Impact of super resolution SIT data for seasonal sea ice predictions

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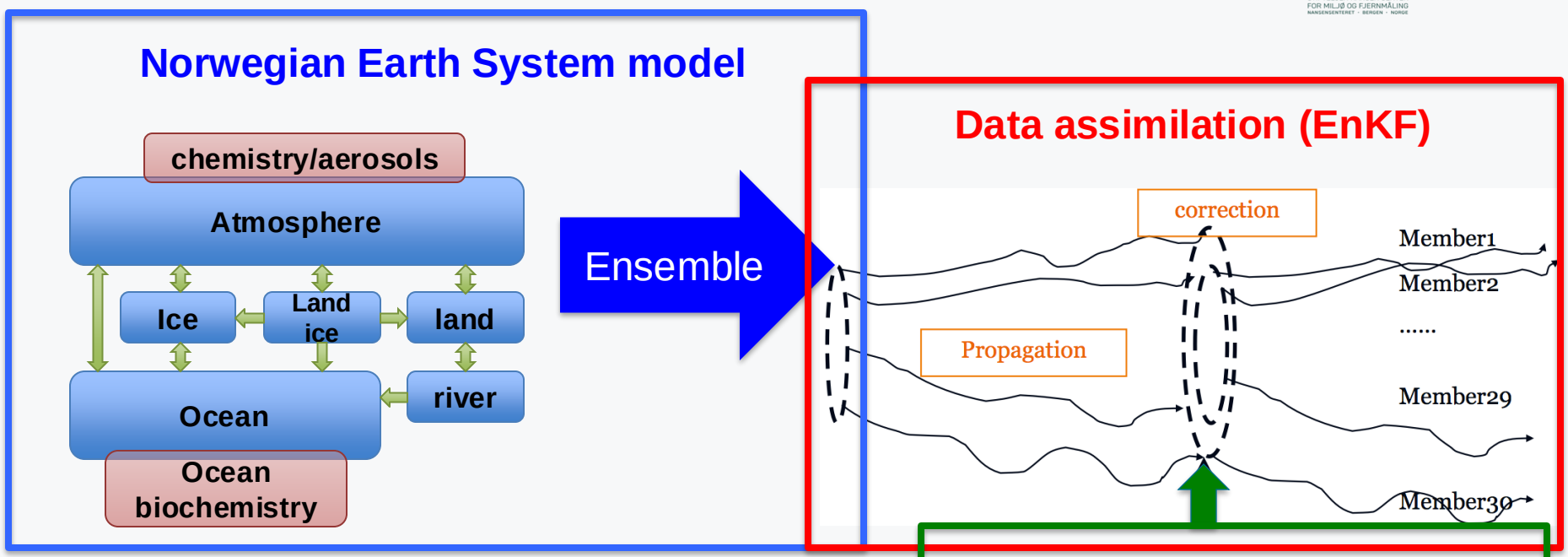
Norwegian Climate Prediction Model (NorCPM)



Objectives:

- **Long climate reanalysis**
  - Instrumental (from 1850, CoRea)
  - Paleoproxy (last millennium, PARCIM)
- **Climate prediction**
  - Seasonal time scale (Climate Services, SFI Climate Futures)
  - Annual-to-decadal time scale (CMIP6 DCPP, WMO-ADCP)

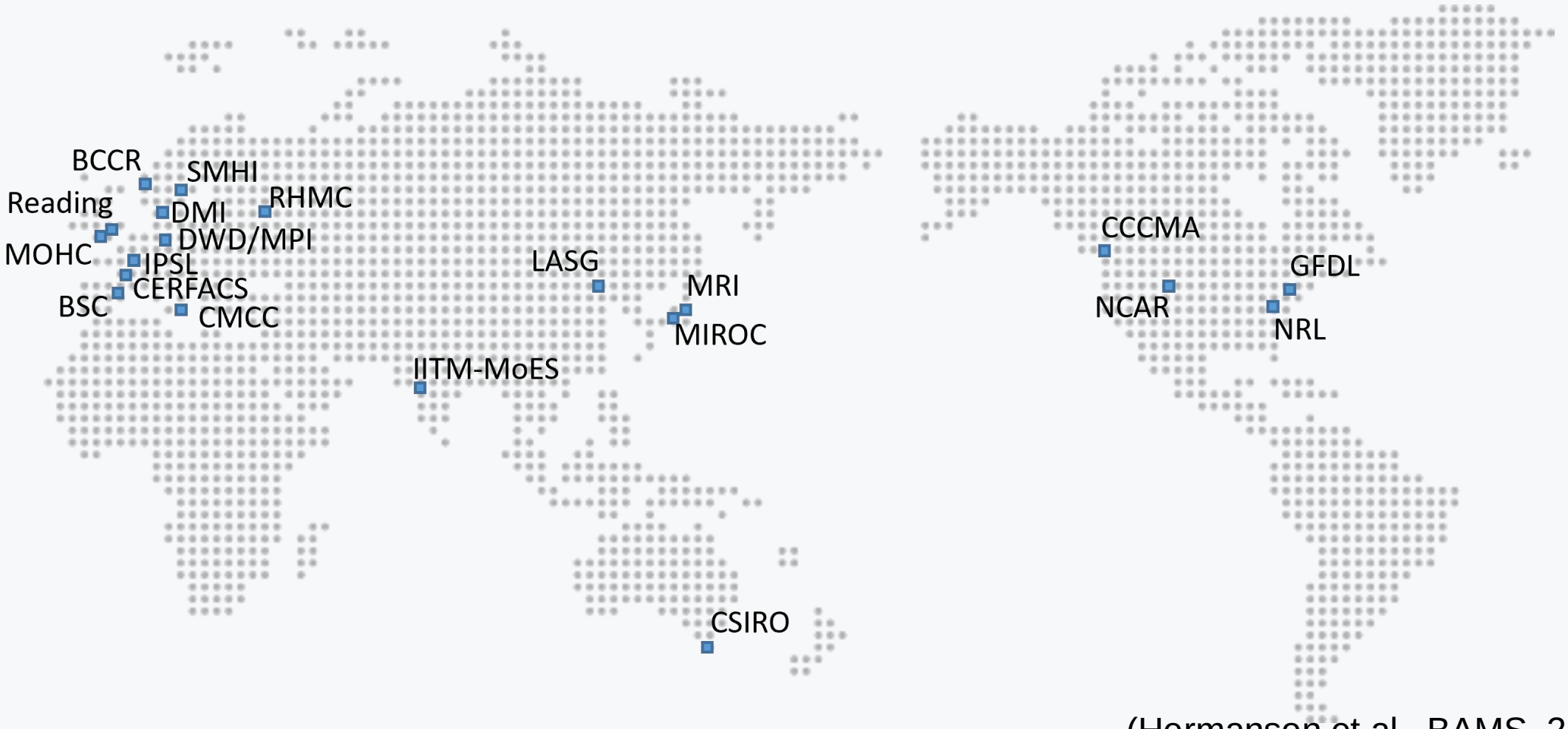
Observations

- SST (HADISST2, NOAA)
- T-S profiles (EN4)
- **SIC (HADISST2, NOAA)**
- **SIT (ESA CCI; C2SMOS)**
- Atm (ERA5)
- Land

(Counillon et al. 2016; Bethke et al. 2021)

Norwegian Climate Prediction Model (NorCPM)

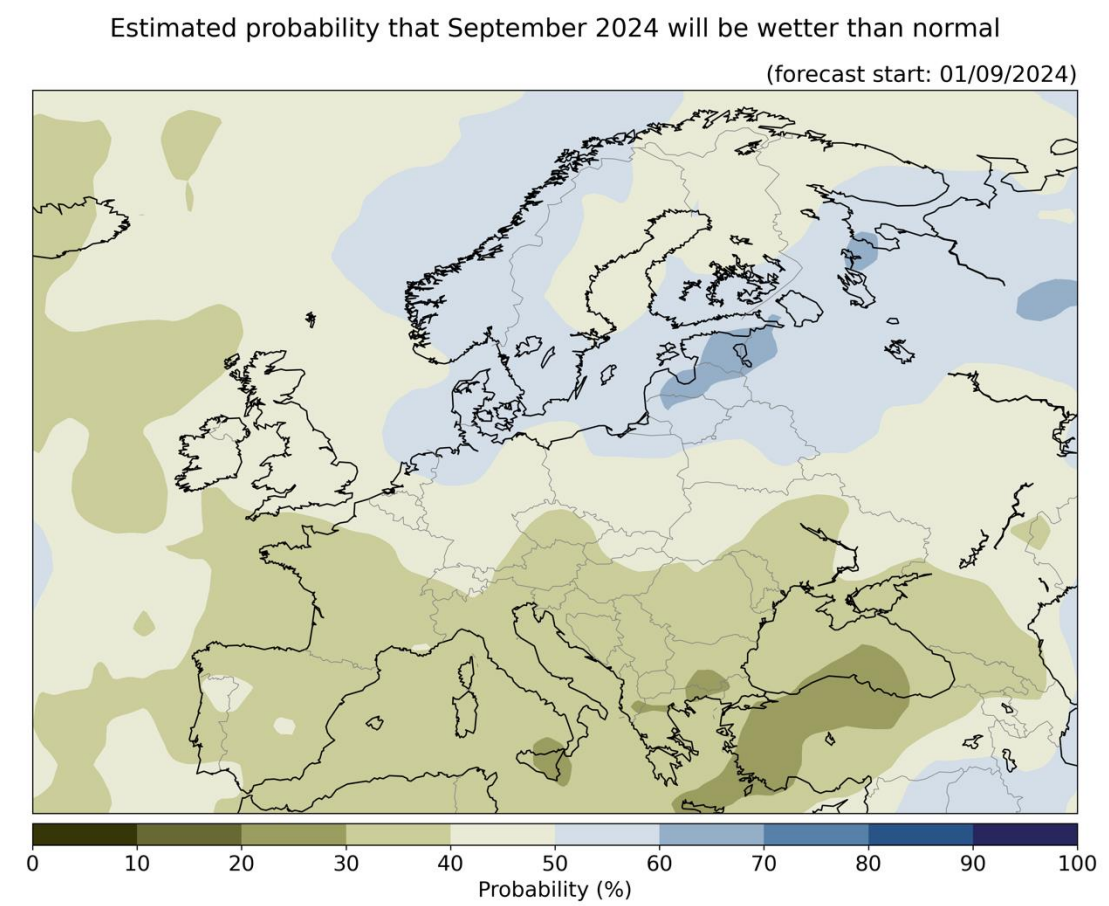
WMO Lead Centre for Annual-to-Decadal Climate Prediction

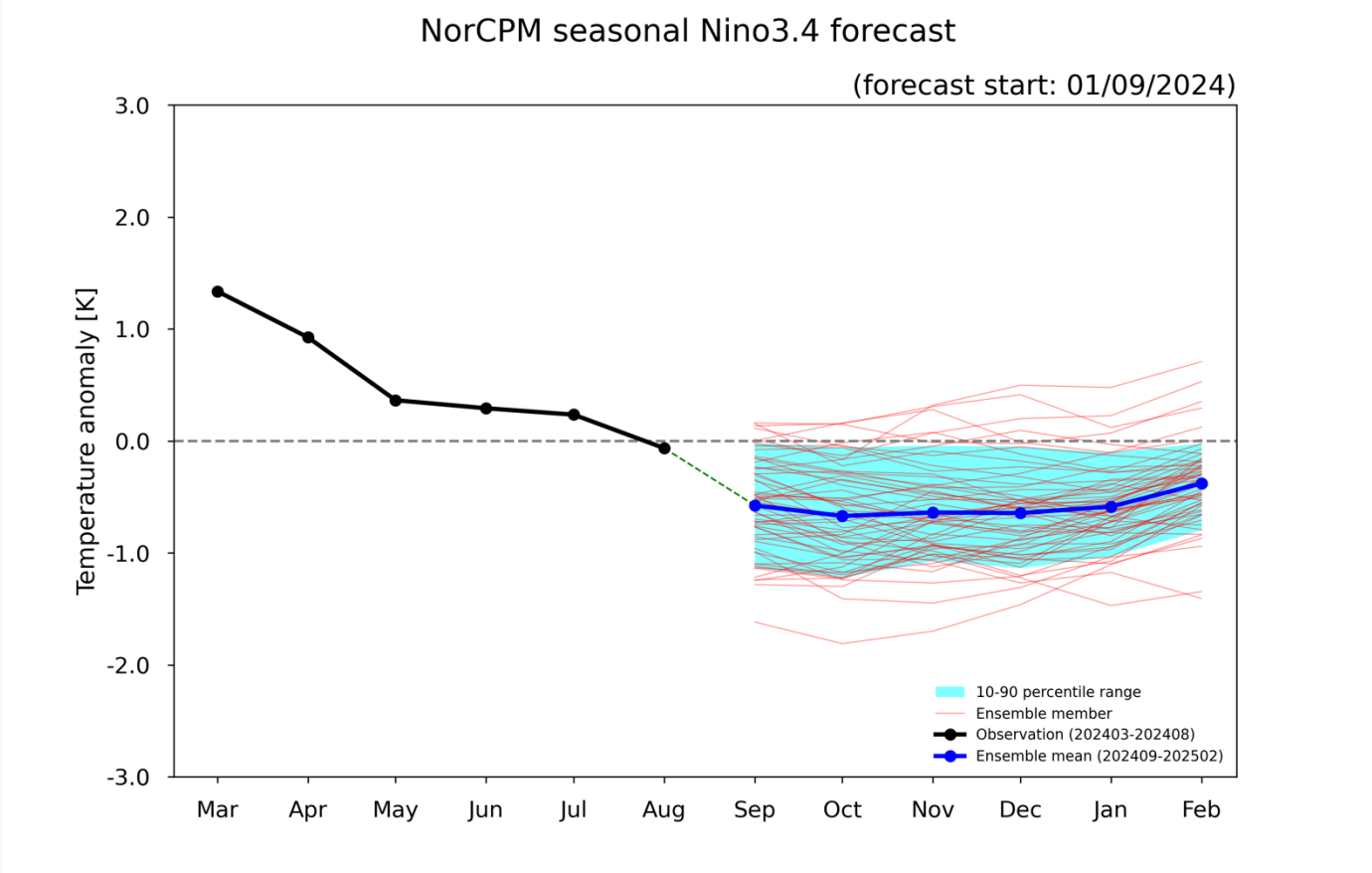


(Hermanson et al., BAMS, 2022)

Norwegian Climate Prediction Model (NorCPM)

Real time seasonal prediction

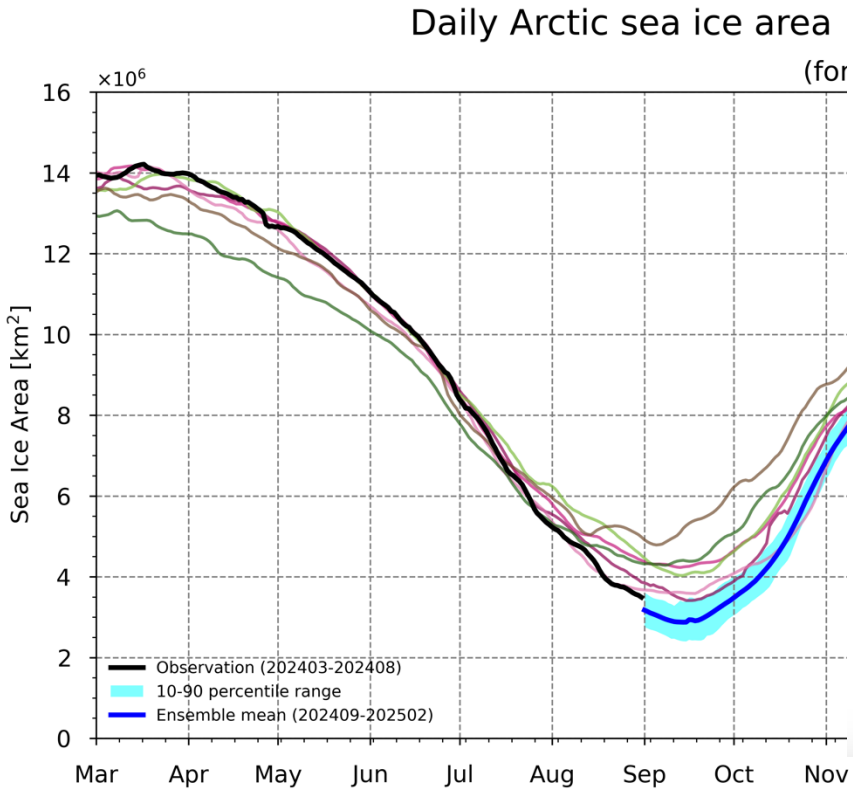


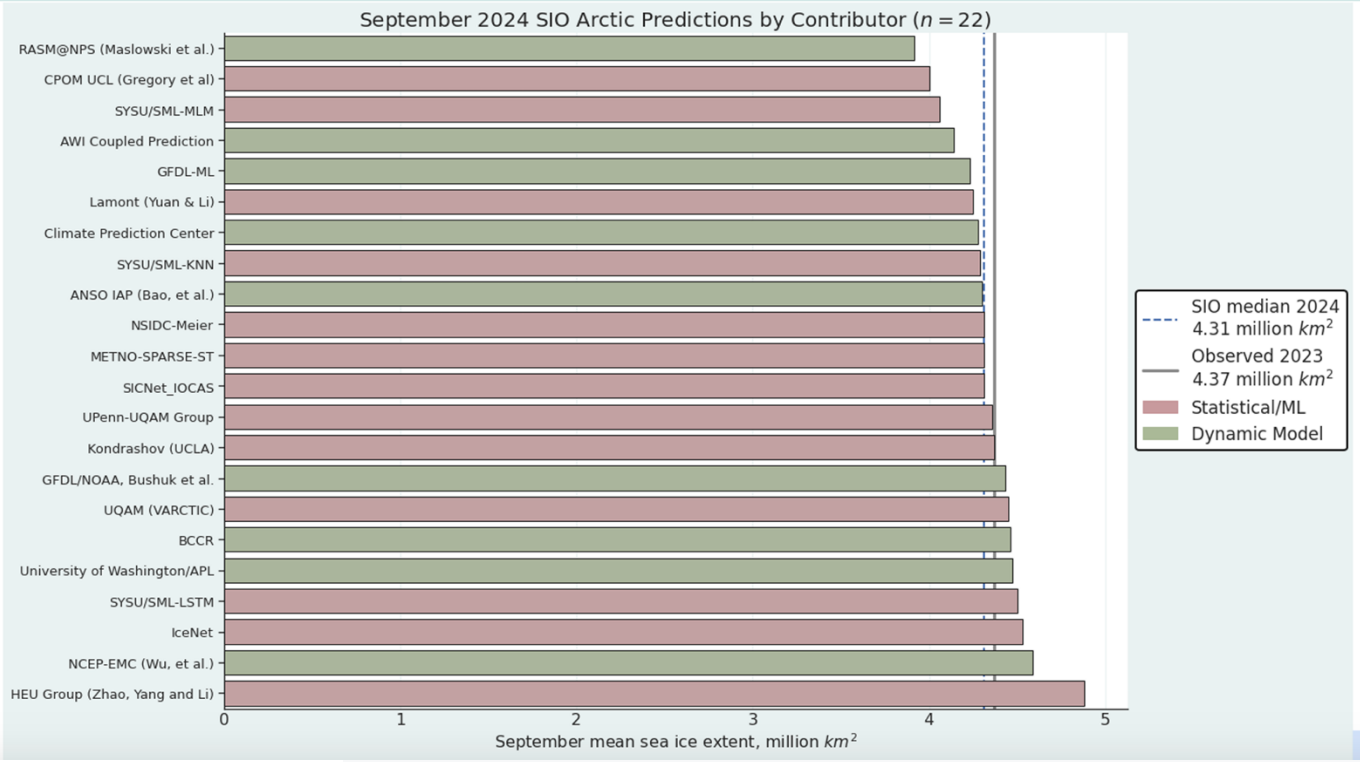


Norwegian Climate Prediction Model (NorCPM)

Real time sea ice prediction

SIPN² Sea Ice Prediction Network





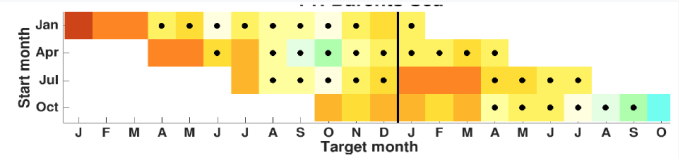
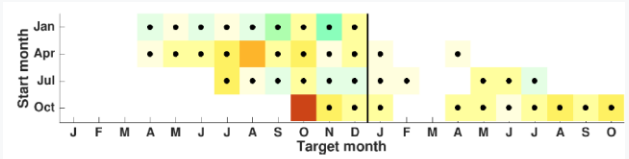
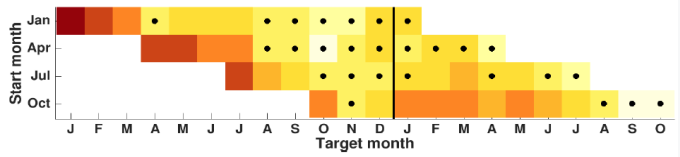
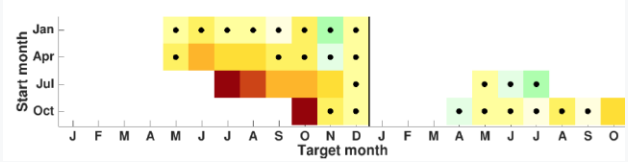
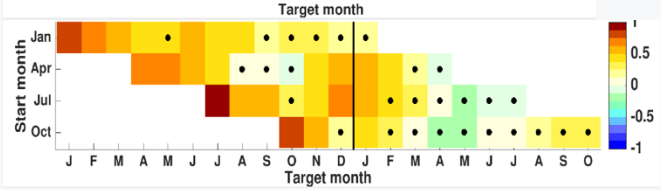
(Kimmritz et al., 2019; Bushuk et al., 2024)

SIC enhances seasonal prediction in the Arctic

Detrended correlation skill of sea ice extent in the real framework

1985:2010

Black dot means not significant

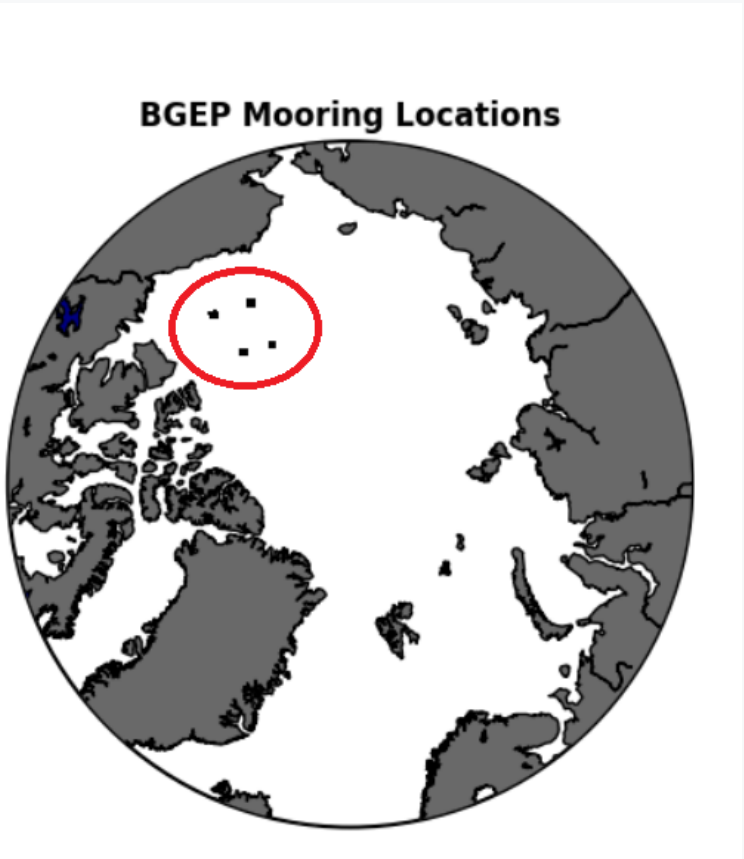
	Barents Sea	Chukchi Sea	Greenland Iceland Sea
ocean obs			
ocean +icec			
	Initialisation of heat content	*Initialisation of SIT in May*	*Improved sea ice export*

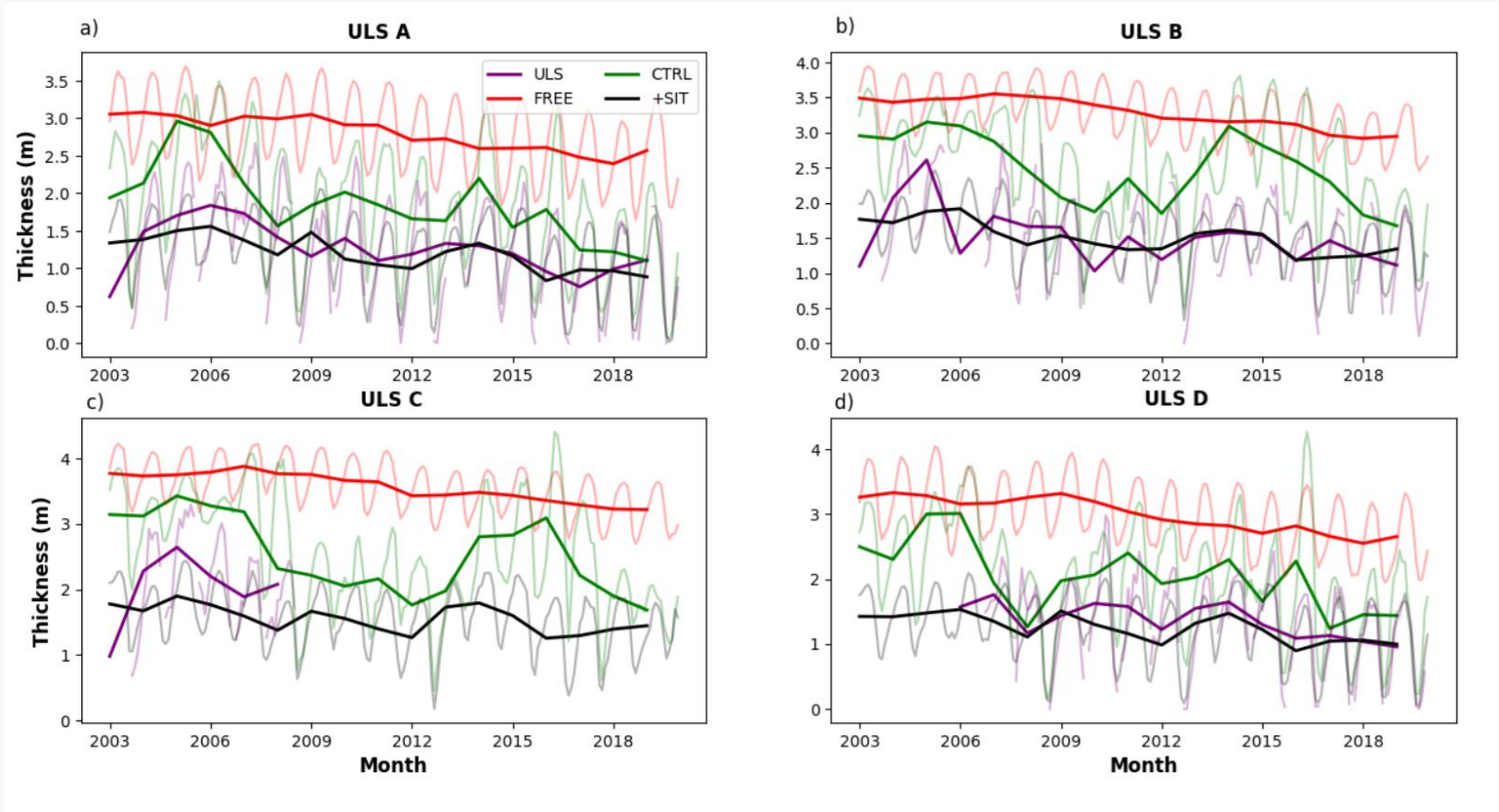
Complementing our system with sea ice concentration data greatly improved prediction skill of sea ice extent

(Kimmritz et al. 2019)

Impact of sea ice thickness assimilation

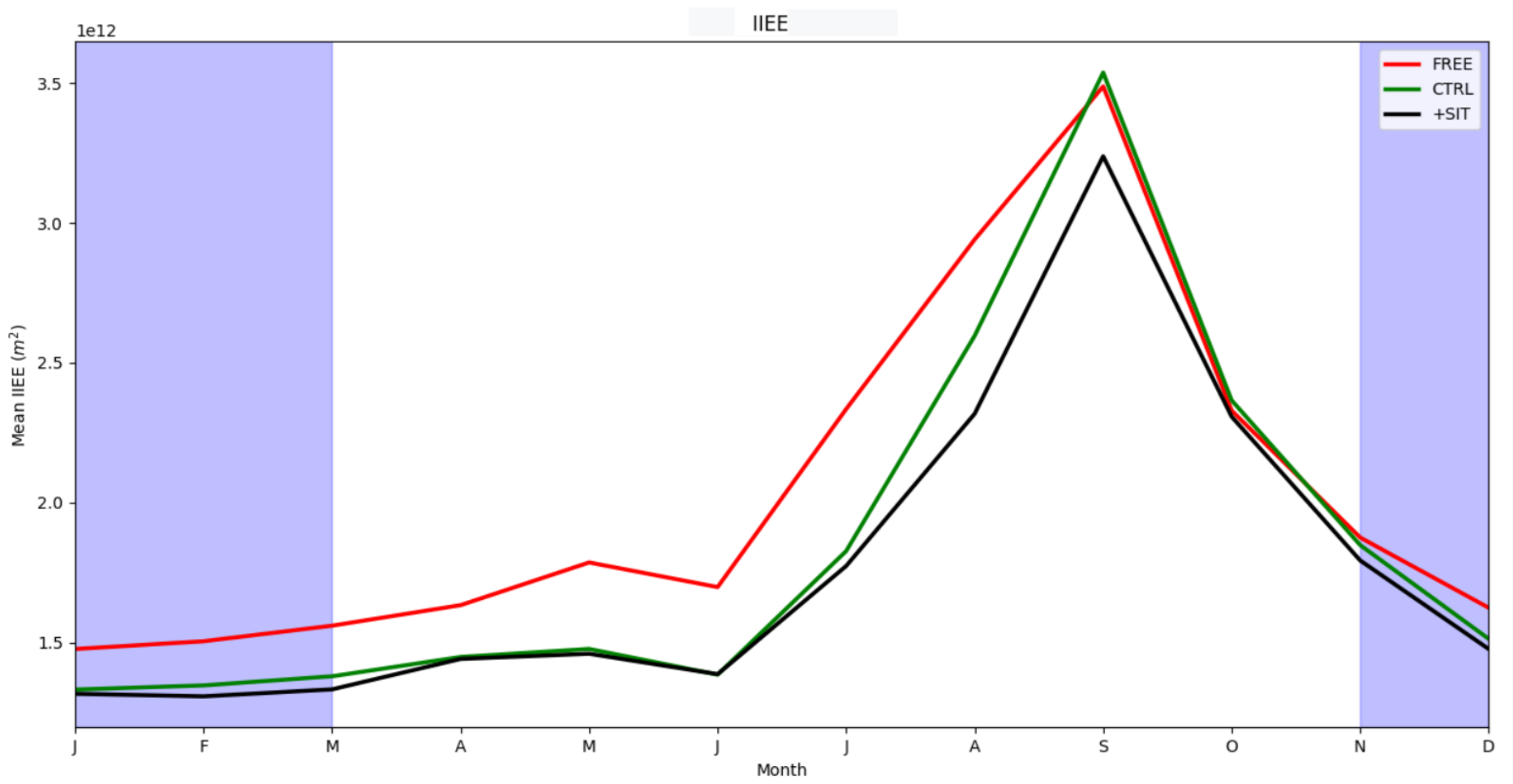
- Assimilate ENVISAT from 2002-2010 (winter) and C2SMOS afterwards (winter)
- Horizontal resolution of **25 km**





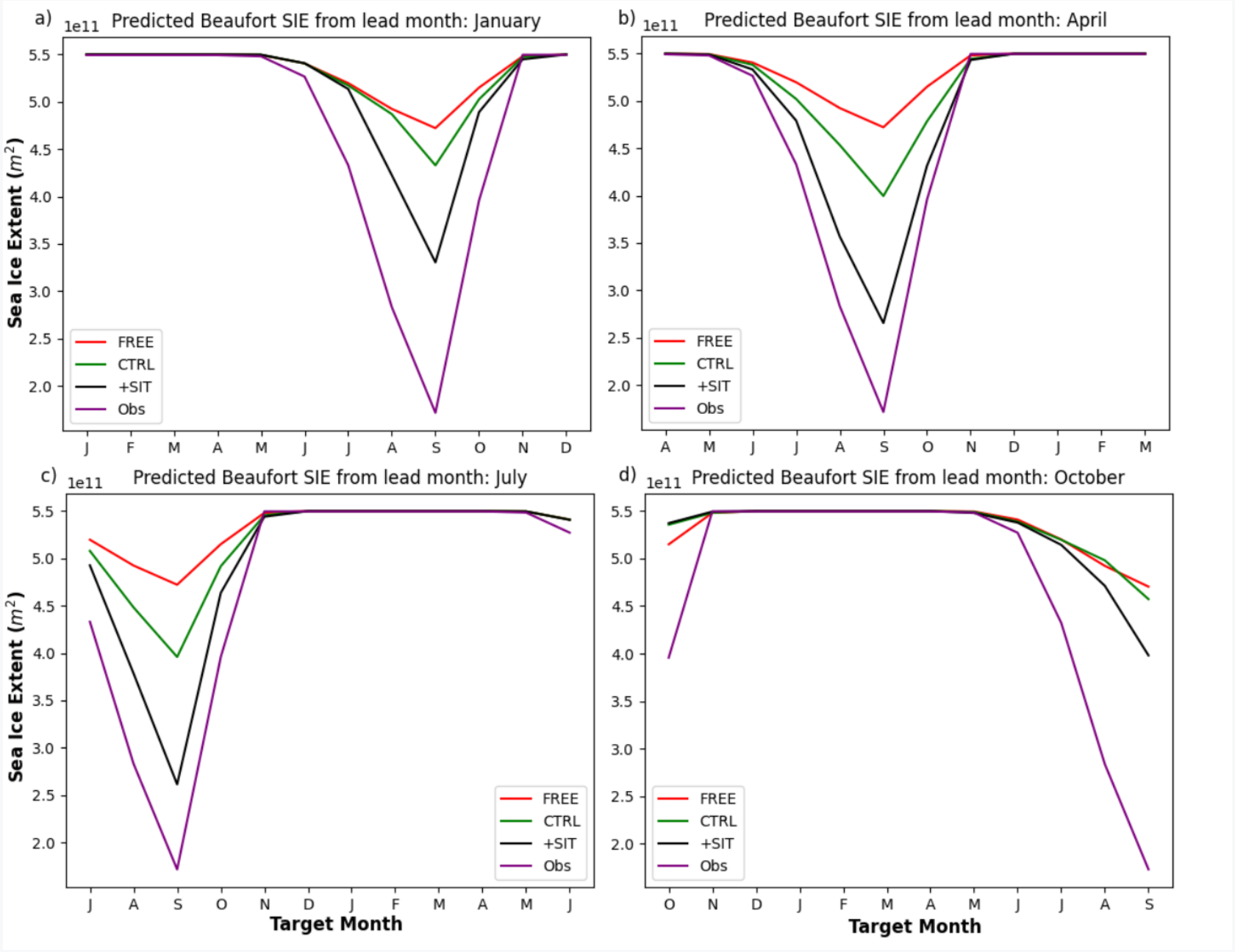
Courtesy of N. Williams

Integrated Ice Edge Error



Our new reanalysis has best location compared to the observations, particularly in summer

Impact of sea ice thickness assimilation

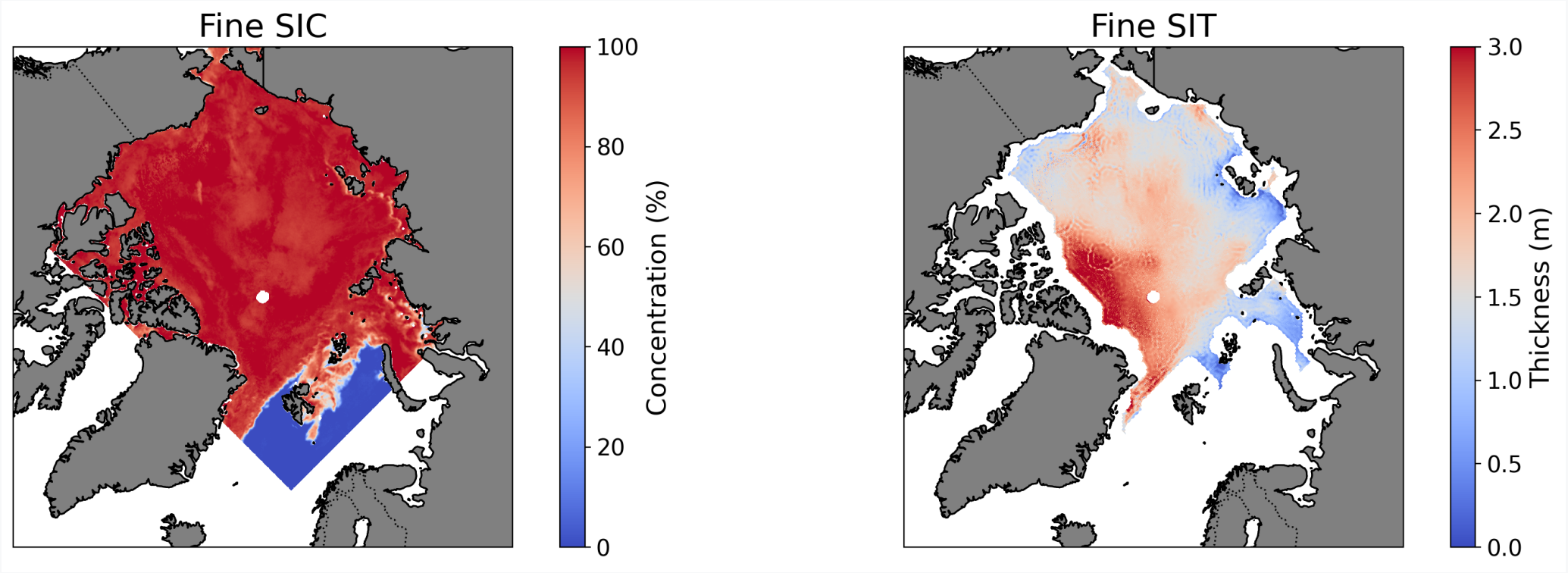


Courtesy of N. Williams

Use of AI super-resolution SIT data

CICE4 sea ice model	
categories	lower bound (m)
1	0.00
2	0.64
3	1.39
4	2.47
5	4.57

SuperIce product



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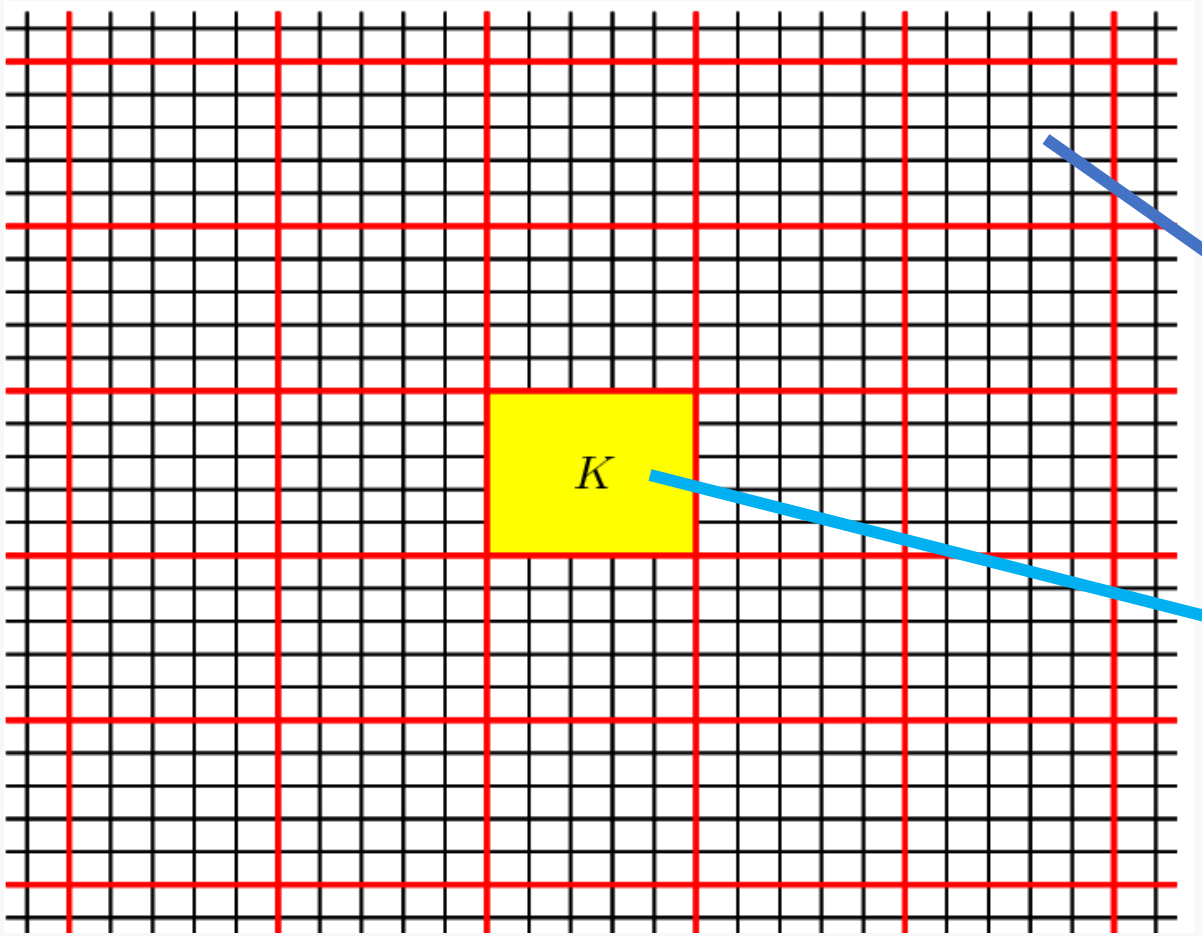
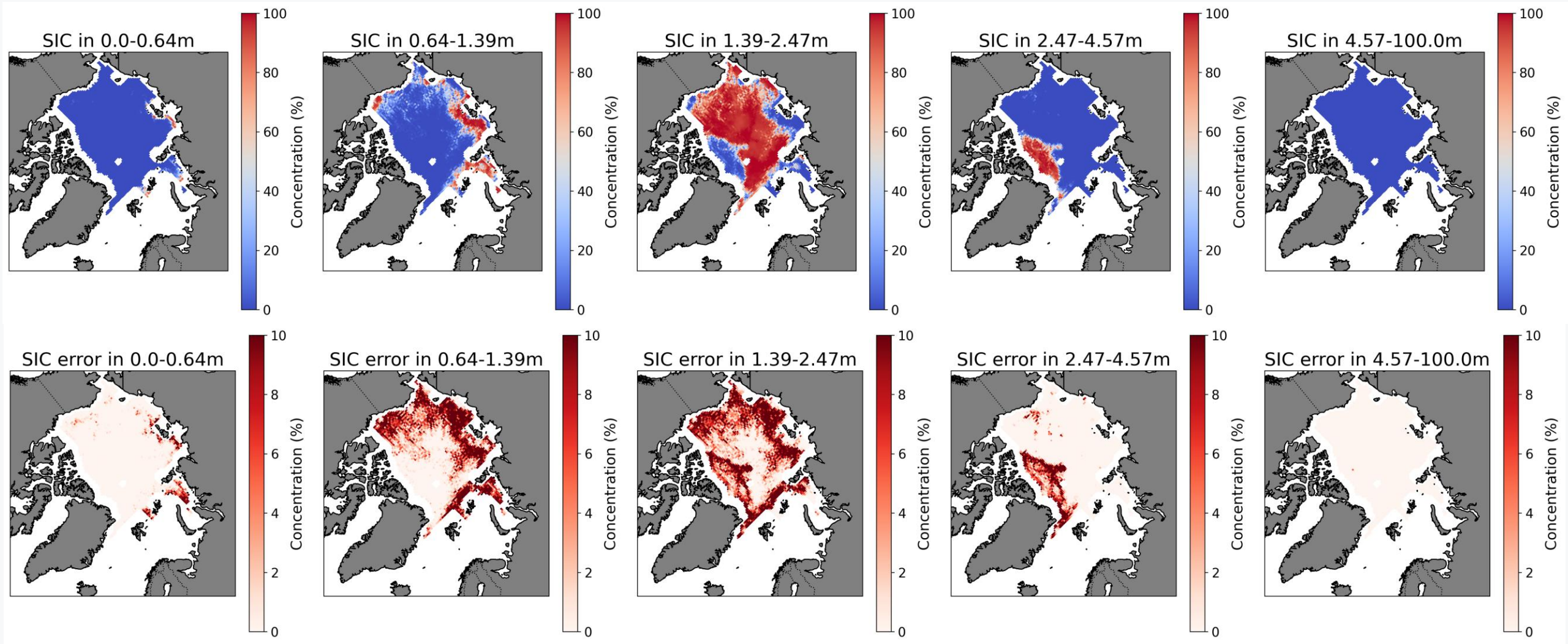


- **Super resolution**
- **Coarse resolution**

SIC and SIT observations
(about 3 km)

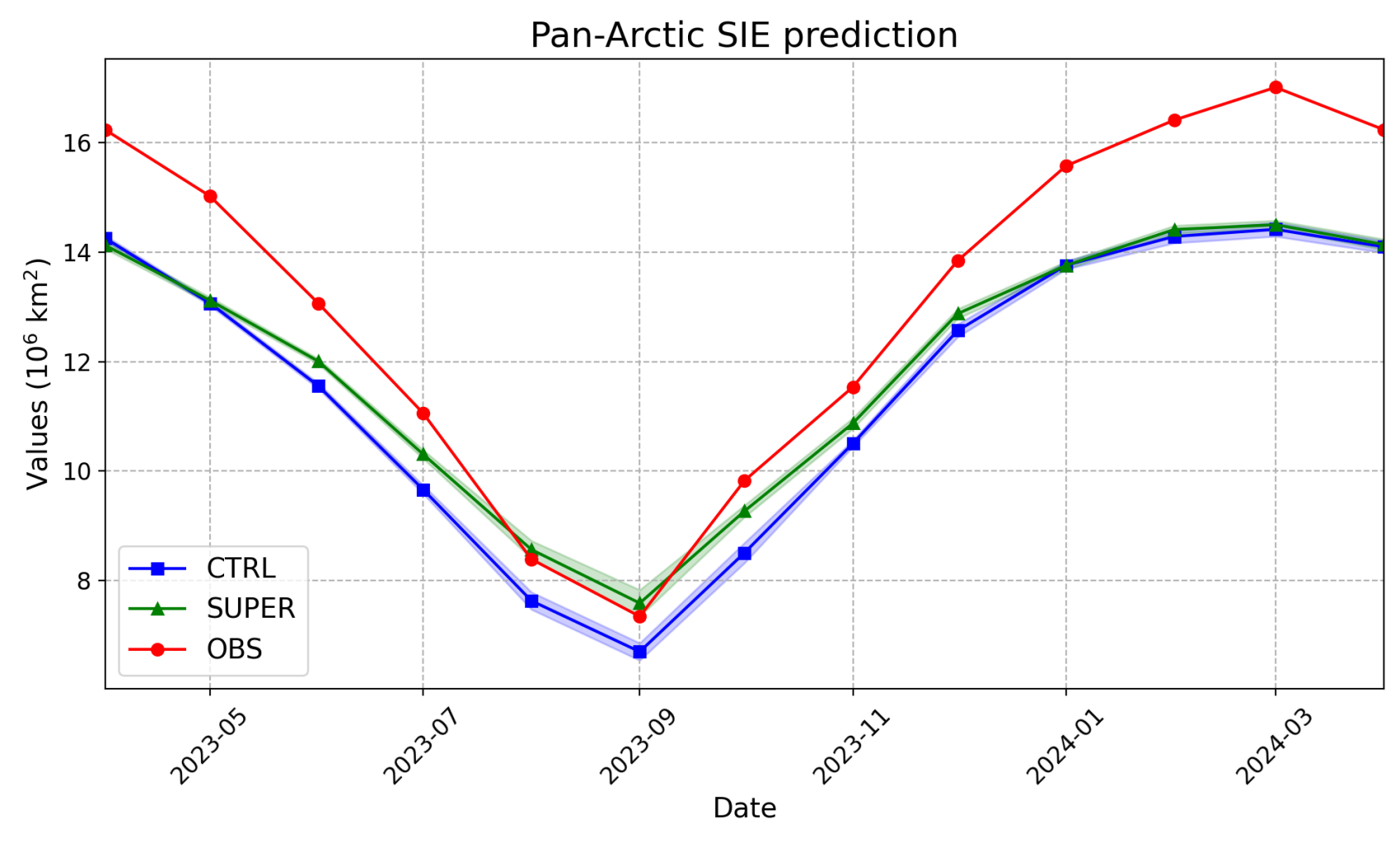
SIC observations in each thickness category (about 36 km)

Use of AI super-resolution SIT data



Case study for prediction from April 2023

CTRL: initialization with SIC and SIT observations (NOAA and CS2SMOS)
SUPER: initialization with category SIC observations (SuperICE)
Obs: SIC observations (NOAA)



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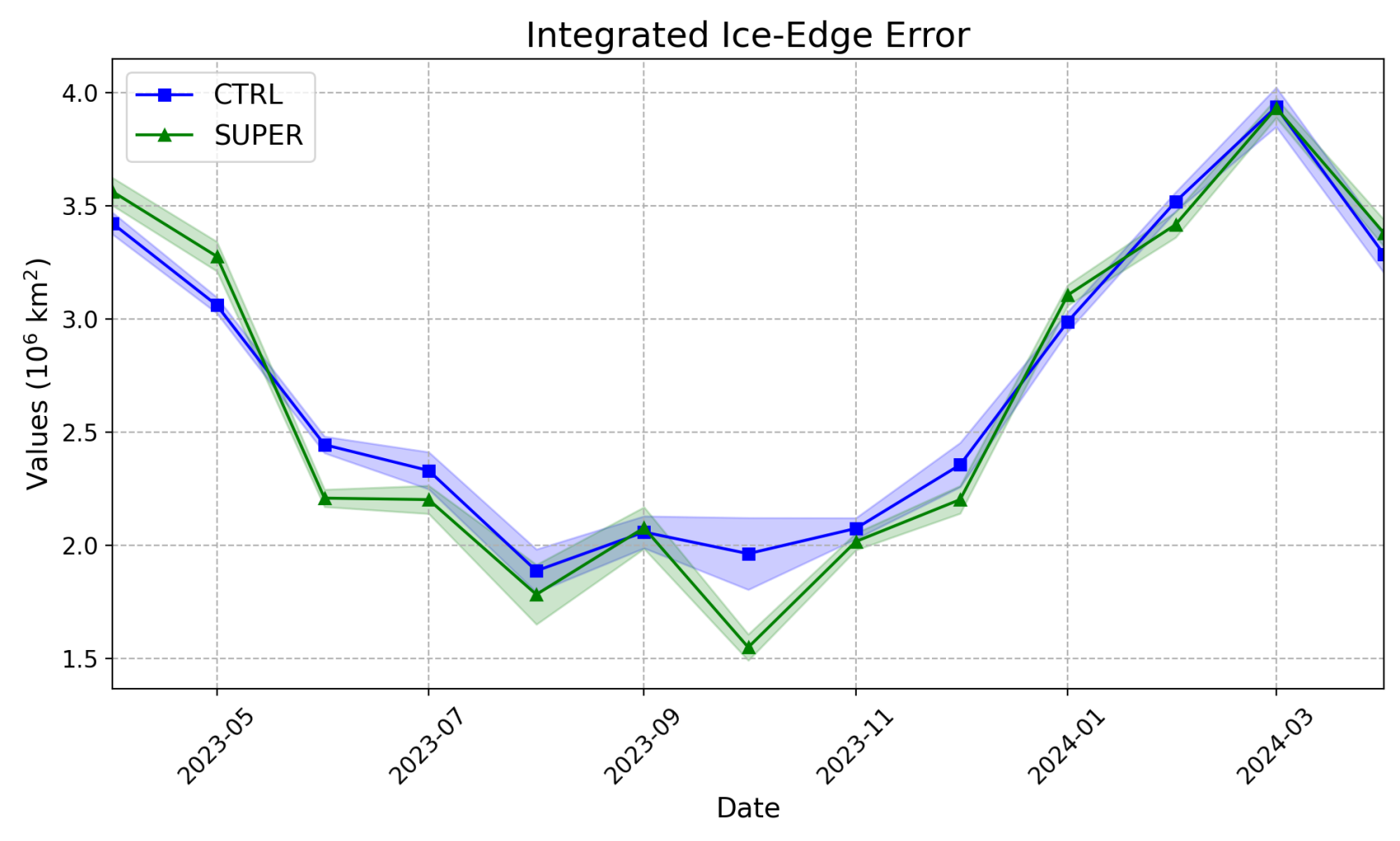
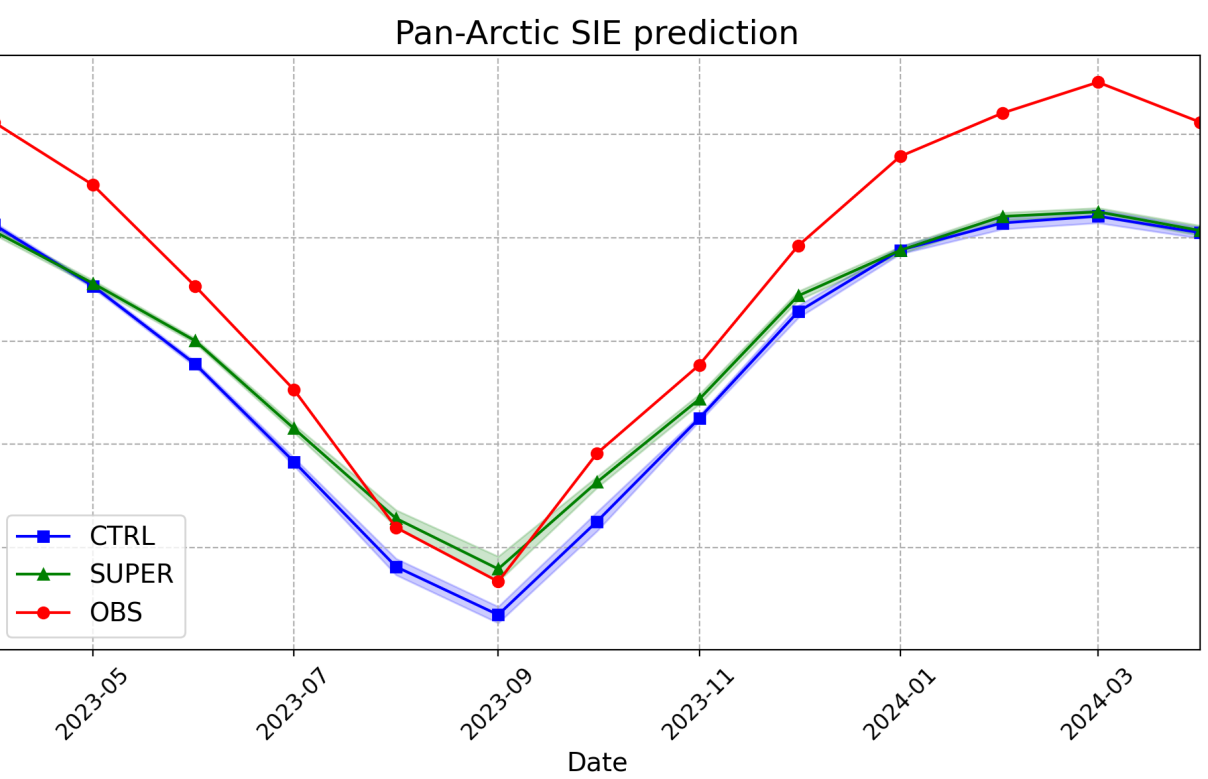
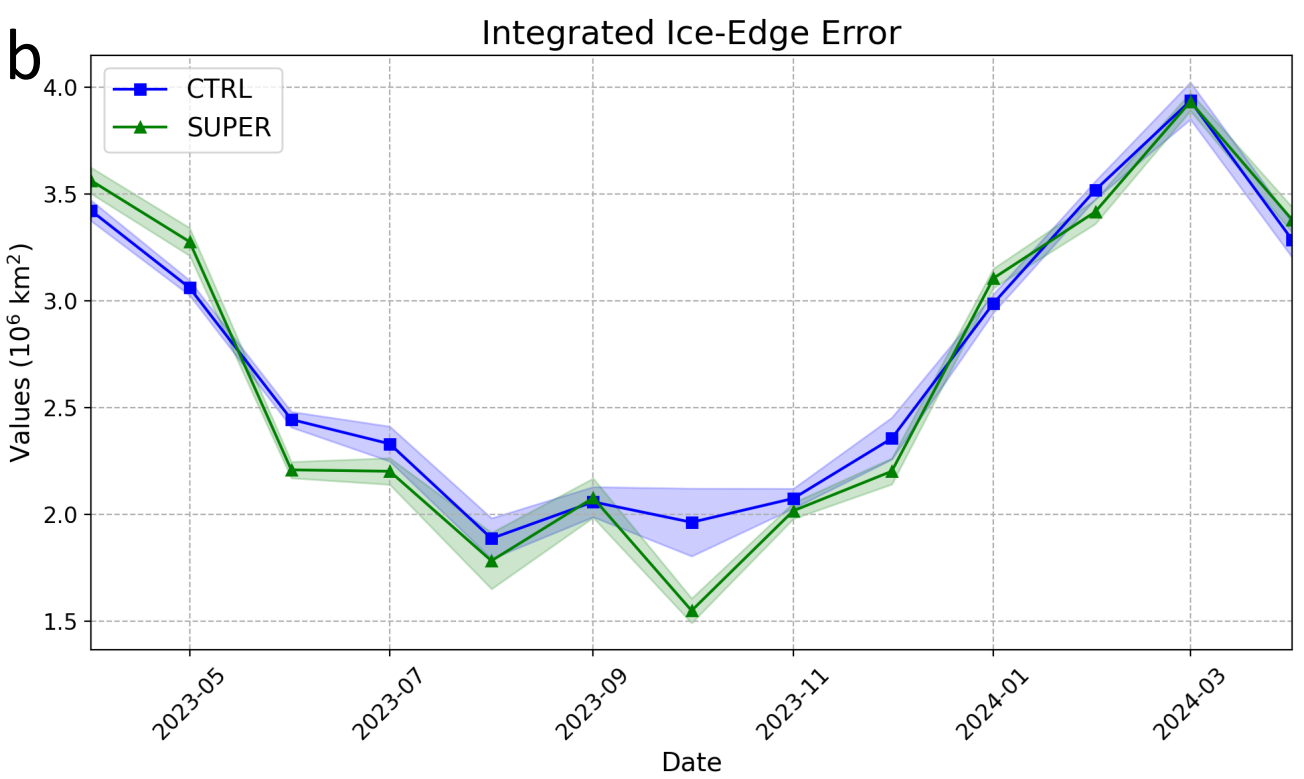



Pan-Arctic SIE prediction
CTRL
SUPER
OBS
2023-05
2023-07
2023-09
2023-11
2024-01
2024-03
Date


b
Integrated Ice-Edge Error
CTRL
SUPER
Values (10^6 km^2)
4.0
3.5
3.0
2.5
2.0
1.5
2023-05
2023-07
2023-09
2023-11
2024-01
2024-03
Date

Take-home messages

- NorCPM is one of state-of-the-art Earth system model, featuring ocean, sea ice, land and atmosphere initialisation.
- We assimilate SIC (NOAA) and SIT (ENVISAT and C2SMOS).
- High-resolution sea ice SIC and SuperIce SIT data are classed to category SIC data.
- For seasonal prediction, initialization with SuperIce SIT data overperforms initialization with conventional SIT data.