National Ice Center

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NOAA/NESDIS/STAR/SOCD

Requirement:

Mission Goal (Commerce and Transportation): *Commerce and Transportation* is the primary goal (Enhance national economic performance through the development and use of an efficient, safe, secure, and environmentally sound U.S. transportation system) but the *Climate, Weather and Water, and Ecosystem* goals are also supported.
- Explore, develop and transition emerging technologies and techniques to enhance marine navigational safety & efficiency
- Develop information and tools to make reliable decisions in preparedness, response, damage assessment, & restoration

New Arctic Specific C&T Arctic Focus: *NOAA Strategic Plan for the Arctic* (Objective IV: Support marine transportation, spill response, homeland security, and other geospatial data-dependent activities in Alaska and the Arctic)
- Increasing maritime operations in the Arctic as well as the Antarctic region requires improved location and characterization of sea ice and icebergs.

Science:

Are there possible refinements to present applications or new approaches to the analysis and exploitation of diverse satellite imagery for ice detection and characterization and for snow mapping?

Can sea ice forecasting models be improved at scales ranging from Daily to Seasonal/Decadal periods to satisfy increased information needs?

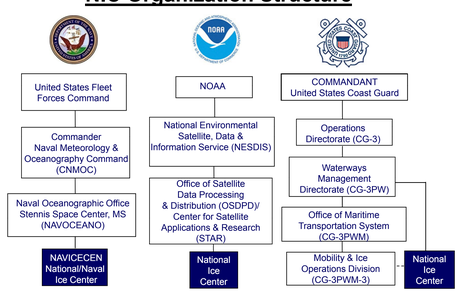
Benefit:

Navy Ice Operations and Situational Awareness (SubForce,ONI, NGA, etc.) ▪ NOAA Arctic Research and Hydrographic Surveys
USCG Icebreaker Operations & Domain Awareness ▪ NSF Polar Research & Logistic Operations ▪ USGS Mammal Research
NOAA Antarctic Marine Living Resources Research ▪ NWS Weather Forecasting
Others (Shipping Industry, Oil&Gas, Cruise Ships, Recreational, International Weather Services, Academia…)

The U.S. National Ice Center

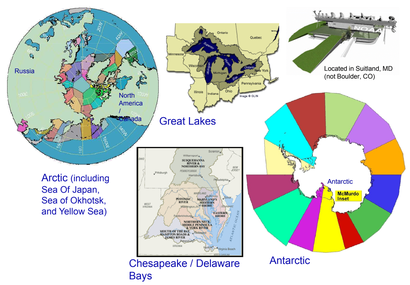
The National Ice Center (NIC) is a multi-agency operational center operated by the United States Navy, the National Oceanic and Atmospheric Administration (NOAA), and the United States Coast Guard. Our mission is to provide the highest quality, timely, accurate, and relevant snow and ice products and services to meet the strategic, operational, and tactical requirements of the United States interests across the global area of responsibility. This area of year round responsibility encompasses the polar regions and subpolar areas subject to sea ice as well as global snow covered regions. In the Northern Hemisphere, sea ice mapping activities include areas as far south as the Bay of Fundy and the Yellow Sea, which lie at about 45° and 35° north latitude, respectively. The Antarctic area of responsibility includes all of the ocean south of 50° south latitude. Ice is also mapped in the Great Lakes and Chesapeake / Delaware Bay regions during the annual ice season, which runs from the appearance of ice around the beginning of December through final melting, usually in May.

NIC Organization Structure

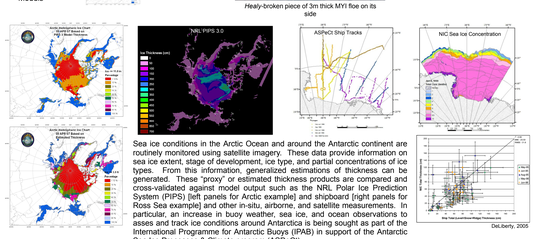


Mission: provide the highest quality timely, accurate, and relevant snow and ice products and services to meet the strategic, operational, and tactical requirements of U.S. national interests across a global AOR.

NIC Area of Responsibility – Global



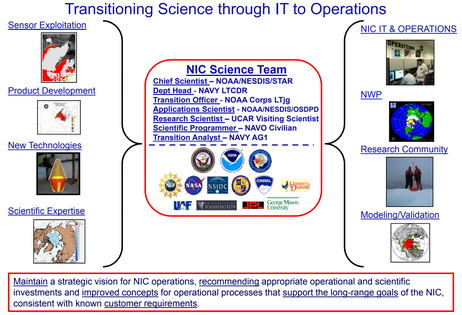
NIC Arctic and Antarctic sea ice analyses, as well as NIC Great Lakes and Chesapeake analyses, are derived from near real-time integration of remotely sensed and in-situ oceanographic as well as meteorological observations. The analyses are produced following standard analysis procedures that optimize the use of data, which varies widely in availability, scale, and resolution. Operational data sources can be grouped into the following categories: satellite-derived data, aerial ice reconnaissance, observations from ship and shore stations, drifting buoy reports, meteorological forecast guidance products, ice prediction model output, climatology and sea ice information obtained from international partners such as foreign ice services. Documentation recording the percentages of each data type used in each sea ice chart can be found in a weekly metadata narrative. Ice charts are labeled using the WMO [World Meteorological Organization] international sea/freshwater ice symbol known colloquially as the *egg code*. Ice features are attributed in the GIS data format using the related WMO SIGRID format code. NIC also produces snow cover maps for the Northern Hemisphere through the Interactive Multisensor Snow and Ice Mapping System (IMS) and experimentally for the Southern Hemisphere using the STAR-developed AutoSnow code.



Sea ice conditions in the Arctic Ocean and around the Antarctic continent are routinely monitored using satellite imagery. These data provide information on sea ice extent, stage of development, ice type, and partial concentrations of ice types. From this information, generalized estimations of thickness can be generated. These "proxy" or estimated thickness products are compared and cross-validated against model output such as the NRL Polar Ice Prediction System (PIPS) [left panels for Arctic example] and shipboard [right panels for Ross Sea example] and other in-situ, airborne, and satellite measurements. In particular, an increase in buoy weather, sea ice, and ocean observations to asses and track ice conditions around Antarctica is being sought as part of the International Programme for Antarctic Buoys (IPAB) in support of the Antarctic Sea Ice Processes & Climate program (ASPeCt).

NIC Science and Applied Technology Department

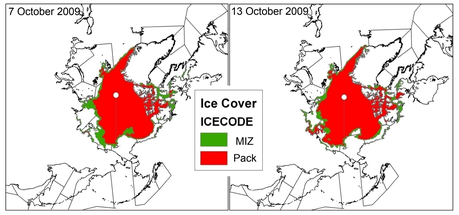
Transitioning Science through IT to Operations



Maintain a strategic vision for NIC operations, recommending appropriate operational and scientific investments and improved concepts for operational processes that support the long-range goals of the NIC, consistent with known customer requirements.

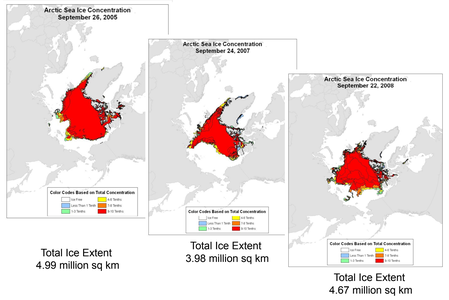
Daily Ice Edge and Marginal Ice Zone (MIZ)

Changes in the Marginal Ice Zone Along the NSR

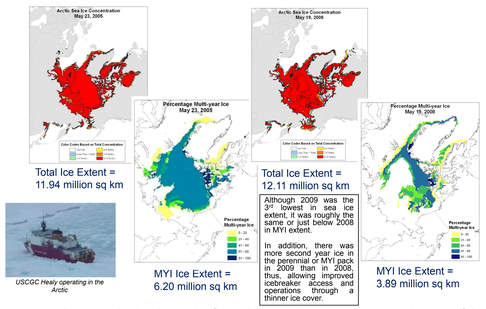


Continuous monitoring of sea ice conditions is critical to understanding rapid regional changes. The daily products exampled above captured a significant ice retreat and extended opening over the Northern Sea Route along the Siberian coast well into the freeze-up season due to wind-forced sea ice compression toward the Canadian side.

NIC Summer Minimum Sea Ice Extent

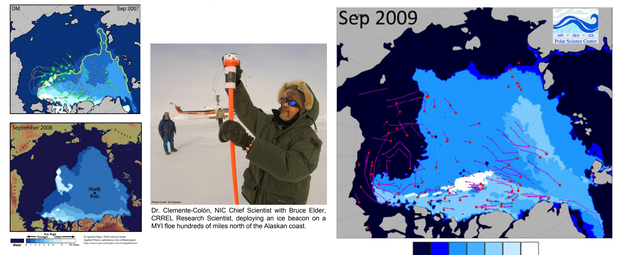


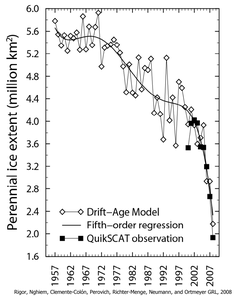
Arctic Sea Ice Extent vs. MYI Distribution

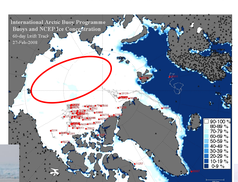


Arctic sea ice extent is showing a significant decrease in recent years. Another part of the picture is the precipitous decrease of the multi year ice (MYI). MYI is thicker than first year ice (FYI) and, therefore, there is less total ice volume present in the Arctic when there is less and younger MYI in the sea ice total extent.

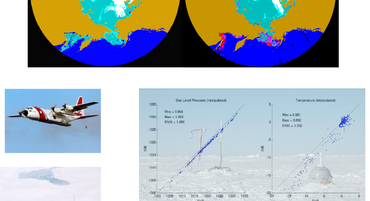
MYI changes Monitored with an Ice Drift and Age Model, Buoys, and QuikSCAT Data

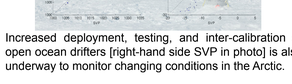






The impact of MYI changes on the distribution of International Arctic Buoy Programme (IABP) buoys calls for the use and development of new seasonal buoys.



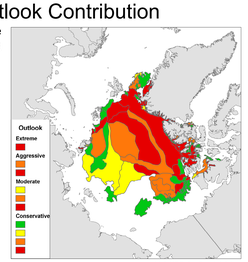


Increased deployment, testing, and inter-calibration of open ocean drifters [right-hand side SVP in photo] is also underway to monitor changing conditions in the Arctic.

SEARCH Summer Outlook Contribution

The NSF-lead Study of Arctic Environmental Change (SEARCH) goal is to provide a forum for comparing various techniques for determining Arctic sea ice extent minimum . There are about 20 participating groups using a variety of statistical, model, and expert insights and methods

The NIC approach uses an ArcGIS analysis and selection tool to create a range of plausible forecasts.
A set of rules based on forecaster insight and expertise on ice cover changes (ice type, drift, and melt) are used to provide Conservative, Moderate, Aggressive, and Extreme outcomes. The rules an most likely outcome are selected in close collaboration and through iterative discussions with NIC Operations analysts. While forecasts for a 90-day outlook have tend to be too low, the 60-day outlook generally capture ultimate conditions. This and other NIC seasonal I Forecasting Efforts Lead by Dr. Todd Arbetter, UCAR Visiting Scientist



Arbetter et al., 2008

Satellite Sensors Used for Sea Ice Charting at NIC

Synthetic Aperture Radar (SAR)
- RADARSAT-1/2, Envisat ASAR, ALOS PALSAR
- PROS – all-weather, day and night, high spatial resolution
- CONS – commercial, limited access, daily low-res mosaics contain significant gaps (ASAR)

Visible and Infrared
- DMSP OLS, POES & MetOp AVHRR, Terra/Aqua MODIS
- PROS – improves characterization (ice type) and concentration estimates, IR nighttime capability
- CONS – significantly impacted by cloud cover, no useful VIS imagery for extended periods.

Scatterometer
- QuikSCAT SeaWinds (Failed Recently), MetOp ASCAT
- PROS – daily basin-scale mosaics, ice edge delineation, automated sea ice classification
- CONS – low resolution, seasonal changes in the quality of products, variable incidence angle (ASCAT)

Passive Microwave
- Aqua AMSR-E, DMSP SSM/I & SSMIS
- PROS – daily basin-scale and long-term routine coverage, automated sea ice concentration
- CONS – low resolution (better for AMSR-E), products miss a significant ice presence and significantly deteriorate during the melt season, atmospheric contamination

Science Challenges:

Recent changes in Arctic sea ice are substantial including extensive thinning of the pack.
High regional interannual variability/uncertainty in the Arctic and in an increasing ice extent Antarctic.
Sea ice thickness observations at required spatial and temporal scales.
Significant melting season effects on algorithms and analysis.
Passive microwave ice concentrations and extent underestimation.
Improved sea ice forecast models to support navigation (Significant investments are required).

Next Steps:

Effective cross-validation of multiple ice thickness measurement and estimation approaches (ULS, EMI, Radar & Laser ALT, ground penetrating radar, drill holes, IMB, imagery and Lagrangian analysis).
Integration of daily passive microwave products with high-resolution imagery analysis.
Access and test Oceansat-2 Ku-band scatterometer data to replace QuikSCAT products.

Transition Path:

Data build-up for validation and transition of future SAR, SCAT, and ALT missions data and products.
Improve analysis & product automation from multiple SAR and Scatterometer data for operational use.
Develop external collaboration for passive/active sea ice concentration analysis improvements.
Support field activities for cross-val of sea ice characterization and snow/ice thickness observations.

Center for Satellite Applications and Research (STAR) Review
09 – 11 March 2010