Differential absorption radar near the 183 GHz water absorption line for inside-cloud humidity profiling

Richard J. Roy*, Ken Cooper, Matthew Lebsock, Jose V. Siles, Luis Millán, Raquel Rodriguez Monje, Robert Dengler

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109
*Contact: richard.j.roy@jpl.nasa.gov

Abstract— Conventional passive remote sensing platforms have limited ability to perform high-resolution observations of vertical water vapor profiles in the presence of clouds, contributing to deficiencies in numerical weather and climate change prediction capabilities. The nascent Vapor/Ice Profiling Radar (VIPR) project at JPL aims to demonstrate a solution to this observational problem by performing airborne radar remote sensing measurements of humidity content with high vertical resolution inside boundary layer clouds. Based on the mature Differential Absorption Lidar (DIAL) method, the VIPR instrument utilizes a frequency-tunable G-band transmitter in a frequency-modulated continuous-wave (FMCW) radar configuration to obtain range-gated differential absorption measurements across the low-frequency (~170 GHz) flank of the 183 GHz water line. These measurements will be inverted using a novel retrieval algorithm to obtain in-cloud vertical humidity profiles. The FMCW radar design is based on previously demonstrated technology developed at JPL for science and security applications in the 95-700 GHz frequency range. The instrument design employs state-of-the-art frequency multipliers and low-noise amplifiers, as well as high transmit/receive isolation to achieve high signal-to-noise FMCW radar measurements. Preliminary ground-based differential absorption measurements which demonstrate the technique will be presented, including a discussion of the retrieved humidity error stemming from radar measurement uncertainty.