Recent developments of the NCAR Integrated Sounding System: Modular Wind Profiler and Lidar

William Brown, John Sobczak, Josh Gebauer, David Ortigoza, Charlie Martin, and Terry Hock. National Center for Atmospheric Research, Earth Observing Laboratory, Boulder, CO.

The NCAR Integrated Sounding System (ISS) consists of profiling sensors such as radar wind profilers, RASS, wind lidar, ceilometers, radiosondes, and other EOL instruments. The ISS has been deployed in over 60 field campaigns over the last 30 years. The system is commonly used for boundary layer meteorology studies, but has also contributed to studies in topics ranging from tropical meteorology, severe weather, mountain meteorology, ocean-atmosphere exchange, precipitation, microphysics, wind energy, agriculture, atmospheric chemistry, atmospheric gravity waves, to radiation and outreach.

The ISS radar wind profilers include the NCAR developed 449 MHz Modular Profiler which is a scalable radar using spaced antenna techniques to make very rapid wind measurements. Recent developments to this system include new radar processor cards, modular power amplifiers, and improvements to signal processing and data analysis. The ISS has also recently acquired a Vaisala / Leosphere Windcube 200S Doppler lidar and a CL61 ceilometer. The scanning capability of the 200S Wind Lidar opens up new possibilities for wind measurement such as the ability to perform PPI and RHI scans over an extended area. The CL61 includes depolarization capability which enables identification of precipitation or aerosol type. Both lidars will also provide additional capability for boundary layer evolution and depth monitoring.

Three ISS (along with other EOL instruments) are available to the community via the NSF Facility and Instrumentation Request Process (FIRP). Future plans include integration into the proposed LOTOSS Lower Troposphere Observing System (LOTOS) facility (see Gebauer et al., this meeting). Tests of sensors for LOTOS were carried out at NCAR’s Marshall field site last summer.

449 MHz Modular Wind Profiler

The Wind Profiler (photo above) uses a unique modular design with multiple receivers to make wind measurements with spaced antenna techniques. The plots at left illustrate the very rapid measurements possible using these techniques. A squall passed over the site and the profiler captured fine structure such as brief strong updrafts and wind gusts aloft in advance of the squall (plots to left). These features can also be seen in PPI scans from the wind lidar (plot at right).

Distributed power amplifiers and receiver systems are being developed for the Modular Profiler. A new data system based on Xilinx Zynq cards with on-board ARM and FPGA processors will provide new data collection and processing capabilities.

Wind Lidar PPI scans of Reflectivity (beta) and radial velocity

Boundary layer analyses

The ISS can be used for multiple purposes and one application is monitoring of Boundary Layer evolution and depth. Radiosonde soundings of course provide a detailed snapshot. In between soundings, various instruments can provide continuous monitoring:

The Modular Wind Profiler can trace BL evolution using the basic Signal to Noise plots (e.g., upper right). The rapid measurement capability of the profiler also allows the use of other approaches such as Doppler spectral width (not shown), vertical velocity (second from top), or derived products (vertical velocity variance or kurtosis). BL depth RASS estimators using the Null analysis (1T) and Mixing Layer depth (n) from soundings are shown over plots from the Modular Wind profiler.

LIDARS: The ISS can also use lidars for BL monitoring. The standard ceilometers (CL31 and CL51) can detect the variations in aerosol at the BL top seen in the gradient of backscatter profile as in the plot below. The CL61 ceilometer can look for variations in the backscatter depolarization ratio due to changes in aerosol type at the BL top (plot at left). The scattering wind lidar can use not only the backscatter profile, but also variations in reflectivity (beta) and vertical velocity in a similar manner to the Modular Profiler (see plots below).

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