Sensitivity of sea-ice model (CICE5) response to the atmospheric forcing

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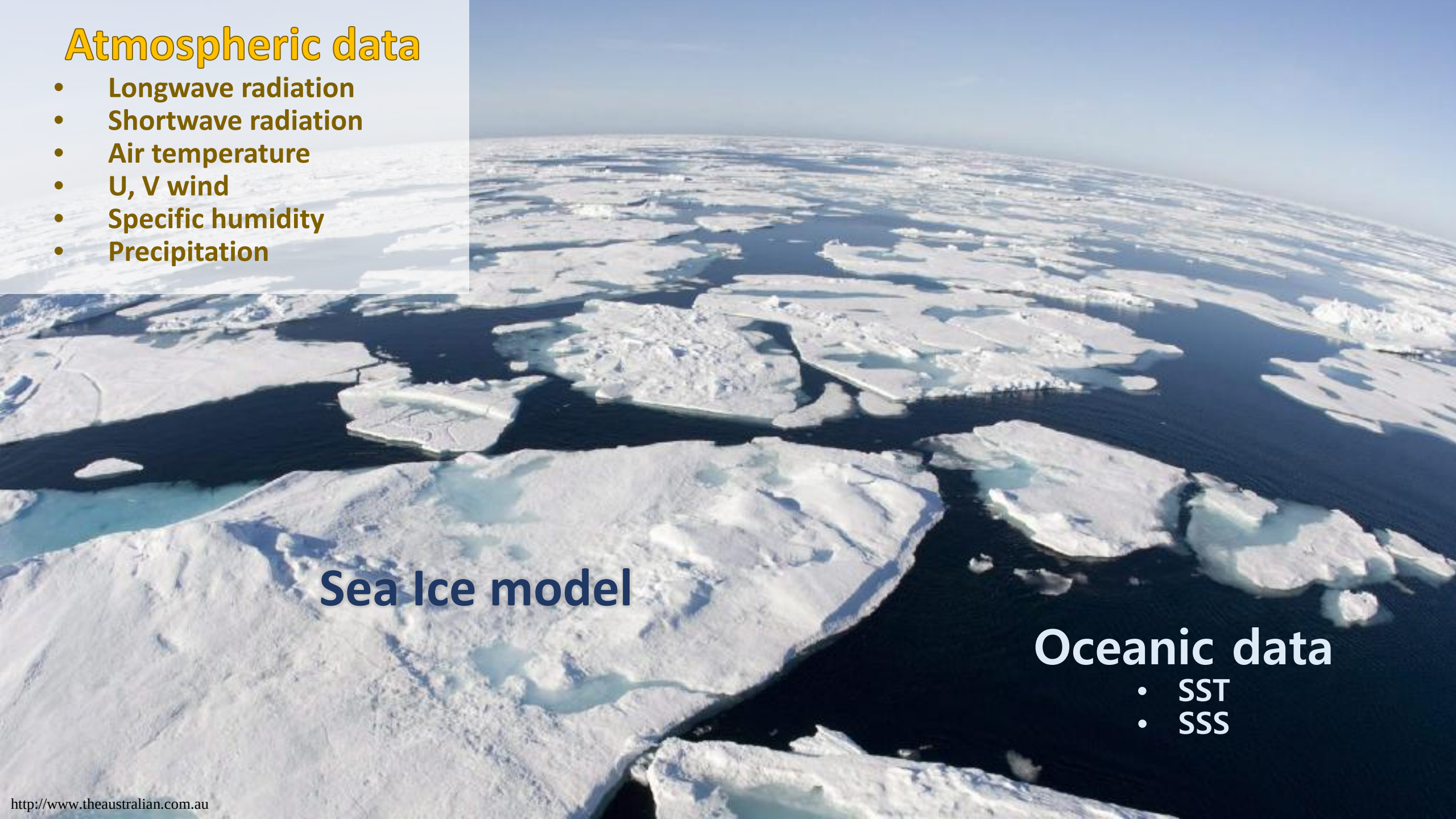
Atmospheric data

- Longwave radiation
- Shortwave radiation
- Air temperature
- U, V wind
- Specific humidity
- Precipitation



Sea Ice model

Oceanic data

- SST
- SSS

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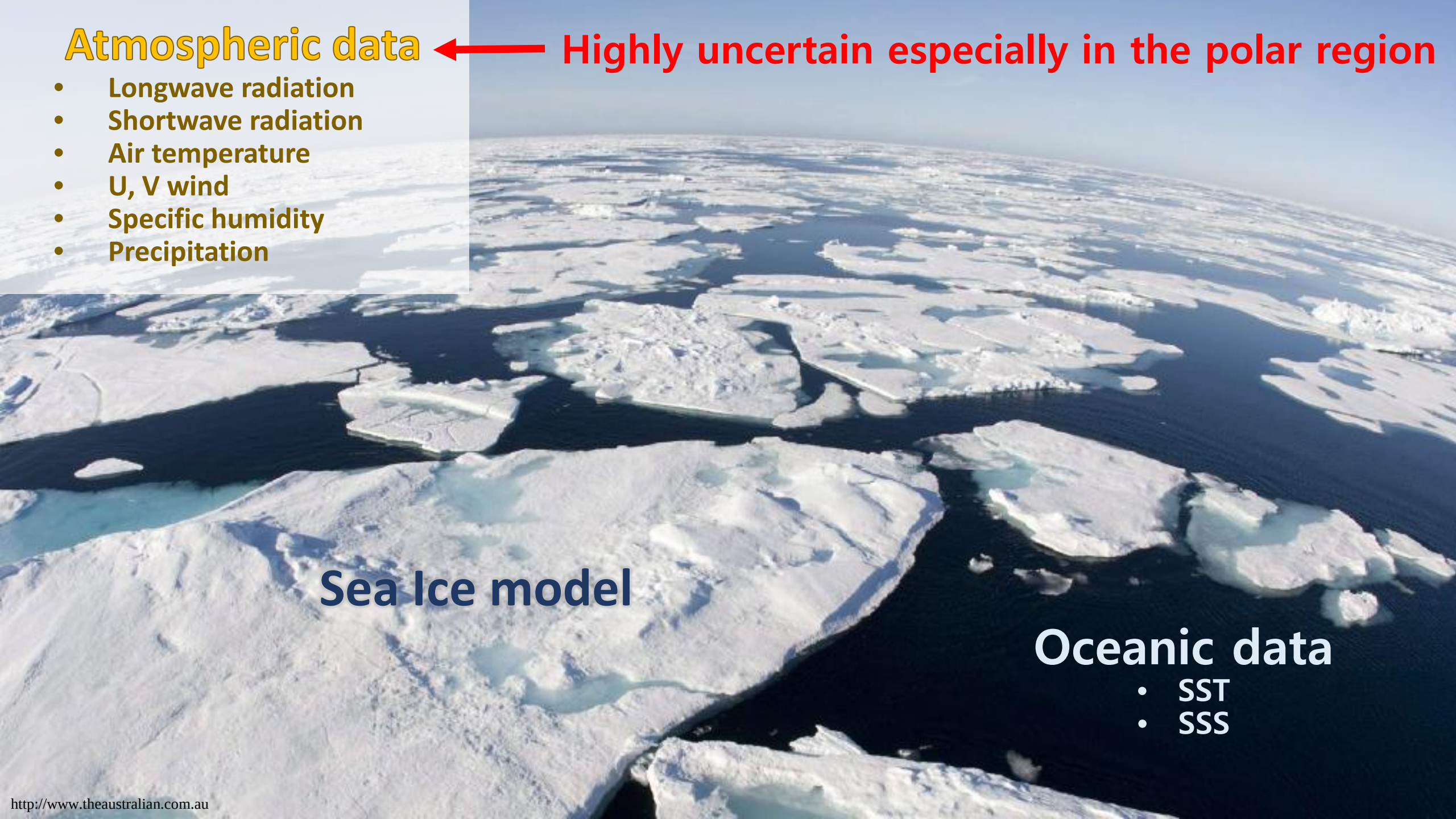

Atmospheric data

- Longwave radiation
- Shortwave radiation
- Air temperature
- U, V wind
- Specific humidity
- Precipitation

Highly uncertain especially in the polar region

Sea Ice model

Oceanic data

- SST
- SSS

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Objective

1. Among those variables, which variable is most uncertain?

2. Among those variables, which variable is most controlling one for sea-ice?

Uncertainty of reanalysis data

Temperature, relative humidity, specific humidity and speed

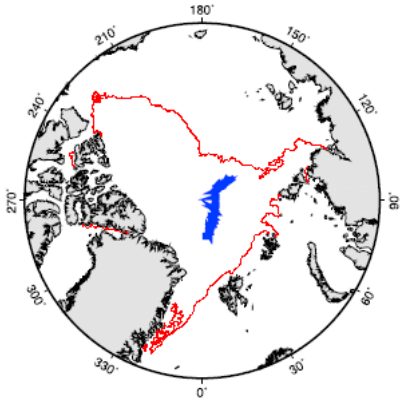


Figure 1. Drift track of TARA during the period of tethersonde soundings, from 25 April to 31 August, 2007.

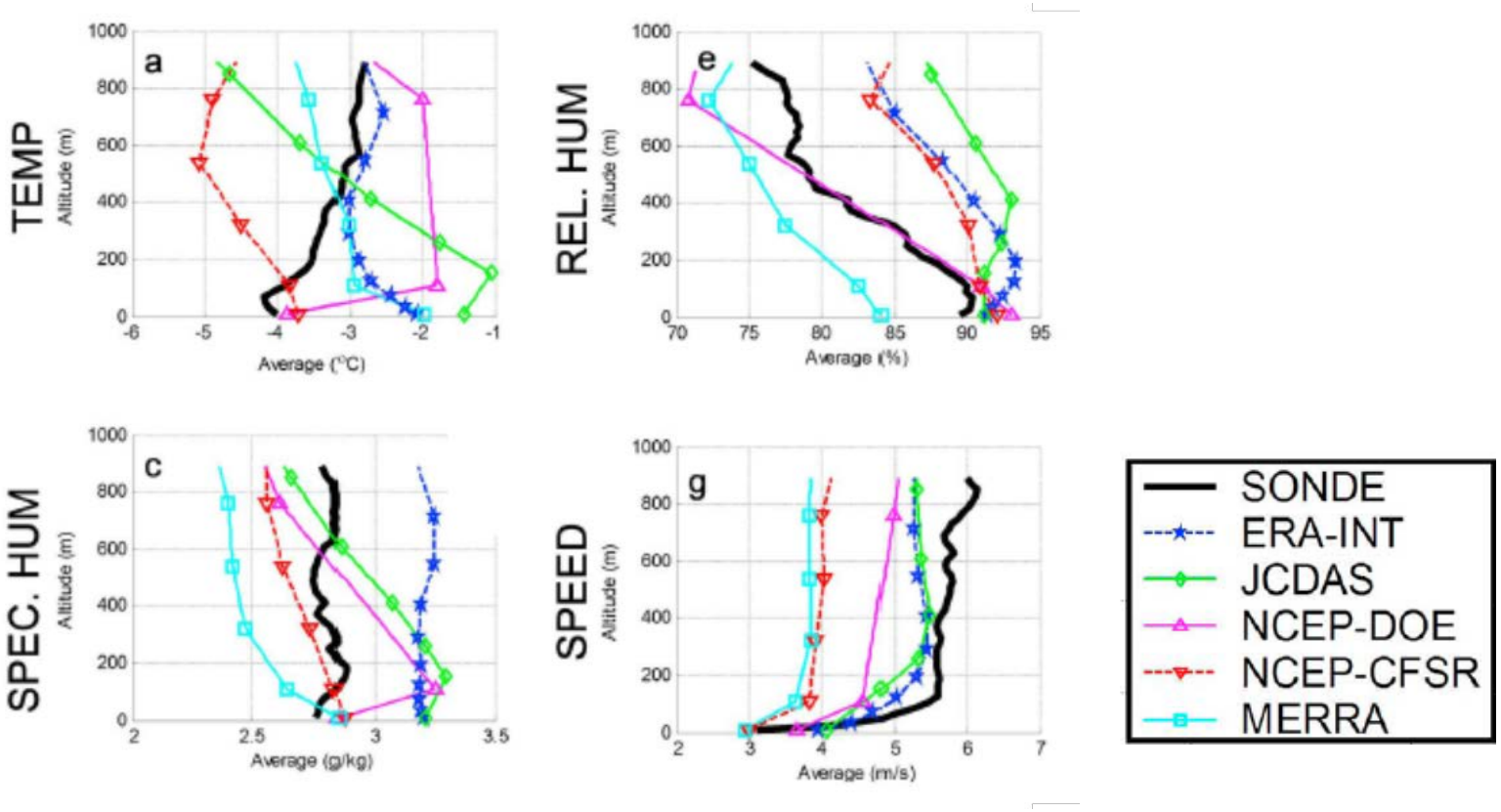
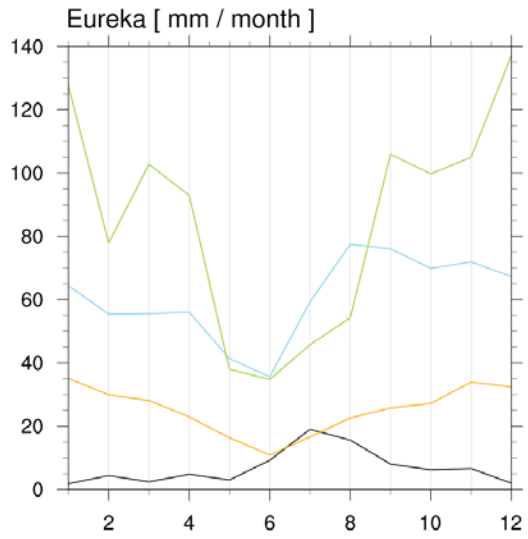
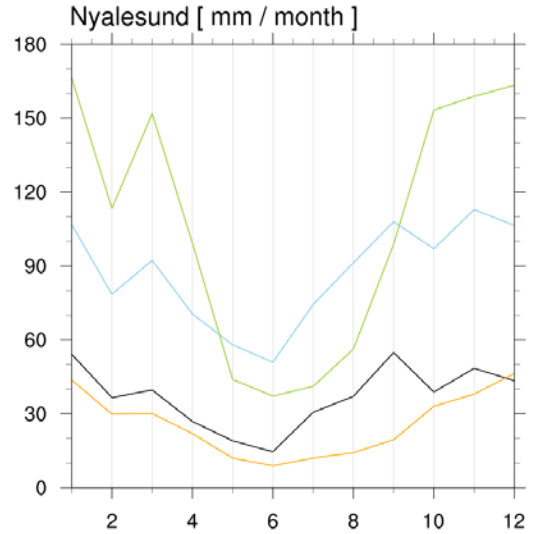


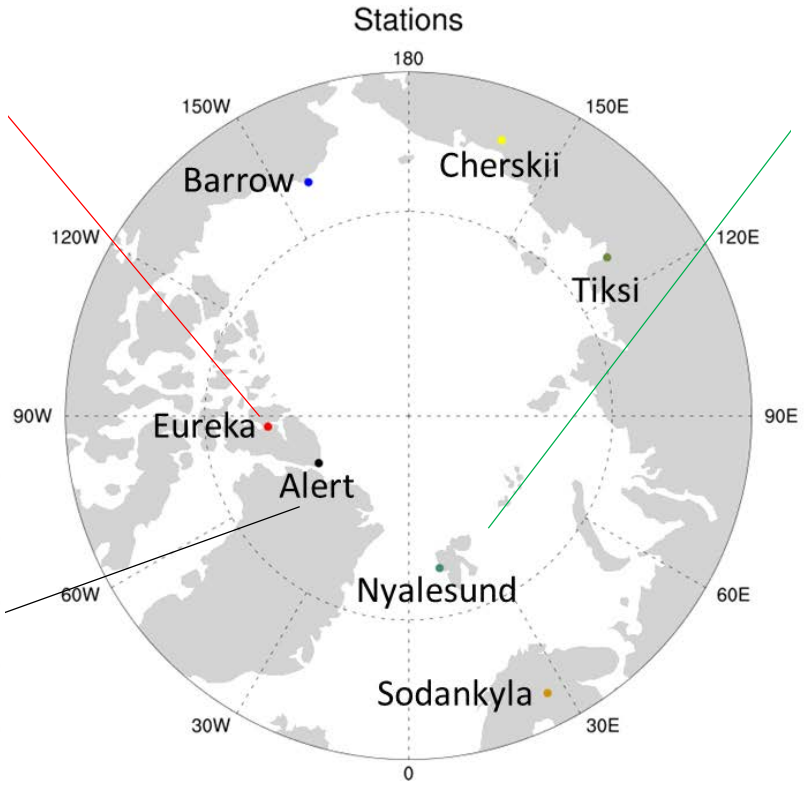
Figure 2. From 29 single profiles calculated: (a) average temperature, (c) average specific humidity, (e) average relative humidity, and (g) average wind speed. (Jakobson et al., 2012)

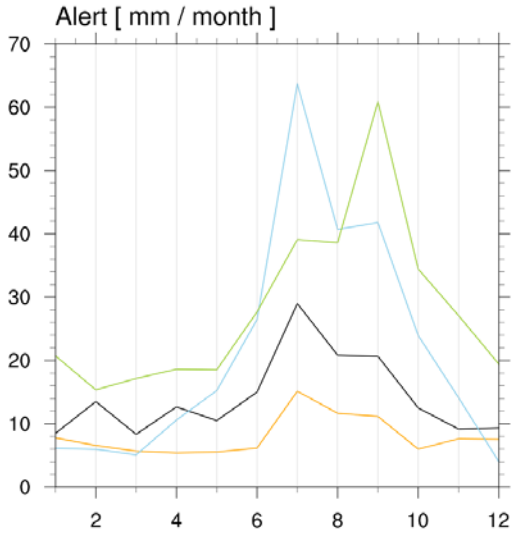
Uncertainty of reanalysis data

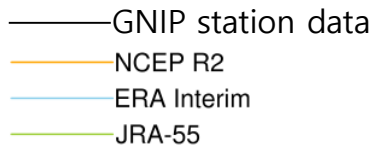
Precipitation











Model configuration

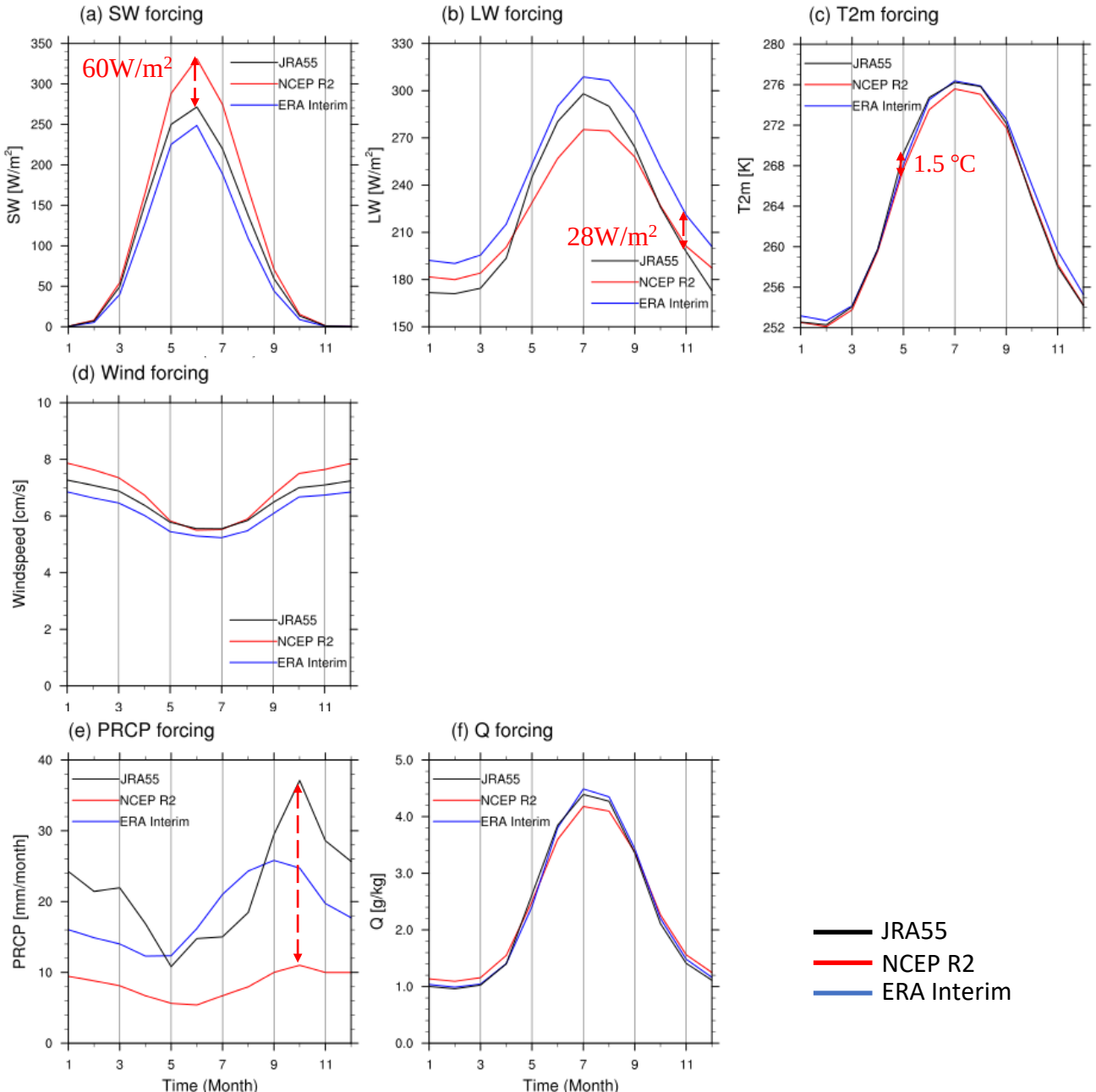
Model	Community Ice CodE (CICE) version 5.1 stand alone
Initial Condition	No ICE
Atm. Forcings	• 6 hourly : T,U,V,Q, Air Density • Monthly : Downward Longwave Radiation, Downward Shortwave Radiation, Precipitation
Ocn. Forcings	Monthly HadISST, default SSS
Integration Period	From 1982 to 2014

Uncertainties in the reanalysis data

Thermodynamical Forcing

Dynamical Forcing

Hydrological Forcing



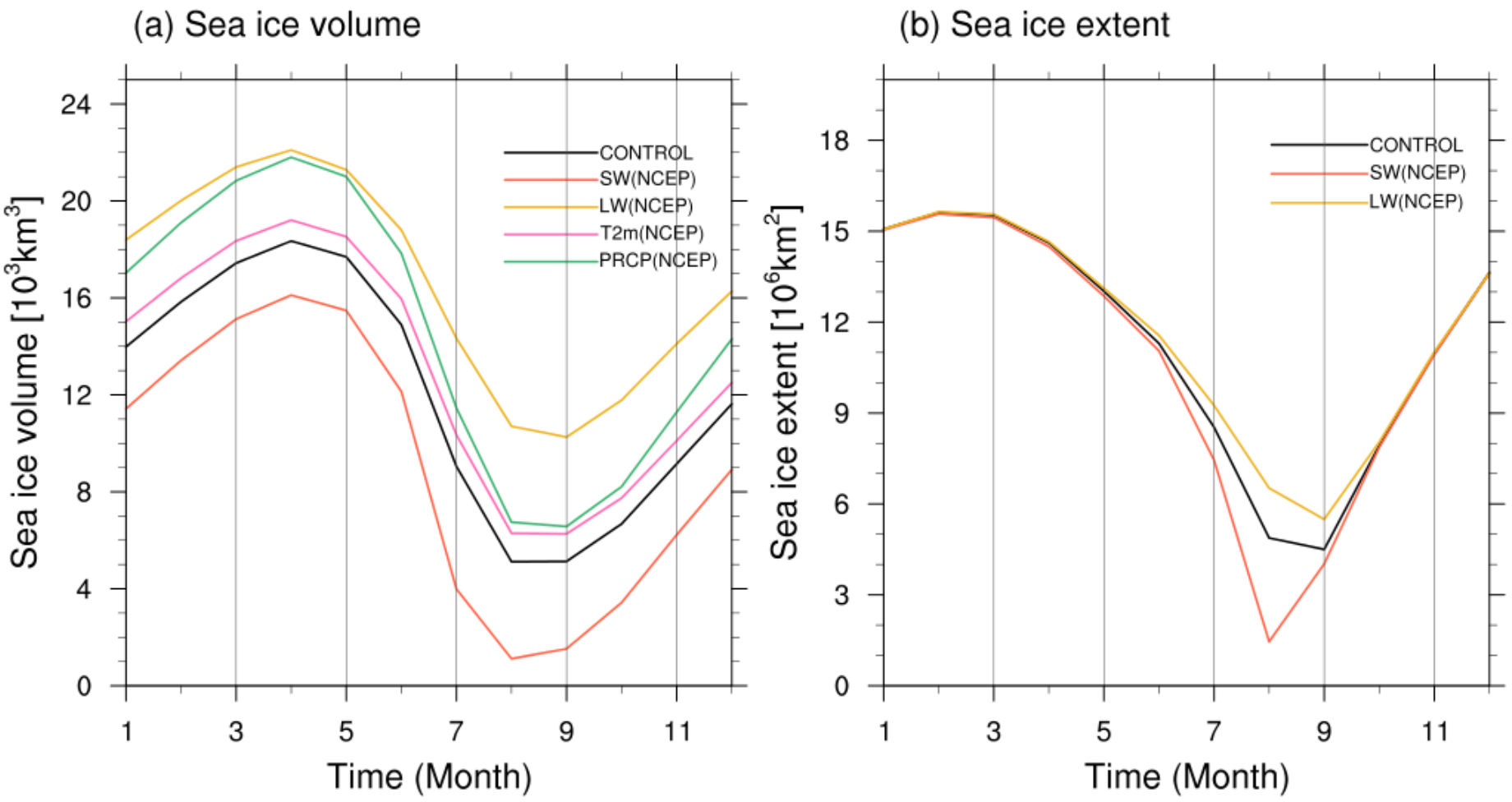
CICE5 response experiments according to atmospheric forcing

Model	Community Ice CodE (CICE) version 5.1 stand alone
Initial Condition	No ICE
Atm. Forcings	• 6 hourly : T,U,V,Q, Air Density • Monthly : Downward Longwave Radiation, Downward Shortwave Radiation, Precipitation
Ocn. Forcings	Monthly HadISST, default SSS
Integration Period	From 1982 to 2014

EXP name	Description
CONTROL	All variables from JRA-55
SW (NCEP)	Same as CONTROL except downward shortwave radiation from NCEP R2
LW (NCEP)	Same as CONTROL except downward longwave radiation from NCEP R2
T2m (NCEP)	same as CONTROL except temperature from NCEP R2
U10 (NCEP)	same as CONTROL except U and V wind from NCEP R2
PRCP (NCEP)	same as CONTROL except precipitation from NCEP R2
Q (NCEP)	same as CONTROL except surface specific humidity from NCEP R2

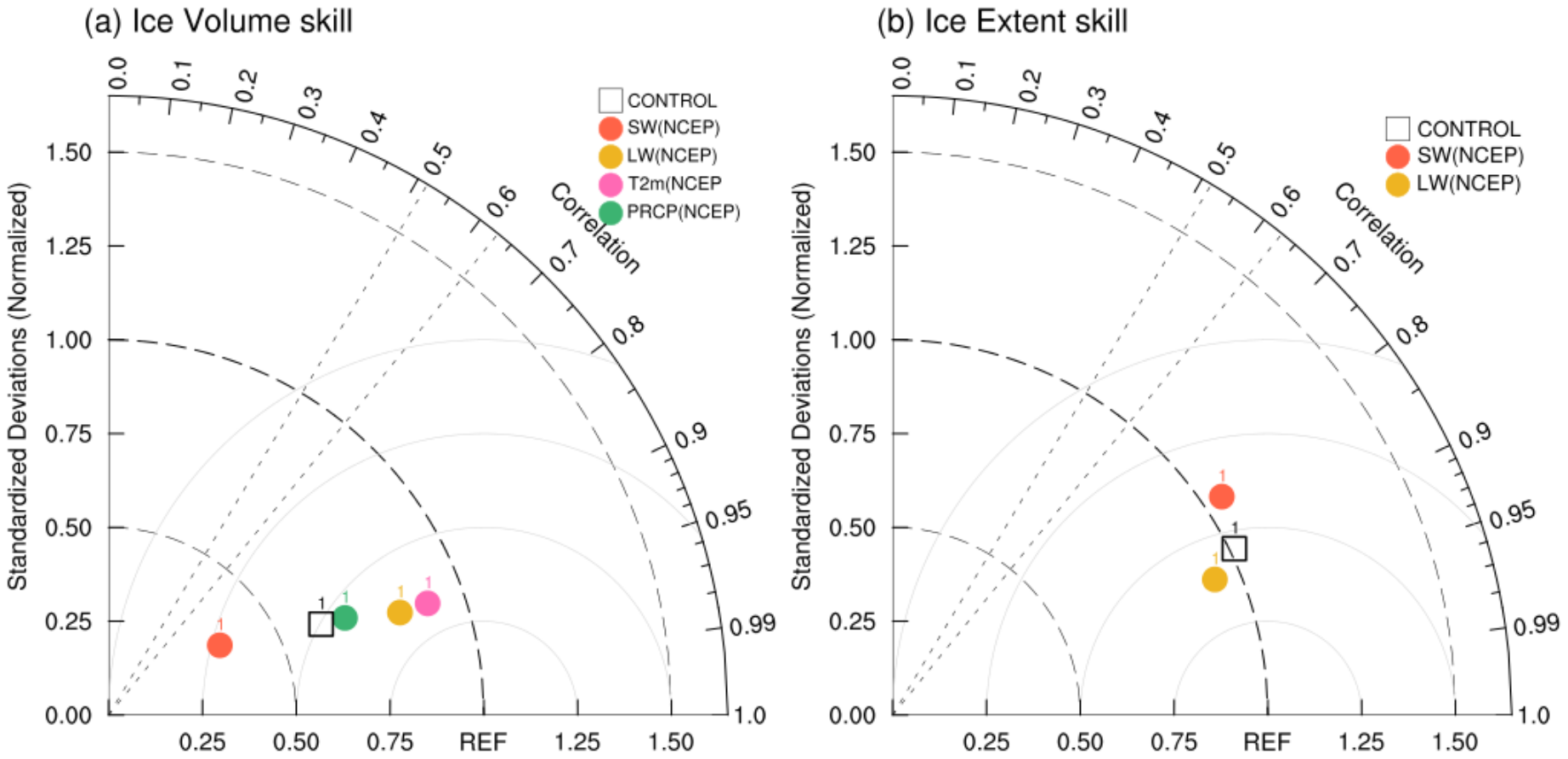
Impact of atmospheric forcing on the sea ice model

Mean



Impact of atmospheric forcing on the sea ice model

Variability



Taylor diagram of (a) sea ice volume and (b) sea ice extent in the Arctic region. Here, the sea ice volume of PIOMAS and the sea ice extent of NSIDC are reference points (REF) of sea ice volume and sea ice extent, respectively. The distance from zero is the normalized standard deviation and the azimuth is the correlation with the observations. The open rectangle is the CONTROL, and SW (NCEP), LW (NCEP), T2m (NCEP), and PRCP (NCEP) experiments are represented by red, yellow, pink, and green circles, respectively.

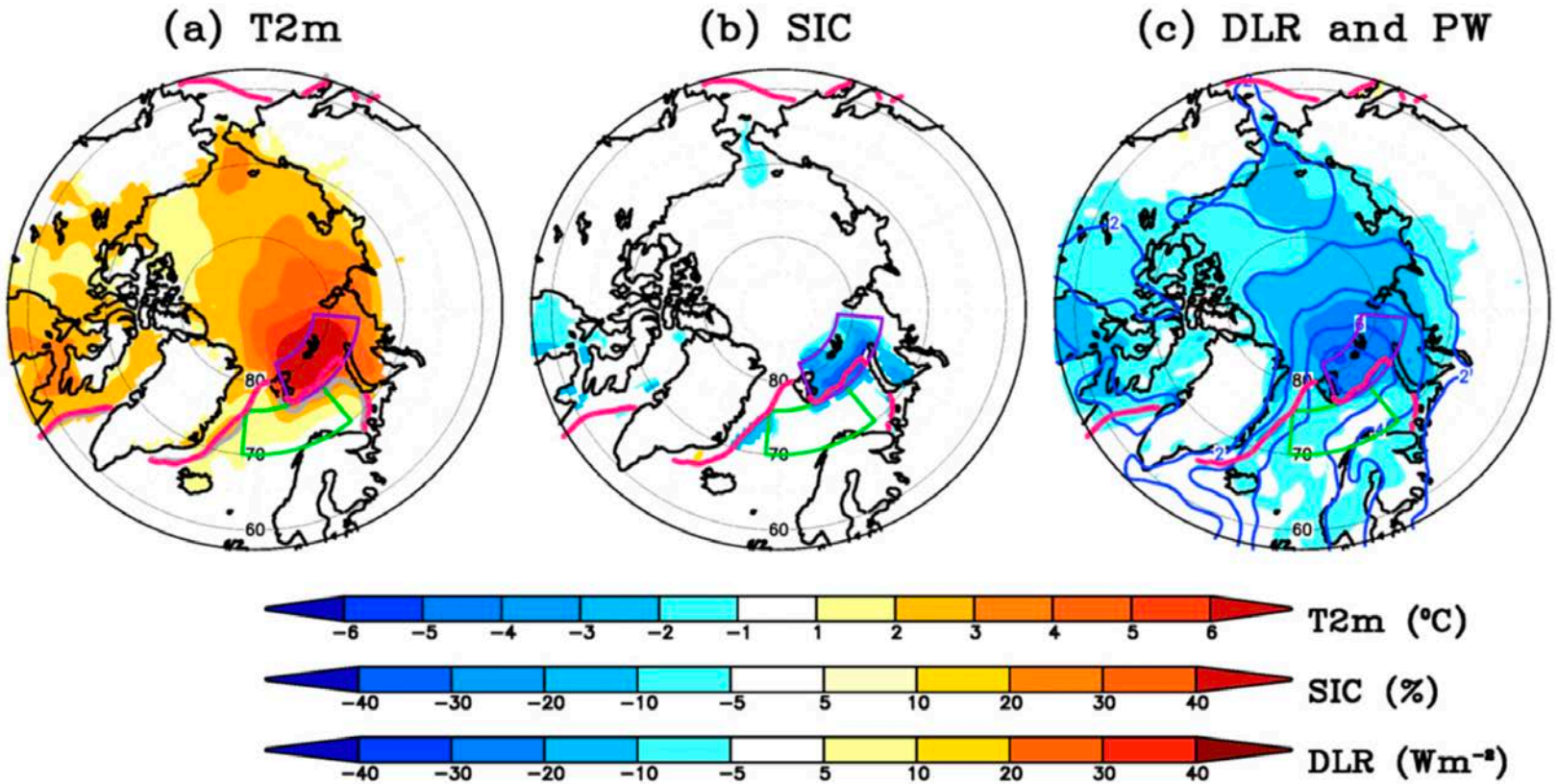


FIG. 2. Warm year composite of anomalous (a) T_{2m} (°C), (b) SIC (%), and (c) DLR (shading; W m^{-2}) and PW (blue contours, with 2 kg m^{-2} contour interval). Positive values for flux indicate upward. Only values exceeding 95% significance level are shaded in (a) and (b). Gray (magenta) contour indicates 15% SIC for climatology (warm Arctic years). Outlined boxes indicate the ice-retreat region (purple box; 76°–82°N, 20°–85°E) and open water region (green box; 70°–76°N, 5°W–40°E).

Kim & Kim (2017, JC)

Summary

- KOPRI is currently studying CICE5 model's response to various atmospheric forcings.
- Reanalysis dataset which is commonly used as forcing data for conventional sea-ice model is highly uncertain especially in the Arctic region.
- In a series of sensitivity experiments, we find that longwave radiation is one of dominant controlling factor for Arctic sea-ice.
- In spite of the importance, unfortunately, we find that longwave radiation is one of most uncertain variable among those variables.
- KOPRI has a plan for measuring in-situ longwave radiation at ARAON and validate CICE5 model's performance over PAG sector in next year.


Thank you