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NASA airborne expedition chases climate, ozone questions

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NASA's Tropical Composition, Cloud and Climate Coupling (TC4) field campaign will begin this summer in San Jose, Costa Rica, with an investigation into how chemical compounds in the air are transported vertically into the stratosphere and how that transport affects cloud formation and climate.

The study will begin the week of July 16 with coordinated observations from satellites, high-flying NASA research aircraft, balloons and ground-based radar. The targets of these measurements are the gases, aerosols and ice crystals that flow from the top of the strong storm systems that form over the warm tropical ocean. These storm systems pump air more than 40,000 feet above Earth’s surface, where it can influence the composition of the stratosphere, home of our planet’s protective ozone layer.

The outflow of these storms also produces vast swaths of icy cirrus clouds that play an important role in how much infrared energy is trapped in Earth's atmosphere. Scientists want to document the full life cycle of these widespread clouds -- down to the size and shape of their tiny ice crystals -- to better understand how Earth will react to a warming climate.

"This campaign is an unprecedented opportunity to use NASA's complete suite of satellite and airborne Earth-observing capabilities to investigate a largely unexplored region of the atmosphere," said Michael J. Kurylo, a TC4 program scientist at NASA Headquarters, Washington. "This tropical transitional layer of the atmosphere between the troposphere and the stratosphere plays a key role in both climate change science and atmospheric ozone chemistry. The data will yield new insights into the composition of this layer and the impact of the deep clouds that penetrate the atmosphere up into this layer."

The effort runs through Aug. 8. It is NASA's largest Earth science field campaign of the year.

"A mission this complex, with three aircraft, deployment sites in Costa Rica and Panama, and more than 400 people involved, can be a real challenge," said Mission Project Manager Marilyn Vasques of NASA Ames Research Center, Moffett Field, Calif.

Soaring high above the cloud systems will be a NASA ER-2 aircraft, which can reach an altitude of 70,000 feet, or 3 miles into the stratosphere. A NASA WB-57 aircraft will fly into the cirrus clouds and sample the chemical make-up of the storm systems’ outflow. NASA's DC-8 aircraft will probe the region between the troposphere and the stratosphere (known as the tropopause transitional layer) with remote-sensing instruments. It also will sample cloud particles and air chemistry at lower altitudes. A weather radar and meteorological balloons will be deployed in Panama to support the campaign. Additional balloons will be launched from Costa Rica and San Cristobal Island in the Galapagos Archipelago.

Observations from seven satellites will complement the aircraft measurements with large-scale views of many different features of the atmosphere. For example, the Aura spacecraft will focus on the chemical composition of the tropopause transitional layer and measure ozone, water vapor, carbon monoxide and particles. NASA's Aqua satellite will map thin cirrus clouds, some of which are so faint they are nearly invisible to the naked eye. Instruments on the CALIPSO and CloudSat satellites will pierce the atmosphere to provide vertical profiles of clouds and aerosol particles that can change how clouds form.

Along the coasts of Colombia and Panama south of Costa Rica, the warm summer waters of the Pacific Ocean are a fertile breeding ground for the type of heat-driven, or convective, storm systems the mission is targeting. Clouds produced by these maritime systems produce heavy rainfall and cloud tops that can reach into the transitional layer.

Mission scientists want to know what effect a warming climate with rising ocean temperatures will have on the intensity of these storm systems. Another unknown is how aerosol particles swept up in these systems change the clouds and are, in turn, affected by the clouds.

These tropical convective systems also may play a role in the recovery of the ozone layer. Estimates of ozone destruction in the stratosphere typically minimize the impact of short-lived chemical compounds that presumably could not survive the long journey there. Mission scientists will investigate whether the rapid movement of air in these strong convective systems provides an express route for ozone-destroying compounds to reach the stratosphere.

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