Integrated Observations and Applications with the SSEC Portable Atmosphere Research Center

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SPARC Overview

The SSEC Portable Atmospheric Research Center (SPARC) enables the deployment of instruments with which to perform targeted measurements of the atmosphere in order to advance our understanding of weather and climate systems. The SPARC consists of three remote sensing instruments, along with a surface meteorology station and radiosonde launching capabilities.

The combination of instruments on the SPARC allows for high-temporal resolution retrievals of thermodynamic variables (temperature, water vapor mixing ratio, wind speed and direction) in the boundary layer in addition to retrievals of aerosol layers and vertical velocities. Each instrument featured on the SPARC is essential to both produce and validate products of other instruments, forming an integrated instrumentation suite aboard a single mobile vehicle.

FRAPPÉ

The Front Range Air Pollution and Chemistry Experiment (FRAPPÉ) took place from 16 July to 16 August 2014 along the Front Range of Colorado. FRAPPÉ aimed to better understand summertime air quality in Colorado. FRAPPÉ utilized the AERI instrument to produce high-temporal resolution observations of thermodynamic and dynamic atmospheric variables in the boundary layer. AERI measures downwelling radiation emitted from the atmosphere between 520 and 3000 cm⁻¹ (19.2 and 3.3 pm) with a resolution of about 1 cm⁻¹ every 20 seconds. Nearly continuous retrievals of thermodynamic variables (temperature and water vapor mixing ratio) and trace gas concentrations, that emit and absorb in the range of wavelengths that the instrument covers (e.g., CH₄, CO₂, CO, O₃), can be derived. Turner and Lohrner (J. Appl. Meteor. Climatol., 2014) developed the AERI ozone, temperature and water vapor mixing ratio profiles from AERI observed radiances.

Identification of aerosols could be used in weather observation to identify mixed layers and inversions. Aerosols can also be used as a tracer, allowing of the detection of turbulence. Backscatter retrievals can be used to identify cloud features, as well, which can have applications to the FRAPPÉ science objectives.

High-Spectral Resolution Lidar:

SNRL uses a laser at 532nm to measure atmospheric extinction and backscatter to make aerosol concentration retrievals. Identifying the location of aerosols could be used in weather observation to identify mixed layers and inversions. Aerosols can also be used as a tracer, allowing of the detection of turbulence. Backscatter retrievals can be used to identify cloud features, as well, which can have applications to the FRAPPÉ science objectives.

An example of HSRL applications can be seen by considering backscatter measurements from 7 July 2015 in Hays, KS. The nocturnal boundary layer is observed as a high concentration of aerosols, seen here below 2 km until 11 UTC, when it begins to break down as the sun rises and diabatic heating begins. Low-level clouds are identified at the top of the nocturnal boundary layer between 1 UTC and 7 UTC. Higher clouds are also observed between 3 UTC and 8 UTC, with intermittent virga being observed.

Case Study: 26 June 2015 Bore

On 26 June 2015, SPARC took observations from 6 UTC until 9 UTC in Sureka, KS. Nearby convection in eastern KS produced a bore that propagated over the SPARC around 730 UTC. The bore displays itself as the hydraulic jump, seen as the spike in vertical velocities in the Doppler lidar retrievals and sudden increase in surface pressure.

Future Work

Future work will utilize the SPARC observing systems to monitor environmental conditions into the future. The instrumentation suite allows high-temporal resolution measurements ideal for a range of atmospheric research including air quality, convection, and boundary layer studies.