

CIMR Support for Future Shipping and Off-Shore Industry Activities

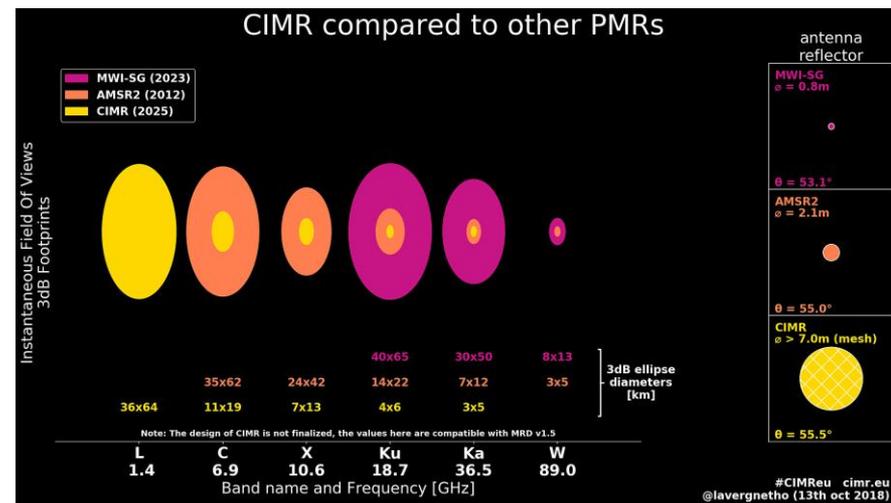
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IUP Seminar on Physics and Chemistry of the Atmosphere
7 June 2019

What is CIMR?

- EU High Priority Candidate Mission (HPCM): CIMR – Copernicus Imaging Microwave Radiometer
- Mission to support the EU Arctic Policy
- Global coverage with focus on Polar Regions
- Observed parameters:
 - **Sea Ice Concentration**
 - **Sea Surface Temperature (SST)**
 - Thin Ice Thickness; Sea Ice Drift
 - Snow Depth on sea ice and SWE on land
 - Salinity; Wind Speed
 - Many more including land (e.g. soil moisture)
- Launch 2025+



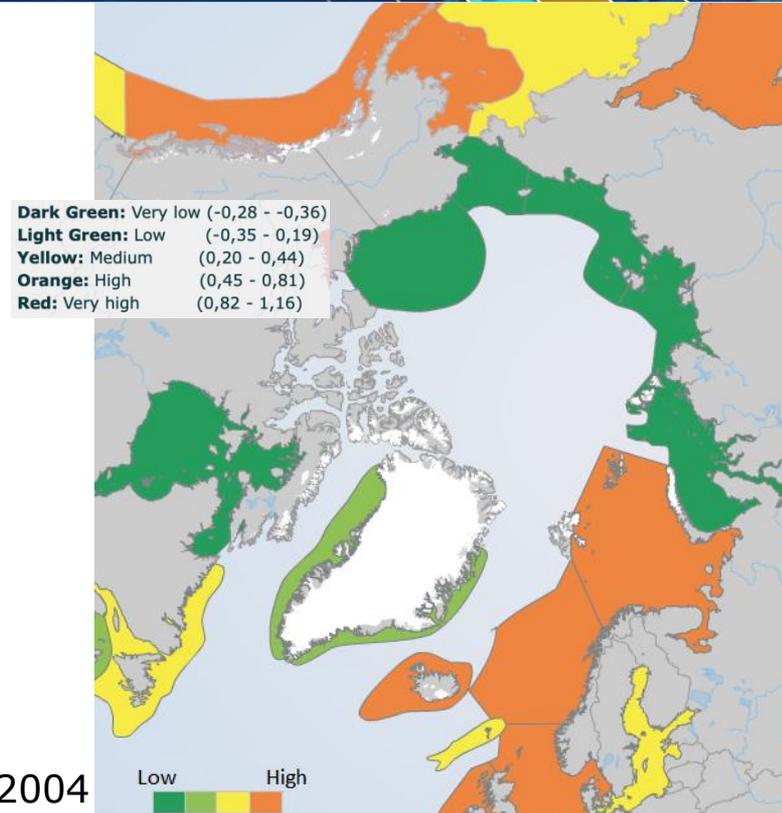
Part I

INCENTIVES FOR HUMAN ACTIVITY IN THE ARCTIC

Fishing

- Economically important fish species are expected to move further north as the water temperature warms
- While fish populations are not expected to move beyond the line of the continental shelf, this still puts them in areas where seasonal sea ice can appear.
- High sea fishing is an industry that can be active around the year as long as the weather and the sea ice conditions allow access.

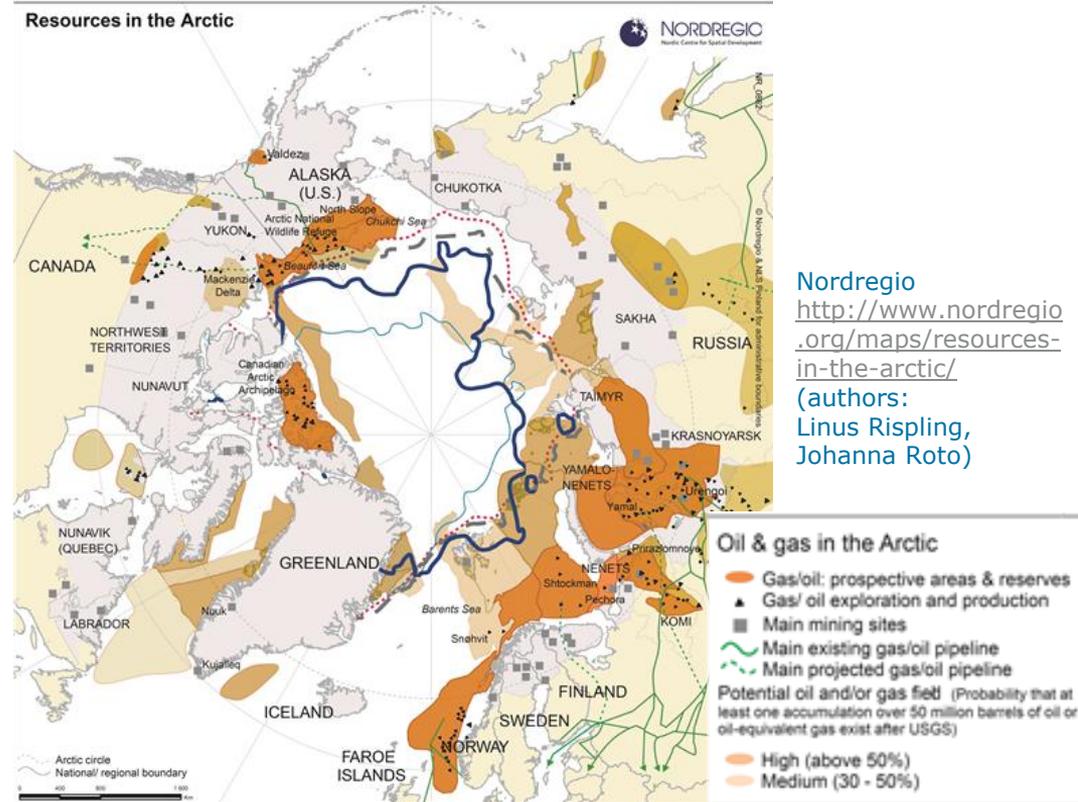
Fisheries catch abundance, 2000–2004



The National Oceanic and Atmospheric Administration (NOAA), the Fishing Portlet (adapted from online map available at the Arctic Portal <http://portal.inter-map.com/#mapID=49&groupID=286&z=1.0&up=-415715.7&left=2001105.4>)

Oil and gas

- Mineral extraction requires a year-round presence in the exploitation region.
- Many sites seasonally or year-round covered by ice
- Resupply operations as well as emergency response efforts depend on the sea ice conditions for safe access to the area.
- Ice information and forecast needed Arctic-wide and several times per day: ice extent, thickness, drift, type etc.



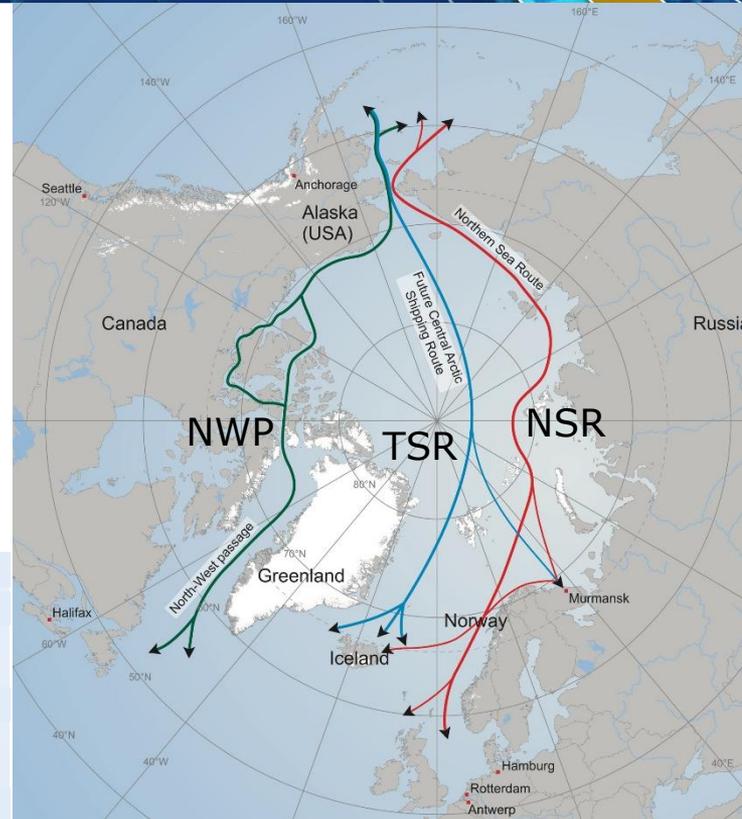
Shipping

- Arctic sea routes are shorter (-40%) and faster (-25%) than traditional ones (Suez Canal)
- The Northern Sea Route (**NSR**) and the North West Passage (**NWP**) include many islands – need for sea ice data close to coastlines
- The ice in the Trans Arctic Shipping Route (**TSR**) needs to be thinner than 1.2 m to allow shipping for ice strengthened vessels (Polar Class 6).

EUROPE TO JAPAN (in nautical miles)

Northern Sea Route	~ 6.900
Suez Canal	~ 11.050
Panama	~ 12.400
Cape of Good Hope	~ 14.540
Transarctic via NE Iceland	~ 6.800
~ 6.500 direct	

Source: AMSA Report 2006



Sailing routes

- North-West Passage
- Trans Arctic Shipping Route
- Northern Sea Route

Source: AMSA, Arctic Portal

Arctic Portal

(<http://library.arcticportal.org/1498/>)

How busy is the Arctic (2012 example)?



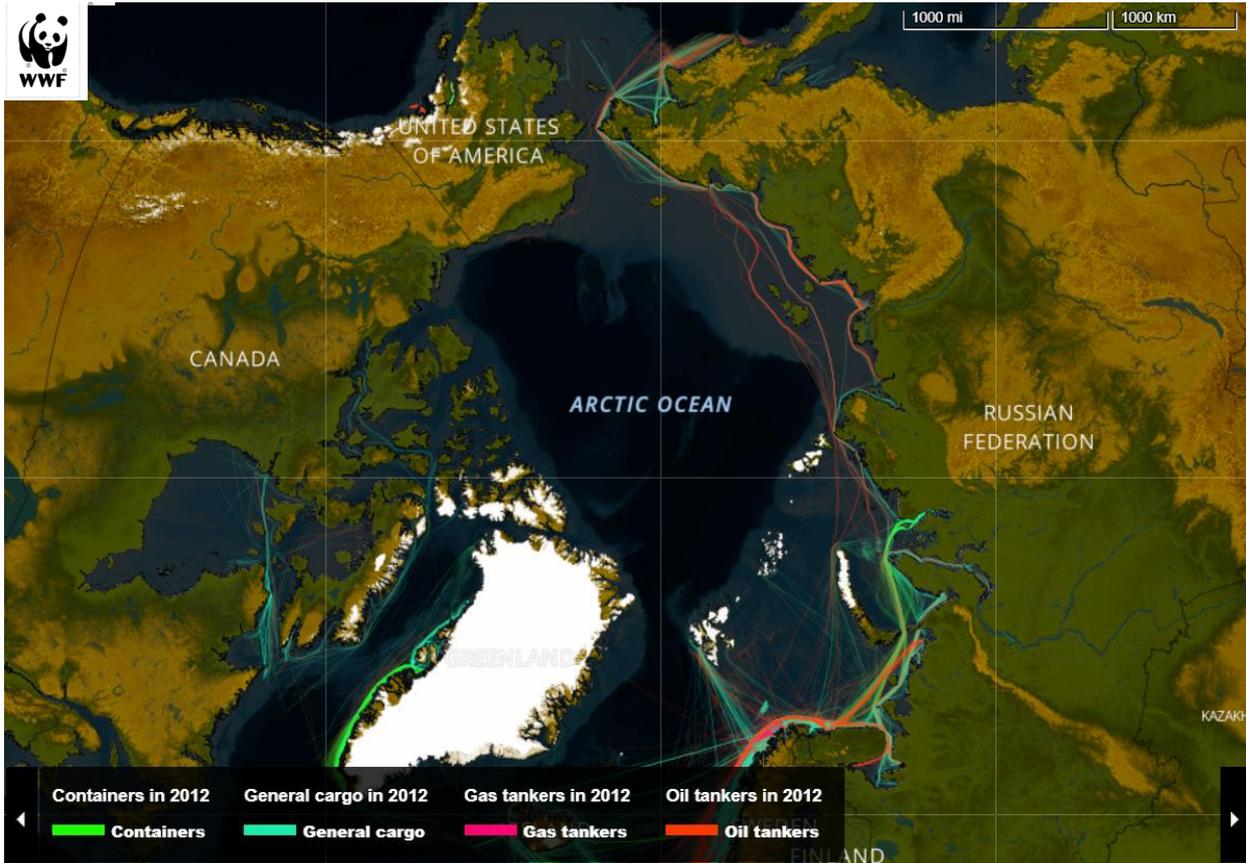
Adapted from map available online at the WWF Arctic Geographical Information System: <http://wwfarcticmaps.org/>

... if we add cargo ships



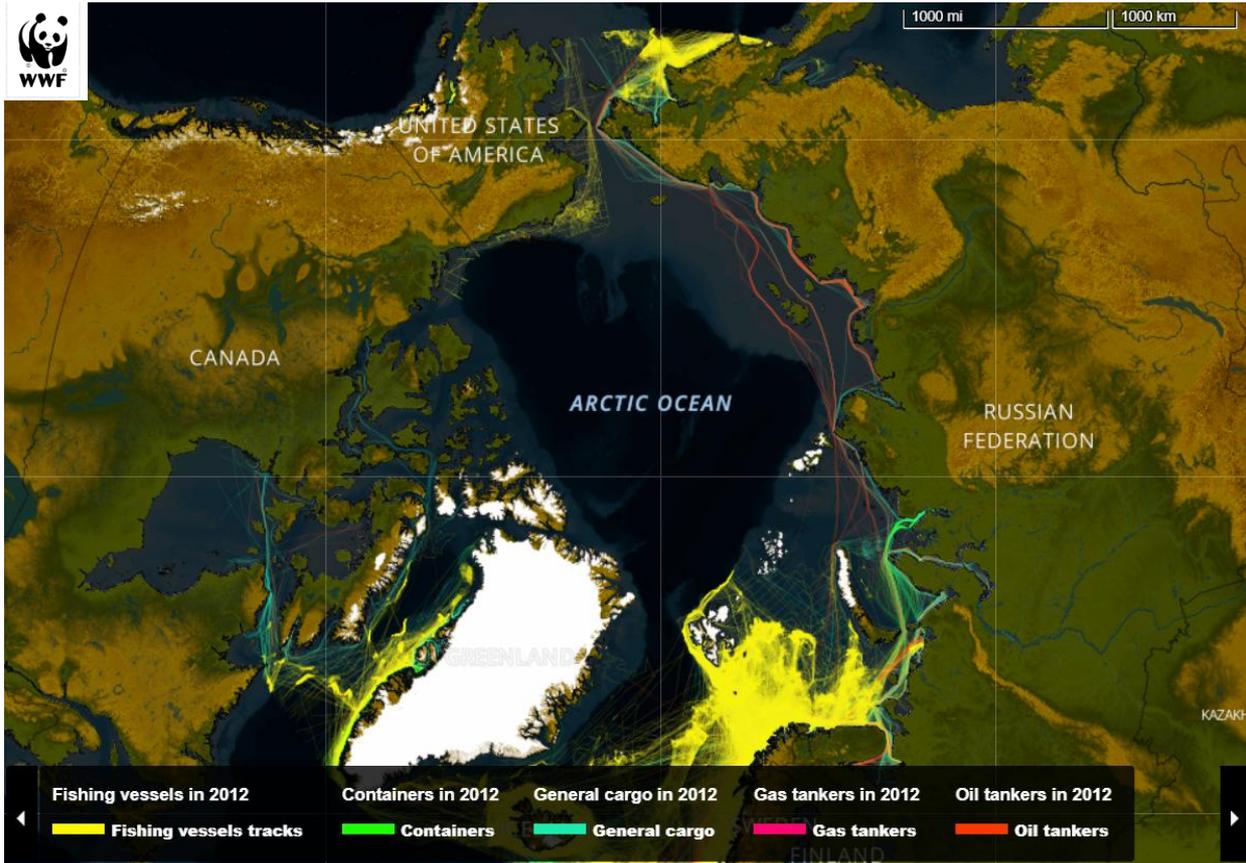
Adapted from map available online at the WWF Arctic Geographical Information System: <http://wwfarcticmaps.org/>

... then gas and oil tankers



Adapted from map available online at the WWF Arctic Geographical Information System: <http://wwfarcticmaps.org/>

... and fishing vessels



Adapted from map available online at the WWF Arctic Geographical Information System: <http://wwfarcticmaps.org/>

2045-2060, September

Projections for shipping routes

Strong emission reduction (RCP 2.6)

Business-as-usual (RCP 8.5)

- Trans-Arctic routes from multi-model projections (Melia et al., 2016).
- Mid-century: Open Water (OW) vessels can routinely use the Arctic routes
- Late century: transit for ice-strengthened vessels (PC6) likely possible for 10-12 months
- **PC6 vessels:** high SIC, max 1.2 m SIT
- **OW vessels:** max 20% SIC, 0.15 m SIT

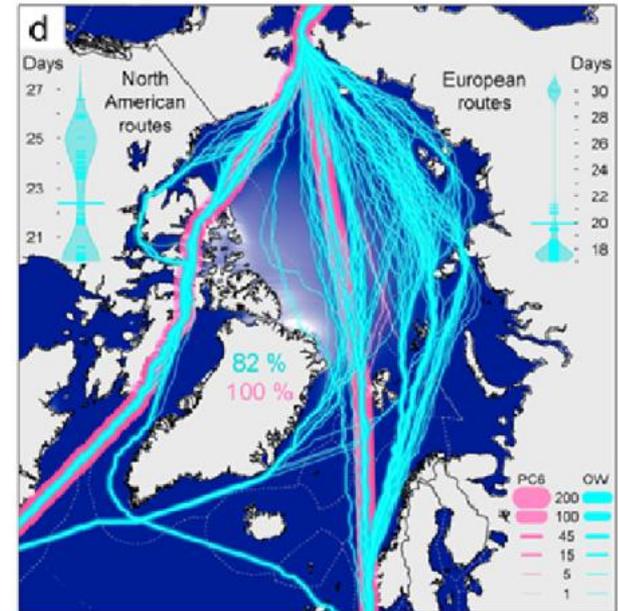
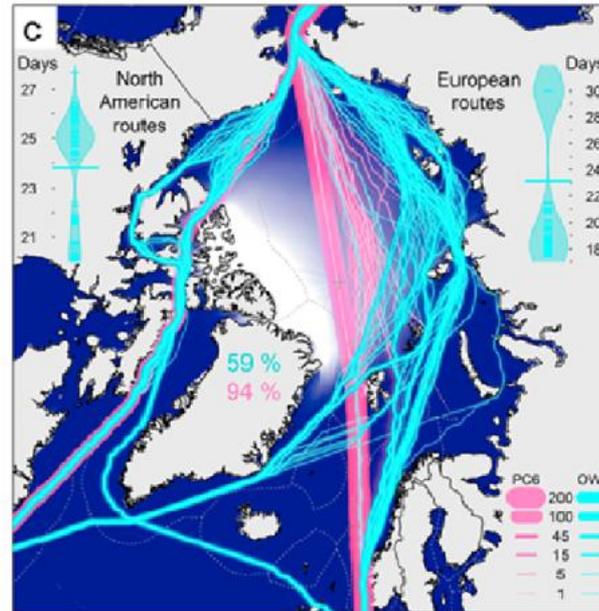


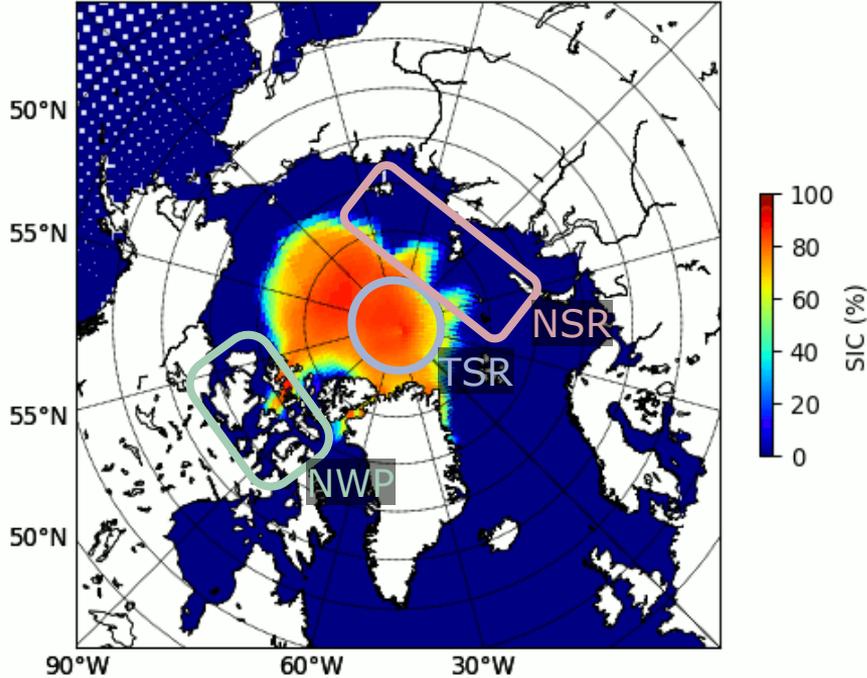
Figure 2 in Melia et al. (2016)

Part II

EO REQUIREMENTS AND CIMR ADVANTAGES

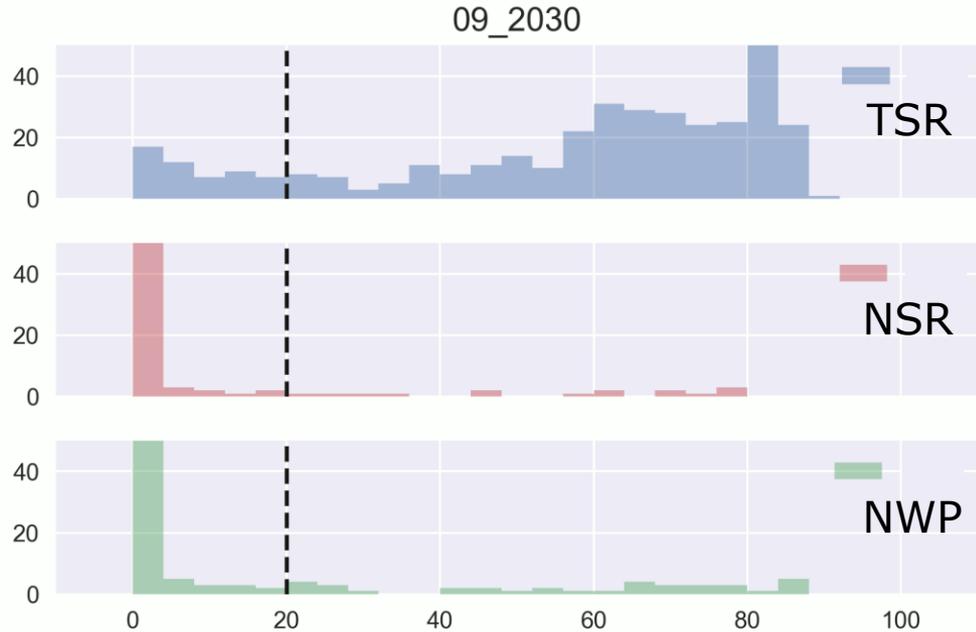
Three areas of interest: TSR, NSR and NWP

Summer sea ice extent
MPI SIC September_2030



Sea ice concentration distributions

→ there is always ice left along the 3 shipping routes



- CMIP 5 business-as-usual scenario (RCP 8.5)

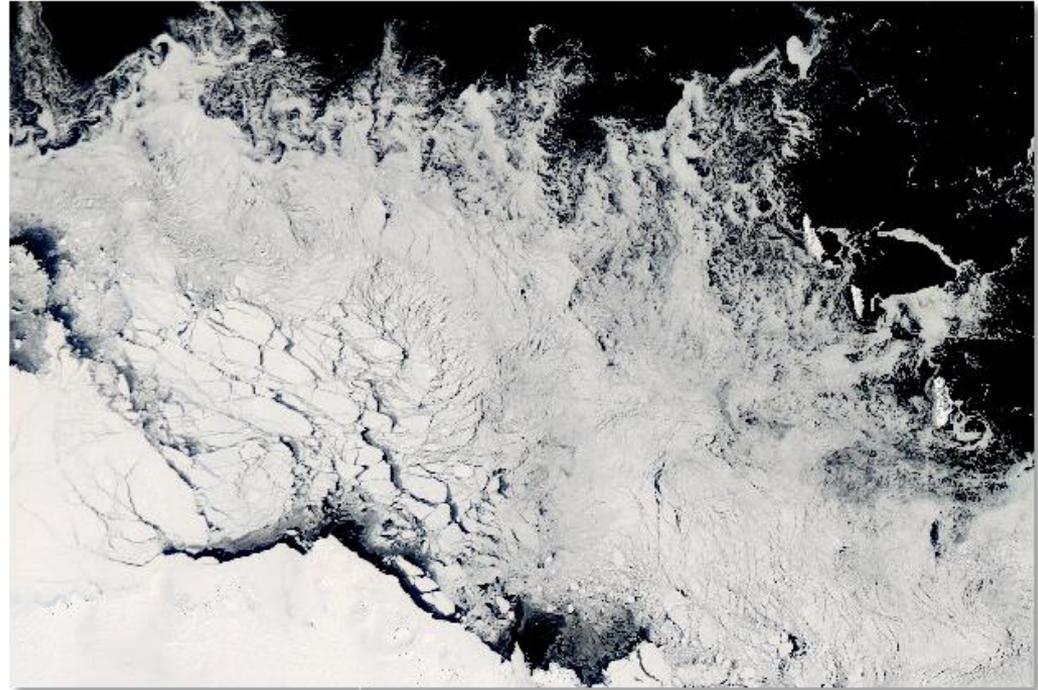
- Max Planck Institute for Meteorology ESM

What can CIMR bring to the table?

Radiometric accuracy and high resolution

- For both operational and forecast needs, the best possible resolution is necessary especially along coasts and the ice edge.
- Unprecedented high spatial resolutions for the 7 to 37 GHz channels (15 to 4 km).

Reference



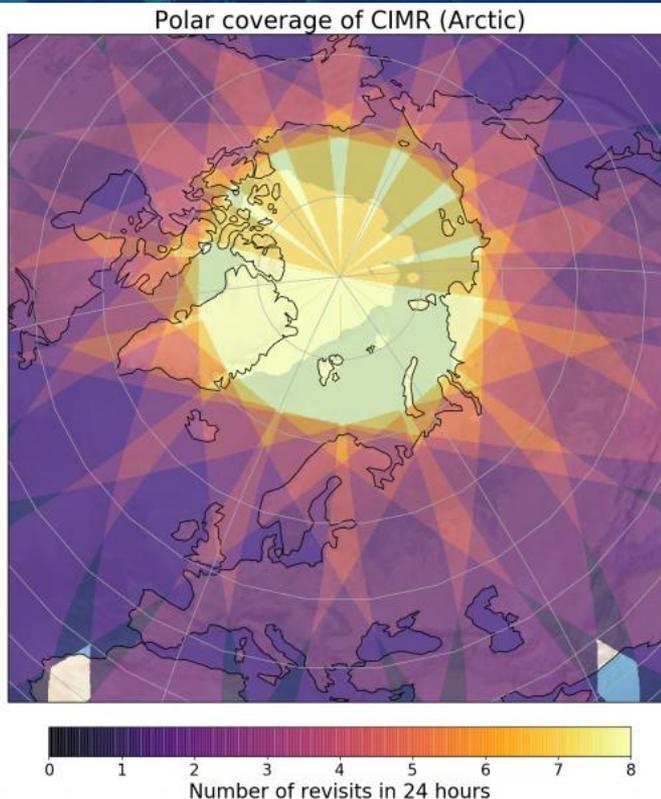
Tonboe, R. (2019)

Spren & Scarlat | University of Bremen | 16/05/2019 | Slide 15

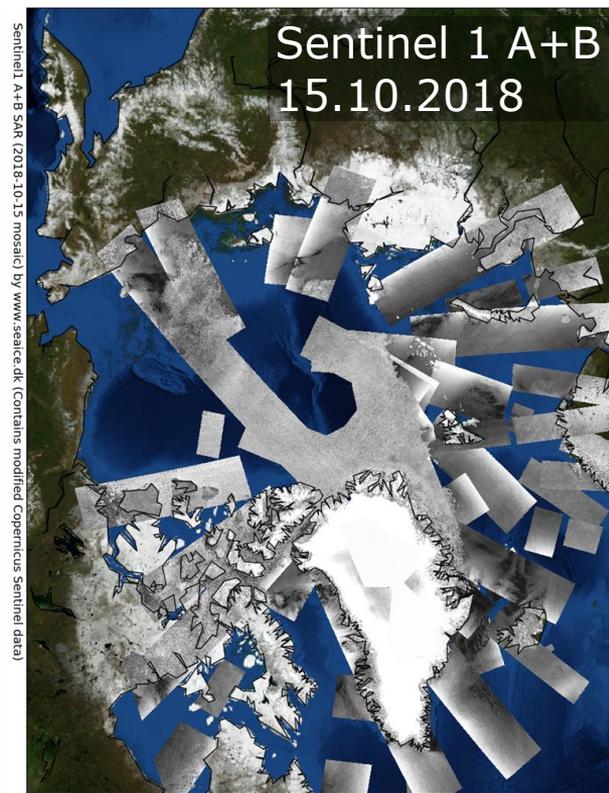
What can CIMR bring to the table?

Spatial and temporal coverage

- Viewing angle of 55° and 1900 km swath covers North Pole
- Orbit which will allow for >4 revisits per day in polar regions
- Will supplement higher resolution SAR data in space and time



Lavergne et al. (2019)

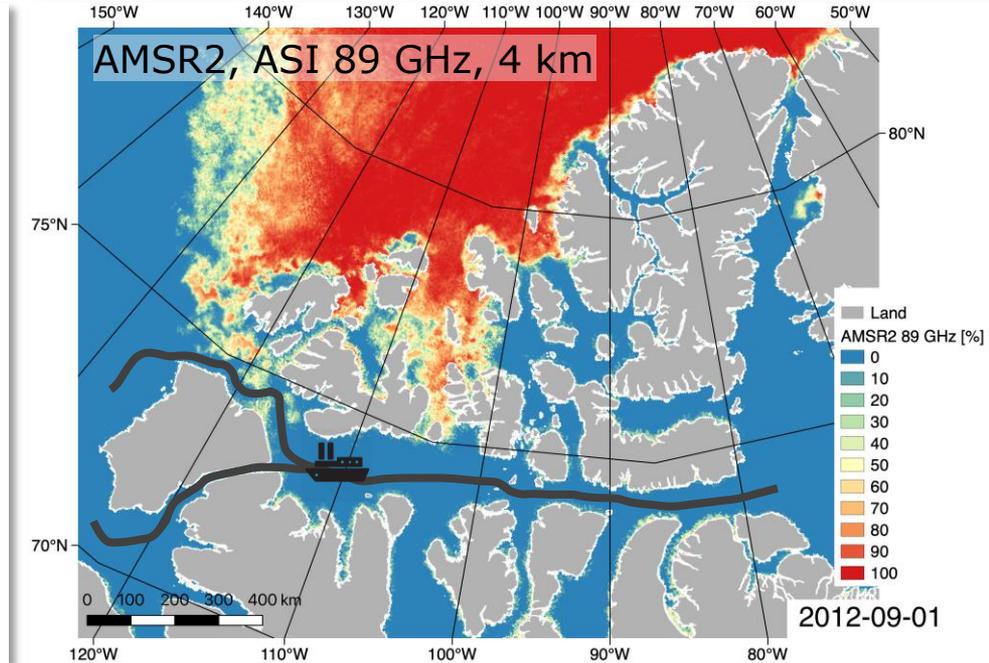
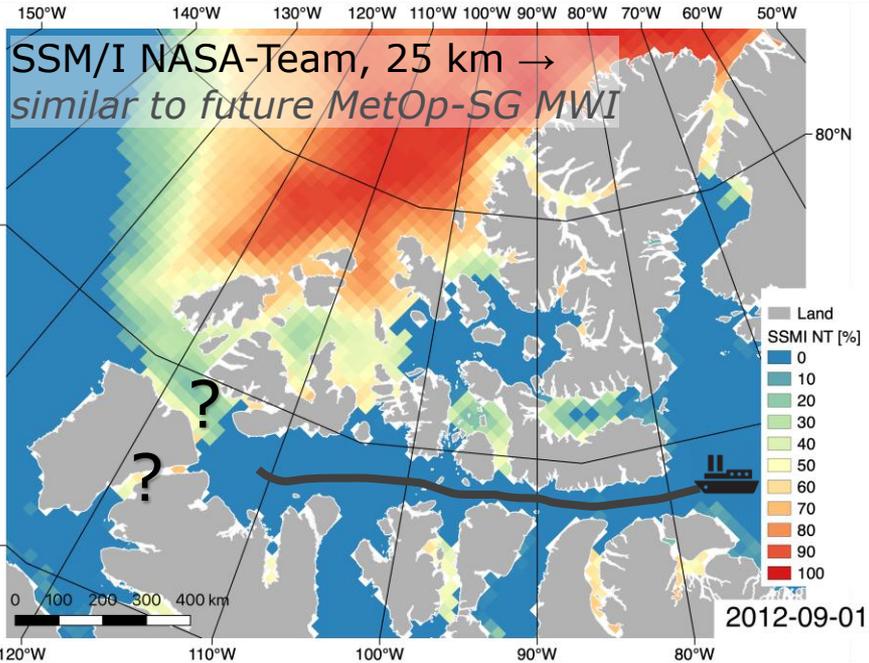


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Part III

CASE STUDY – POTENTIAL CIMR IMPACT ON ARCTIC OBSERVATION

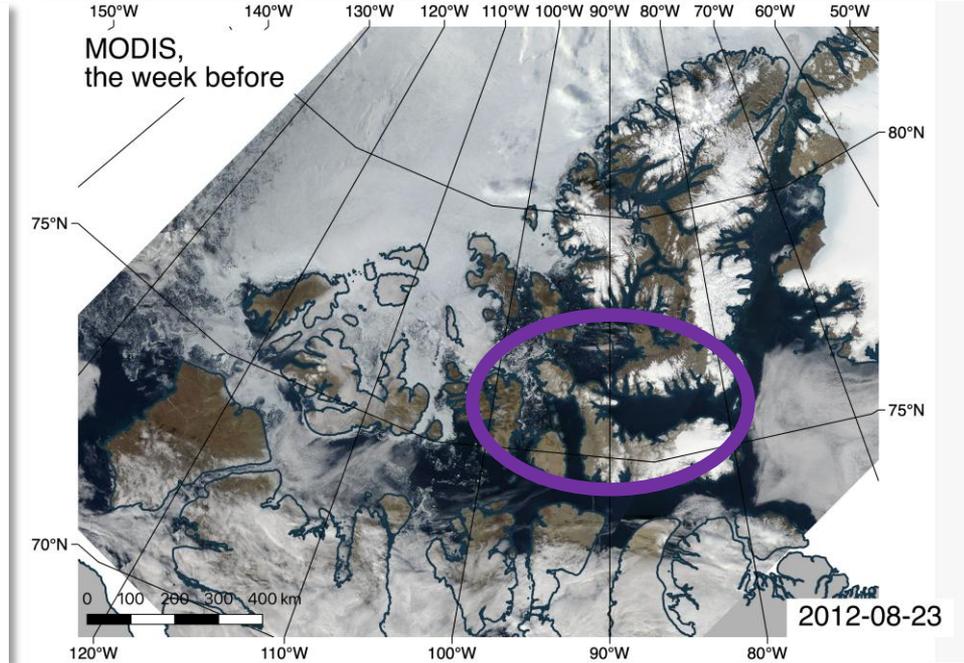
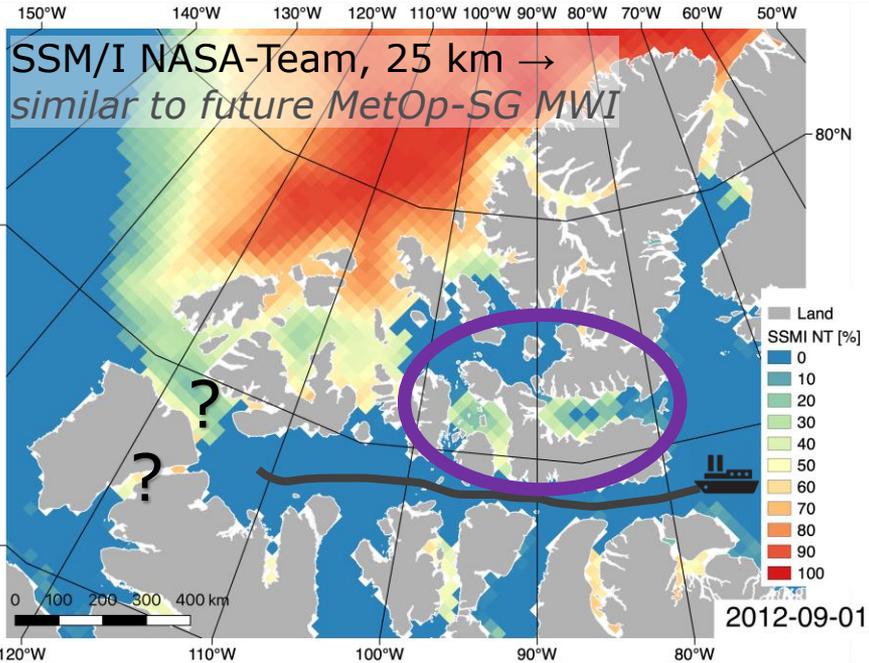
North-West Passage



- Important future shipping route
- Will not open up completely for longer times in a future climate
- Some ice remains between the islands and accurate information for shipping, especially along the coasts is needed

↑ *resolution similar to future CIMR but with better quality, especially close to coast*

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- Sea ice in channels cannot be resolved by SSMI (land spill-over)
- CIMR can measure much closer to land

Summary

- Model projections show that the **opportunities for increased human activity in the Arctic will increase** as the **sea ice cover shrinks**
- Motivation for increased activities include (i) **faster transport routes**, (ii) **mineral and oil deposits**, and (iii) productive **fishing grounds**
- However, **some sea ice will remain along the transport routes** most of the year
- Thus EO needs include sea ice area, thickness, and type (and more) from satellite observations at **higher spatial resolution, closer to coastlines** and with **better temporal coverage** than today
- **CIMR will meet these requirements**
- This is demonstrated by examples using CIMR equivalent data (high resolution ASI SIC) for typical future ice conditions along the NWP and TSR