

Southern Ocean freshwater initiative

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We propose a standardised Southern Ocean freshwater forcing protocol to quantify the impact of missing Antarctic meltwater on climate simulations across multiple models.

Motivation

Antarctic ice sheets and shelves are melting, adding meltwater to the Southern Ocean and changing the ocean circulation. Antarctic meltwater stratifies the upper ocean, resulting in cooling of the surface Southern Ocean (Fig.1), but warming at depth that could accelerate ice shelf melting.

Coupled climate models used to project 21st Century climate do not represent ice sheets or shelves, neglecting important climate impacts.

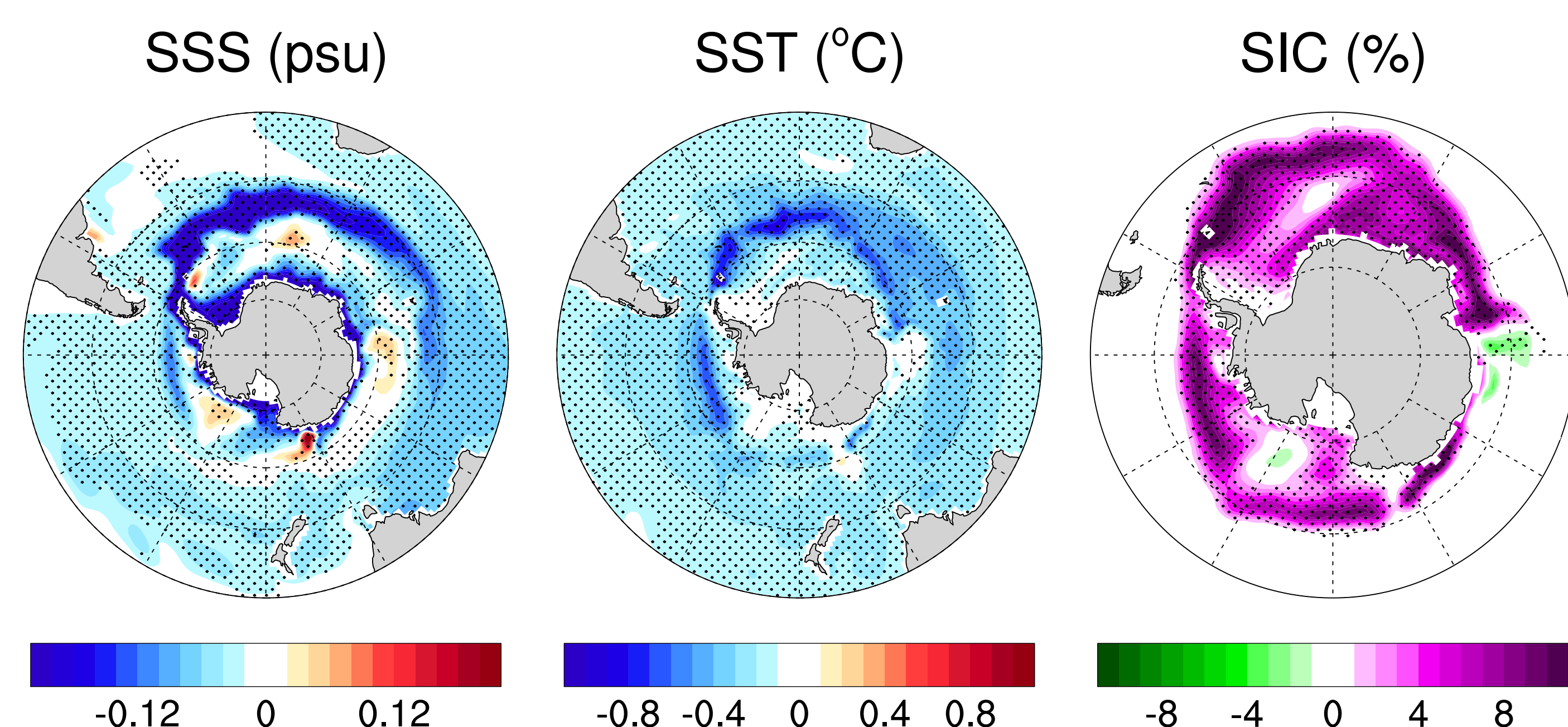


Figure 1: Anomalies from five 100-year ACCESS-ESM1.5 antwater runs, relative to the 1000-year piControl run.

Studies examining the role of Southern Ocean surface freshening in contributing to Antarctic sea ice trends reached conflicting conclusions due to different experimental designs and models used (Bintanja et al. 2013, 2015; Swart and Fyfe 2013; Pauling et al. 2016, 2017; Purich et al. 2018; Rye et al. 2020). A standardised meltwater intercomparison is needed to better understand the global climate response to Antarctic meltwater additions.

Objectives

The Southern Ocean freshwater release model experiment initiative (SOFIA) will address gaps in our understanding of the climate response to Antarctic meltwater, forcing uncertainty and model uncertainty.

Freshwater protocol

We describe protocols for coupled models to maximise participation and to provide distinct pieces of information:

Tier	Experiment	Freshwater forcing
1	antwater	constant 0.1 Sv
2	hist-antwater	0.1, 0.3, 0.5, 1.1 x 10 ⁻³ Sv y ⁻¹ ramps
	ssp126-ismip6	ISMIP6 SSP126 basal melt
	ssp585-ismip6	ISMIP6 SSP585 basal melt
3	60Swater	constant 0.1 Sv south of 60°S
	antwater-lh	constant 0.1 Sv with latent heat

Freshwater anomalies are applied at the ocean surface in the grid cell adjacent to the Antarctic coast.

Preliminary results

Tier 1 output is available for six coupled models, including **ACCESS-ESM1.5**. Preliminary analysis is underway (Fig. 2).

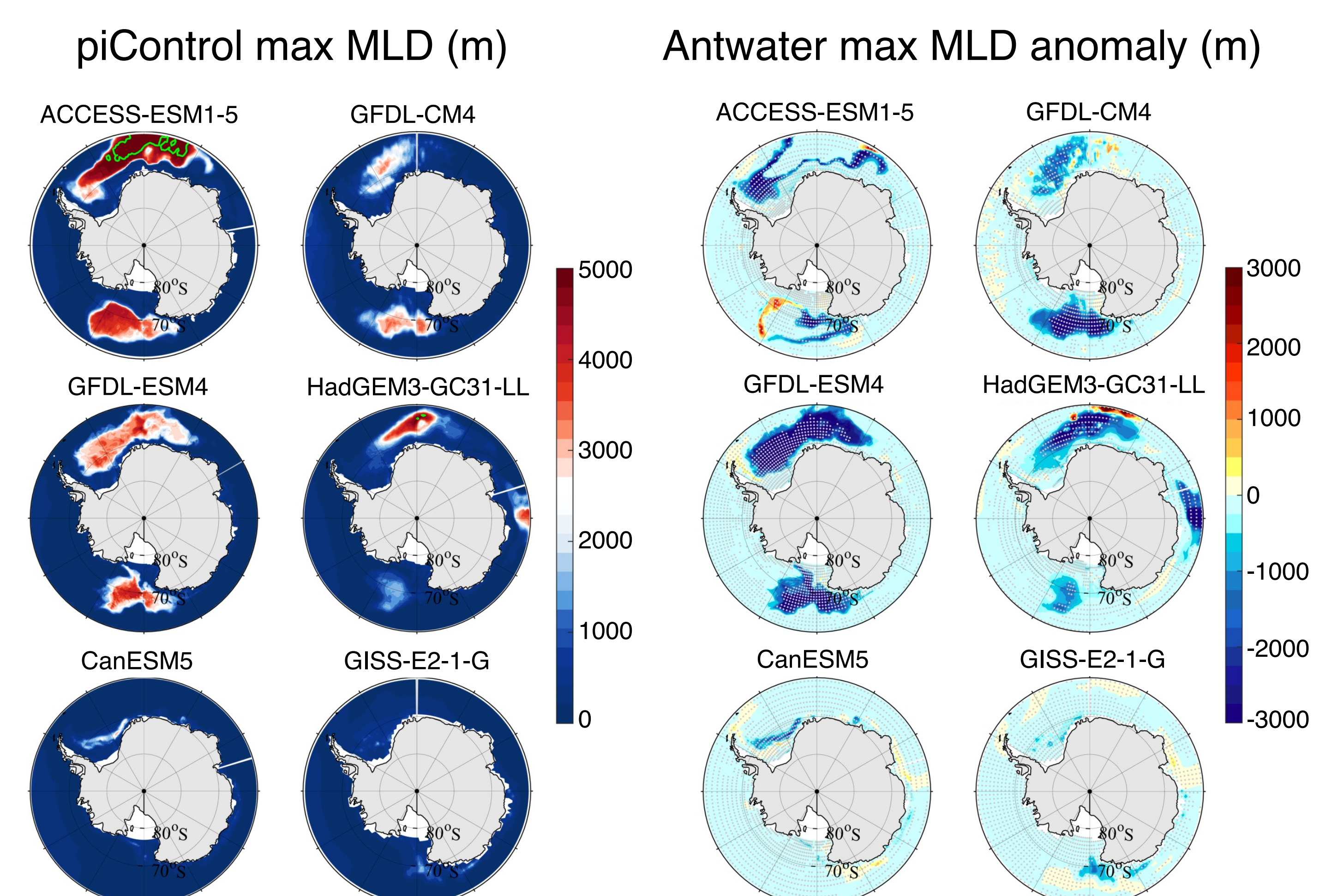


Figure 2: Maximum MLD climatologies and antwater anomalies for six models participating in the freshwater initiative (from Jia-Jia Chen).

This standardised meltwater model comparison will improve our understanding of how Antarctic meltwater will influence 21st Century ocean circulation and climate.