observed synoptic variability of CO2 over North America during the period.

Estimation of sources and sinks from the concentration timeseries is complicated by the fact that the surface exchanges of CO2 vary strongly from hour to hour and from day to day. We have developed a data assimilation method using backward-in-time Lagrangian transport and a Maximum Likelihood Ensemble Filter (MLEF) to estimate spatially-explicit multiplicative biases in simulated photosynthesis and respiration from variations in mixing ratios. In tests with synthetic observations, the MLEF significantly improves forward simulations over several hundreds of km upstream of each observing station over 10-day assimilation cycles. Full-rank ensembloe assimilation is able to closely approximate the correct solution. Using covariance localization

it is possible to obtain an approximate solution with much smaller ensembles.