FACT Sheet

National Aeronautics and
Space Administration

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Lidar Atmospheric Sensing Experiment (LASE)

An Airborne Laser System to Study Our Atmosphere

The Lidar Atmospheric Sensing Experiment (LASE) is a laser system developed to remotely measure water vapor, clouds and small particles (called aerosols) in the Earth's lower atmosphere. Lidar, which stands for LIght Detection And Ranging, is similar in concept to a radar, but uses laser light instead of radio waves.

LASE was developed to be flown aboard NASA research aircraft, such as the high-altitude ER-2 or the medium-altitude DC-8, though the same technology could one day be used to measure the atmosphere from space. Once in the air aboard a research aircraft, LASE can make measurements without human intervention, and its data can be viewed in real-time.

LASE uses the Differential Absorption Lidar (DIAL) technique which measures the atmosphere by comparing the light scattered by two laser beams. The two laser beams are pointed out of the aircraft both upwards and downwards. Both of the laser beams reflect off air molecules, clouds and aerosols in the atmosphere, much like radar waves reflect off rain droplets and solid objects. One of the two laser beams is also absorbed by water vapor, while the other is not. The difference in the amount of laser light scattered back to the aircraft by the two laser beams can be used to determine how much and where water vapor is present in the atmosphere.

The LASE system is capable of making accurate water vapor profile measurements over very large distances. Also, because it uses laser beams, LASE can make measurements both day and night.

Why Measure Water Vapor?

Water vapor, an invisible gas mostly concentrated in the lower atmosphere, is fundamentally important to the Earth's weather and climate, the atmospheric energy budget, the global water cycle and atmospheric chemistry. The measurement of the vertical distribution of water vapor in the lower atmosphere, as well as the total content of water vapor in the atmosphere, can be used in many critical atmospheric investigations.

LASE has already proven its ability to measure water vapor in the lower atmosphere during several airborne experiments. The LASE system was determined to be reliable, accurate and sensitive, with the ability to provide high-resolution water vapor data (both vertically and horizontally) from very dry to very wet conditions. LASE can provide water vapor data in the atmosphere every 300 meters vertically by 10 kilometers horizontally, giving atmospheric "modelers" the high-resolution data they need to accurately simulate water vapor processes in the atmosphere.

Atmospheric modelers use mathematical equations to represent how the atmosphere behaves under various conditions. Their "atmospheric models" can simulate the behavior of the Earth's atmosphere the same way a computer can simulate the way an airplane flies. Knowledge of how the atmosphere behaves is the result of thousands of scientific studies such as those done using LASE.

Cloud and Aerosol Measurements

LASE can make aerosol and cloud measurements every 30 meters vertically by 200 meters horizontally. The simultaneous measurement of aerosol and cloud distributions can provide important information on atmospheric structure and movement. Many meteorological variables also can be inferred from these data. The atmospheric science investigations that can be conducted with LASE are also greatly enhanced because measurements of water vapor are made simultaneously with aerosol and cloud distributions.

LASE Hurricane Hunters

In August-September 1998, LASE will take part in the third Convection and Moisture Experiment (CAMEX-3) to study the atmosphere in and around hurricanes. During CAMEX-3, LASE will be used to make measurements in the lower atmosphere over the Atlantic Ocean off the coast of southern Florida. The August-September timeframe is traditionally the most active of the Atlantic hurricane season in this region.

Water vapor is one of the key atmospheric variables required to understand the complex processes associated with hurricanes. During CAMEX-3, LASE will measure water vapor, aerosols and clouds from the NASA DC-8 aircraft on long-range flights around hurricanes. In addition to analyzing the LASE data in real-time aboard the aircraft, the LASE team will work extensively with teams from Florida State University and the University of Virginia to perform real-time atmospheric modeling studies with the LASE water vapor, aerosol and cloud data.

During its final validation experiment in September 1995, the LASE instrument was flown over Hurricane Luis off the coast of Virginia. Scientists are hoping that similar data can be obtained during CAMEX-3 to help atmospheric modelers better understand the processes that occur in and around hurricanes.

Studies involving water vapor measurements are very important in the tropics mainly because so little water vapor data is available for that region. Also, satellites generally cannot provide data with enough vertical resolution to allow hurricane trackers and atmospheric modelers to truly understand the processes ongoing in a hurricane during its formation, life and decay. Because of these constraints, there is considerable uncertainty in hurricane forecasting models with respect to predicting storm intensity, structure, movement and landfall.

Future LASE Missions

Other proposals are underway for LASE to participate in a number of major field programs managed by NASA's Earth Science Enterprise. Information gathered by the LASE instrument will become an integral part of many future airborne atmospheric studies. Though LASE is a first step towards the long-range goal of developing a spaceborne water vapor lidar instrument, it is already gathering important data for atmospheric research.

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