

A study of medium-range predictability of sea ice
distribution in the Arctic Ocean based on TOPAZ4
data assimilation system:
Toward to the development of Arctic Shipping
Navigation System

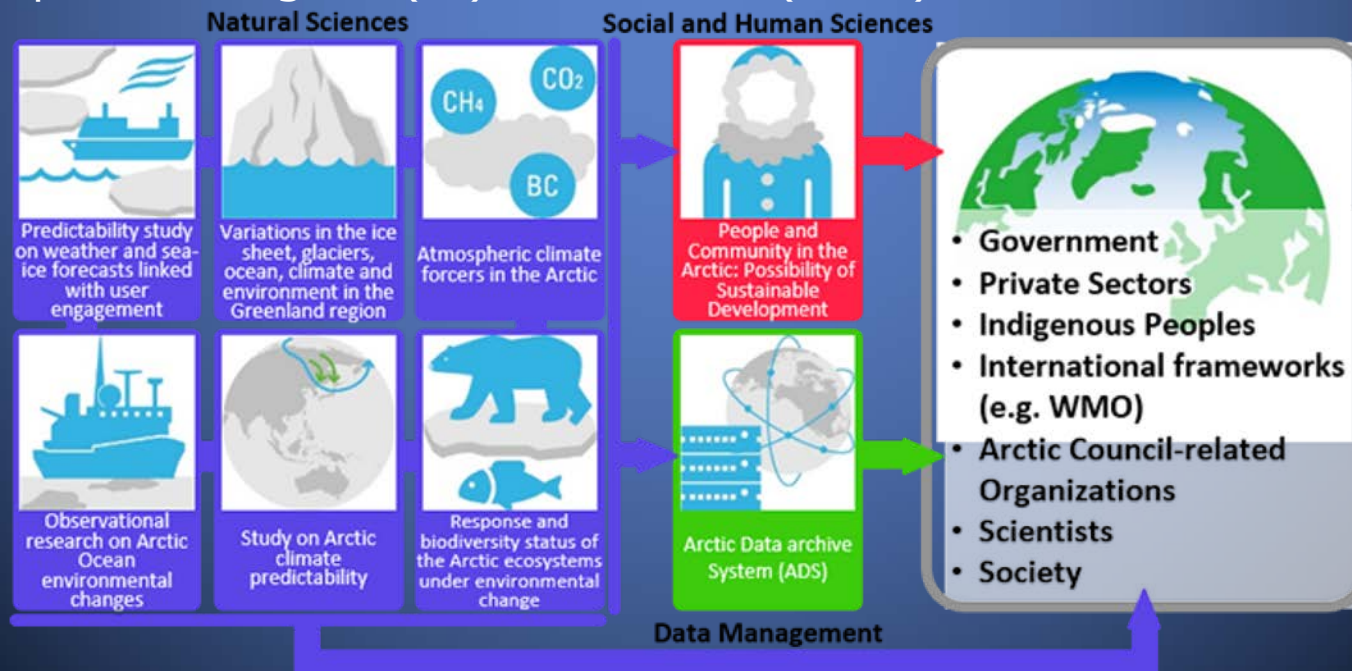
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August 2018)



Arctic Challenge for Sustainability (ArCS) projects

- **A national flagship project**
 - funded by the Ministry of Education, Culture, Sports, Science and Technology
 - NIPR, JAMSTEC, & Hokkaido University are involved
 - Project was started from 2015 (Sep. 2015 to Mar. 2020)
- **Theme1: Predictability study on weather and sea-ice forecasts linked with user engagement**
 - Principal Investigator(PI): Jun Inoue (NIPR)



Medium-range predictability (about 1 week) of SIT distribution in East Siberian Sea

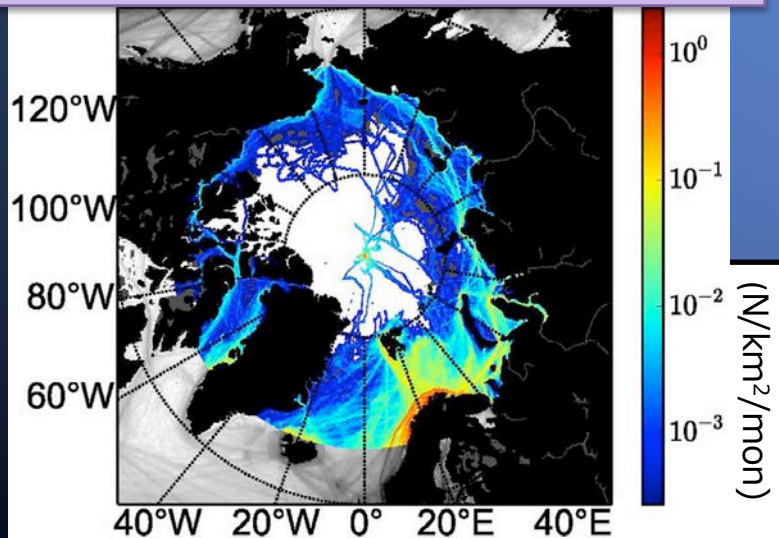
Background:

- ✓ The number of vessels in NSR (in particular, ESS) has increased in recent years, but significant sea ice exists in early summer (July)
- ✓ For safe and optimum navigation for commercial vessels with ice-breaking ability, The information of sea ice condition (distribution and thickness) is crucial

Purpose

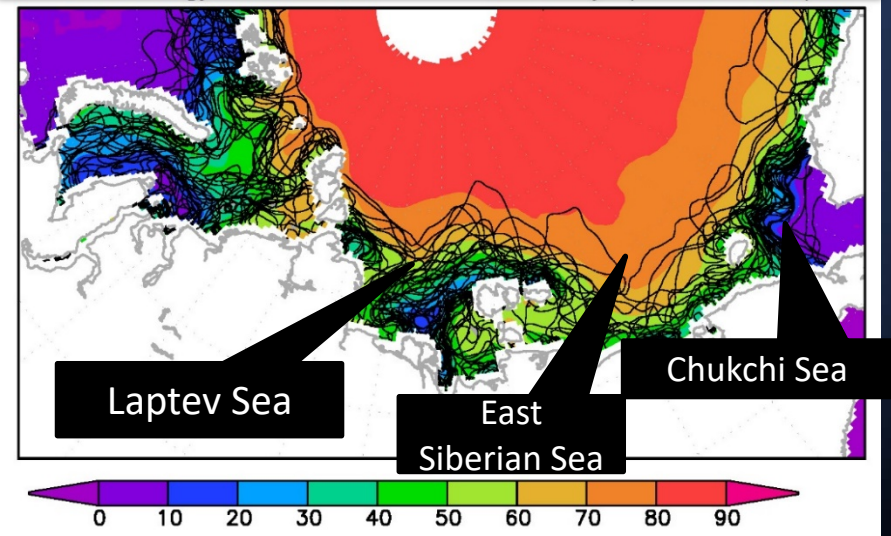
- ✓ To examine the medium-range predictability of SIT distribution in ESS in early summer and develop the Arctic Sea Route Search System based on operational sea ice forecast data

Vessel numbers in 2014 of AIS data

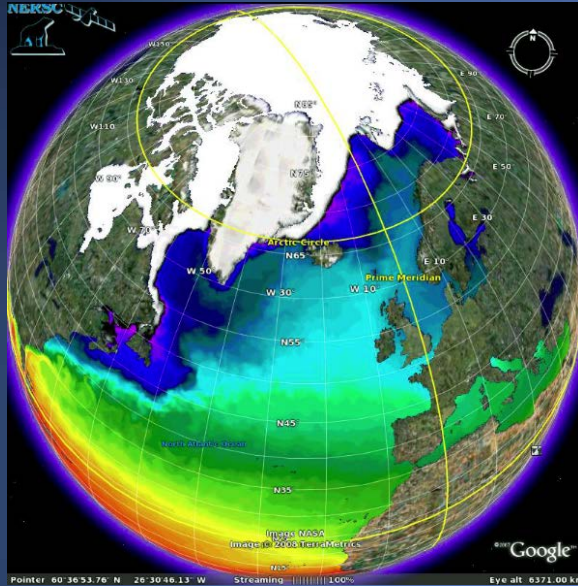


Eguíluz et al. [2016]

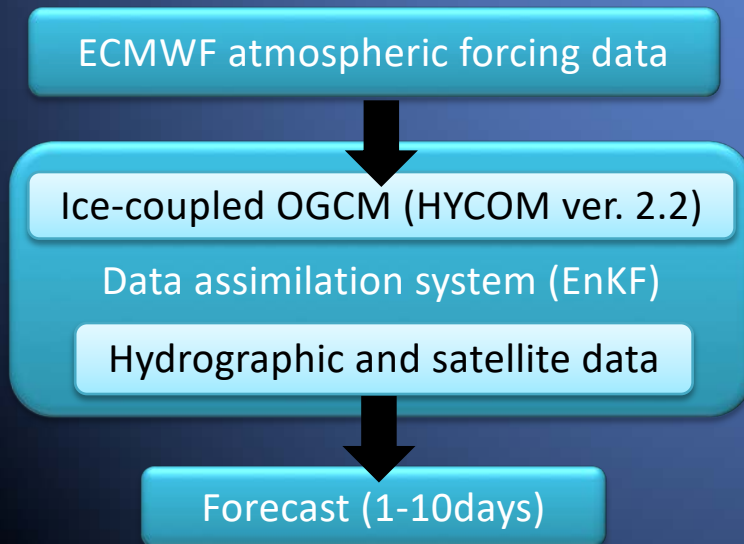
SIC & sea ice edge in July (1979-2016)



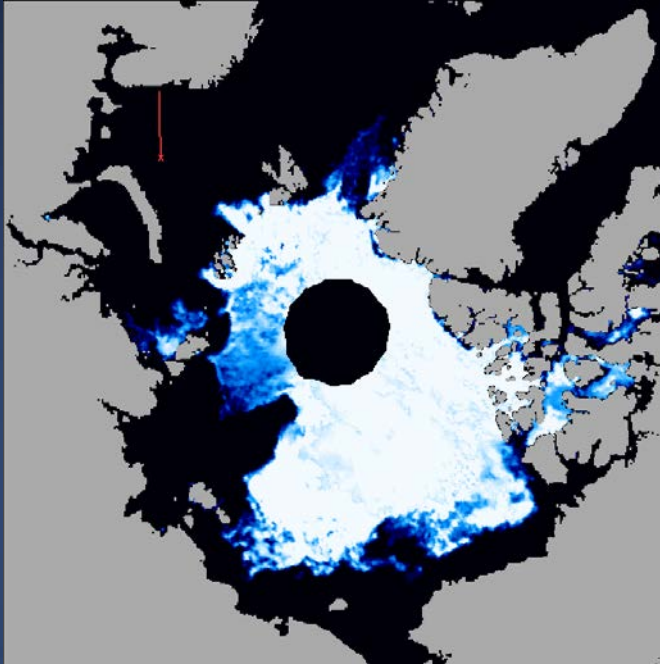
Arctic ice-ocean coupled data assimilation system (TOPAZ4)



- TOPAZ4 is developed at Nansen Environmental and Remote Sensing Center and used for operational forecast system in Met Norway [Simonsen et al. 2017]
- Data assimilation
 - EnKF (7 day assimilation cycle)
 - Hydrographic observation & SSM/I SIC, sea ice velocity, CryoSat2 data
- Forecast system
 - 10-days forecast based on ECMWF atmospheric forecast data
- Reliability & Predictability
 - SIT is comparable to in situ and satellite estimates within 10-30 cm
 - SIT distribution is skillfully predicted up to 4 days [Nakanowatari et al. 2017]

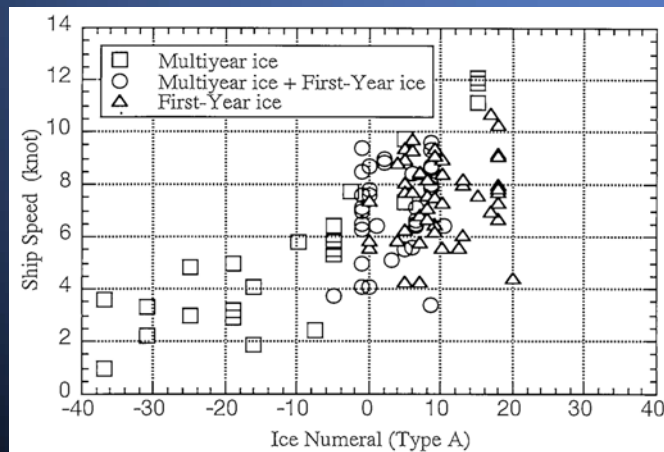


Arctic Sea Route Search System



- The web service providing an optimum shipping route information in Arctic Ocean
- This system is developed by our research group (Arctic Data Archive System)
- The optimum shipping route is calculated based on the cost function (Ice index) & duration (T)
- I is linearly related to ship speed

<https://ads.nipr.ac.jp/routeSearch/#/top>



$$I = I_n + I_b + I_c$$
$$\simeq I_n = F(h_{icem})f_{icem} + F(h_{icef})f_{icef}$$

- Sea ice forecast data in TOPAZ4 are used for this system

Yamaguchi et al. [1995]

Purpose of this school

- To learn the data managing skill of recent satellite data and limitation
- Based on the integrated knowledge of Arctic data and its management, I will additionally utilize satellite sea ice data (such as SAR and Sentinel images) as the additional information for the data assimilation and shipping navigation