Title: Spatial variability in column CO2 inferred from high resolution GEOS-5 global model simulations: Implications for remote sensing and inversions

Authors: Ott, L., B. Putman, S. Pawson, J. Collatz, and W. Gregg.

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Abstract

Column CO2 observations from current and future remote sensing missions represent a major advancement in our understanding of the carbon cycle and are expected to help constrain source and sink distributions. However, data assimilation and inversion methods are challenged by the difference in scale of models and observations. OCO-2 footprints represent an area of several square kilometers while NASA's future ASCENDS lidar mission is likely to have an even smaller footprint. In contrast, the resolution of models used in global inversions are typically hundreds of kilometers wide and often cover areas that include combinations of land, ocean and coastal areas and areas of significant topographic, land cover, and population density variations. To improve understanding of scales of atmospheric CO2 variability and representativeness of satellite observations, we will present results from a global, 10-km simulation of meteorology and atmospheric CO2 distributions performed using NASA's GEOS-5 general circulation model.

This resolution, typical of mesoscale atmospheric models, represents an order of magnitude increase in resolution over typical global simulations of atmospheric composition allowing new insight into small scale CO2 variations across a wide range of surface flux and meteorological conditions. The simulation includes high resolution flux datasets provided by NASA's Carbon Monitoring System Flux Pilot Project at half degree resolution that have been downscaled to 10-km using remote sensing datasets. Probability distribution functions are calculated over larger areas more typical of global models (100-400 km) to characterize subgrid-scale variability in these models. Particular emphasis is placed on coastal regions and regions containing megacities and fires to evaluate the ability of coarse resolution models to represent these small scale features. Additionally, model output are sampled using averaging kernels characteristic of OCO-2 and ASCENDS measurement concepts to create realistic pseudo-datasets. Pseudo-data are averaged over coarse model grid cell areas to better understand the ability of measurements to characterize CO2 distributions and spatial gradients on both short (daily to weekly) and long (monthly to seasonal) time scales.