Air Resources Laboratory

Boundary Layer Research

Improving weather and climate forecasting; air quality prediction, and water resource management

NOAA's Air Resources Laboratory (ARL) researches the surface of the Earth from one meter below the soil up to 2,000 meters in the atmosphere (aka the boundary layer), a region which has a significant impact on people's health and safety, business, and the environment. ARL studies the physical and chemical, short- and long-term processes that occur in the boundary layer. In particular, ARL deals with the mixing, exchange, and transformation properties of energy, moisture, trace gases, and particles, and in contributing inputs to meteorological models and forecast operations that are vital in improving weather forecasts. Primary applications include emergency response, homeland security, air quality, weather forecasts and climate outlooks, and commerce and transportation.

Boundary Layer Research

Improving the accuracy of short- and longer-term weather and climate forecasts and outlooks including air quality will not only save lives but also property. Advancements in our forecast modeling systems are achieved when the myriad of physical processes at work are better understood and represented in the modeling systems. Some of the largest uncertainties in our current predictions are associated with a lack of understanding of how processes in the planetary boundary layer (PBL), which is the lowest 1-2 km of the atmosphere, interact and respond to the daily heating and cooling of the Earth's surface. Reducing uncertainties in NOAA's forecast and dispersion models requires a tactical and coordinated measurement and modeling approach.

ARL's focus on the boundary layer processes will help NOAA provide actionable weather and climate information that will be used not only to protect life and property but will also be critical in managing and supporting air quality predictions, water resources and renewable energy resources. ARL's interest in the boundary layer processes is critical and has implications in nearly every ARL research theme.

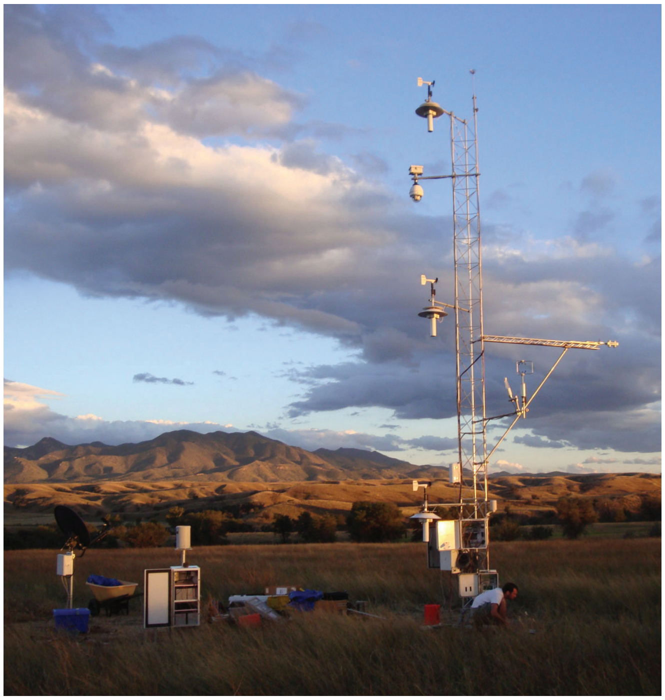
Air Quality and Dispersion Modeling

The stability and mixing of the boundary layer has a significant impact on the production and accumulation of pollutants close to the surface. Improving our predictive capabilities of boundary layer parameters such as atmospheric stability, turbulence levels, and the height of the boundary layer, are extremely beneficial in generating air quality forecast alerts, especially in highly populated areas where chemical precursors and aerosols are more abundant and lead to more occurrences of public health concerns. Observations of boundary layer turbulence statistics a invaluable in understanding the performance of numerical weather prediction and chemistry transport forecast models including hazardous pollutants. Combining model predictions with direct observations advances both our scientific understanding and the monitoring and forecasting of air quality and air pollution dispersion events. An overall increase in forest and grassland fire events that affect the air quality not only locally but also regionally (multiple states) has brought renewed attention to understanding atmospheric dispersion.

Hydrologic and Water Resources

The current limitations of freshwater availability and impacts from climate change will likely alter the spatial distribution of precipitation, will require careful planning and actionable tools and information. Local and regional resource managers need the most accurate information from which to make the most efficient use of available water. An understanding the thermodynamics of the boundary layer, including the inputs of heat and water, are critical to improve NOAA's short term and seasonal predictive capabilities of water resources. ARL's measurement capabilities of boundary layer processes include observations of heat and moisture fluxes from the land surface (Surface Energy Budget Network) and profiles of thermodynamic variables using UAS platforms that provide high resolution boundary layer data in time and space.

Image captions, Front left: Astronauts aboard the ISS captured this photo of Earth's atmospheric layers on July 31, 2011, revealing the troposphere, or boundary layer (in orange-red), stratosphere and above. Image credit: NASA. Front right: Small UAS vehicle prepared for flight in Oak Ridge, TN. Left: Surface Energy Budget Network station in Arizona. Bottom: Engineers in Oak Ridge, TN take vertical profiles of the atmosphere using a small UAS, while an observer monitors the progress and weather conditions.



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