Combining *in situ* and Satellite Observations of CO_2 in a Synthesis Inversion Framework for the U.S. Corn Belt

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Agriculture has been central to the Anthropocene, is intricately tied to recent and projected increases in global population, and is fundamentally coupled to the global carbon cycle. Farming activity contributes a substantial portion of the total anthropogenic-greenhouse gas emissions but intensification and advances in technology have also resulted in high levels of crop photosynthesis (GPP). As a result, intensively managed, high-productivity agricultural areas such as the U.S. corn belt exhibit the largest growing season fluxes globally, and result in drawdown of atmospheric CO_2. Increases in crop GPP are also due, in part, to effects of rising CO_2 concentrations, a phenomenon known as CO_2 fertilization. However, higher CO_2 levels can also reduce stomatal conductance and density, thereby suppressing carbon uptake. Stomatal conductance also decreases in response to rising atmospheric demand of moisture from the leaf surface, which is associated with rising temperatures. Taken together, these factors complicate our ability to accurately model crop yield responses to climate change and carbon-climate feedbacks. Carbon cycle models typically use biogeochemical relationships between processes and meteorological variables to infer carbon fluxes. However, processes are often simplified and sometimes remain unvalidated at large spatial and temporal scales. Top down models can be used to assimilate observed CO_2 concentrations to constrain fluxes, but prior flux models, sparsity of CO_2 observations, and errors in modelling transport can be major sources of uncertainties in these models. Recently, satellite measurements of column-integrated CO_2 have been successfully assimilated in inversion models, helping to increase measurement density, but evidence of potential biases in satellite retrievals has been found. No studies to-date have combined surface data with the satellite data in such a framework that combines the increased observation density of the satellite data with state-of-the-art, crop-specific prior flux models and highly precise surface observations. We introduce here an approach that combines these strengths in an attempt to minimize posterior flux uncertainty. Here we present preliminary results from a synthetic data study, in which pseudo-data CO_2 concentrations simulate real observational coverage (i.e., *in situ* surface data and satellite data) for the U.S.-corn belt (Fig. 1) for the 2015 growing season. We used NOAA's CT-Lagrange inversion framework coupled with WRF-STILT footprints and a novel crop-specific, spatially explicit parametrization of the CLM-APSIM model as prior flux.

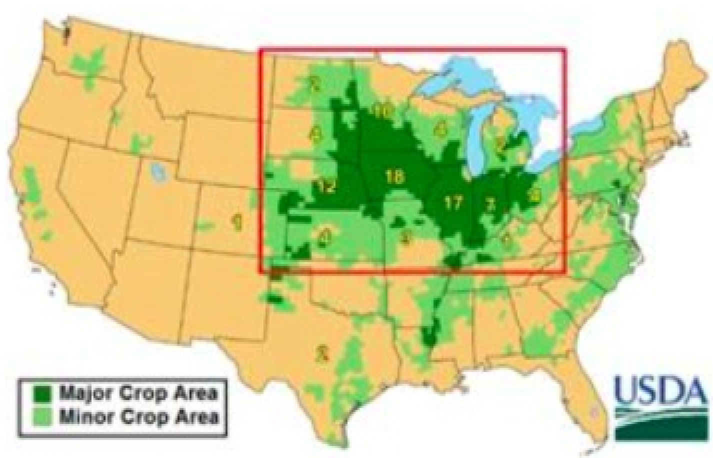

Figure 1. Study domain shown in the red box. The background shows the averaged corn production from 2007–2012, and the numbers indicate the percentage (%) of the state production to the national total corn production.