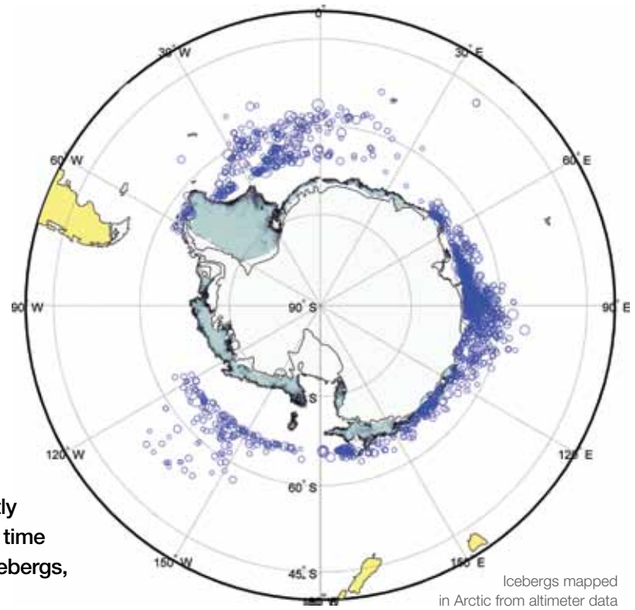
NO HIDING PLACE

In January, when the Maxi Banque Populaire V—an ocean racing trimaran—shattered the world record for circumnavigating the globe (surpassing the old record by more than two days and clocking an average speed of 26.5 knots), another "first" was quietly being celebrated behind the scenes. This was the first time that altimeter data was used operationally to detect icebergs, writes Andrew Safer, from St John's, Newfoundland



Icebergs mapped in Arctic from altimeter data

C-CORE of St. John's, Newfoundland and Labrador on the east coast of Canada has been providing iceberg detection service for round-the-world yacht races since 2003, relying on satellite-based Synthetic Aperture Radar (SAR) images. This method was proving to be both time-consuming and expensive, particularly when covering massive areas of ocean. A typical area where iceberg detection is required is south of Africa, between Australia and South America in the southern Indian Ocean. "That's a horrendously large area," exclaims Desmond Power, C-CORE's vice president of remote sensing. "It takes hundreds of images to survey properly, and many weeks to capture and analyse the data." A significant number of icebergs have been sighted in that region over the years, making it an area of prime interest to racers. "They want to sail as far south as possible in the Pacific," says Power, "but they want to sail north of the icebergs."

In the fall of 2011, Power was talking to Marcel van Triest, a consultant helping to determine the Maxi Banque Populaire V's route. "He was looking for a lower-cost service", Power recalls, which put the use of altimeter data on C-CORE's "radar", as Power and his colleagues were familiar with papers that had been published about this potential application. Using altimeter data to detect icebergs had been the subject of research papers for several years, dating back to a 2008 paper written by Jean Tournadre of the French Research Institute for Exploration of the Sea in Plouzane, France.

Around the same time, Dr. Igor Zakharov, a senior research scientist and engineer, joined LOOKNorth, an initiative of C-CORE aimed at applying remote sensing technologies to support safe, sustainable resource development in Northern environments. His initial focus was on applying remote sensing techniques to the detection, drift, deterioration, and threat assessment of large ice masses. "We were looking at what was available for detecting icebergs," recalls LOOKNorth Executive Director Paul Adlakha, adding that in Antarctica it can be extremely expensive to do this using satellite radar. "We were looking at what else we could use that would provide very cost-effective data." They identified the free altimeter data from Jason- 1 and -2, which was the second impetus to develop altimeter data analysis capability.

Signature detection

With support from C-CORE's Remote Sensing team, Dr. Zakharov developed algorithms and data processing methods to detect iceberg signatures (differentiating icebergs from background noise) and to analyse data (eliminating false detections) for reliable output of results. Within a month the Altimeter Iceberg Detector (AID) had been developed and also validated using C-CORE's extensive iceberg database. C-CORE implemented AID by mid-December, in time to monitor icebergs for the Maxi Banque Populaire V. The AID detected between 2,000 and 3,000 icebergs per month, in addition to those detected by SAR.

The altimeter is a radar pulse directed straight down from a satellite, which measures the height of the sea surface and detects anomalies. The Jason-1, Jason-2, and Cryosat satellites produce a continuous stream of altimeter data, which provides information that is used to model ocean circulation and to record, and monitor sea level changes and climate change over time. This data is free, compared to a cost of $5,000 per image (500 sq. km.) for SAR data.

The altimeter detects large-scale sea surface anomalies and is not as precise as SAR imagery. It cannot see growlers (less than 5 meters long at the sea surface) or berg bits (less than 15 meters long at the sea surface); rather, the altimeter can detect large clusters (greater than 300 meters) of icebergs. Altimeter radar has now been proven to detect a 300-meter long iceberg, but Dr. Zakharov believes that further work on iceberg parameters could improve upon this.

Unlike SAR, the altimeter cannot differentiate between an iceberg and a ship. The advantage of using altimeter data is that large areas can be monitored quickly and inexpensively. Areas of interest can then be further investigated with SAR. "It enables us to take a bird's eye view, and then swoop down for a closer view with SAR," says Power. "It allows us to be more focused."

For the Volvo Ocean Race, between the end of December 2011 and beginning of March 2012, C-CORE detected 8,000 icebergs in the Southern Ocean. Dr. Zakharov estimates that 80 to 90 per cent of the work involved the use of altimeter data, which was then confirmed and further delineated with SAR.

Image: C-CORE

Surveillance

The cost differential between the two methods is significant. For some races, SAR coverage costs between Euro 35,000 and 75,000 ($42,000 – 91,000), compared to E5,000 for altimeter coverage, reports Power, who is quick to add that in most cases, both methods are used in combination. "We use fewer SAR images, it's less work, and a typical quote to the company might be 10 to 15 per cent of the cost (of 100 per cent SAR images)." He adds that in some cases the altimeter provides some information where there was none before, such as the Kerguelean Islands in the Indian Ocean where SAR data is provided directly to ship surveillance services and is not publicly available.

Referring to use by the oil and gas industry, Power says "the altimeter is low-cost to them, and it can be used to help focus SAR acquisitions." Between March and May 2012, C-CORE used altimeter data in support of drilling operations in the vicinity of the Falkland Islands. Power says this was a prime opportunity to use altimeter data because it's a very large area that would have been costly to cover with SAR. "The altimeter figures in very nicely there," he says. "We can use that to focus where we want to do our SAR acquisitions. That's a really effective solution."

Altimeter data isn't being used on the Grand Banks, says Power, where there is established infrastructure, including an aerial monitoring and surveillance program, but he adds that it's well suited for frontier areas where there is little infrastructure, a large coverage area, and the ready use of satellites.

"The high Arctic and the North figure into this pretty nicely," he says.

LOOKNorth's Adlakha sees altimeter data benefitting the oil industry in a number of ways. "I see us being able to support the offshore better with early indications of icebergs, " he says, by using the altimeter data when conducting iceberg population surveys in the eastern Arctic. "There is definitely a huge hit in terms of continuous monitoring of ice island features," he adds. Adlakha also points to competition for SAR satellite resources on the east coast of Canada due primarily to the requirements of national ice centres, adding this option can help reduce conflicts in ordering data. In addition, there is the considerable cost-savings from reduced usage of SAR. FE

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Fukushima fallout

Satellite photos from the European Space Agency show huge icebergs were created when the Japanese tsunami (cause of the failure of the Fukushima nuclear plant in March 2011) hit West Antarctica's Sulzberger Ice Shelf. This caused 125 sq km of ice to break off - or calve - from a shelf front that has remained stable for the past 46 years. These findings, by a US based team of scientists from NASA, University of Chicago and Northwestern University, were recently published in the Journal of Glaciology. (Vol. 57, No. 205 2011, p785-788). The waves generated by the 9.0 magnitude earthquakes in Japan travelled about 13,000km across the Pacific Ocean before reaching the Sulzberger shelf, causing ice to break off and float into the sea. These activities were monitored in detail using a series of these 30m resolution geo-referenced images provided by the Polar View team, in which Canada's C-Core is a lead contractor.

www.polarview.org