SAFE NAVIGATION IN ARCTIC

Dr. Burcu Ozsoy-Cicek
Director, Polar Research Center (PolRec)
Istanbul Technical University (ITU)

www.polarresearch.center
burcu@polarresearch.center

Co-Authors:
Dr. Sevilay Can
Dr. Cpt. Tanzer Satır

ShipARC - Malmö, 25-27 August 2015
Outline

- Arctic sea ice
- Arctic Climate
- Arctic Navigation and Vessel construction/equipment
- To take home
Arctic Sea Ice

Sea ice

What is this? Well, sea ice is ...

- ... saline ice made of sea water floating on polar oceans
- ... covers between 4 million km² (September) and 14 million km² (March) in the Arctic
- ... is up to 2 meter (seasonal or so-called first-year sea ice) and between 3 to 5 meters thick (multiyear ice)
- ... carries snow (10 to 50 cm)
- ... reflects sunlight
- ... insulates ocean against cold winter atmosphere
- ... modifies water masses during its formation and melt
- ... moves and deforms
Sea ice moves and deforms

- Just half of the story is above the sea ice (blocks, voids, “hidden” ice mass)
- Ridge structure can be different from keel structure

Arctic Sea Ice

Which parameters to observe?

- Sea ice concentration → fraction of known area covered with ice
- Sea ice thickness → draft, freeboard, snow depth, density
- Sea ice motion → displacement, deformation, roughness
- Sea ice type → young, old, level, deformed ice
Arctic Sea Ice

Where do we observe changes?

- Sea ice area and extent: Decrease
- Sea ice age & composition: More younger than older ice
- Sea ice thickness: Decrease
- Sea ice volume: Decrease
- Sea ice drift speed: Acceleration
- Melt season: Length increase
Arctic Sea Ice

Where do we observe changes?

Arctic sea ice area for 1992-2014 → decreases
Arctic Sea Ice

Where do we observe changes?

- Combined 60-year long sea ice extent data set
- Decrease in both winter (=March) and summer (=September)
- Decrease seems to accelerate in last 2 decades

Meier et al., 2012, The Cryosphere, 6
Arctic Sea Ice

Where do we observe changes?

- Ice thickness measured from underneath by submarines for 20+ years
- Combined record shows clear decrease in ice thickness

Kwok and Rothrock, 2008, Geophysical Research Letters, 36
Arctic Sea Ice

Where do we observe changes?

Maslanik et al., 2011, Geophysical Research Letters, 38
Outline

- Arctic sea ice
- **Arctic Climate**
- Arctic Navigation and Vessel construction/equipment
- To take home
Arctic Climate

Overland et al., 2011, Polar Research, 30
Arctic Climate

Direct (= in the Arctic), proven
- Less & thinner sea ice / longer melt season
  - sea routes open
  - longer time for off-shore operations
  - animals depending on sea ice presence on the run

Indirect (= mid-latitudes), under debate
- Feedback to Siberian snow cover
- Feedback on general tropospheric circulation (slowing down of jet stream) → heat- and cold waves
Arctic Climate

Selected Implications - I

Direct (= in the Arctic), proven

- Less & thinner sea ice / longer melt season
  - sea routes open
  - longer time for off-shore operations
  - hunting habits need to change
  - animals depending on sea ice presence on the run

Indirect (= mid-latitudes), under debate

- Feedback to Siberian snow cover
- Feedback on general tropospheric circulation (slowing down of jet stream) \( \rightarrow \) heat- and cold waves
Arctic Climate

Selected Implications - II

Decrease in ice area & thickness
→ opens sea routes
→ increases time for shipping and off-shore activities

Prediction of ice-free months for 2030, 2060 & 2090

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast Passage</td>
<td>2030</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2060</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2090</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northwest Passage</td>
<td>2030</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2060</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2090</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rogers et al., 2013, The Cryosphere, 7
Arctic Climate

Selected Implications - III

Less sea ice & longer melt season

→ Longer time for waves to impact coasts

→ More coastal erosion

→ Particularly bad for coasts with high fraction of permafrost

Barnhart et al., 2014, The Cryosphere, 8
More snow in Siberia in early winter is correlated with less sea ice in the Chukchi and East Siberian Sea in late fall.

Ghatak et al., 2010, Journal of Geophysical Research - Atmospheres, 115
Arctic Climate

Selected Implications - V

Future climate scenarios, e.g. RCP4.5 2006-2050:

→ positive surface air temperature in Arctic & particularly Barents Sea
→ linked to negative surface air temperature over Europe

Yang and Christensen, 2012, Geophysical Research Letters, 39
Outline

- Arctic sea ice
- Arctic Climate
- **Arctic Navigation and Vessel construction/equipment**
- To take home
Arctic Navigation and Vessel construction/equipment

Ship Routes in Arctic

Arctic Council, 2009
Arctic Navigation and Vessel construction/equipment

Types of Navigation According to Conditions and Environment

• Coastal navigation
• Open sea navigation
• Navigation in narrow channels
• Navigation in traffic separation
• Arctic navigation
Navigational Aids, Fixing Position

- Chart projections
- Chart coverage and datums
- Compasses
- Radar for position fixing
- Terrestrial navigational aids
- Bridge watches
- Engine watches
- Deck watches
- Visual ice indication
- Radar ice detection
First year ice in Pike Resor Channel: Electronic chart A; Ice hazard radar showing ice distinct from shoreline B; standard X band radar does not show ice clearly C; actual ice conditions D

Arctic Navigation and Vessel construction/equipment

Passage Planning in Ice Regions

- Appraisal
- Planning
- Execution
- Monitoring

Snider, D., 2012
Arctic Navigation and Vessel construction/equipment

• **Marine Communications Traffic Monitoring in Arctic**
  Vhf, mf, hf, inmarsat, AIS, VTS systems

• **Personnel and Maritime Training/Education**
  STCW and the IMO’s Guidelines for Ships Operating in Arctic Ice-covered Waters

• **Arctic Marine Insurance**
  Protection & Indemnity Clubs (P & I Clubs)

• **Arctic Icebrakers**
  Close escort of shipping in ice, maintenance of shipping tracks in ice-covered water
Arctic Navigation and Vessel construction/equipment

WHAT DOES THE POLAR CODE MEAN FOR SHIP SAFETY?

EQUIPMENT
- WINDOWS ON BRIDGE: Means to clear melted ice, freezing rain, snow, mist, spray and condensation
- LIFEBOATS: All lifeboats to be partially or totally enclosed type
- CLOTHING I: Adequate thermal protection for all persons on board
- CLOTHING II: On passenger ships, an immersion suit or a thermal protective aid for each person on board
- ICE REMOVAL: Special equipment for ice removal: such as electrical and pneumatic devices, special tools such as axes or wooden clubs
- FIRE SAFETY: Extinguishing equipment operable in cold temperatures; protect from fire; suitable for persons wearing bulky and cumbersome cold weather gear

DESIGN & CONSTRUCTION
- SHIP CATEGORIES: Three categories of ship which may operate in Polar Waters, based on:
  A) medium first-year ice
  B) thin first-year ice
  C) open water/ice conditions less severe than A and B
- INTACT STABILITY: Sufficient stability in intact condition when subject to load, and stability calculations must take into account the icing allowance

MATERIALS
- Ships intended to operate in low air temperature must be constructed with materials suitable for operation at the ship's polar service temperature
- STRUCTURE: In ice strengthened ships, the structure of the ship must be able to resist both global and local structural loads

OPERATIONS & MANNING
- NAVIGATION: Receive information about ice conditions
- CERTIFICATE & MANUAL: Required to have on board a Polar Ship Certificate and the ship's Polar Water Operational Manual
- TRAINING: Masters, chief mates and officers in charge of a navigational watch must have completed appropriate basic training (for open water conditions) and advanced training for other waters, including ice

BACKGROUND INFO
- THE INTERNATIONAL CODE FOR SHIPS OPERATING IN POLAR WATERS WAS ADOPTED NOVEMBER 2014 BY THE IMO MARITIME SAFETY COMMITTEE
- IT APPLIES TO SHIPS OPERATING IN ARCTIC AND ANTARCTIC WATERS
- THE AIM IS TO PROVIDE FOR SAFE SHIP OPERATION AND THE PROTECTION OF THE POLAR ENVIRONMENT BY ADDRESSING RISKS PRESENT IN POLAR WATERS AND NOT ADEQUATELY MITIGATED BY OTHER INSTRUMENTS
Outline

- Arctic sea ice
- Arctic Climate
- Arctic Navigation and Vessel construction/equipment
- To take home
To Take Home

Arctic sea ice
- 2-5 meters thick
- It moves & deforms
- Its volume decreases & it tends to become faster
- Arctic amplification of global warming enhances decrease
- Its decrease affects human activities & Arctic environment
- Its decrease potentially affects / will affect mid-latitude winter weather
- Safe Navigation and Polar Code
Thank You!

Dr. Burcu Ozsoy-Cicek
www.polarresearch.center
burcu@polarresearch.center