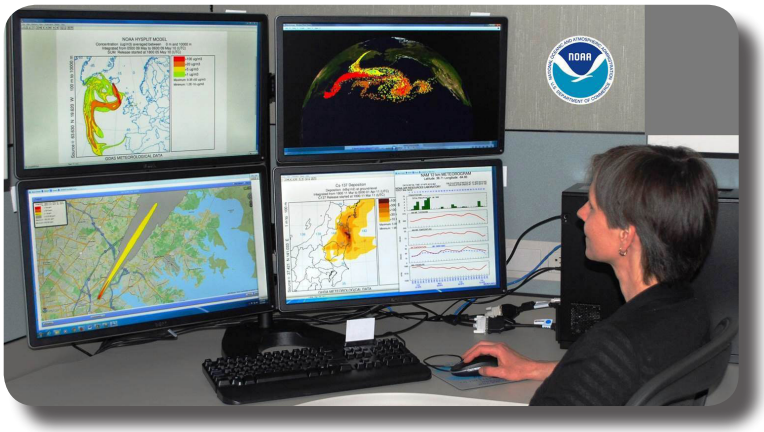
Air Resources Laboratory

Atmospheric Dispersion Research

State-of-the-Art Modeling and Data to Better Predict the Fate of Harmful Airborne Material

The accidental or intentional release of chemical, biological, or nuclear agents, as well as ash associated with volcanic eruptions, can have significant health, safety, national security, economic, and ecological implications. The Air Resources Laboratory (ARL) has an Atmospheric Dispersion Research Program that provides critical modeling and observation data to understand how, where, and when chemicals and materials are transported through the atmosphere. Having this understanding is essential for emergency managers and the aviation industry to respond appropriately and minimize or prevent disaster.

A highly-valued research tool, developed by ARL, is the 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 thousands of users around the world. Operationally, the model is used by NOAA, primarily the National Weather Service through its National Centers for Environmental Prediction, and at local Weather Forecast Offices.



Examples of HYSPLIT Model simulations. Photo: NOAA

In addition, ARL developed and maintains a web-based system providing rapid access to HYSPLIT dispersion simulations and supporting information. See www.ready.noaa.gov for more information.

ARL performs routine maintenance at one of the high-resolution meteorological stations located at the top of Big Southern Butte in Idaho. Photo: NOAA

ARL also operates and maintains high-resolution meteorological observing networks (e.g., stations typically 10 miles or less apart, compared to 100 miles or more apart for the national weather observing network) to capture small-scale air flows that can have a significant impact on how and where airborne chemicals and materials are transported. ARL evaluates how this high-resolution information can be incorporated into NOAA's large-scale weather models to improve predictions of surface wind fields.

Often complex terrain, water bodies, and man-made structures distort the wind fields that carry airborne materials. To improve and evaluate dispersion models, ARL conducts short-term field studies on atmospheric flows in different types of conditions. This provides basic information required to ground truth dispersion models used for emergency response applications.

For More Information, Contact:

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Air Resources Laboratory

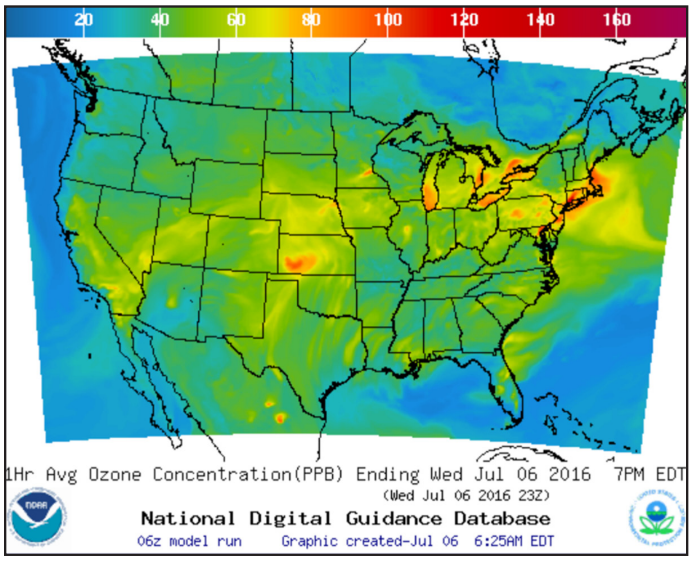
Air Quality Forecasting Products Research

Improving Air Quality Forecasting Models to Protect Human Health and the Environment

While air quality has improved dramatically over the past few decades, air pollution is still recognized as a major cause of acute and chronic respiratory and cardiovascular problems and annually leads to tens of thousands of premature deaths. The costs of health effects in the United States each year is more than $100 billion. Accurate air quality forecasts enable communities to take actions that can reduce the severity of episodes of poor air quality (e.g., encourage people to telecommute or take mass transit instead of driving). They also enable individuals to take protective actions that limit their own exposure to poor air quality, such as limiting exercise or staying indoors.

The Air Resources Laboratory's Air Quality Forecasting Products Research helps to ensure that forecast models, run operationally by NOAA's National Weather Service (NWS), provide consistently high quality forecast products and support air quality planners and managers, air quality forecasters, and the research community. To this end, ARL has led the research, configuration and testing of the National Air Quality Forecasting Capability, an integrated modeling system linking the National Weather Service's numerical weather prediction model to the NOAA-EPA developed Community Multiscale Air Quality model. As a result of ARL's research, NOAA has consistently improved operational air quality forecasting products.

The two most important air pollutants of concern are ground-level ozone (O_3) and fine particulate matter ($PM_{2.5}$). These pollutants are linked to serious health impacts, including chronic bronchitis, asthma, and premature deaths. They also contribute to reduced visibility ($PM_{2.5}$), crop damage (O_3), and greater vulnerability to disease in some tree species (O_3).



An example map of ground-level O_3 concentrations predicted for the continental U.S. The NWS generates such maps twice daily using an ARL-developed modeling system.

O_3 is a gas typically produced from other air pollutants reacting in the presence of sunlight. O_3 is a major constituent of smog. Motor vehicles, power plants, industrial operations, gasoline vapors, and chemical solvents, as well as natural processes, are emission sources of the pollutants that act to form ground-level O_3. ARL has a world class emission modeling team working with scientists in other NOAA laboratories, other federal agencies, and universities to improve air quality forecasting models and to generate data needed to model the significant processes that control the concentrations of ground-level O_3.

Fine particulate matter ($PM_{2.5}$) is composed of tiny particles with a diameter of 2.5 micrometers or less (or less than 1/30th the width of a human hair). $PM_{2.5}$ is especially dangerous to human health because fine particles can be inhaled into and accumulate in the respiratory system. $PM_{2.5}$ is emitted directly into the air from combustion processes (burning of fossil fuels, residential fireplaces, agricultural burning, and fires), volcanic emissions, and windblown dust and can also form in the air as a result of chemical reactions.

Operational Air Quality Predictions
www.weather.gov/aq
ARL Air Quality R&D
www.arl.noaa.gov/AirQual.php
NOAA Smoke Forecasting System
www.arl.noaa.gov/smoke.php

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