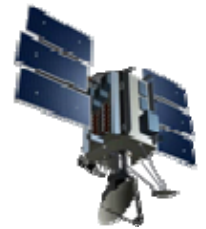
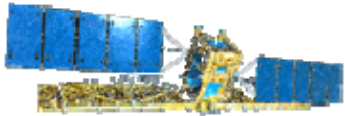


U.S. National / Naval Ice Center (NIC) Support to Naval and Maritime Operations



***09 June 2009
CDR Denise M. Kruse
Director National Ice Center***



USCG



USN

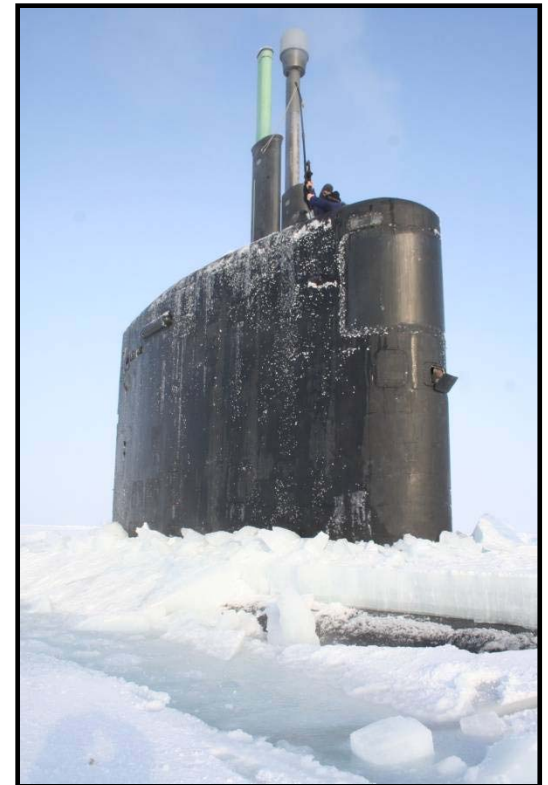


NOAA



Outline

- **NIC mission and structure**
- **Products and customers**
- **Observed changes**
- **Challenges**
- **Advances**
- **Future**





NIC Mission and Structure

- **Tri-agency organization**
 - 60 military and civilian personnel in Washington, D.C. metro area
 - Global sea ice analysis and forecasting
- **International Partnerships**
 - **North American Ice Service (NAIS)**
 - Canadian Ice Service (CIS)
 - International Ice Patrol (IIP)
 - **International Arctic Buoy Programme (IABP)**
 - **International Ice Charting Working Group (IICWG)**



NAIS

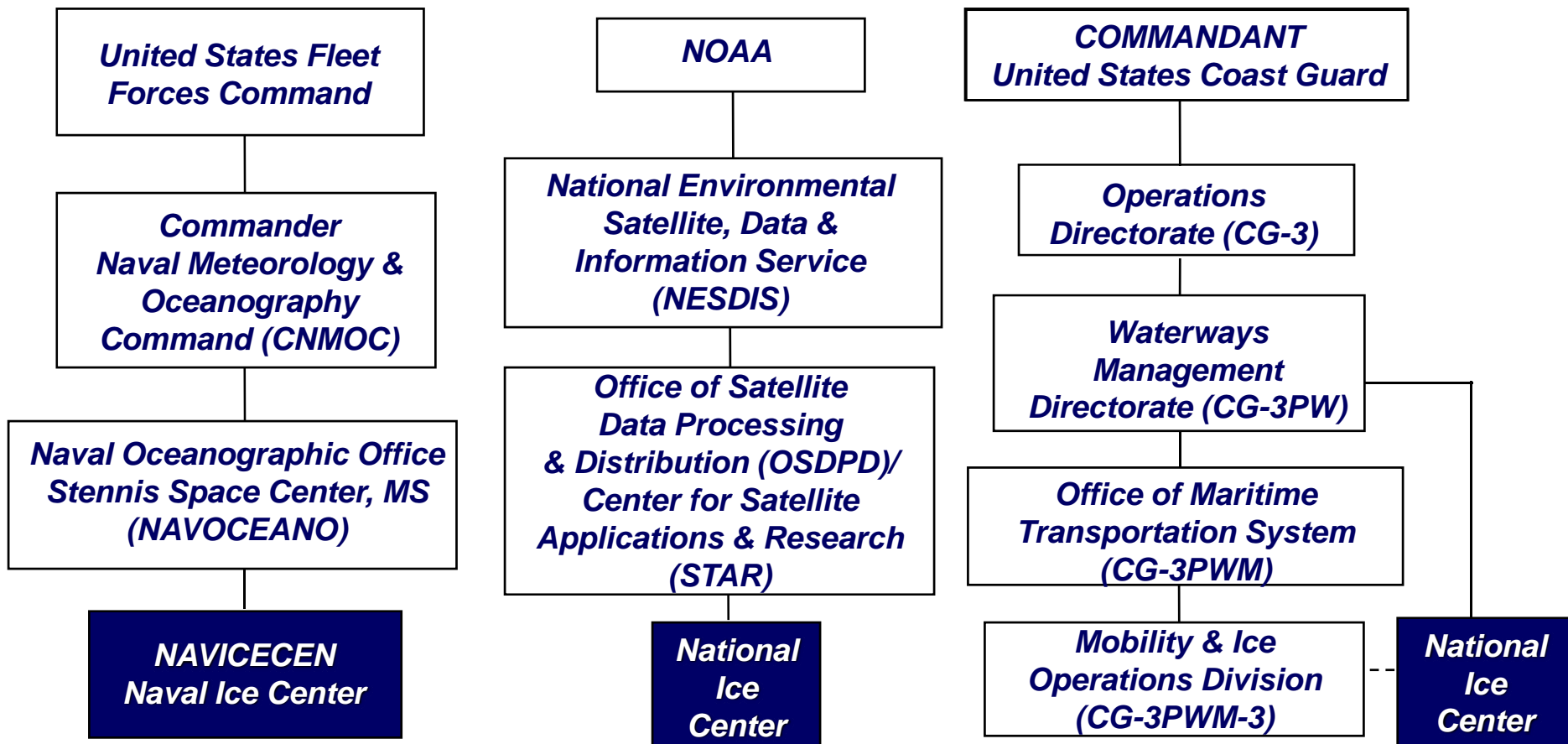
IABP

IICWG

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.



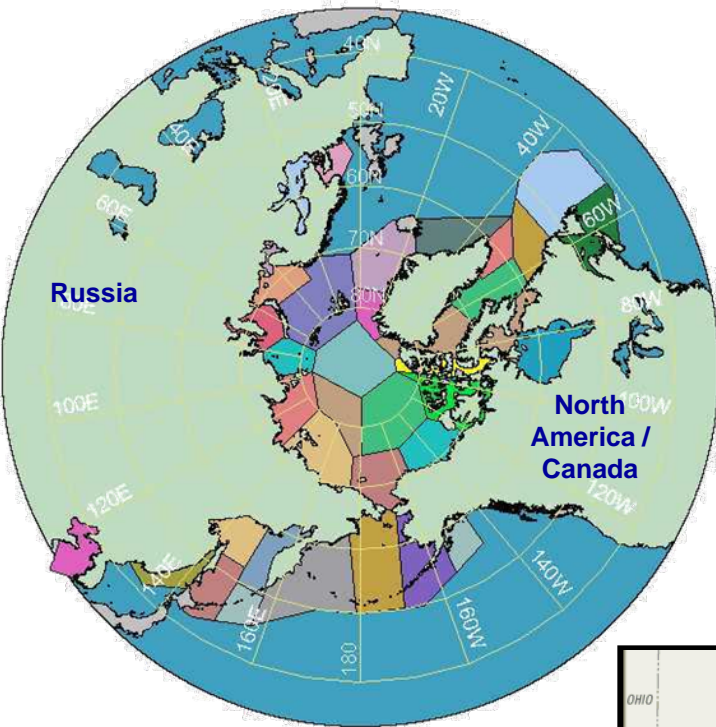
NIC Organization Structure





Area of Responsibility - Global

Arctic, Great Lakes, Antarctic



Arctic (including Sea Of Japan, Sea of Okhotsk, and Yellow Sea)



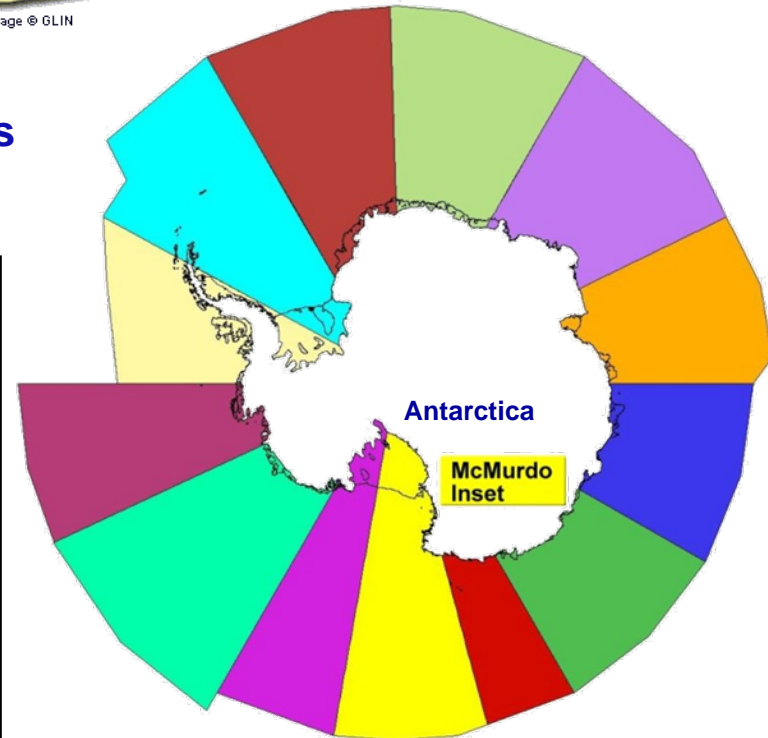
Great Lakes



Located in Suitland, MD (not Boulder, CO)



Chesapeake / Delaware Bays



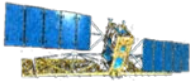
Antarctic



Operations and Product Generation

Human, Derived, Automated, and Reconfigured

Inputs



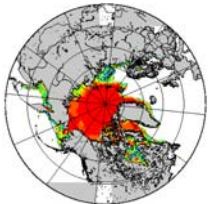
Satellites



Aircraft



Surface Obs



Models



Buoys

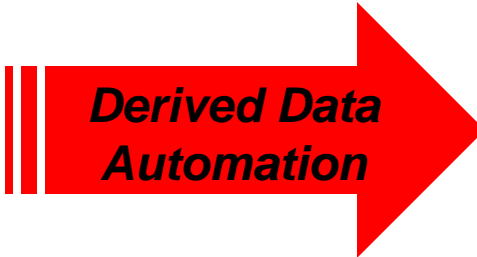
Expert Ice Analyses, Forecasting, and Quality Control



Ingest 45GB Daily



Data Fusion

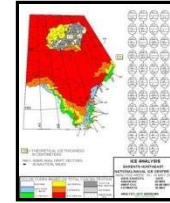


Derived Data Automation

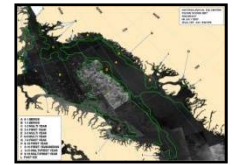


Direct Data Dissemination

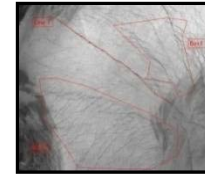
Products



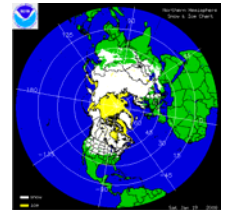
Hemispheric and Regional Ice Charts



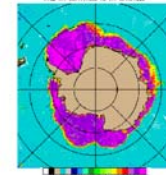
Annotated Images



Fractures, Leads and Polynyas (FLAP)

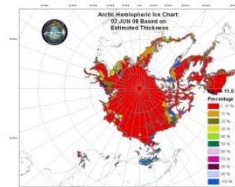
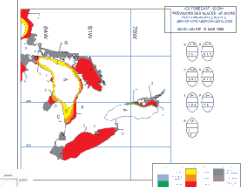


IMS snow and ice maps



Microwave Sea Ice Concentration products

Ice Forecast Outlooks

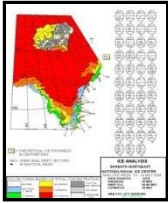


Ice Thickness Estimations

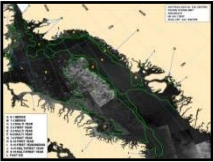


Customers

Products



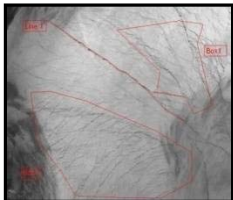
Hemispheric Ice Charts



Annotated Images



Special Arctic Oceanographic Synopsis (SPAROS)



Fractures, Leads and Polynyas (FLAP)



**Public web page
Dissemination**



**approx 140
customers**



USN



ONI



NSF



MSC



NWS



Local Gov.



NOAA



USCG

Mission/Goal Supported

Battlespace Awareness

SA / ISR / I&W

Scientific Research

Maritime Shipping

Commercial Fisheries

Oceanographic and Atmospheric Models (NWP)

Safety of Life and Property At Sea

Safety of Navigation

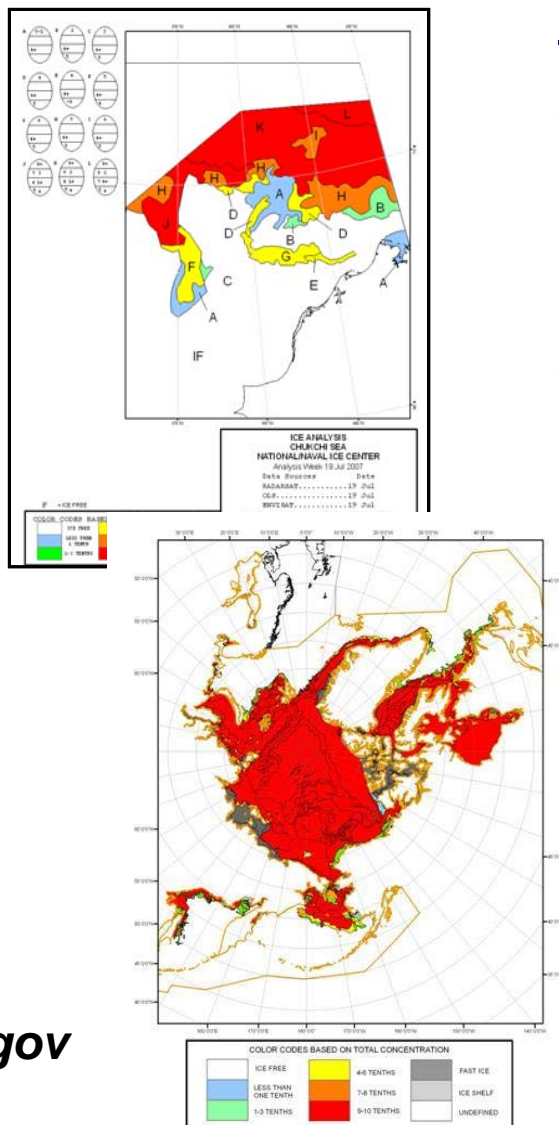


NIC – Routine Products

Weekly-Daily

Charts produced based on the detailed analysis of satellite data, observations, and model sources:

- RADARSAT-1 and 2;
- ESA Envisat;
- NASA QuikSCAT;
- NASA Terra and Aqua;
- DMSP;
- Ship observations
- Buoy data
- Model Output



Weekly Products:

Weekly and bi-weekly Arctic and Regional Charts

Bi-weekly Antarctic Charts

Weekly Hemispheric Chart

Weekly Thickness Chart

Daily Products:

Ice Edge and Forecast

Marginal Ice Zone

Snow and Ice Product (IMS)

Antarctic Iceberg ID and Tracking

<http://www.natice.noaa.gov>



NIC – Special Support Products

Special Support Products:

Annotated Imagery – high resolution imagery depicting ice concentration, ice types – thickness, location of icebergs, openings in the ice. May also be annotated with route recommendation (**OTSR**). Imagery may be ordered in direct support of customer.

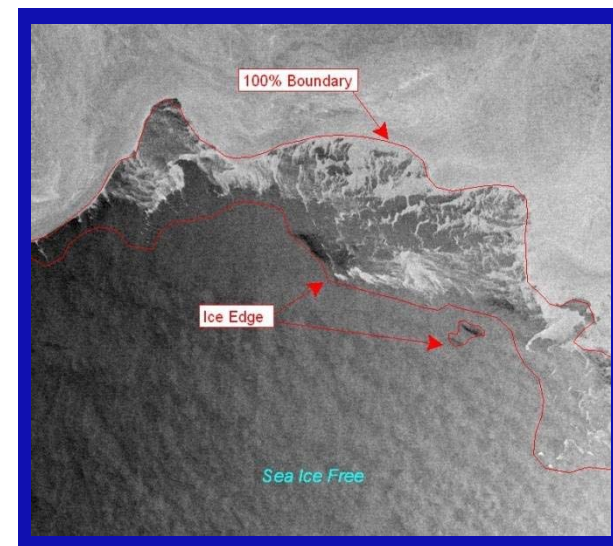
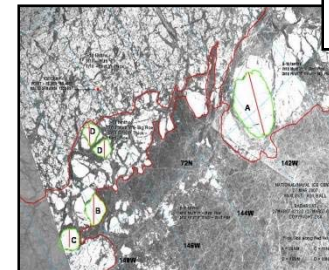
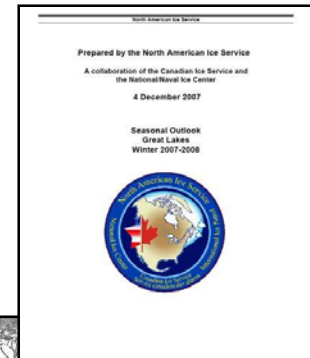
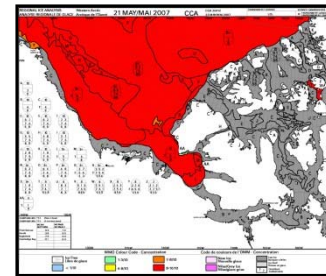
Fractures, Leads, and Polynyas (FLAP) – Text message delineating areas of weaknesses or openings in the ice. Also notes orientation of fractures/leads, ice types in vicinity, and any expected changes during valid period.

Special Ice Conditions – Graphic/Imagery detailing special features such as the opening of the Northwest Passage, etc.

Ice Forecasts – seasonal forecasts and tailored forecasts upon request

Ice Climatology – planning, pre-sail briefs

Notice to Mariners – icebergs outside ice edge





Recent Tailored Support

2008-09 Special Support Customers

SUBFOR

Arctic Submarine Lab

Deep Freeze/NSF

Ice Camp - ASL

ONI

Ice Camp – NASA

NAVOCEANO (Climo)

NGA/NORTHCOM

MSC

CCGC Laurier

CCGC St Laurent

USCGC Polar Sea

USCGC Healy

R/V Gould

R/V Palmer

R/V Revelle

M/V Oscar Dyson

M/V Oden

M/V American Tern

M/V Miller Freeman

USNS Gianella

USNS Paul Buck

NOAA Ship McArthur II

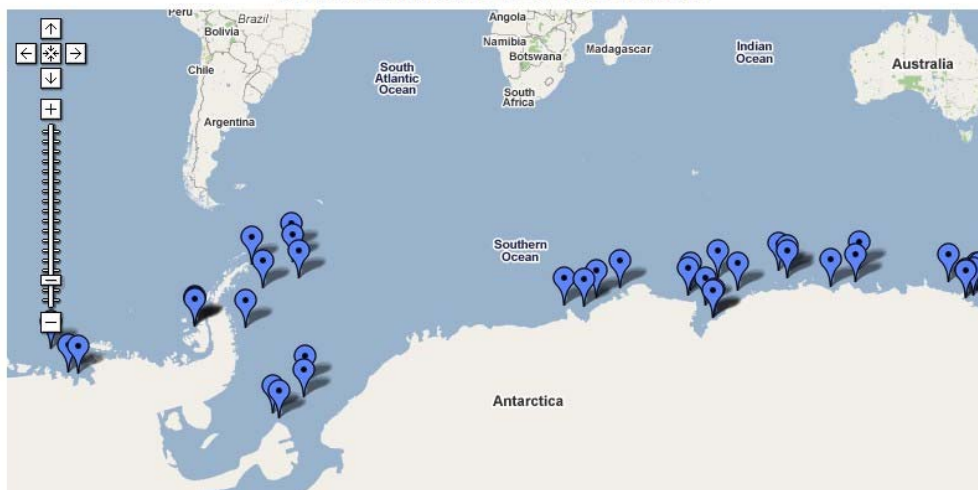


Antarctic Iceberg Tracking

NATIONAL ICE CENTER

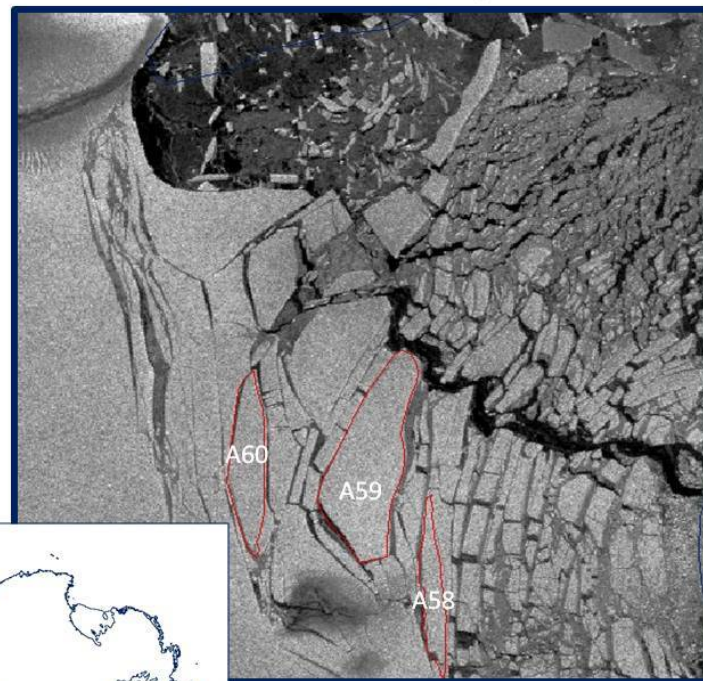
Click links for latest information -- Image of the Week (Wilkins Ice Shelf) -- Press Release - C-19E -- Press Release - C-24 --

CURRENT ANTARCTIC ICEBERG POSITIONS



- ***Icebergs 10NM long and longer numbered and tracked.***
- ***Revisiting Requirements for Antarctic sea ice and iceberg products.***

Wilkins Ice Shelf

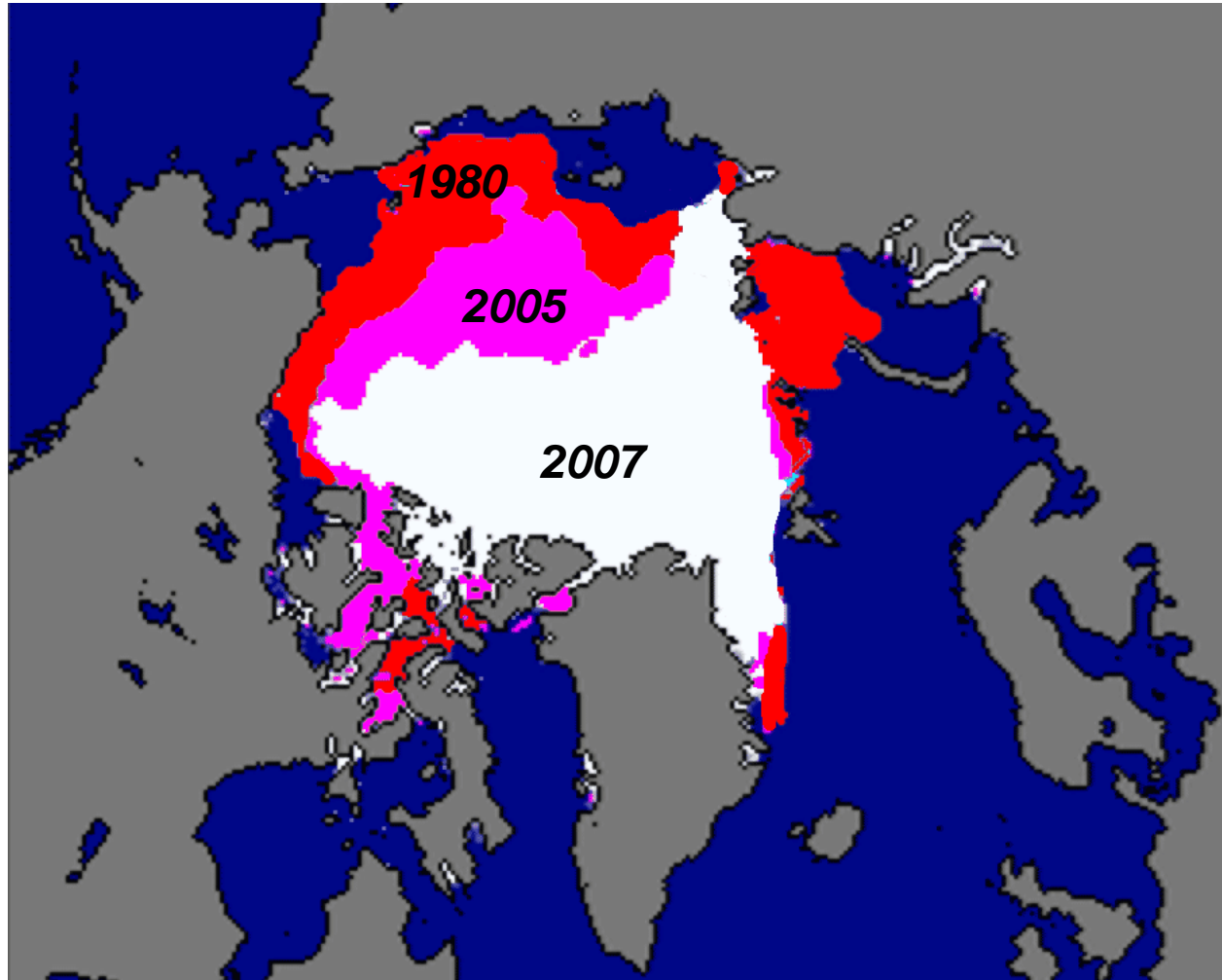


ENVISAT image from May 1, 2009

NIC continues to monitor icebergs calving from the northern front of the Wilkins Ice Shelf. Following the April 5, 2009 collapse of the ice bridge that connected the Antarctic mainland to Charcot Island, the area seems to have become destabilized with numerous icebergs calving from the remaining shelf ice. The NIC will only name and track those icebergs 10nm or longer.



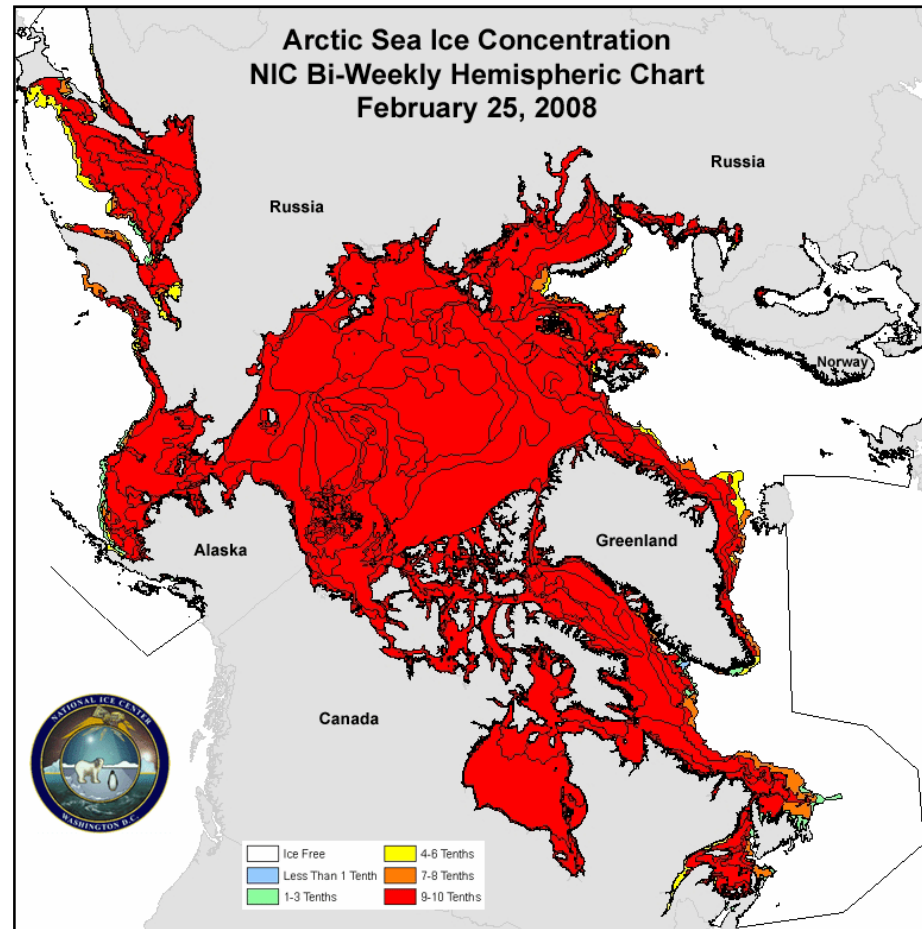
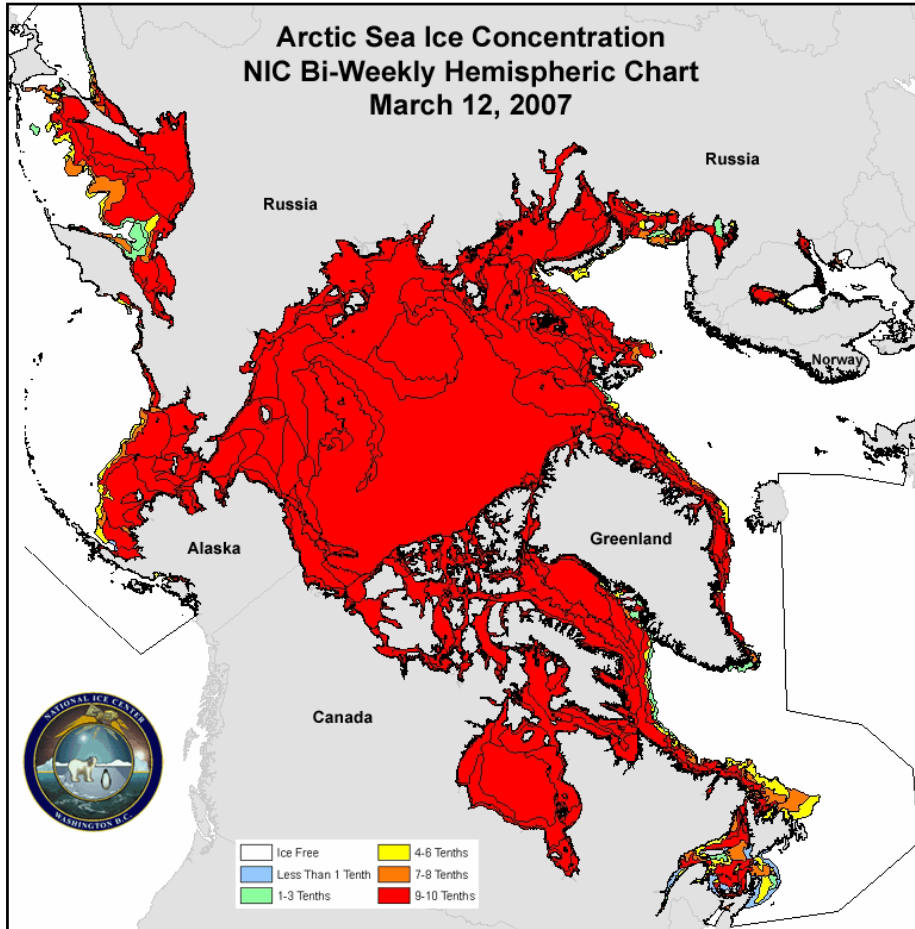
Changes in Sea Ice Extent



Summer Minimum Reduction from 1980 to 2005 to 2007



2007 and 2008 Seasonal Ice Pack Retreats

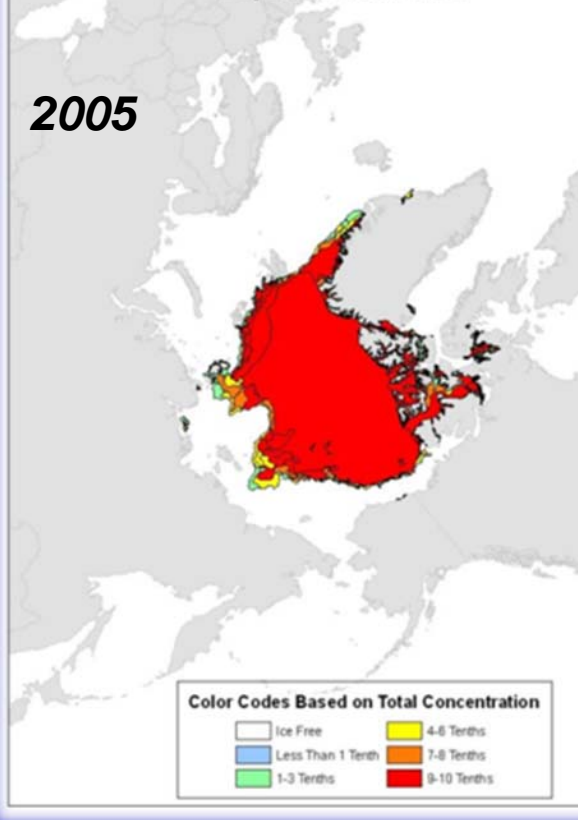




Summer Minimum Ice Conditions

Arctic Sea Ice Concentration
September 26, 2005

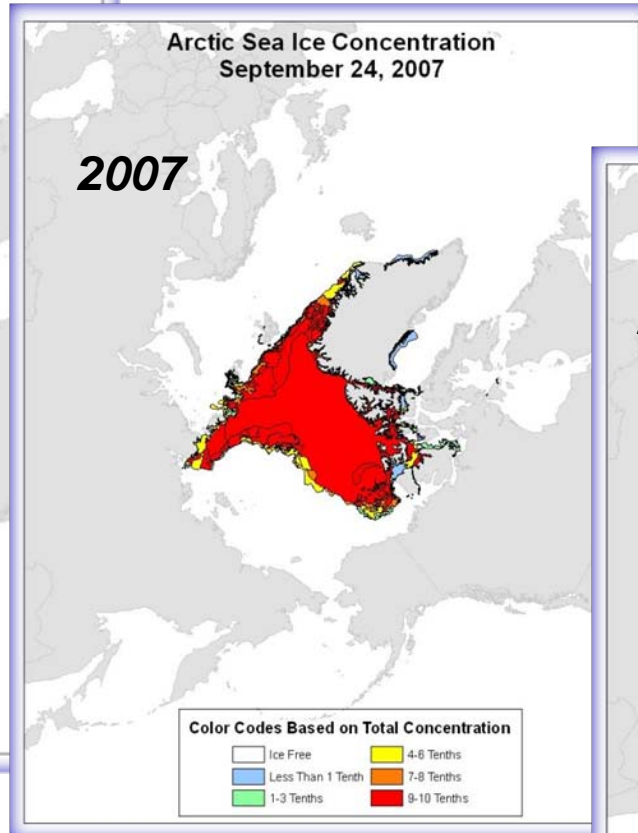
2005



Total Ice Extent
4.99 million sq km

Arctic Sea Ice Concentration
September 24, 2007

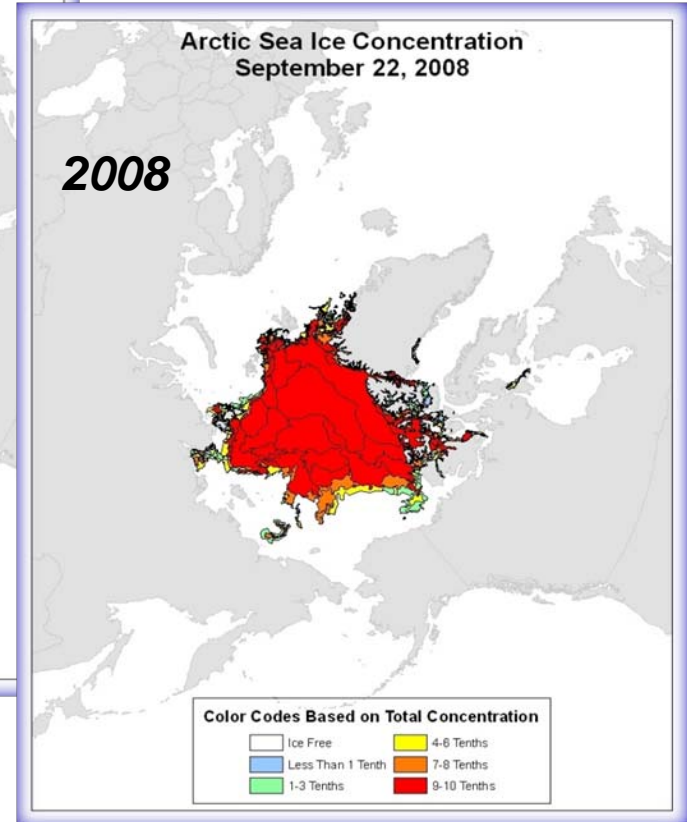
2007



Total Ice Extent
3.98 million sq km

Arctic Sea Ice Concentration
September 22, 2008

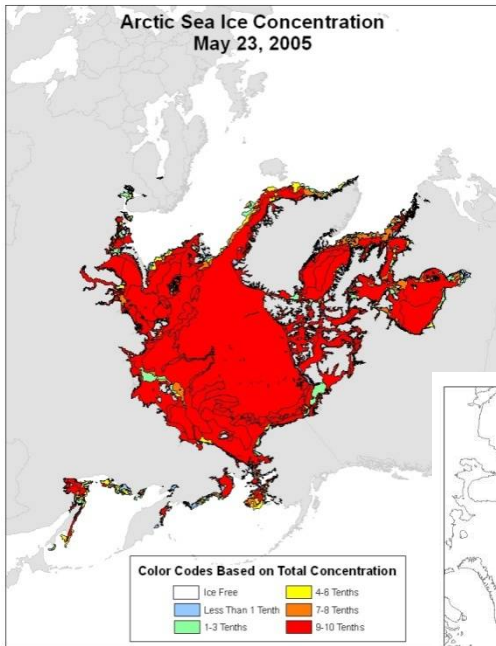
2008



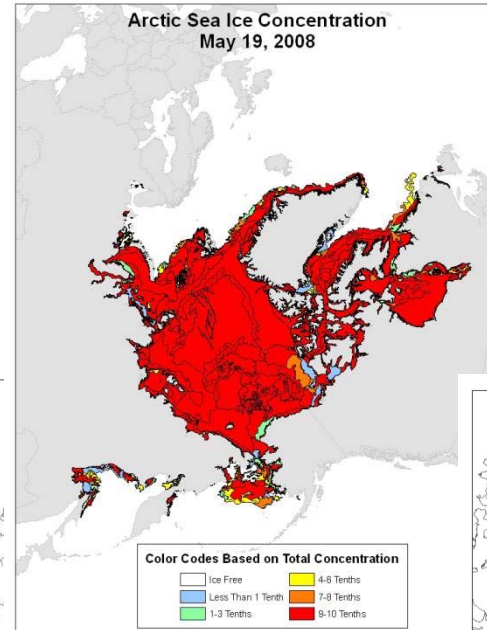
Total Ice Extent
4.67 million sq km



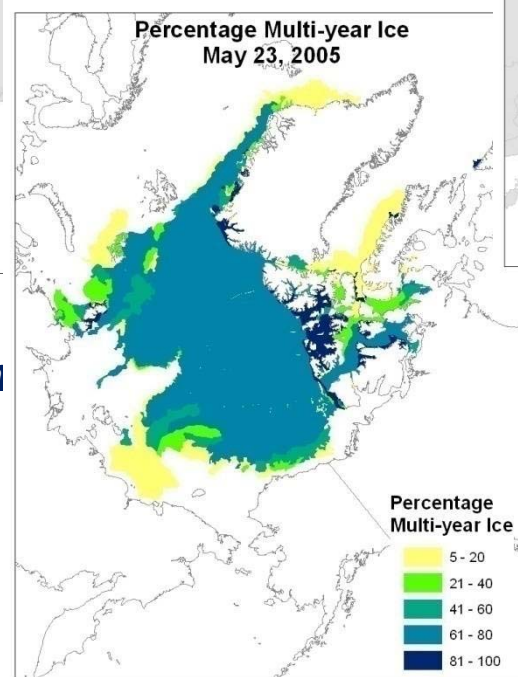
Arctic Sea Ice Extent vs. MYI Distribution



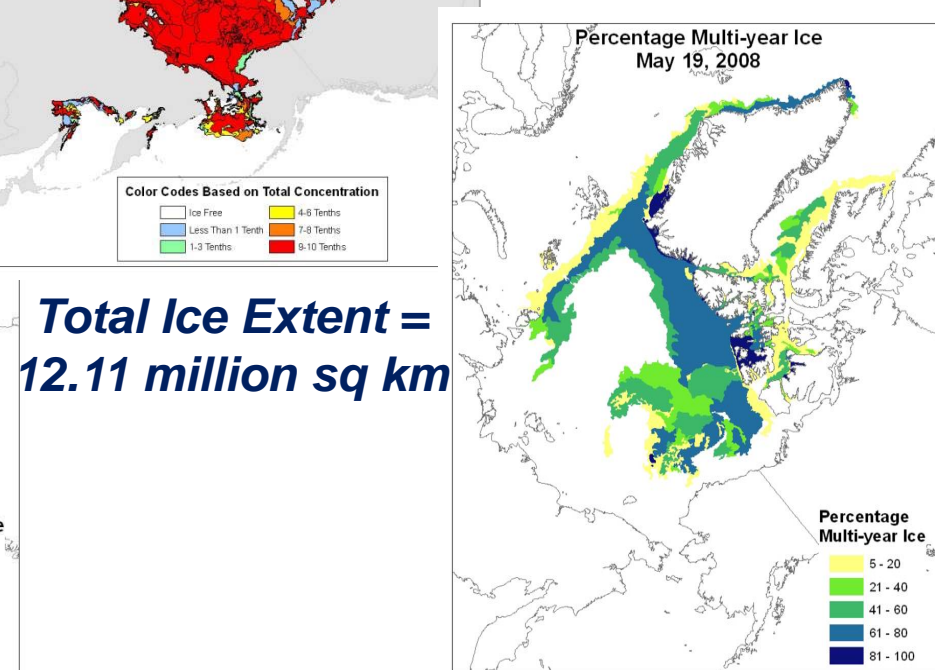
May 2005



May 2008



**Total Ice Extent =
11.94 million sq km**



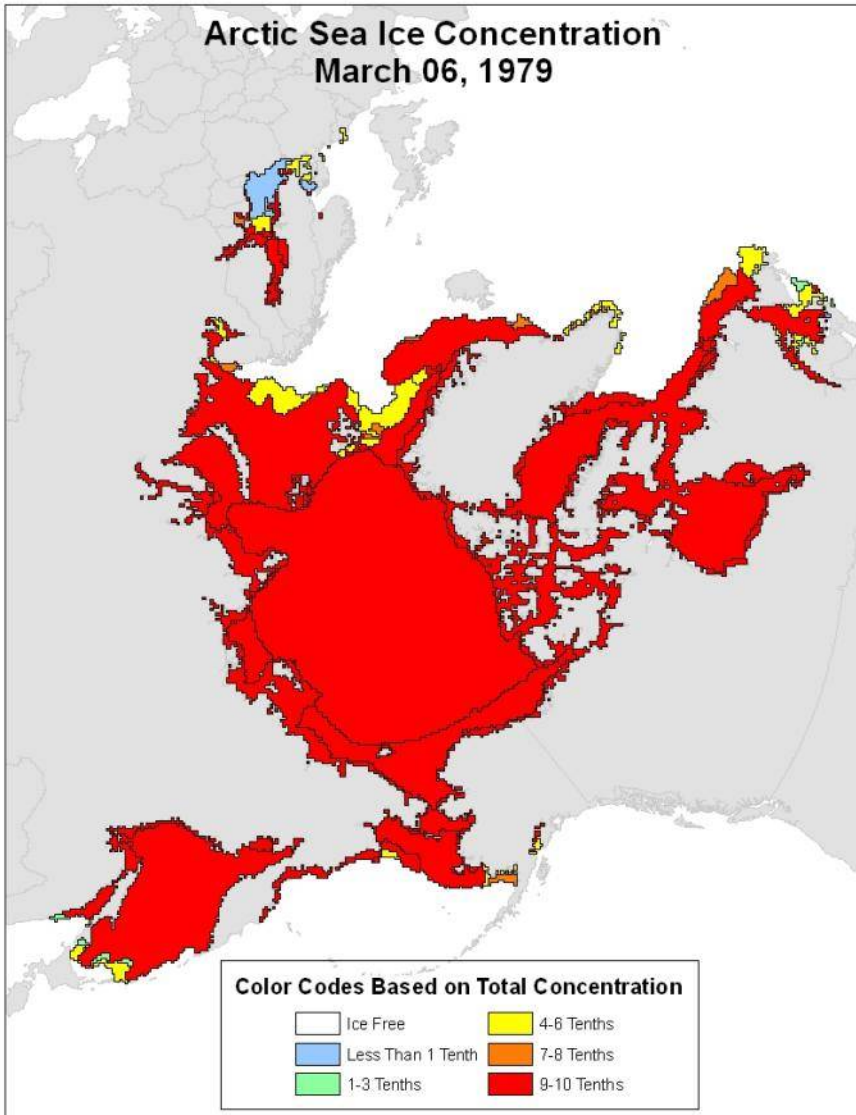
**Total Ice Extent =
12.11 million sq km**

**MYI Ice Extent =
6.20 million sq km**

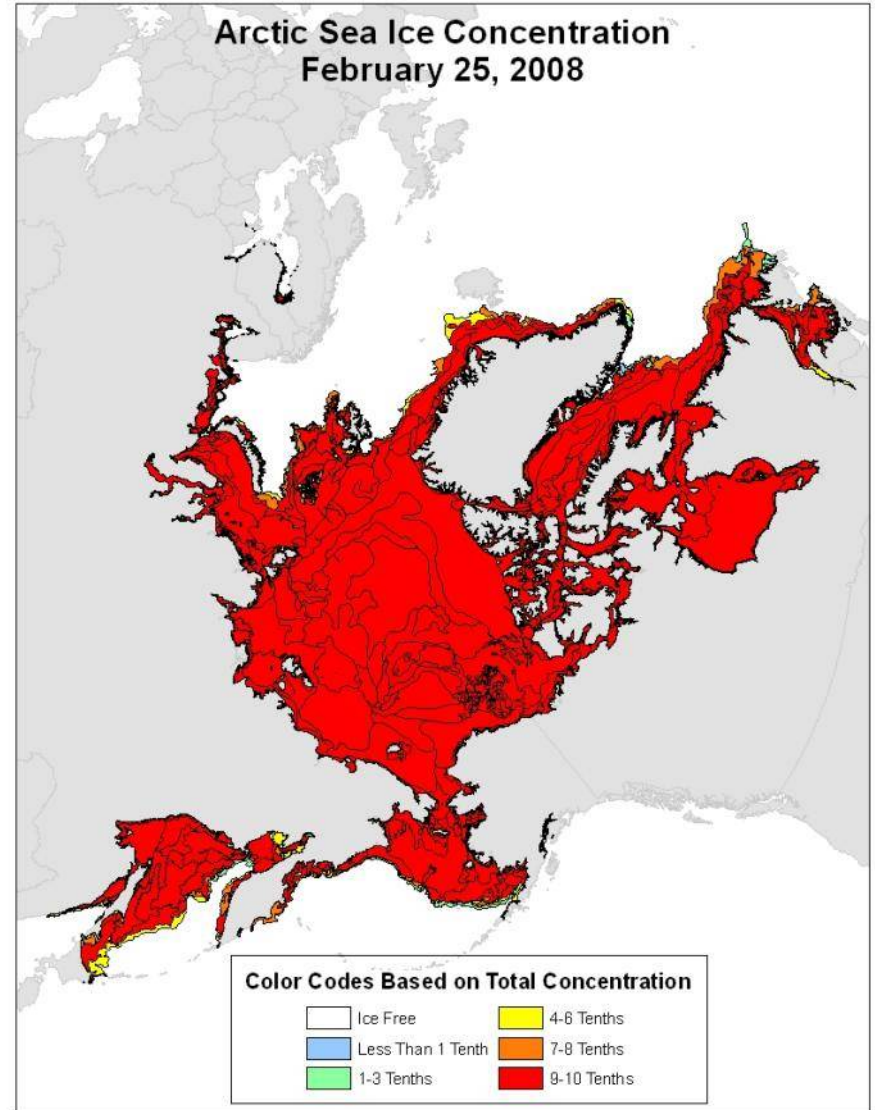
**MYI Ice Extent =
3.89 million sq km**



Increased Detail of NIC Analysis 1979 to 2008



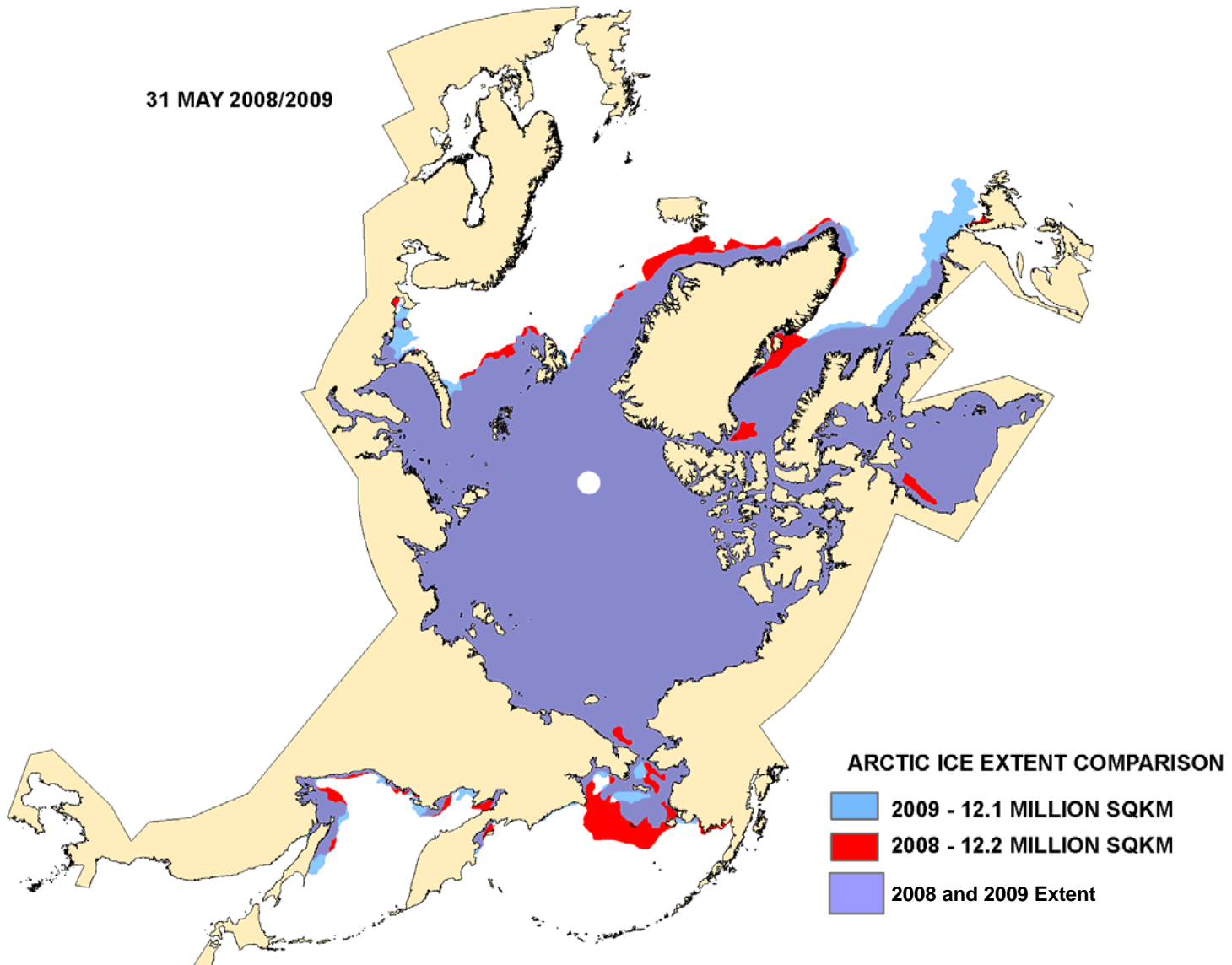
Total Ice Extent = 15.41 million sq km



Total Ice Extent = 14.63 million sq km



Arctic Ice Extent 31 May 2009 vs. 2008

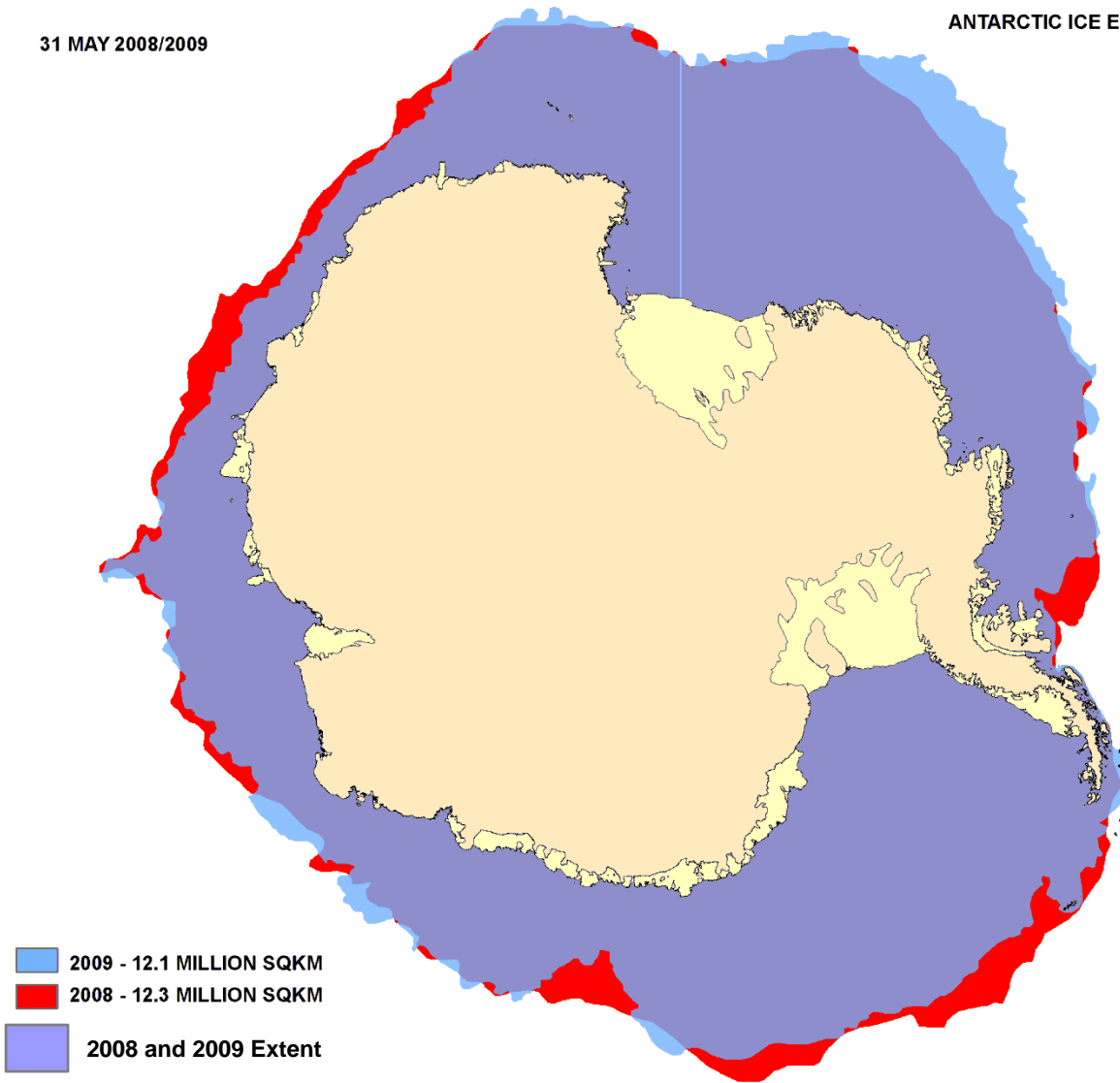




Antarctic Ice Extent 31 May 2009 vs. 2008

31 MAY 2008/2009

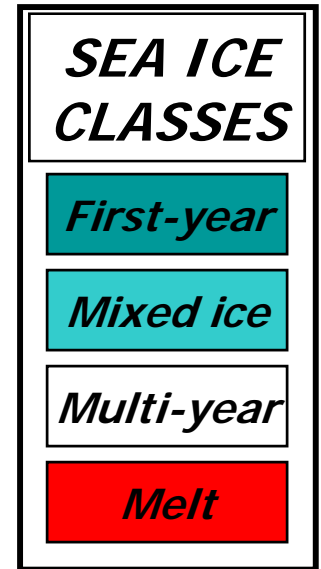
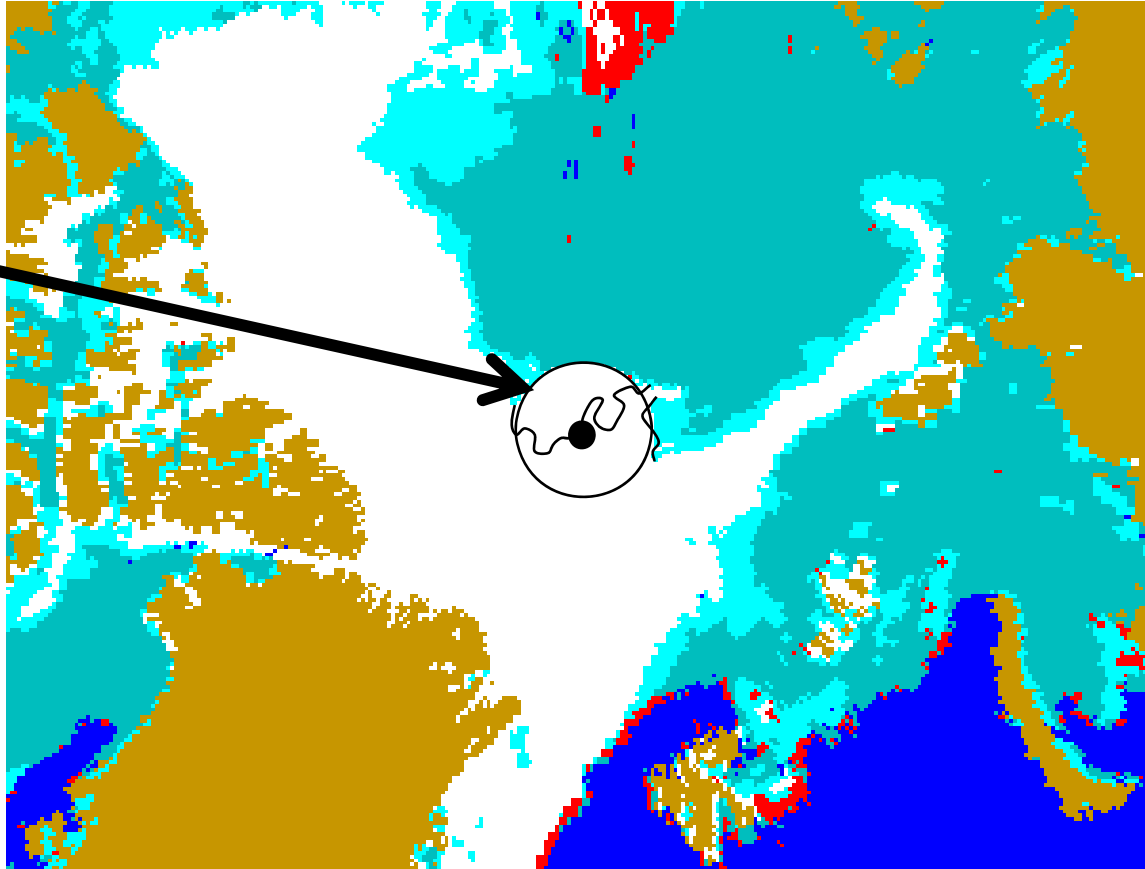
ANTARCTIC ICE EXTENT COMPARISON





Arctic Satellite Coverage Concern

Typical
Satellite
Imagery
Blind
Spot

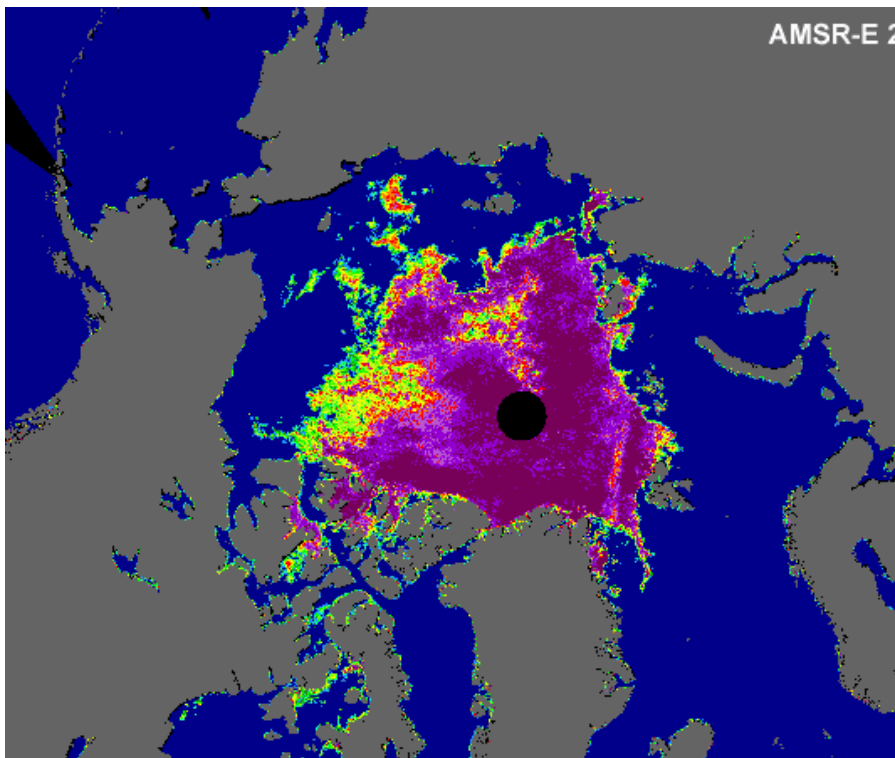


Perennial ice boundary at North Pole by 12/2/2007



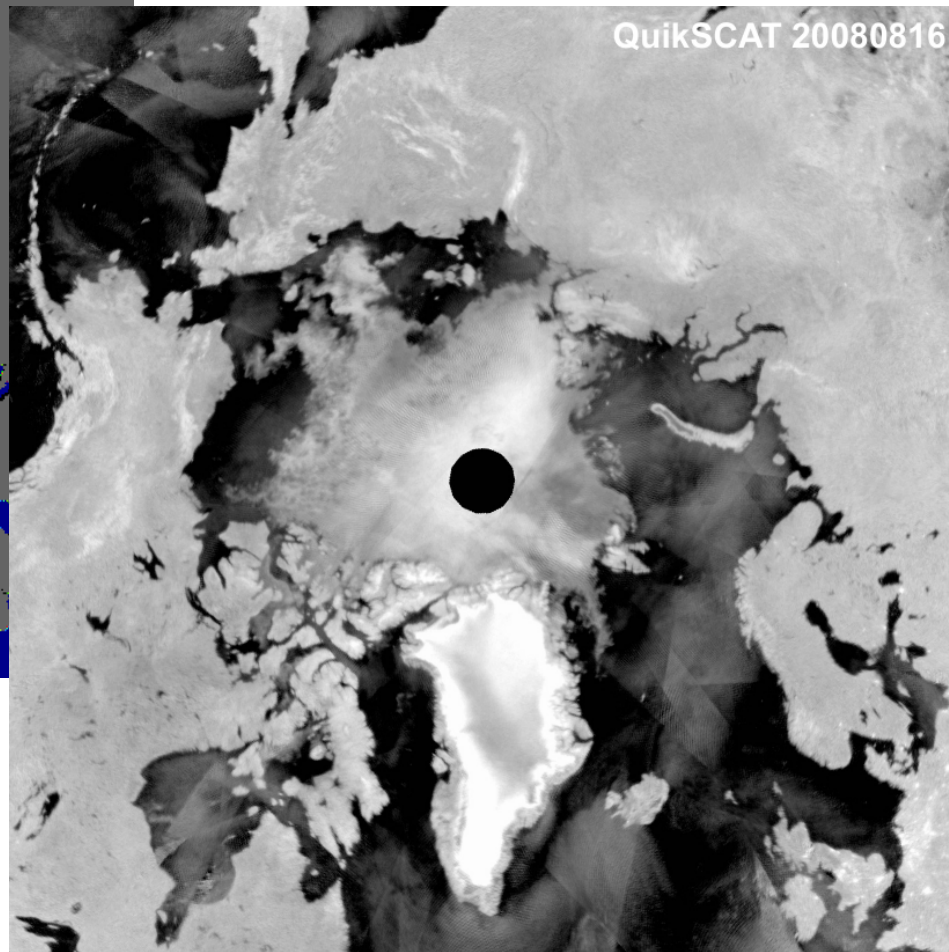
Arctic Satellite Coverage Concern

AMSR-E 20080820



*Passive Microwave Sea Ice Concentration
20 August-27 September 2008*

QuikSCAT 20080816



*Active Microwave Sea Ice Backscatter
20 August-26 September 2008*



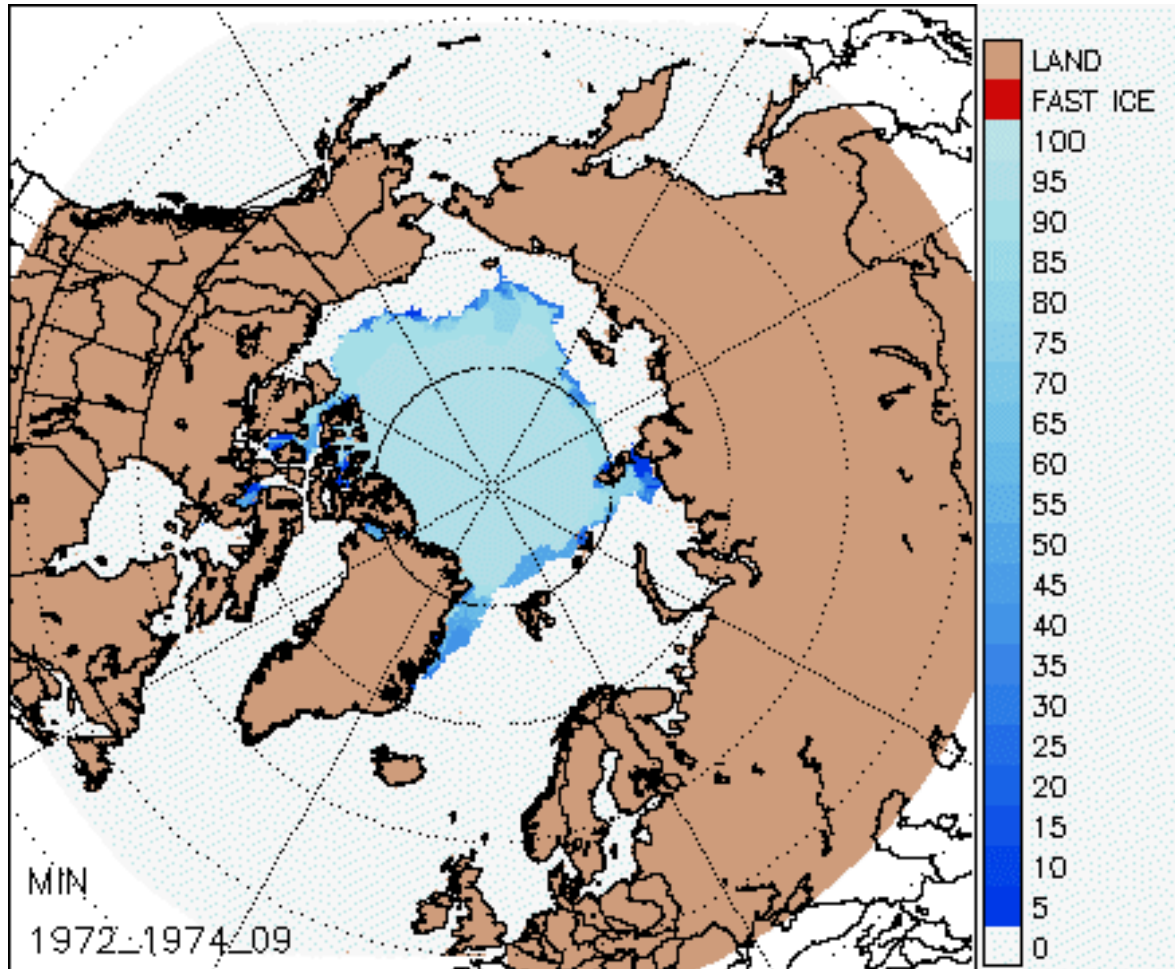
Developments

- **Climatology to 2007 – working toward 2009**
- **Use of Envisat data**
- **Interactive Multi-Sensor Snow and Ice Mapping System (IMS) operational at the NIC 2008**
- **NWS and CIS standardization and cooperation**
- **Graphical Marginal Ice Zone (MIZ)**
- **All products in KML/geo-referenced**
- **Operational Sea Ice Index**
 - **Joint project with NSIDC**
 - **IMS Ice Mask, Daily, 4km**



Arctic Climatology

NIC Arctic sea ice charts and 35 year climatology dataset



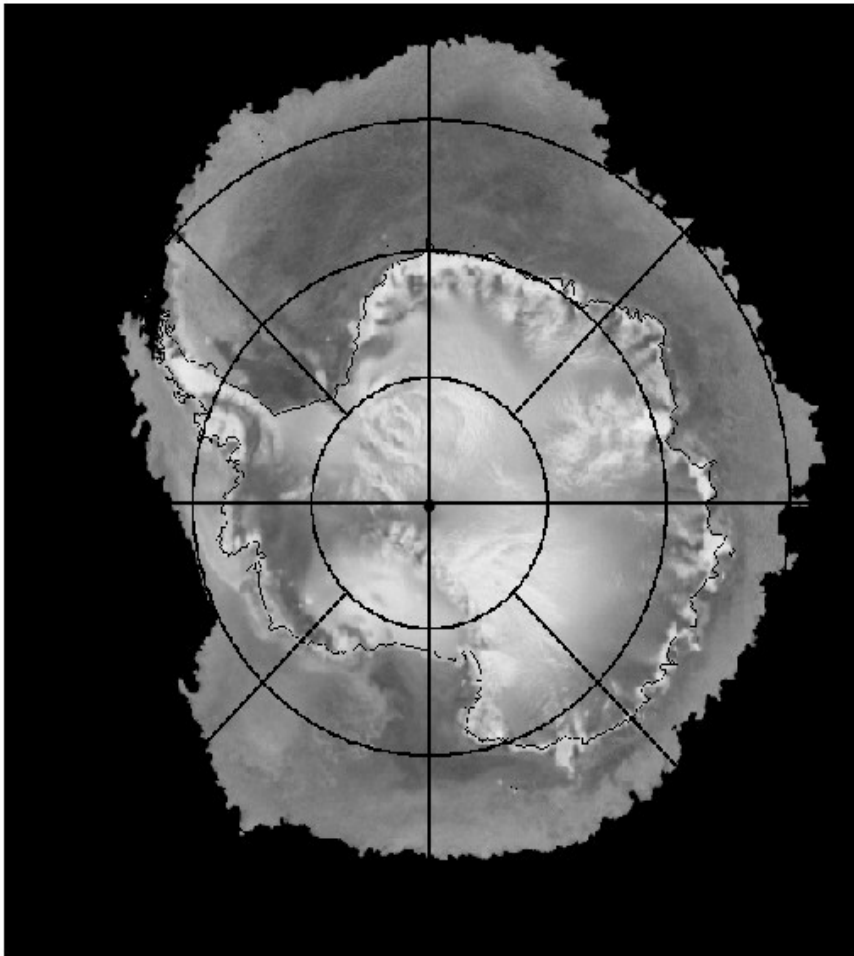
Uses

- *Input to NIC analysis*
- *Input to numerical forecast models*
- *Climate research*
- *Mission / route planning*
- *Updated to 2007*

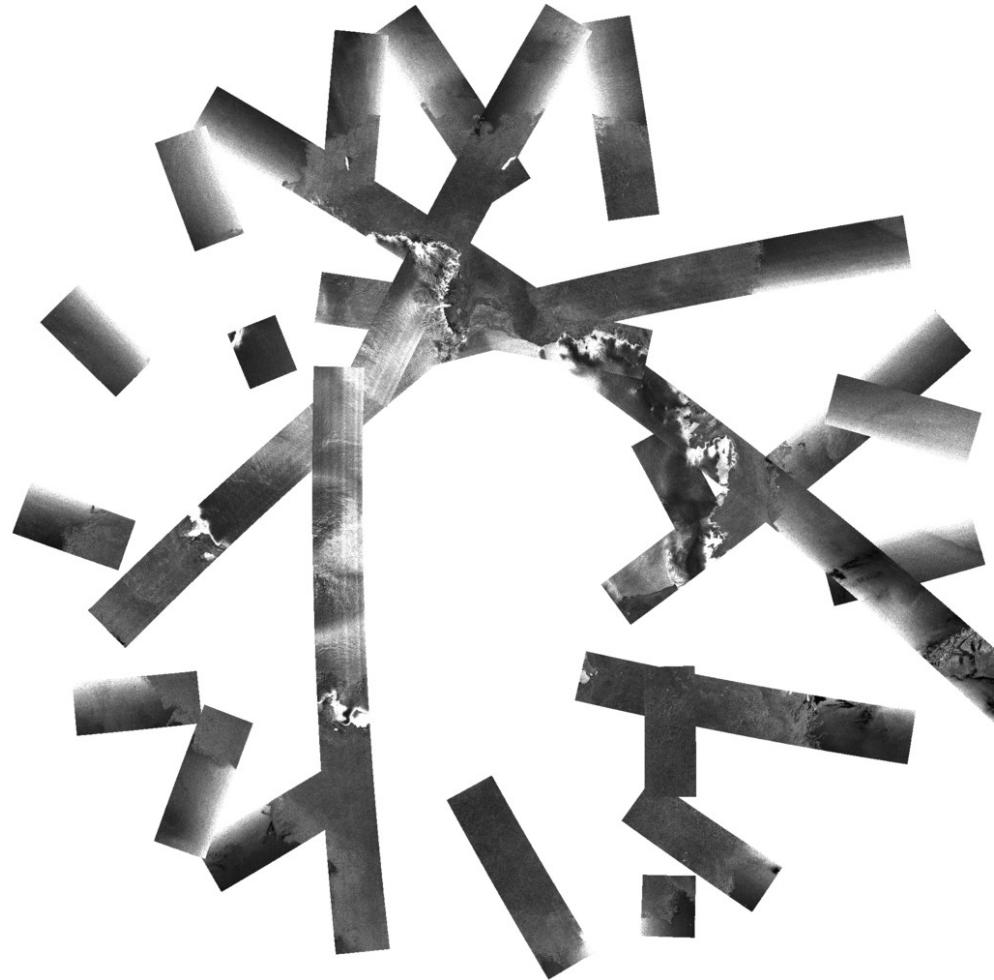


2007 Began Operational Use of Envisat Hemispheric Data

Southern Hemisphere Quikscat
00z 9/18/2005



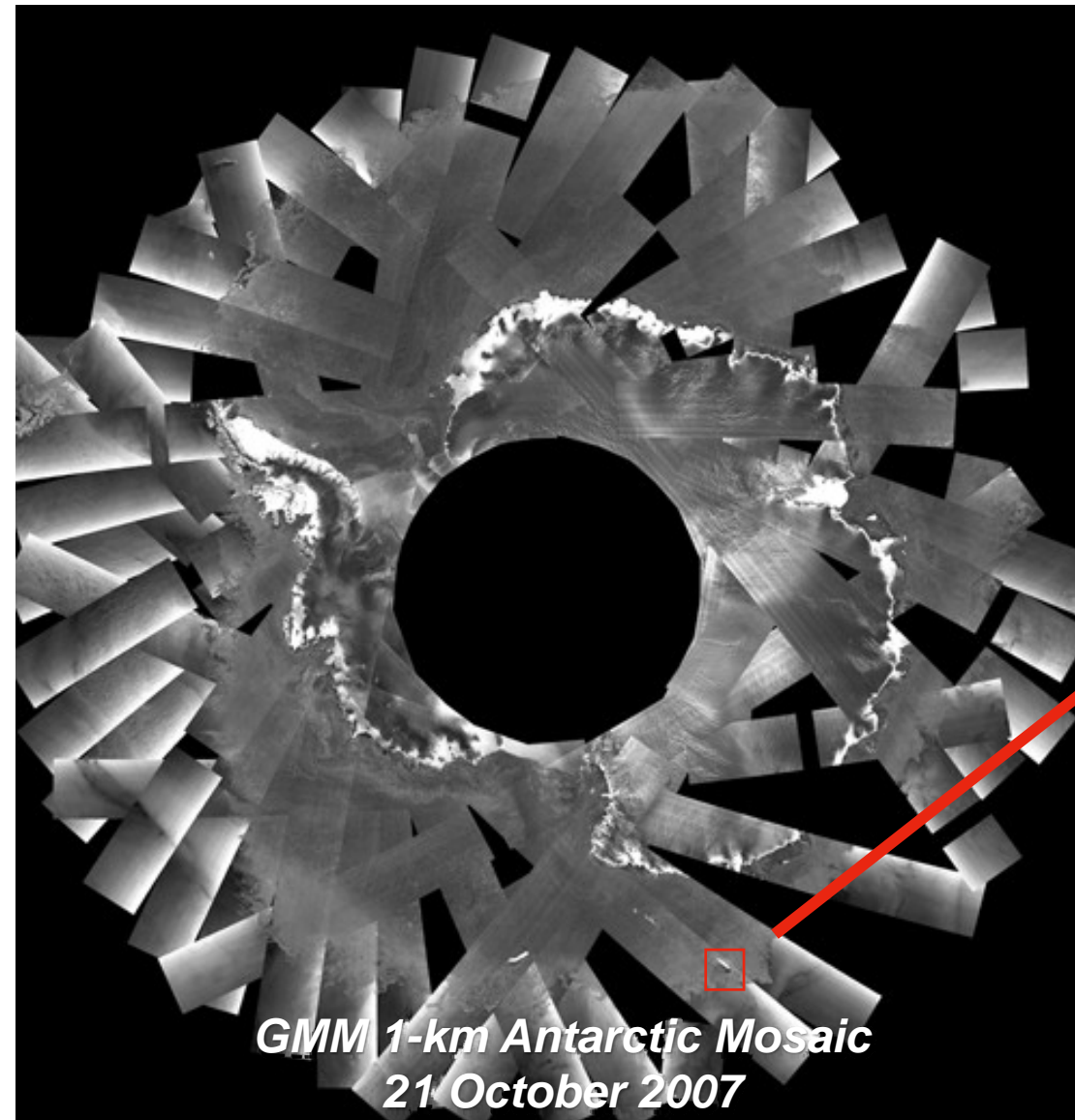
Ice Mask



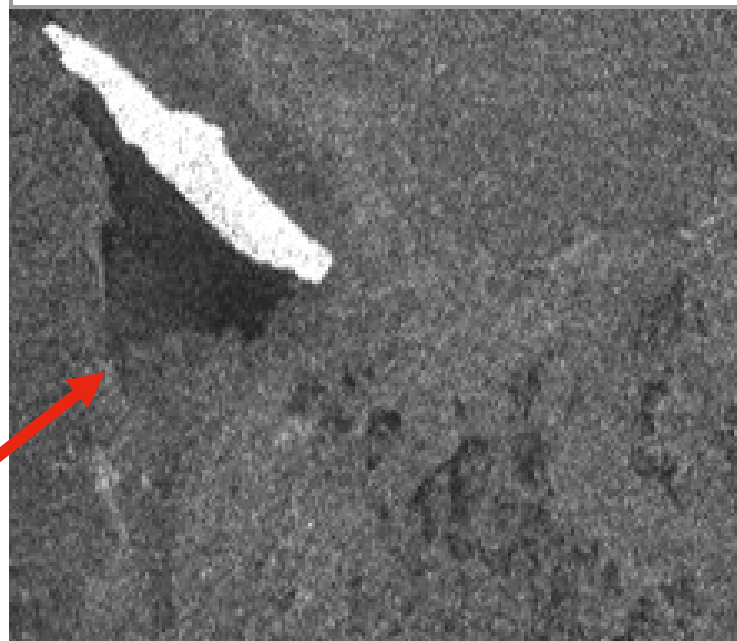
GMM 1-km Antarctic Mosaic
21 October 2007



Envisat ASAR GMM 3-day Mosaic



*GMM 1-km Antarctic Mosaic
21 October 2007*



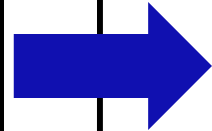
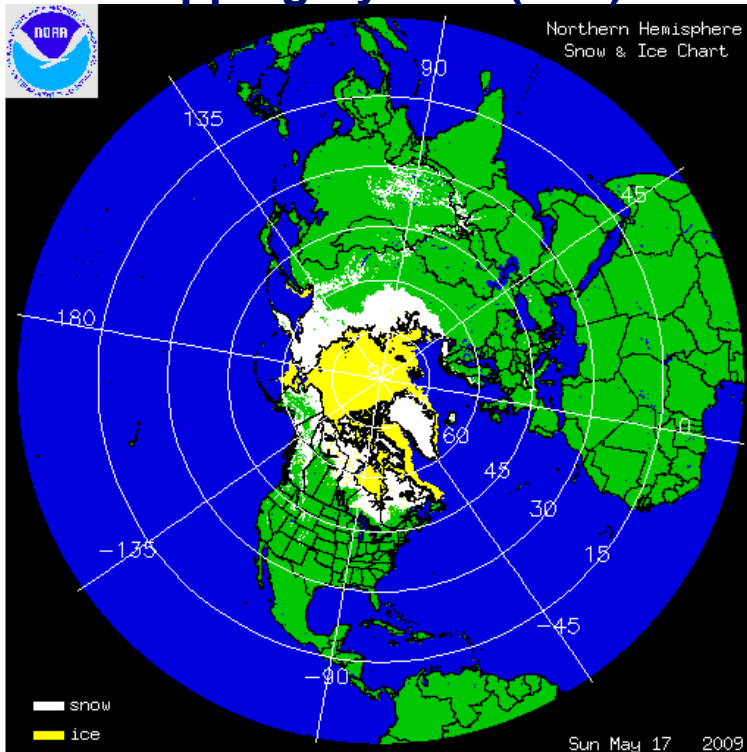
EARTH OBSERVATION FOR POLAR MONITORING



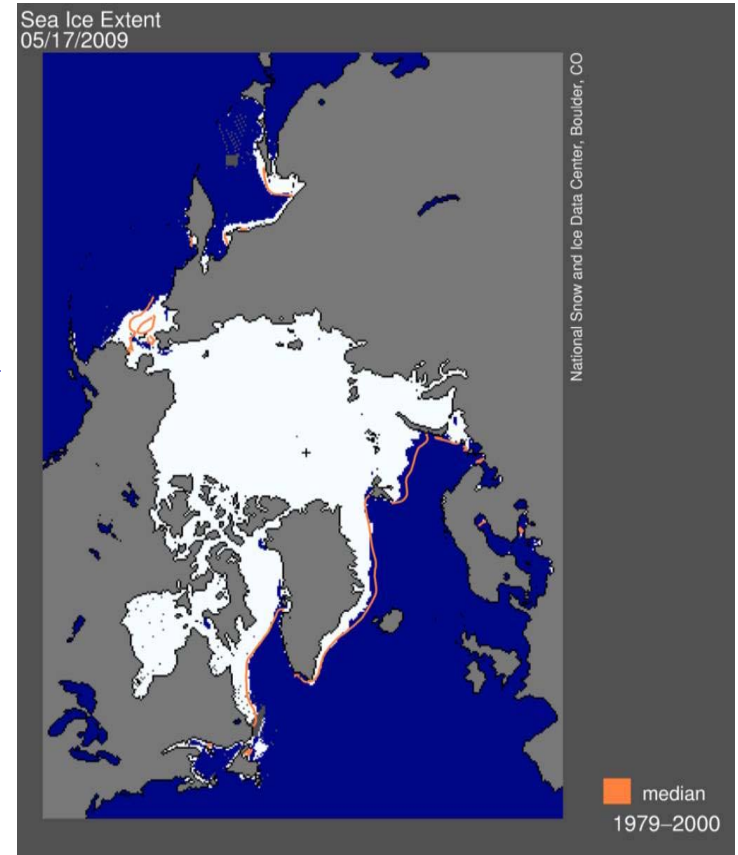


New Operational SII Product Under Development

Interactive Multi-Sensor Snow and Ice Mapping System (IMS)



An Operational Sea Ice Index (OSII)



- 4km Daily Northern Hemisphere analysis

Inputs: Visible, Infrared, Microwave, Derived snow/ice products, Surface Observations

To complement the NASA-developed methods using passive-microwave data from the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave/Imager (SSM/I).



Changes in Requests and Requirements

- **Manned and resourced for past mission, stated requirements, and limited operations**
- **Important and expanding mission for USCG, Navy, and NOAA**
 - **Change in type and number of missions to support (non-ice hardened ships and ice breakers)**
- **Forecast needs (7-days, 1-3 months, 1 year, 5-10 years)**
- **More complex and detailed ice information: Location, thickness, age, movement**
- **Broad based ice information still needed**

Navy, NOAA, Coast Guard, and other customers must clearly articulate ice product requirements for current and future arctic operations in order for NIC to plan, resource, and provide

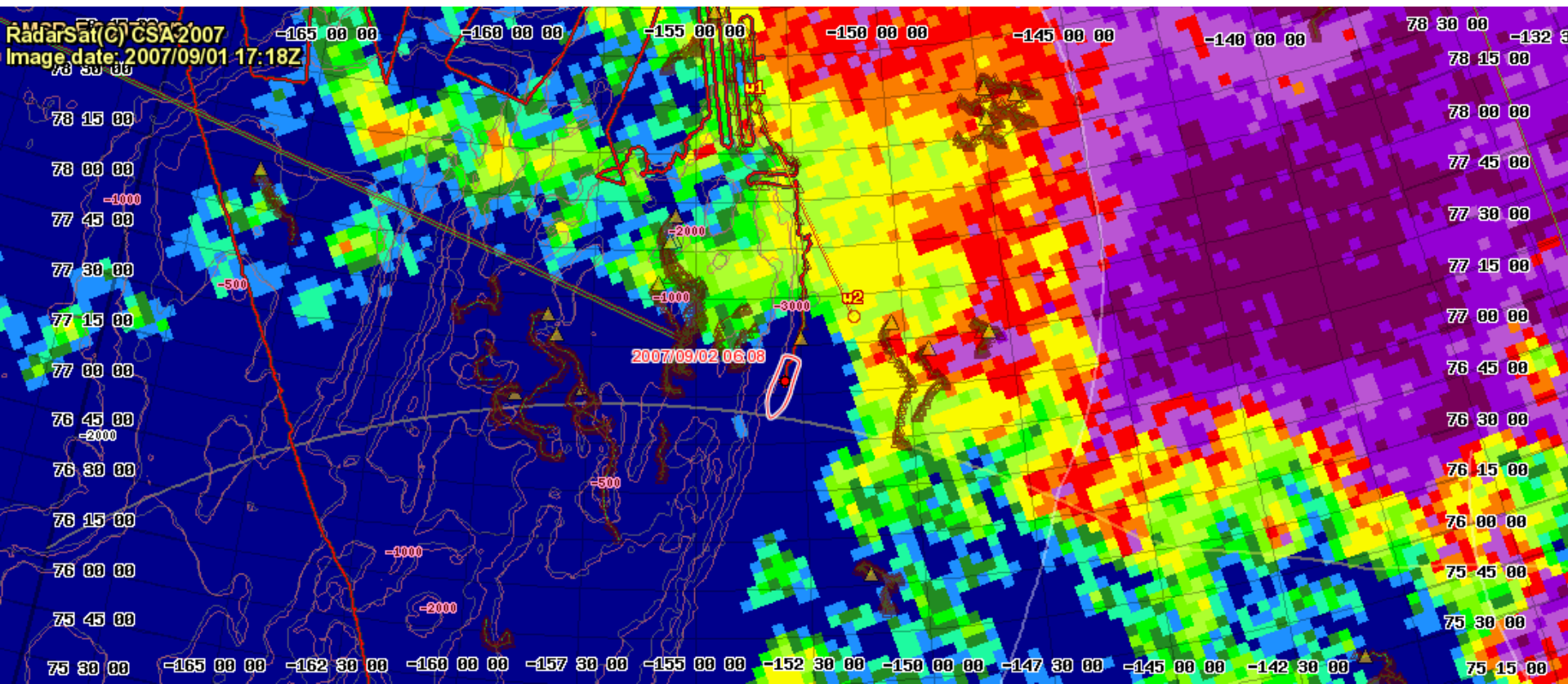


Ice Support Requirements for Safe Navigation

- **Increases in data resources**
 - **Real-Time availability of all-weather, day and night high resolution Synthetic Aperture Radar (SAR) imagery is key.**
 - **Seasonal ice buoys**
 - **Open ocean drifting buoys**
- **More analysts for increased detail and missions**
- **Ice Recon – USCG (IIP, D17), Navy?, (UAV/UUV?)**
- **Marine radar systems tuned to find, track, and report ice**
- **On board expertise by ice pilot or sea ice specialist**

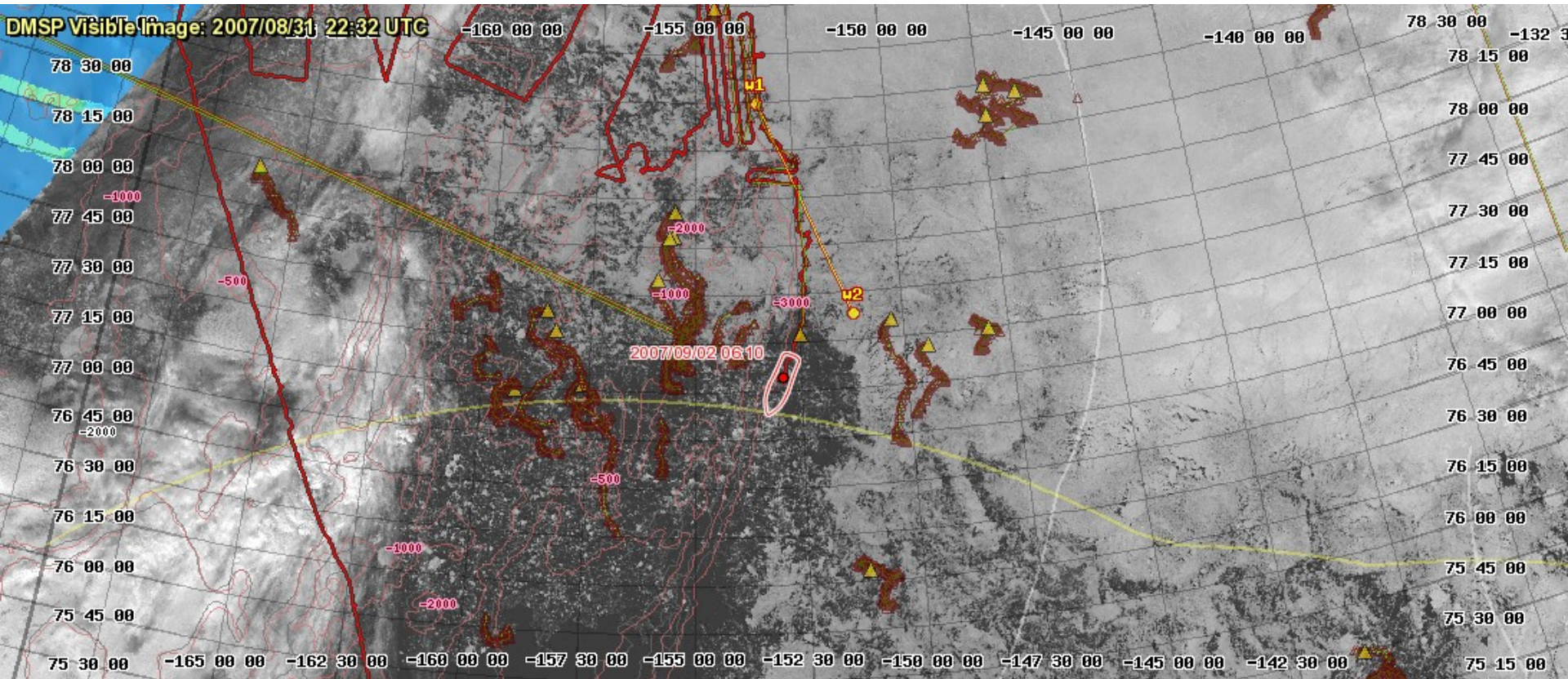


AMSR-E Passive Microwave Sea Ice Concentration



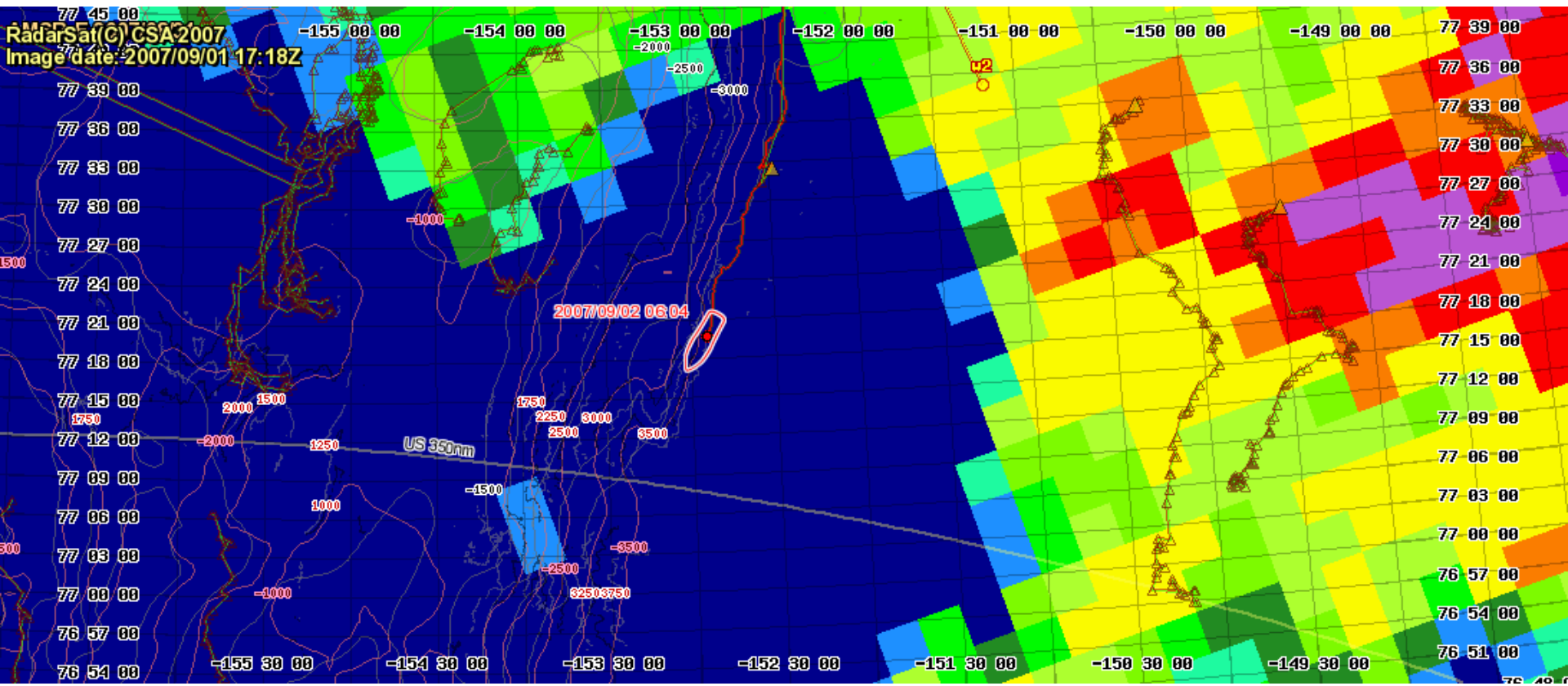


DMSP Visible Sea Ice Detection



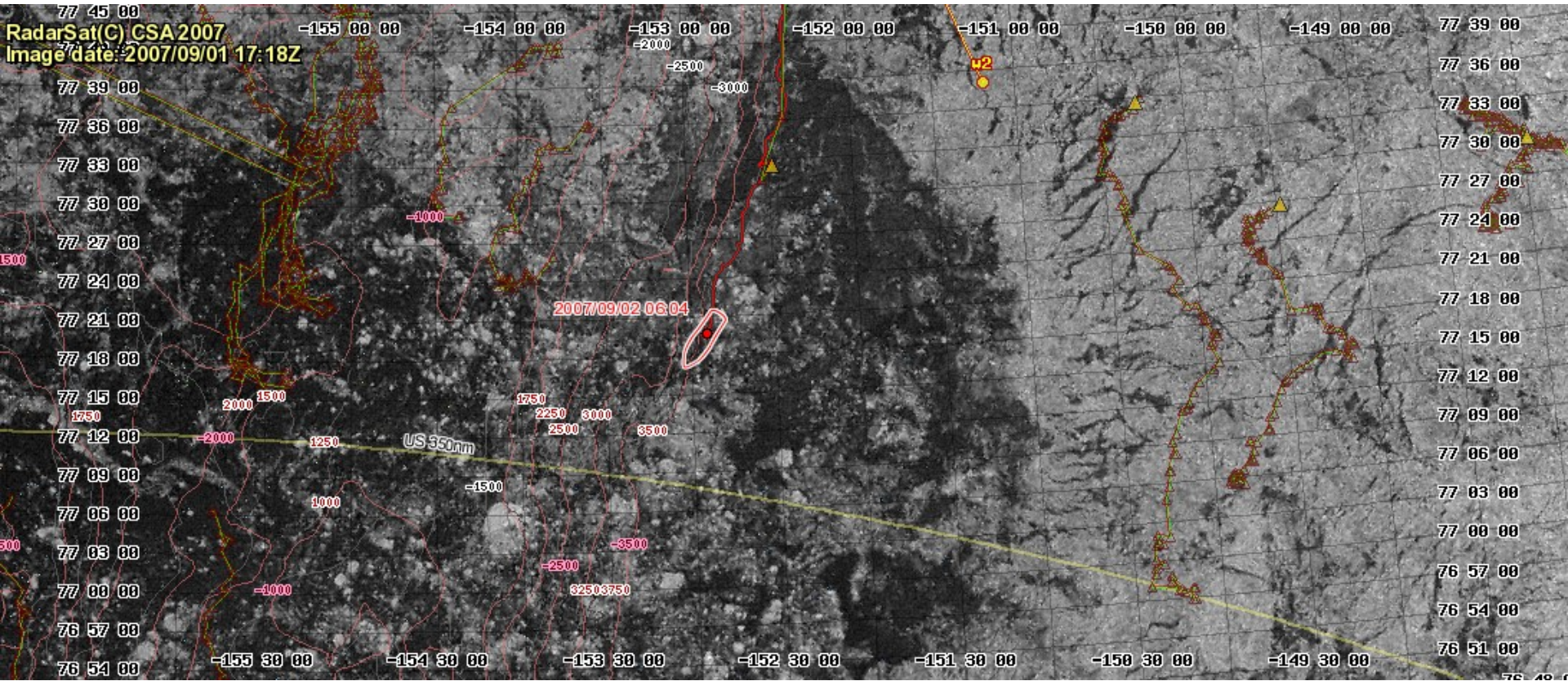


AMSR-E Passive Microwave Sea Ice Concentration





RADARSAT-1 SAR Sea Ice Detection







Ice Forecasting Capabilities

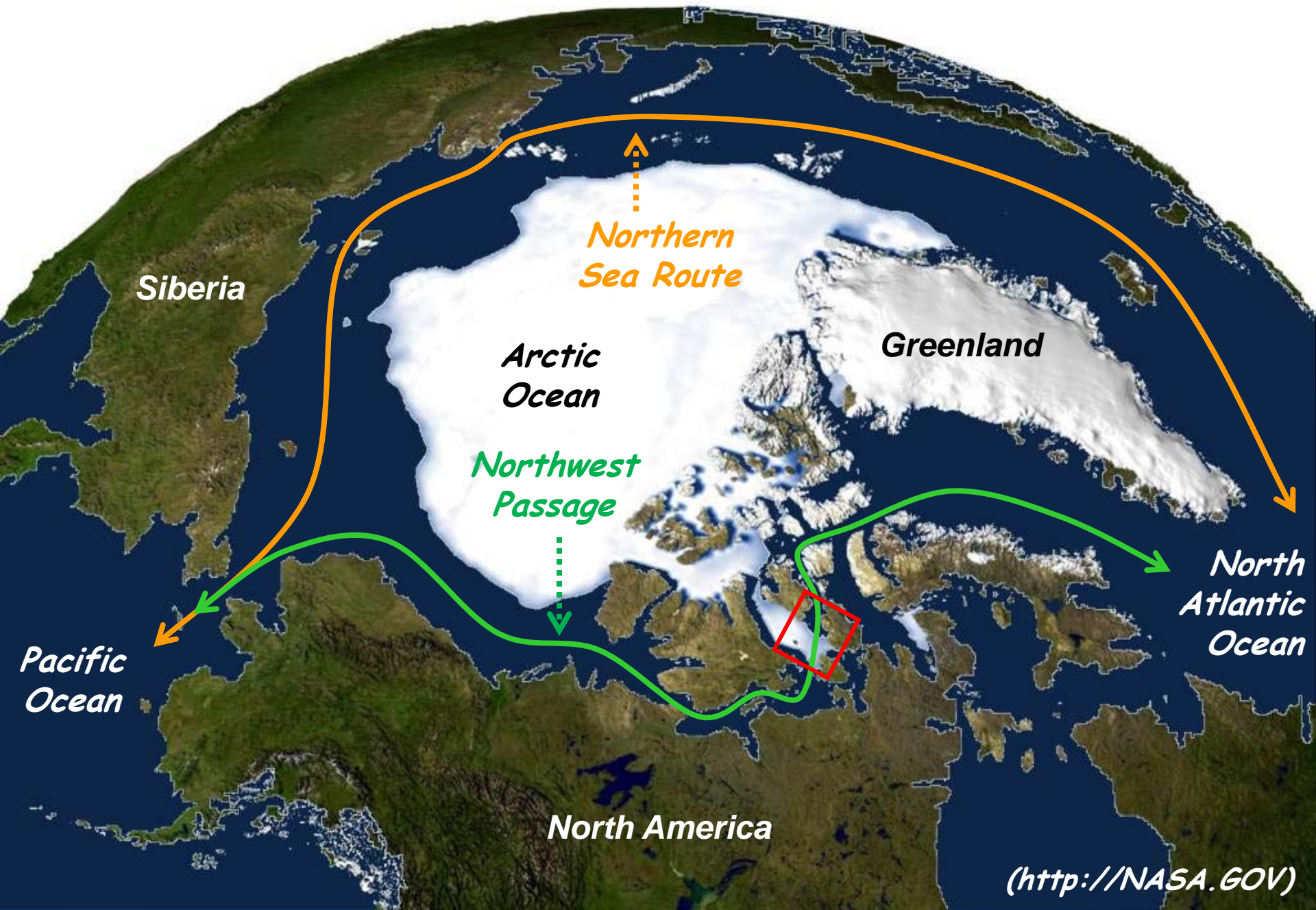
- **National/Naval Ice Center Current Mission and Capabilities**
 - **Expert ice analysis and nowcasting**
 - Tailored support for operational units (ice hardened/breakers/subs)
 - Daily Ice Edge and Marginal Ice Zone identification and forecast (24 to 48 hours)
 - Seasonal Outlooks for long-term planning based on probabilistic and historical analog methods
 - Hemispheric and regional products (not for direct operational support)
- **Future Mission and Capability Requirements:**
 - **Current PLUS forecasting ice location/movement expansion to 72 hours with 5 NM resolution supporting OTSR and WEAX operational support**
 - **Current PLUS forecasting ice location/movement expansion to 7 days for operational planning, 1-3 months, 1 year, 5-10 years for longer range planning**



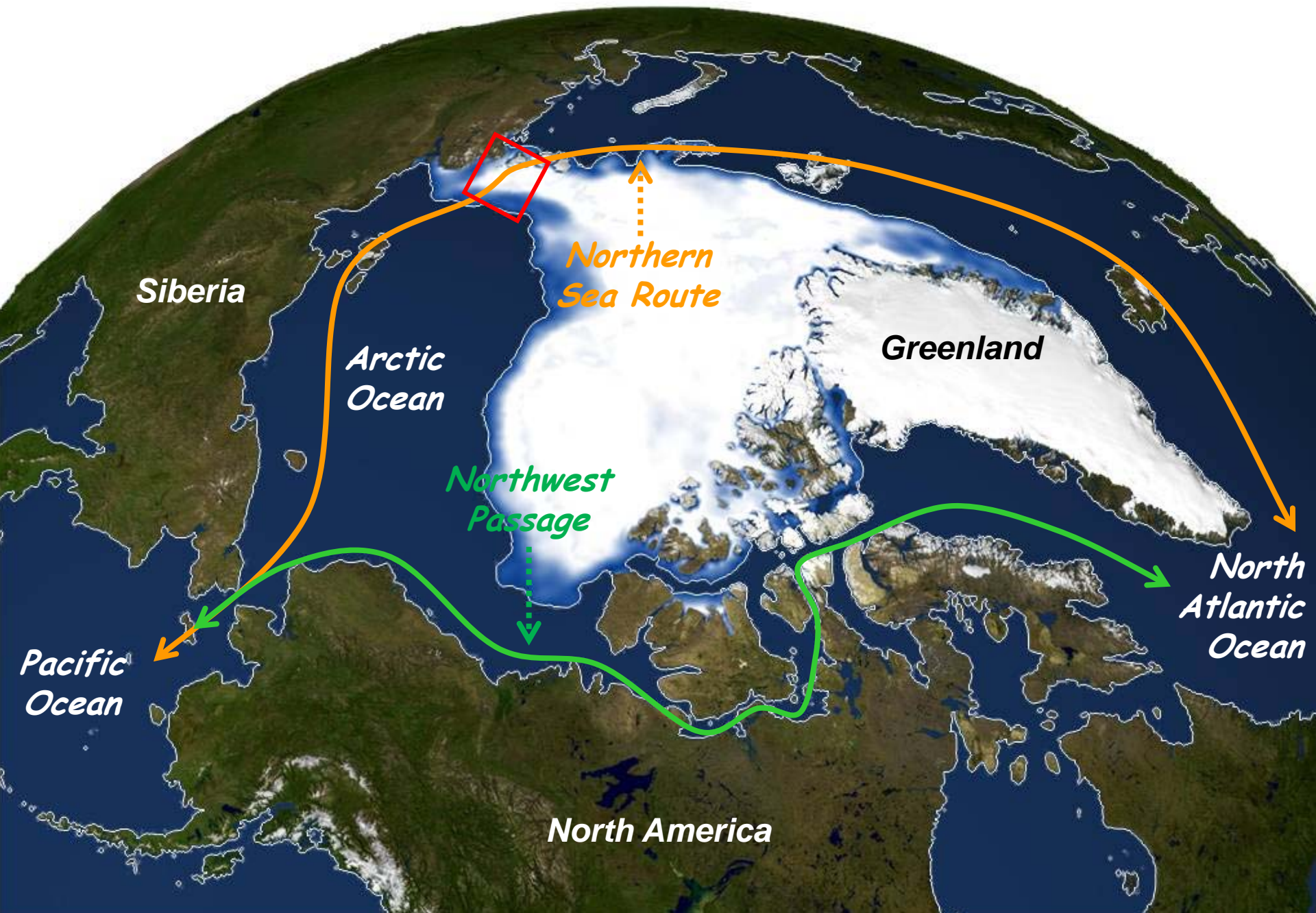
Required Capability Developments

- **Model improvements**
 - Validate present method and model skills to expanded forecasts
 - Improve PIPS or CICE using HYCOM or NOAA GFS
 - Assimilate higher spatial resolution AMSR-E data versus SSM/I
 - Use of new regionally tuned deterministic community sea ice models (ex. UAF model)
- **Increased observational systems**
 - ice and ocean buoys
 - hydrographic sensors
 - UAVs
- **Greater quantity of high resolution satellite imagery**
- **Increase in ice analysts and improvements and application of automated analysis capabilities**

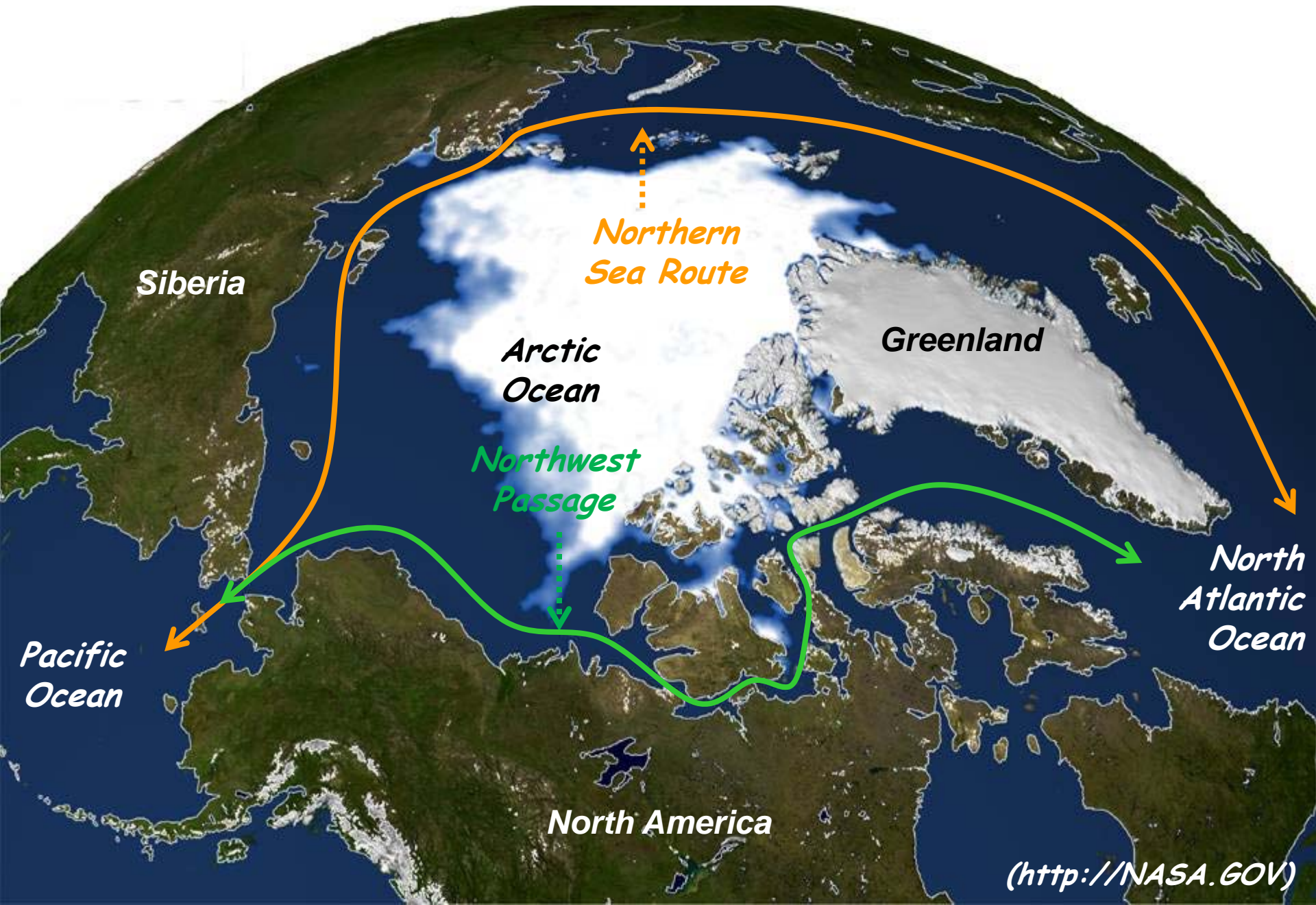
Arctic Routes and 2005 Sea Ice Minimum



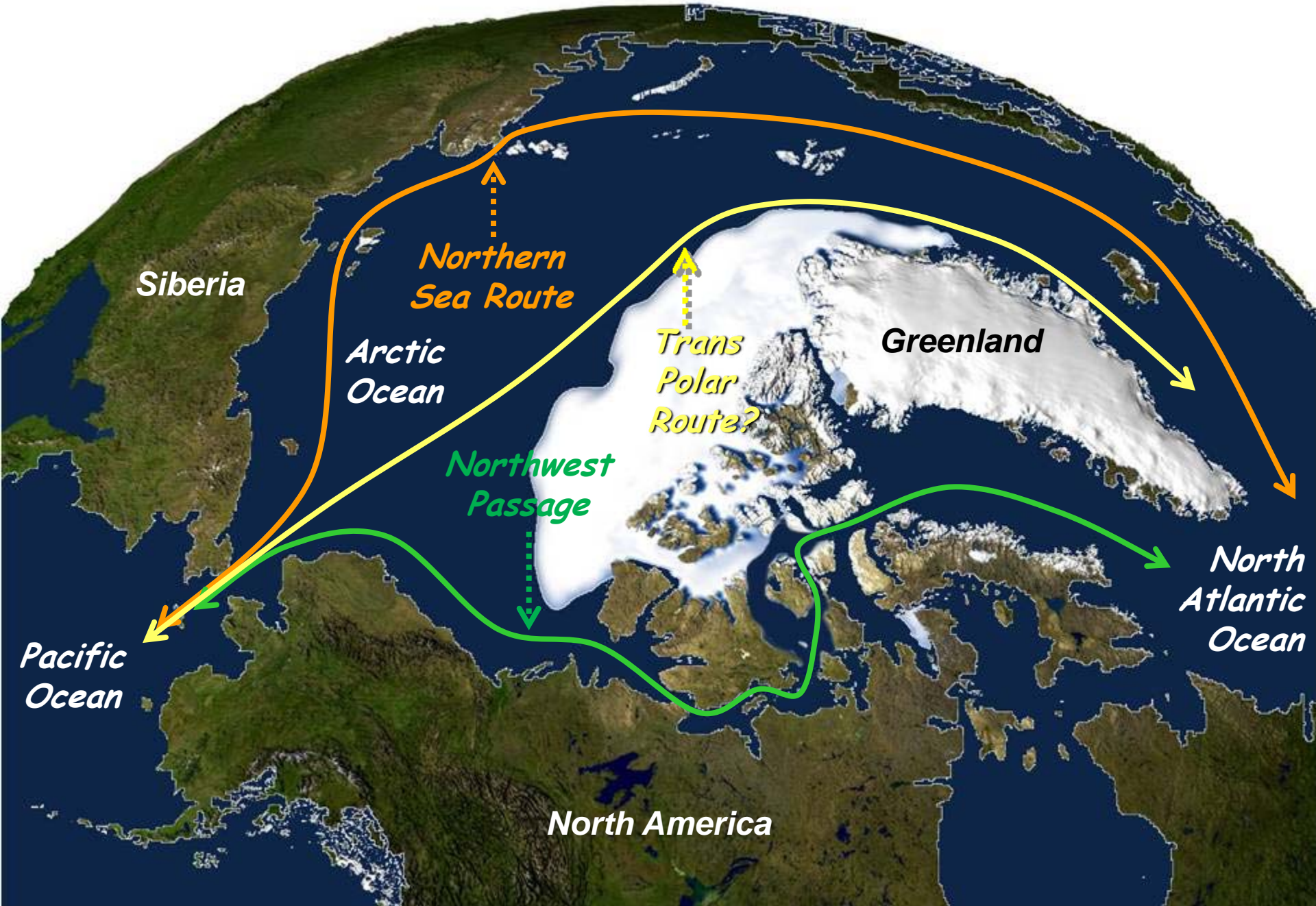
Arctic Routes and 2007 Record Minimum



Arctic Routes and 2008 Sea Ice Minimum



What is next and when???



Siberia

**Northern
Sea Route**

**Arctic
Ocean**

**Trans
Polar
Route?**

Greenland

**Northwest
Passage**

**North
Atlantic
Ocean**

**Pacific
Ocean**

North America



Questions?

