

# **APPLICATIONS OF POLARIMETRIC AND INTERFEROMETRIC SAR FOR ICEBERG DETECTION AND MONITORING**

**S. V. NGHIEM**

**JET PROPULSION LABORATORY, MS 300-235**

**CALIFORNIA INSTITUTE OF TECHNOLOGY**

**4800 OAK GROVE DRIVE**

**PASADENA, CALIFORNIA 91109**

**TEL: 818-354-2982, FAX: 818-393-3077**

**E-MAIL: [nghiem@solar.jpl.nasa.gov](mailto:nghiem@solar.jpl.nasa.gov)**

Icebergs pose serious hazard to ship and can cause major damage in terms of human lives and property loss. The most infamous catastrophe was the sinking of the RMS Titanic by an iceberg. Large icebergs in the ocean area off-shore from St. John island in Newfoundland, Canada, pose certain threat to the gigantic Hibernia oil platform (as high as half of the New York's Empire State Building) owned by Exxon, Chevron, Petro-Canada and other corporations. Icebergs are carried from high latitude Arctic ocean by the cold Labrador Current into the North Atlantic Shipping Lanes (the Great Circle Shipping Lanes) between Europe and major ports of US and Canada. Archived data shows that icebergs drifted extremely south to around or even below 30°N. Moreover, the meeting of two water masses, the cold Labrador Current and the warm Gulf Stream Current, produces dense fog.

Detecting and monitoring icebergs are very important to ship navigation and off-shore infrastructures. The International Ice Patrol (IIP), a consortium of 17 countries, is responsible for such work. Icebergs have different shapes and sizes and they are classified into 6 classes by shape and 6 categories by size. During the International Ice Charting meeting in Tromso (November 2001), it was indicated that existing satellite sensors including single polarization satellite SARs (such ERS and RADARSAT) has been very confusing or even discouraging in iceberg detection. This is because of the nature of single-polarization satellite SAR data. Airborne real aperture radar at X-band and single polarization is currently used by the USCG IIP for operational iceberg detection and monitoring. The real aperture radar technology is very old, the data processing is non-digital, and single polarization is not efficient for iceberg detection.

The use of advanced polarimetric and interferometric SAR needs to be investigated to develop a new method for iceberg detection. Major advantages of SAR are its high resolution and its capability to see through dense fog. Because of different shape, size, height, and speed relative to ocean surface current, polarimetric and interferometric SAR data can provide better techniques to detect different classes and categories of icebergs. An example of polarimetric SAR data acquired by the Danish polarimetric EMISAR is shown as an illustration for iceberg detection. The IIP has expressed a strong interest in a joint experiment using the JPL polarimetric and interferometric AIRSAR system, and has pledged support for in-situ observations and validation campaign for an iceberg

detection project. Such project will determine polarimetric and interferometric SAR signatures for iceberg detection. It is expected to have specific applications for the IIP in particular and for satellite SAR missions in general:

- Polarimetric SAR data of iceberg can be used to develop and validate iceberg detection algorithms for actual applications to the upcoming multi-polarization ENVISAT SAR and the future polarimetric RADARSAT-2 SAR. ESA has selected a proposal by JPL, IIP, US National Ice Center, and Canadian Ice Service (CIS) and ESA will provide ENVISAT SAR data for iceberg applications. CIS is expected to obtain RADARSAT-2 SAR data for iceberg detection after RADARSAT-2 launch.
- Both polarimetric and interferometric SAR data at different frequencies can be used to define an optimal SAR system for development of the next generation of airborne radar that should provide a tremendous technology leap (compared to the current single-polarization X-band real aperture radar used by USCG IIP) for operational airborne iceberg monitoring mission of IIP.
- Results will be useful to determine SAR parameters for a future US SAR mission for Earth applications including iceberg detection and monitoring.

There are definite benefits from such project for use by the IIP consortium, by US National Ice Center and other ice centers in many countries, and certainly valuable to the shipping industry, fishing industry, and marine oil exploration and production.