Airborne Measurements of Atmospheric Pressure made using an IPDA lidar operating in the Oxygen A-Band

Haris Riris[1], Michael Rodriguez[2], Graham Allan[2], William Hasselbrack[2], Jianping Mao[3], James B. Abshire[1], Mark Stephen[1]

1. NASA Goddard, Science and Exploration Directorate, Greenbelt MD 20771 USA
2. Sigma Space, NASA GSFC Code 694, Greenbelt MD 20771 USA
3. GESTAR, Code 614, NASA Goddard, Greenbelt MD 20771 USA

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Abstract:

We report airborne measurements of atmospheric pressure made using an integrated path differential absorption (IPDA) lidar that operates in the oxygen A-band near 765 nm. Remote measurements of atmospheric temperature and pressure are needed for NASA's Active Sensing of CO2 Emissions Over Nights, Days, and Seasons (ASCENDS) mission to measure atmospheric CO2. Accurate measurements of tropospheric CO2 on a global scale are very important in order to better understand its sources and sinks and to improve our predictions of climate change. The goal of ASCENDS is to determine the CO2 dry mixing ratio with lidar measurements from space at a level of ~1 ppm. Analysis to date shows that with current weather models, measurements of both the CO2 column density and the column density of dry air are needed. Since O2 is a stable molecule that uniformly mixed in the atmosphere, measuring O2 absorption in the atmosphere can be used to infer the dry air density.

We have developed an airborne (IPDA) lidar for Oxygen, with support from the NASA ESTO IIP program. Our lidar uses DFB-based seed laser diodes, a pulsed modulator, a fiber laser amplifier, and a non-linear crystal to generate wavelength tunable 765 nm laser pulses with a few uJ/pulse energy. The laser pulse rate is 10 KHz, and average transmitted laser power is ~20 mW. Our lidar steps laser pulses across a selected line O2 doublet near 764.7 nm in the Oxygen A-band. The direct detection lidar receiver uses a 20 cm diameter telescope, a Si APD detector in Geiger mode, and a multi-channel scalar to detect and record the time resolved laser backscatter in 40 separate wavelength channels. Subsequent analysis is used to estimate the transmission line shape of the doublet for the laser pulses reflected from the ground. Ground based data analysis allows averaging from 1 to 60 seconds to increase SNR in the transmission line shape of the doublet. Our retrieval algorithm fits the expected O2 lineshapes against the measurements and determines the atmospheric pressure by minimizing the error between the observations and model. We first demonstrated our airborne lidar during flights during summer 2010. We made several improvements and made measurements during the Ascends flights during July 2011. More information about the technique, lidar instrument, airborne measurements, and pressure estimates will be described in the presentation.