SITool (v1.0)
An evaluation tool for large-scale sea ice model simulation

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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
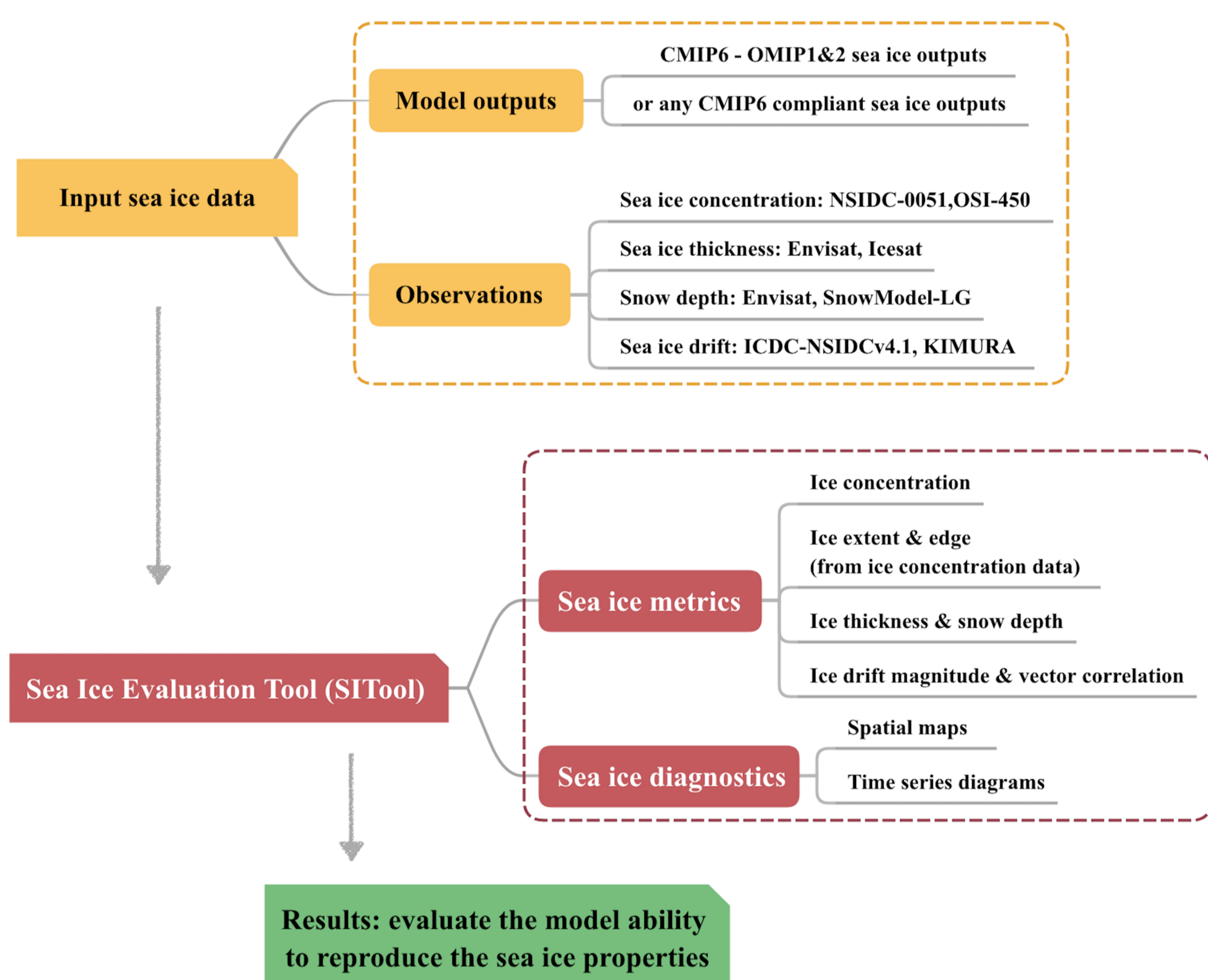
2 The methods in SITool

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)

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

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

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

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
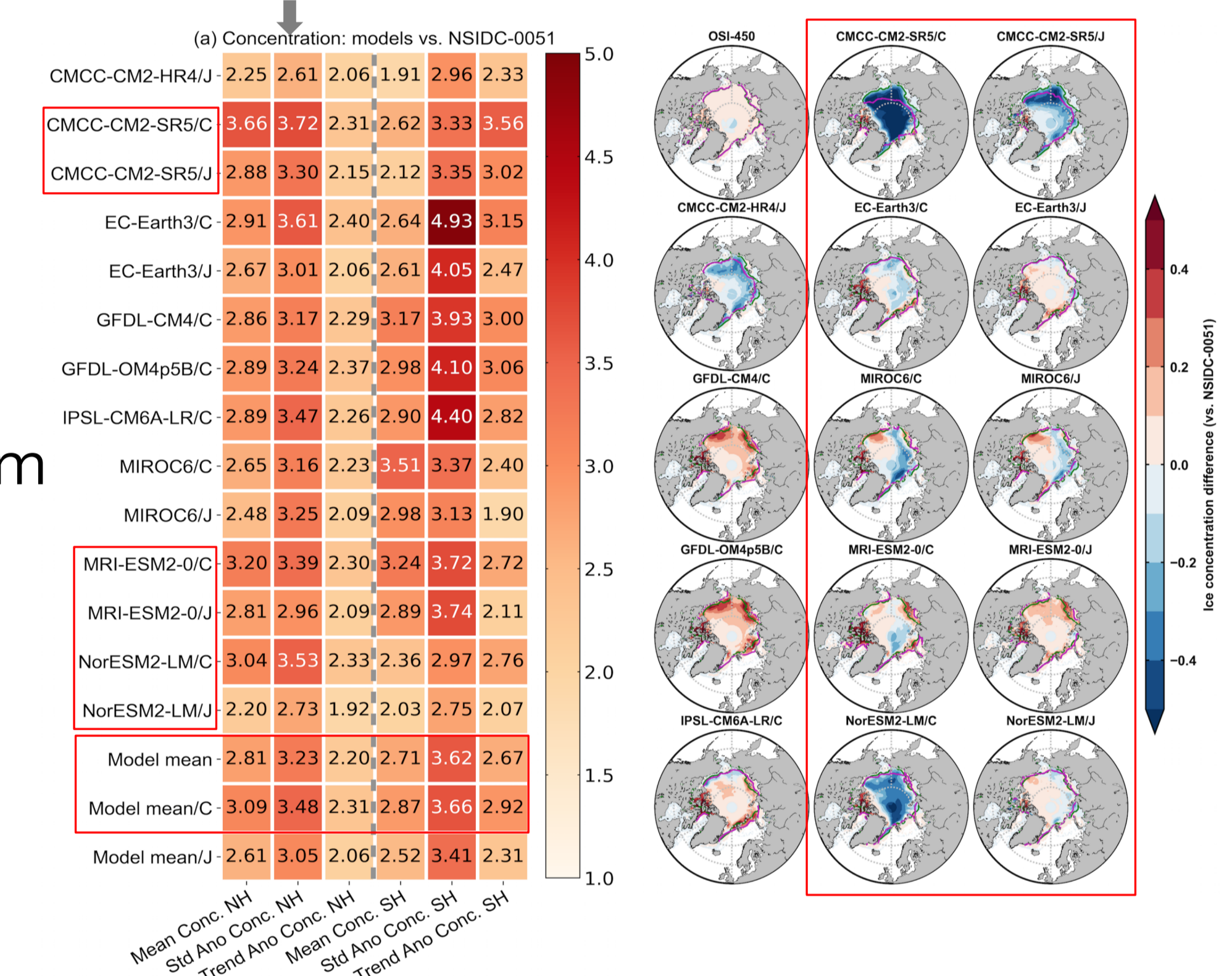
3.1 Sea ice concentration

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

|	Mean Conc. NH	Std Ano Conc. NH	Trend Ano Conc. NH	Mean Conc. SH	Std Ano Conc. SH	Trend Ano Conc. SH
CMCC-CM2-HR4/J	2.25	2.61	2.06	1.91	2.96	2.33
CMCC-CM2-SR5/C	3.66	3.72	2.31	2.62	3.33	3.56
CMCC-CM2-SR5/J	2.88	3.30	2.15	2.12	3.35	3.02
EC-Earth3/C	2.91	3.61	2.42	2.64	4.93	3.15
EC-Earth3/U	2.67	3.01	2.06	2.61	4.05	2.47
GFDL-CM4/C	2.86	3.17	2.29	3.17	3.93	3.00
GFDL-OM4p5B/C	2.89	3.24	2.37	2.98	4.10	3.06
IPSL-CM6A-LR/C	2.89	3.47	2.26	2.90	4.40	2.82
MIROC6/C	2.65	3.16	2.23	3.51	3.37	2.40
MIROC6/J	2.48	3.25	2.09	2.98	3.13	1.90
MRI-ESM2-0/C	3.20	3.39	2.30	3.24	3.72	2.72
MRI-ESM2-0/J	2.81	2.96	2.09	2.89	3.74	2.11
NorESM2-LM/C	3.04	3.53	2.33	2.36	2.97	2.76
NorESM2-LM/J	2.20	2.73	1.92	2.03	2.75	2.07
Model mean	2.81	3.23	2.20	2.71	3.62	2.67
Model mean/C	3.09	3.48	2.31	2.87	3.66	2.92
Model mean/J	2.61	3.05	2.06	2.52	3.41	2.31

Diagnostic maps:
Reduced negative bias of summer Arctic ice concentration in OMIP2

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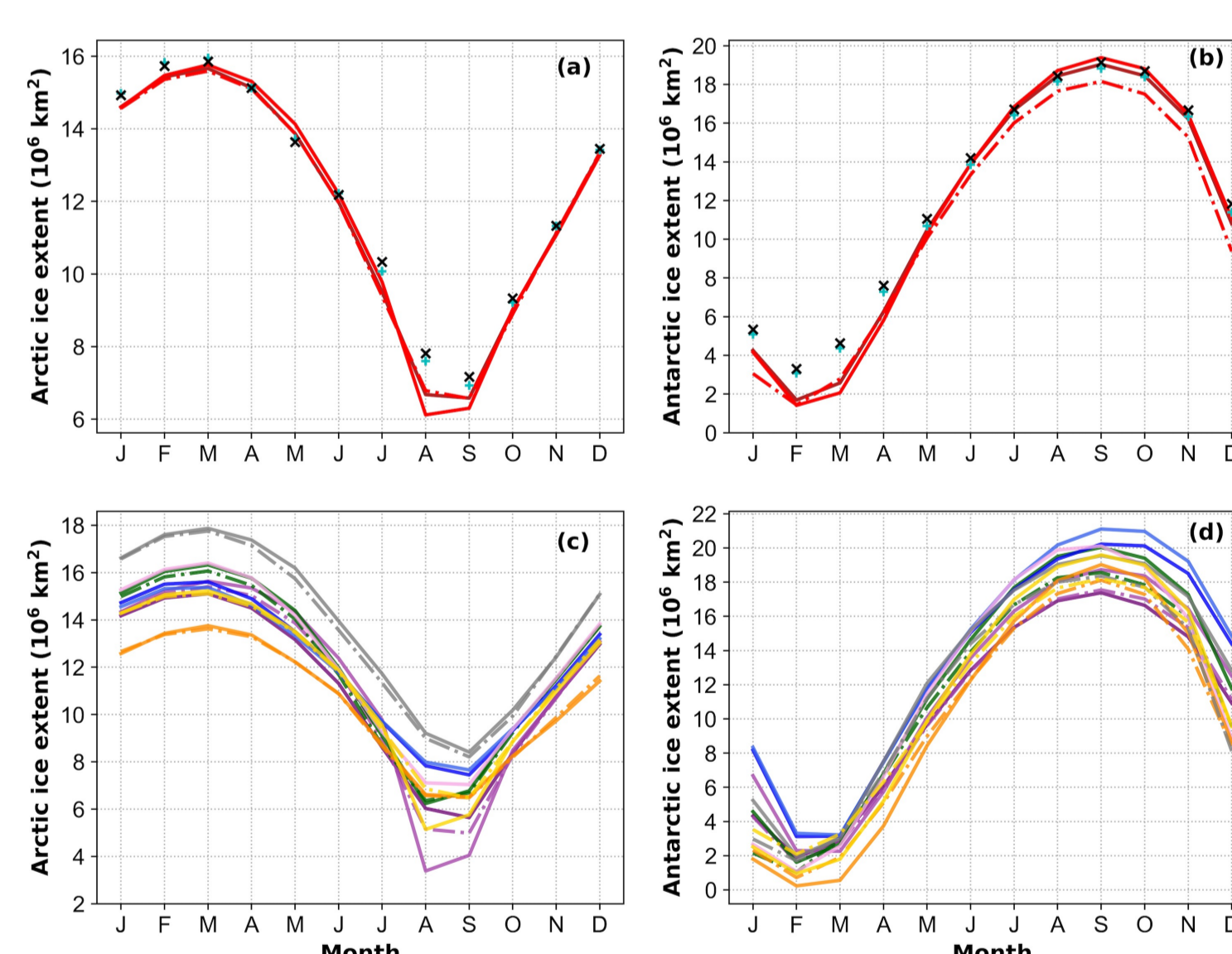
Ice extent: total area of grid cells with the ice concentration above 15%

–negative ice extent biases in the summer reduced in OMIP2
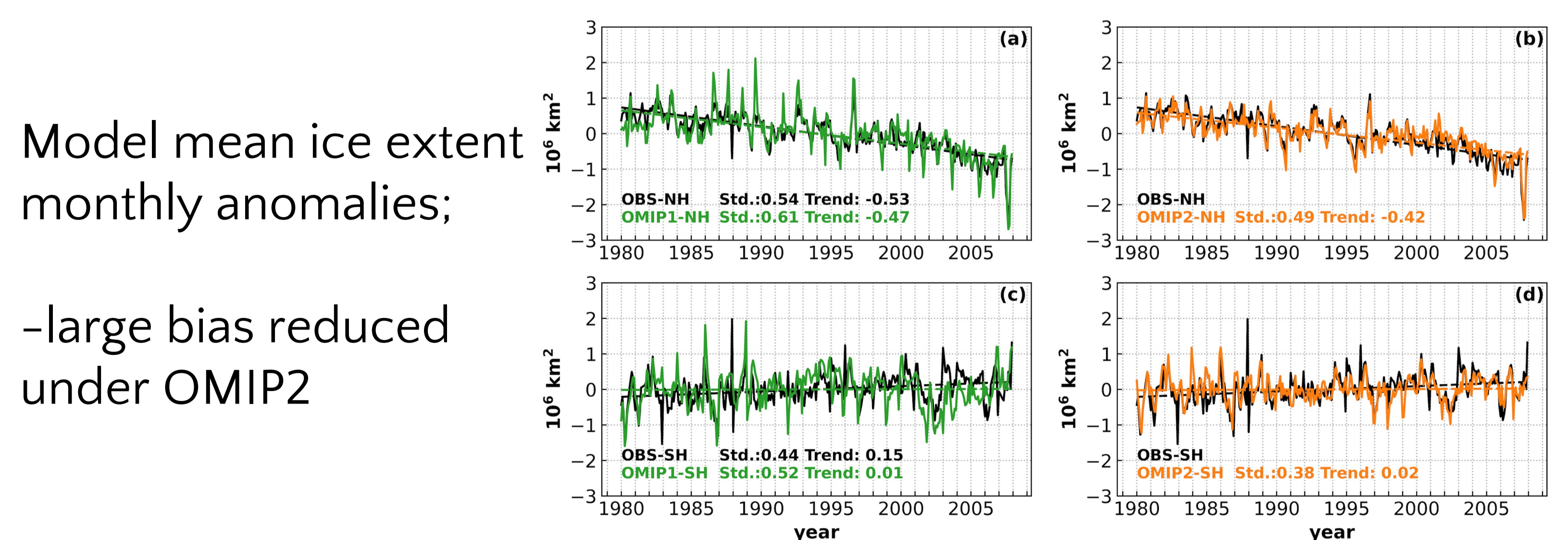
Model mean ice extent monthly anomalies;

–large bias reduced under OMIP2

Any comments/questions? Get in touch! xia.lin@uclouvain.be

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.