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

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

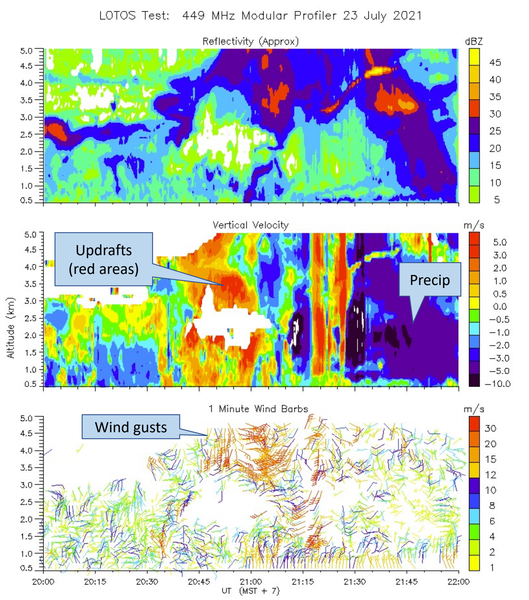
The National Center for Atmospheric Research Earth Observing Lab (NCAR / EOL) deploys suites of instruments known as the Integrated Sounding Systems (ISS) in support of university researchers studying a wide variety of topics in locations all around the world. The ISS consists of profiling sensors such as radar wind profilers, RASS, wind lidar, ceilometers, radiosondes, and other sensors.

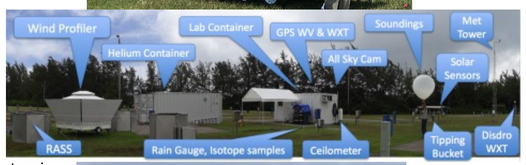
Radar Wind Profilers	449 MHz NCAR Modular Wind Profiler 915 MHz and 1290 MHz Vaisala / Radian LAP3000 RASS (Radio Acoustic Sounding System)
Wind Lidar	Vaisala / Leosphere Windcube 200S Scanning Doppler lidar
Ceilometers	Vaisala CL31, CL51 and CL61 (with depolarization channel)
Radiosonde Soundings	Vaisala MW41 / RS41 radiosondes iMet-3050A / iMet-1 radiosondes
Surface Met on 3 or 10 meter towers	Gill Wind Observer (2D sonic anemometer) Lufft WS300 (Temp/RH/Pressure) and WS800 (Wind/Precip/T/RH/P) Vaisala PTB210 / PTB330 (Pressure) Hukseflux NR01 4-component radiation OTT Parsivel-2 optical disdrometer and and HSA Tipping bucket rain gauge
GPS Integrated Water Vapor	Trimble NetR8 with Vaisala WXT

The ISS have 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 education 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.

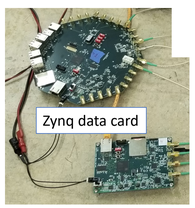
Three ISS (along with other EOL instruments) are available to the community via the NSF Facility and Instrumentation Request Process (FIRP). Future plans include integration into the proposed LOTOS (Lower Troposphere Observing System) facility (see Gebauer et.al, this meeting). Tests of sensors for LOTOS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

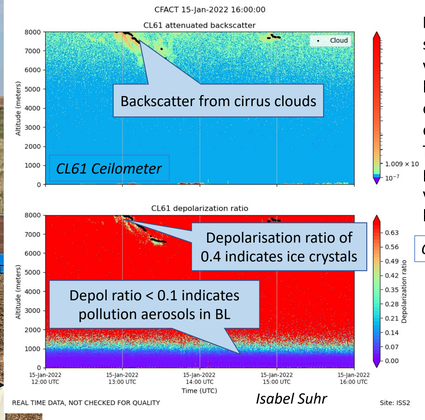




449 MHz Modular Wind Profiler
The Wind Profiler (photo above) uses a unique modular design with multiple receivers to make wind measurements with spaced antenna techniques. The plots at left illustrate the very rapid measurements possible using these techniques. A squall passed over the site and the 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.





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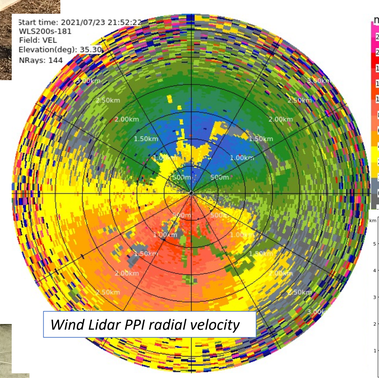

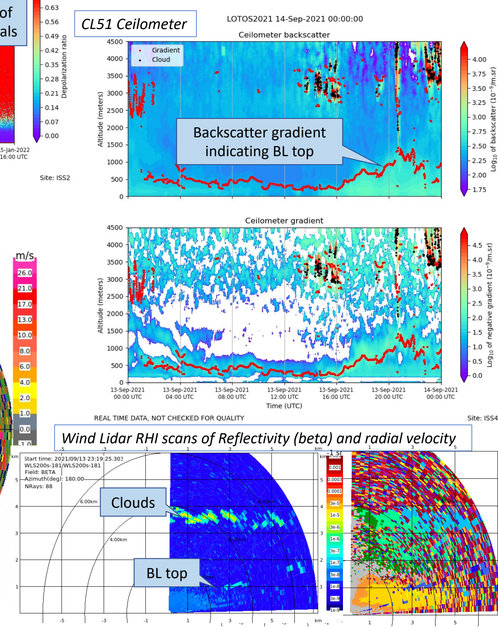

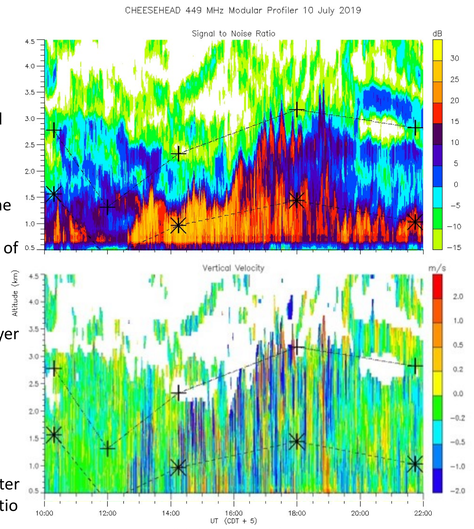

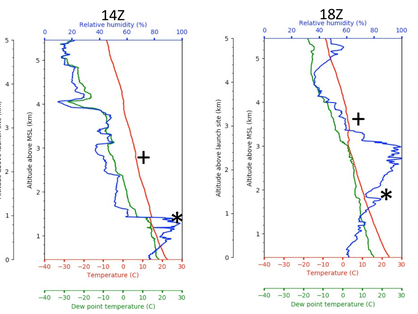

Boundary layer analyses
The ISS can be used for multiple purposes and one application is monitoring of Boundary Layer evolution and depth. Radiosonde soundings of course provide a detailed snapshot. In between soundings, various instruments can provide continuous monitoring:

The Modular Wind Profiler can trace BL evolution using the basic Signal to Noise plots (eg, 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 RAOB estimators using the Stull analysis (*) and Mixing Layer depth (+) 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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