What is the importance of sea ice physics in global simulations at decadal time scales?

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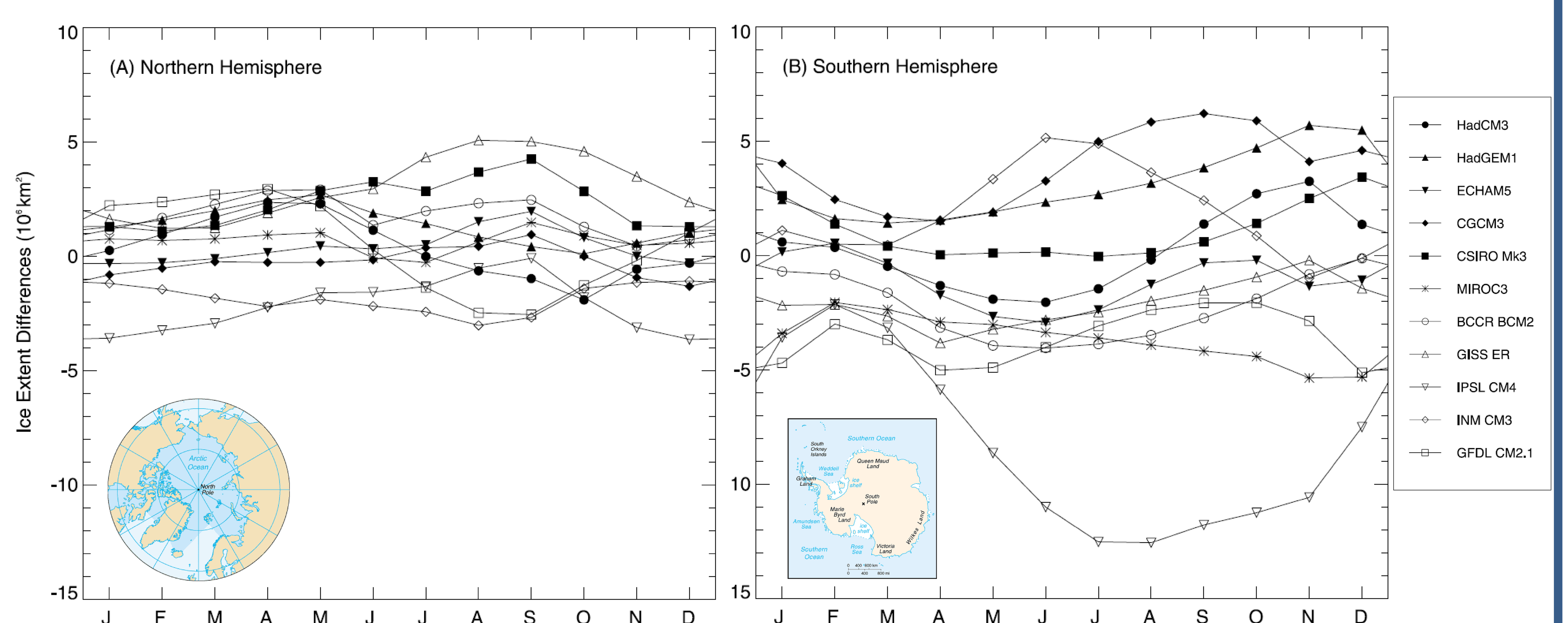
The question

Decadal simulations of sea ice with the **current General Circulation Models** (GCMs) show 3 noticeable features:

1. Large intermodel **spread**
2. Weak to strong **biases** with respect to observations
3. Remarks 1. and 2. are particularly **marked** in the **Southern Hemisphere**

This can be explained by several factors, e.g. the differences in resolution, initial conditions, and the formulation of physics in each GCM.

Here we run two almost identical simulations differing only in their sea ice component to address the **importance of sea ice physics in global, decadal simulations of sea ice.**



Difference of the mean (1979-2004) seasonal sea ice extent between 11 IPCC AR4 GCMs and satellite observations. From Parkinson et al., 2006

One answer

Experimental design

Atmospheric forcing

NCEP/NCAR atmospheric reanalyses
+ various climatologies

1° resolution
Run 1948-2007
Focus on 1983-2007

Ocean model

NEMO 3.1
www.nemo-ocean.eu

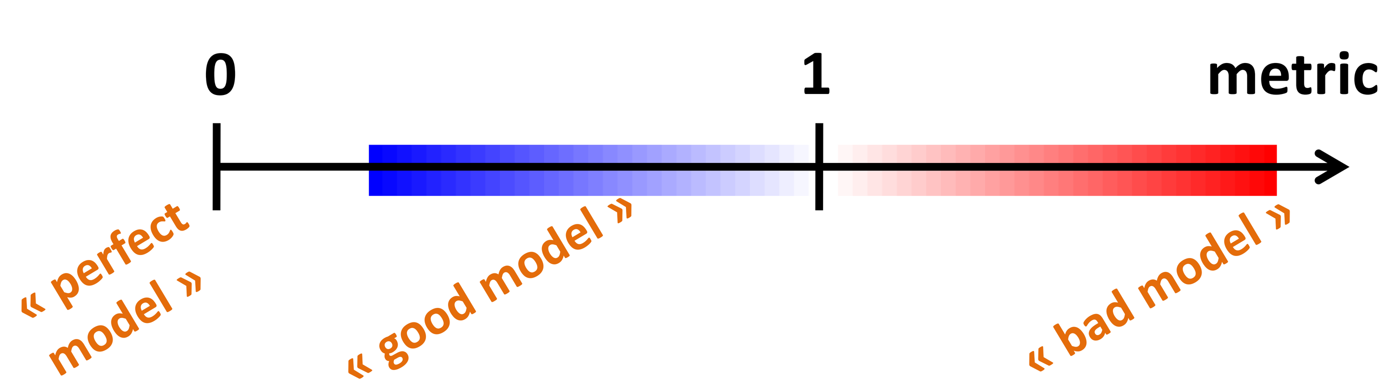
2 sea ice models

LIM2	**LIM3**
Fichefet and Morales Maqueda, 1997	*Vancoppenolle et al., 2009*
•Simple sea ice and snow thickness distribution	•Multicategory ice and snow thickness distribution
• 2+1 layers of ice and snow	• 5+1 layers of ice and snow
•Basic brine modelling	•Explicit brine and salinity distribution
•VP-rheology, B-grid	•EVP-rheology, C-grid

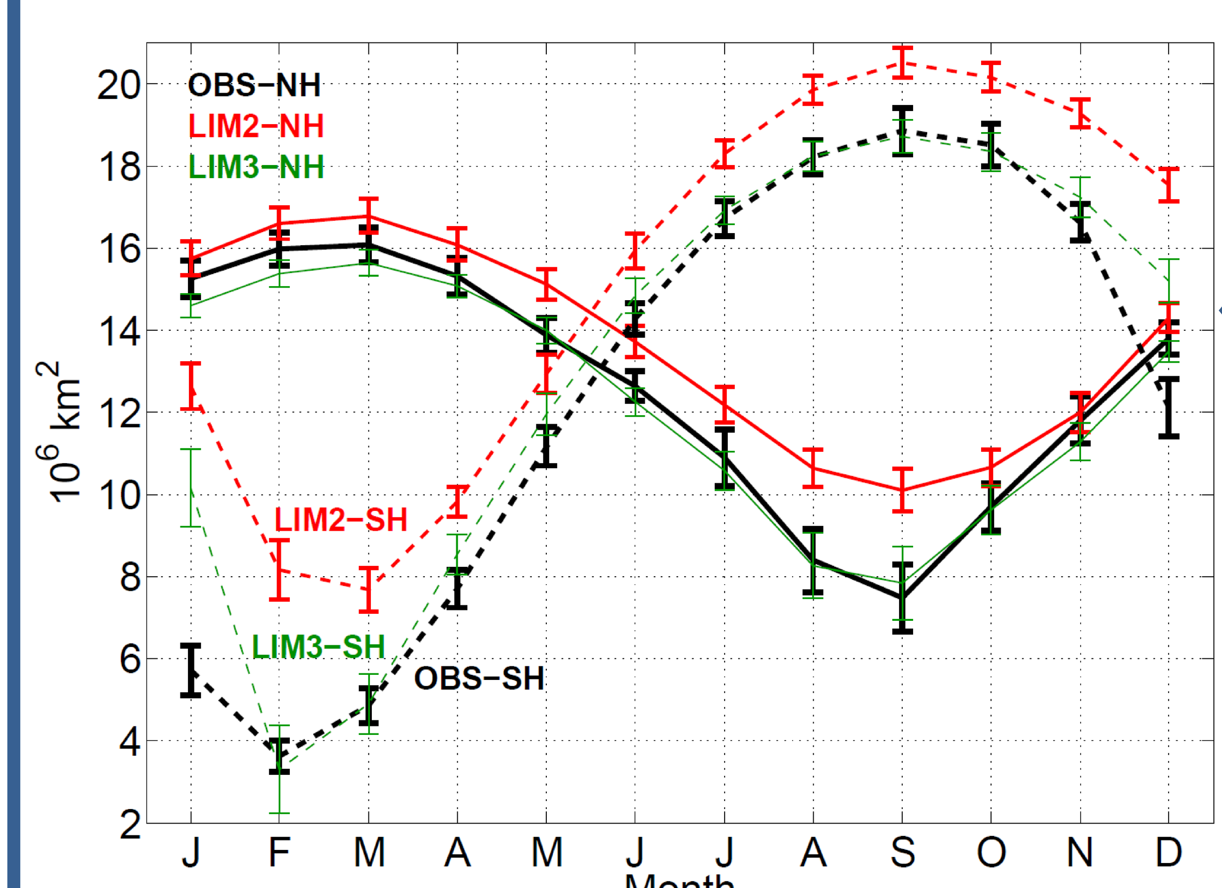
www.climate.be/lim

Performance metrics for sea ice

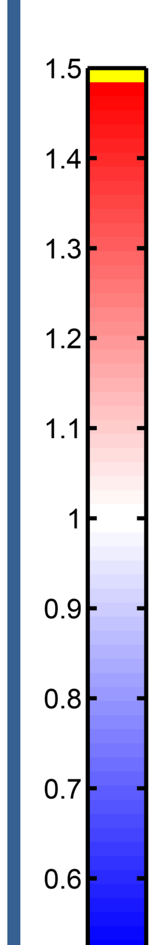
$$\textbf{metric} \overset{\text{DEF}}{=} \frac{|\textbf{model} - \textbf{obs}|}{\textbf{typical error}}$$



Results and discussion



Simulated and observed (OSISAF, 2010) **mean seasonal cycle of sea ice extent** over 1983-2007. The error bars denote ± 1 standard deviation over that period.

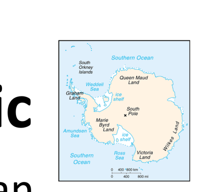


Metrics Arctic

	LIM2	LIM3	
conc.	0.97	0.79	mean
	1.03	0.77	std ano
	1.03	0.78	trend
extent	1.33	0.43	mean
	1.22	0.61	std ano
	0.23	0.46	trend
thick.	0.94	0.67	mean
	0.72	0.32	trend
drift	0.39	0.61	kin. energy
	0.86	0.76	circulation
Fram export	0.44	0.7	mean area
	0.34	0.9	std ano area
	1.14	0.82	mean vol
	0.09	0.8	std ano vol

Higher skill for LIM3 (concentration, extent, thickness)
• Effect of subgrid scale ice thickness distribution
• Importance of salinity variations

Metrics Antarctic



	LIM2	LIM3	
conc.	1.07	1.12	mean
	0.8	0.71	std ano
	0.92	0.94	trend
extent	3.58	1.17	mean
	0.48	1.1	std ano
	0.9	0.52	trend
thick.	3.22	2.45	mean
drift	1.3	1.4	kin. energy
	1.26	1.26	circulation

Lower, similar skill for both models
• Resolution
• Atmospheric forcing
• Thinner ice

References

- Parkinson et al., JGR 2006, doi:10.1029/2005JC003408
- Fichefet and Morales Maqueda, JGR 1997
-Vancoppenolle et al., Oc. Mod. 2008, doi:10.1016/j.ocemod.2008.10.005
- OSISAF, 2010, http://osisaf.met.no