Untangling Greenhouse Gas Fluxes and Transport using ACT-America Observations

B.J. Gaudet[1], D.F. Baker[2], Z. Barkley[1], S. Basu[3,4], K. Bowman[5], E.V. Browell[6], Y. Choi[6], S. Crowell[7], K.J. Davis[1,8], J. DiGangi[6], F. Deng[9], L. Feng[10], S. Feng[1], A.R. Jacobson[3,4], D. Jones[9], T. Lauvaux[1], J. Liu[5], S. Pal[1], P. Palmer[10], A.E. Schuh[2] and B. Weir[11]

[1]Department of Meteorology and Atmospheric Science, The Pennsylvania State University, University Park, PA 16802; 814-867-2110, E-mail: bjg20@psu.edu
[2]Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO 80521
[3]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309
[4]NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO 80305
[5]NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109
[6]NASA Langley Research Center, Hampton, VA 23681
[7]University of Oklahoma, Norman, OK 73019
[8]Earth and Environmental Systems Institute, The Pennsylvania State University, University Park, PA 16802
[9]University of Toronto, Toronto, Ontario, Canada
[10]University of Edinburgh, Edinburgh, United Kingdom
[11]NASA Goddard Space Flight Center (GSFC), Greenbelt, MD 20771

The Atmospheric Carbon and Transport (ACT) - America mission aims to improve our understanding of transport and fluxes of greenhouse gases (GHGs) via aircraft campaigns that cover three regions of the U.S. and four seasons, include frontal and fair-weather conditions, and span the boundary layer to the upper troposphere and horizontal transects of several hundred kilometers. Observations include GHG mole fractions and meteorological properties. Observations have shown large, spatially-coherent differences in GHGs that extend throughout the depth of the troposphere across fronts in summer and winter, large horizontal variability in GHGs in the atmospheric boundary layer (ABL) in fair weather conditions, and GHG "rivers" associated with cold frontal boundaries. A broad effort to compare these observations with a variety of atmospheric GHG numerical reanalyses is underway. An evaluation of the posterior carbon dioxide (CO_2) fields from the OCO-2 inverse MIP using summer 2016 campaign data reveals patterns of model-data differences. Inversions based on *in situ* data tend to be negatively biased in the lower troposphere, while land-nadir OCO-2 inversions tend to be positively biased. In the Mid-Atlantic, TM5-based inversions show more negative biases in lower tropospheric CO_2 than Goddard Earth Observing System-Chem (GEOS-Chem) -based inversions. Mid-Atlantic biases are largest, and Gulf biases are the smallest. WRF-Chem simulations that use CarbonTracker boundary conditions and surface fluxes are being used to isolate the impact of transport, and evaluation of the relative mix of CO_2 continental fluxes vs. boundary inflow are being examined to lend more insight into the causes of documented biases, and to inform how to improve atmospheric inversion systems.

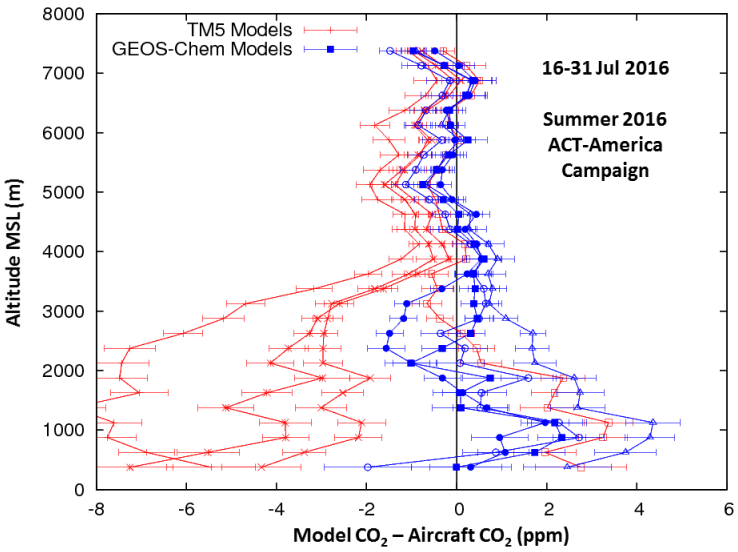

Figure 1. Model-data CO_2 differences from summer 2016 ACT-America vertical profiles in the Mid-Atlantic region. Models use *in situ* data in their inversions. Red indicates TM5 inversions, while blue indicates GEOS-Chem inversions.