EARTH SCIENCE and Climate Monitoring

NASA Using Aircraft To Study Polar Ice While Awaiting ICESat Replacement

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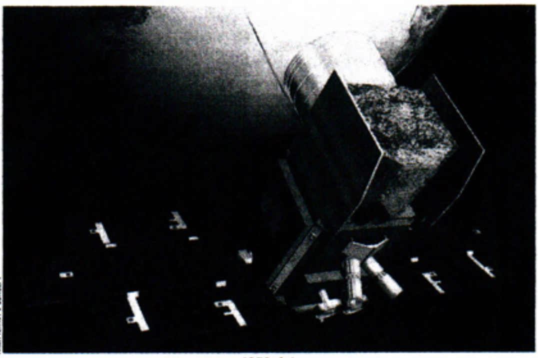
NASA scientists plan to conduct extensive airborne campaigns to gather data on changing polar ice conditions during the gap in time between completion of the first Ice, Cloud and land Elevation Satellite (ICESat-1) mission and the launch of the spacecraft's successor, ICESat-2.

The ICESat-1 mission's Geoscience Laser Altimeter System (GLAS), which has conducted periodic surveys of polar ice sheets since the spacecraft was launched in 2003, has provided scientists with important data showing that the overall size and thickness of the ice sheets is decreasing. "The thing that is unique about ICESat is that you get detailed elevation information at a continental scale," said Tom Wagner, cryosphere program manager at NASA headquarters.


NASA ARTIST'S CONCEPT
ICESat-1

Information on polar ice conditions is a critical component of climate change models because the enormous ice sheets, which are sometimes larger in land area than the continental United States, reflect solar energy. When those ice sheets melt, the exposed sea water absorbs the solar energy, which warms the ocean and produces more melting ice, Wagner said. If the Greenland and Antarctic ice sheets were to melt completely, sea levels would rise approximately 70 meters, said Howard Zebker, L-band principal investigator for an airborne ice survey that began May 1.

The ICESat-1 mission was scheduled to end in April. When the GLAS instrument was turned off, however, NASA engineers discovered that the instrument could be used for an additional science campaign. "There is a little life left in it," Wagner said. As a result, NASA officials are discussing whether to use the ICESat spacecraft to conduct another ice survey this fall, he added.

ICESat's GLAS instrument is equipped with three lasers, one of which failed several weeks after launch. After concluding that the problem, mechanical failure of a pump diode array, was likely to occur in the other two lasers, NASA modified the mission. Instead of continuous operations, the GLAS lasers are turned on just twice a year for one-month periods to gather data. The final GLAS laser is slowly degrading on orbit, said NASA spokesman Stephan Cole.

Even if ICESat-1 can complete an additional survey of sea ice conditions, NASA officials face a significant gap in space-based data because the ICESat-2 mission is not scheduled to begin until 2014 or 2015. NASA officials have not yet determined the launch date for that mission or the specific instruments that the ICESat-2 spacecraft will carry, Wagner said.

To fill that gap in scientific data on ice conditions, NASA officials plan to conduct airborne science campaigns. The first campaign, known as Operation ICE Bridge, began March 30 when a P-3 maritime patrol aircraft began making measurements of land and sea during flights from Thule Air Base in Greenland.

During that campaign, which ended in early May, the P-3 was equipped with an Airborne Topographic Mapper, which uses laser reflections to produce an elevation map of the ice surface, and Pathfinder Airborne Radar Ice Sounder instruments, which uses radio signals to measure the elevation of the rocky bed below the ice. By combining the data retrieved by those two instruments with precision location information obtained from GPS satellites, NASA scientists can determine ice thickness at specific locations. The P-3 also carried a Laser Vegetation Imaging Sensor and the Kansas University Ultra Wide Band Snow Radar as it surveyed changes in the ice on the coast of Greenland, the coast of Antarctica, the Antarctic Peninsula and interior Antarctica.

"We are discussing conducting more of these surveys between ICESat-1 and ICESat-2," Wagner said. This fall, for example, NASA is likely to use a DC-8 aircraft to study the Antarctic Peninsula and Pine Island Glacier, Wagner said.

While the airborne observations are useful in providing detailed surveys of areas where the ice is changing rapidly, they will never erase the need for instruments like GLAS, which can provide detailed elevation information at a continental scale, Wagner said. "ICESat is critical to telling us what is going on in the big picture," he added.

Another airborne campaign designed to shed light on the changing nature of polar ice began May 1 when scientists from NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., and Dryden Flight Research Center in Edwards, Calif., flew a Gulfstream 3 to Greenland. Scientists will use the Gulfstream 3, equipped with two radars developed by JPL scientists, to conduct a two-month study of Greenland and Iceland.

The first radar, an Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) is designed to use microwave energy to penetrate the ice, allowing scientists to monitor the flow of glaciers and ice sheets 100 meters to 200 meters below the surface, said Zebker, a geophysics professor at Stanford University in Palo Alto, Calif.

The second radar, called Glacier and Land Ice Surface Topography Interferometer (GLISTIN), is designed to create maps of the surface of the ice. The GLISTIN surveys will show whether a microwave radar operating in the Ka-band can be used to create accurate topographic maps of the icy region, said Delwyn Moller, Ka-band principal investigator from Remote Sensing Solutions, Barnstable, Mass. In the past, Ka-band radars have not been used to create topographic maps because the microwaves penetrated the snow by several meters, making it difficult to determine surface height. GLISTIN is designed to reduce that penetration to 10 centimeters to 30 centimeters in dry snow, and negligible penetration for wet snow, Moller said. Ground-based measurements will be used to verify the accuracy of GLISTIN results, she added.

The results of the UAVSAR and GLISTIN experiments will help scientists determine the merits of the two various technologies and their potential use for future space-based radars, Zebker and Moller said.