Lower Atmospheric Thermodynamics and Turbulence Experiment (LATTE): Overview and Initial Results

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A multi-institutional and multi-sensor boundary-layer research experiment called LATTE (Lower Atmospheric Thermodynamics and Turbulence Experiment) was recently conducted in Colorado at the base of the Rocky Mountains. The aim of this presentation is to provide an overview of LATTE and to discuss some of the initial findings. LATTE was conducted at the National Oceanic and Atmospheric Observatory (NOAA) Boulder Atmospheric Observatory (BAO) during February 2014. The BAO provided an excellent venue for the experiment because of its 300-m meteorological tower; the infrastructure provided at the site to support the various instruments used during the experiment; and its proximity to the National Center for Atmospheric Research (NCAR), which assumed the lead role in organizing the experiment. Other institutions participating in LATTE included: the University of Oklahoma, NOAA, Lawrence Livermore National Laboratory, NorthWest Research Associates, Inc., and the University of Colorado, Boulder. The three primary objectives of the experiment were to:

* Validate both wind and reflectivity measurements from the NCAR 449-MHz wind profiling radar (WPR) using 3-D sonic anemometers, Doppler lidars, and an instrumented unmanned aerial system (UAS): The NCAR WPR operates in a spaced antenna mode and recently has been upgraded to allow range imaging (RIM) operations as a means of improving its range resolution, thereby allowing wind measurements with improved spatial and temporal resolution as compared to conventional wind profilers using Doppler Beam Swinging (DBS) techniques. Observations from the scanning Doppler lidars are being used to validate the three-dimensional wind estimates produced by the radar. Additionally, wind observations from the tower-mounted sonic anemometers are being integrated into the comparison. Moreover, flights from the UAS provide a means of generating estimates of Cn2, which is related to the radar reflectivity produced by Bragg scatter. The UAS-derived winds can also be compared with the tower and wind profiler.
* Compare Bragg scatter from NCAR’s S-band Polarimetric (S-Pol) weather radar with reflectivity data from the WPR and Cn2 estimates from the UAS: S-band weather radar can detect true clear air scatter (Bragg scatter) produced by gradients in the refractive index. When turbulence in homogeneous, isotropic, volume-filling, and within the inertial subrange, then the backscattered power detected by radar operating at the appropriate wavelength can be related to Cn2. Range Height Indicator (RHI) scans using S-Pol have been made along a radial corresponding to the location of the BAO. Signals from S-Pol indicative of Bragg scatter, e.g., enhanced reflectivity, low differential reflectivity (ZDR), relatively high correlation coefficients, can be used to compare retrieved values of Cn2 from S-Pol with those estimated using the 449-MHz WPR and UAS.
* Determine the extent to which Doppler lidars can be used to measure atmospheric turbulence: Doppler lidars not only provide measurements of the atmospheric wind, but they can also be used to study atmospheric turbulence. A variety of methods can be used to extract estimates of atmospheric turbulence from lidar depending on the type of system and scanning strategy employed. Wind and turbulence estimates from the lidars can be compared against observations from tower-mounted sonic anemometers, optical image-motion anemometers, UAS, and radar. By examining data from LATTE we are exploring the strengths and weaknesses of several such techniques. Results can be used for such applications as wind energy, air traffic safety, and air quality monitoring.

Data collected during LATTE are providing a unique opportunity to cross-validate various sensor technologies developed for lower atmospheric observations and to investigate the structure and evolution of the planetary boundary layer.