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

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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 Laurence 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


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 Ordonia 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:

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

Lack of ice in Northwest Passage stuns researchers

Last Updated: Tuesday, October 31, 2006 | 0:52 AM CT
CBC News
Unusual sea-ice events January 2007

Multi-year pack ice with leads

Rapid westward expansion of large leads

Lead 25 km

Ward Hunt Ice Shelf

Ward Hunt Island
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/Goddard Space Flight Center Scientific Visualization 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

Photo credit Martin Fortier – ArcticNet
A tracking beacon was installed on the summer 2008 Petermann Ice Island as it entered Baffin Bay. The ice island is approximately 8 km long, 20 km² in area, and has a draft of 50-55 m.

Current Position of the Petermann Ice Island:
- 19-Oct
- 02-Dec
- 06-Dec
- 11-Dec
- 05-Jan
- 26-Jan
- 31-Jan
- 14-Feb
- 09-Feb
- 14-Mar
- 16-Mar
- 1305

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

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

Holland et al., GRL 2006
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-2** has the capability to send and receive data in both **horizontal (H)** and **vertical (V)** polarizations.
Detection of Multi-Year ice within an area of medium first year ice.

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

Difficult to detect the area of multi year ice.

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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.
Detection of multi-year ice within an area of medium first year ice.

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

- Good detection of multi-year ice and
- Good detection of thinner ice areas within the medium ice pack.
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.
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.

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Detection of an Ice Island within an first year ice pack

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

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

<table>
<thead>
<tr>
<th>High demand Unstable</th>
<th>Low demand Unstable</th>
<th>Low demand Stable</th>
<th>High demand Stable</th>
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<tbody>
<tr>
<td>Many internat’l players &amp; competition for Arctic resources</td>
<td>Global economic downturn persists</td>
<td>Arctic oil and gas reserves disappointing</td>
<td>Economic rebound</td>
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<tr>
<td>Political tensions</td>
<td>Increased domestic challenges</td>
<td>Alternative energy emerges as a viable alternative</td>
<td>Systematic development of Arctic resources</td>
</tr>
<tr>
<td>Climate warming faster than expected</td>
<td>Reduction in sea slower than predicted</td>
<td>Public concern about climate change influences</td>
<td>Cooperative economic and political efforts by Arctic States</td>
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<tr>
<td></td>
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<td>Climate warms as expected</td>
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Scenarios on the Future of Arctic Marine Navigation in 2050

More demand:
- **Arctic Race**: High demand and unstable governance set the stage for a “no holds barred” rush for Arctic wealth and resources.
- **Arctic Saga**: High demand and stable governance lead to a healthy rate of development that includes concern for the preservation of Arctic ecosystems and cultures.

Governance:
- Unstable & ad-hoc
- Stable & rules-based

Resources:
- Polar Lows: Low demand and unstable governance bring a murky and under-developed future for the Arctic.
- Polar Preserve: Low demand and stable governance slow development while introducing an extensive Arctic eco-preserve with stringent “no-shipping zones.”

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?

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