VIIRS ICE PRODUCTS: SURFACE TEMPERATURE, CONCENTRATION, AND THICKNESS

Mark Tschudi, CCAR, University of Colorado, Boulder

Y. Liu, R. Dvorak, X. Wang, SSEC, University of Wisconsin, Madison

J. Key, NOAA/NESDIS
## Sea Ice Cal/Val Team Members

<table>
<thead>
<tr>
<th>PI</th>
<th>Organization</th>
<th>Team Members</th>
<th>Roles and Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>J. Key</td>
<td>NOAA NESDIS</td>
<td>M. Tschudi, Y. Liu, R. Dworak, X. Wang, A. Letterly</td>
<td>Ice conc &amp; thickness cal/val IST development, cal/val IST cal/val Ice thickness development, cal/val NDE cryo products assessment</td>
</tr>
</tbody>
</table>


VIIRS Ice Surface Temperature

IST is the radiating, or "skin", temperature at the ice surface. It includes the aggregate temperature of objects comprising the ice surface, including snow and melt water on the ice.

Ice surface temperature (IST) composite from all overpasses over the Arctic on March 1, 2015. From Liu et al., 2015.
NOAA-20 and S-NPP IST, Arctic, Aug 18, 2018
(all NOAA-20 images in this presentation are generated by CIMSS)
NOAA-20 vs S-NPP IST

Arctic IST VIIRS NOAA-20 Versus S-NPP Composites on 2018-09-18
Bias: -0.057
RMS: 2.143

Antarctic IST VIIRS NOAA-20 Versus S-NPP Composites on 2018-06-18
Bias: -0.118
RMS: 2.942
VIIRS IST IceBridge Validation

2013-17 Arctic IceBridge P3 KT-19, VIIRS NDE and IDPS

IDPS Bias = +0.06
IDPS STD = 0.96
IDPS RMS = 0.97

NDE Bias = +0.25
NDE STD = 0.96
NDE RMS = 0.99

AVG KT-19 = 249.02
AVG IDPS = 249.08
AVG NDE = 249.27
AVG M15 = 248.85
AVG M16 = 248.61
Sea ice concentration is the areal extent of ice, calculated as the fraction of each pixel covered in ice. The concentration of sea ice varies within the ice pack due to deformation, new ice development, melting, and motion.

*Ice concentration over the Arctic Ocean from VIIRS on February 20, 2015.*
NOAA-20 and S-NPP Ice Concentration, Arctic, Aug 1, 2018
NOAA-20 and NPP Ice Concentration, Antarctic, Aug 1, 2018
NOAA-20 vs S-NPP Ice Concentration

Bias: 0.123
RMS: 9.189

Bias: 0.0076
RMS: 5.346
The Sea Ice Characterization EDR is a 3-category product: new/young ice (< 30 cm thick), “other ice”, and ice-free. The Enterprise product provides a continuous ice thickness range from 0 ~ 2.5 m.

Validation with submarine sonar and modeled ice thicknesses.
NOAA-20 and S-NPP Ice Thickness, Arctic, Aug 18, 2018
NOAA-20 and S-NPP Ice Thickness, Antarctic, Aug 18, 2018
NOAA-20 Ice Thickness vs. IceBridge

April 6, 2018

Mean OIB thickness: 3.014m
Mean N-20 thickness: 3.114m

OIB Std Dev: 1.313m
N-20 Std Dev: 0.270m

Correlation: 0.124
VIIRS Sea Ice Thickness on the OB River, Western Siberia

On-ice thickness: 55-60 cm
S-NPP VIIRS thickness: 70 cm
Sea Ice Thickness: NOAA-20 vs CryoSat-2

NOAA-20

CryoSat-2

Arctic
April 22-29, 2018
NOAA-20 vs S-NPP Ice Thickness

Bias = 0.00066
RMS = 0.0245

Bias = 0.0070
RMS = 0.4832

The cryosphere products reviewed were binary and fractional snow cover, ice surface temperature, ice concentration, and ice thickness/age.

The products were accepted as achieving the Beta Maturity level.

Example of the sea ice thickness product that was evaluated in the maturity review.
# VIIRS Sea Ice Product Performance Summary

<table>
<thead>
<tr>
<th>Product</th>
<th>L1RDS APU Thresholds</th>
<th>Performance</th>
<th>Meets Spec?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice surface temperature</td>
<td>1 K uncertainty</td>
<td>0.9 K</td>
<td>Y</td>
</tr>
<tr>
<td>Ice concentration</td>
<td>10% uncertainty</td>
<td>8.9%</td>
<td>Y</td>
</tr>
<tr>
<td>Ice thickness/age</td>
<td>70% correct typing (new/young, other ice); no thickness requirement</td>
<td>90% (first-year/other); 0.5 m precision for thickness</td>
<td>Y</td>
</tr>
</tbody>
</table>
Thank you
VIIRS / MODIS IST
Inter-comparison

Differences between NPP VIIRS and MODIS (Aqua and Terra) IST in the Arctic from August 2012 to July 2015.

From: Yinhui Liu, Jeffrey Key, Mark Tschudi, Richard Dworak, Robert Mahoney, and Daniel Baldwin, 2015: Validation of the Suomi NPP VIIRS Ice Surface Temperature Environmental Data Record, Remote Sens. 2015, 7, 13507-13527; doi:10.3390/rs71013507
### VIIRS IST Validation Approach

<table>
<thead>
<tr>
<th>Validation Dataset</th>
<th>Parameter</th>
<th>Spatial Resolution</th>
<th>Spatial Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA IceBridge KT-19 IR Surface Temperature</td>
<td>Snow/ice temperature</td>
<td>15 x 15 m</td>
<td>Arctic and Antarctic</td>
</tr>
<tr>
<td>MODIS Ice Surface Temperature</td>
<td>Snow/ice temperature</td>
<td>1 km</td>
<td>Arctic and Antarctic</td>
</tr>
<tr>
<td>MODIS simultaneous nadir overpass</td>
<td>Snow/ice temperature</td>
<td>0.05 degree longitude by 0.05 degree latitude</td>
<td>Arctic</td>
</tr>
<tr>
<td>Arctic drifting buoy</td>
<td>2 m air temperature</td>
<td>Point observations</td>
<td>Arctic</td>
</tr>
<tr>
<td>NCEP/NCAR reanalysis</td>
<td>Air temperature at 0.995 sigma level</td>
<td>2.5 x 2.5 degree latitude/longitude</td>
<td>Arctic and Antarctic</td>
</tr>
</tbody>
</table>
NRT Demo for NWS ASIP; Status; Milestones

Accomplishments / Events:
- In April, 2018, the VIIRS Cryosphere Team performed a near-real-time demonstration of ice products for the Alaska Sea Ice Program (ASIP, NWS).
- Level 1b data and the Enterprise Cloud Mask were obtained from the University of Alaska-Fairbanks direct broadcast system. Ice products were then generated by CIMSS and sent to GINA for display and use by ASIP.
- The ice products include ice concentration, ice thickness, ice surface temperature, and ice motion.
- While some issues were encountered, they were quickly resolved and testing by ASIP was largely successful.

Overall Status:

<table>
<thead>
<tr>
<th>Reason for Deviation</th>
<th>Green(^1) (Completed)</th>
<th>Blue(^2) (On-Schedule)</th>
<th>Yellow(^3) (Caution)</th>
<th>Red(^4) (Critical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost / Budget</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical / Programmatic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schedule</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Project has completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Project is within budget, scope and on schedule.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Project has deviated slightly from the plan but should recover.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Project has fallen significantly behind schedule, and/or significantly over budget.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Issues/Risks:
None

Highlights:

- Ice surface temperature (IST) north of Alaska from VIIRS.

FY18 TTA Milestones

<table>
<thead>
<tr>
<th>FY18 TTA Milestones</th>
<th>Original Date</th>
<th>Forecast Date</th>
<th>Actual Completion Date</th>
<th>Variance Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1 post-launch calibration/validation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta Maturity: IST</td>
<td>May-18</td>
<td>May-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta Maturity: Snow</td>
<td>Jun-18</td>
<td>Jun-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta Maturity: Sealce</td>
<td>Jul-18</td>
<td>Jul-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provisional Maturity (IST, Snow, and Sealce)</td>
<td>Sep-18</td>
<td>Sep-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J1 algorithm adjustments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary DAP to ASSISTT (science team to ASSISTT)</td>
<td>Apr-18</td>
<td>Apr-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary DAP to NDE (ASSISTT to NDE)</td>
<td>Jun-18</td>
<td>Jun-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNPP/J1 algorithm Refinement (Maintenance DAP)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Improvements to snow and ice algorithms</td>
<td>Sep-18</td>
<td>Sep-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add J1 products to EDR monitoring web</td>
<td>Sep-18</td>
<td>Sep-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JPSS EPS algorithm updated DAPs</td>
<td>11/21/17; 02/02/18 (J1 capability)</td>
<td></td>
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Accomplishments / Events:

- **NOAA-20 Maturity Review:**
  - The cryosphere products reviewed were binary and fractional snow cover, ice surface temperature, ice concentration, and ice thickness/age.
  - They were accepted as achieving the Beta Maturity level.
  - The Provisional Maturity review will be held in a few months, possibly September.

Overall Status:

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1. Project has completed.
2. Project is within budget, scope and on schedule.
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Issues/Risks:

None

Highlights:

*NOAA-20 Sea Ice Thickness*

- Mapped reduced resolution
- Original resolution (1 km)

**Example of the sea ice thickness product that was evaluated in the maturity review.**