



technology opportunity

SIERRA: A New Unmanned Aircraft for Earth Science Investigations

For precise, accurate, safe, and cost-effective remote sensing



NASA is offering a new way for companies, universities, and government agencies to gather important Earth science data using an innovative, safe, and cost-effective aerial platform. The Systems Integration Evaluation Remote Research Aircraft (SIERRA) is a medium-class, unmanned aircraft system (UAS) that can perform remote sensing and atmospheric sampling missions in isolated and often inaccessible regions, such as over mountain ranges, the open ocean, or the Arctic. UAS missions are of particular value when long flight durations or range-measurement requirements preclude a human pilot or where remote or harsh conditions place pilots and high-value aircraft at risk. Designed by the U.S. Naval Research Laboratory and developed at NASA's Ames Research Center, the SIERRA is well suited for precise and accurate data collection missions because it is large enough to carry up to 100 pounds of scientific instruments for up to 600 miles yet small enough not to require a large runway or hangar. NASA invites industry, academia, and government agencies to tap into the SIERRA's capabilities for relevant research and Earth observation missions.



Aircraft Specifications

- **Wingspan:** 20 ft
- **Length:** 11.8 ft
- **Height:** 4.6 ft
- **Flight duration:** 8-10 hrs
- **Range:** 600 mi
- **Useful payload:** up to 100 lbs
- **Gross take-off weight:** 445 lbs
- **Max altitude:** 12,000 ft
- **Air speed:** 50-80 kts
- **Power:** 19 Amps, 28 VDC

Technology Details

The SIERRA has the capability to travel long distances at low altitudes, gathering a wide range of scientific data. Its excellent maneuverability, slow flight speed, moderate size, and relatively large payload make the aircraft ideal for many types of tropospheric chemistry sampling and remote sensing missions, including arctic ice reconnaissance, land cover mapping, ecosystem assessment, fire monitoring surveys, disaster surveillance, even levee assessment.

The aircraft is unique in its ability to carry up to 100 pounds of scientific instruments on mission ranges as far as 600 miles. Its scalable nose payload bay supports a broad range of optical or radar imaging and air sampling missions. On-board data processing enables real-time data streams and on-the-fly georectification (i.e., course changes). The aircraft has demonstrated the capability of gathering earth science data from passive (i.e., imagers), active (e.g., synthetic aperture radar (SAR)), and in situ (e.g., air sampling) remote sensing systems.

Communications links feature a primary line-of-sight radio/modem system, operating at 900 MHz and up to one watt within a 10-mile range. A secondary communications link is implemented through the Iridium SatCom constellation, providing over-the-horizon communications at up to 2.4 bits/sec bandwidth. The autopilot uses a set of coordinates to perform waypoint navigation and allows real-time course changes. The autopilot specifications support such advanced automation capabilities as formation flying as many as 20 constellation aircraft, with control centralized in a single ground station.

Science Mission Success: The SIERRA Provides Unprecedented Data to Arctic Ice Cover Study

Characterization of Arctic Sea Ice Experiment (CASIE) is the aircraft campaign portion of the larger NASA-funded, 3-year effort titled “Sea Ice Roughness as an Indicator of Fundamental Changes in the Arctic Ice Cover: Observations, Monitoring, and Relationships to Environmental Factors,” to study the large-scale environmental changes in Earth’s polar regions that have led to loss of the oldest and thickest types of sea ice.

In its first science mission, the SIERRA provided the CASIE project with an unprecedented level of high-resolution data over a range of sea ice conditions within the Fram Strait region between northern Greenland and Norway in July 2009. The SIERRA logged nearly 60 hours over 11 flights, for a total of 1,800 miles over open ocean and sea ice, at altitudes as low as 300 feet, to map and measure ice conditions. The data provided surface topography observations, standard electro-optical imagery, synthetic aperture radar imagery, and surface reflectance and temperature measurements. CASIE included the northernmost known operations of a UAS.



The SIERRA sent position, temperature, and humidity data to the ground. Through real-time processing, the information was displayed within the Google Earth™ Mapping Service, allowing researchers to revise course plans and protect the aircraft from icing conditions during flight. The combination of satellite data and real-time data from the SIERRA allowed many researchers to contribute to the mission without traveling to the region.

To illustrate the instrument-carrying capacity of the SIERRA, the payload suite for this mission included two laser altimeters, a SAR, zenith- and nadir-pointing microspectrometers, digital still and video-tracking cameras, a pyrometer, and a zenith-pointing pyranometer. All instruments were contained in the nose cone of the SIERRA, with the exception of the SAR antenna, which was mounted in a pod to the side of the fuselage.

“The SIERRA performed very well during this op...[When] the aircraft unintentionally flew through clouds and potential icing conditions, the engine, flight controls, and other aircraft systems never missed a beat.”

—Mark Sumich, SIERRA Chief Pilot, NASA’s Ames Research Center

“One of the questions I had regarding operations was the degree to which we could revise flight plans during flight to accommodate changing conditions. ... We tested this by shifting the flight pattern to take into account changes in wind direction. The ground operator was able to revise the plan quickly once I supplied the revised latitude/longitude waypoints. I did this simply by changing the flight plan in Google Earth [mapping service] and then e-mailing the revised pattern to the ground operator.”

—Dr. James Maslanik, CASIE Principal Investigator, University of Colorado

“I’m very impressed by the performance of the aircraft and the NASA team. Being in this location, with this aircraft, sensor package, and team, [was] a rare opportunity of which we [took] full advantage.”

—Dr. James Maslanik

Science and Application Support Areas

- Atmospheric composition and chemistry
- Arctic surveys
- Land cover characterization
- Surface to air fluxes
- Disaster response and assessment
- Agriculture and ecosystem assessment
- Biological/physical oceanography
- Island and coastal remote sensing
- Coral reef monitoring

Partnership Opportunities at NASA's Ames Research Center

The SIERRA is available to support U.S. Naval Research Laboratory missions for government entities and research organizations, along with a number of other potential missions that have been identified with collaborating government entities, including:

- National Oceanic and Atmospheric Administration (NOAA)
- U.S. Geological Survey (USGS)
- U.S. Forest Service (USFS)
- Department of Homeland Security (DHS)
- State of California

NASA's Ames Research Center is actively seeking partnerships to better characterize and validate information from NASA Earth science satellites and support process studies. Grants for pursuing research using NASA aircraft typically are funded through NASA's Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) process. When writing a proposal that includes the SIERRA, please register a placeholder flight request (at <http://airbornescience.nasa.gov>), to ensure that cost and schedule estimates can be provided.



Ames partners with academic, industrial, and government agencies to benefit NASA's mission and foster commercial application of NASA technologies. Ames seeks partnerships to promote the development of a robust commercial space industry, to benefit and support NASA's exploration, science, and aeronautics mission goals. In addition, Ames works collaboratively with the Federal Aviation Administration, conducting research in air traffic management to make safer, less expensive, and more efficient air travel a reality. Ames also conducts informational and educational outreach programs.

For More Information

If you would like more information about the Systems Integration Evaluation Remote Research Aircraft (SIERRA) or NASA's Ames Research Center, please contact:

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