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EVALUATION OF THE YEAR 2000 ARCTIC ICE PACK USING MODIS

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1. INTRODUCTION

Monitoring of the Arctic ice pack, in addition to being important to transportation and commerce, has taken on increased significance as researchers and policy makers look for evidence and impacts of global warming. Satellite passive microwave measurements have proved to be a rich source of information on the extent and conditions of the Arctic ice pack, but their coarse spatial resolution and sensitivity to surface conditions have limited their usefulness. Also, passive microwave instruments cannot provide information such as ice surface temperature and albedo which are important in determining the surface energy balance.

Optical measurements of the sea ice from satellite also have a long history. However, it is only with the launch of NASA's Earth Observing System (EOS) Terra spacecraft that a daily global mapping of sea ice based on optical measurements began to be produced. This paper provides a preliminary evaluation of the Moderate Resolution Imaging Spectroradiometer (MODIS) sea ice product by examining the Arctic ice pack in the year 2000.

2. THE MODIS SEA ICE PRODUCT

MODIS is a scanning spectroradiometer providing imagery in 36 discrete bands between 0.4 and 14.5 µm (Justice 1998). The spatial resolution of these bands varies from 250m to 1km at nadir. MODIS is carried on board the Terra spacecraft, which was launched on December 18, 1999 and began collecting science data on February 24, 2000. The MODIS instrument will also be aboard the Aqua spacecraft, scheduled to be launched in 2001.

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The MODIS sea ice mapping algorithm uses a Normalized Difference Snow Index (NDSI) as well as a computed surface temperature to identify and classify sea ice. The algorithm is applied only in ocean regions that are determined to be cloud-free, according to the MODIS cloud and land/water masks. Then the radiances from selected bands are used as input. The NDSI is useful in distinguishing sea ice from clouds and open ocean because snow and ice are considerably more reflective in the visible than in the short-wave infrared part of the spectrum, while the reflectance of most clouds is high in both the visible and short-wave infrared. The MODIS sea ice algorithm involves threshold tests and decision rules that are applied on a pixel-by-pixel basis (Riggs, et al. 1999).

2.1 *Product Description*

Each record of MODIS level 2 (or "swath") sea ice product covers a 2330 km (cross-track) by 2030 km (along-track) area. These level 2 products are subsequently gridded to make a daily level 3 product. The Lambert Azimuthal Equal Area projection is used in making north and south polar maps which are divided into tiles approximately 1000 km on a side.

Both the level 2 and level 3 sea ice products are at 1 km resolution and contain 2 quality arrays and 4 data arrays. The data arrays are: Sea Ice by Reflectance, Ice Surface Temperature (IST), Sea Ice by IST, and Combined Sea Ice. The combined sea ice product indicates whether each pixel or grid cell is determined to be sea ice by reflectance, by IST or by both.

2.2 *Data Coverage*

The sea ice extent for 27 December 2000, based on the level 2 MODIS ice surface temperature, is shown in Figure 1. Sea ice is shown as dark gray while the light gray regions in the central Arctic are clouds. The darkest gray

shade is ice-free ocean or inland water. On this day the Arctic Ocean is mostly cloud free, but clouds obscure the ice edge in most places.

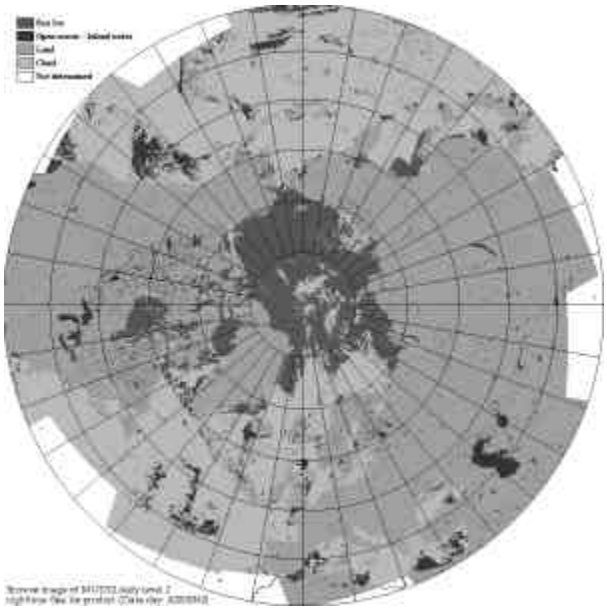

Figure 1. Daily sea ice browse for 27 December 2000, courtesy of the MODIS Land Science Team

2.3 *Comparison with Passive Microwave*

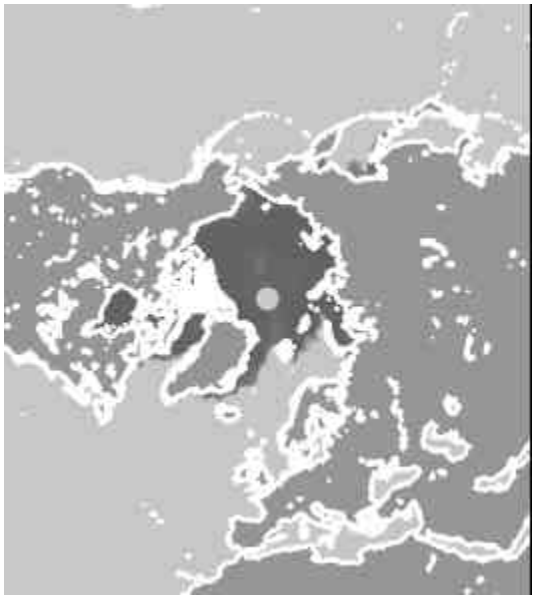

Figure 2. Sea ice concentration from passive microwave for 27 December 2000. White is mixed land/water pixels where no determination is made.

Sea ice concentration for 27 December 2000, derived from the Special Sensor Microwave / Imager (SSM/I) instrument, is shown in Figure 2 for comparison. These data are from the National Snow and Ice Data Center's Near Real Time Ice and Snow Extent (NISE) product. The comparison is generally favorable. However, a greater sea ice extent is measured by MODIS in several regions, notably in far eastern and western portions of the Barents Sea, in the mouth of Hudson Straight and in the Sea of Okhotsk.

Full (1 km) resolution MODIS imagery and more detailed comparisons with other sea ice products will be provided at the presentation of this paper.

3. DATA ACCESS

MODIS sea ice products, as well as snow cover products, are archived at NASA's Distributed Active Archive Center (DAAC) located at the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado. For more information visit http://nsidc.org/NASA/MODIS/, or contact NSIDC User Services at 303-492-6199, or nsidc@kryos.colorado.edu.

4. SUMMARY

MODIS provides the first automated global daily sea ice maps using optical measurements. Based on both reflected solar and thermal infrared measurements, the MODIS sea ice products complement and enhance similar maps made using passive microwave instruments. Preliminary comparisons with SSM/I data suggest that MODIS may be better able to detect sea ice under certain conditions.

5. REFERENCES

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