#1039

Innovative Sea and Lake Ice Products from VIIRS

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Introduction

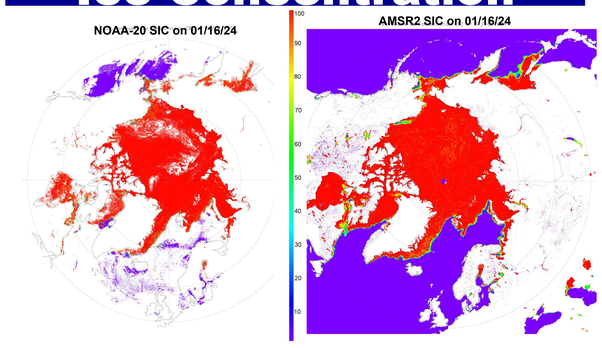
Sea and lake ice products for the Visible Infrared Imaging Radiometer Suite (VIIRS) on the S-NPP, NOAA-20 and NOAA-21 polar-orbiting satellites include ice concentration, ice surface temperature, and ice age and thickness, with ice motion as an experimental product. These operational products are also being routinely generated at the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin, Madison. These products are vital for monitoring the global ice conditions and understanding the changing climate of the Earth. Presented are examples of the products and numerous validation studies that compare these products to other satellite-based products and field campaigns. Results show that these products are meeting or exceeding the mission requirements to be used in operations. Furthermore, for better monitoring of rapid changes and understanding the physical processes, new and innovative ice products are needed. Here, we present various experimental products that utilize the high spatial resolution VIIRS data. First, we show an all-weather sea ice concentration product that blends lower resolution passive microwave AMSR2 data with high resolution VIIRS information. Further, we show ice products that utilize the VIIRS high spatial resolution I-band with a nominal pixel size of 375 m. Lastly, we show an ice motion product and examples of level-3 ice deformation and shear products that utilize the various ice motion products.

Discussion

Numerous JPSS Ice products are exhibited below and have been validated versus other satellites and in-situ datasets. The Sea Ice Concentration (SIC), Temperature (IST) and Thickness/Age (ITA) have been deemed operational and are available on NOAA CLASS (https://www.avl.class.noaa.gov/saa/products/welcome). These products have been demonstrated at NOAA ASIP through GINA (http://hippy.gina.alaska.edu/distro/ice_eval/) , with SIC used in operations at NSIDC. The SIC product has also been used in model impact studies with Naval Oceanographic Office (NAVO) showing positive impact on forecasting sea ice edge. Further experimental products have been developed and show potential to be used in operations and model assimilation. The Ice Motion (IM) product in particular can be used for sea ice forecasting with additional level-3 products that are currently being tested, such as ice deformation. Routine very high resolution I-band Ice products (375-m resolution) are also being generated with enhanced ability to resolve smaller scale features in the sea ice field. Further work is being done at creating blended products, especially for IM and SIC that utilize the strengths and limits the weaknesses of AMSR2 and VIIRS. Future plans include the development of a blended Ice Thickness product.

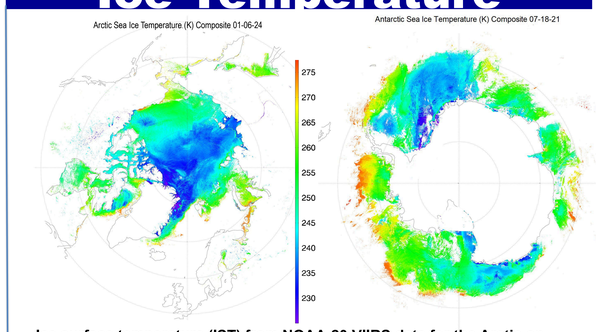
Ice Products

Ice Concentration



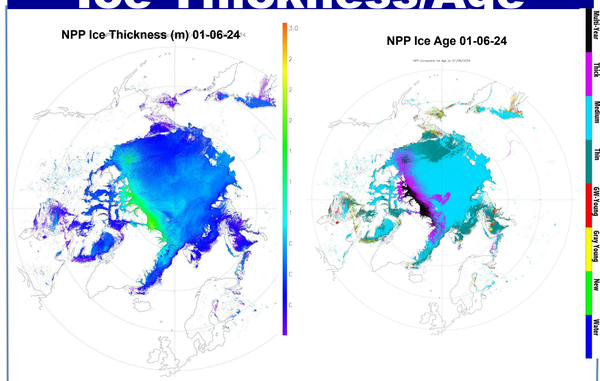
Sea ice concentration (SIC) from NOAA-20 VIIRS data for the Arctic on January 16, 2024 (left) and from AMSR2 NASA Team-2 algorithm for the same day (right).

Ice Temperature



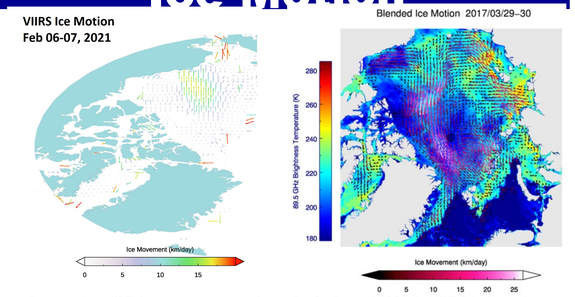
Ice surface temperature (IST) from NOAA-20 VIIRS data for the Arctic on January 06, 2024 (left) and for the Antarctic on July 18, 2021 (right).

Ice Thickness/Age



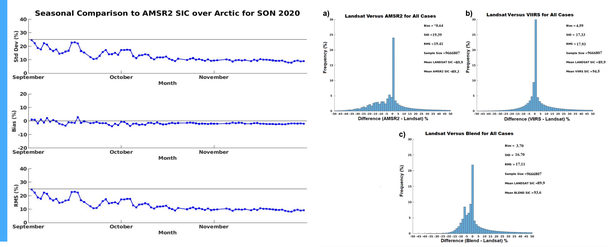
Sea ice thickness (left) and sea ice age (right) from NOAA-20 VIIRS data for the Arctic on January 06, 2024.

Ice Motion

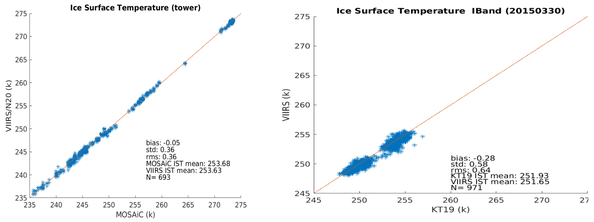


Ice motion (IM) is now generated routinely from AMSR2, VIIRS infrared (M15 and I5), and the VIIRS day-night band (DNB). Additionally, a blended VIIRS-AMSR2 product is also produced. The picture left show the ice motion vectors derived from, VIIRS IR (M15) band, on February 06-07, 2021. The picture right is the blended AMSR2 and VIIRS Ice motion vectors for the date of March 29-30, 2017.

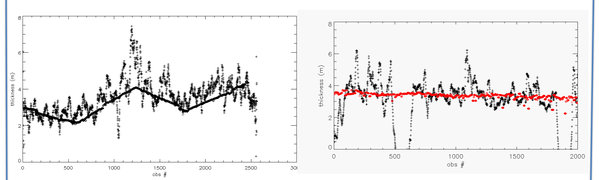
Validation



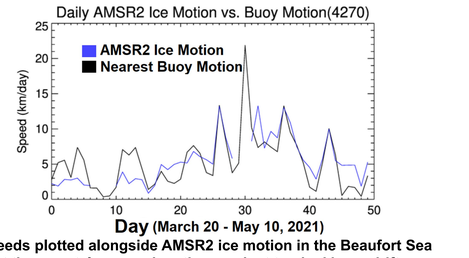
Timeseries comparison of SIC from AMSR2 to VIIRS, starting from September 01 through November 30, 2020. Histogram distribution plots of differences compared to Landsat SIC for a) AMSR2, b) VIIRS and c) Blended SIC



Left scatter plot is VIIRS IST for M-band (750 m, x-axis) comparison to measurments during MOSAiC from Dec 2019 to Sept 2020. Right scatter plot is VIIRS IST for I-band (375 m) versus Ice Bridge KT-19 pyrometer flown on P3 over the Arctic on March 30, 2015.

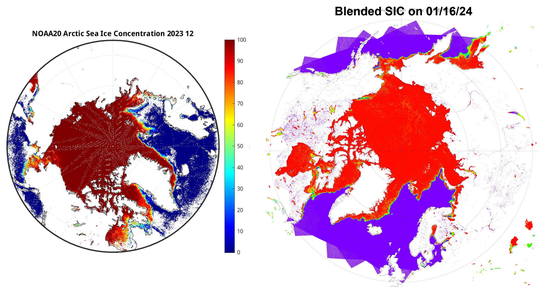


VIIRS Ice Thickness (v6.2, dark line) compared to Ice Bridge (scatter points) on April 20, 2019 (left). VIIRS ice thickness product (red) vs. IceBird ice thickness measurements (black) along the April 5, 2019 flight track (right).

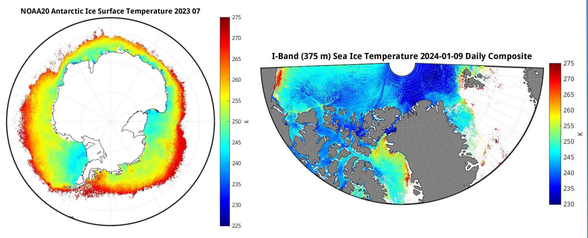


Buoy speeds plotted alongside AMSR2 ice motion in the Beaufort Sea show that the remotely-sensed motion product tracked buoy drift very closely over a 50-day time period (March - May, 2021).

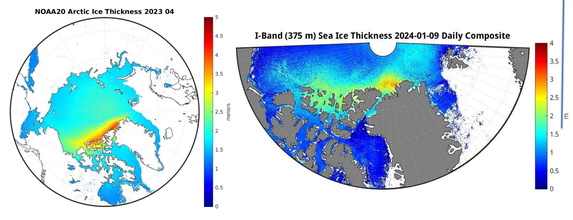
Innovation



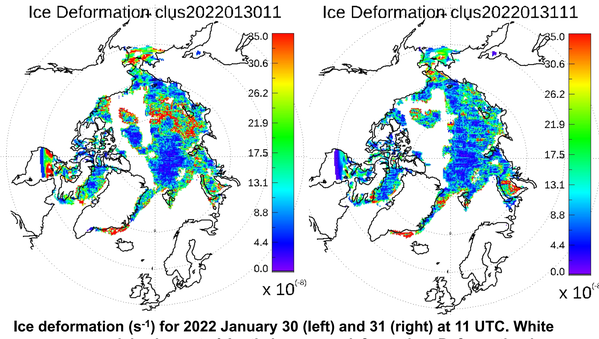
NOAA-20 monthly mean SIC from 2023-Dec (left). Blended AMSR2 and VIIRS SIC from same day on top (January 16, 2024).



NOAA-20 monthly mean IST from 2023-July (left). VIIRS I-band (375-m) IST on January 9, 2024, over the west Arctic.



NOAA-20 monthly mean Ice thickness from 2023-Apr (left). VIIRS I-band (375-m) Ice thickness on January 9, 2024, over the west Arctic.



Ice deformation (s^{-1}) for 2022 January 30 (left) and 31 (right) at 11 UTC. White areas over pack ice in central Arctic have zero deformation. Deformation is derived from Ice Motion using clustering method. This product is experimental and at preliminary stage.