National Aeronautics and Space Administration

NASA facts

ER-2 High-Altitude Airborne Science Aircraft

NASA operates two Airborne Science ER-2 aircraft for a wide variety of environmental science, atmospheric sampling and satellite data verification missions. (NASA / Carla Thomas)

NASA operates two Lockheed ER-2 Earth resources aircraft as flying laboratories in the Airborne Science Program under the agency's Science Mission Directorate. The aircraft, based at NASA's Dryden Aircraft Operations Facility in Palmdale, Calif., collect information about Earth resources, celestial observations, atmospheric chemistry and dynamics, and oceanic processes. The aircraft also are used for electronic sensor research and development, satellite calibration and satellite data validation.

Program History

NASA acquired its first ER-2 aircraft in 1981 and a second in 1989. They replaced two Lockheed U-2 aircraft, which NASA had used to collect science data since 1971. The U-2s, and later the ER-2s, were based at NASA's Ames Research Center in Moffett Field, Calif., until 1997, when the ER-2s and their operations moved to NASA Dryden.

Since the Airborne Science Program's inaugural flight on Aug. 31, 1971, NASA U-2s and ER-2s have flown more than 4,500 data missions and test flights in support of scientific research.

NASA's ER-2 set a world-altitude record for the class of aircraft with a takeoff weight between 26,455 and 35,275 pounds on Nov. 19, 1998, when the aircraft reached 68,700 feet.

Atmospheric Experiments

NASA ER-2s have played an important role in Earth science research because of their ability to fly into the lower stratosphere at subsonic speeds, enabling direct stratospheric sampling as well as virtual satellite simulation missions. The aircraft's unique capabilities enable studies such as stratospheric ozone concentrations over Antarctica and the Arctic.

In August and September 1987, an ER-2 traveled to Chile to conduct overflights of the Antarctic. The direct measurements from the ER-2, combined with remote-sensing measurements from ground-based and satellite sensors, provided information suggesting that human-made chemical compounds, specifically chlorofluorocarbons, caused ozone depletion over the Antarctic region. The first field study of summer polar ozone conditions took place during a series of flights from Fairbanks, Alaska, between April and September 1997.

During the winter of 1999/2000, an ER-2, teamed with NASA's DC-8 flying science platform, participated in the SAGE III Ozone Loss and Validation Experiment (SOLVE). Based in Kiruna, Sweden, SOLVE was the largest field campaign conducted to measure ozone in the Arctic stratosphere.

The ER-2 has been an invaluable tool for studying tropical cyclone (hurricane) development, tracking, intensification and landfall impacts. During the July 2005 Tropical Cloud Systems and Processes mission based in Costa Rica, the ER-2 carried instruments that measured the buildup and behavior of tropical storm systems over Mexico and Central America and in the eastern Pacific, Caribbean and Gulf of Mexico. The aircraft flew over several hurricanes, including Emily and Dennis that were both violent Category 4-5 storms, and collected information on their entire vertical structure. Data were collected about the temperature, humidity, precipitation and wind related to tropical cyclones and other related phenomena that often lead to development of more powerful storms at sea.

Satellite Sensor Development and Simulation

Since Airborne Science's inception, the NASA U-2s and ER-2s have assisted in developing satellite sensors by testing prototypes or by simulating proposed configurations with existing systems.

The ER-2 carries the Airborne Visible Infrared Imaging Spectrometer (AVIRIS), a 224-band hyper-spectral scanner designed by NASA's Jet Propulsion Laboratory in Pasadena, Calif. AVIRIS is a prototype of hyper-spectral scanners proposed for orbit on future satellite platforms. Collecting data with prototype instruments allows scientists to analyze and interpret the information future satellites will provide.

In December 2010, the ER-2 first carried the Multiple Altimeter Beam Experimental Lidar (MABEL), an Ice, Cloud and land Elevation Satellite-2 (ICESat-2) simulator. MABEL, developed by NASA's Goddard Space Flight Center in Greenbelt, Md., was flown to test the satellite's measurement concept. MABEL was again mounted in the nose of the aircraft in March 2011 for flights over a variety of terrains. In April 2012, the aircraft carried MABEL for a deployment to study Greenland's ice sheet, glaciers and sea ice. Based in Iceland, the ER-2 flew to altitudes of 65,000 feet as the sensor gathered algorithm development data that may allow ICESat-2, scheduled to launch in 2016, to make more precise measurements of global ice.

NASA Dryden life support technician Jim Sokolik assists pressure-suited pilot Dee Porter into the cockpit of NASA's ER-2 Earth resources aircraft. (NASA / Jim Ross)

ER-2 Deployments

The ER-2 has deployed to six continents investigating global warming and ozone depletion and acquired extensive digital multispectral imagery for global climate change research and aerial photography. These missions have tested prototype satellite imaging sensors and have acquired Earth resources data for research projects sponsored by NASA and federal agencies such as the U.S. Forest Service, Environmental Protection Agency, U.S. Fish and Wildlife Service and the Army Corps of Engineers.

ER-2 Aircraft Capabilities

The ER-2 is a versatile aircraft well suited to perform multiple mission tasks.

The ER-2 operates at altitudes from 20,000 feet to 70,000 feet, which is above 99 percent of the Earth's atmosphere. Depending on aircraft weight, the ER-2 reaches an initial cruise altitude of 65,000 feet within 20 minutes. Typical cruise speed is 410 knots. The range for a normal eight-hour mission is 3,000 nautical miles yielding seven hours of data collection at altitude. The aircraft is capable of longer missions in excess of 10 hours and ranges in excess of 6,000 nautical miles. The ER-2 can carry a maximum payload of 2,600 pounds (1,179 kilograms) distributed in the equipment bay, nose area and wing pods.

The aircraft has four large pressurized experiment compartments and a high capacity AC/DC electrical system, permitting it to carry a variety of payloads on a single mission. The modular design of the aircraft permits rapid installation or removal of payloads to meet changing mission requirements.

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Dryden Flight Research Center
P.O. Box 273
Edwards, California 93523

www.nasa.gov

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