Effect of including CO_2 vertical profiles on partitioning carbon sources and sinks between hemispheres in atmospheric inversions

Zhonghua Yang[1], Nir Krakauer[1], Paul Wennberg[1,2], James Randerson[3]

[1] *Division of Geological and Planetary Science, California Institute of Technology, Pasadena, CA 91125; yangzh@gps.caltech.edu*

[2] *Division of Engineering and Applied Science, California Institute of Technology, Pasadena, CA 91125*

[3] *Department of Earth System Science, University of California, Irvine, Irvine, CA 92697*

ABSTRACT

Understanding the geographical distribution of carbon uptake by the terrestrial biosphere is critical for predicting future trends of atmospheric CO_2. With inverse techniques, atmospheric CO_2 measurements can be used to estimate this uptake. The results from this approach, however, depend on the accuracy of the transport model(s). Because of the covariance between the seasonally-varying biosphere exchange and the strength of vertical mixing (the rectifier effect), using only the surface CO_2 observations for this analysis yields an inferred carbon flux that is highly sensitive to the details of the boundary-layer dynamics in the transport model [Gurney et al., 2004]. One possible way to reduce the sensitivity of these inversions to poorly-represented boundary-layer dynamics is to use CO_2 vertical profiles (and/or column CO_2 measurements) in addition to surface observations. In theory, multi-level aircraft CO_2 measurements from several well-positioned sites are capable of improving the estimate of the true annual mean inter-hemisphere CO_2 gradient and thereby improving the estimate of the partitioning of carbon sinks between the two hemispheres.

In this study, we used output submitted to TransCom3 from 15 transport models to perform carbon-flux inversions with different combinations of data from surface observations and aircraft profiles (using 2000-2003 mean concentrations from GlobalView). We found that, averaged across the transport models, the Northern Hemisphere carbon sink inferred from the aircraft observations is considerably weaker than that calculated using only the surface records, possibly indicating a systematic bias in transport within the atmospheric models.

Table 1: 2000-2003 Northern flux (Land + Ocean, in PgC/year)

	Northern flux	Inter-model Standard Deviation
Priors	-2.06±3.46	
Land	-0.74±3.17	
Ocean	-1.32±1.40	
Inversion		
Surface Data	-1.78	0.44
Aircraft Data	-1.53	0.25
Surface + Aircraft Data	-1.69	0.37

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