NASA Ice Campaign Takes Flight in Antarctica

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NASA's DC-8 flying laboratory takes off in Punta Arenas, Chile, during NASA's AirSAR 2004 campaign. Now, the same aircraft will make flights from Punta Arenas to Antarctica as part of Operation Ice Bridge. Credit: NASA/Jim Ross Early in the 20th century, a succession of adventurers and scientists pioneered the exploration of Antarctica. A century later, they're still at it, albeit with a different set of tools. This fall, a team of modern explorers will fly over Earth's southern ice-covered regions to study changes to its sea ice, ice sheets, and glaciers as part of NASA's Operation Ice Bridge.

Starting next month, NASA will fly its DC-8, a 157-foot-long airborne laboratory that can accommodate many instruments. The fall 2009 campaign is one of few excursions to the remote continent made by the DC-8, the largest aircraft in NASA's airborne science fleet.

The plane is scheduled to leave NASA's Dryden Flight Research Center in Edwards, Calif., on October 12 and fly to Punta Arenas, Chile, where the plane, crew and researchers will be based for through mid-November. For six weeks, the Ice Bridge team will traverse the Southern Ocean for up to 17 flights over West Antarctica, the Antarctic Peninsula, and coastal areas where sea ice is prevalent. Each round-trip flight lasts about 11 hours, two-thirds of that time devoted to getting to and from Antarctica.

Operation Ice Bridge is a six-year campaign of annual flights to each of Earth's polar regions. The first flights in March and April carried researchers over Greenland and the Arctic Ocean. This fall's Antarctic campaign, led by principal investigator Seelye Martin of the University of Washington, will begin the first sustained airborne research effort of its kind over the continent. Data collected by researchers will help scientists bridge the gap between NASA's Ice, Cloud and Land Elevation Satellite (ICESat) -- which is operating the last of its three lasers -- and ICESat-II, scheduled to launch in 2014.

The Ice Bridge flights will help scientists maintain the record of changes to sea ice and ice sheets that have been collected since 2003 by ICESat. The flights will lack the continent-wide coverage that can be achieved by satellite, so researchers carefully select key target locations. But the flights will also turn up new information not possible from orbit, such as the shape of the terrain below the ice.

"Space-based instruments like the ICESat lasers are the only way to find out where change is occurring in remote, continent-sized ice sheets like Antarctica," said Tom Wagner, cryosphere program scientist at NASA Headquarters in Washington, D.C. "But aircraft missions like Ice Bridge allow us to follow up with more detailed studies and make other measurements critical to modeling sea level rise."

Lasers and Radars

ICESat launched in January 2003 and since then, its sole instrument -- a precise laser altimeter -- has helped scientists map ice sheet elevation, calculate sea ice thickness, and monitor how both have changed.

"With ICESat, we have seen significant changes, things we wouldn't otherwise know were taking place," said Jay Zwally of NASA's Goddard Space Flight Center in Greenbelt, Md., and ICESat investigator on the mission. For example, shifts in surface elevation have previously revealed the draining and filling of lakes below Antarctica's ice.

After ICESat, scientists will rely on an airborne laser called the Airborne Topographic Mapper (ATM), developed at NASA Wallops Flight Facility in Wallops Island, Va. ATM pulses laser light in circular scans on the ground, and those pulses reflect back to the aircraft and are converted into elevation maps of the ice surface. By flying ATM over the same swath of ground covered by ICESat, researchers can compare the two data sets and calibrate them so that aircraft can continue the record keeping after the satellite data ends. They can also make more detailed elevation studies over dynamic areas, such as the Crane glacier on the Antarctic Peninsula, which sped up following the collapse of the Larsen Ice Shelf in 2002.

In addition, University of Kansas scientists will fly the Multichannel Coherent Radar Depth Sounder, which measures ice sheet thickness. It can also map the varied terrain below the ice, which is important for computer modeling of the future behavior of the ice.

The Laser Vegetation Imaging Sensor, developed at Goddard, will map large areas of sea ice and glacier zones. And a gravimeter, managed by Columbia University, will measure the shape of seawater-filled cavities at the edge of some major fast-moving major glaciers. Finally, a snow radar from University of Kansas will measure the thickness of snow on top of sea ice and glaciers, allowing researchers to differentiate between snow and ice and make more accurate thickness measurements.

Targets
The Antarctic continent may be remote, but it plays a significant role in Earth's climate system. The expanse is home to glaciers and ice sheets that hold frozen about 90 percent of Earth's freshwater -- a large potential contribution to sea level rise should all the ice melt.

How and where are Antarctica's ice sheets, glaciers, and sea ice changing? Compared to the Arctic, where sea ice has long been on the decline, sea ice in Antarctica is growing in some coastal areas. Snow and ice have been accumulating in some land regions in the east. West Antarctica and the Peninsula, however, have seen more dramatic warming and rapid ice loss.

"We don't see the same sea ice changes in Antarctica that we see in the Arctic, and the reason is that the system is more complex," said Thorsten Markus of NASA Goddard, the principal sea ice investigator for the mission. "But the fact that we don't see the same changes in Antarctica that we see in the Arctic doesn’t make it less important to study those changes. It's really important for us to understand the global climate system."

With the DC-8 limited to just a few hours over Antarctica on each flight, mission planners have carefully selected targets of current and potential rapid change.

One such target is West Antarctica's Pine Island Glacier. "That glacier is one of the great unknowns because its bed -- where the glacier contacts rock -- is below sea level," Martin said. "So if there's a surge or dramatic change, seawater could get under the glacier and we could be looking at very rapid change."

Other proposed targets along the Amundsen coast include the Thwaites, Smith, and Kohler glaciers and the Getz Ice Shelf. Researchers also intend to study the myriad glaciers and ice shelves on the Peninsula, which has been undergoing dramatic changes.

"A remarkable change is happening on the Earth, truly one of the biggest changes in environmental conditions on Earth since the end of the ice age," Wagner said. "It's not an easy thing to observe, let alone predict what might happen next. Studies like this one are key."

Links:

Operation Ice Bridge
http://www.nasa.gov/topics/earth/features/ice_bridge/index.html

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