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Advancements in the Retrieval of CO_2 from an Airborne IM-CW Lidar operating in 1.57-um Region

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Accurate understanding of carbon balance in the environment is critical to projections of the future evolution of the Earth's climate. Uncertainties in the modeling of carbon sources and sinks remain large due to the limited set of observations from the current network of in-situ and surface measurements. Global, spaceborne measurements of atmospheric CO_2 can reduce these uncertainties. As a result, the NRC Decadal Survey (DS) of Earth Science and Applications from Space identified Active Sensing of CO_2 Emissions over Nights, Days, and Seasons (ASCENDS) as an important mid-term (Tier II) mission. The active space remote measurement of the column CO_2 mixing ratio (XCO_2) that is called for by the NRC in the ASCENDS mission requires the simultaneous measurement of the CO_2 number density column and the O_2 number density column to derive the average XCO_2 column. The NRC recommendation calls for XCO_2 to be measured to a precision of less than 2 ppm and must be made without bias from aerosols, dust, or clouds.

This paper discusses the latest flight test results from the Multi-Functional Fiber Laser Lidar (MFLL), a laser absorption spectrometer (LAS) system under developed by ITT Exelis under evaluation by NASA LaRC for the ASCENDS mission. The MFLL is a multi-frequency intensity-modulated continuous-wave (IM-CW) LAS operating near 1.57 um to obtain remote CO_2 column measurements. During these tests, encoded modulation techniques for minimizing the impact of thin clouds on CO_2 measurements were demonstrated and the MFLL remote CO_2 column measurements were evaluated against airborne in situ CO_2 profile measurements under a wide variety of surface and atmospheric conditions. This paper describes the modulation techniques employed and presents algorithms minimizing bias from thin clouds on CO_2 retrievals. MFLL and in situ CO_2 data comparisons are presented and observations of CO_2 column enhancements in the Four Corner's power plant plumes and CO_2 uptake over the cornfields in Nebraska and Iowa are discussed.