Ice Cover and Concentration with GOES-R ABI and NPP/JPSS VIIRS

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Introduction

The cryosphere has profound socio-economic value due to its role in water resources and its impact on weather, climate, transportation, fisheries, hunting, herding, and agriculture. Mature satellite algorithms exist for ice identification and ice surface temperature, but others such as ice concentration, ice thickness and age are experimental or under development. Errors in existing algorithms must be determined by inter-comparing products from other sensors and comparing those products to in situ observations. An overview of the Geostationary Operational Environmental Satellite (GOES-R) Advanced Baseline Imager (ABI) ice cover and concentration algorithms are presented here. Similar methods are being used with the Visible/Infrared Imager Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (NPP) satellites. Validation efforts indicate that products meet the required ABI ice detection and concentration accuracies.

Method

Apply group threshold tests to detect possible ***ice cover:***

•Daytime: Normalized Difference Snow Index (NDSI) and reflectance at near infrared channel (Fig 1)

•Nighttime: retrieved surface skin temperature

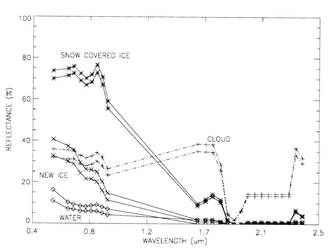

Fig. 1. Reflectance means for ice, clouds, and water (Riggs et al. 1999)

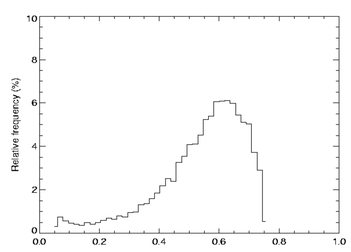

Fig 2. Reflectance probability distribution at 0.64 m for for ice cover over Lake Erie, Feb 24, 2008.

Utilize tie point algorithm to calculate ***ice concentration:***

•Determine reflectance (temperature) of pure ice in a search window (Fig 2). Value for water is prescribed.

•Use tie points of pure ice and pure water to calculate ice concentration

Adjust ice cover based on the ice concentration.

GOES-R Ice Cover and Concentration Using Proxy data and Validation

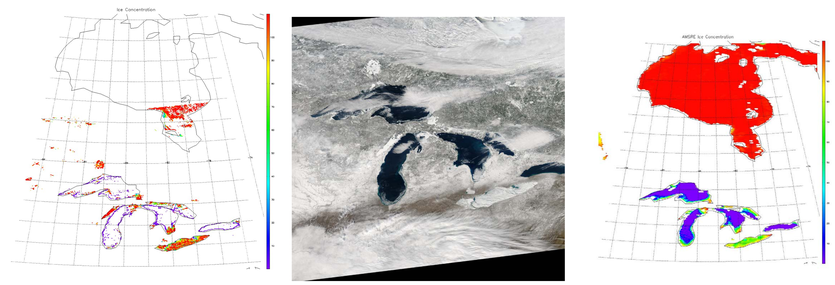

Fig 3. Lake ice concentration (%) with MODIS Aqua data (left), MODIS true color image (middle), and from AMSR-E (right) over Great Lakes on Feb 24, 2008.

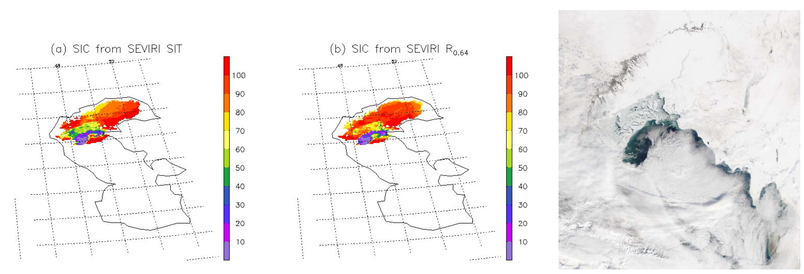

Fig 4. Lake ice concentration (%) retrieved from (a) SEVIRI Surface Ice Temperature (SIT), (b) SEVIRI visible band reflectance (0.64 m, and (c) satellite true color image over Caspian Sea on January 27th, 2006

Cases: 1576298	Sea/Lake ice cover from AMSRE-E	Water determined from AMSR-E
Sea/Lake ice cover	1075124	
Water		305872
Correct detection = 87.6%, requirement is 85%		

Table 1: Ice cover product performance: agreement with AMSR-E.

Ice Concentration difference of AMSRE and MODIS	Mean bias (%)	Standard Deviation (%)
Over Arctic Ocean	4.0	15.7
Over Great Lakes	-4.0	25.6
Required Accuracy	10	
Required Precision		30

Table 2: Ice concentration product performance

VIIRS Ice Concentration and Validation

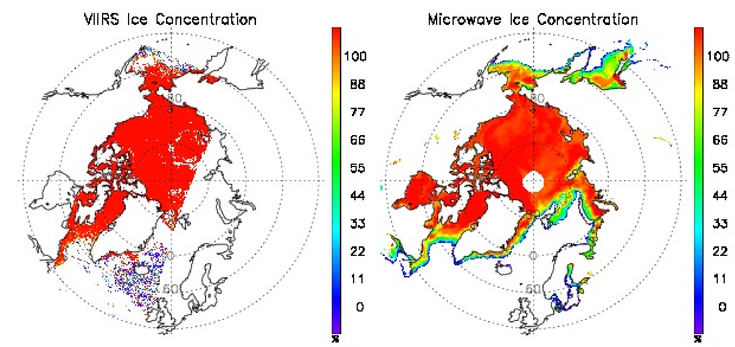

Fig 5. Ice concentration from VIIRS 1440 to 1500 UTC (left) and SSM/I daily mean (right) over Arctic on March 7, 2012.

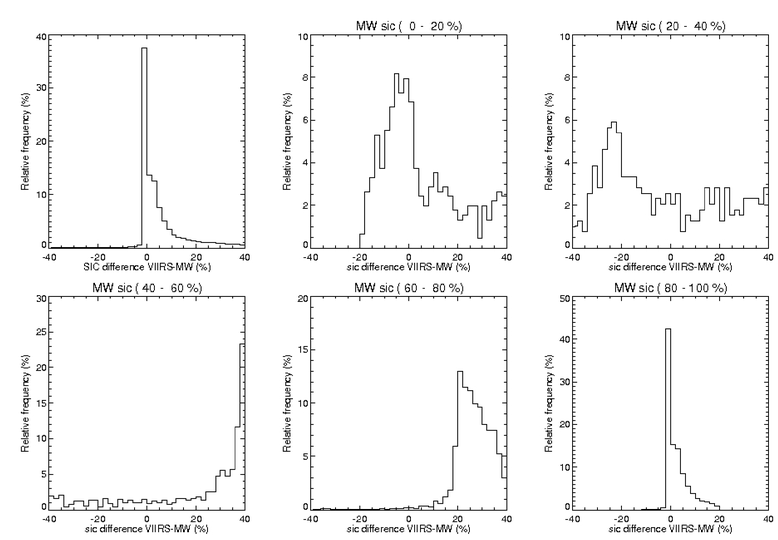

Fig 6. Histogram of VIIRS and SSM/I ice concentration difference for SSM/I all values, (0 – 20%), (20 – 40%), (40 – 60 %), (60 – 80%), and (80 – 100%).

Conclusions and Perspectives

- GOES-R ABI ice cover and concentration product is produced using a group threshold and tie-point algorithm. Validation with AMSR-E shows that products meet the required measurement accuracy and precision.
- VIIRS ice concentration is produced using tie-point algorithm. Validation with passive microwave products show general agreement, but VIIRS ice concentration is biased high overall.