OPERATIONAL DEMONSTRATION OF ERS-1 SAR IMAGERY AT THE JOINT ICE CENTER

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ABSTRACT

Synthetic Aperture Radar (SAR) imagery from the European Space Agency's ERS-1 satellite are used to determine sea ice types, ice motion and to identify ice camp location in the Alaska region. These functions are made possible by a cooperative effort between NASA, NOAA and Navy that enables the Alaska SAR Facility to transmit same day SAR imagery to the Navy/NOAA Joint Ice Center in Suitland, Maryland. There ice analysts interpret the imagery with the aid of ice classification and ice motion algorithms. Derived products are then used to support field operations and improve current analysis products. Algorithm results are discussed with particular attention to future SAR applications to global sea ice analysis in the RADARSAT timeframe.

INTRODUCTION

The Navy/NOAA Joint Ice Center (JIC) was organized in 1976 to bring together Navy and NOAA resources for the analysis and forecasting of sea ice conditions on a global basis. The JIC is tasked with providing sea ice support to government, private and foreign users. Routine products include weekly sea ice analyses for the Arctic and Antarctic, thrice weekly analyses for the Alaskan and Great Lakes regions, 7 Day and 30 Day forecasts for the Arctic and Seasonal Outlooks for the Alaskan North Slope, Baffin Bay and Western Ross Sea regions. Special support for vessels and field programs are provided upon request, in as much detail as ice observing sources permit.

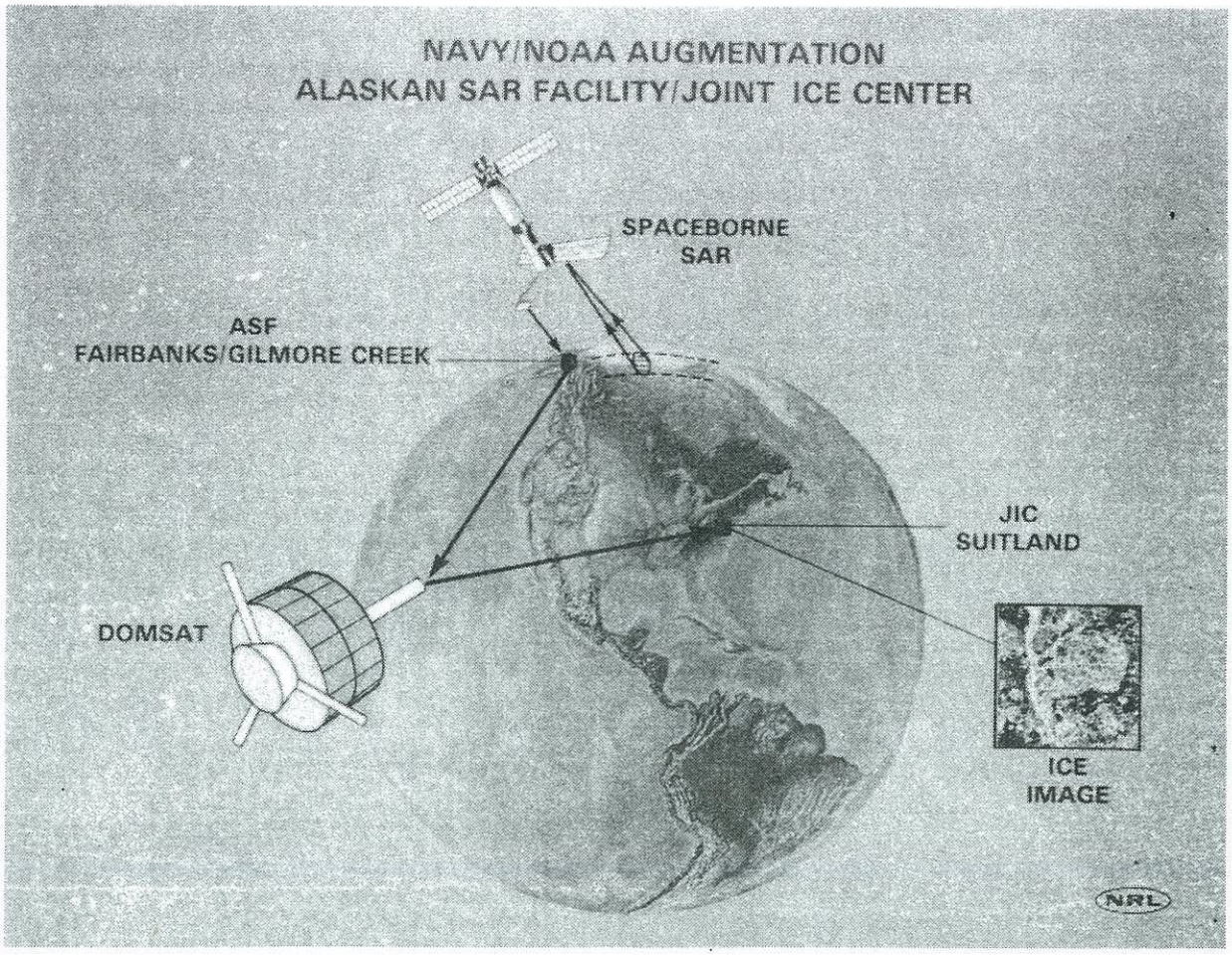
Every effort is made to employ all sources of operational sea ice information. Imagery from the NOAA polar orbiting satellites, the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) and the Special Sensor Microwave Imager (SSMI), and GOES satellite data (for the Great Lakes) are the primary sources. The JIC makes use of first-hand airborne reconnaissance observations provided by Navy personnel, Canadian ice observers and occasional reports from other sources.

Increasingly, the JIC has been called upon to assist ships at sea in navigating near the ice edge for scientific research and to assist US Coast Guard icebreakers and other ships in penetrating the ice cover in a safe and efficient manner. This direct ship support requires the most detailed sea ice imagery possible in order to accurately portray sea ice conditions to the vessel's crew who are concerned with ice features on scales of 10's to 100's of meters for maneuvering and 10's of kilometers for transiting through the ice. Surface vessels require detailed forecasts, especially of convergence/divergence of the ice cover, in order to plan activities. The JIC has requirements for reliable, local scale (10's to 100's of meters) sea ice data to provide support to those vessels. Prior to the launch of the European Space Agency's European Remote Sensing Satellite (ERS-1), only costly first-hand aerial reconnaissance provided such information. Preliminary analysis of satellite Synthetic Aperture RADAR (SAR) data from SEASAT indicated that SAR should provide the high quality local scale data [1] required for direct ship support, including detailed information concerning the amount of leads and very thin ice that is important for efficient ship routing.

The JIC'S SAR SYSTEM

A joint NOAA/Navy/NASA program was designed to demonstrate the utility of SAR imagery and products to the JIC. To meet the JIC's operational demands a communications system, SARCOM, was designed by the Navy and installed at the Alaska SAR Facility (ASF), University of Alaska in Fairbanks. The ASF receives, processes and archives SAR imagery in cooperation with NASA. SARCOM is used to retrieve archived SAR imagery and to access Quick-Look imagery that is processed within 6 hours of acquisition on request of the JIC.

SAR images are stored at the ASF until a "window" becomes available on the NOAA/NESDIS satellite link between its Gilmore Creek Ground Station and the central receiving site near Washington, DC. SAR data are then sent to Gilmore Creek where they are forwarded to the JIC (Figure 1).



SAR WORKSTATION

Upon arriving at the JIC, SAR imagery is automatically fed into a workstation designed by NASA for digital SAR analysis. The workstation software maps the SAR imagery to a polar stereographic grid (the same used for meteorological products) and enters pertinent information into a relational database. Users can access the imagery by entering date/time, orbit number or location parameters. Searches for imagery can be expedited using an application that allows users to establish "sites" and narrowing the dates for acceptable imagery.

The workstation displays the location of all images selected for each search on a World Vector Shoreline base map then permits the user to display the actual image at several scales. Standard Low Resolution image products from the ASF are available at 240 meter resolution (Figure 2). Full resolution (30 meter) products are available on a more limited basis due to greater image size. SARCOM applies a sophisticated 32:1 compression algorithm at the ASF to speed communications and the JIC workstation automatically reconstructs these images. Besides user controlled image enhancements, the workstation includes algorithms to automatically classify sea ice type and to determine sea ice motion between image pairs [2,3]. The user can interact with the ice classification application and create a different "backscatter" based Look-Up Table if desired. Similarly an application exists for "supervised" sea ice motion detection from selected image pairs.

Once a basic product is created (either an enhanced image, ice type or ice motion product) the user can use several graphic applications to annotate, color code, affix a map grid, draw a ship route or draw boundaries. The final version can be saved to disk and printed on either a high quality color printer or a laser printer.