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Retrieval of Vertical Structure of Atmospheric CO_2 Concentration from Airborne Lidar Measurements during the 2011 and 2013 ASCENDS Science Campaigns

Jianping Mao (1), Anand Ramanathan (1), James B. Abshire (2), Haris Riris (2), Michael Rodriguez (3), Graham R. Allan (3), William E. Hasselbrack (3), Clark Weaver (1), S. Randy Kawa (4), and Edward V. Browell (5)

(1) University of Maryland, College Park, MD 20740, United States (jianping.mao@nasa.gov), (2) Solar System Exploration Division, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States, (3) Sigma Space Inc., Greenbelt, MD 20771, United States, (4) Atmospheric Chemistry and Dynamics Lab., NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States, (5) STARSS-II, NASA Langley Research Center, Hampton, VA 23681, United States

NASA Goddard Space Flight Center has developed an integrated-path, differential absorption lidar approach to measure atmospheric CO_2 concentrations from space as a candidate for NASA's ASCENDS (Active Sensing of CO_2 Emissions over Nights, Days, and Seasons) mission. The approach uses pulsed lasers to measure both CO_2 and O_2 absorption simultaneously in the vertical path to the surface at a number of wavelengths across a CO_2 line at 1572.335 nm and the O_2 line doublet near 764.7 nm. Measurements of time-resolved laser backscatter profiles from the atmosphere allow the technique to estimate column CO_2 and O_2 number density and range to cloud tops in addition to those to the ground. This allows sampling the vertical structure of CO_2 and O_2 when broken and/or thin clouds are present. This additional information can improve absorption line fits and estimates of column-averaged CO_2 and O_2 number density, and help isolate and identify sources/sinks of CO_2 near the surface.

We show some results with this capability using airborne lidar measurements in the summer 2011 and winter 2013 ASCENDS airborne science campaigns. These show simultaneous retrievals of CO_2 and O_2 column densities for laser returns from ground, low-altitude clouds and cirrus clouds. Meanwhile, in the clear sky sampling multiple points of a single line allows for vertically resolved retrievals. In this paper, we present some preliminary results showing 2-level retrievals over clear air using absorption line-shape information. The CO_2 concentration in the planetary boundary layer, free troposphere, and lower stratosphere are estimated and compared to those from in-situ CO_2 profiles measured during the campaigns.