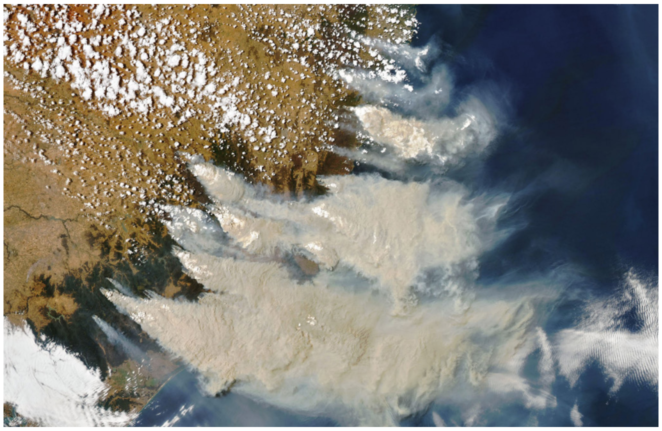
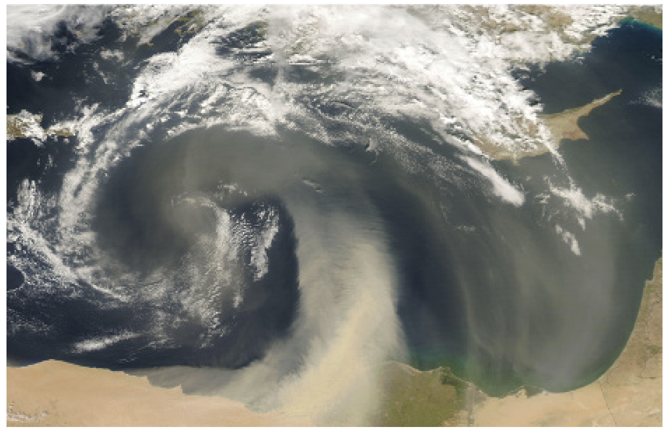
Air Resources Laboratory



Smoke plumes from massive wildfires in Australia on Jan. 4, 2020, Image credit: NASA



Saharan dust plume interacts with a weather system over the Mediterranean Sea, Sept. 25, 2008, Image credit: NASA

Atmospheric Composition and Emissions Research

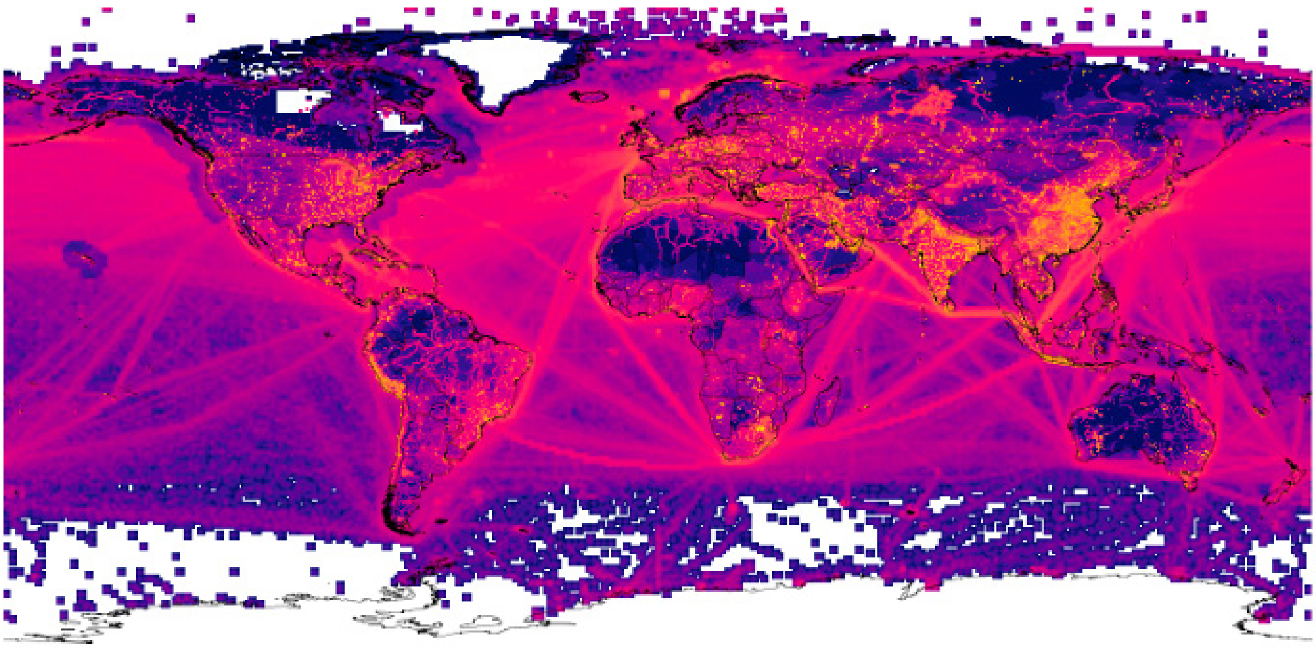
Improving Air Quality, Weather and Sub-Seasonal to Seasonal Forecasts

The Atmospheric Composition and Emissions Research performed in the Air Resources Laboratory provides support for atmospheric forecast models run operationally by NOAA's National Weather Service. These include air quality forecasts of ground-level ozone (O_3) and inhalable atmospheric particles ($PM_{2.5}$) from the National Air Quality Forecasting Capability and global aerosol forecasts from the Global Ensemble Forecast System. Longer-term research in the Air Resources Laboratory is supporting the incorporation of advanced atmospheric composition and aerosols in short-range weather forecast models as well as sub-seasonal to seasonal weather outlooks. The emissions data, algorithms and processing systems developed by Air Resources Laboratory provide a vital foundation for incorporating the critical effects of aerosols on weather and short-term climate prediction and help ensure that air quality managers and planners have consistent, high-quality forecasts which the public can use to take preventive actions to improve health, save lives, and mitigate property or crop loss.

Earth's atmosphere is composed of nitrogen, oxygen, argon, water vapor, carbon dioxide, and trace amounts of other gases, as well as a suspension of microscopic solid and liquid particles called aerosols. All of these components make up the air that we breathe and form the medium in which weather and climate occur. Historically, numerical weather prediction models idealized the composition of the atmosphere as only containing air (i.e., primarily nitrogen and oxygen) and water vapor. The important role of aerosols in the atmosphere's radiation balance and their effects on cloud microphysics has long been included in climate models. Many operational weather prediction models include semi-static aerosol distributions based on a derived climatology, but more dynamic representations of aerosol distributions and effects should provide more accurate forecasts. As part of the effort to create a Unified Forecast System (UFS), NOAA is working to include operational aerosol predictions in UFS atmospheric models. Research done by the Air Resources Laboratory is helping to achieve this goal.

Wildfires release a huge amount of aerosols and trace gases into the atmosphere, which have a significant impact on weather, air quality and human health. Since 2000, an annual average of over 71,000 wildfires burned an average of 6.9 million acres in the U. S. Nearly 4.5 million U.S. homes have been identified at high or extreme risk of wildfire, with more than two million in California alone, and losses from wildfires have totaled over $5 billion over the past ten years. A warmer and drier climate is expected to lead to more frequent and more intense fires near or within populated areas. Widespread burning in spring and summer is rapidly becoming the "new normal" in the American West. NOAA's Air Resources Laboratory performs research to improve the emission estimates of trace gases and aerosols from wildfires and their impacts on short-term weather and air quality.

Dust lifted from the Earth's surface naturally by winds or by human activity can have significant impacts on the absorption and scattering of solar radiation, can alter the structure and intensity of storms and precipitation, and can have deleterious effects on air quality and human health. As with wildfires, a warmer and drier global climate will likely lead to increased frequency of large dust events and result in larger atmospheric effects. ARL's research on atmospheric dust emissions dates back to the 1970's and recently has resulted in improved global dust emissions estimates in the NOAA's global aerosol model. Ongoing dust research in the Air Resources Laboratory aims to further refine dust emission estimates and extend their accuracy across spatial and temporal scales.



Sulfur dioxide emissions used in NOAA's global aerosol model.

Dust storms are becoming more frequent in the western United States.

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