Water Vapor DIAL

NCAR/EOL and Montana State University (MSU) have worked together to expand and evaluate the capability of a new technique to remotely measure atmospheric water vapor. The collaboration has resulted in a next-generation instrument – built on the success of previous MSU diode-laser-based prototypes – that advances the technology to provide measurements over a broadened range of atmospheric conditions. The new instrument allows for unattended operations with a completely eye-safe beam. The instrument was field tested over a wide range of atmospheric conditions alongside other instrumentation, including numerous radiosondes and a continually-operating passive infrared radiometer, to evaluate its performance. This evaluation has shown that the technology is well-suited for autonomous, long-term profiles of water vapor over a wide variety of moisture regimes, from polar regions to mid-latitude to the tropics.
WV-DIAL Applications

» Forecasting high-impact weather through detailed moisture observations
» Providing high-resolution continuous water vapor profiles for data assimilation into numerical models
» Assessing atmospheric moisture response to climate change through long-term observations
» Increasing understanding of the hydrological cycle
» Studying water vapor variability and transport
» Contributing to model validation

DIAL Technique

Use of a diode laser in a lidar has distinct benefits. The lasers are considerably more compact, reliable and less expensive than typical lasers used for lidar instrumentation. They are low-power and continuous wave, so they need to be amplified into pulses at high repetition rates to be suitable for lidar applications. This “micro-pulse” lidar technique is inherently easier to make eye-safe since the pulse energy is low, however, they require detectors capable of counting individual photons and careful suppression of the solar background is imperative for daytime operation.

AN OBSERVATIONAL GAP

New developments are needed to fill an observational gap in moisture measurements. Radiosondes, combined with satellite-based measurements, form the backbone of observations used for weather forecasting. However, the limited spatial and temporal observations prohibit forecasting of mesoscale high-impact weather events like thunderstorms. Passive sensors are useful at low ranges close to the surface but in general only provide coarse vertical resolutions. GPS receivers provide integrated precipitable water vapor retrievals. Raman lidars provide the high spatial and temporal measurements of water vapor that are desired, however, they are inherently large and expensive instruments. NCAR and MSU are progressively showing that diode-laser-based micro-pulse DIAL systems may play a substantial role in partially filling this observational gap.