

Changing Ice Conditions: The North American Ice Service (NAIS) Challenge



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Chief, Strategic Planning,
Canadian Ice Service, Environment Canada

Impacts of an Ice-Diminishing Arctic on Naval
and Maritime Operations
June 9 -11, 2009



Outline

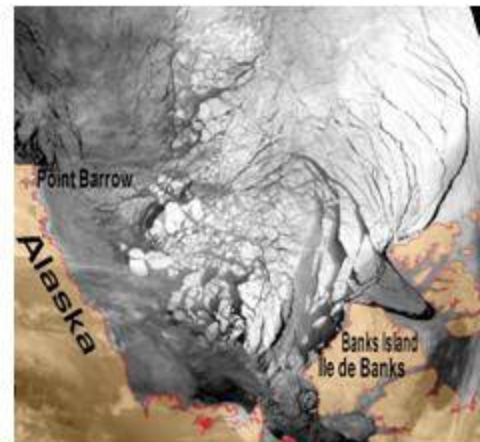
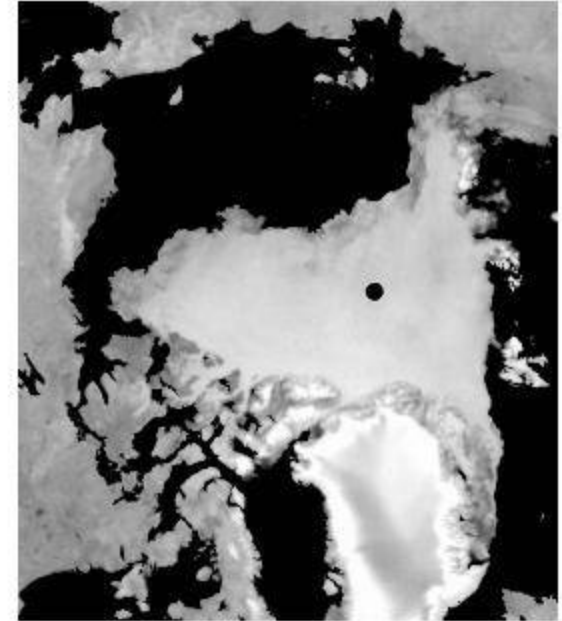
North America Ice Service

The ongoing challenges

Changing Arctic sea ice conditions

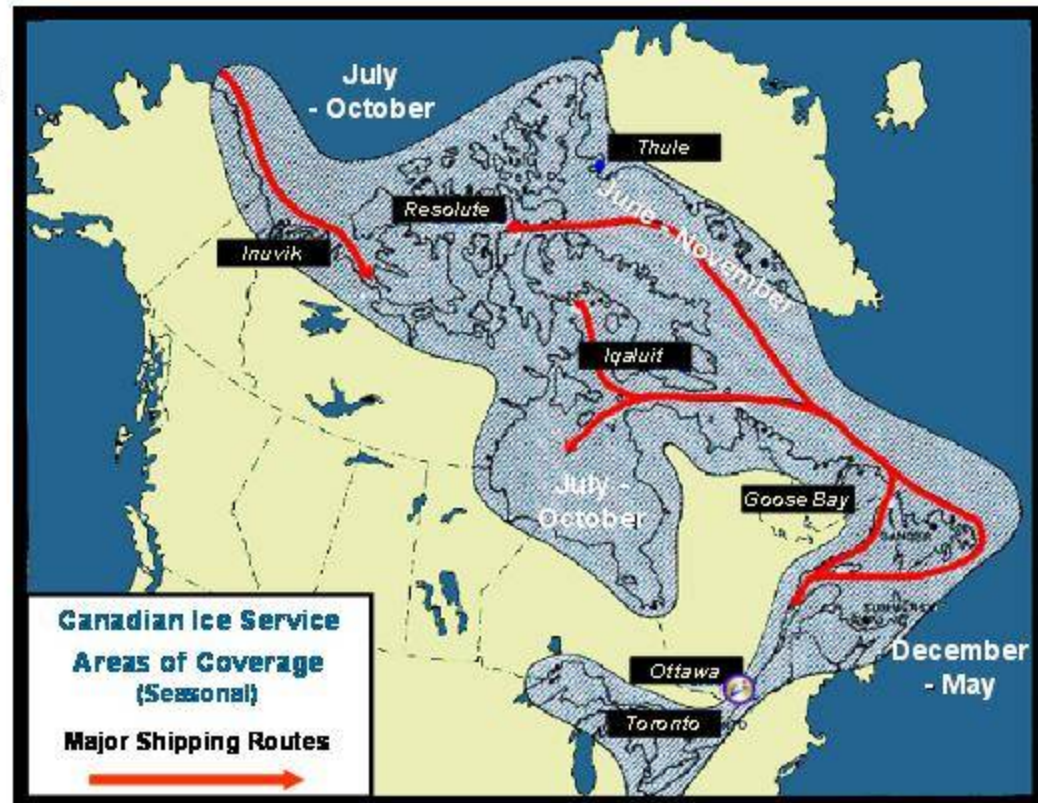
What now?

Conclusions



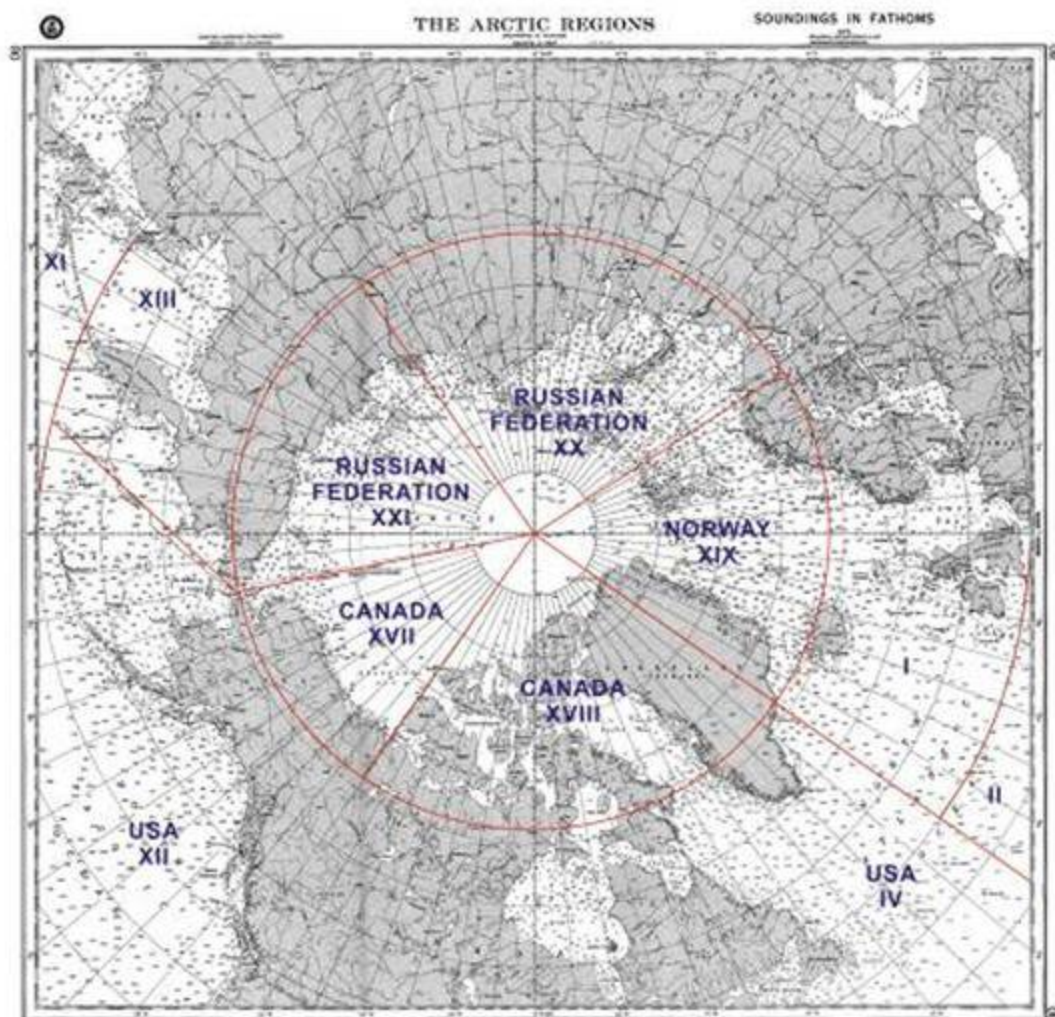
Sea ice is a North American issue

- The most northerly part of the continent has the most remaining MY ice
- North America east coast is known as “iceberg alley”
- Annual variation in extent of ice is tremendous
- Includes St Lawrence Seaway and Great Lakes
- Seasonal effects on:
 - weather and climate
 - marine ecosystems
 - safety and efficiency of marine transportation



And the issue is increasing in scope

- The Arctic ocean may be seasonally navigable within the foreseeable future and mariners will require aids to navigation
- Canada, in partnership with the USA, will be providing mariners with weather and ice information for two new METNAV areas
- Russia and Norway have responsibility for the remaining three



The North; a harsh marine environment under normal conditions...



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



Sea ice is a significant marine hazard (especially multi-year ice)



Photos courtesy of Stephen Neatt CCG

Icebergs are a significant hazard



Reduta Ordon in drydock after striking an iceberg (July, 1996)



Icebergs are a significant hazard



The North American Ice Service supports safe and efficient shipping;

- Delays are a significant deterrent to transit shipping**
- Marine and Ice information reduces transit times & increases safety**

**M/V Umiak-I
Voisey Bay
May 27, 2007**

**Courtesy Tim Keane,
Fednav Shipping Ltd.**

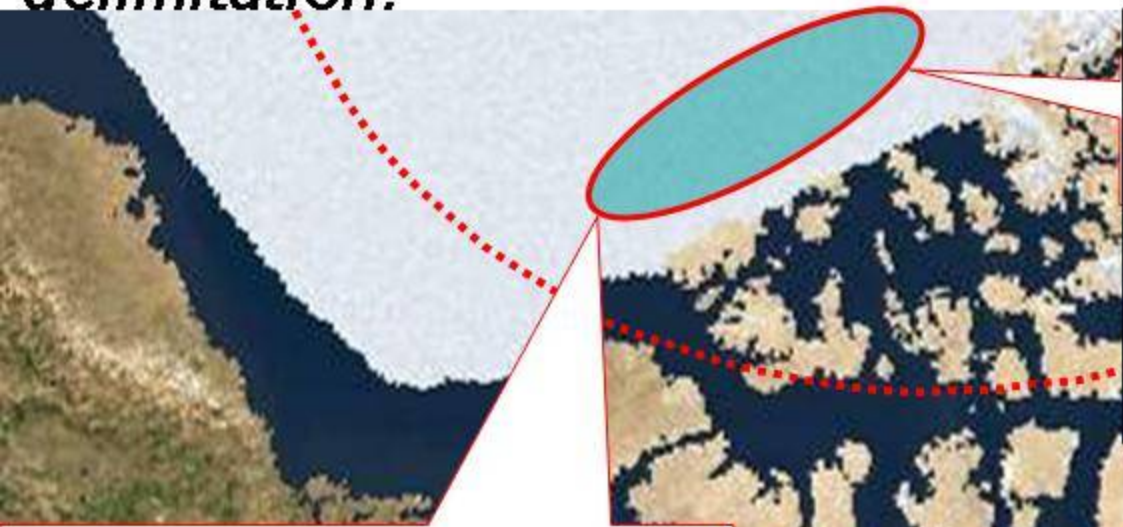


... works closely with many partners on policy initiatives....

- Arctic Strategies
- Sustainable Development
- Climate Change
- Academic and government research
- Support for security



...assists with the UNCLoS Northern continental shelf delimitation:



USCG Healy

• The CCGS Louis S. St. Laurent along with USCGC Healey will be conducting seismic surveying from 09 Aug to 16 Sep 09 for UNCLoS.



CCGS Louis St. Laurent

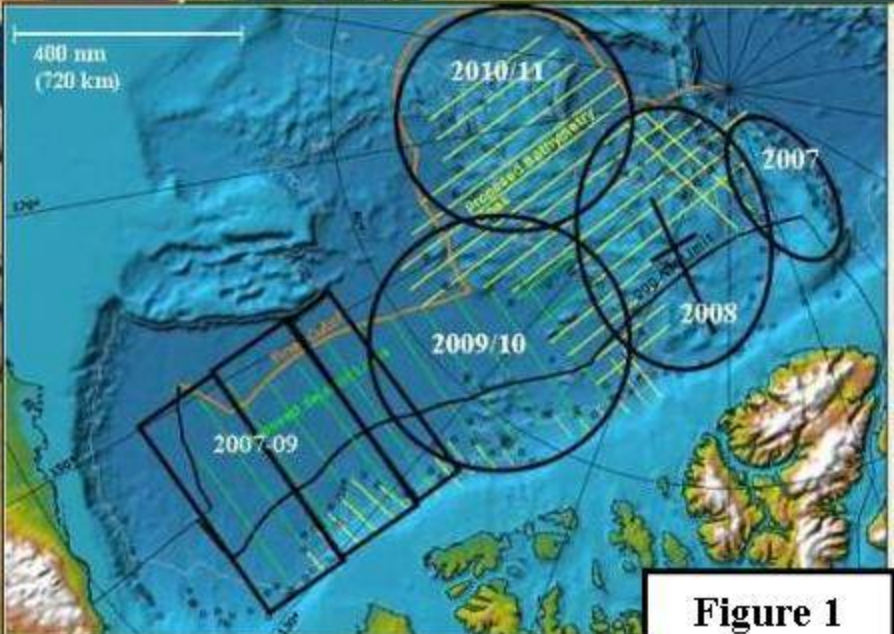
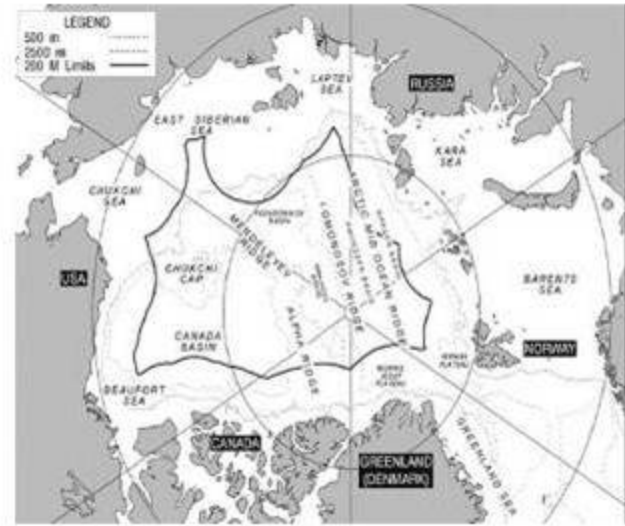


Figure 1

...provides expertise for science and policy development;



NAIS provided expertise during IPY and ongoing support to science...



...and for the extension of the Arctic Waters Pollution Prevention Act in Canada



...supports Northern communities;



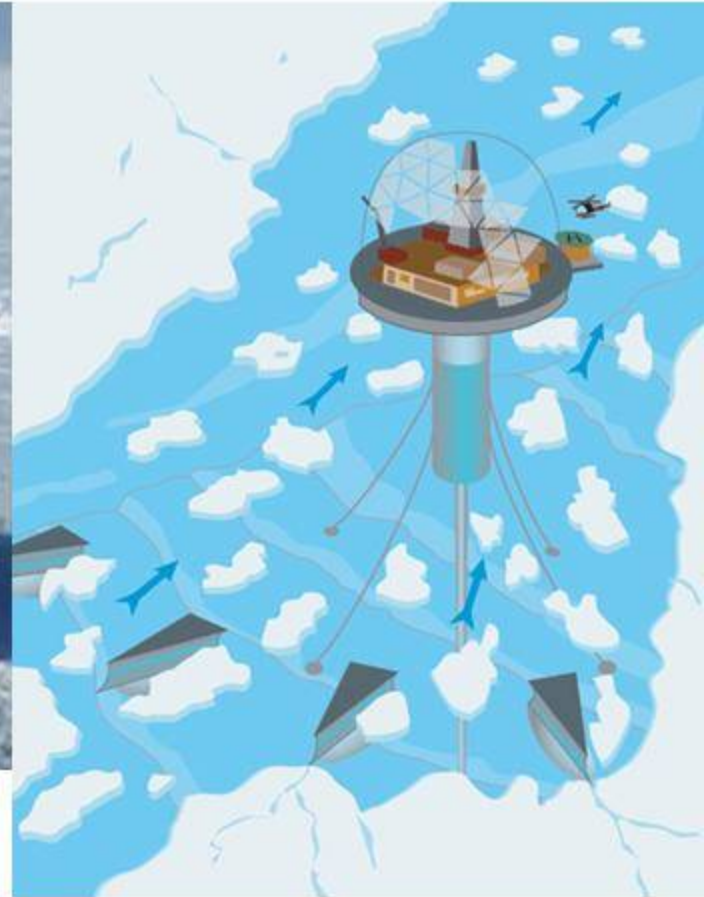
Sea ice information is used on a daily basis by those who live by and travel on sea ice



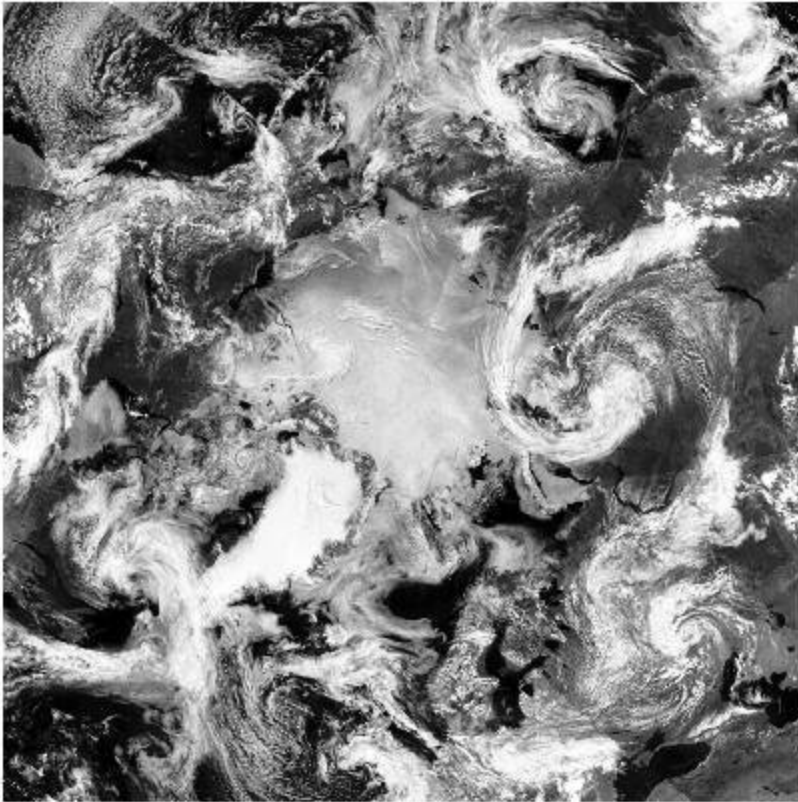
...enables offshore industry;



***Ice information is used in the design,
construction & operation of offshore
platforms***



... provides input into weather forecasting;



Ice information is used in numerical weather models to forecast weather



... and supports enforcement targeting illegal marine oil discharges;

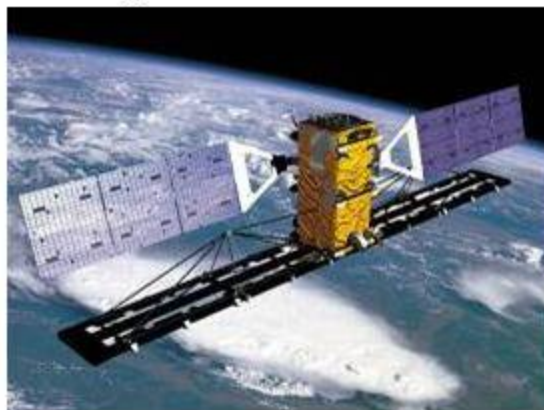
**Recognized as a problem Nationally
& Internationally**

**It is reported that 100,000 coastal
sea birds are killed each year**

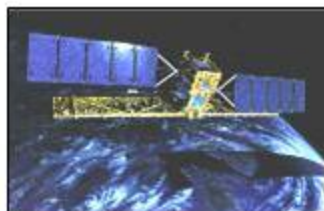


How does the NAIS do all of this ?

- **Expertise:** highly-trained staff; image analysts, field ice specialists, applied science and informatics
- **Data:** monitoring in a dynamic marine environment is very information-intensive. This is a particular challenge in the Arctic due to the sparseness of available *in situ* data.
 - Satellite data is a key element. Ice Services are one of the largest users of Synthetic Aperture Radar (SAR) in the world and had significant influence on improvements to RSAT-2. The capacity to utilize both R-1 and R-2 will prove beneficial. The ability to share data within the NAIS partnership is essential in leveraging the Canadian investment in RADARSAT.
- **Partnerships:** effective long-standing collaborations are critical



Sustained observations from a variety of sources essential for weather & ice services.



Satellite
Optical
NOAA AVHRR
Others



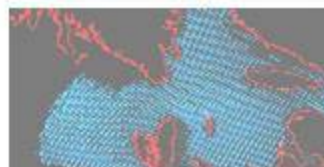
Microwave
RADARSAT
ENVISAT
QUIKSCAT
DMSP SSM/I



Airborne
Visual Obs
SLAR/SAR



Surface
Buoys
Ship Reports
Shore Obs



Models
Weather
Ice



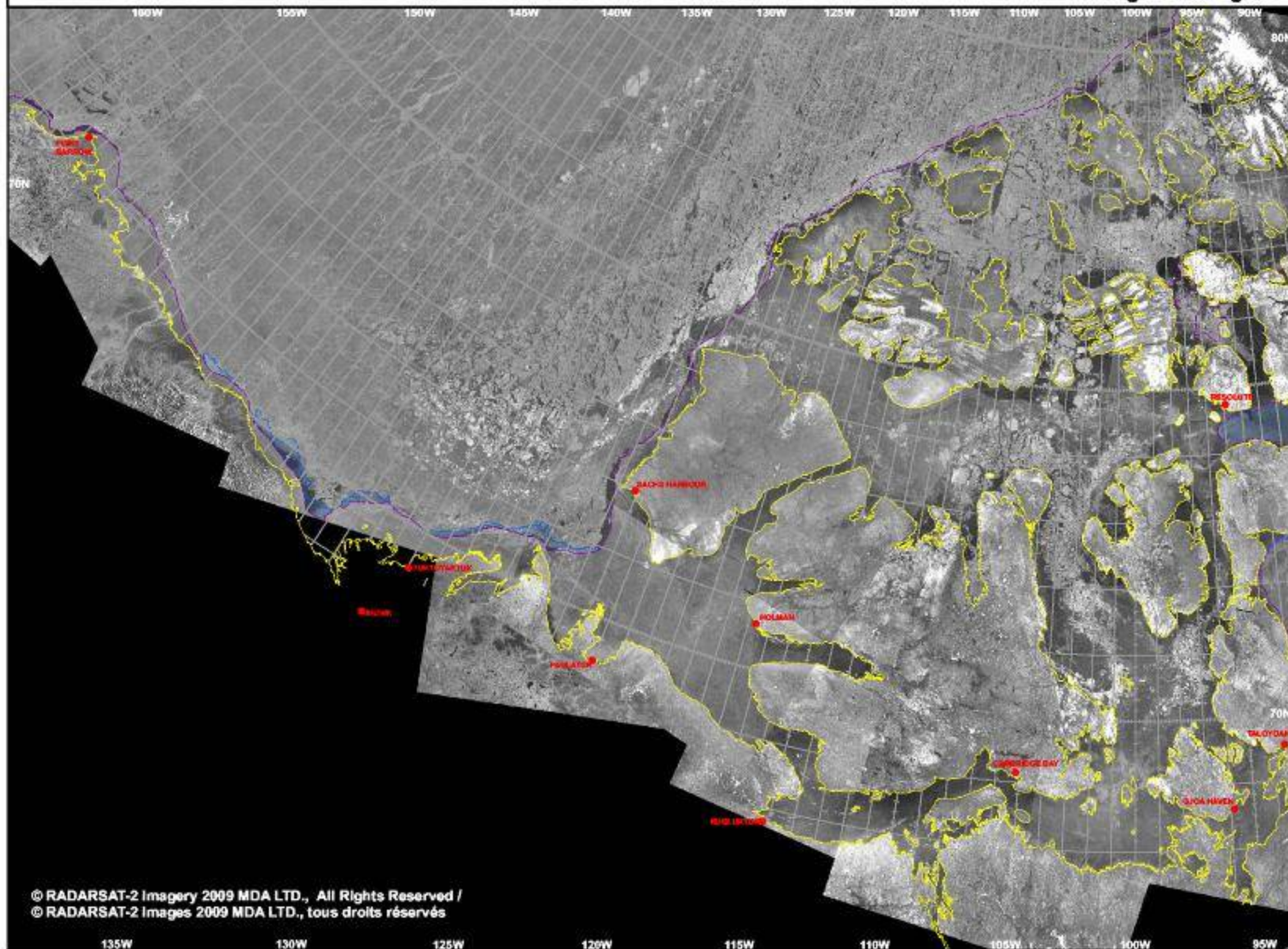
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Image Products
Analysed
images

Chart Products
Daily tactical
ice analyses
Weekly
strategic ice
analyses

Climatological
Products
Ice Atlases
Normals /
Extremes

Text Products
Ice hazard
warnings
30-day
forecasts
Seasonal
Outlooks



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RADARSAT Mosaic: Western Arctic / Mosaïque de RADARSAT: Arctique de l'Ouest

Imagery acquired between: May 22, 2009 and May 25, 2009 / Les images acquises entre: 22 Mai, 2009 et 25 Mai, 2009

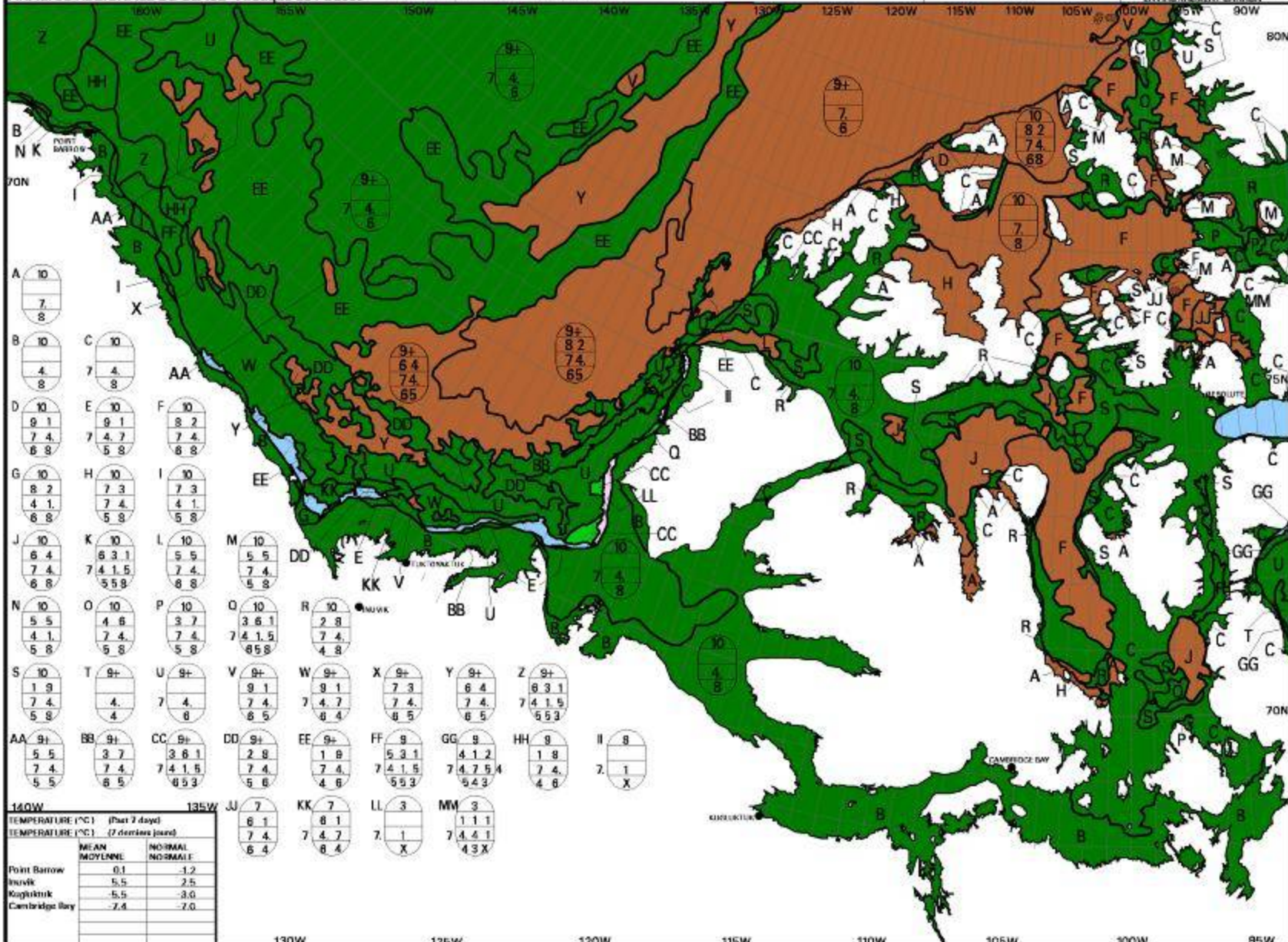


Median Ice Edge (1971-2000)
 Limite médiane des glaces (1971-2000)

< 1/10 Ice
 < 1/10 Glace

Fast ice Edge
 Lisière de la banquise côtière





WMO Colour Code - Stage of Development

Code de couleurs de l'OMM - Stade de formation

Ice Free Libre de glace	New Nouvelle	Gray white Blanchâtre	Thin First-year Mince de première année	Old ice Vieille glace	Undefined Fast Ice Indéfini Banquise c/défini
Open Water Eau Libre	Gray Grise	First-year Première année	Medium First-year Moyenne de première année	Second-year Deuxième année	Ice Shelf Plateau de glace
Icebergs			Thick First-year Épaisse de première année	Multi-year Plusieurs années	Undefined Indéfini

Canada and the United States collaboration The North American Ice Service (NAIS)



- This has allowed the US National Ice Center and International Ice Patrol and the Canadian Ice Service to meet all marine ice information needs and obligations of both the United States and Canadian governments
- Accomplishments include joint support for Canadian Coast Guard Ship Louis St. Laurent and United States Coast Guard Cutter Healy during 2008 UNCLOS mapping



Photo courtesy of USGS



Partnering with other Ice Centres

WMO-IOC JCOMM ETSI, IICWG



Unusual sea-ice events 2005

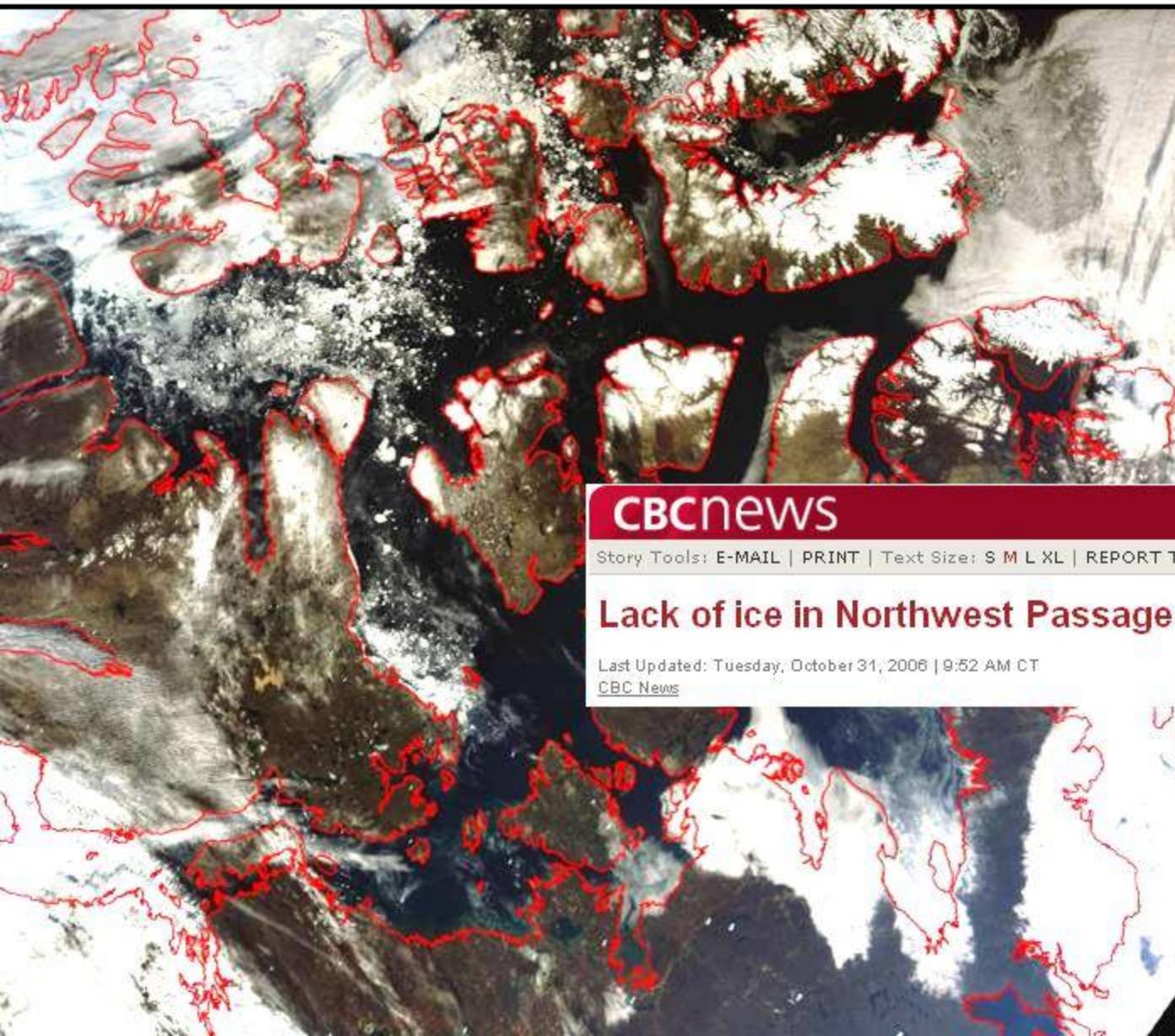
- The 66 square-km Ayles ice shelf
- Broke away in August 2005
- Freed by high temperatures and winds.
- 3,000 years old
- 15 km long by 5 km wide
- 35 meters thick
- Detected by Laurie Weir CIS



Copland, Mueller and Weir (2007)



Unusual sea-ice events 2006



MODIS

September 24, 2006

CBCnews

CANADA | NORTH

Story Tools: [E-MAIL](#) | [PRINT](#) | Text Size: [S](#) [M](#) [L](#) [XL](#) | [REPORT TYPO](#) | [SEND YOUR FEEDBACK](#)

Lack of ice in Northwest Passage stuns researchers

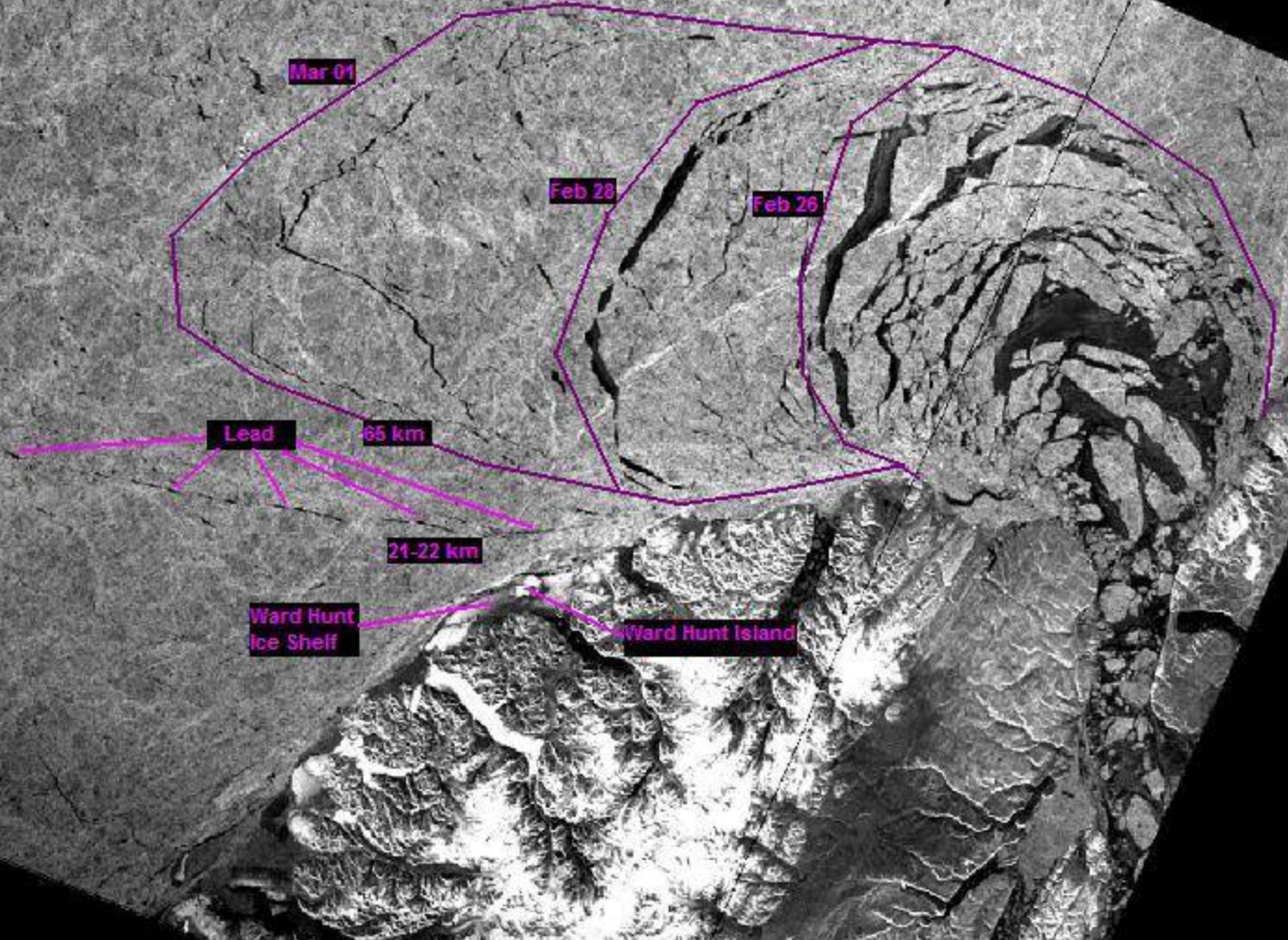
Last Updated: Tuesday, October 31, 2006 | 9:52 AM CT

[CBC News](#)

Unusual sea-ice events January 2007

Multi-year pack ice with leads

←←← Rapid westward expansion of large leads



Large fracturing of Lincoln Sea

- Occurs when Nares Strait does not consolidate
- Unusually wide-spread fracturing resulted around northern Ellesmere Island
- Warnings issued to polar teams heading to the North Pole from Ward Hunt
- Event happened again in the spring of 2008



Unusual sea-ice events 2007

“Crushing ice imprisons sealing ships
Coast Guard pushing hard to aid 100 trapped
vessels, including one of their own”



“Stunning” reduction in summer minimum sea ice extent in 2007 compared to the 30 year average

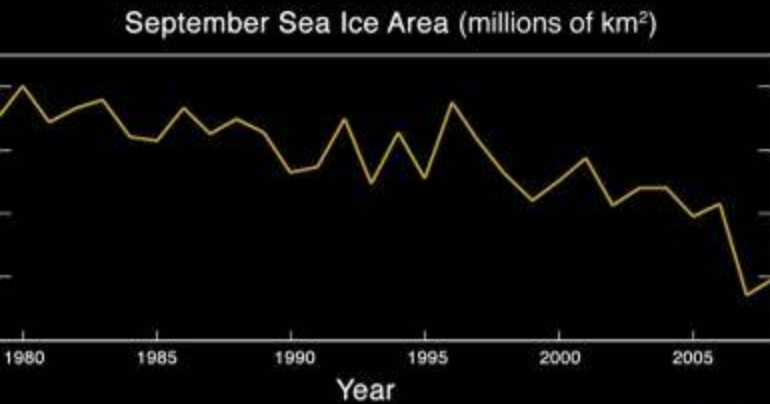
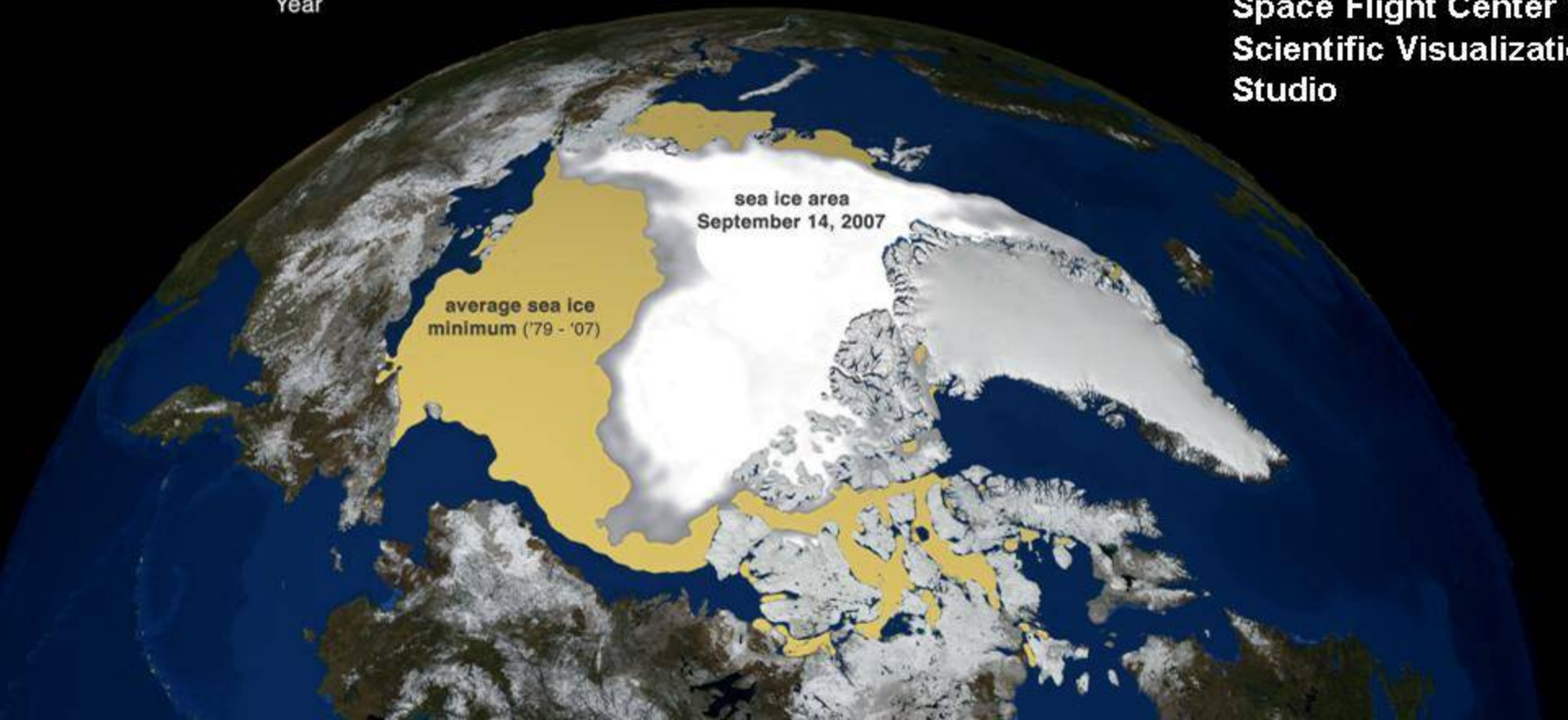
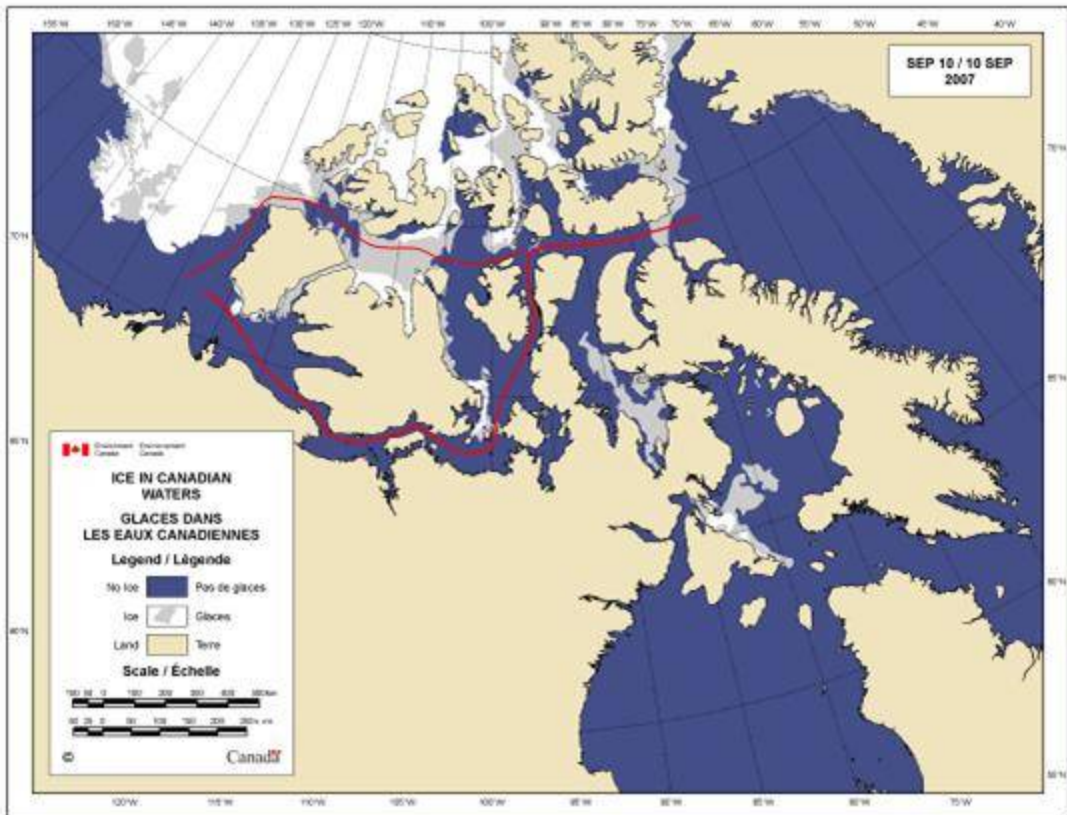


Image: NASA/Godda
Space Flight Center
Scientific Visualizati
Studio

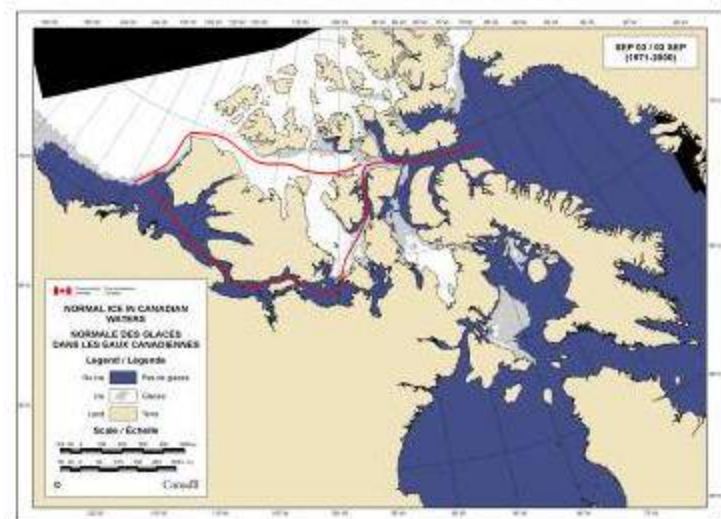


As of 2008, the NWP southern route had been navigable for a record 3 consecutive years.

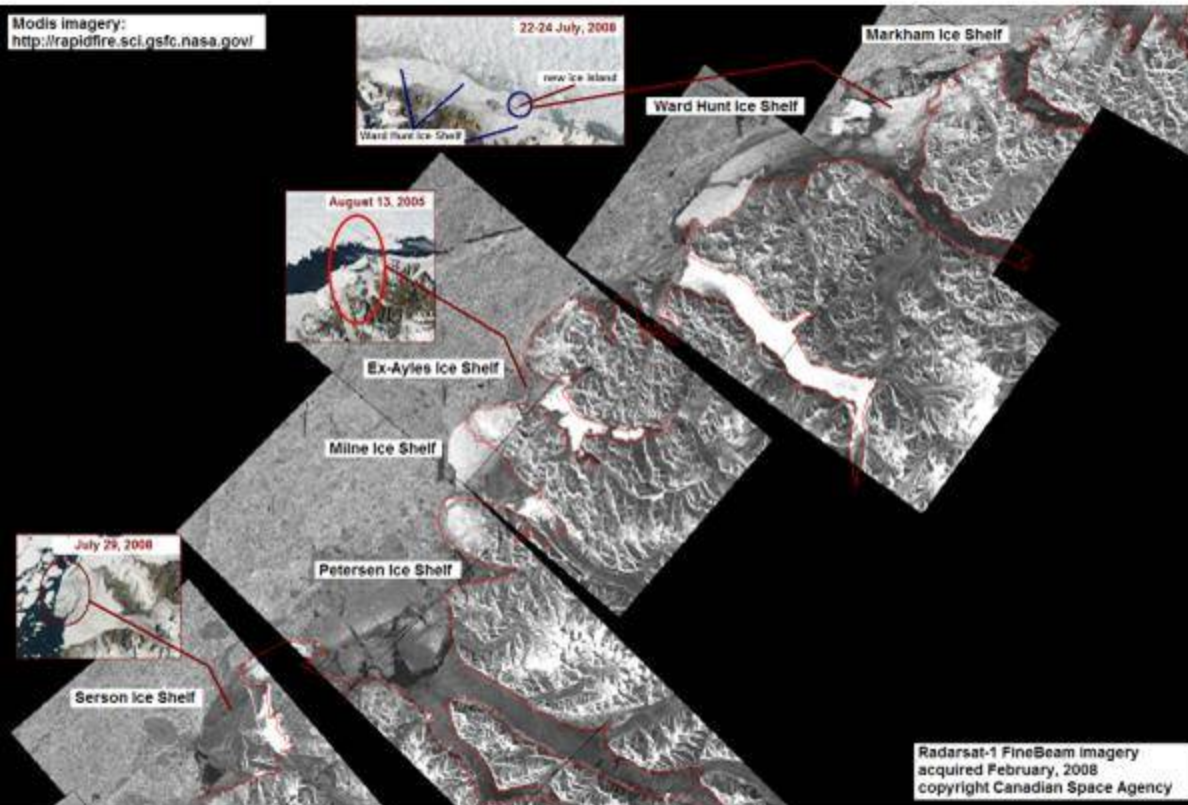
And the northern deep draft channel had been navigable throughout its length for the first 2 years in recorded history



“Normal” ice conditions in Sept. (30 year average)



As well, Canada lost 3 ice shelves from the northern coast of Ellesmere Island in 2008



The Ward Hunt Ice Shelf fragmented July 22-24

Then the Serson Ice Shelf broke off July 31 - Aug 1

Finally the Markham Ice Shelf disintegrated between Aug 4-12



Finally, in 2008, a “super iceberg” calved and has drifted south into Canadian waters and may threaten offshore oil

- Calved off Petermann Glacier July 15
- Initially about 21 km²
- Tracking beacons deployed from CCGS “Amundsen”
- Current size is est. to be 14 km² and mass about 750,000,000 tons
- Potential risk to offshore oil infrastructure Spring 2009
 - Normal “iceberg management” not feasible
 - Could reach Grand Banks by June requiring shutdowns/evacuation/movement of FPSO



Petermann Glacier
-50 00 July 15, 2008: 25 km² ice island calves from glacier front

A tracking beacon was installed on the summer 2008 Petermann Ice Island as it entered Baffin Bay

~8km long, 20 km², draft of 50-55m,

~5km long, 13.75 km²

Current Position of the Petermann Ice Island

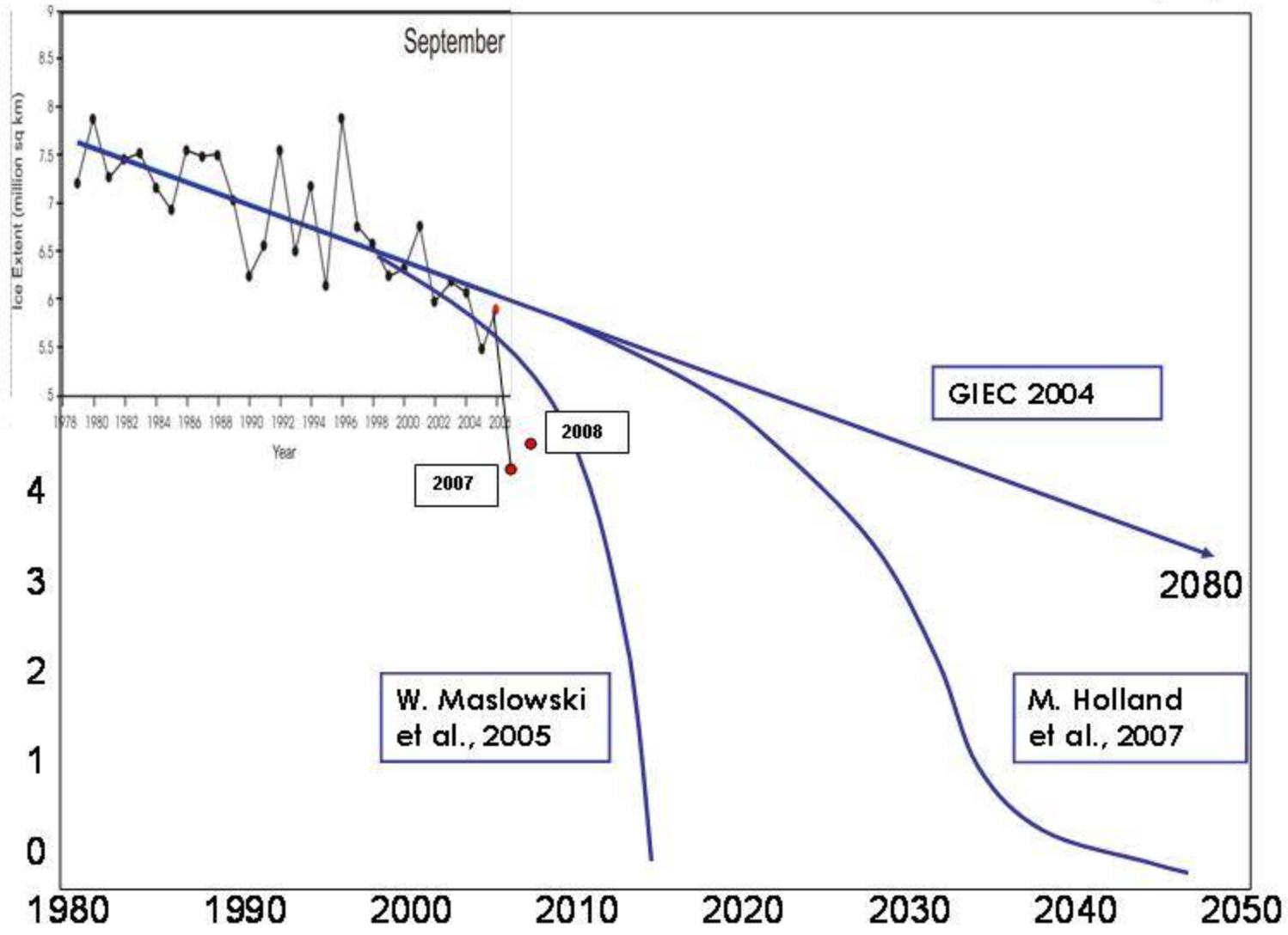
Real time internet URL:
<http://www.sailwx.info/shiptrack/shipposition.phtml?call=47557>

Grand Banks Oil Platforms / Atlantic Shipping Lanes

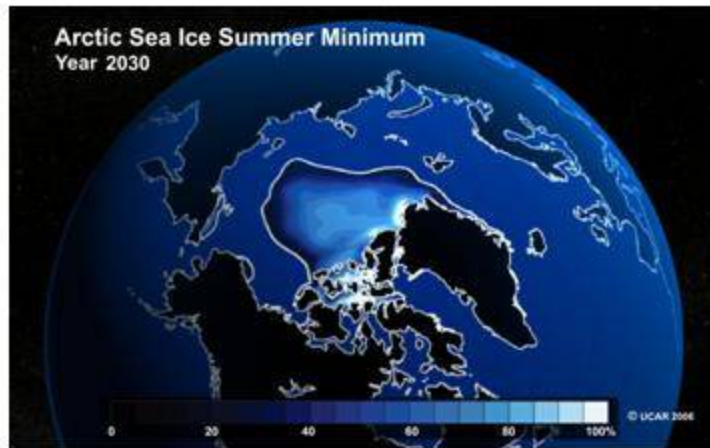
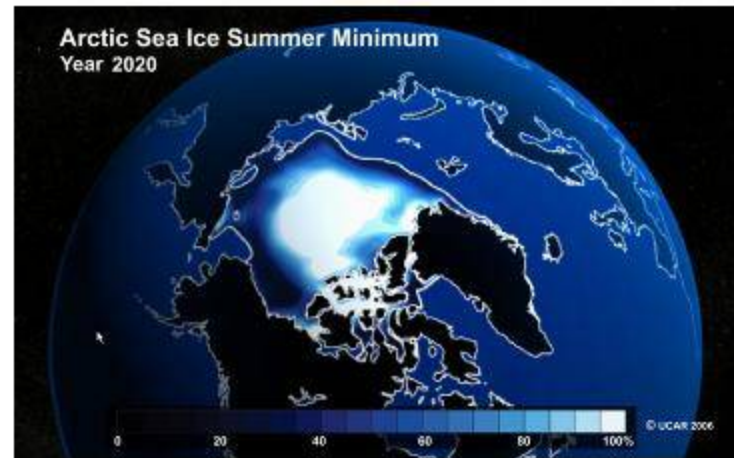
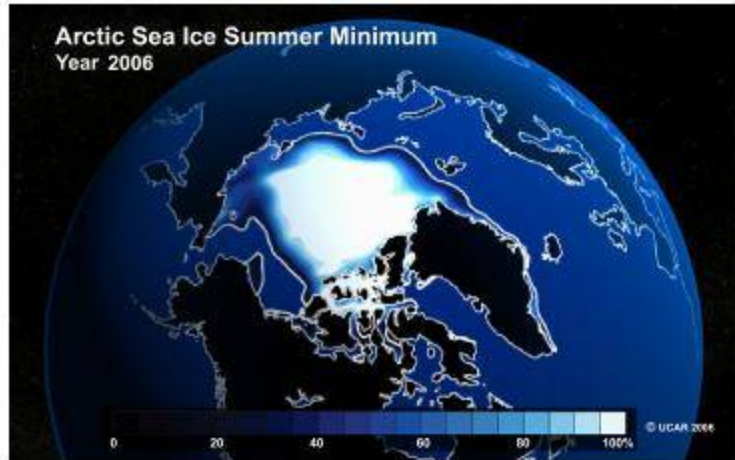


Actual observations of sea ice extent are less than even the most aggressive predictions...

From L. Fortier, 2008)



...and we know the timing of the changes in Arctic Sea ice is currently not well-predicted by models.



Conditions in 2007 were close to what was predicted for 2030

Holland et.al., GRL 2006

Note the last remaining multi-year ice will occur in and pushed up against the Canadian Arctic Archipelago

TIME

This polar bear's in danger, and so are you. Here's how global warming is already threatening Canada—and the whole planet

ARCTIC MELTDOWN

2ND-QTR SIZZLE PROFITS AT 900 COMPANIES (P.36) PAYING FOR COLLEGE BEWARE OF THOSE HIGH 529 FEES (P.50) TERRORISM WHAT COMPANIES STILL NEED TO DO (P.20)

BusinessWeek

GLOBAL WARMING

Why Business Is Taking It So Seriously

BY JOHN CAREY (P.50)

FROM THE DIRECTOR OF INDEPENDENCE DAY

THE DAY AFTER TOMORROW

WHERE WILL YOU BE?

Canada's **Notre climat change**

Il est temps d'agir!

Antarctic MELTDOWN?

Will Melting Ice Flood the Land?

L'EFFET DE SERRE
le rôle des océans, l'impact sur les glaciers

HAS GLOBAL WARMING BEGUN?

MICHAEL CRICHTON

STATE OF FEAR

SPECIAL REPORT GLOBAL WARMING

TIME

BE WORRIED. BE VERY WORRIED.

Climate change isn't some vague future problem—it's already damaging the planet at an alarming pace. Here's how it affects you, your kids and their kids as well

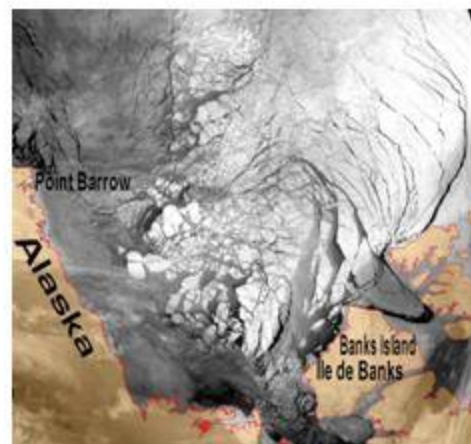
EARTH AT THE TIPPING POINT
HOW IT THREATENS YOUR HEALTH

HOW CHINA & INDIA CAN HELP
SAVE THE WORLD—OR DESTROY IT

THE CLIMATE CRUSADERS

What does it all mean?

- All these events are consistent with the other changes in the Arctic
- Global sea ice is declining in extent, age and volume
- Due to increased mobility, multi-year ice is moving into shipping lanes causing increased hazards
- Icebergs continue to present a significant danger and there may be an increasing presence of ice islands as a result of ice shelf fracturing
- Sea ice extent within the Canadian Arctic is extremely variable and demanding ice conditions will continue in Canadian navigable waters for the foreseeable future

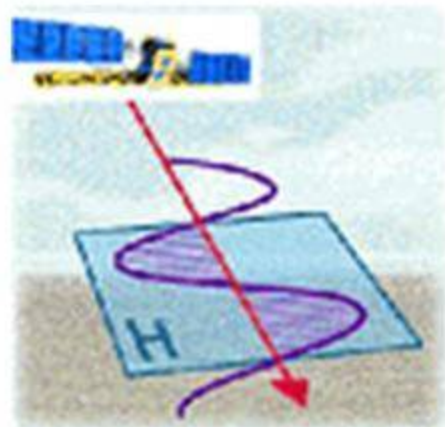


**There are challenges, but do not
abandon hope, all ye who enter here....**



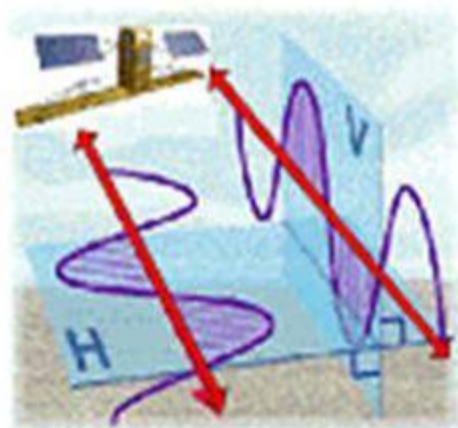
Improvement in our tools should help us

RADARSAT-1 is horizontally polarized – radar wave is horizontal to the Earth's surface.



RADARSAT-1

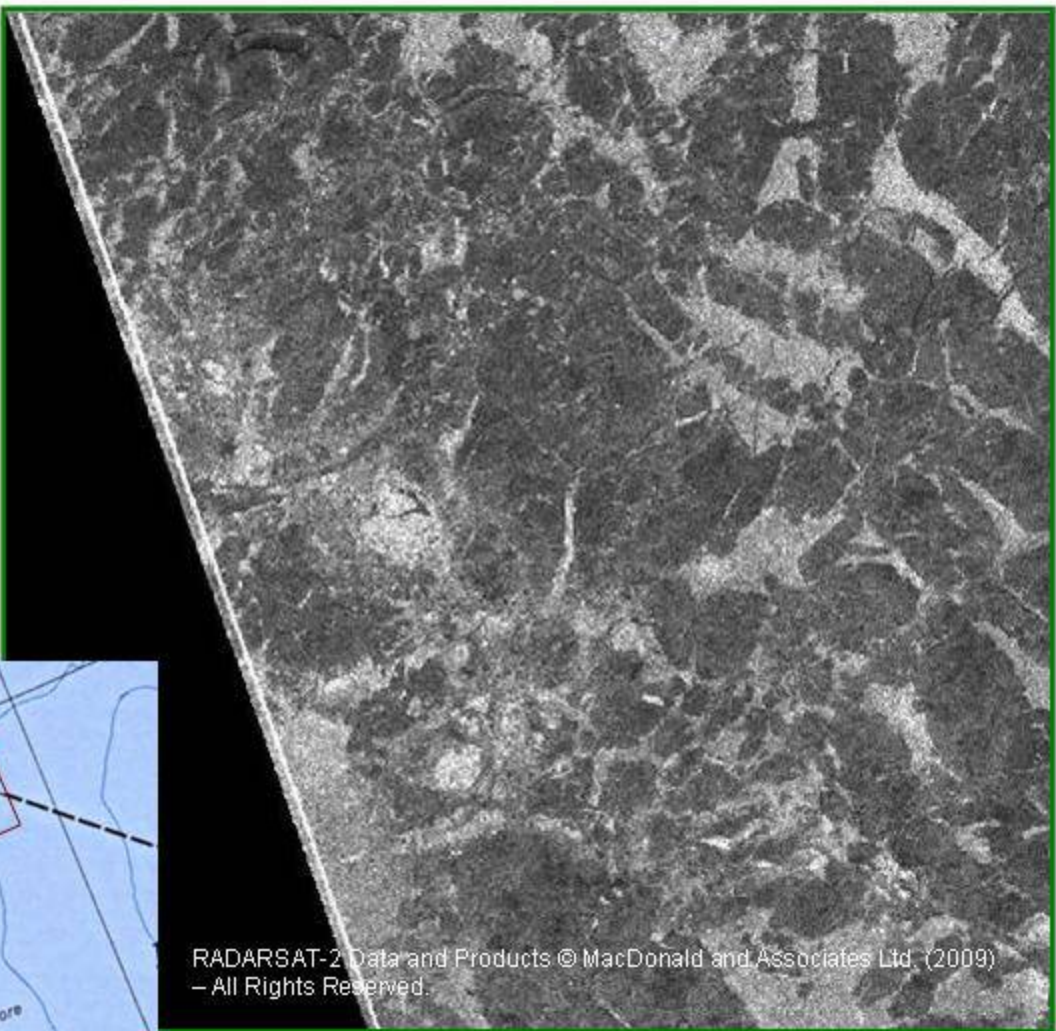
RADARSAT-2 has the capability to send and receive data in both **horizontal (H)** and **vertical (V)** polarizations.



RADARSAT-2

Detection of Multi-Year ice within an area of medium first year ice.

January 25, 2009 RADARSAT-2 (HH) Baffin Bay



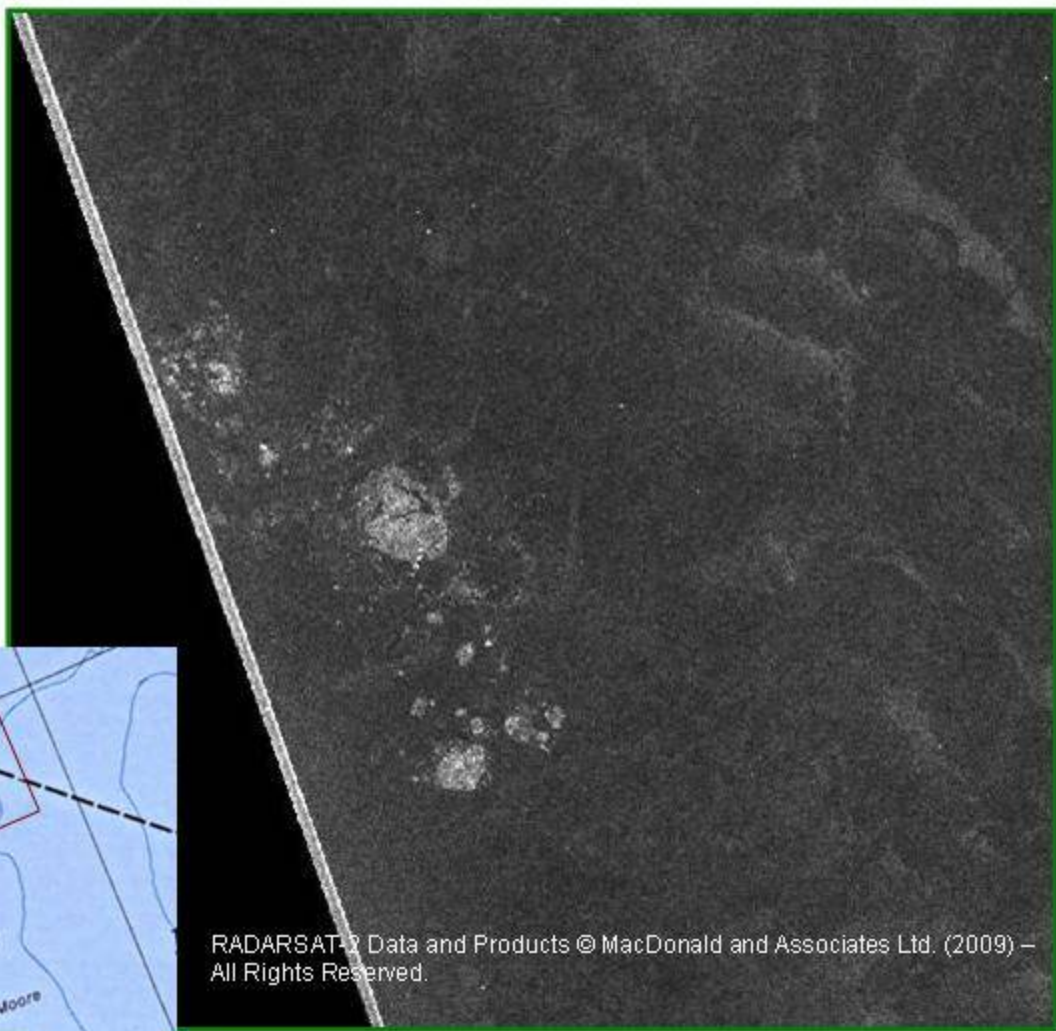
HH Image

Difficult to detect the area of multi year ice.

RADARSAT-2 Data and Products © MacDonald and Associates Ltd. (2009) – All Rights Reserved.

Detection of Multi year ice within an area of medium first year ice.

January 25, 2009 RADARSAT-2 (HV) Baffin Bay



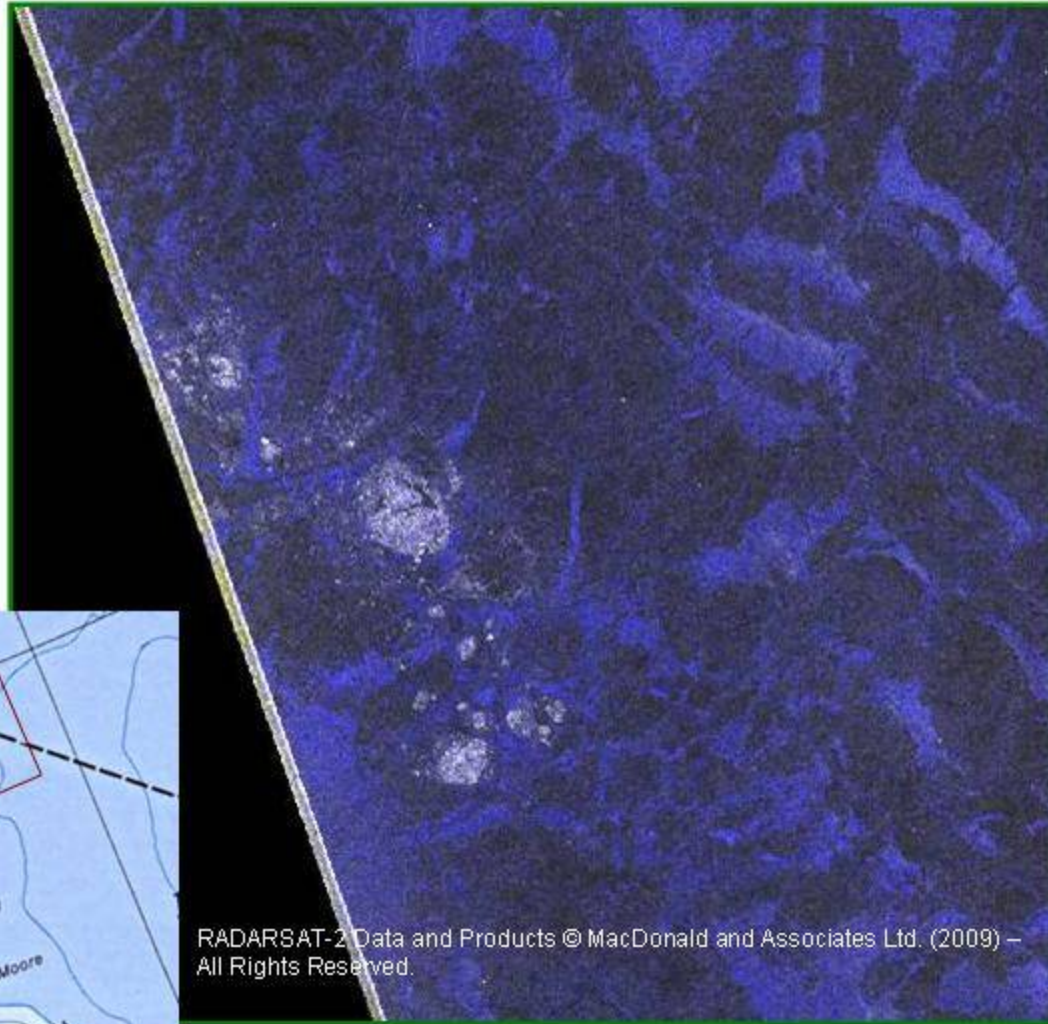
HV Image

Much improved detection of multi year ice with the HV image.

RADARSAT-2 Data and Products © MacDonald and Associates Ltd. (2009) – All Rights Reserved.

Detection of Multi year ice within an area of medium first year ice.

January 25, 2009 RADARSAT-2 (RGB221 or HV,HV,HHHV)



RGB221 Image

Good detection
of multi year ice
and

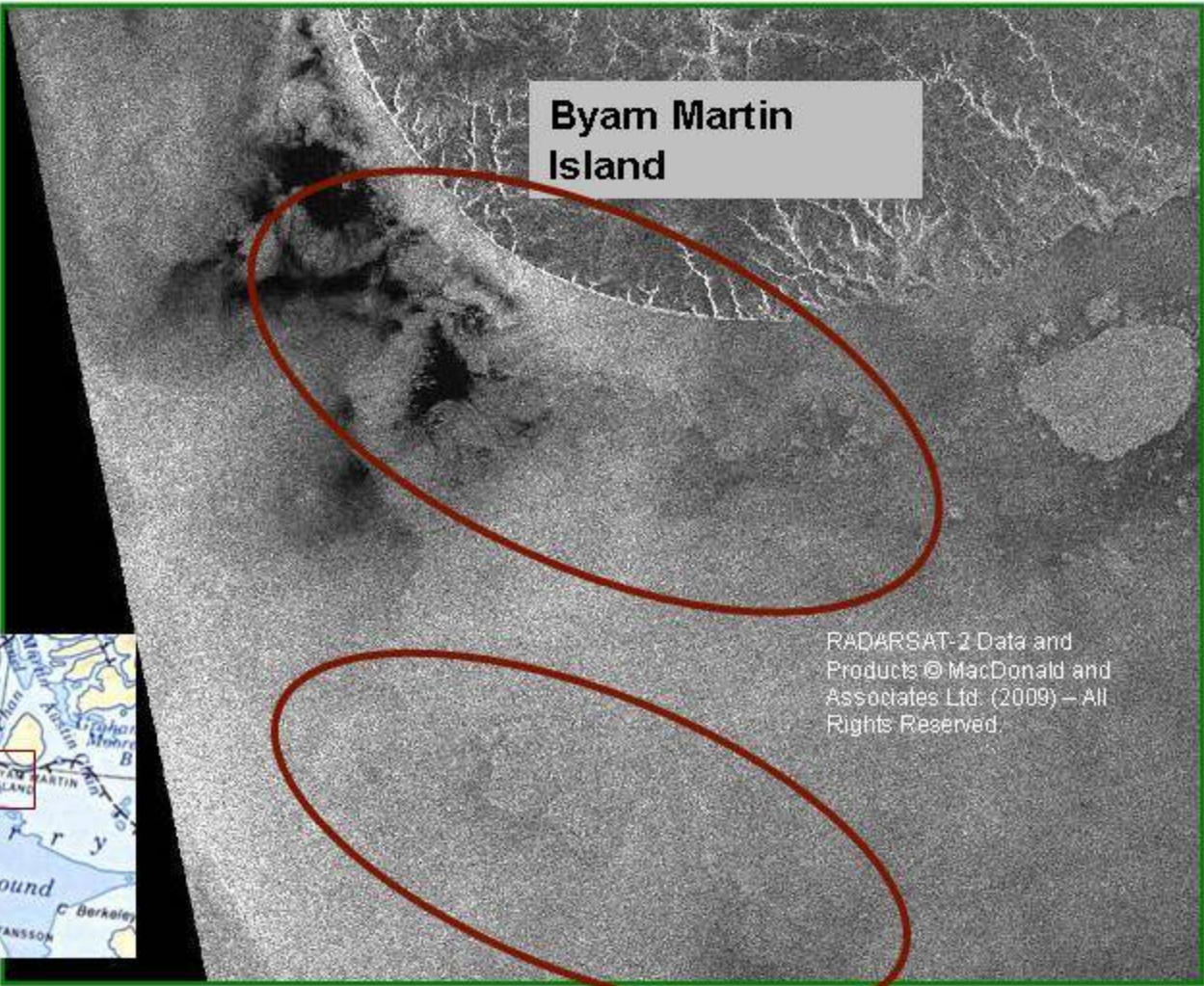
Good detection
of thinner ice
areas within the
medium ice
pack.



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Detection of Thick First Year ice with some Multi-Year ice

September 11, 2008 RADARSAT-2 (HH) Viscount Melville Sound



Byam Martin
Island

HH Image

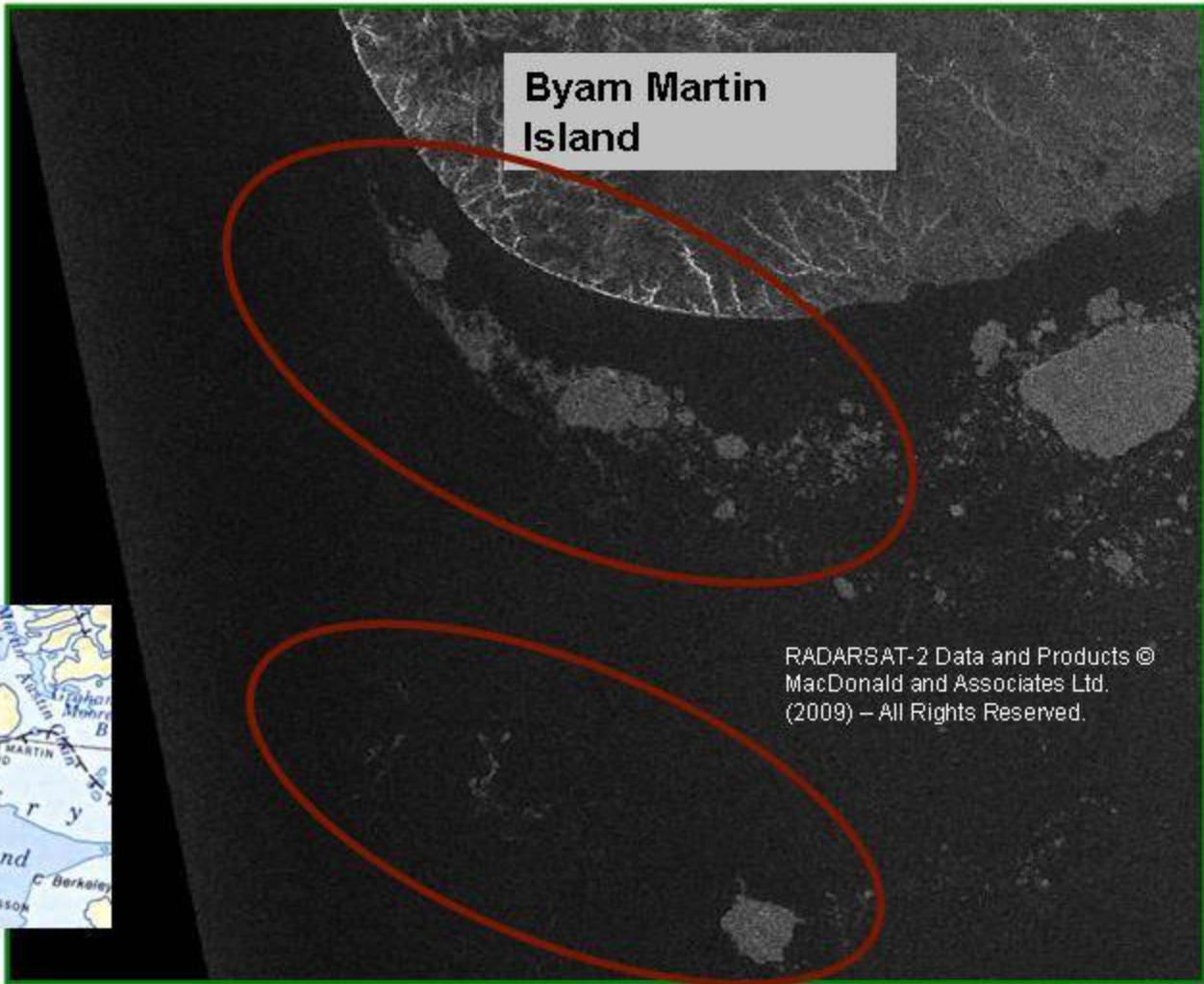
Difficult to
detect ice in
the near
range.

RADARSAT-2 Data and
Products © MacDonald and
Associates Ltd. (2009) – All
Rights Reserved.



Detection of Thick First-Year ice with some Multi-Year ice

September 11, 2008 RADARSAT-2 (HV) Viscount Melville Sound



Byam Martin Island

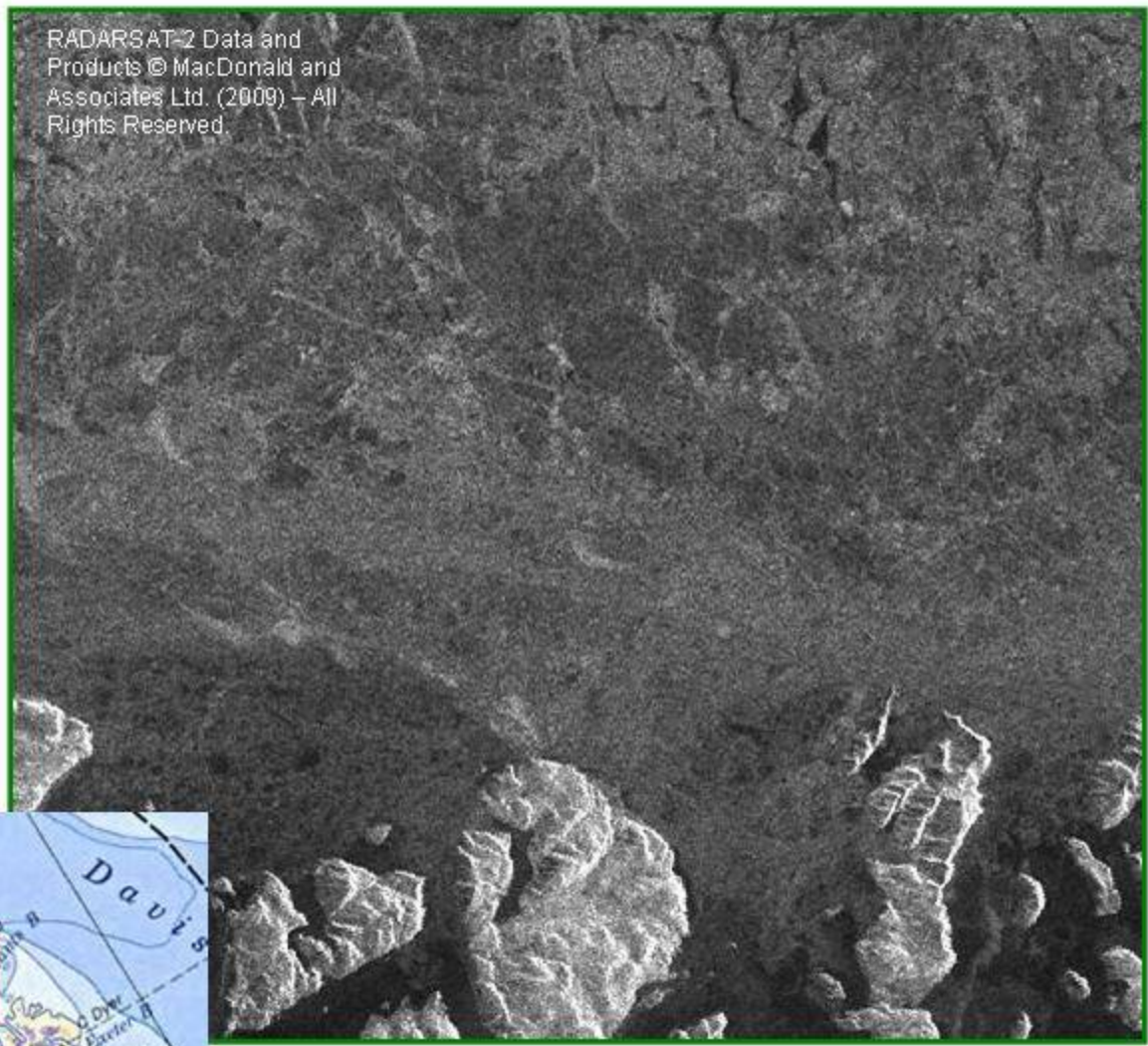
HV Image
Significantly improved detection.

RADARSAT-2 Data and Products ©
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(2009) – All Rights Reserved.



Detection of an Ice Island within an first year ice pack

January 25, 2009 RADARSAT-2 (HH) Davis Strait



RADARSAT-2 Data and Products © MacDonald and Associates Ltd. (2009) – All Rights Reserved.

HH Image

Very difficult to detect the Petermann Ice Island in this image.



Detection of an Ice Island within a First-Year ice pack

January 25, 2009 RADARSAT-2 (HV) Davis Strait

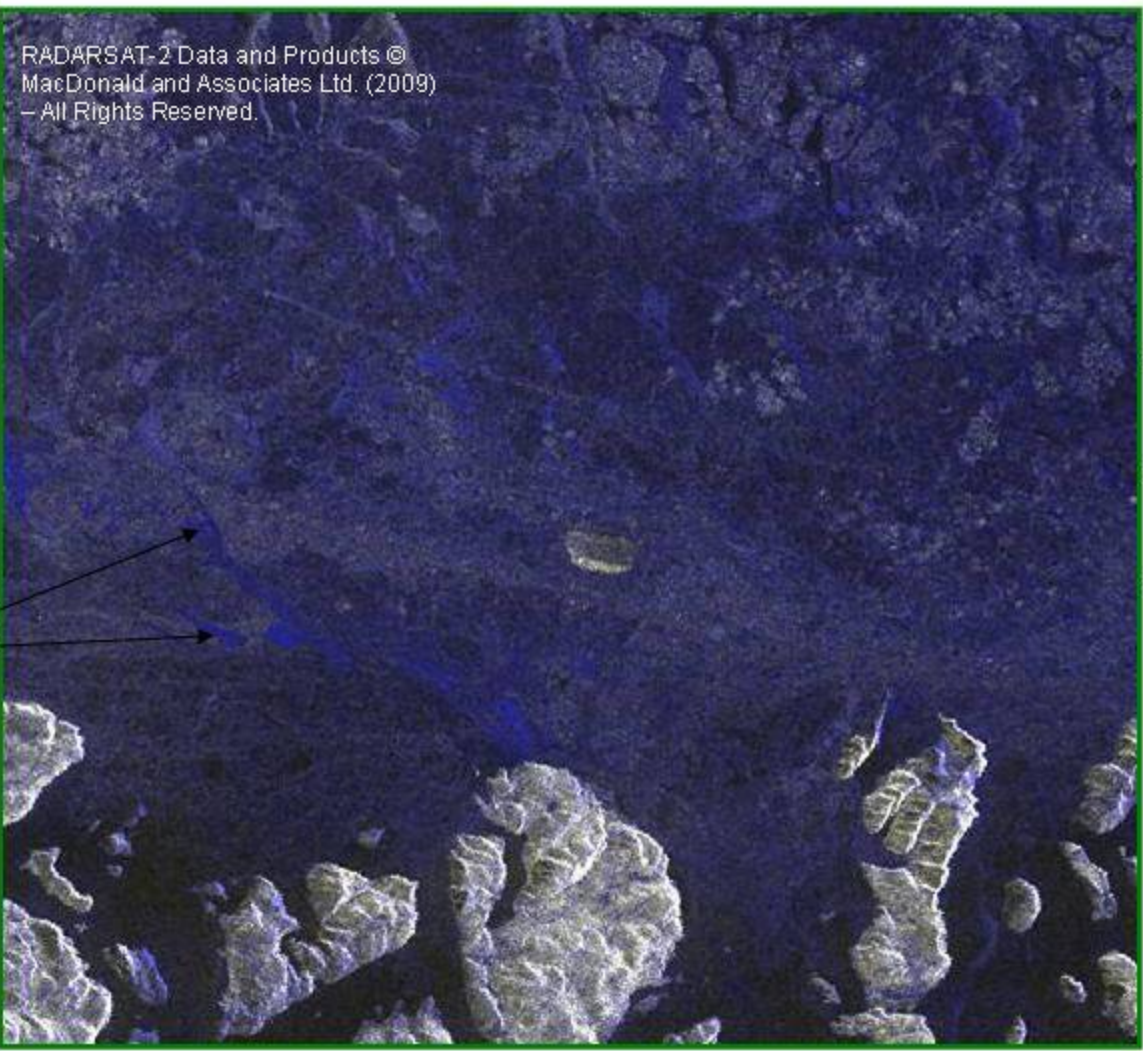


HV Image

Petermann Ice Island is easily detectable in this image.

Detection of an Ice Island within an first year ice pack

January 25, 2009 RADARSAT-2 (RGB221 or HV,HV,HH)



RGB 221
Image

Petermann Ice Island is easily detectable in this image along with areas of thinner ice in the first year ice pack.

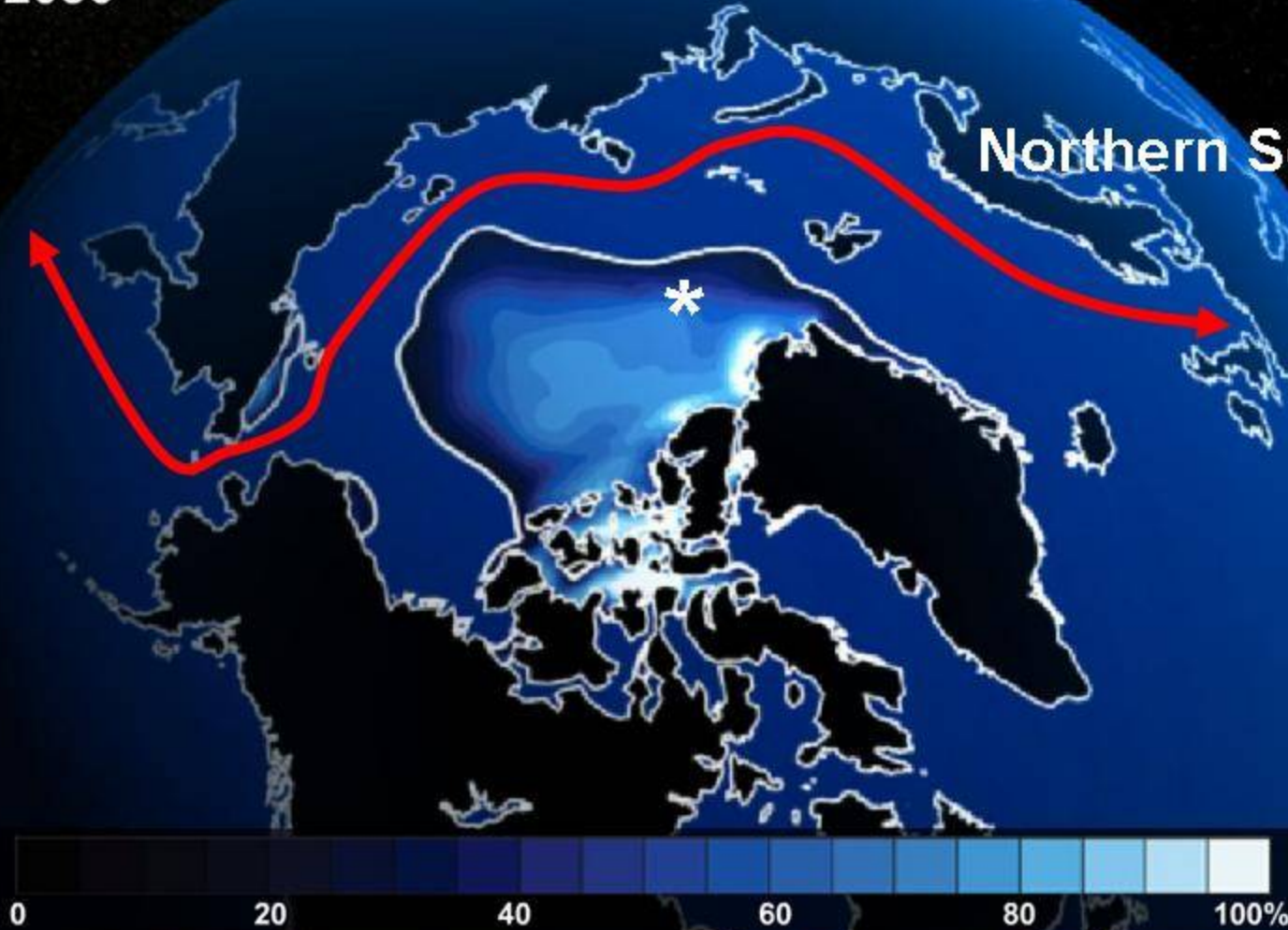
Thinner Ice /
open areas



NWP will have to compete with alternative transit routes that are predicted to open first – Northern Sea Route

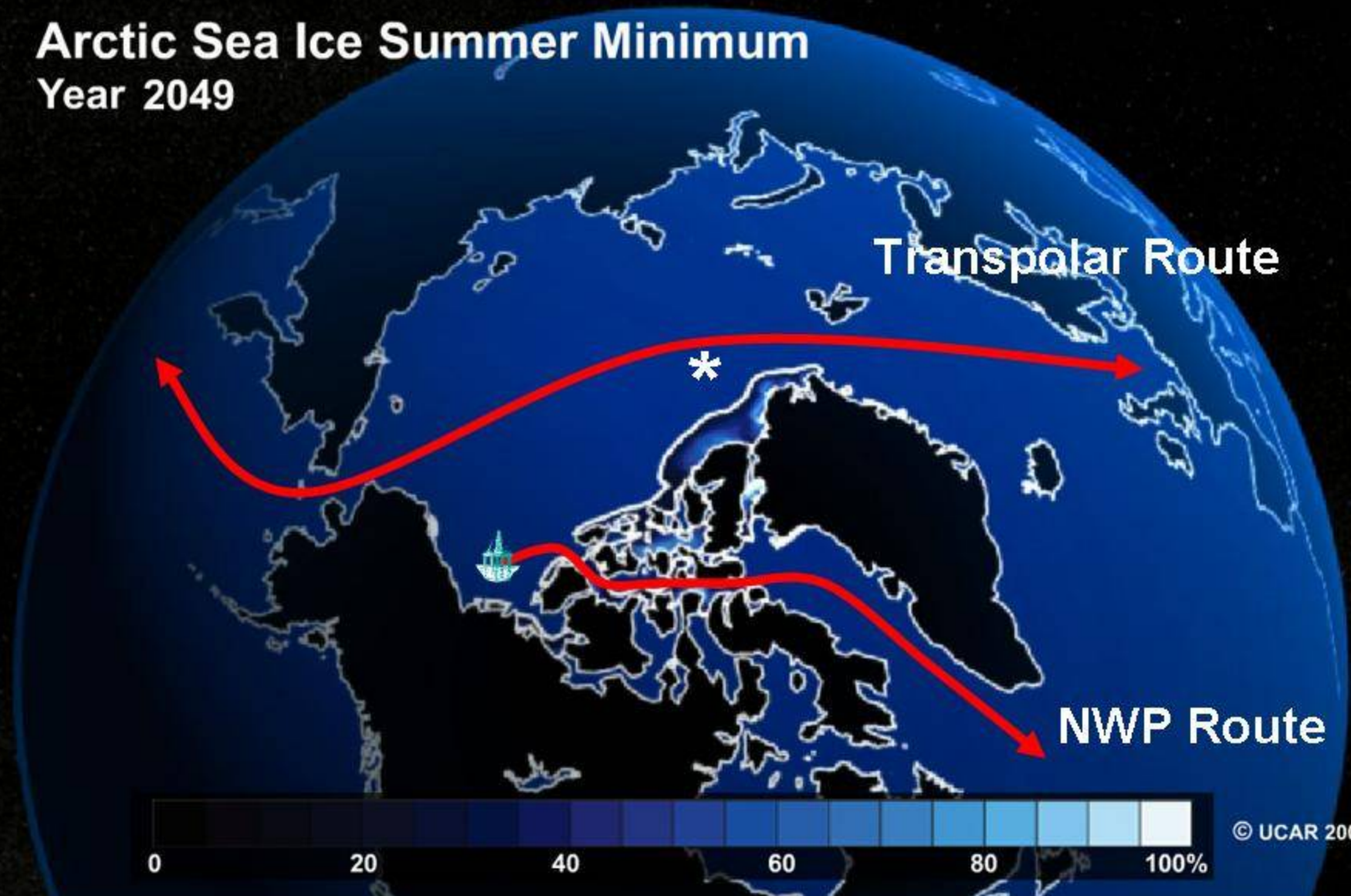
**Arctic Sea Ice Summer Minimum
Year 2030**

Northern Sea Route



NWP will have to compete with alternative transit routes that are predicted to open first – Transpolar Route

**Arctic Sea Ice Summer Minimum
Year 2049**



Transpolar Route

NWP Route

© UCAR 2006

What, so what, now what?

- What should nations do?
- What should be the focus of policy-makers when looking to the north?
- How can we best meet our interests and values?
- A partial answer to that general question from our own focus on northern shipping.
- Why? When it comes to economic drivers, marine shipping and related transportation infrastructure will be essential to sustained northern development, and for nations.



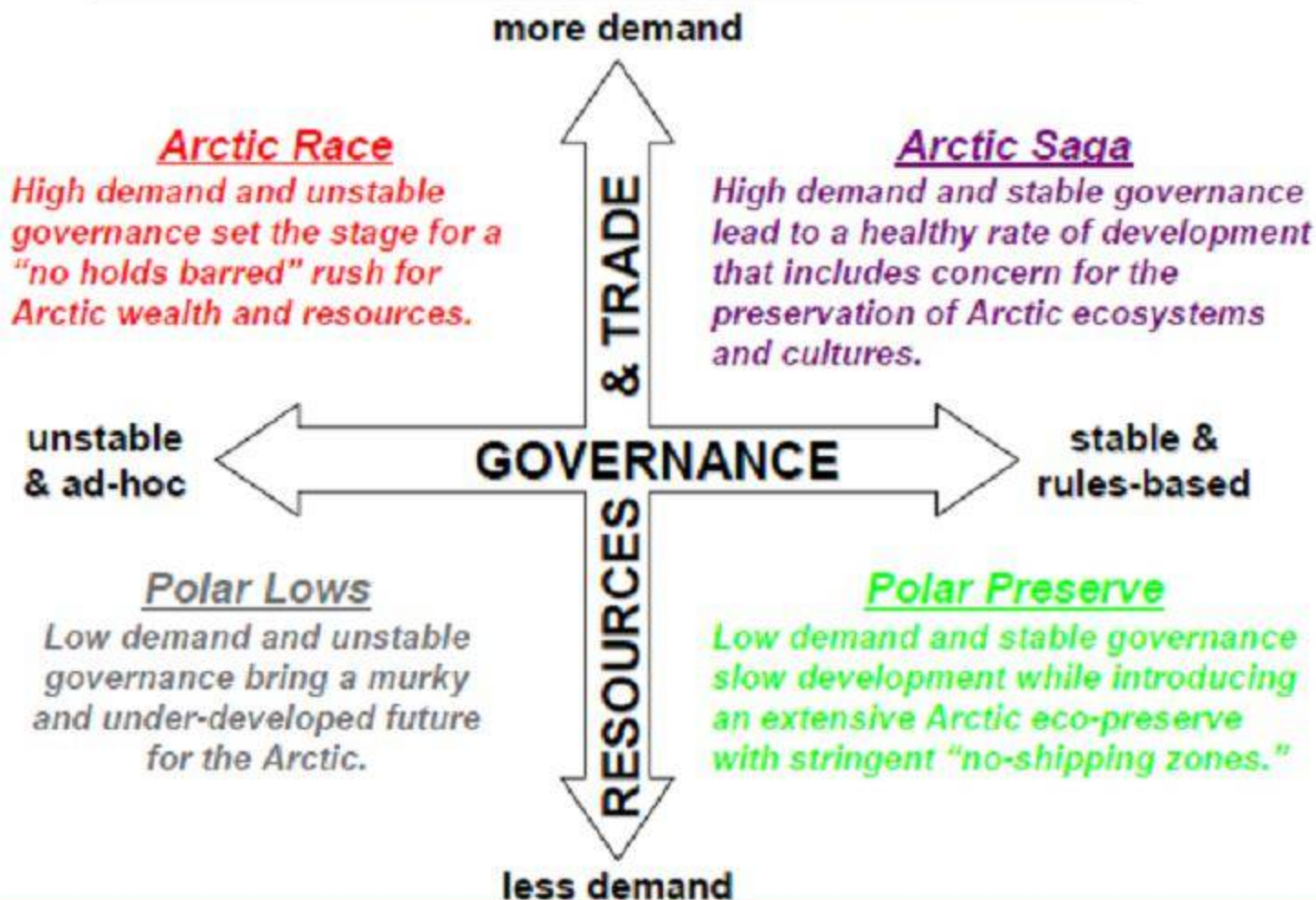
Arctic Marine Navigation Scenarios – Mid-Century

- Two workshops were held in 2007 to create and analyse possible scenarios surrounding the future of Arctic marine navigation in the mid-century
- Workshop participants identified “**Governance**” and “**Resources & Trade**” as the most important and uncertain issues shaping future Arctic marine navigation.
- They speculated that depending on the response to the primary drivers including Climate Change – there could be 4 possible “worlds”

High demand Unstable	Low demand Unstable	Low demand Stable	High demand Stable
Many internat'l players & competition for Arctic resources	Global economic downturn persists	Arctic oil and gas reserves disappointing	Economic rebound
Political tensions	Increased domestic challenges	Alternative energy emerges as a viable alternative	Systematic development of Arctic resources
Climate warming faster than expected	Reduction in sea slower than predicted	Public concern about climate change influences	Cooperative economic and political efforts by Arctic States
			Climate warms as expected



Scenarios on the Future of Arctic Marine Navigation in 2050



From the "Scenario Narratives Report: Future of Arctic Marine Navigation in Mid-Century", Arctic Council's PAME Working Group, March 2008



Arctic Marine Shipping Assessment

- Produced in response to Key Finding # 6 of the Arctic Climate Impact Assessment (ACIA) Report released in November 2004, namely:

“Reduced sea ice is very likely to increase marine transport and access to resources”

- The AMSA was approved at the Sixth Ministerial Meeting of The Arctic Council, 29th of April, 2009, in Tromsø, including its recommendations
 - on enhancing Arctic marine safety,
 - protecting Arctic people and environment,
 - building Arctic marine infrastructure,
 - the request that Senior Arctic Officials (SAOs) to develop appropriate follow up actions.

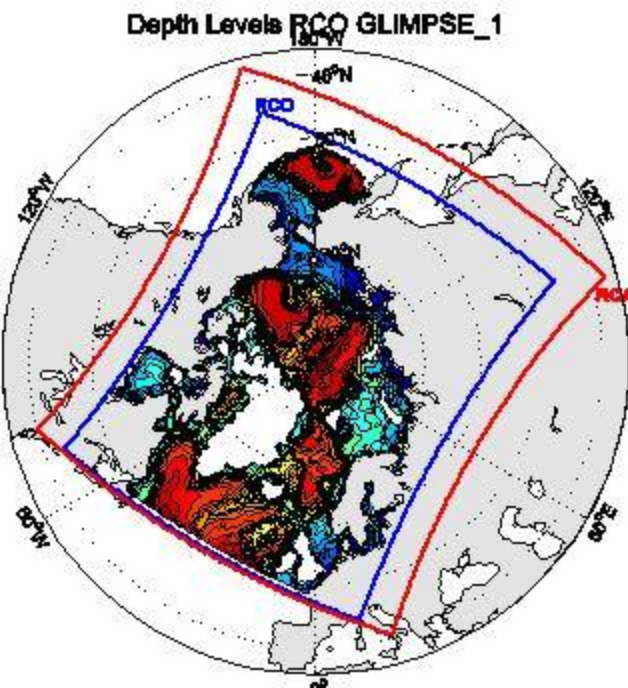


Because of these changes, the need for reliable sea ice information by Canada and the United States of America has never been greater.

- **Northerners on front-line of changing northern conditions**
 - facing higher risks
- **Arctic shipping season is increasing temporally and spatially**
 - Starting earlier in the Summer – lasting longer in Fall, with many requests for increased forecast lead times
 - Destination shipping traffic is increasing
- **Increasing need for reliable information to inform resource, regulation and policy development**
 - We do not have sustained observations in the Arctic
 - We need global collaboration and data sharing amongst arctic nations
 - The Arctic Council is attempting to address this, i.e. through
 - establishment of Sustained Arctic Observation Network (SAON)
 - Arctic Marine Shipping Assessment
- **Increasing need to support security operations**

What else should we be doing?

- Reduce the uncertainty!
- Develop operational data assimilating coupled ice-ocean-atmosphere models to provide a proper basis for forecasts



Three temporal scales

- Tactical – 0 to 7 days
support operations
- Operational – inter-seasonal
support planning
- Strategic – 30 year ensembles
support infrastructure
design

Final Words

- In summary, we need to ensure that the future for the Arctic is one of balance – a successful “Arctic Saga” rather than a politically-charged, wild-west “Arctic Race”
- We need to jointly and co-operatively implement recommendations such as those that have been tabled in documents like the AMSA
- Most importantly, though, we need to ***invest in people*** to make all of this happen - providing the interdisciplinary training and expertise for them to be ready for this profound journey



Questions?

Acknowledgements

All the men and women
of the NAIS (CIS, IIP, NIC)

Special thanks:

Doug Bancroft
Luc Desjardins
Roger DeAbreu
John Falkingham
Louis Fortier
Marie-France Gauthier
Darlene Langlois
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Canadian Coast Guard
FedNAV, Transport Canada, Department of National Defence, Polar Continental Shelf Project
...and many more

