



Environment
Canada

Environnement
Canada

Canada



What's Really Happening with Arctic Sea Ice?

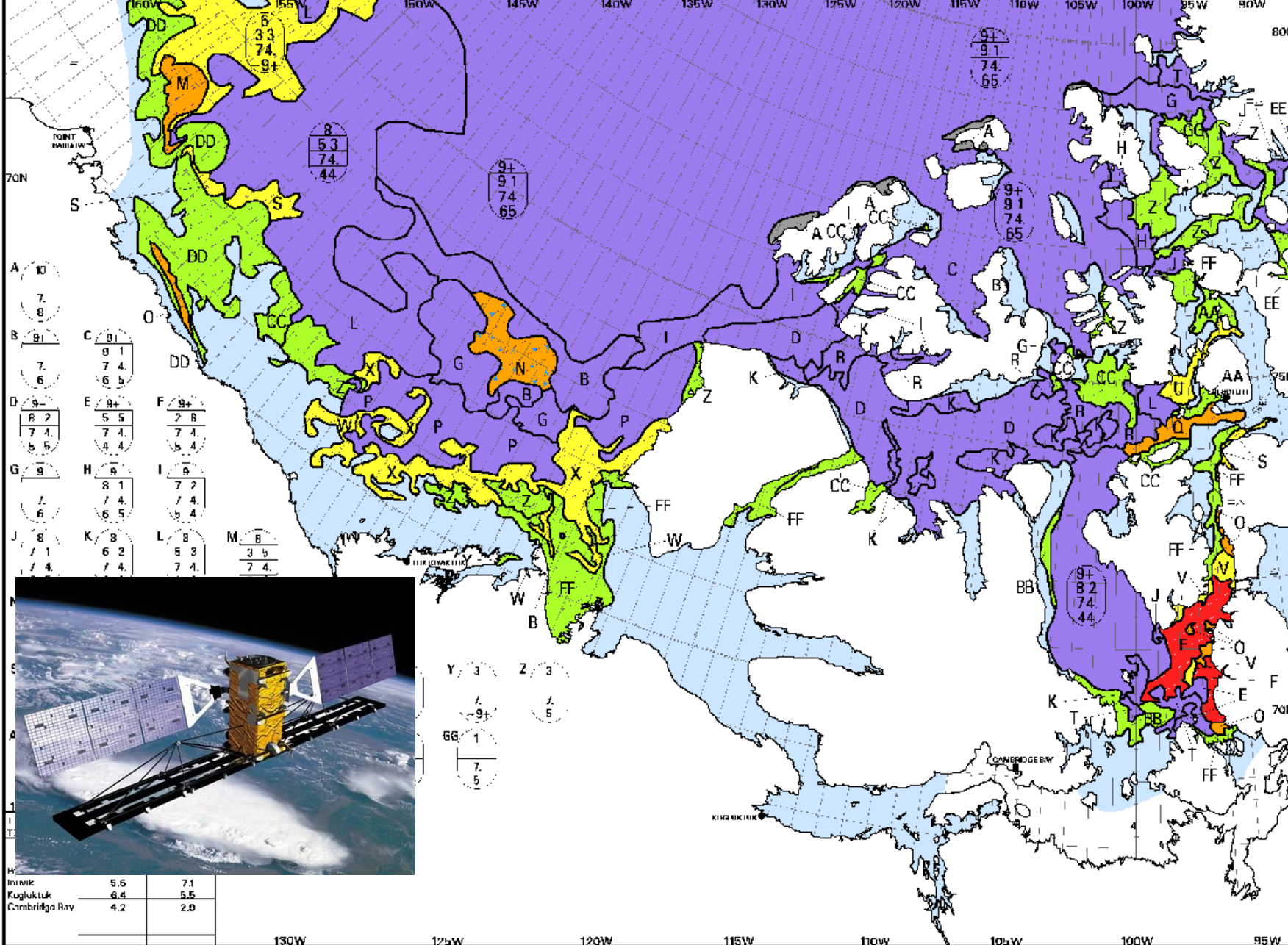
Leah Braithwaite

Acting Director, Canadian Ice Service

October 30 2013

REGIONAL ICE ANALYSIS Western Arctic
 ANALYSE REGIONALE DE GLACE Arctique de l'Ouest 05 SEP/SEP 2005

CANADIAN GLACIERS ENVIRONMENT CANADA
 SI RIVICI CANADII NDI RIGIACI S ENVIRONMENT CANADA



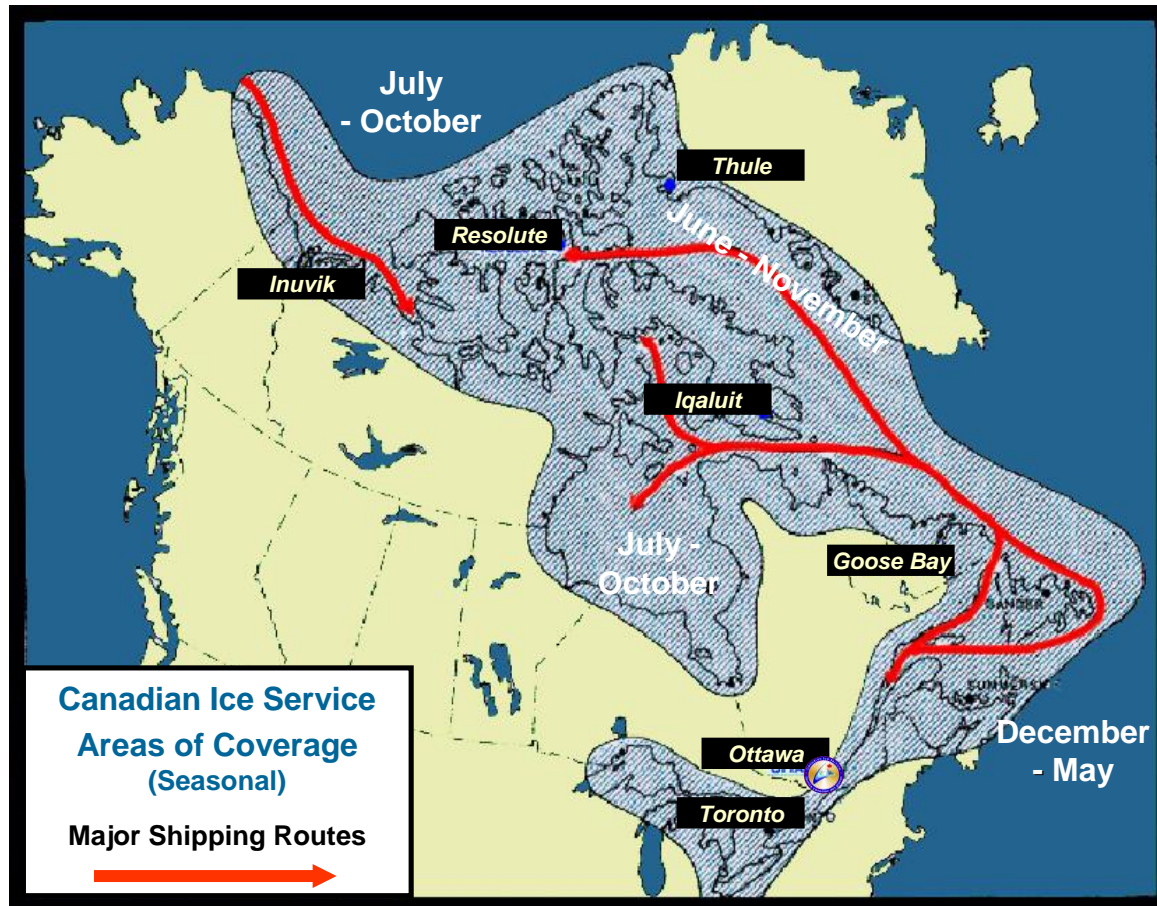
A	10	7	8
B	91	7	6
C	91	91	74
D	82	74	55
E	9+	55	74
F	9+	28	74
G	9	74	54
H	9	81	74
I	9	72	74
J	8	6	54
K	8	7	4
L	8	62	74
M	8	53	74



Inuvik	5.6	7.1
Kugluktuk	6.4	5.5
Cambridge Bay	4.2	2.9

Sea ice is a very Canadian issue...

- Canada claims the world's:
 - longest coastline
 - greatest area of ice
- Annual variation in extent of ice is approx. $\frac{1}{2}$ the area of Canada (4M km²)
- Ice exerts seasonal effects on:
 - weather and climate
 - marine ecosystems
 - Northern culture
 - **safety and efficiency of marine transportation**



***...and the risks of Arctic marine transportation
to safety and the environment are real...***

Grounding of Malaysian-
flag Bulk Carrier M/V
Selendang Ayu on the
north shore of Alaska,
December 8, 2004.

Six crew lost and
336,000 gallons of fuel
spilled



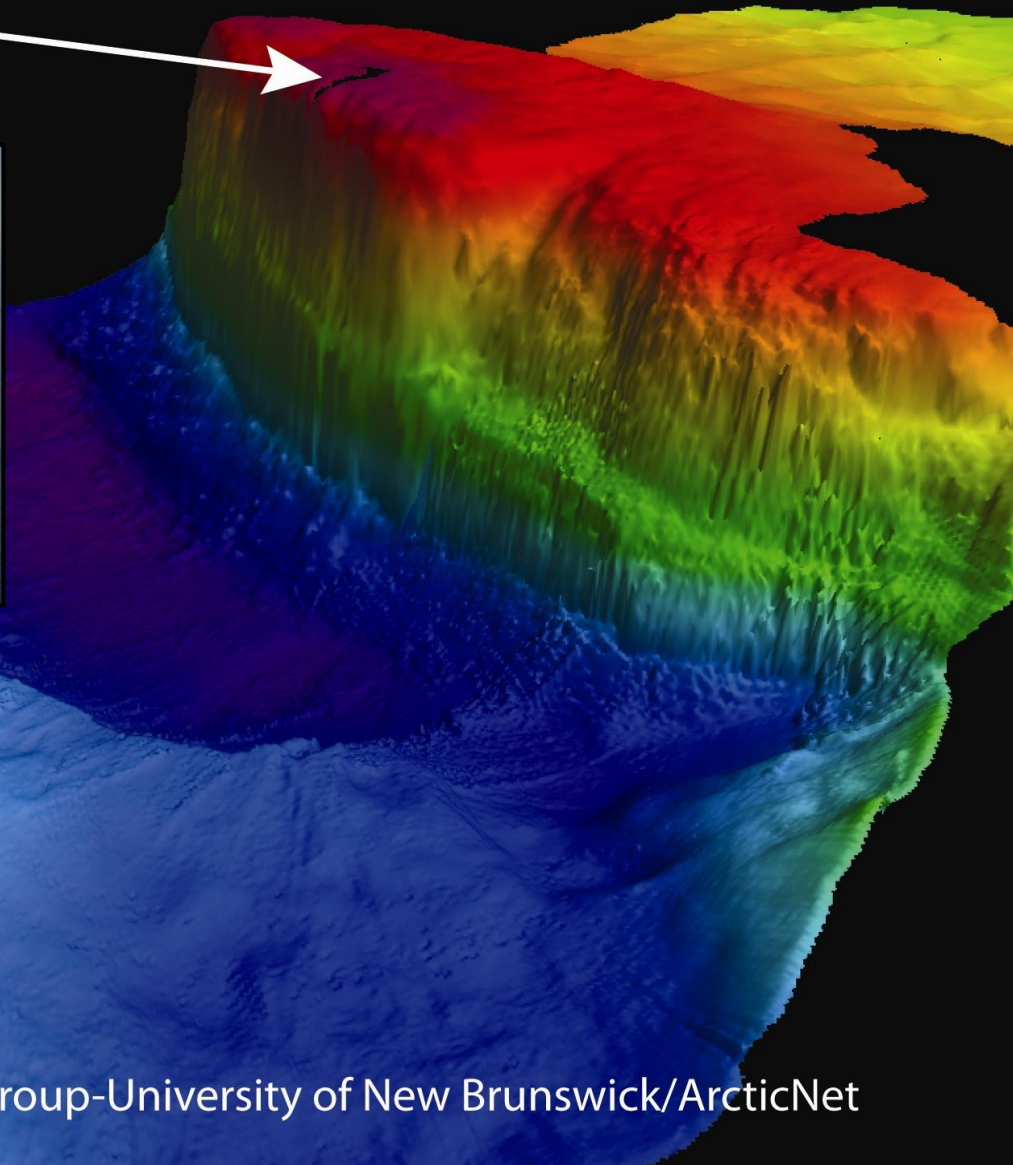
...and increasing. In 2010, three vessels ran aground in Canadian Arctic waters.



- M/T Mokami
- Clipper Adventurer
- M/T Nanny



MV Clipper Adventurer



Depth (m)

3

15

30

45

60

75

90

115

Image © Ocean Mapping Group-University of New Brunswick/ArcticNet

19:28:35 23/09/2013

Depth
Tilt
Pan

457.0Htrs
-33.1Deg
0.7Deg



19:30:44 23/09/2013

Depth
Tilt
Pan

457.0Htrs
-32.4Deg
0.7Deg



Sea Ice development



Encountering sea ice

- It has different stages of development:
 - New ice, grey, grey-white,
 - thin/medium/thick first year,
 - second year, multi-year
- There is usually ridging and rafting
- The pack ice is not uniformly one type and can contain ice of land origin
- It is frequently snow covered, so difficult determine ice type



There are challenges...

- Periods of 24 hr darkness, dangerous cold; affecting people and equipment
- Vast distances and lack of infrastructure: ports, repair, salvage, fuel/provisions
- Navigation issues: charts, radar, satellite, manouvering room
- Charts: 10% of Arctic is charted to modern standards
- Communications
- Weather events – winds, blizzards, freezing spray, fog
- Water depth, rocks, shoals
- Tides, currents
- Sea ice, icebergs
- Ice conditions: old ice, ice pressure, ridges, snow cover



The Arctic is changing...

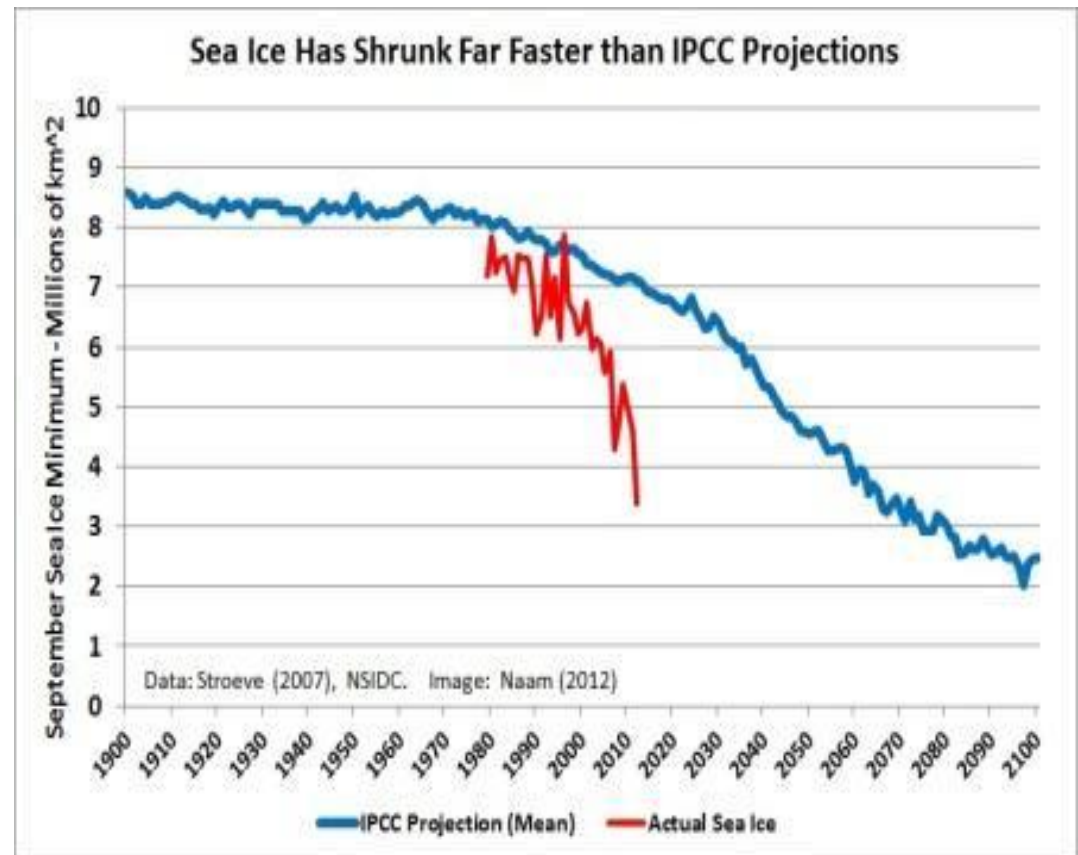
...and warming faster than any other region on the planet.

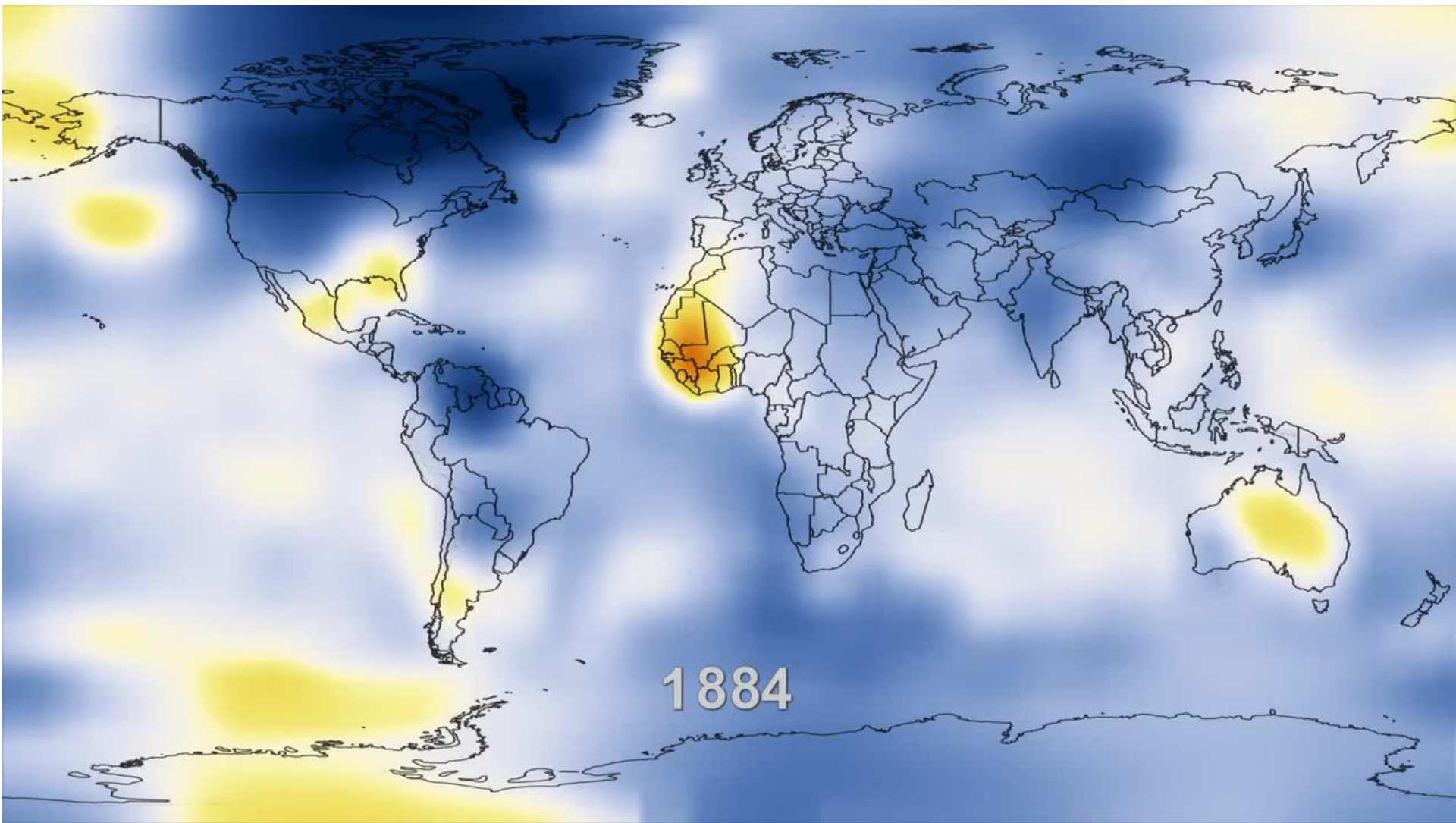
The most sophisticated models today are beginning to converge on an Arctic T° increase of approx. 8-9 $^{\circ}\text{C}$ if CO_2 is 2.5 - 3 times greater than 19th C

These complex computer programs simulate the climate of a virtual earth

A model is “tuned” until it correctly simulates the climate of the past 10 – 15,000 years

Then it is projected into the near future using different CO_2 scenarios and other GHG concentrations

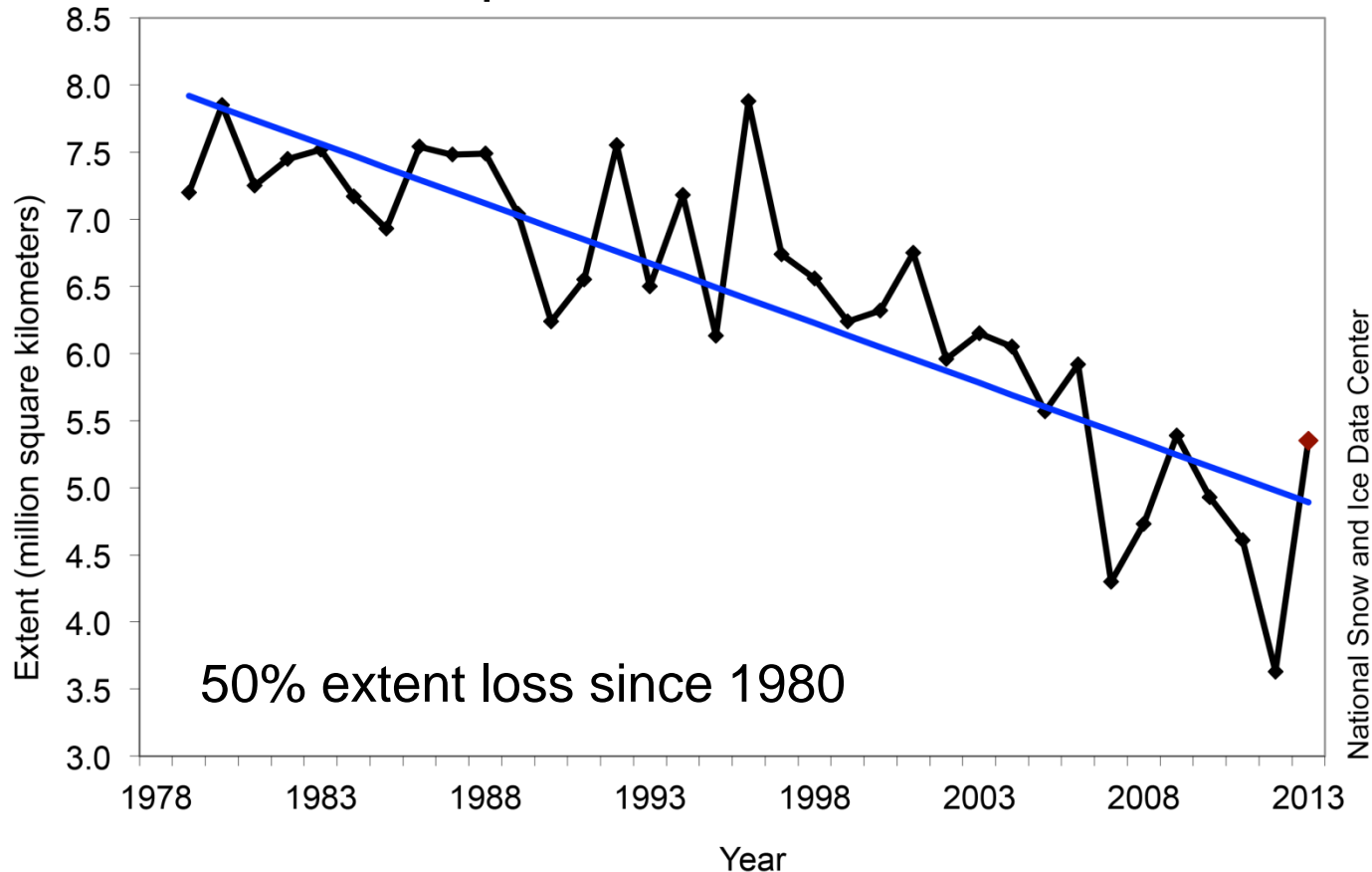




NASA

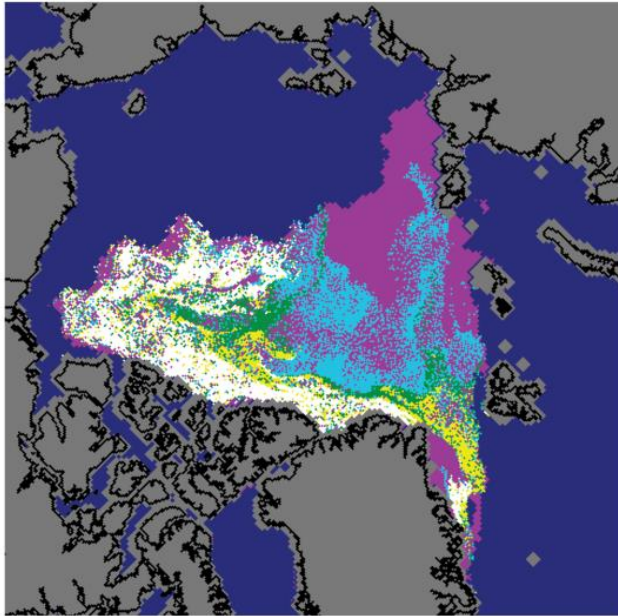
What's happening to sea ice minimum extent ?

Average Monthly Arctic Sea Ice Extent September 1979 - 2013

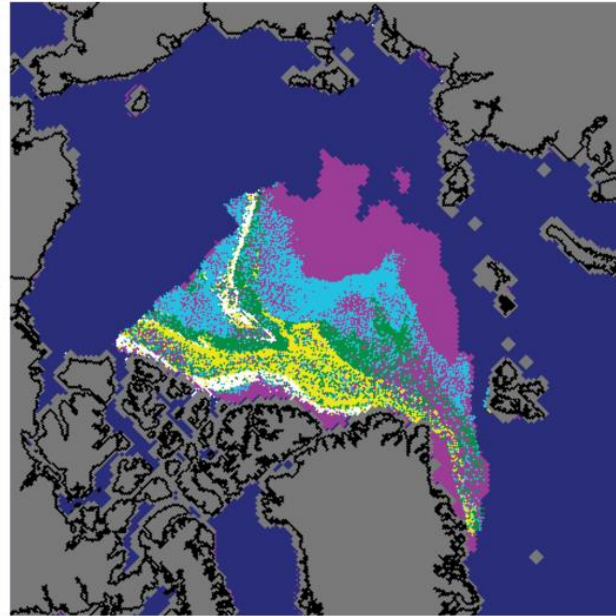


What's happening to Arctic sea ice age ?

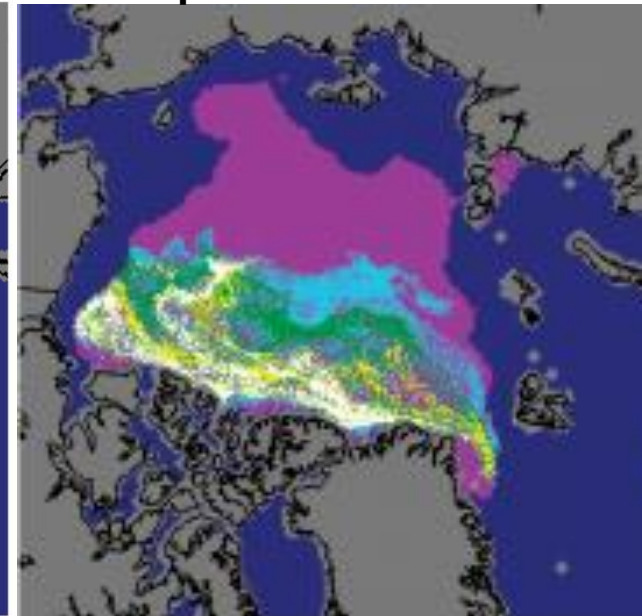
September 2007



September 2012

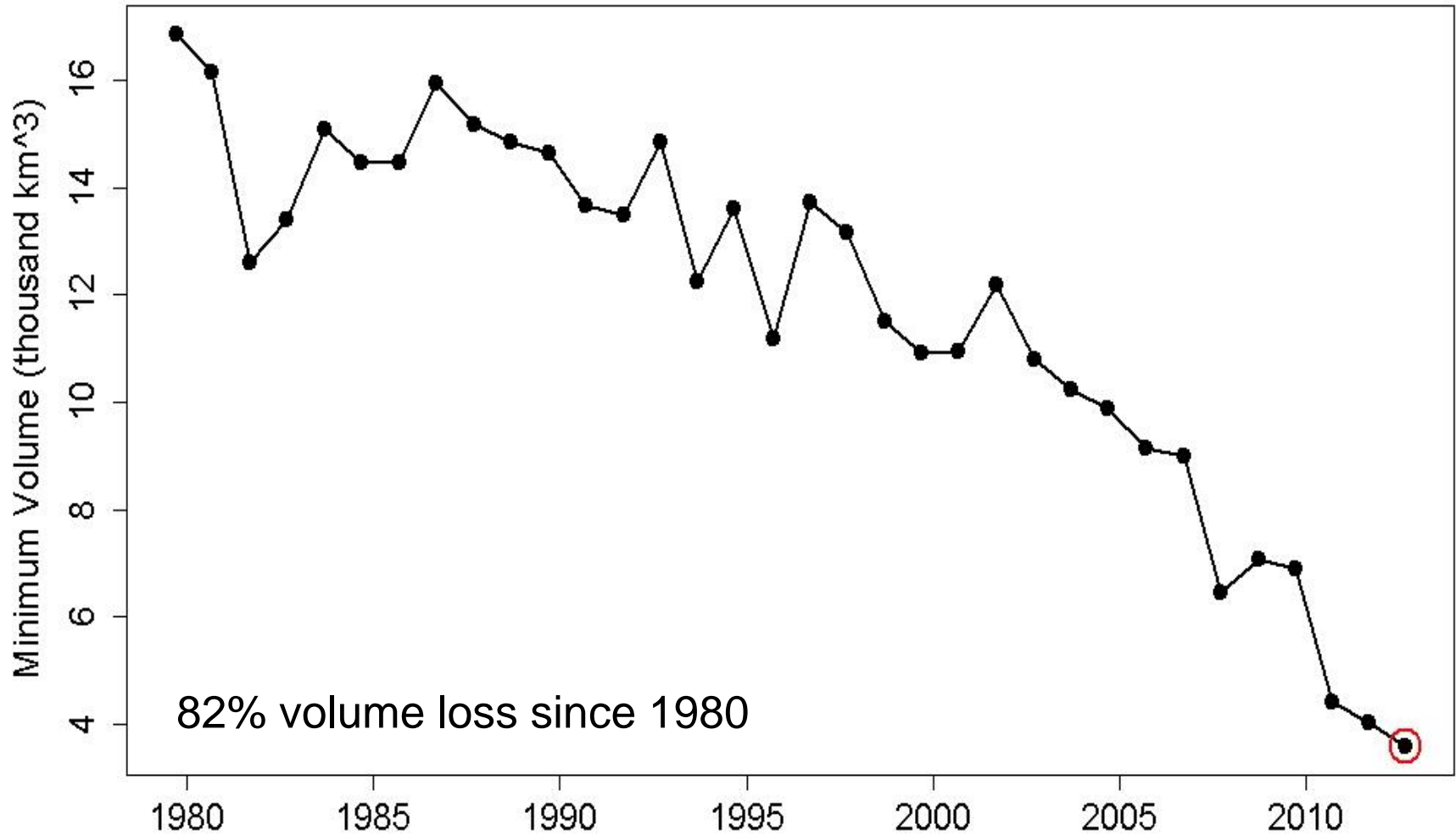


September 2013

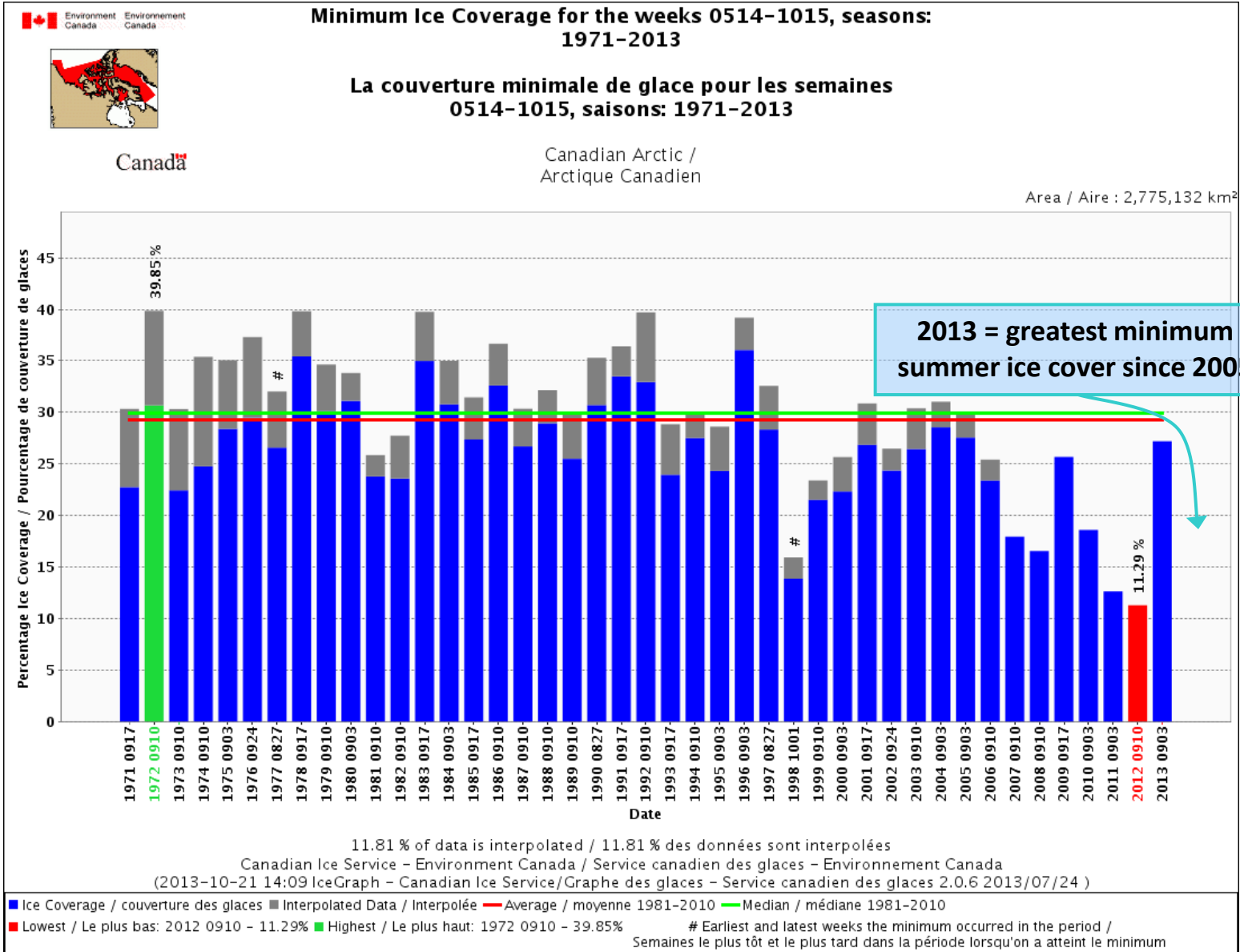


What's happening to Arctic sea ice summer minimum volume ?

PIOMAS

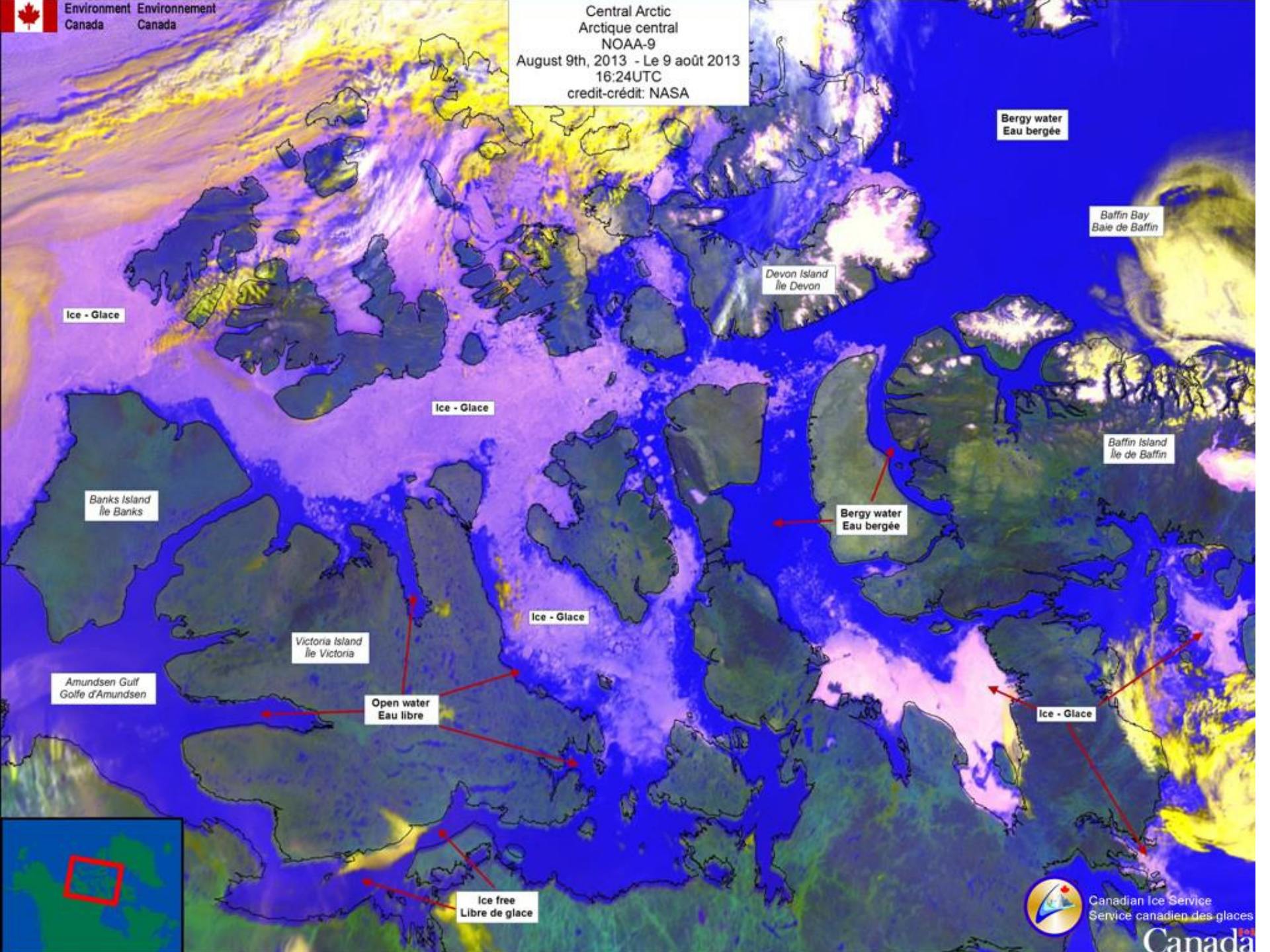


What's happening in the Canadian Arctic?





Central Arctic
Arctique central
NOAA-9
August 9th, 2013 - Le 9 août 2013
16:24UTC
credit-crédit: NASA



Bergy water
Eau bergée

Baffin Bay
Baie de Baffin

Devon Island
Île Devon

Ice - Glace

Ice - Glace

Banks Island
Île Banks

Baffin Island
Île de Baffin

Bergy water
Eau bergée

Ice - Glace

Victoria Island
Île Victoria

Amundsen Gulf
Golfe d'Amundsen

Open water
Eau libre

Ice - Glace

Ice free
Libre de glace



Summary - Canadian Arctic 2013

- Ice cover in the Canadian Arctic was close to normal throughout the 2013 summer season.
 - The average May-Oct coverage in 2013 was greater than that of the previous 7 summers.
- Sea ice coverage reached a minimum of 27.2% during the week of September 03, 2013,
 - only 2.8% less than the 1981-2010 median minimum coverage.
- The southern shallow water route of the Northwest Passage was navigable, albeit with some difficulty, this summer
- The northern deep water route was entirely closed to navigation, except for ice breakers (western half)

Changing sea ice conditions are impacting marine activity

- Loss of sea ice occurring at a faster pace than most models predicted
- Activity levels increasing accordingly
 - Baffinland's Mary River project
 - Beaufort oil and gas exploration
 - Destinalional shipping
 - Tourism and adventurism
- International concern for safety in Arctic marine environment and environmental protection



...and Northern communities need more information

- The Northern way of life is being significantly impacted by changes in weather, ice and ocean conditions
- Changes in the environment are having an impact on day-to-day activities
- Traditional Knowledge to 'read' the weather not working like it used to – conditions change too quickly and in unexpected ways
- More and better information about weather, water, ice is needed to protect health and safety
- A better understanding of climate is needed to plan for the future



TRANSPORTATION - A NEW OCEAN TO NAVIGATE

Challenges and Opportunities !

NW Passage



NE Passage



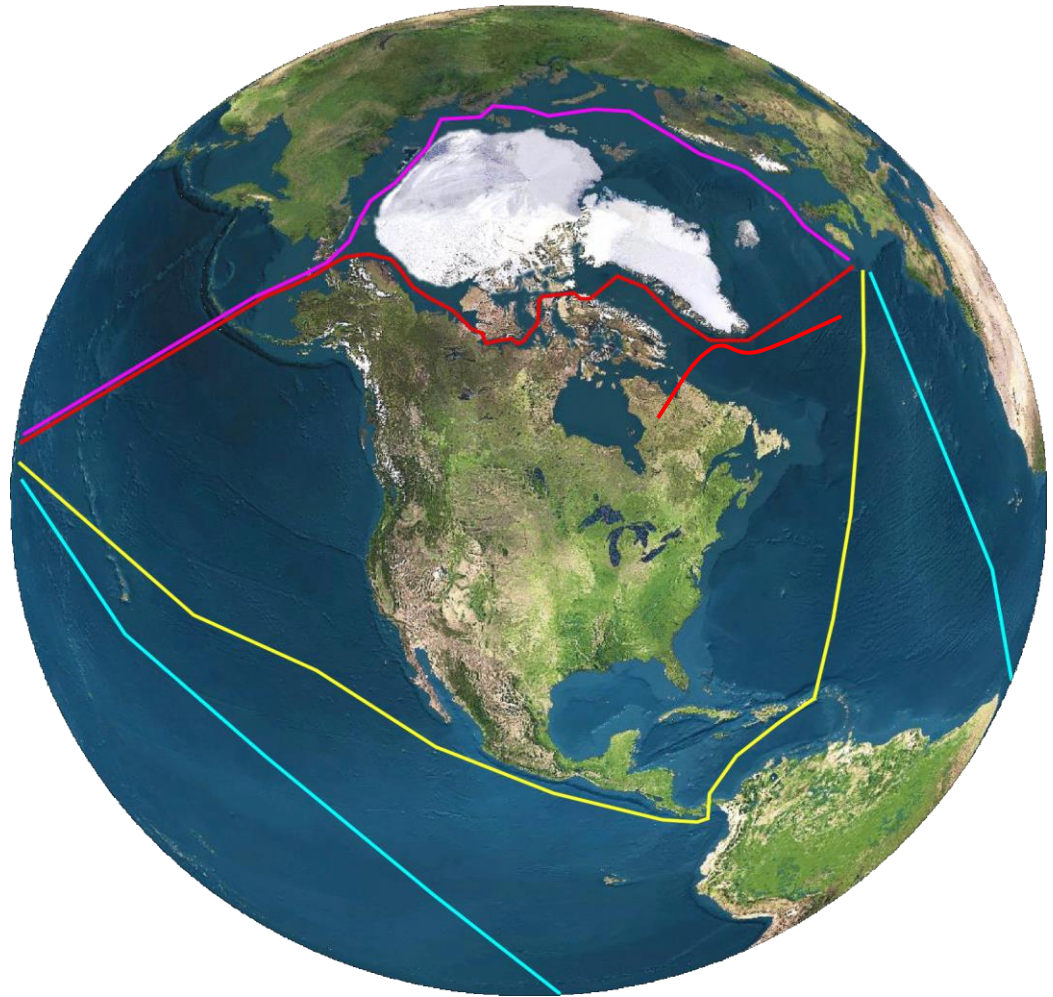
Panama

(+ 11 000 km)



Cape Horn

(+ 19 000 km)



The advent of Double Acting Tankers (DAT)

M/T Tempera



Ahead in open water

- Propulsion provided by an Azipod unit that can rotate 360° .
- Speed of 17 knots in open water and 3 knots in ice 1m thick.



Astern in ice covered waters

- Can break independently through 13m deep ice ridges.
- No icebreaker assistance requirement.

EMERGING MINERAL RESOURCES

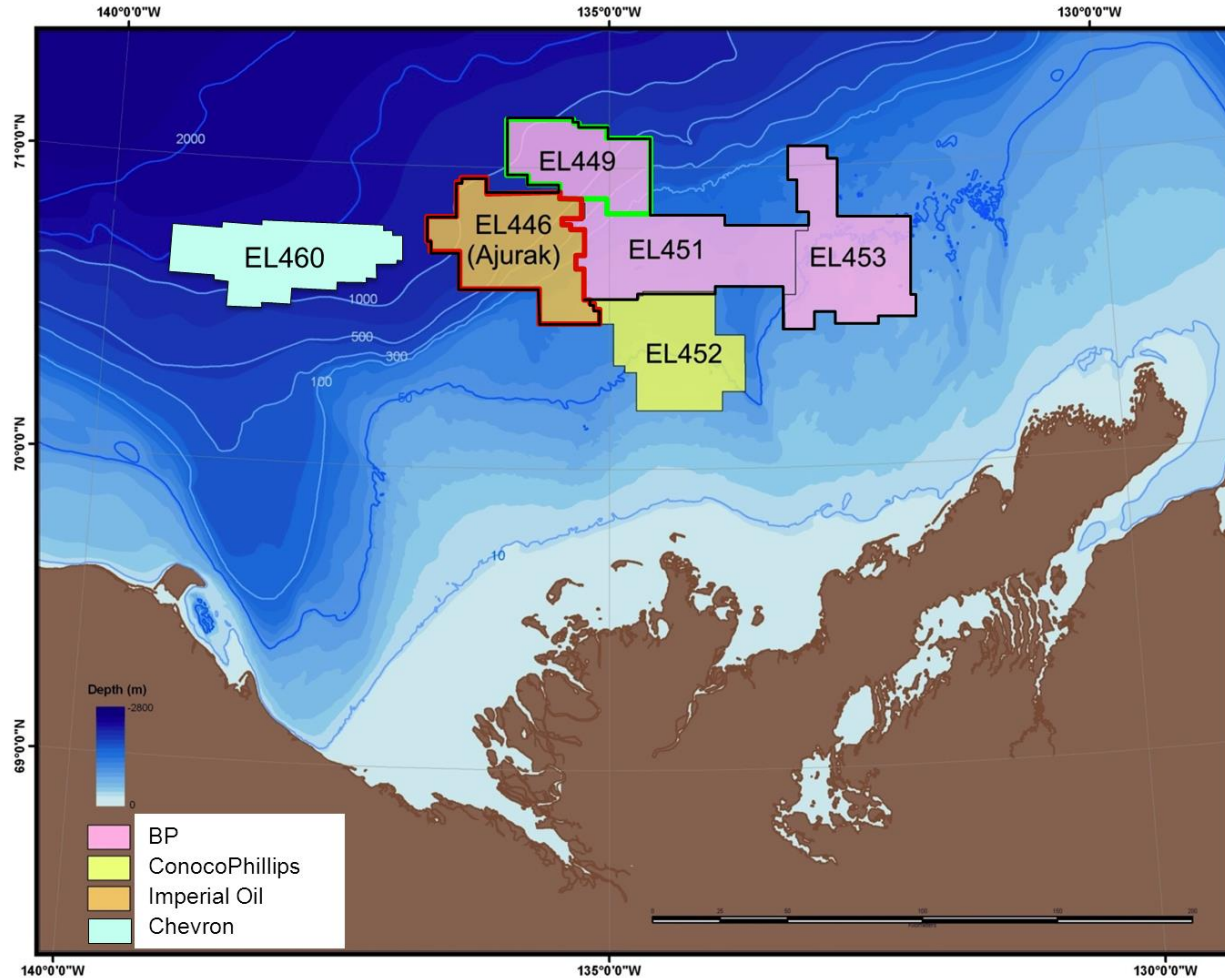
A harsh but fragile environment

The Mary River mine project on northern Baffin Island will have a profound impact on the region's Inuit population, its fragile landscape and a wide array of animals and plants. During public hearings, Baffin region villagers' concern has focused on the fate of Barrenland caribou, which have been hunted by Inuit in the Mary River area for centuries.



Offshore interest in the Canadian Beaufort Sea

Over 2 billion CAN\$ committed to the exploration of offshore leases in the Beaufort since 2007 with blocks awarded to Imperial Oil, BP, ConocoPhillips and Chevron

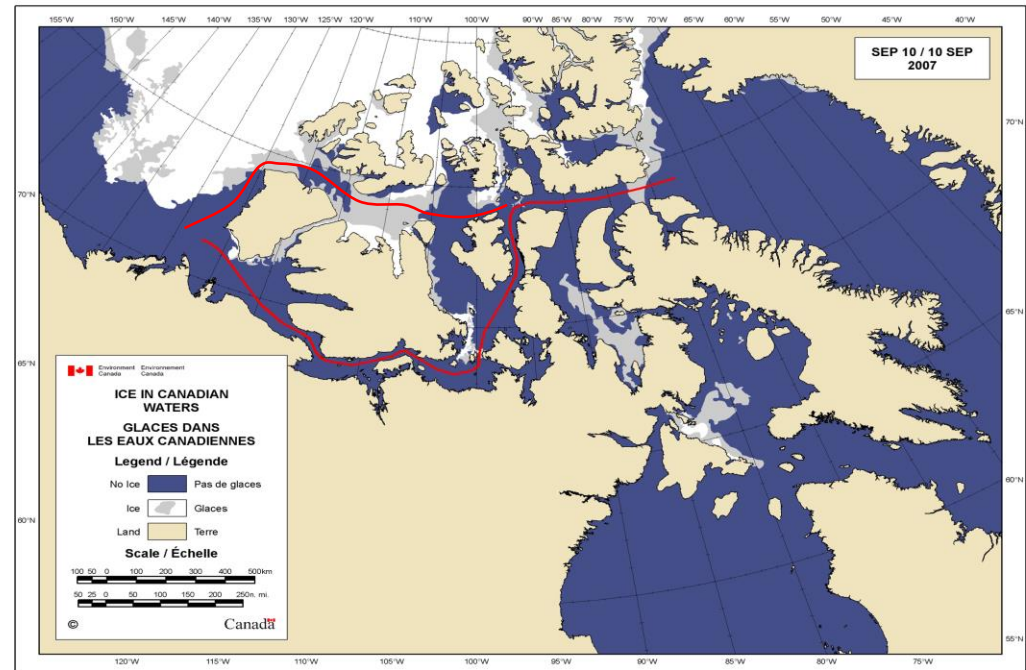


Ice information services...

- *The Canadian Ice Service is the leading authority for information about ice in Canadian navigable waters.*

Mission:

- *provide timely and accurate information about sea ice, lake/river ice and icebergs*
- *Maintain the Canadian Ice Service Digital Archive of ice climatological data used for both policy/regulation development and research*
- *Integrated Satellite Tracking of Pollution (ISTOP):*
 - *uses satellite imagery to support spill confirmation, tracking and evidence procurement*



What are the products and who are they for...

Daily charts

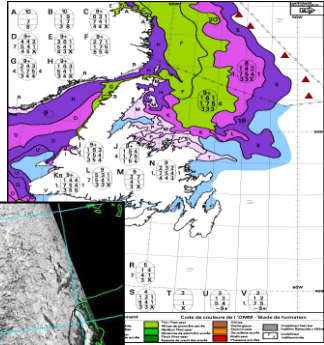
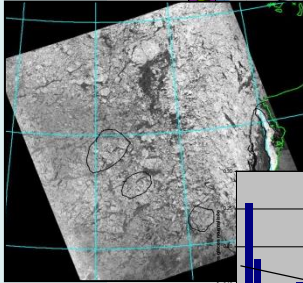
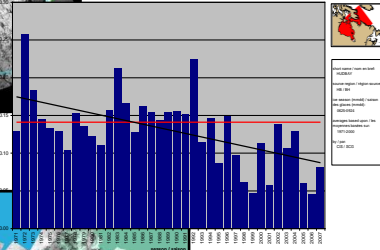


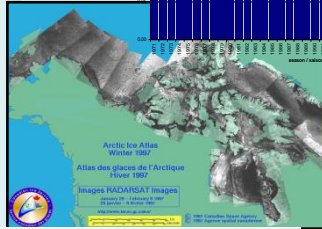
Image analyses



Statistical analysis



Climate products



Iceberg charts



Bulletins / Warnings

FICN11 CWIS 181450
ICEBERG BULLETIN FOR EAST COAST
WATERS AND THE STRAIT OF BELLE
ISLE
AND ITS APPROACHES ISSUED BY
ENVIRONMENT CANADA FROM
CANADIAN ICE
SERVICE IN OTTAWA AT 1500 UTC
WEDNESDAY 18 OCTOBER 2000.



Canadian Coast
Guard
Icebreakers



Mariners



Researchers



Offshore
Development



Northern
Communities



Media & Public

Environmental security

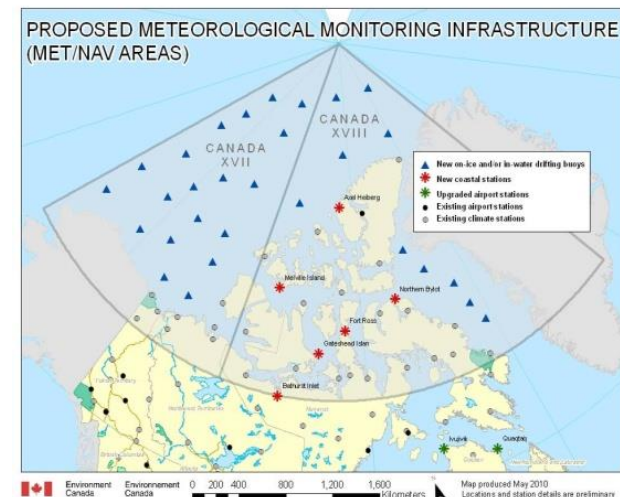
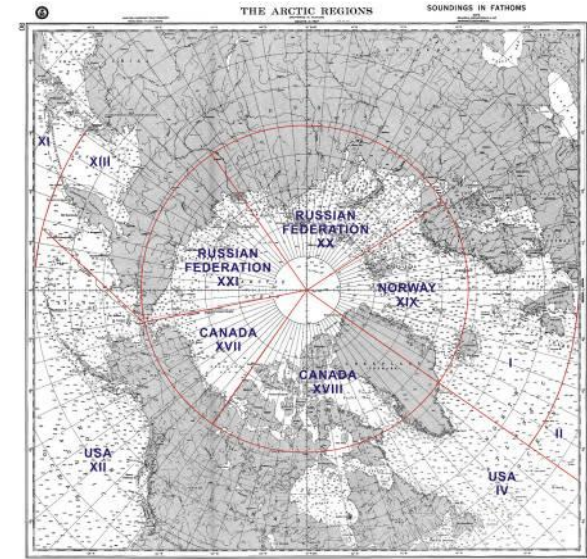
Integrated Satellite Tracking of Pollution (ISTOP) program

- Deterrence, detection and support of enforcement and prosecution of illegal marine oil releases through :
 - Operational monitoring of satellite imagery for early detection of spills and illegal marine oil releases
 - Aerial reconnaissance capability in partnership with the Transport Canada National Aerial Surveillance Program
 - R&D to improve
 - satellite detection of marine oil in ice-covered waters, and,
 - Monitor and forecast spill trajectories in ice or after freeze-up



Meteorological Service of Canada (MSC)

- Year-round provision of timely and accurate weather and ice information and forecasting, in support safe and efficient shipping, and, most importantly, accident prevention!
- Environmental (wind, temperature, wave height, freezing spray etc.) and ice climatological information for planning sustainable offshore developments (ex. BREA CanICE database)
- Monitoring, tracking and forecasting extreme ice hazards threatening offshore infrastructure
- Operational services in direct support of oil spill response:
 - Specialized weather and sea state forecast and warnings
 - Customized ice information forecasts and warnings
 - High resolution wind and wave parameters combined with ocean modeling capability for spill trajectory forecasts
- *In situ* environmental monitoring network to improve domain awareness for shipping and spill responders



What does it all mean?

- The Arctic environment is changing and the shipping season is increasing spatially and temporally
- Arctic marine traffic is changing
- Due to increased mobility, multi-year ice is moving into shipping lanes causing increased hazards
- Icebergs and ice of land origin continue to present a significant danger and will into the future
- Sea ice extent within the Canadian Arctic is extremely variable and demanding ice conditions will continue in Canadian navigable waters for the foreseeable future
- Extreme weather events will increase as open water increases
- More demands on services: CCG, EC, MSC-CIS, TC, DND



What does the future hold...

- Continued dependency on satellite observations

Transition from RADARSAT-2 to the RADARSAT Constellation Mission

Seek out additional sources of satellite data – TerraSAR-X and Sentinel-1

Polar and Communications and Weather Satellite (PCW)

- More reliable ice forecast capacity
 - Longer lead times for seasonal forecasts
 - Verification
 - Reliability

- Expanded Ice Services for Northern Communities
 - We now begin Arctic Ice Charting services much earlier in the season around Northern communities well-before CCG enters
 - Seeking partnerships with Transport Canada and the Search and Rescue Secretariat to provide Community-focused ice information

- Continued and enhanced client engagement
 - Domestic
 - International



PRESENT AND FUTURE SEA ICE TRAVEL

VOYAGES ACTUELS ET FUTURS SUR LA GLACE DE MER

RESOLUTE, NUNAVUT

Arctic Ice Charting Report for 2000-01

Arctic Bay / Baie Arctique

Amiraglio Belin Strait / Détroit Lancaete Sound

April 15 avril, 2000

Legend	
Red diamond	Ice edge / Edge de la glace
Green diamond	Ice concentration / Concentration de glace
Blue line	Ice thickness / Épaisseur de la glace
Yellow line	Ice type / Type de glace
Red line	Ice motion / Mouvement de la glace
Green line	Ice motion / Mouvement de la glace
Blue line	Ice motion / Mouvement de la glace

CCG Arctic Ice Charting / Service canadien de cartographie de la glace arctique

Towards and Northern Transportation Strategy...

- Innovation (ArcticNet, NEXTAW)
 - *ex. Energy Security ?*
 - *Local transportation needs ?*
- International models and partners ?
- Inter-connected but robust
 - Daisy Chain vs Hub and Spoke ?



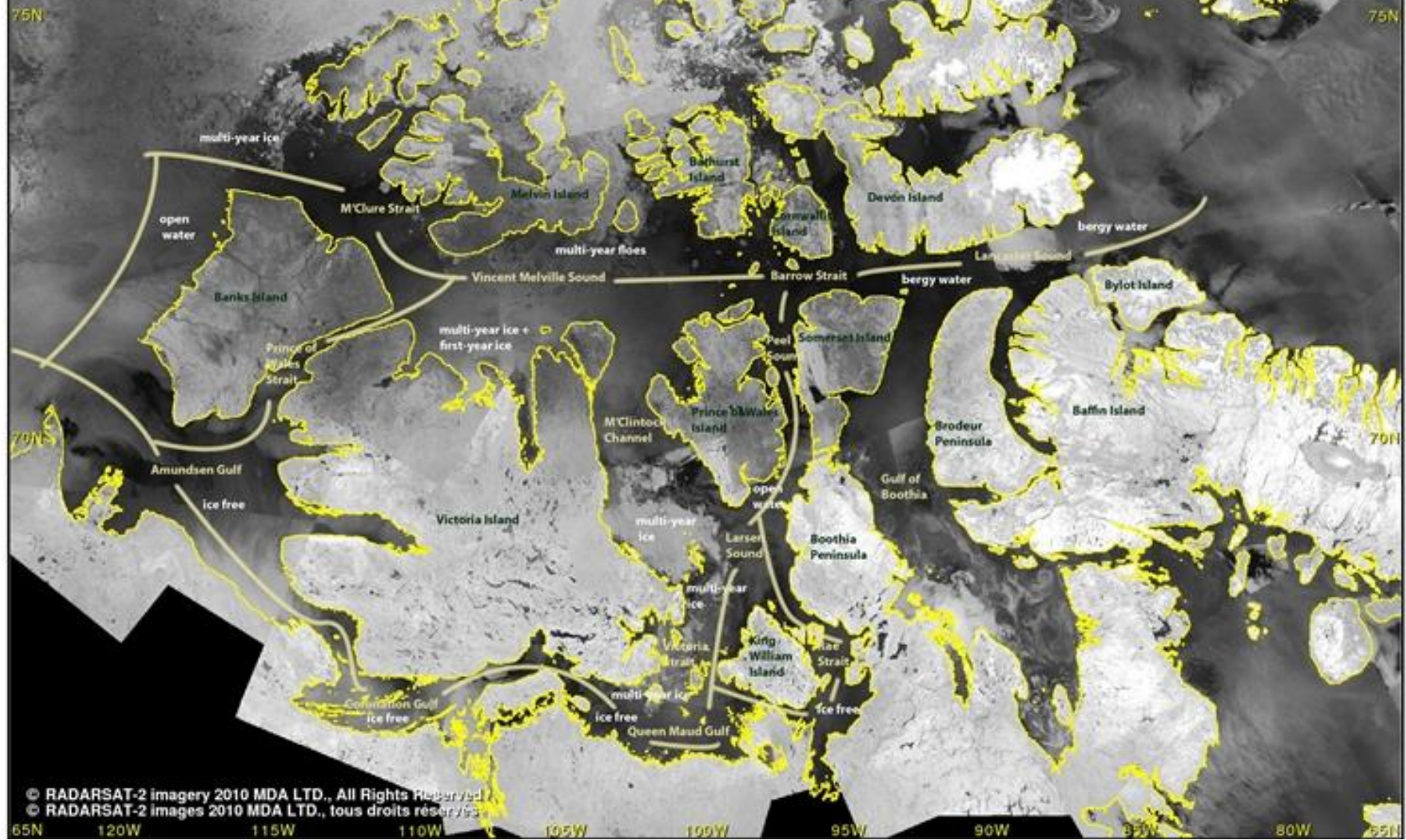
A large, jagged iceberg floats in the center of a sea of smaller ice floes. The scene is illuminated by the warm, golden light of a sunset or sunrise, with the sun's reflection shimmering on the water. The sky is a mix of orange and yellow, and the water is a deep blue. The ice floes are scattered across the water, creating a textured surface. The overall mood is serene and majestic.

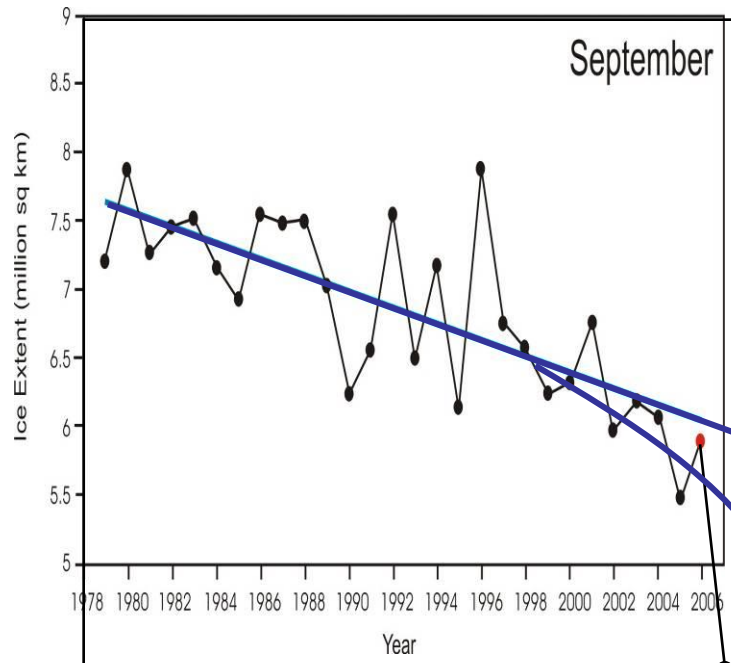
Thank You!

Photo: Erin Clark

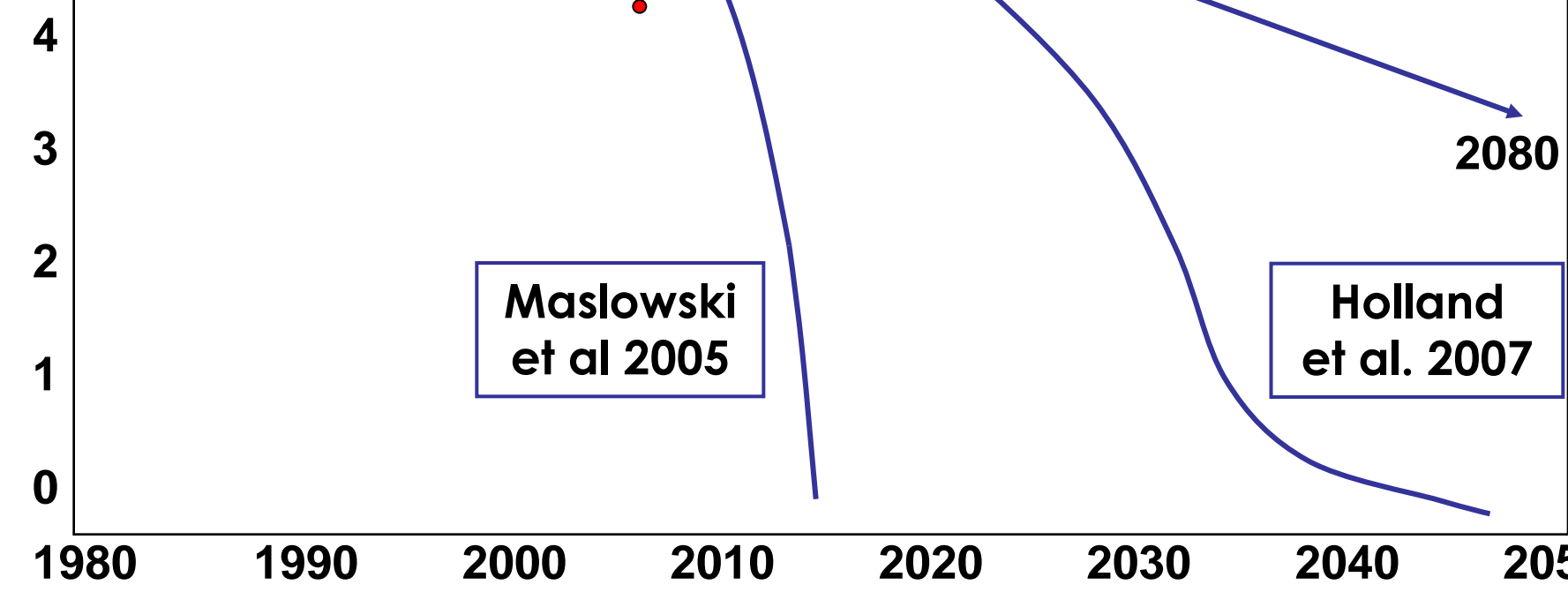
Northwest Passage

September 4 to 6, 2010
RADARSAT-2 image mosaic





Actual observations of sea ice extent are less than even the most aggressive predictions...



Canadian Arctic Ice Summary – Summer 2013

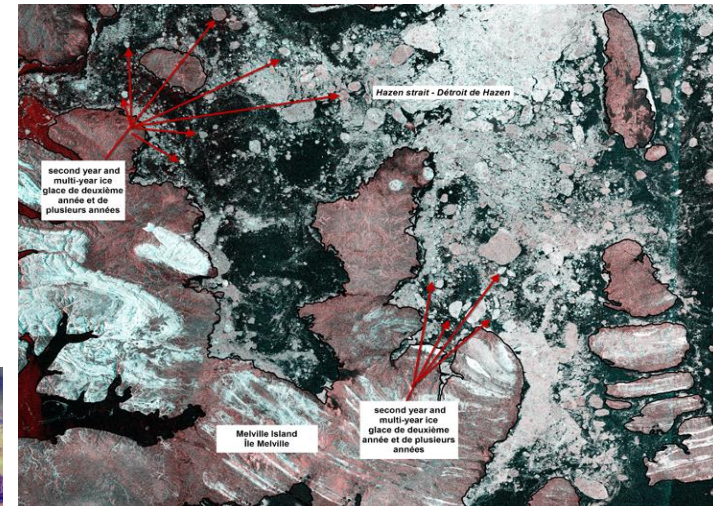
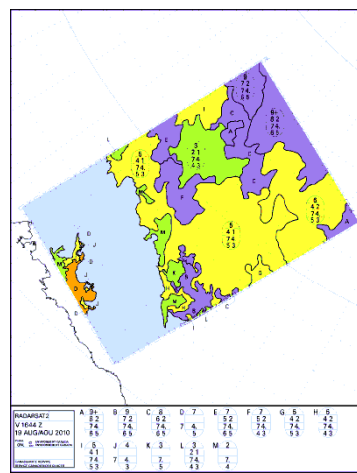
- After record-breaking low extents during Summer 2012, Arctic-wide and Canadian Arctic sea ice coverage was closer to normal in Summer 2013.
- Arctic-wide sea ice extents reached a minimum of 5.099M sq km Sept 13, 2013, making it the 6th lowest minimum extent recorded during the satellite era.
- In the Canadian Arctic, sea ice coverage (not including Hudson Bay) reached a minimum of 27.2% (or 0.76 million square kilometres) during the week of September 03, 2013, only 2.8% less than the 1981-2010 median minimum coverage
- Ice coverage in the Canadian Arctic is variable from area to area and from year to year. In Summer 2013, air temperatures in the Canadian Arctic (north of 70°N) were generally below normal, particularly in the central and western sections where many areas experienced average daytime temperatures that were 1-2°C below normal. As a result, ice melt was slow and new ice formation began early in northern sections (near the end of August).
- The southern route of the Northwest Passage has been navigable (for a few weeks each year) since 2006. In 2013, certain sections difficult to navigate throughout the summer.
- Average sea ice coverage along the southern route reached a minimum of 3.5% (or 9600 sq km) during the week of September 10, 2013 (a week later) This is 2.5% less than the 1981-2010 median minimum coverage for this route.
- The northern route of the Northwest Passage has been navigable for a few weeks every summer since 2007, except for 2009. In Summer 2013, the route was closed to all ships except icebreakers.
- The average sea ice coverage along the northern route reached a minimum of 37% (or 64,000 sq km) during the week of September 03, 2013 (9% less than the 1981-2010 median minimum coverage).
- Although the average ice coverage along the route was only 37%, the minimum ice coverage in certain individual sections of the route was much higher (e.g. 61% in M'Clure Strait).

Search and Rescue missions

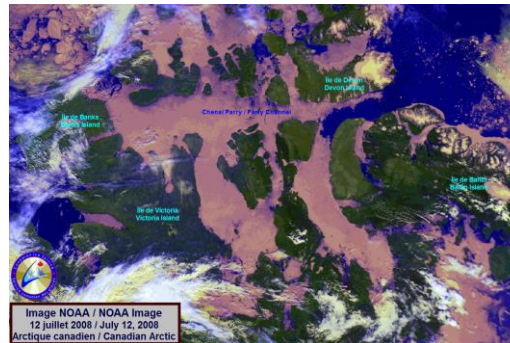
Providing area-specific ice information

- RADARSAT image analysis charts
- Daily Ice charts and bulletins
- Consultation of expected ice conditions
- FTP of Satellite imagery

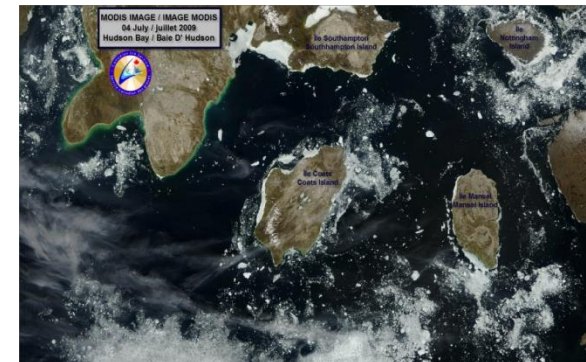
- RADARSAT
- MODIS
- NOAA AVHRR



RADARSAT

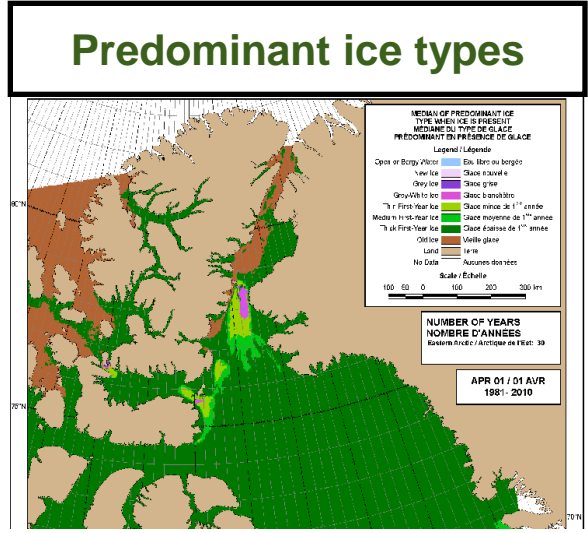
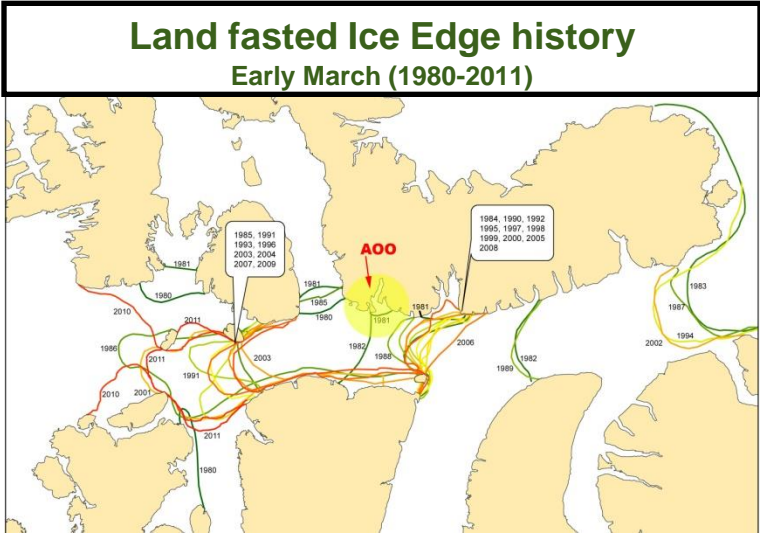
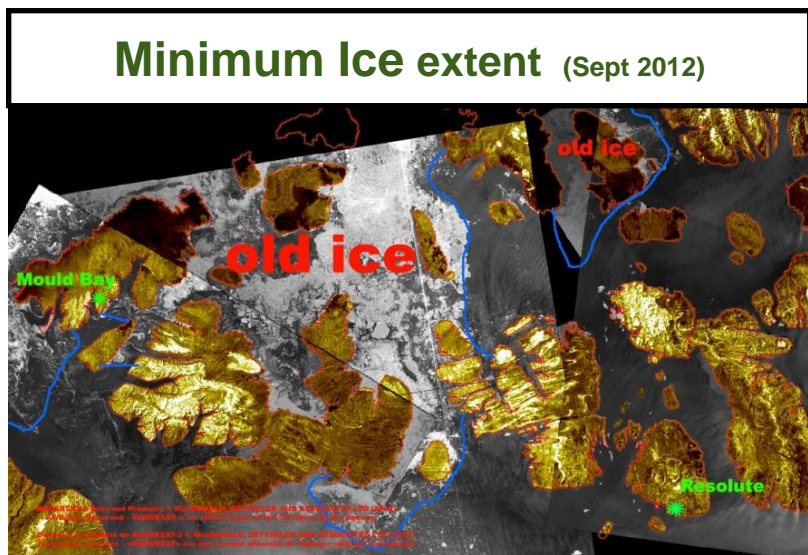
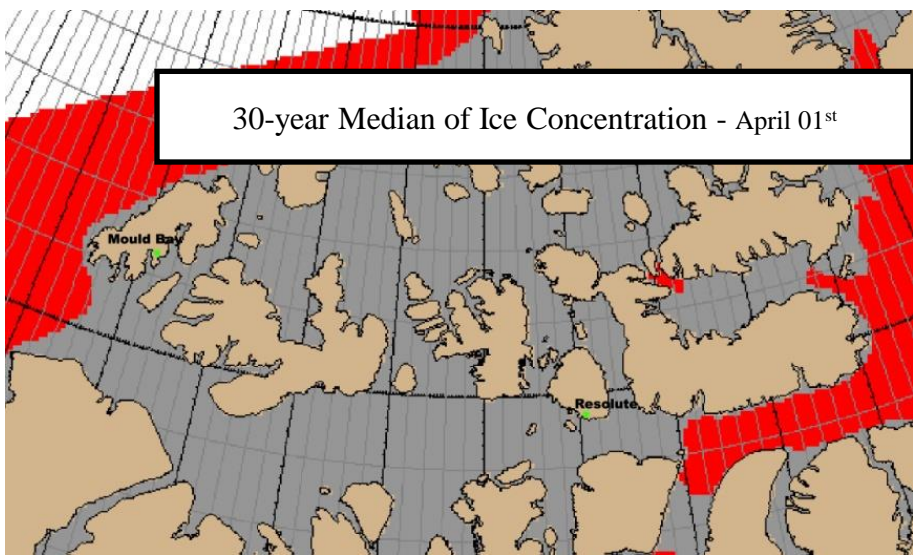


NOAA AVHRR

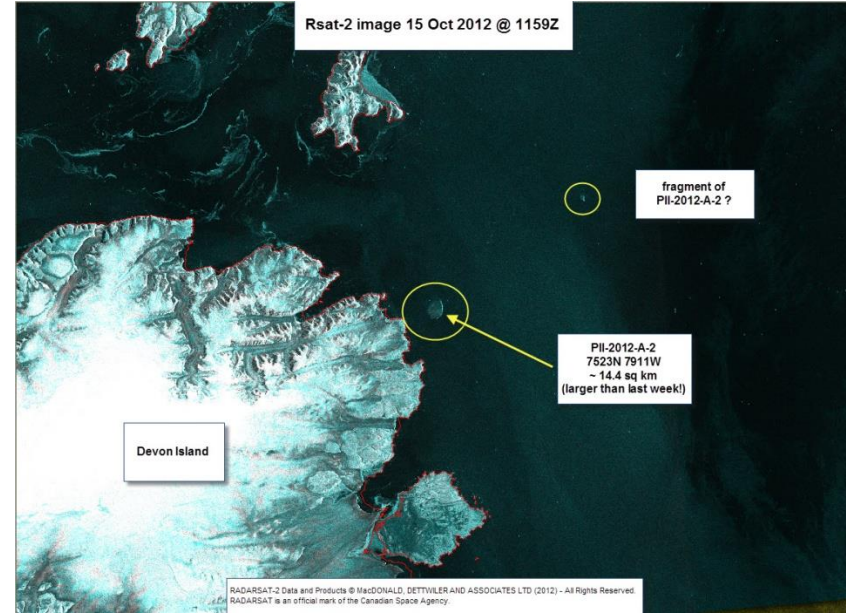


MODIS

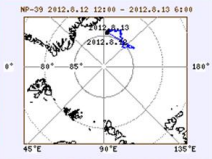
Ice climatology



Monitoring of icebergs and Ice Islands



Monitoring of the Russian North Pole Drifting Ice Station



NP-09 2012.08.12 12:00 - 2012.08.13 06:00

[Dolnĭĭ] [English]

Drifting station North Pole - 39

WMO index - UFTA

[Operative meteorology] [Station drift data]
[Photo] [Staff] [WMO GIS] [NP32] [NP36] [NP1...38_archive]

North Pole-39: 2012.08.13 06:00 UTC 84.4N 97.5W T



Drift information

Station drift coordinates [ARGO and IABP buoys](#)

Drift statistics

Drift dates/period(days): 2011-10-02 06:00:00 / 2012-09-15 03:00:00 / 348.88
 Start coordinates (lat/lon): 84.16547 / -148.81228
 End coordinates (lat/lon): 83.94972 / -96.72832
 Total/general drift (km)/dir: 1884.957 / 579.751 / 92
 Vel(kpd) min/max/mean: .004 / 37.513 / 5.403

5-day Drift Forecast

Russian Drifting Station NP39 (WMO index: UFTA; SailWr: Volsoeft-131)

AARI website coordinates: Degrees + fraction Degrees + minutes
 Coordinate at 18 Feb 2012, 00Z: 83.89N 116.90W 83°53.4'N 116°54.0'W
 Coordinate at 18 Feb 2012, 12Z: 83.88N 116.83W 83°52.8'N 116°49.8'W
 Coordinate at 19 Feb 2012, 00Z: 83.87N 116.70W 83°52.2'N 116°42.0'W

Forecast Drift and new coordinates, issued 19 Feb 2012, 2000Z:
 *Note: wind direction is "from", ice drift direction is "towards"

Day/time (UTC)	Initial Lat/Lon	Wind	Ice Drift (0.5% of wind)	Final Lat/Lon (valid at time + 12h)
19/00Z	83°52.2'N 116°42.0'W	290/20KT	ESE 2.2 km/12hr	83°51.8'N 116°31.4'W
19/12Z	83°51.8'N 116°31.4'W	315/20KT	SE 2.2 km/12hr	83°50.9'N 116°23.5'W
20/00Z	83°50.9'N 116°23.5'W	315/15KT	SE 1.7 km/12hr	83°50.3'N 116°17.5'W
20/12Z	83°50.3'N 116°17.5'W	022/15KT	SSW 1.7 km/12hr	83°49.5'N 116°20.7'W
21/00Z	83°49.5'N 116°20.7'W	045/10KT	SW 1.1 km/12hr	83°49.0'N 116°24.7'W
21/12Z	83°49.0'N 116°24.7'W	045/10KT	SW 1.1 km/12hr	83°48.6'N 116°28.6'W
22/00Z	83°48.6'N 116°28.6'W	035/15KT	SSW 1.7 km/12hr	83°47.9'N 116°33.5'W
22/12Z	83°47.9'N 116°33.5'W	040/20KT	SW 2.2 km/12hr	83°47.0'N 116°40.7'W
23/00Z	83°47.0'N 116°40.7'W	330/15KT	SSE 1.7 km/12hr	83°46.2'N 116°36.5'W
23/12Z	83°46.2'N 116°36.5'W	295/20KT	ESE 2.2 km/12hr	83°45.7'N 116°26.3'W
24/00Z	83°45.7'N 116°26.3'W	270/25KT	E 2.8 km/12hr	83°45.7'N 116°12.3'W

Note: very last coordinate valid at 2412Z

