(51-210426-C) **Multi-Season Evaluation of CO_2 Weather in OCO-2 MIP Models**

L. Zhang[1], K.J. Davis[1,2], A.E. Schuh[3], A.R. Jacobson[4,5], S. Pal[1], Y. Cui[1], D. Baker[3], S. Crowell[6], F. Chevallier[7], M. Remaud[7], J. Liu[8], B. Weir[9,10], S. Philip[11,12], M.S. Johnson[12], and F. Deng[13]

[1]The Pennsylvania State University, Department of Meteorology and Atmospheric Science, University Park, PA 16802; 6098651811, E-mail: alex.zhang@psu.edu
[2]Earth and Environmental Systems Institute, The Pennsylvania State University, University Park, PA 16802
[3]Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO 80521
[4]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309
[5]NOAA Global Monitoring Laboratory, Boulder, CO 80305
[6]University of Oklahoma, Norman, OK 73019
[7]Laboratoire des Sciences du Climat et de l'Environnement (LSCE), Institut Pierre-Simon Laplace, Orme des Merisiers, France
[8]NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109
[9]Universities Space Research Association (USRA), Colombia, MD 21046
[10]NASA Goddard Space Flight Center (GSFC), Greenbelt, MD 20771
[11]NASA Academic Mission Services (NAMS) by Universities Space Research Association (USRA)
[12]NASA Ames Research Center, Earth Science Division, Moffet Field, CA 94035
[13]University of Toronto, Department of Physics, Toronto, Ontario, Canada

The performance of current state-of-the-science global models in the transport of CO_2 induced by mid-latitude, synoptic-scale weather systems remains unclear but important for estimating regional and global carbon budgets. Here, we evaluate simulations from nine models that participated in the Orbiting Carbon Observatory-2 model intercomparison project (OCO-2 MIP version 9) with intensive aircraft measurements in multiple seasons collected from the Atmospheric Carbon Transport (ACT)-America mission. We study the ability and fidelity of global models in simulating the spatial distribution and variability of CO_2 mole fractions in mid-latitude cyclones. Our results show that the OCO-2 MIP models are able to simulate observed CO_2 frontal differences but with varying degrees of success in summer and spring. All models tend to underestimate observed CO_2 frontal differences in winter and fall. The GEOS-Chem models underestimate the frontal CO_2 differences in summer possibly due to biases in transport. The models often underestimate the observed boundary layer-to-free troposphere CO_2 differences in spring and autumn, which is likely associated with model biases in boundary layer height, but attribution of the causes of model biases in other seasons remains challenging. Posterior fluxes constrained with different data sources do not change the model performance, suggesting that transport errors, prior fluxes, and inversion algorithms appear to be the primary cause of these biases. The metrics presented in this study yield new insights into the ability of global atmospheric inversion systems to reproduce the CO_2 structure of mid-latitude weather systems, a key component of greenhouse gas transport within and across the mid-latitudes. Controlled experiments will be needed to link these results more directly to the accuracy of regional or global flux estimates.

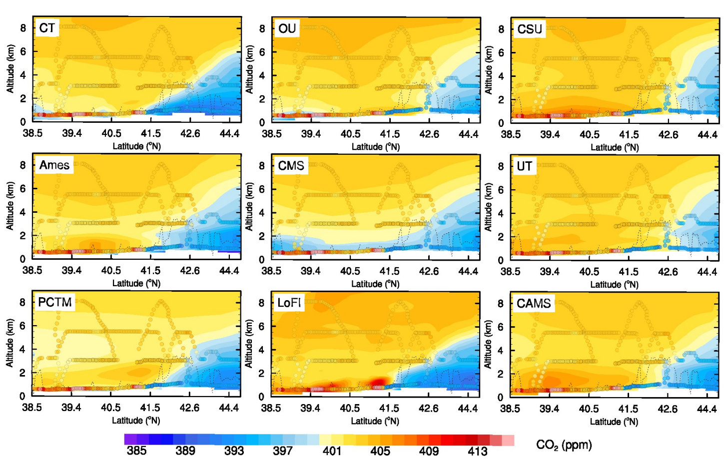

Figure 1. Figure 1. Latitude-height curtains of model-simulated [CO2] (color shading) from the OCO-2 MIP IS experiment along the flight track crossing the mid-west on August 4, 2016 (purple line in Figure 8). The color-coded circles denote measurements of [CO2] by two aircrafts (C130 and B200), the dashed line represents the boundary layer height derived from measurements by the airborne lidar on C130, the solid grey lines denote model-simulated boundary layer height, and the white lines are isentropic surfaces.