

Sea ice plays a fundamental role in the polar environment, by influencing *air-ice* and *ice-sea exchange*, *atmospheric and oceanic processes*, and *climate change*. *Large inter-model spread* exists in the performance of sea ice simulations. *Systematic projections and evaluations* on sea ice simulations are needed.

*Want to quantify the bias in sea ice simulations?*

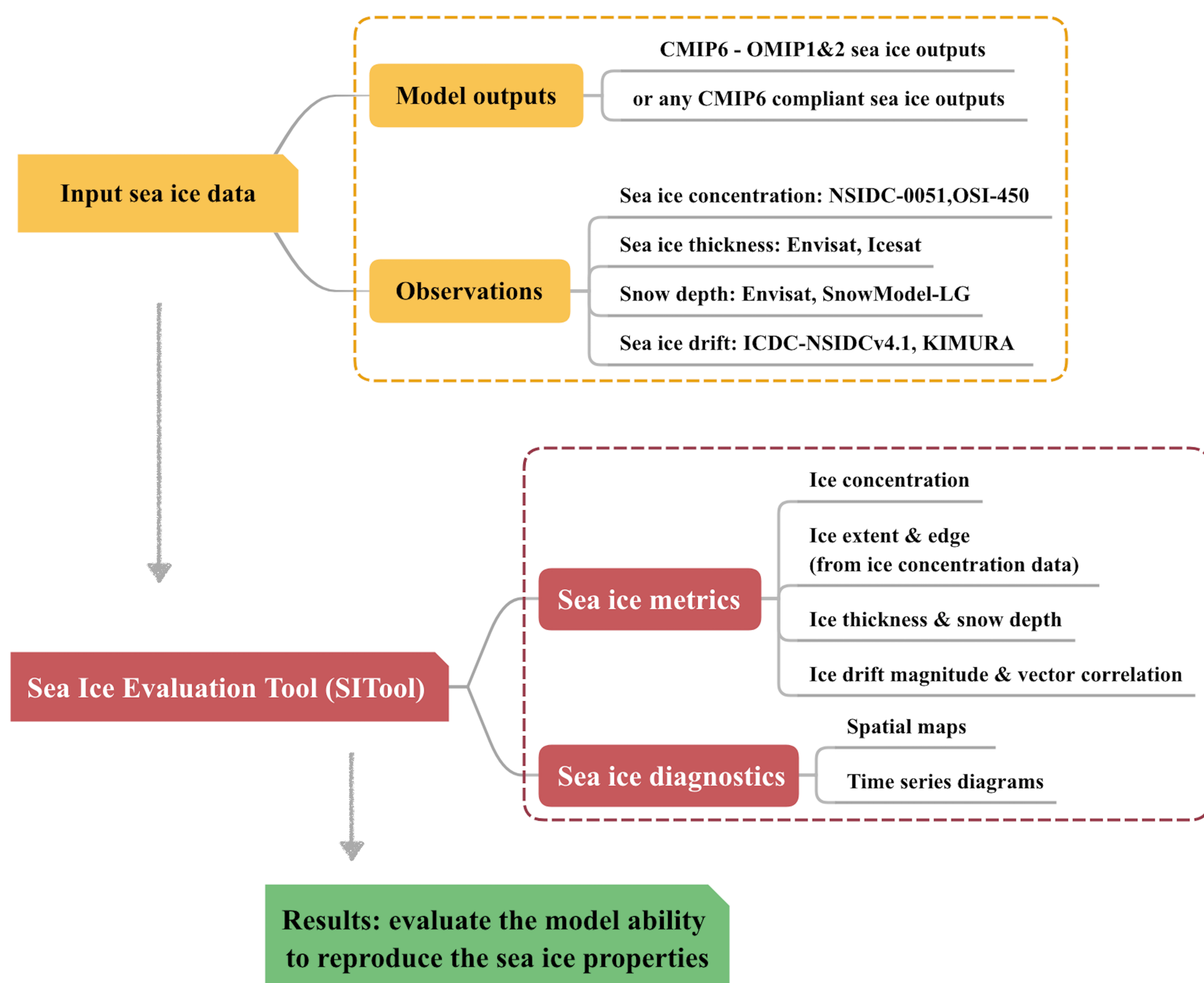
*Want to track performance across different model versions?*

Try SITool released on the GitHub (open-access): <https://github.com/XiaLinUCL/Sea-Ice-Evaluation-Tool>

A performance metrics and diagnostics tool developed to evaluate the skill of Arctic and Antarctic model reconstructions of sea ice concentration, extent, edge location, drift, thickness, and snow depth.



### 1 The concept of the SITool



### 2 The methods in SITool

#### 1) Absolute errors at each grid cell (1980–2007)

**Mean:** → monthly mean over 12 months (Meandiff)

**Interannual variability/trend:** monthly anomalies

→ standard deviation (SDdiff)/linear regression (Trenddiff)

#### 2) Average spatially weighted by grid cell areas

#### 3) Scaled by typical errors (absolute difference between two observations)

$$\text{Meandiff} = \frac{\sum_{n=1}^{n=12} \left[ \frac{\sum_{i=1}^{i=N} |C_{0M}^i - C_{1M}^i| \times A_i}{\sum_{i=1}^{i=N} A_i} \right] \times D_n}{\sum_{n=1}^{n=12} D_n} \quad (1)$$

$$\text{SDdiff} = \frac{\sum_{i=1}^{i=N} |SD(C_0^i - C_{0M}^i) - SD(C_1^i - C_{1M}^i)| \times A_i}{\sum_{i=1}^{i=N} A_i} \quad (2)$$

$$\text{Trenddiff} = \frac{\sum_{i=1}^{i=N} |\text{trend}(C_0^i - C_{0M}^i) - \text{trend}(C_1^i - C_{1M}^i)| \times A_i}{\sum_{i=1}^{i=N} A_i} \quad (3)$$

$n$  (months);  $i$  (grid cells);  $C_{0M}, C_{1M} / C_0, C_1$  (two monthly mean/monthly ice concentration);  $A$  (grid cell area);  $D$  (days in each month).

### 3 Application to CMIP6 OMIP

#### SITool provides metrics and diagnostic maps

##### 3.1 Sea ice concentration

###### Metrics:

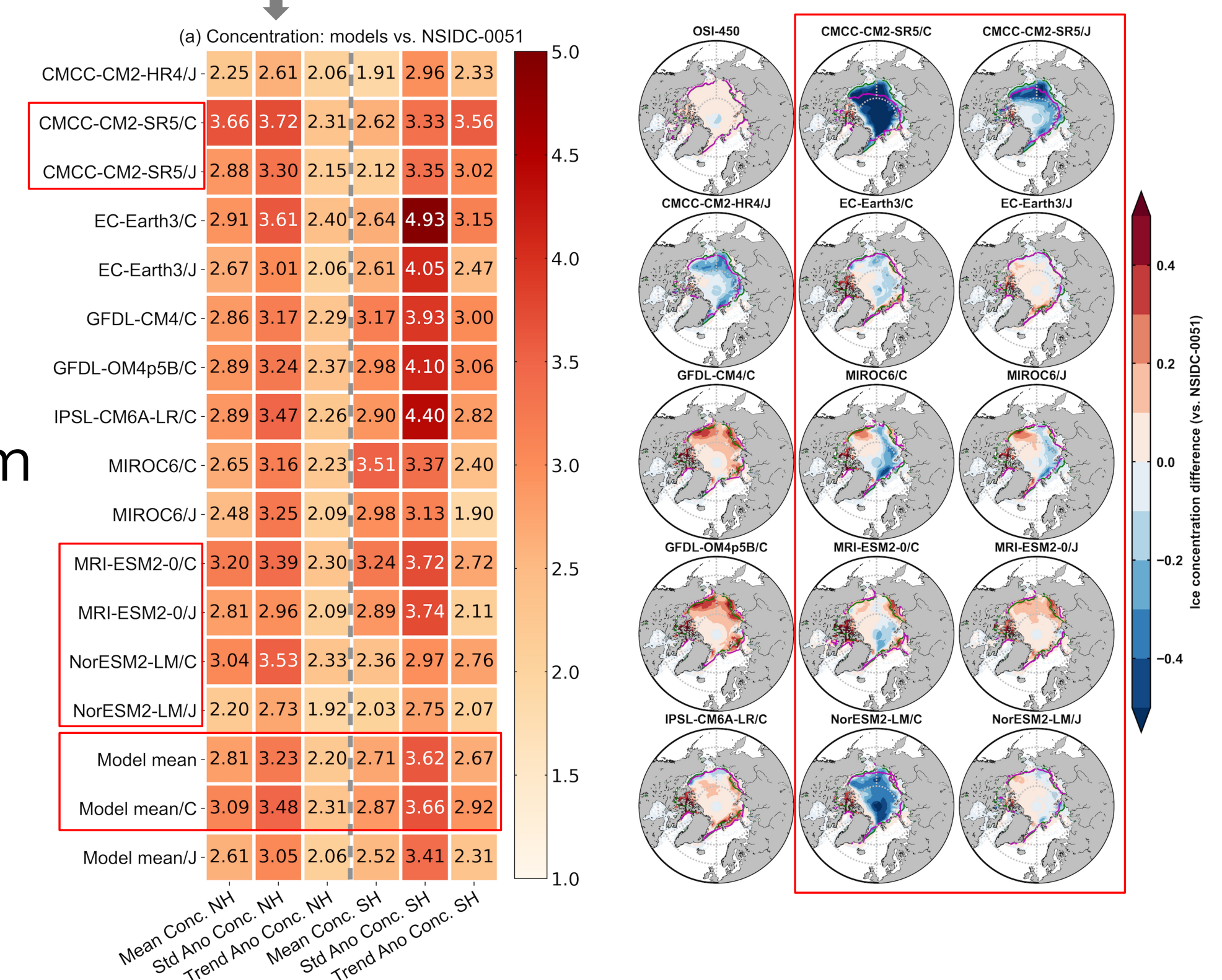
Lower values → better skill

1) Model errors

>> observational uncertainty

2) Improved simulations from OMIP1 (CORE-II) to OMIP2 (JRA55-do)

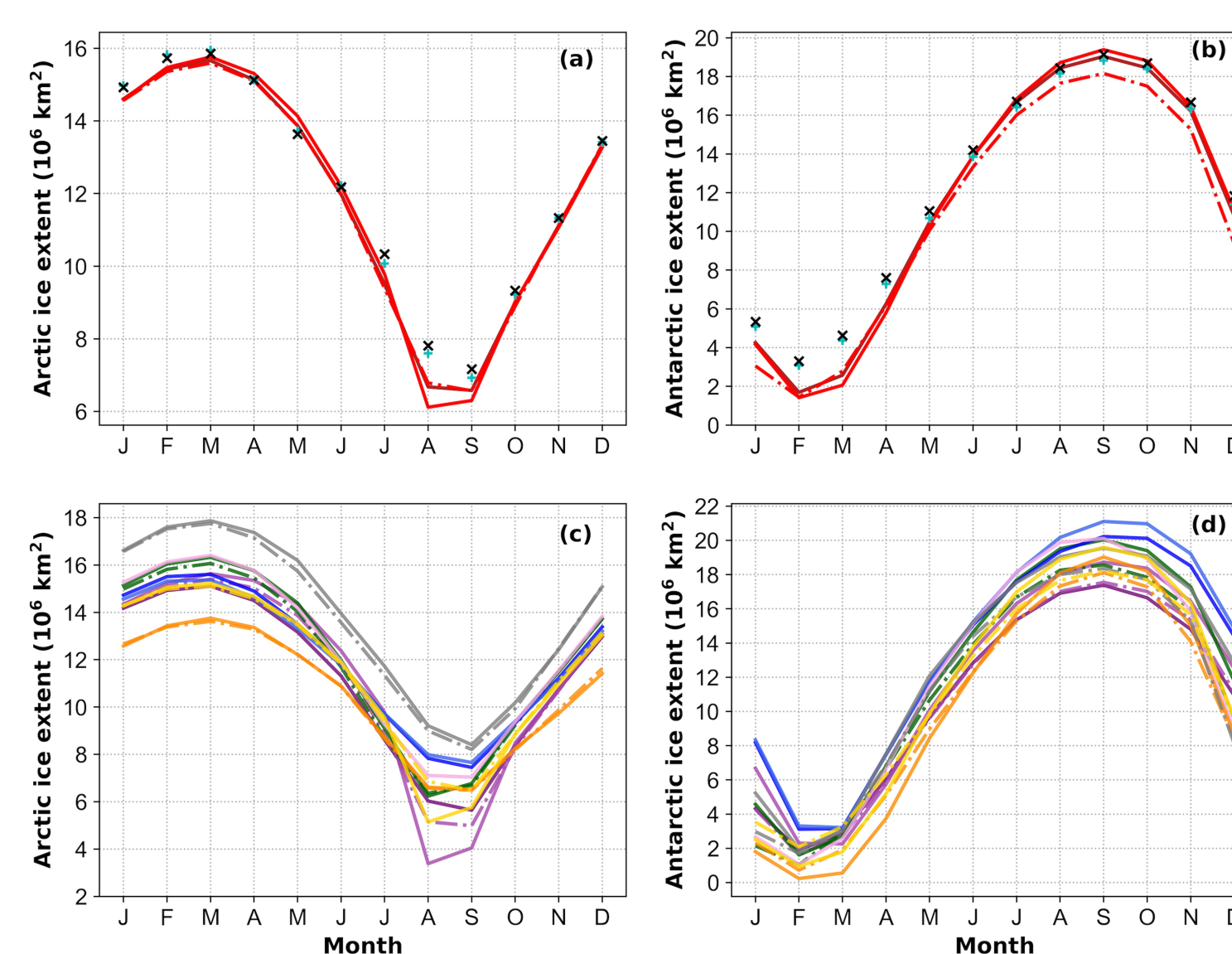
3) Lower skill on the ice concentration variability



###### Diagnostic maps:

Reduced negative bias of summer Arctic ice concentration in OMIP2

##### 3.2 Sea ice extent

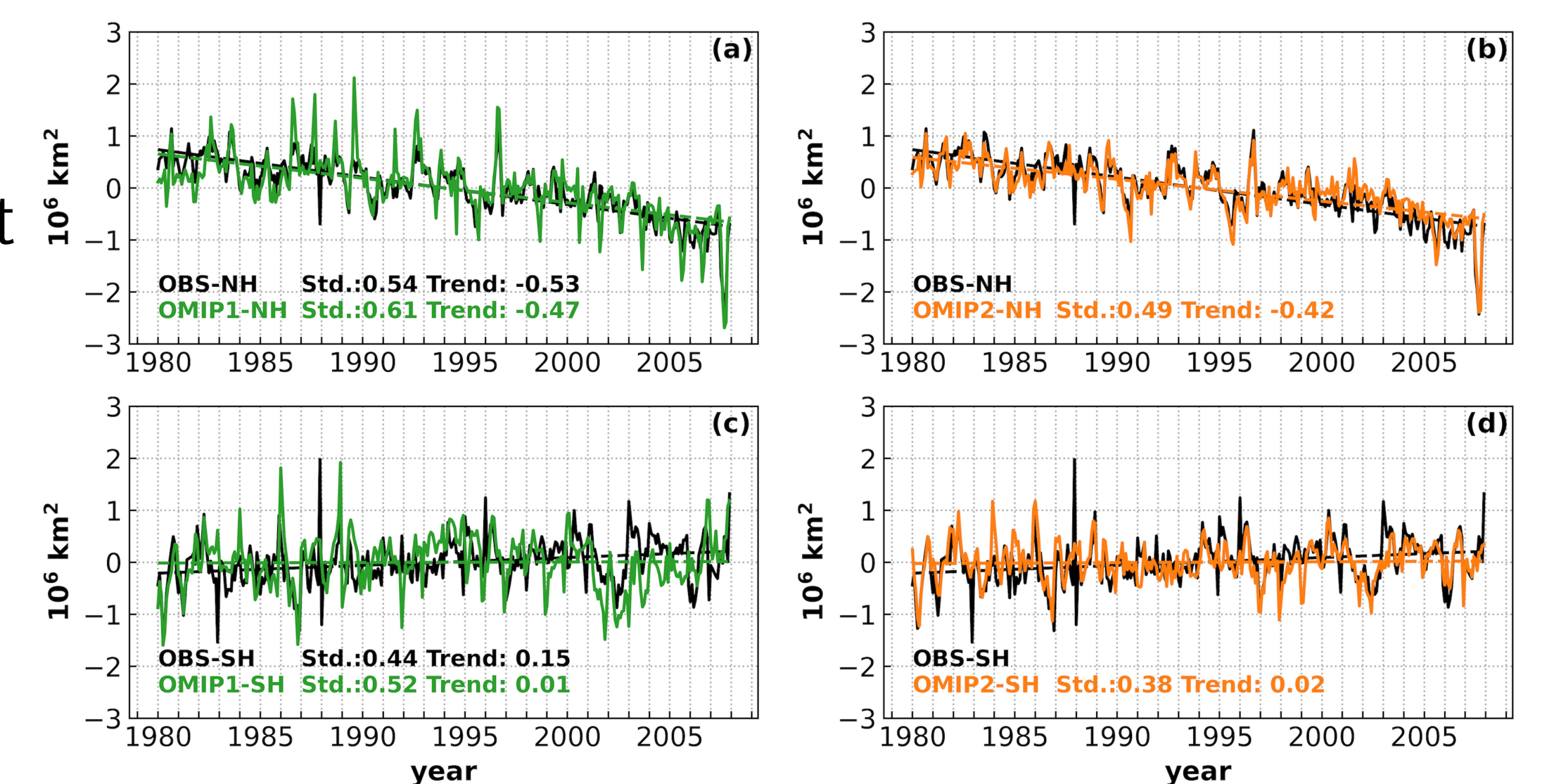


Ice extent: total area of grid cells with the ice concentration above 15%

–negative ice extent biases in the summer reduced in OMIP2

Model mean ice extent monthly anomalies;

–large bias reduced under OMIP2



Any comments/questions? Get in touch! [xia.lin@uclouvain.be](mailto:xia.lin@uclouvain.be)

Find more information on the sea ice edge location, drift, thickness and snow depth in Lin et al. (2021).

Xia Lin, François Massonnet, Thierry Fichefet and Martin Vancoppenolle, SITool (v1.0) – a new evaluation tool for large-scale sea ice simulations: application to CMIP6 OMIP. Geosci. Model Dev., 14, 1–24, 2021.

