

Numerical simulation on oceanic state and sea ice distribution of the Arctic Ocean

Mi Ok Kwon, Ho Jin Lee*

College of Ocean Science and Technology, Korea Maritime and Ocean University, Busan 606-791, Korea

Model description

Ice-Ocean Coupled Model

- Ocean Model**
 - ROMS (Regional Ocean Modeling System) Ver 3.4
- Ice Model**
 - Ice dynamic
 - : Hunke and Dukowicz (1997), Hunke (2001)
 - The elastic-viscous-plastic (EVP) rheology
 - Ice thermodynamic
 - : Mellor and Kantha (1989)
 - 2 ice layer & 1 snow layer

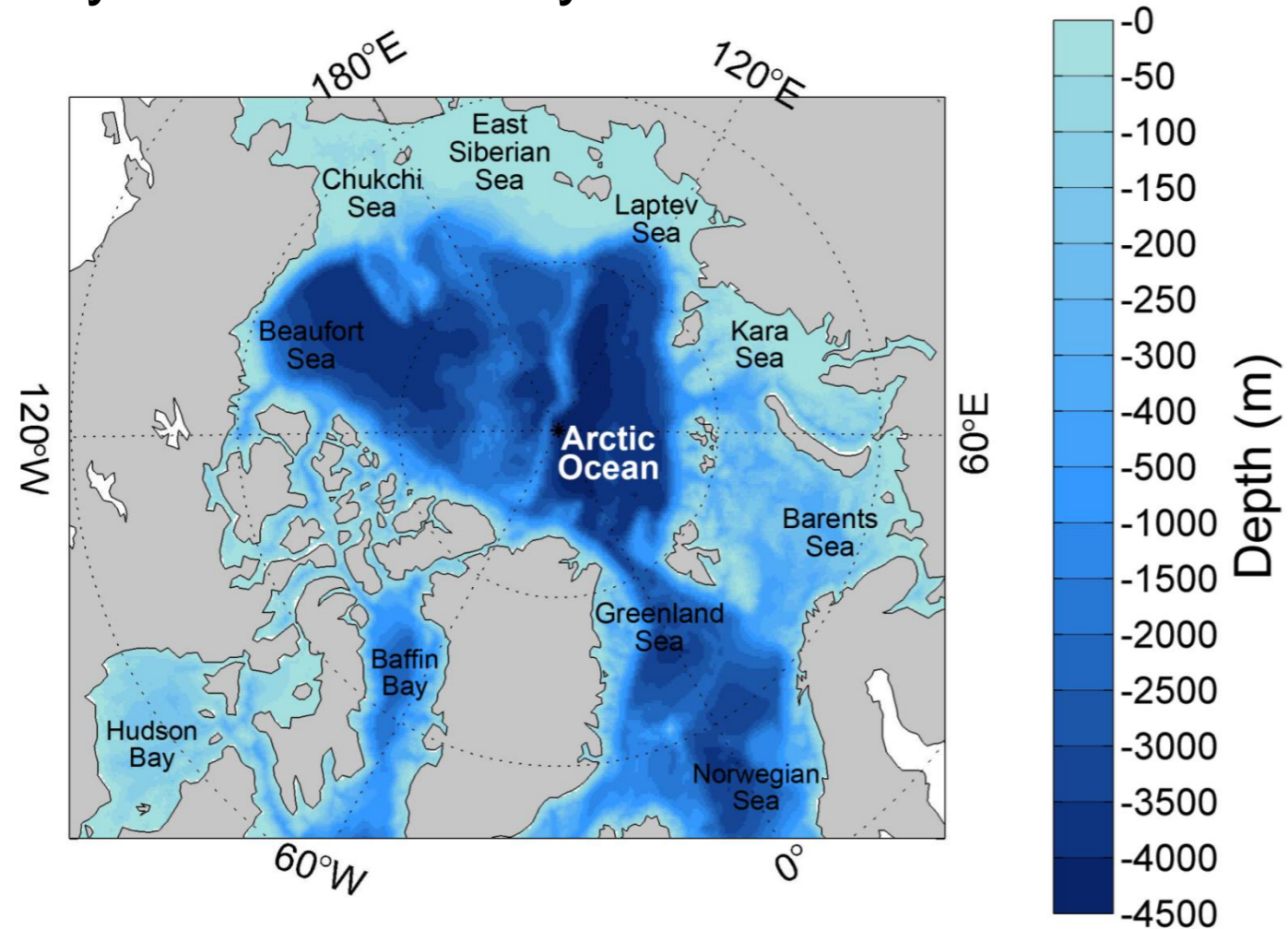


Fig. 1 Model domain and bathymetry

Grid Resolution

- 11-13 km, 50 levels

Bathymetry data

- International Bathymetric Chart of the Arctic Ocean (IBCAO Version 3.0, Jakobsson et al., 2012)

Initial Condition

- Polar science center Hydrographic Climatology (PHC, Steele et al., 2001) Temperature and Salinity

Sea Surface Flux

- 12-hourly ECMWF data from 1985 to 2012

Open Boundary Flux

- Simple Ocean Data Assimilation (SODA, version 2.2.4) from 1989 to 2008

- ◆ Bulk type heat flux at the sea surface

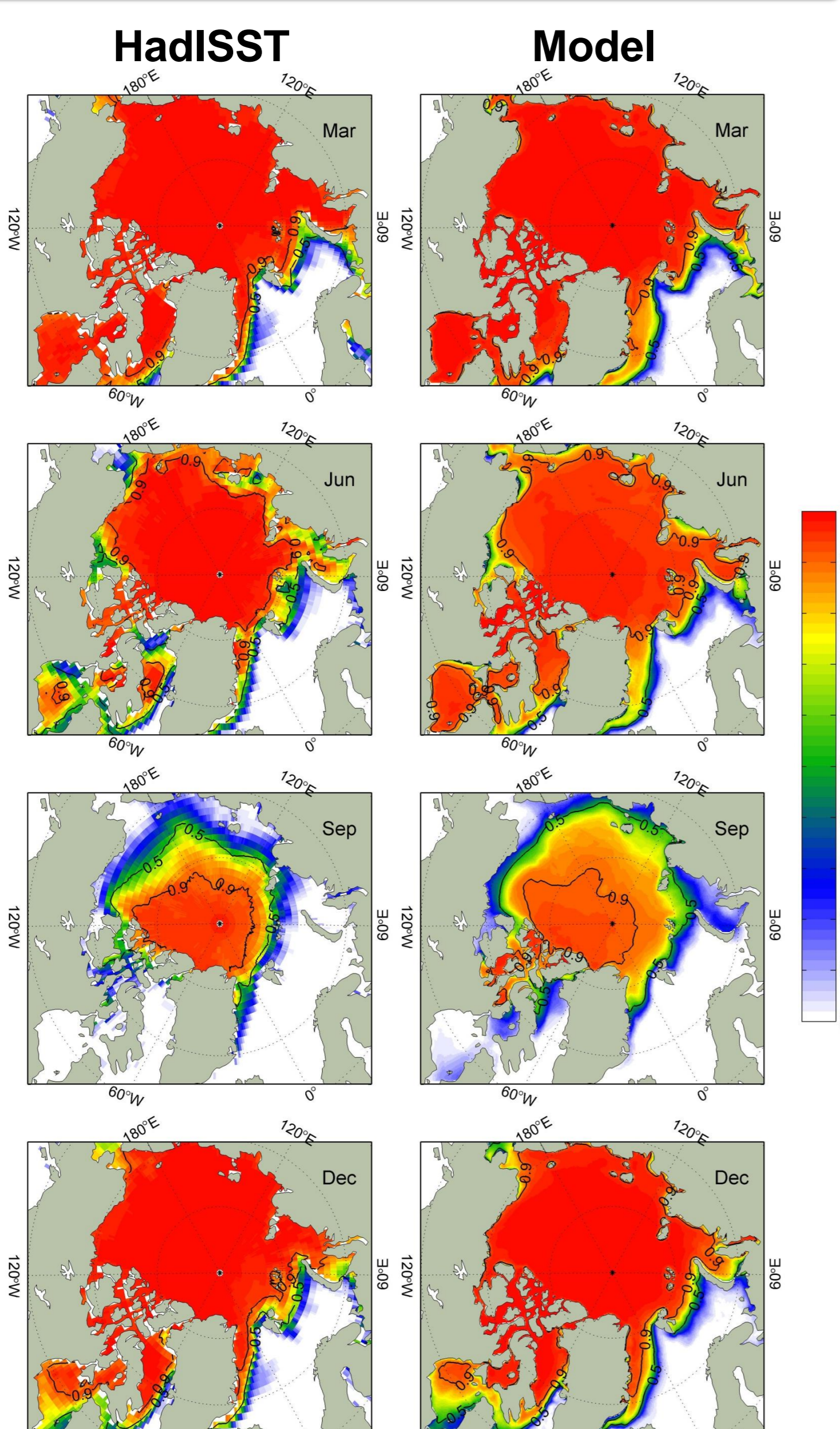
- ◆ LMD (The Large, McWilliams and Doney, 1994) scheme for vertical viscosity and diffusivity

- ◆ Smagorinsky scheme for the horizontal viscosity

- ◆ 28-year hindcast run from 1985 to 2012 after 10-year spin-up

Sea ice concentration

Fig. 2 28-year (1985-2012) monthly mean sea ice concentration. HadISST means Hadley Centre Sea ice and Sea Surface Temperature data set.



➤ The model appears to overestimate the sea ice concentration, especially in September.

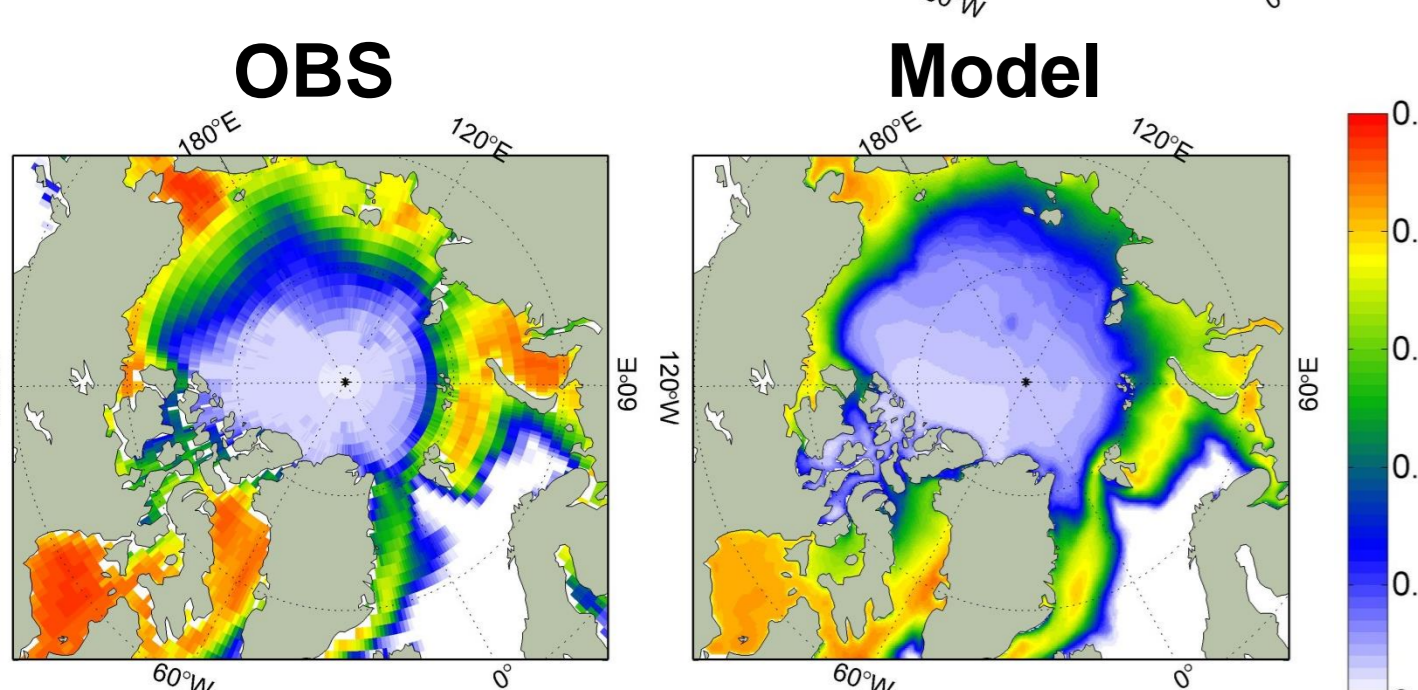


Fig. 3 The standard deviation of monthly sea ice concentration during the period from 1985 to 2012.

Sea ice thickness

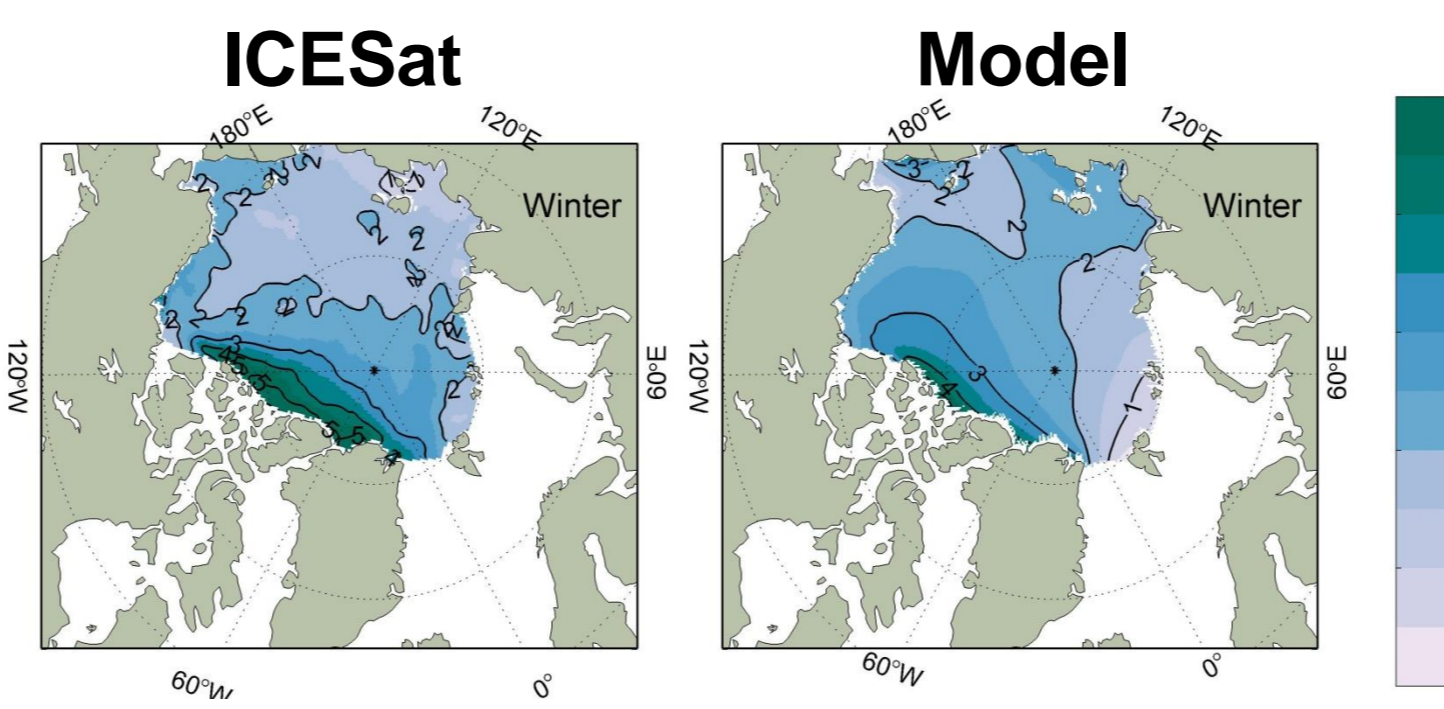


Fig. 4 Seasonal mean sea ice thickness during winter in 2004-2008 obtained from ICESat (the Ice, Cloud, and land Elevation Satellite) data and model results.

Sea ice extent

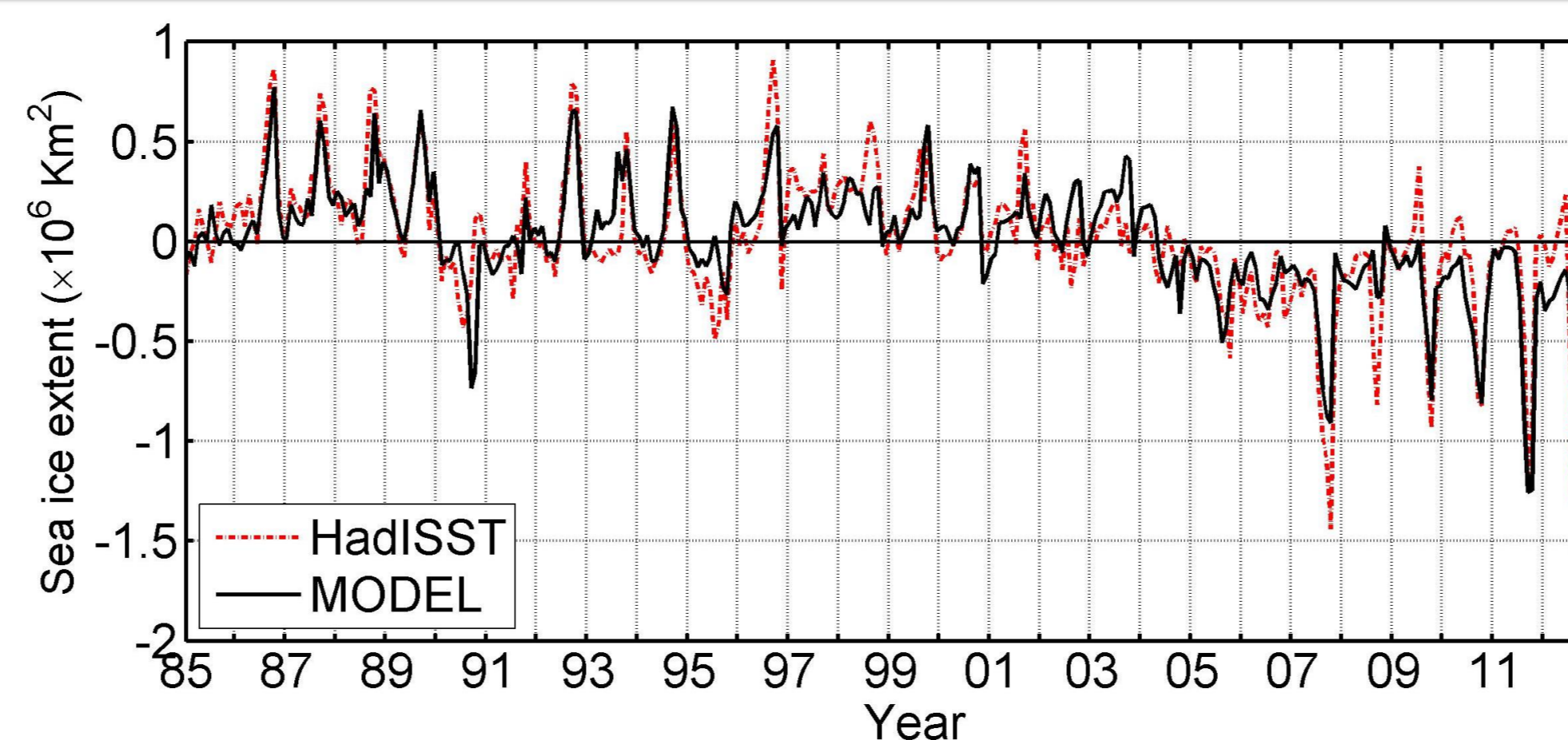


Fig. 5 Time series of sea ice extent anomaly. Sea ice extent is defined as the area where the sea ice concentration is greater than 0.15.

Sea ice velocity

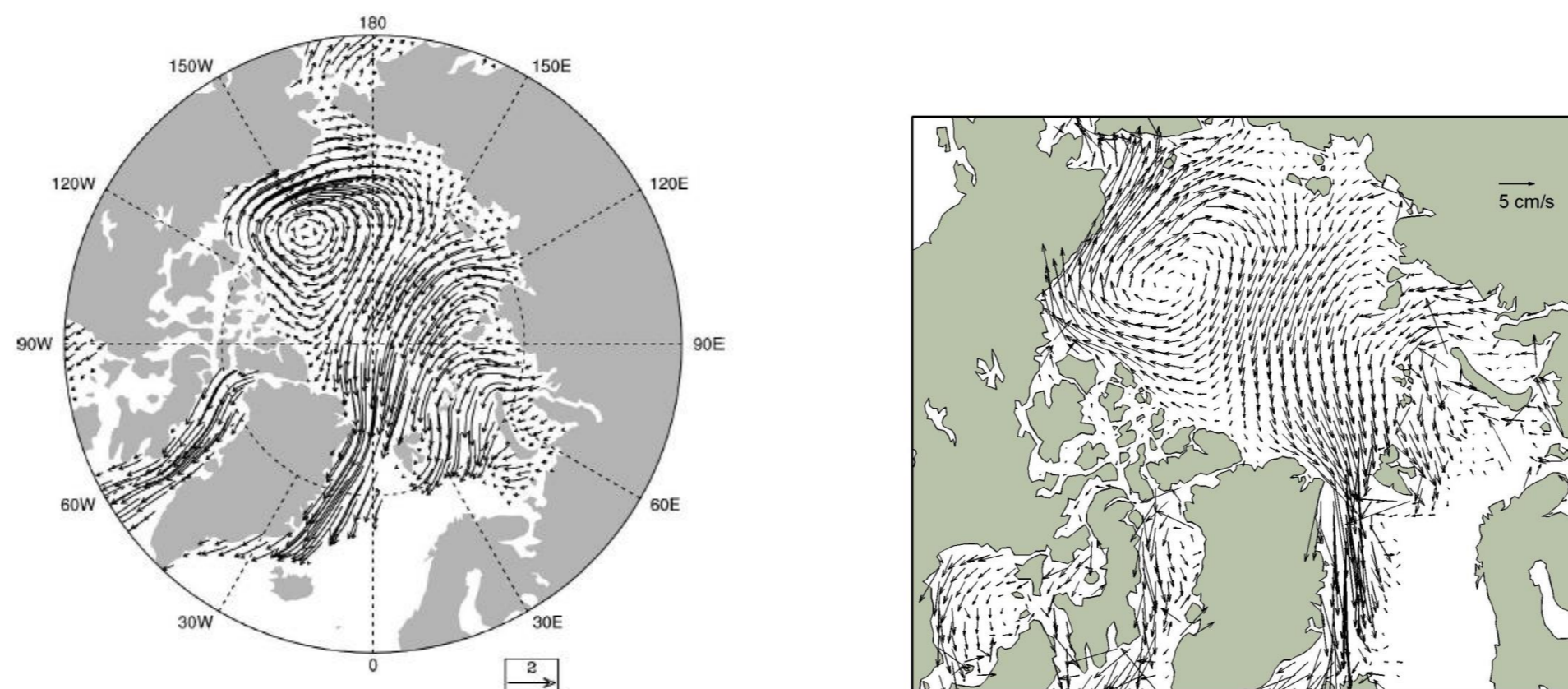


Fig. 6 The averaged ice velocity over 1980-1999 from satellite observation (Fowler 2003, cm/s). Fig. 7 Calculated sea ice velocity.

Temperature and Salinity

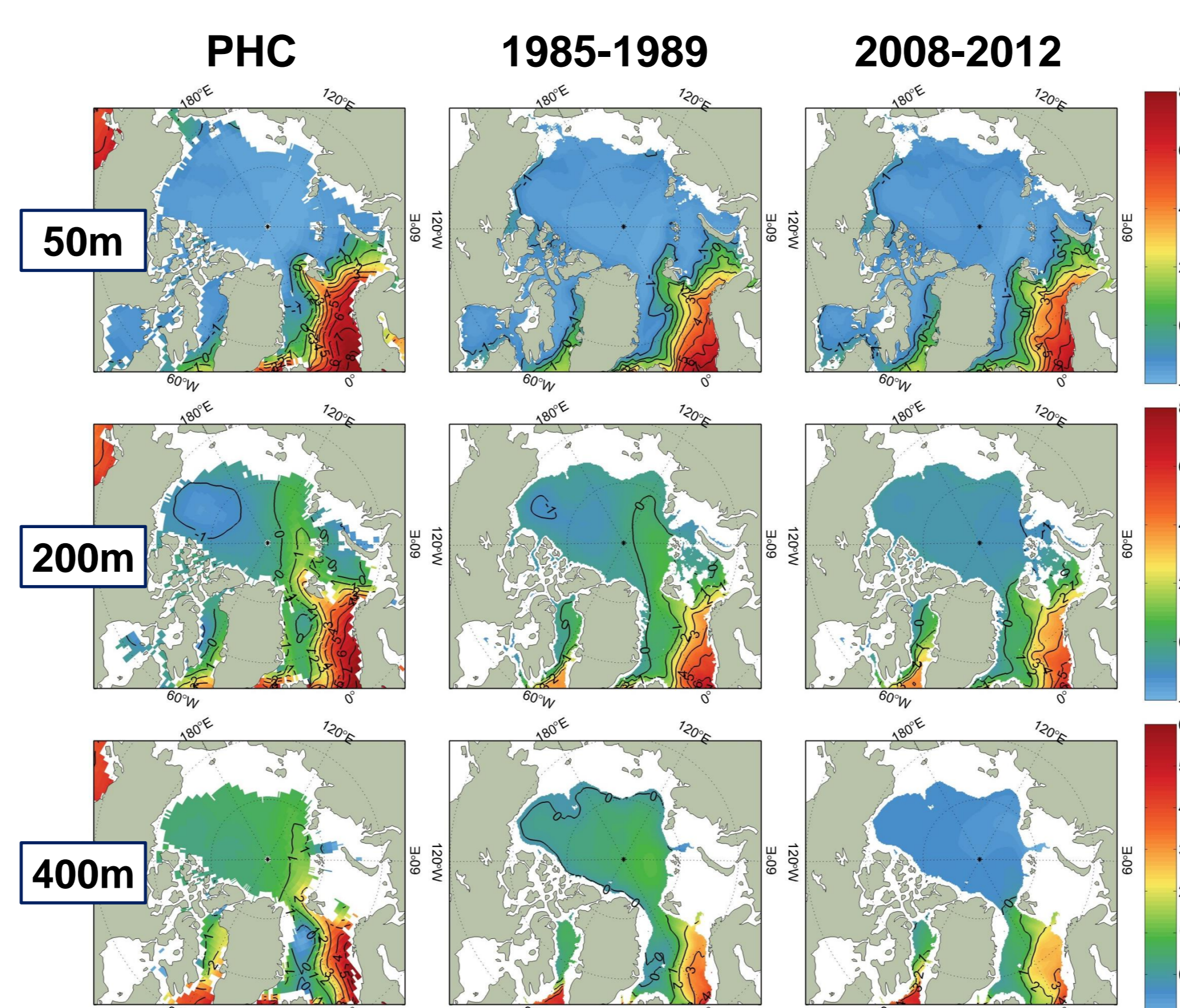


Fig. 8 Annual mean temperature distribution at different depths. PHC means Polar science center Hydrographic Climatology data sets, model results are averaged over the first 5-year(1985-1989) and last 5-year(2008-2012).

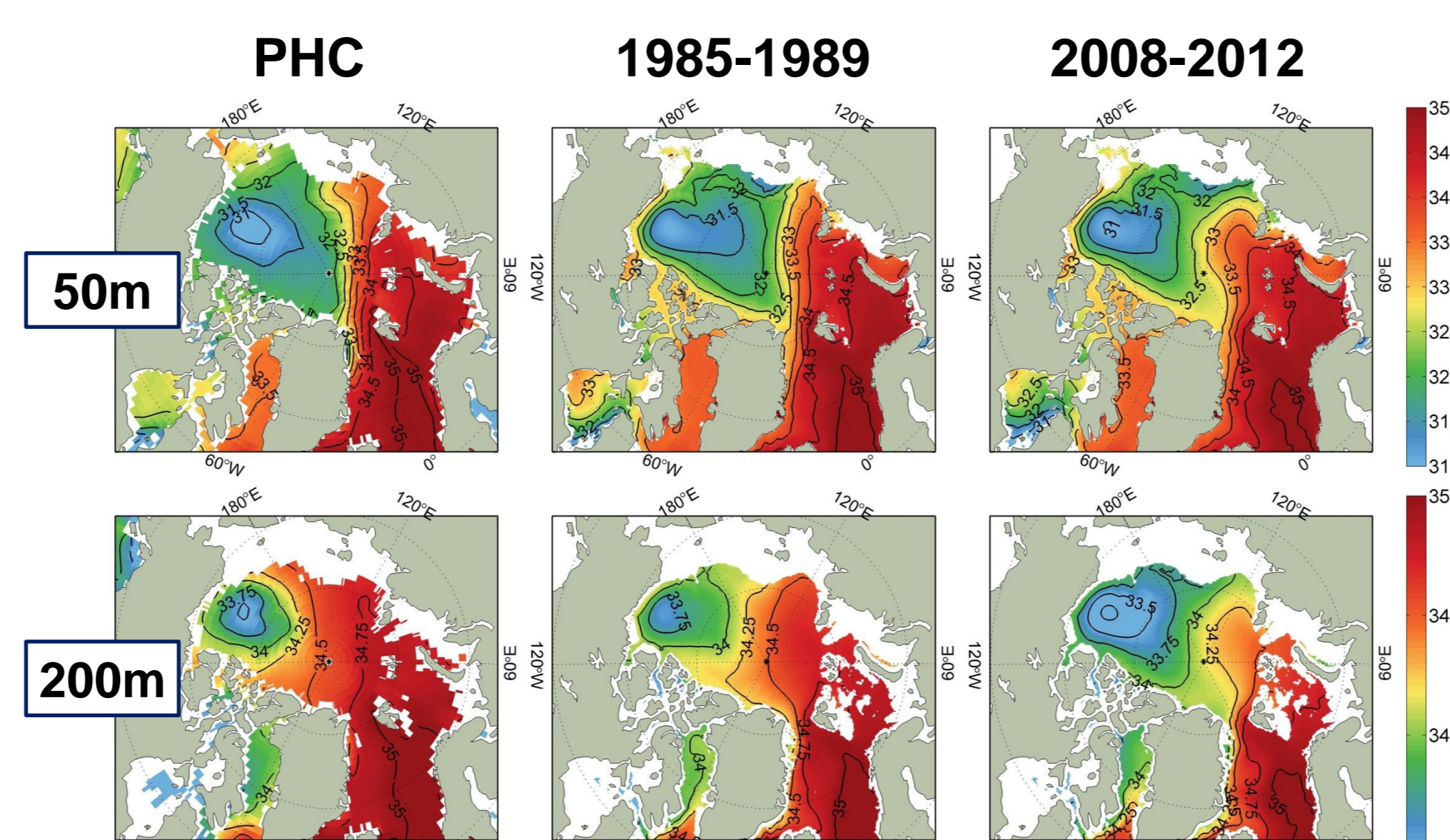


Fig. 9 Annual mean salinity distribution at different depths.

Arctic Ocean water mass

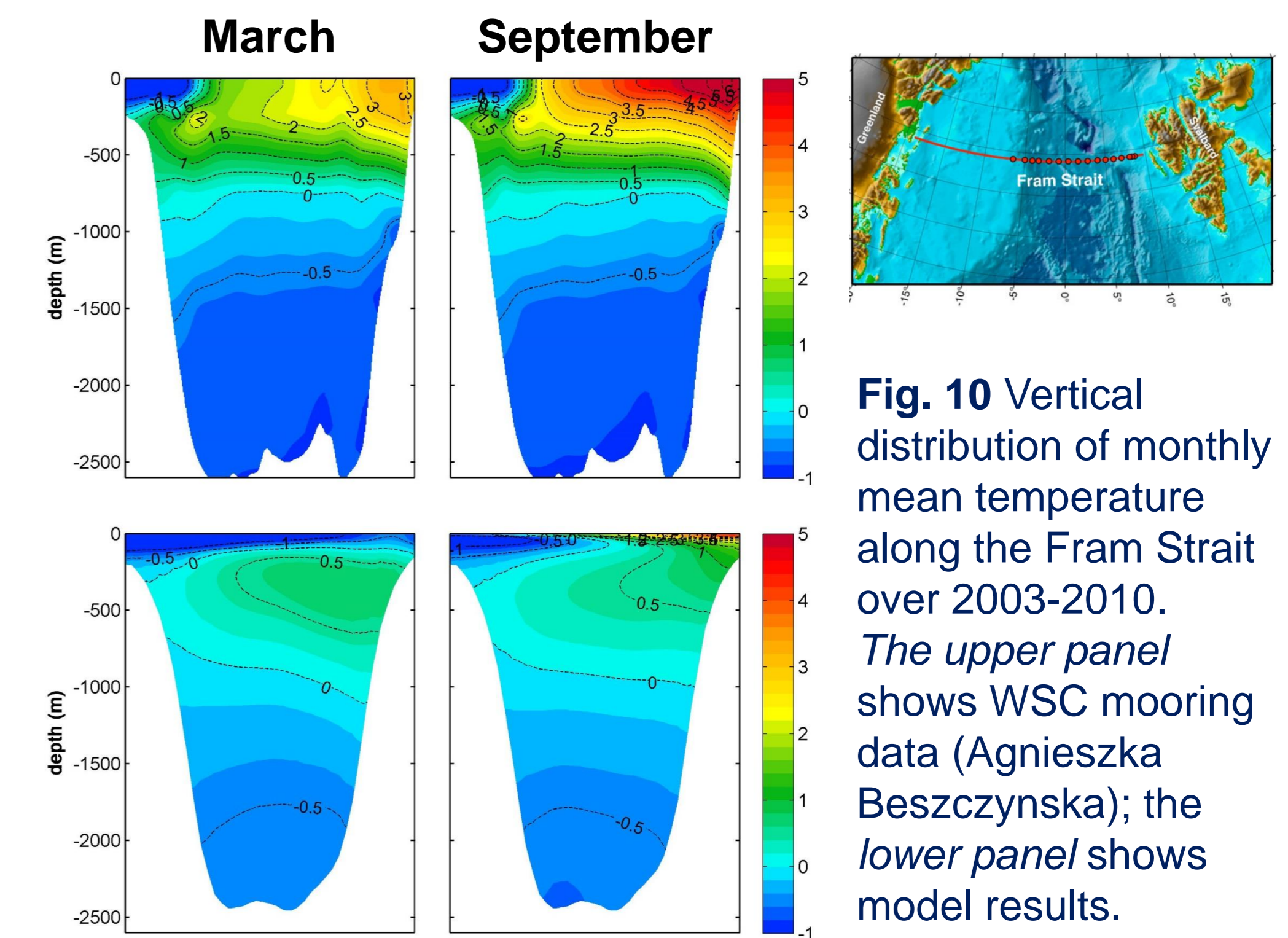


Fig. 10 Vertical distribution of monthly mean temperature along the Fram Strait over 2003-2010. The upper panel shows WSC mooring data (Agnieszka Beszczynska); the lower panel shows model results.

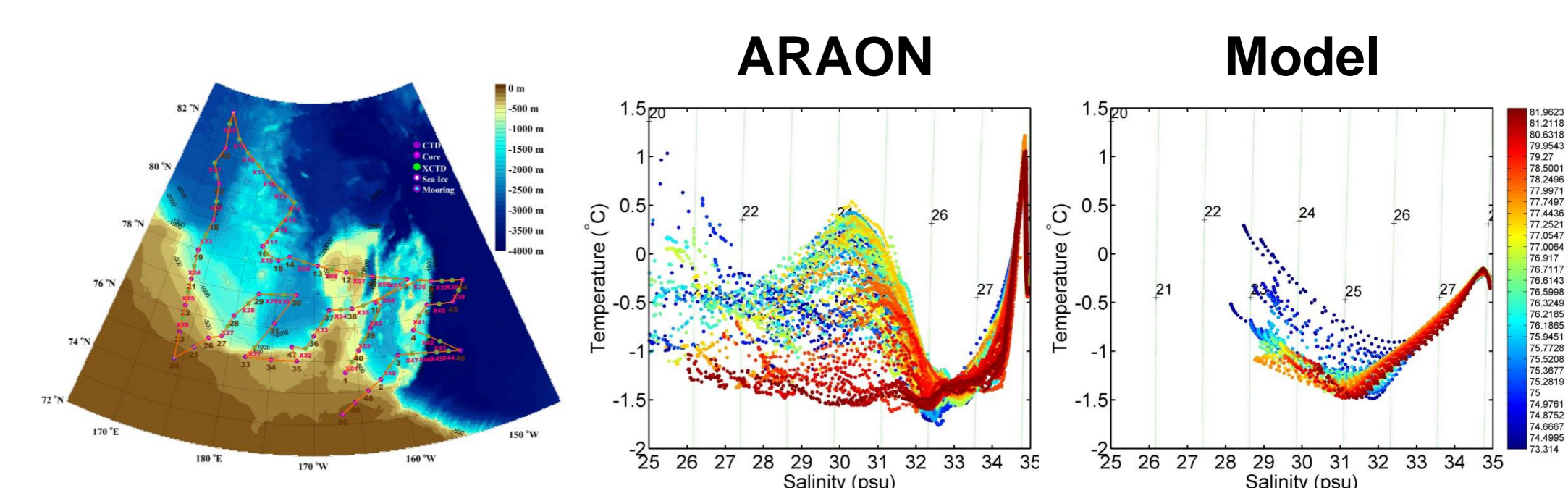


Fig. 11 T-S diagram from 2012 ARAON cruise and model results.

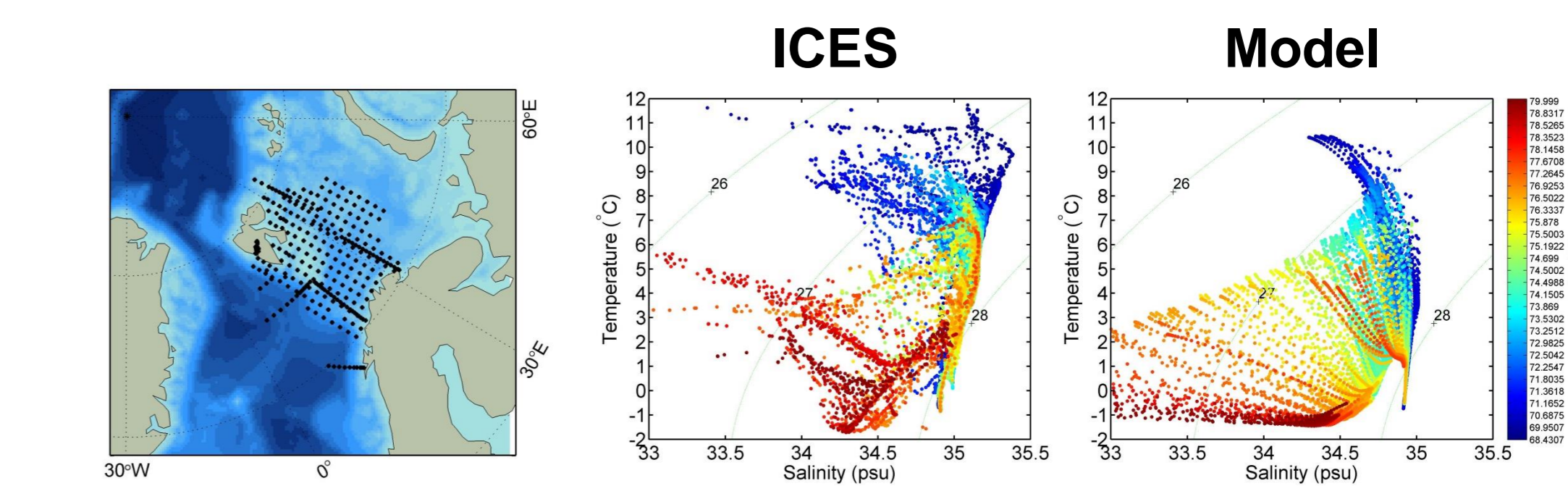


Fig. 12 T-S diagram from ICES Data Centre and model results.

Ocean circulation

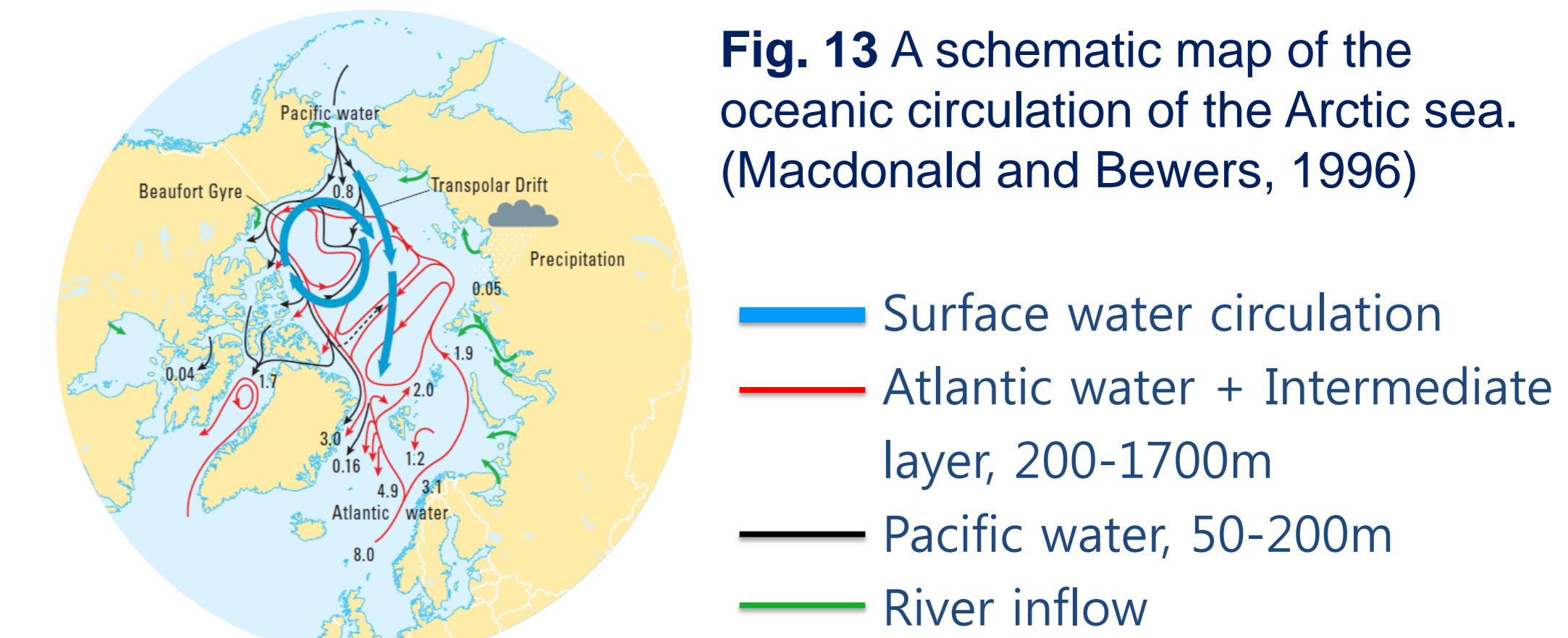


Fig. 13 A schematic map of the oceanic circulation of the Arctic sea. (Macdonald and Bowers, 1996)

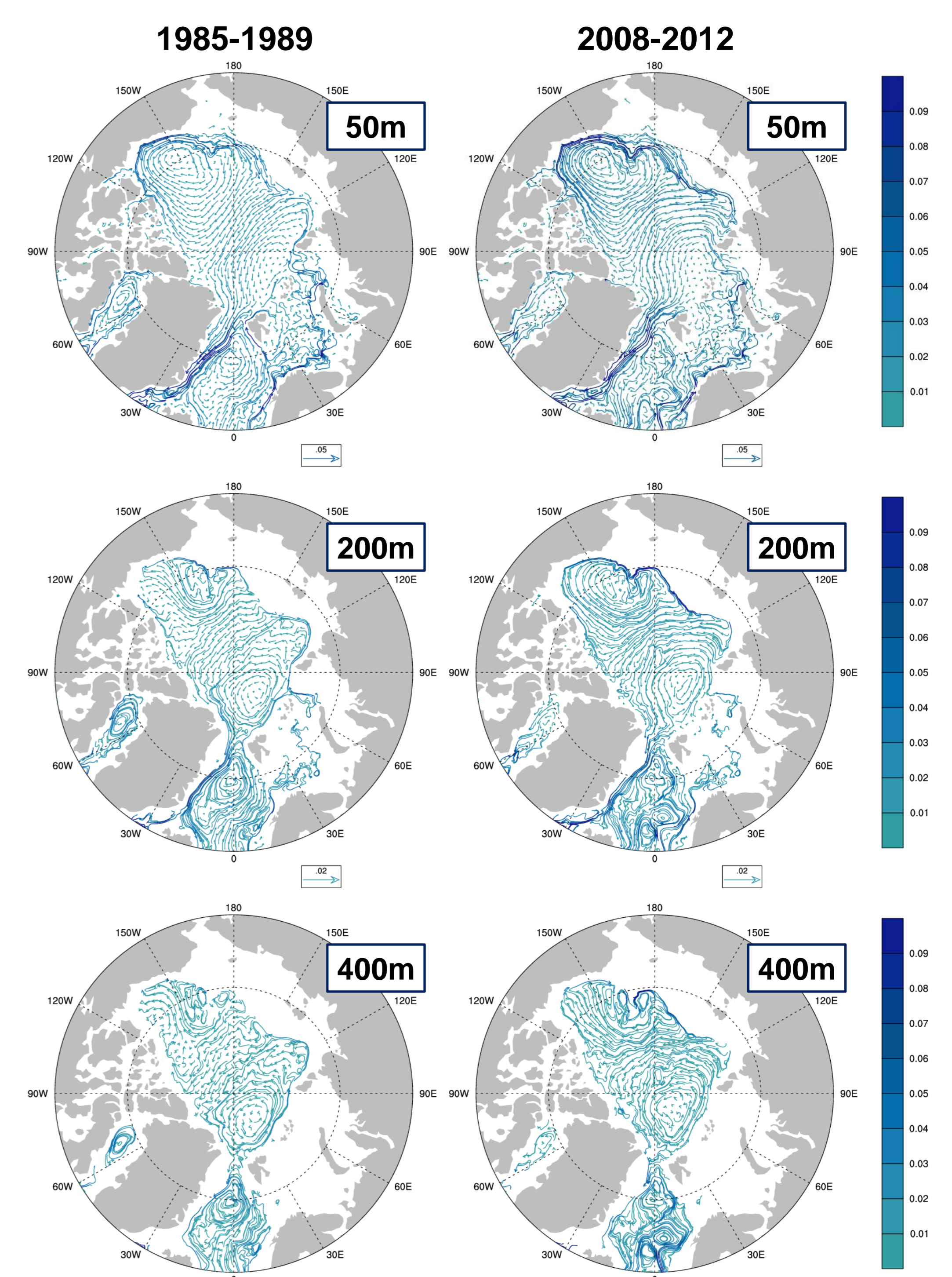


Fig. 14 Calculated flow fields at different depths.