Integration of New Satellite Observations into the U.S. National Ice Center's Snow and Ice Mapping System

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Introduction

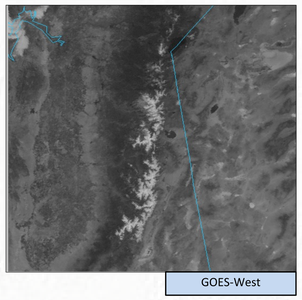
The Interactive Multisensor Snow and Ice Mapping System (IMS) is a specialized software environment that provides data overlays from multiple sources to analysts for production of quality controlled daily snow and ice maps over the Northern Hemisphere used by the numerical modeling community. The analysts rely heavily on remote sensing data from both geostationary and polar-orbiting platforms. New features to the system will allow analysts to expand the application of Arctic composite imagery, Synthetic Aperture Radar (SAR), and Advanced Microwave Scanning Radiometer 2 (AMSR2) data in fall of 2017. With the launch of GOES-16 and upcoming launch of JPSS-1, increased spatial and temporal resolution data will be available enabling IMS analysts to complete the daily analysis with a higher degree of accuracy. Specifically, the addition of a near-visible channel on GOES-16's Advanced Baseline Imagery (ABI) will further assist the analyst in distinguishing cryospheric features and the fractional snow cover algorithm applying GOES ABI spectral information will improve snow classification. Future GOES, JPSS, and SAR imagery algorithms being tested as NOAA Risk Reduction projects will further refine the IMS output and benefit its users.

New Satellite Integration

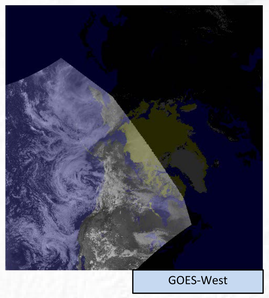
Current Data Sources

Manual Analysis

Snow



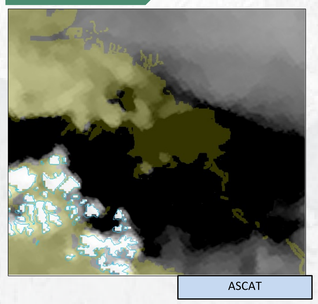
GOES-West



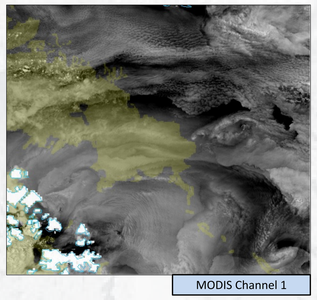
GOES-West

The Sierra Nevada Mountains from the current GOES-West visible image (left). Current IMS view of GOES satellite coverage in the Arctic (right). Only one satellite loop can be viewed at a time.
Image from GOES-WEST in IMS, June 30, 2017

Ice



ASCAT

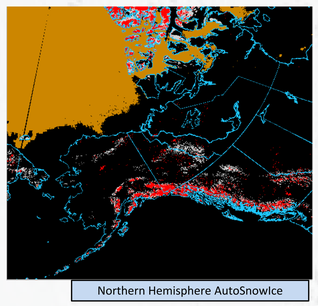


MODIS Channel 1

ESA's ASCAT image (left), does not allow the ice to be seen at all. A composite from NASA's MODIS from TERRA and AQUA demonstrates the clouds contamination of the image (right). This make it difficult to determine the presence of ice.
Images from ASCAT (left) and MODIS (right) in IMS, June 30, 2017

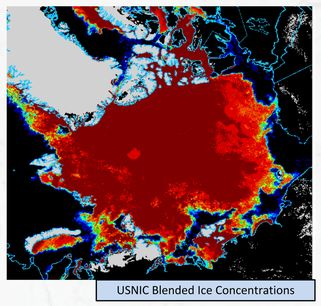
Automated Analysis

Snow



Northern Hemisphere AutoSnowIce

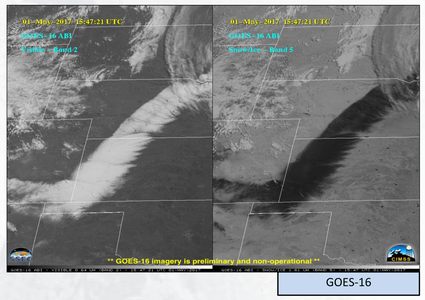
Ice



USNIC Blended Ice Concentrations

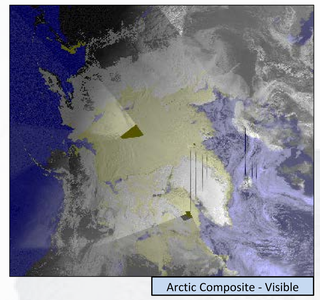
Current automated algorithms used in IMS include USNIC Blended Ice and AutoSnow.
Images from IMS, July 10, 2017

New Data Sources



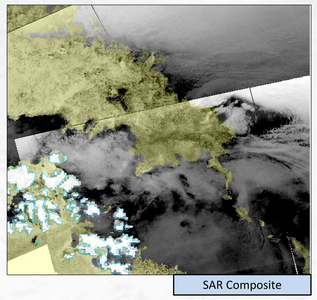
GOES-16

A late season snowfall moves quickly through the Midwestern U.S. On the left is GOES-16's 0.64 µm visible ("red") Band 2. On the right, is an example of the GOES-16's 1.6 µm Snow/Ice Band (Band 5).
Image from CIMSS/SSEC May 01, 2017



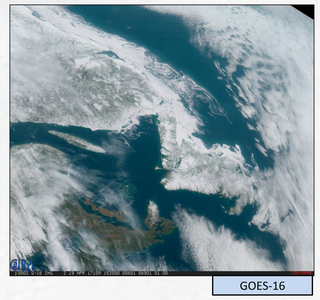
Arctic Composite - Visible

Composites of multiple imagery sources with the same spectral signatures can be animated to generate a quasi-geostationary effect to track snow and ice cover at the high latitudes.
Image from Arctic Composite Visible imagery in IMS, May 24, 2017



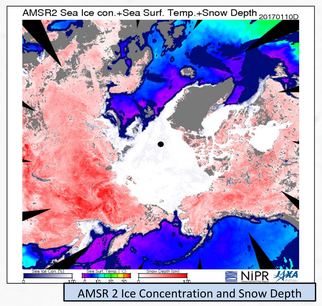
SAR Composite

SAR imagery from Sentinel-1 and Radarsat-2 allow the analyst to clearly see the distinction between the ice and cloud cover.
Image from SAR in IMS, June 30, 2017; Radarsat images from MDA

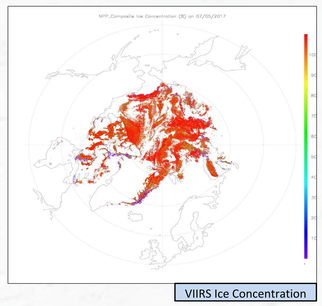


GOES-16

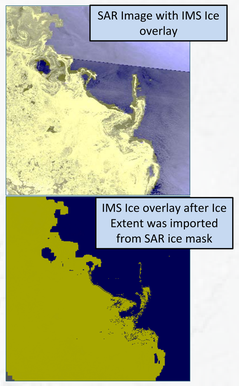
Imagery from ABI Channels 1, 2, and 3 allows for multispectral ice identification at higher resolutions and frequencies than was possible with previous GOES imagers.
Image from CIRA April 19, 2017



AMSR 2 Ice Concentration and Snow Depth



VIIRS Ice Concentration



New Snow Cover and Sea Ice Concentration Algorithms will give the analysts another source for determining sea ice and snow. Analysts will be able to replace a hand drawn analysis with a derived analysis in a selected region.
Left image from JAXA VISHOP, January 10, 2017; Center image from NOAA CIMSS, June 7, 2017; Right Image from SAR in IMS, May 24, 2017

Discussion

GOES 16 will offer new capacities for snow and ice mapping, allowing for improved forecasting. GOES resolution will increase from about 1km every 15 minutes to .5km every 5 minutes. This will increase the accuracy of the analysis.

The new snow/ice band (Band 5) is most similar to the current SNPP VIIRS band 3, but is new for the GOES capabilities. This will give analysts another tool in distinguishing the cryospheric features.

IMS is prepared to use combined hourly NOAA GOES/POES composite imagery using GOES West/East, Meteosat, MTSAT, NOAA 18 & 19 AVHRR, Aqua/Terra, MetOp-A, MetOp-B, S-NPP, and MTSAT satellites. IMS uses 3 wavelengths, e.g., Infrared (~11.0 µm), Shortwave Infrared (~3.8 µm), and Visible (~0.6 µm), over the Arctic polar region of the globe.

Images (left) are taken from the same location off the Eastern coast of Franz Josef Land, Russia with our drawn ice analysis overlaid in yellow shading. The grayscale imagery of ASCAT is useful to view through clouds and is available year-round, but can show both false positives and/or false negatives. Features are often difficult to distinguish due to the coarse, 5km resolution. ASCAT imagery is also influenced by wind, so knowledge of current wind speed in the area is necessary.

NASA's Polar MODIS is only available during the summer months when there is enough light to see the image. In these images, it is often difficult to distinguish between clouds and ice. In areas such as the Arctic that are frequently cloudy, several days may pass before there is a clear, usable image.

Recent integration of SAR imagery into the IMS allows the analysts to clearly see the distinction between the ice and cloud cover. New and thin ice was frequently missed because it did not show up clearly on previous data sources. SAR imagery has a finer resolution of about 100m.

Additional GOES 16 ABI channels and improved resolution at higher latitudes will improve ice identification throughout North America.

The USNIC blended ice product is a blend of IMS ice cover analysis, AMSR 2, ATMS MIRS, VIIRS Ice Concentration, Ice Charts (USNIC, CIS, DMI, MetNo, NWS, Alaska, etc…), and NWP models.

AutoSnowIce creates a 4km snow and ice analysis of the Northern Hemisphere based on visible, near-infrared, middle-infrared, infrared, and passive microwave imagery. An advantage to AutoSnowIce is that it can be used even in cloudy regions.

Automated algorithms will decrease the amount of time that an analyst needs to spend on an area. If the analyst decides that the algorithm is working correctly, they will be able to import a small section to replace the hand drawn analysis. Data sources that could be imported directly in the analysis include AutoSnowIce, VIIRS Ice cover, VIIRS Snow Cover, NOAA NOHRSC SNODAS analysis, Blended Ice Concentrations, and a composite SAR ice mask. This will be useful in difficult or hard to see areas. Despite the advances in accuracy of these products, the analyst will still need to determine if and when it is more accurate than a hand-drawn analysis.