ARL Research Themes

Theme #1: **Atmospheric Dispersion and Boundary Layer**

The accidental or intentional release of chemical, biological or nuclear agents, as well as natural airborne releases (e.g., volcanic ash) can have significant health, safety, homeland and national security, economic, and ecological implications. The Air Resources Laboratory (ARL) provides critical modeling and observation data to understand how, where, and when chemicals and materials are atmospherically transported. Having this understanding is essential for emergency managers, air traffic controllers, and the aviation industry to respond appropriately and minimize or prevent disaster. A primary tool developed by ARL is the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) modeling system. HYSPLIT is designed to support a wide range of simulations related to the atmospheric transport and dispersion of pollutants and hazardous materials, as well as the deposition of these materials to the Earth's surface. Some of the applications include tracking and forecasting the release of radioactive material, volcanic ash, wildfire smoke, and hazardous chemicals. ARL regularly improves, tests, and distributes HYSPLIT to hundreds of users around the world. Operationally, the model is used by NOAA's National Weather Service through the National Centers for Environmental Prediction and at local Weather Forecast Offices. In addition, ARL sponsors a web site providing rapid access to HYSPLIT dispersion simulations and supporting information.

ARL develops instrumentation; designs, evaluates, and operates high resolution observing networks; and conducts tracer field studies to improve the accuracy of atmospheric dispersion predictions in the atmospheric boundary layer. Closely related to this work, ARL conducts research on boundary layer issues that have applications beyond dispersion. This work includes measuring air-sea fluxes in hurricanes, improving wind predictions at the height of wind turbines, and providing land-based validation of satellite observations. ARL conducts dispersion and boundary layer research in various locations around the country and also provides meteorological and dispersion support for the safe operation of two major Department of Energy facilities in Idaho and Nevada.

Theme #2: **Air Quality**

Poor air quality causes significant health, economic and ecological consequences. In the United States tens of billions of dollars are spent each year to reduce air pollution in order to protect public health and the environment. While much progress has been made in reducing releases of harmful air pollutants, many locations in the U.S. continue to experience problems associated with air pollutants and poor air quality. On an annual basis, air pollution contributes to tens of thousands of premature deaths from cardiovascular and respiratory diseases, damages crops and forests, degrades aquatic ecosystems, and contributes to and is influenced by climate change. The Air Resources Laboratory (ARL) evaluates and improves computer models used by the National Weather Service to forecast the occurrence of ground-level ozone and the emission, formation, and transport of fine particulate matter. These forecasts improve the ability of communities and individuals to respond to anticipated episodes of poor air

quality by reducing pollutant emissions (e.g., limit driving) and by taking personal protective measures (e.g., limit outdoor exercise).

ARL conducts a variety of research on the exchange of pollutants between the air and the Earth's surface, which improves the scientific basis for creating and evaluating air quality policies and plans, and designing monitoring networks to measure air quality and visibility. ARL focuses on pollutants, such as mercury, reactive nitrogen and sulfur compounds, which can have significant impact on the environment —and in the case of mercury—human health. ARL activities include development and application of a state-of-the-art modeling system that tracks mercury emission sources and links these emissions to atmospheric transport, transformation, and deposition; long-term, intensive ambient air monitoring of mercury; short-term, process-level field studies for mercury and reactive nitrogen compounds; long-term, research- grade monitoring of acids and nutrients in precipitation; and coordination of national monitoring of fine particulate matter.

Theme #3: **Climate**

The Air Resources Laboratory (ARL) provides essential information and tools for decision-makers to understand how and why climate has changed and what changes might occur in the future. ARL's climate research and development activities concentrate on climate variability and change analysis, with a focus on the climate of the atmosphere above the surface. Significant effort is directed toward understanding archived historical weather observations and identifying any artificial signals that might mask or imitate true signals of climate variability. In related work, ARL's radiosonde data analysis is used to develop methods to address data problems and to produce new, improved datasets. These new datasets allow more confident estimations of climate trends and more complete characterization of the uncertainty of those estimates. Through collaboration with climate modeling groups, ARL's datasets are used to evaluate global climate models.

ARL is a key participant in several climate reference observing networks, both nationally and internationally. ARL designed the instrument suites and infrastructure for the U.S. Climate Reference Network and the U.S. Historical Climatology Network-Modernization project and provides the installation and maintenance for both networks. ARL also is a leader in the development of the Global Climate Observing System- Reference Upper-Air Network, the world's first climate reference network for upper-air observations. In addition, ARL scientists conduct long-term field studies, through the Surface Energy Budget Network, to better understand how the atmosphere and land surface influence each other. This information is essential for evaluating and improving climate models. ARL also works with external partners in the development of a state-of-the-art regional climate and earth system model. The model has been applied to a wide range of issues, including agriculture, water resources, and environmental protection, to improve understanding of the regional impacts of climate change. ARL scientists also have been, and will continue to be, key players in national and international climate assessments.