PROGRESS IN ARCTIC SEA ICE REMOTE SENSING

C. A. Luther[1], S. V. Nghiem[2], D. K. Perovich[3], and D. G. Barber[4]

[1]Geoscience and Remote Sensing Society, Virginia, USA

[2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

[3]Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, USA

[4]Center for Earth Observation Science, Faculty of Environment, University of Manitoba, Winnipeg, Manitoba, Canada

In keeping with the 30th anniversary theme for GRSS and IGARSS, the session on Arctic Sea Ice Change and Impacts will begin with a review of the progression of sea ice remote sensing research over the last three decades of outstanding accomplishments leading up to the extraordinary change presently occurring in the arctic sea ice cover.

Arctic remote sensing research had its beginning during the Arctic Ice Dynamics Joint Experiment (AIDJEX) conducted during 1975-1976 in the Beaufort Sea off Point Barrow, Alaska. During this experiment detailed crystallographic, dielectric properties, reflectivity and brightness temperatures of first year, multiyear, and first year/multiyear mixtures were measured, and the ability to distinguish multiyear and first year mixtures was verified.

In June of 1978 the launch of Seasat-A satellite provided fascinating oceanographic and sea ice data and imagery which generated the potential for obtaining synoptic data of large expanses of remote, ice covered oceans and land under all weather conditions. Extensive field campaigns, primarily in the Beaufort Sea and the Marginal Ice zone of the Fram Strait began and continued throughout the 1980's. These late winter and spring experiments concentrated on the ability to classify ice types and to describe ice field kinematics and dynamics. Determination of optimum frequencies, polarization, and incidence angles, and the development of algorithms for extracting geophysical parameters from sea ice imagery were the ultimate goal of these experiments.

Laboratory studies addressing these issues were conducted at the Cold Regions Research and engineering Laboratory during the 1980s and early 1990s, where near-realistic conditions were duplicated in both outdoor and indoor facilities. These laboratory studies culminated in an Accelerated Research Initiative (ARI) [1], sponsored by the Office of Naval Research. This initiative sought to relate the measured electromagnetic scattering and emission signatures of sea ice to its physical properties through forward models; and in turn, to use the forward models to develop inverse methods through which ice geophysical properties (thickness, roughness, type etc) could be determined from remotely sensed electromagnetic data.

Since the 1990s, the advent of multiple international satellite sensors collecting multispectral (spectroradiometer), active (synthetic aperture radar, scatterometer), and passive microwave data (radiometer). From ARI and earlier efforts, the research on sea ice signatures from laboratory and field experimental measurements, together with forward and inverse electromagnetic modeling of sea ice, provides the fundamental basis for interpretations of satellite signatures to obtain geophysical parameters. Further field experiments were carried out to evaluate and validate sea ice remote sensing results: Surface HEat Budget of the Arctic Ocean (SHEBA), Sea Ice Remote Sensing and Modeling Campaign (SIRSM), and Seasonal Sea Ice Monitoring and Modeling Campaign (SIMM).

Under multi-agency support, new algorithms have been developed to observe the state of sea ice including different sea ice types, melt process, ice albedo and radiation change. With remote sensing observations, together with surface networks such as the International Arctic Buoy Programme, Ice Mass Balance Buoys, and the North Pole Environmental Observatory, the drastic reduction of Arctic sea ice has been closely monitored. Followed on with the Study of Arctic Environmental Arctic Change (SEARCH) [2] the International Polar Year (IPY 2007-2009) [3], the drastic change of Arctic sea ice has been documented with record lows of total sea ice extent, of perennial ice extent, of ice thickness, and of sea ice mass in the Arctic Ocean in the last decade. The record decline of sea ice has serious implications on Arctic environments. From IPY results, advances have been made in identifying and monitoring changes in Arctic sea ice, understanding mechanisms causing sea ice change, and quantifying impacts of such change in the Arctic environments.

Bibliography

[1] K. C. Jezek, D. K. Perovich, K. M. Golden, C. Luther, D. G. Barber, P gogineni, T. C. Grenfell, A. K. Jordan, C. D. Mobley, S. V. Nghiem, and R. G. Onstott, “A broad spectral, interdisciplinary investigation of the electromagnetic properties of sea ice,” IEEE Trans. Geosci. Remote Sens., vol. 36, no. 5, pp. 1633-1641, Sep. 1998.

[2] Study of Arctic Environmental Change, Internet site at URL http://www.arcus.org/search/sciencecoordination/development.php.

[3] International Polar Year, Internet site at URL http://www.ipy.org/.