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Initial results of an ensemble data assimilation system for a hemispheric air quality model

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Data assimilation can be used with air quality models to improve historical simulations or initial conditions for forecasts. The ensemble Kalman filter is an assimilation technique that uses a low-dimensional representation of the background error covariances. We have coupled an offline chemical transport model, the DEHM (the Danish Eulerian hemispheric model), with an asynchronous ensemble Kalman filter (AEnKF), which accounts for timing discrepancies between observation and the analysis time.

We will present the structure and initial results using this simulation-assimilation framework. To evaluate the DEHM-AEnKF system, we assimilated a single species, carbon monoxide. Carbon monoxide is a moderately long-lived atmospheric trace gas, and its concentration is measured routinely from a number of different measurement platforms. The chemistry of CO is simpler than other well-studied species (e.g., ozone). Thus CO is a good candidate species for the initial testing of a chemical data assimilation system. We assimilated retrieved CO column concentrations from MOPITT (an instrument aboard the polar orbiting NASA satellite Terra) and from surface measurements from the Global Atmosphere Watch monitoring network. Simulations were evaluated against measurements from the AirBase network of European monitoring stations.

The initial results show that the simulations without assimilation grossly underestimate surface CO concentrations, and the DEHM-AEnKF system eliminates this large and systematic bias. Furthermore, the temporal variability of the DEHM-AEnKF CO concentrations were far more consistent with surface measurements (compared to the simulations without assimilation). While these preliminary results are promising, this is a single-species assimilation for a moderately long-lived atmospheric trace gas, and thus represents a relatively simple assimilation challenge. We will discuss how the DEHM-AEnKF system can be scaled to accommodate multi-species assimilation, as well as how some of the short-comings of the present design can be overcome.