Current NSIDC sea ice extent

Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)

Extent (millions of square kilometers)

Aug  Sep  Oct  Nov  Dec

2011  2007
1979–2000 Average
±2 Standard Deviations

21 Nov 2011
Passive microwave sea ice products

- **NSIDC**
  - NASA Team, Bootstrap
  - NOAA/NSIDC CDR (combined NT, BT; NetCDF_CF; data quality)
  - Sea Ice Index (images, extent/area stats)
  - News and Analysis website (NRT science analysis)
  - MASIE (Multi-sensor Analyzed Sea Ice Index)

- **JAXA**
  - AMSR-E, AMSR2 (2012)
  - Sea Ice Monitor (extent timeseries)

- **NASA Goddard** (most distributed through NSIDC)
- **Cryosphere Today** (Univ. Illinois)
  - ice area timeseries, browse images
- **ArcticROOS** (Nansen Environmental and Remote Sensing Center)
- **PolarView** (Danish Meteorol. Institute)
- **EUMETSAT Ocean and Sea Ice Satellite Application Facility**
  - NetCDF_CF, error estimates
Operational sea ice products

- International Ice Chart Working Group members
  - Canadian Ice Service
  - U.S. National Ice Center
  - Danish Meteorological Institute (PolarView)
  - Norwegian Meteorological Institute
  - Federal Maritime and Hydrographic Agency of Germany
  - Arctic and Antarctic Research Institute
  - Swedish Meteorological and Hydrological Institute
  - British Antarctic Survey
- Finnish Meteorological Institute
- NSIDC/NIC MASIE (Multi-sensor Analyzed Sea Ice Extent)
- EUMETSAT Ocean and Sea Ice Satellite Application Facility
<table>
<thead>
<tr>
<th>Source</th>
<th>Web site</th>
<th>Type of product</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSIDC NASA Team, Bootstrap</td>
<td><a href="http://nsidc.org/data/seaice/pm.html">http://nsidc.org/data/seaice/pm.html</a></td>
<td>Gridded concentration data files</td>
</tr>
<tr>
<td>NOAA/NSIDC CDR</td>
<td><a href="http://nsidc.org/data/g02202.html">http://nsidc.org/data/g02202.html</a></td>
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<td>NSIDC Sea Ice Index</td>
<td><a href="http://nsidc.org/data/seaice_index/">http://nsidc.org/data/seaice_index/</a></td>
<td>Value-added data (browse, timeseries)</td>
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<td>NSIDC News and Analysis</td>
<td><a href="http://nsidc.org/arcticseaicenews/">http://nsidc.org/arcticseaicenews/</a></td>
<td>Value-added data and analysis</td>
</tr>
<tr>
<td>NSIDC MASIE</td>
<td><a href="http://nsidc.org/data/masie/">http://nsidc.org/data/masie/</a></td>
<td>Operational, multi-sensor data, browse, timeseries</td>
</tr>
<tr>
<td>University of Bremen</td>
<td><a href="http://www.iup.uni-bremen.de/seacie/amsr/">http://www.iup.uni-bremen.de/seacie/amsr/</a></td>
<td>Browse, data, timeseries</td>
</tr>
<tr>
<td>JAXA Sea Ice Monitor</td>
<td><a href="http://www.ijis.iarc.uaf.edu/cgi-bin/seaiemonitor.cgi?lang=e">http://www.ijis.iarc.uaf.edu/cgi-bin/seaiemonitor.cgi?lang=e</a></td>
<td>Browse, timeseries</td>
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<td>Cryosphere Today</td>
<td><a href="http://arctic.atmos.uiuc.edu/cryosphere/">http://arctic.atmos.uiuc.edu/cryosphere/</a></td>
<td>Browse, timeseries (ice area)</td>
</tr>
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<td>ArcticROOS</td>
<td><a href="http://www.arctic-roos.org/">http://www.arctic-roos.org/</a></td>
<td>Timeseries</td>
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<tr>
<td>EUMETSAT OSI-SAF</td>
<td><a href="http://www.osi-saf.org/">http://www.osi-saf.org/</a></td>
<td>Gridded data files, browse</td>
</tr>
<tr>
<td>Danish Meteorol. Institute (EUMETSAT OSI-SAF)</td>
<td><a href="http://ocean.dmi.dk/arctic/icecover.uk.php">http://ocean.dmi.dk/arctic/icecover.uk.php</a></td>
<td>Timeseries</td>
</tr>
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<td>PolarView</td>
<td><a href="http://www.polarview.org/services/simf.htm">http://www.polarview.org/services/simf.htm</a></td>
<td>Browse</td>
</tr>
<tr>
<td>Canadian Ice Service</td>
<td><a href="http://ice-glaces.ec.gc.ca/">http://ice-glaces.ec.gc.ca/</a></td>
<td>Operational ice charts, climatologies</td>
</tr>
<tr>
<td>U.S. National Ice Center</td>
<td><a href="http://www.natice.noaa.gov/">http://www.natice.noaa.gov/</a></td>
<td>Operational ice charts</td>
</tr>
<tr>
<td>Google Arctic Sea Ice graphs</td>
<td><a href="https://sites.google.com/site/arcticseaicegraphs/">https://sites.google.com/site/arcticseaicegraphs/</a></td>
<td>Browse, timeseries (aggregate)</td>
</tr>
<tr>
<td>Watt’s Up With That blog</td>
<td><a href="http://wattsupwiththat.com/reference-pages/sea-ice-page/">http://wattsupwiththat.com/reference-pages/sea-ice-page/</a></td>
<td>Browse, timeseries (aggregate)</td>
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Satellite-derived Sea Ice Products Community Workshop

26 total attendees from 8 countries
Ten attendees’ travel partially or fully funded by WCRP CliC
Algorithm developers
Product distributors
Operational community
Users (models, remote sensing)
Input solicited from invitees who could not attend

Focused mostly on discussion of major issues
Uncertainties
Documentation
Conventions and methods
Data formats
Future plans for collaboration

15-16 March 2011
NASA Goddard

Workshop sponsored by WCRP CliC
Satellite-derived Sea Ice Products Community Workshop

**Key Recommendations**

- Uncertainty estimates at grid-cell level need to be further developed
- Validation of uncertainty estimates
- Work towards consistent ancillary information
  - land masks (Antarctic ice shelves)
  - regional masks
  - climatology period
- Potential consideration of feasibility for ensemble estimate
- Collaborate on community endeavors
  - Sea Ice Outlook
  - Future assessments
  - Describing daily/monthly minimum extent
  - Review journal article of algorithm products
- Data formats – NetCDF and/or other self-describing fields
Primary sea ice concentration algorithms

Archived at NSIDC

- SMMR-SSM/I
  - NASA Team (NTA)
  - Bootstrap (SBA)
- AMSR-E
  - NASA Team 2 (NT2)
  - AMSR Bootstrap (ABA)

Other algorithms

- ASI (AMSR) – Univ. of Bremen
- Bristol (BRI) – EUMETSAT OSI-SAF
- Norsex (NOR) – Norwegian Polar Institute
- Cal/Val (CAL), aka AES-York
Sea ice algorithm comparison

1. NTA – NSIDC SSM/I standard product
2. NT2 – AMSR-E standard product
3. ABA – derived from AMSR-E standard product
4. ASI – produced at Univ. Bremen from AMSR-E

Run in-house from SSM/I:
5. SBA – SSM/I Bootstrap
6. BRI – Bristol algorithm
7. NOR – Norsex algorithm
8. CAL – Cal/Val algorithm

Common (expanded) land mask and weather filters
All gridded to 25 km polar stereographic grid
March – September 2008 Sea Ice

Avg. Concentration  Conc. Range  Melt/Extent Indicator

Combined from all 8 algorithms

Max – Min concentration

# algorithms >15%

likely melt
Total sea ice area, 2007 and 2008

Avg. of 8 algorithms & ±1 st. dev. range
Total sea ice extent, 2007 and 2008

Avg. of 8 algorithms & ±1 st. dev. range

Date

Extent (10^6 square kilometers)

2007

2008
MASIE – a new operational product

- http://nsidc.org/masie/
- Produced operationally at U.S. National Ice Center (NOAA IMS)
- Multiple data sources (PM and non-PM) interpreted by human analysts
- Operational, so best that can be done on a give day – i.e., not consistent over long term
- 4 km resolution, ice extent only (ice/no-ice for each grid cell)
- Available as GeoTIFF, shapefile, KML, PNG browse; and comma-delimited text files of total extent
- Entire Arctic and individual regions
- Since 2006, but only last month publically available
Sea ice extent, summer 2011

2011 Extent and Comparison with 2007 Record Low

- Bremen AMSR-E
- JAXA AMSR-E
- NSIDC SSMIS
- MASIE multi-sensor

Total Extent

Extent relative to 2007 record

Only Bremen showed 2011 dipping below 2007
What is a Climate Data Record?

“A time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change” – U.S. NRC Report on Climate Data Records from Environmental Satellites, 2004

- At least 30+ years
- Thorough inter-sensor calibration
- Detailed data quality information
- Metadata for data preservation

* In NASA-speak: “Earth Science Data Record” (ESDR)
In ESA-speak: “Essential Climate Variable” (ECV)
NOAA/NSIDC sea ice CDR

- NOAA Climate Data Record program
- Combined NTA, SBA
  - SBA ice edge
  - Highest concentration from NTA and SBA
  - Standard deviation field
  - Data quality flags (melt, land spillover)
- NetCDF4 with CF metadata
- Plan to transition Information Service products (Sea Ice Index and News and Analysis) to use CDR
CDRs and ESDRs at NSIDC

- NOAA CDRs for sea ice concentration, ice age, ice motion
- NASA ESDRs for sea ice melt, snow cover, ice sheet albedo and melt
  - Ground freeze/thaw, ice sheet velocity ESDRs also coming to NSIDC
  - http://nsidc.org/data/measures/

Rutgers University Global Snow Lab, http://climate.rutgers.edu/snowcover/
Other sea ice CDR products being developed

- Ice motion
- Ice age
- Ice thickness
  - Vis/IR (Key et al.)
  - CryoSat?
Should all sea ice products be considered equal?

Requirements for climate products

- Use validated, peer-reviewed methods
- Demonstrate long-term consistency
  - Operational products can provide targeted information for real-time users as well as validation for climate products
- Bear a reasonable resemblance to reality and a confidence level in that resemblance to reality (i.e., data quality/error information)
- Processing transparent and reproducible
- Archived in a self-describing format, but distributed in a variety of usable formats (e.g., GIS, KML, GeoTIFF, browse, etc.)

Currently*: OSI-SAF, NOAA/NSIDC, MASIE

* In Walt’s humble opinion
Thank you!