



# Flight of the Phoenix



## CRYOSAT RISES AGAIN

*Artist's drawing of CryoSat courtesy of ESA.*

“Jay, I think we lost her.” So wrote lead investigator Duncan Wingham to a colleague after the launch of CryoSat on October 8, 2005. Over 1000 person-years had gone into the satellite’s planning, design, and construction, and hundreds of scientists and engineers had worked exclusively on the project, some since it was first proposed in 1999.

All of this effort fell into the Arctic Ocean last October with the remains of CryoSat and the second and third stages of the rocket that was to blast it into orbit. Later reports showed that human error—a mistake in the control program that “drives” the rocket—caused the second-stage engine to fail to shut down at the appropriate time. The onboard computer responded by terminating the mission at just over 300 seconds into flight.

CryoSat’s loss was a huge blow to the European Space Agency (ESA), which financed the project, and to the polar science community as well. But in late February 2006, ministers from the 17 ESA member states gave the green light to build CryoSat 2 based on the original satellite’s design. ESA estimates that CryoSat 2 should be ready to launch in 2009, at a cost of \$127 million.

The Greenland ice sheet holds enough frozen water to raise sea level by 5 meters. Recent results show that the ice sheet’s margins have been melting for the last 10 years, and outlet glaciers are flowing faster. A large portion of Earth’s population lives very near sea level, and events such as hurricane Katrina and the 2004 Indian Ocean tsunami highlight the vulnerability of coastal settlements. So it’s more important than ever to determine the nature and status of Earth’s large reservoirs of frozen water. CryoSat’s mission—to observe changes in the Earth’s ice cover with unprecedented resolution and accuracy—works toward this goal.

Until recently, no satellite had been launched exclusively for the study of the cryosphere, the frozen parts of Earth. Earlier radar altimeters were able to measure the surface elevation of much of the Antarctic and Greenland ice sheets,

but measurements in relatively steep topography near the margins were less reliable. And while sea ice area can be measured with imaging sensors, thickness has been a challenge to measure from space, primarily because the open-water leads in the sea-ice are frequently smaller than the resolution of the radar altimeter.

CryoSat has solutions for these problems. Sea-ice thickness will be easier to measure thanks to CryoSat’s Synthetic Aperture Radar (SAR) mode, which gives the radar increased resolution. For the margins of ice sheets and smaller ice caps, CryoSat has SAR/Interferometric (SARin) mode, which allows the radar to pinpoint the location of the echo with even greater resolution.

In SAR mode, CryoSat uses the Doppler effect to determine the direction from which the echo came. We’ve all experienced the Doppler effect: as the race car whizzes past, the sound changes in pitch from high to low. *RrrrrrrrooooooOOOOOWWW!* CryoSat’s radar uses the same principle to determine where a radar echo came from.

To improve resolution further, CryoSat’s radar altimeter in SARin mode uses two separate antennas to receive the echo. These two antennas help determine the location of an echo in the same way that animals with two ears can determine the location of a sound: the echo (or sound) arrives at one antenna (or ear) slightly earlier than the other, allowing the hearer to pinpoint the source.

To ensure the radar is pointed directly at the ground, three star-tracking cameras view the overhead sky and, using the positions of the stars, determine the orientation of Cryosat to within a few thousandths of a degree. The precise positioning needed for satellite altimetry is provided by a French system similar in concept to GPS called DORIS (Doppler Orbitography and Radio-positioning

## GREENLAND News

Ready, set! Our Kangerlussuaq team has headed north for the summer. Greenland project manager Robin Abbott joined operations manager Mark Begnaud and the Raven team in Kanger on Monday to prepare for the first NYANG flight of the season on 12 April. The guard will bring Kanger team members Ed Stockard and Ben Toth and loads of preseason construction cargo.

**Update from Summit Station:** The four-person phase-3 crew barely established a routine before they geared up during the second week in March to welcome three more souls to Summit. So Eric Steig researchers Julia Jarvis and Kathy Huybers could begin their seasonal measurements of atmospheric reactive nitrogen compounds in snow, folks moved the Bally Building from the cargo berm to the satellite camp. For more on Eric Steig's work, [http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0454803](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0454803)

Of course, weather delayed the flight. Kathy Young reports wind gusts reached 45knots over the course of a five-day storm. "The winds pushed you along when you walked from one building to the next. The snow piled up. . . The Big House felt like you were on a ship as it swayed with the gusts of wind."

Finally, on 19 April, the weather allowed the Twin Otter access to the station. Jake Speed, VPR's equipment operator, also joined life at Summit. That night, the setting sun looked like a "large ball of red pooled out across the horizon." Kathy reports that later, the night sky seemed to celebrate the day's activities: "It was so clear that every star was out. The entire sky in camp was [lit] up with greens, red, and yellow." Welcome to the world's roof.

As March wore on, Jake zipped around on the D-6, clearing snow and grooming the runway, demonstrating, writes Kathy, "there's a reason they call him Jake Speed."



*This distinguished visitor to Summit Station must have heard the Phase-3 crew were a bunch of foxes.*

## INTERNATIONAL News

The North Pole Environmental Observatory is gearing up for the season, with VPR-supported researchers expected to arrive on 15 April.

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0352754](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0352754)

Kelly Falkner-led freshwater flux researchers head to the Nares Strait this week to recover their mooring array.

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0230354](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0230354)

## DENVER News

**Renewable Energy:** VPR Renewable energy guru Tracy Dahl judged entries in the Clean Snowmobile Challenge at Michigan Technological University. Two challenge participants will join Tracy this month to evaluate their electric snowmobiles at Summit. Read Tracy's report on the contest:

<http://www.vecopolar.com/Files/PDFs/2006CSCTripRpt.pdf>



*Good, clean fun: the snowmobile challenge.*

# ALASKA News

The NOMADS GoNorth! dog sled expedition is traveling the north coast of Alaska. For VPR's record on participant Henry Huntington's research go to

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0505736](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0505736)

Researcher Molly Chambers spent March 26-April 3 in villages throughout the Seward Peninsula working on Dan White's water resources project.

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=032868](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=032868)

## Working in Barrow, Alaska

It's late March in Barrow, Alaska, and the whaling season is just around the corner. So are the scientists who will be doing research on a shallow lake located just outside of town at the Barrow Environmental Observatory (BEO). In the winter, the BEO looks like any other remote polar region on the planet. It's desolate, barren, cold, windy...and as white as a polar bear's canines. You think of that when you go to work outside town limits. The tracks polar bears leave behind are a testament to their presence. No matter what anyone says, there's something unnerving about going to work with a shotgun strapped to your back.

In April when the sea ice begins to break and the bowhead whales migrate through these frigid Arctic waters, the people begin a tradition passed down through many Inupiat generations. It's whaling. They depend on it for subsistence and for the survival of their culture. Drive through Barrow and you see that already sealskin boats are appearing outside homes.

This is the backdrop to my work overseeing Ukpeagvik Inupiat Corporation's installation and improvement of the infrastructure needed for continued scientific research on the BEO Biocomplexity Project, a complex, multi-investigator study of carbon processes in tundra ecosystems responding to a warming and drying climate. This week workers concentrated on assembling more boardwalk platforms,



*A sealskin boat awaits whaling season. Photo by Chico Perales.*

transporting the finished pieces and adjoining components to the site.

So far no polar bears have been sighted but an alpha fox has made a point of marking its territory by spraying every marker flag. Maybe it's trying to remind us just who really is in charge up here.

—Chico Perales, VPR Barrow Project Coordinator

For VPR's complete on-line record of the Oechel-led biocomplexity experiment, go to

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0421588](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0421588)

## SCIENCE & Other News

Bill Fitzgerald's Alaska-based study of how sun converts mercury in lakes into a form not absorbed by fish is discussed in the Alaska Science Forum. <http://www.gi.alaska.edu/ScienceForum/ASF17/1795.html>

Here's VPR's on-line project record:

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0425562](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0425562)

VPR-supported researcher Martin Truffer talks about surging glaciers after the McGinnis Glacier in the Alaska Range went "totally nuts," probably over the winter. <http://www.gi.alaska.edu/ScienceForum/ASF17/1794.html>

View Martin Truffer's extraordinary photos of McGinnis glacier: <http://www.gi.alaska.edu/~truffer/McGinnisSurge/>

Continued from Page 1

Integrated by Satellite).

Despite the long names and acronyms, CryoSat was designed to be as simple a machine as possible. It contains no moving parts. Many of the systems on the spacecraft were based on systems from previous satellites, speeding development time and reducing the cost of the project. Even the memory banks were optimized to allow the unit to be downloaded from only one ground station, simplifying the already complex and carefully laid plans for ground processing of the data.

Any remotely sensed data needs “ground truth” (checking remote measurements against observations on the ground) for validation, and CryoSat’s is no exception. In 2004, ESA carried out an extensive calibration and validation study, using simultaneous ground and airborne observations. In spite of the loss of CryoSat, this spring will see another mobilization of field scientists and aviators. A Twin Otter, specially fitted with radar similar to that

aboard CryoSat, will make a massive lap of Greenland and neighboring areas. Taking measurements over teams working on both land and sea ice, the plane will fly to Svalbard, Station Nord (North Greenland), Alert (Arctic Canada), Thule, and finally end up back where it began, in Kangerlussuaq.

The challenges of coordinating a field campaign of this nature are considerable. More than a dozen different institutions from almost as many nations must place research teams in the field for the moment the aircraft flies over. The ground experiments range from a few scientists erecting a reflecting target, to a team of two traversing on snowmobiles from the edge of the ice sheet all the way up to Summit.

For more information about this research, go to:

<http://www.esa.int/SPECIALS/Cryosat/>

(EGIG) traverse, first traveled in 1957. Along the way she will measure density profiles to a depth of 10 meters. This information will be used to assess the potential for the radar altimeter to penetrate deeper into the snow than previously thought.

Although it can readily detect the surface, recently the radar altimeter has also been able to “see” up to 12 meters into the snow pack, and the returns have shown annual layers. This allows scientists to track the history of snow accumulation along the flight line. Looking forward to 2009, CryoSat 2 represents a new hope for anyone interested in changes in Earth’s ice cover—and given recent observations from both poles, that should be all of us.

– Bob Hawley

*Bob Hawley is a glaciologist at the Scott Polar Research Institute in Cambridge, England. He regularly studies firn compaction at field sites in Greenland, and is also a working member of the CryoSat calibration, validation, and retrievals team.*



*Researcher Liz Morris reaches Summit after traversing the EGIG route in 2004. She retraces her tracks this spring. Photo by Geoff Somers.*

## SCIENCE & Other News

Information on ancient climate from coral reefs and ice cores, together with climate models, suggests the Greenland and Antarctic ice sheets could melt faster this century than was earlier predicted. Read the NSF’s coverage:

[http://www.nsf.gov/news/news\\_summ.jsp?cntn\\_id=106798&org=OPP&from=news](http://www.nsf.gov/news/news_summ.jsp?cntn_id=106798&org=OPP&from=news)

*New York Times* science writer Andy Revkin toured Greenland during 2003, visiting Summit, Swiss Camp, and the North Pole Environmental Observatory among other sites. His book aimed at readers 10 and up, *The North Pole Was Here: Puzzles and Perils at the Top of the World*, has recently been published.

<http://www.houghtonmifflinbooks.com/catalog/titledetail.cfm?titleNumber=561115>