



# SEAC<sup>4</sup>RS

## NASA's Studies of Emissions, Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys Mission

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- NASA's most complex and ambitious airborne science campaign of 2013 -- the Studies of Emissions, Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys, or SEAC<sup>4</sup>RS -- will conduct flights beginning Aug.6 and continuing through September.
- SEAC<sup>4</sup>RS will probe a vast expanse of the U.S. atmosphere to investigate how air pollution and natural emissions, which are pushed high into the atmosphere by large storms, affect atmospheric composition and climate.
- To develop a detailed view of these intertwined atmospheric processes, the campaign will draw together coordinated observations from satellites, research aircraft, balloons and an array of sites on the ground.
- Satellites involved in the study include Terra, Suomi NPP, and those in NASA's A-Train, a fleet of formation-flying satellites that pass over the study region every day. Sensors on the satellites will detect different features of the scene below.
- The study will use specially equipped U.S. aircraft including NASA's DC-8 flying laboratory and the agency's high-altitude ER-2. In addition to the NASA aircraft, a Learjet from SPEC Inc. of Boulder, Colo., will measure cloud and aerosol properties. Flights will be operated from Houston's Ellington Field, which is operated by NASA's Johnson Space Center.
- SEAC<sup>4</sup>RS will take advantage of opportunities to collaborate with concurrent airborne research campaigns: NASA's DISCOVER-AQ, an air quality mission flying this summer over Houston; and NASA's Hurricane and Severe Storm Sentinel (HS3), an airborne mission to measure the properties of tropical cyclones.
- Brian Toon of the University of Colorado Boulder is SEAC<sup>4</sup>RS lead scientist.
- The campaign is sponsored by the Earth Science Division in the Science Mission Directorate at NASA Headquarters in Washington. Partial support comes from the Naval Research Laboratory. More than 200 scientists, engineers, and flight personnel are participating in SEAC<sup>4</sup>RS. NASA involvement includes:
  - NASA Headquarters, Washington
  - NASA Ames Research Center, Moffett Field, Calif.
  - NASA Dryden Flight Research Center, Edwards, Calif.
  - NASA Goddard Space Flight Center, Greenbelt, Md.
  - NASA Jet Propulsion Laboratory, Pasadena, Calif.
  - NASA Johnson Space Center, Houston
  - NASA Langley Research Center, Hampton, Va.

# SEAC<sup>4</sup>RS at a Glance

## What is SEAC<sup>4</sup>RS?

The SEAC<sup>4</sup>RS field campaign is a unique opportunity to combine observations from satellites, aircraft, balloons and the surface to provide an unprecedented view of the composition of the atmosphere mainly over the southern U.S. Aircraft and sensors will probe the atmosphere from top to bottom at the critical time of year when weather systems are sufficiently strong and regional air pollution and natural emissions are prolific enough to pump gases and particles high into the atmosphere. The result has potential global consequences for Earth's atmosphere and climate.

## Why is NASA conducting research in the southern U.S.?

SEAC<sup>4</sup>RS will provide new insights into the effects of the gases and tiny aerosol particles in the atmosphere. The mission is targeting two major regional sources of summertime emissions: intense smoke from forest fires in the U.S. West and natural emissions of isoprene, a carbon compound, from forests in the Southeast.

Forest fire smoke can change the properties of clouds. The particles in the smoke can reflect and absorb incoming solar energy, potentially producing a net cooling at the ground and a warming of the atmosphere. The addition of large amounts of chemicals, such as isoprene, can alter the chemical balance of the atmosphere. Some of these chemicals can damage Earth's protective ozone layer.

## What are some questions that SEAC<sup>4</sup>RS scientists will address?

Never heard of the North American monsoon? The phenomenon provides significant rainfall to the U.S. Southwest, particularly from July until September. Scientists want to know what else, besides water, is being pumped high into the atmosphere over the Southwest. What mechanisms are responsible for the material reaching such heights, and how does it compare to the Asian monsoon?

Scientists using NASA satellite data and climate models have already projected that drier conditions are likely to cause increased forest fire activity across the United States in coming decades. Scientists want to take a closer look at what is emitted from large forest fires and how the materials interact. Which components of fire emissions reach high into the atmosphere, and in what amounts? How does smoke impact convection?

The Southeast U.S. is a natural laboratory for studying air chemistry, from the region's pollution from large urban areas and oil and gas exploration, to the region's emissions from agricultural fires and natural sources. How do these natural and human-produced emissions interact and affect the composition of the atmosphere? What happens to the emissions when they are lofted high into the atmosphere? How do the small airborne particles influence weather and climate?

## What role will aircraft play in the mission?

The NASA DC-8 flying laboratory will provide observations from near the surface to 12 kilometers (39,370 feet). The DC-8 will carry a suite of 31 instruments -- the aircraft's largest science payload to date -- some with unusual names like hygrometer, chromatograph,

spectroradiometer and sun photometer. These and other instruments will study trace gases, black carbon, cloud particles and formaldehyde along with other airborne chemicals that contribute to pollution.

A NASA ER-2 will collect data at higher altitudes, reaching into the lower stratosphere, and conduct important remote sensing observations that will connect satellite data with observations from lower-flying aircraft and data from sites on the ground. The ER-2 will carry 15 instruments including a "pushbroom" camera, a broadband radiometer, a gas analyzer, a lidar and a scanning polarimeter. The sensors will collect data about water vapor, turbulence, terrestrial and atmospheric processes, clouds and aerosols, carbon monoxide and nitrous oxide.

A third aircraft, a SPEC Inc. Learjet equipped with advanced sensors, will measure the properties of clouds and aerosols.

### **What NASA satellites will be involved?**

Scientists will use data from a number of NASA satellites.

CloudSat monitors the state of Earth's atmosphere and weather with a sophisticated cloud profiling radar system. The instrument can detect which clouds produce rain, observe snowfall and monitor the liquid and frozen content of clouds.

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) satellite provides observations of the geographical and vertical distribution of aerosols, aerosol properties and cirrus clouds around the planet.

The Aqua satellite has six different Earth-observing instruments on board and is named for the large amount of information being obtained about water in the Earth system. The water variables being measured include almost all elements of the water cycle and involve water in its liquid, solid and vapor forms.

The Terra satellite collects data about Earth's changing climate. Terra carries five state-of-the-art sensors that study the interactions among Earth's atmosphere, land surface, ocean and radiant energy.

The Aura satellite has four instruments that study the atmosphere's chemistry and dynamics. Aura's measurements enable scientists to investigate questions about ozone trends, air quality changes and their link to climate change.

The NASA-NOAA Suomi NPP satellite carries six instruments capable of a wide range of Earth observations. For SEAC<sup>4</sup>RS, the satellite's Ozone Mapping and Profiler Suite and the Visible Infrared Imaging Radiometer Suite (VIIRS) will measure atmospheric properties. VIIRS will also collect views of fire activity.

## Media Resources

SEAC <sup>4</sup> RS mission page	<a href="http://www.nasa.gov/seac4rs">http://www.nasa.gov/seac4rs</a>
SEAC <sup>4</sup> RS photo gallery	<a href="http://go.nasa.gov/17A5VMV">http://go.nasa.gov/17A5VMV</a>
SEAC <sup>4</sup> RS on Twitter	<a href="http://www.twitter.com/NASA">www.twitter.com/NASA</a> #seac4rs
DC-8 Airborne Science Laboratory	<a href="http://go.nasa.gov/19YTroc">http://go.nasa.gov/19YTroc</a>
ER-2 High-Altitude Airborne Science Aircraft	<a href="http://go.nasa.gov/1eEeSZg">http://go.nasa.gov/1eEeSZg</a>

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