IBS Center
for Climate Physics

Estimating Antarctic Ice Sheet Contributions to Future Sea Level Rise Using a Coupled Climate-Ice Sheet Model

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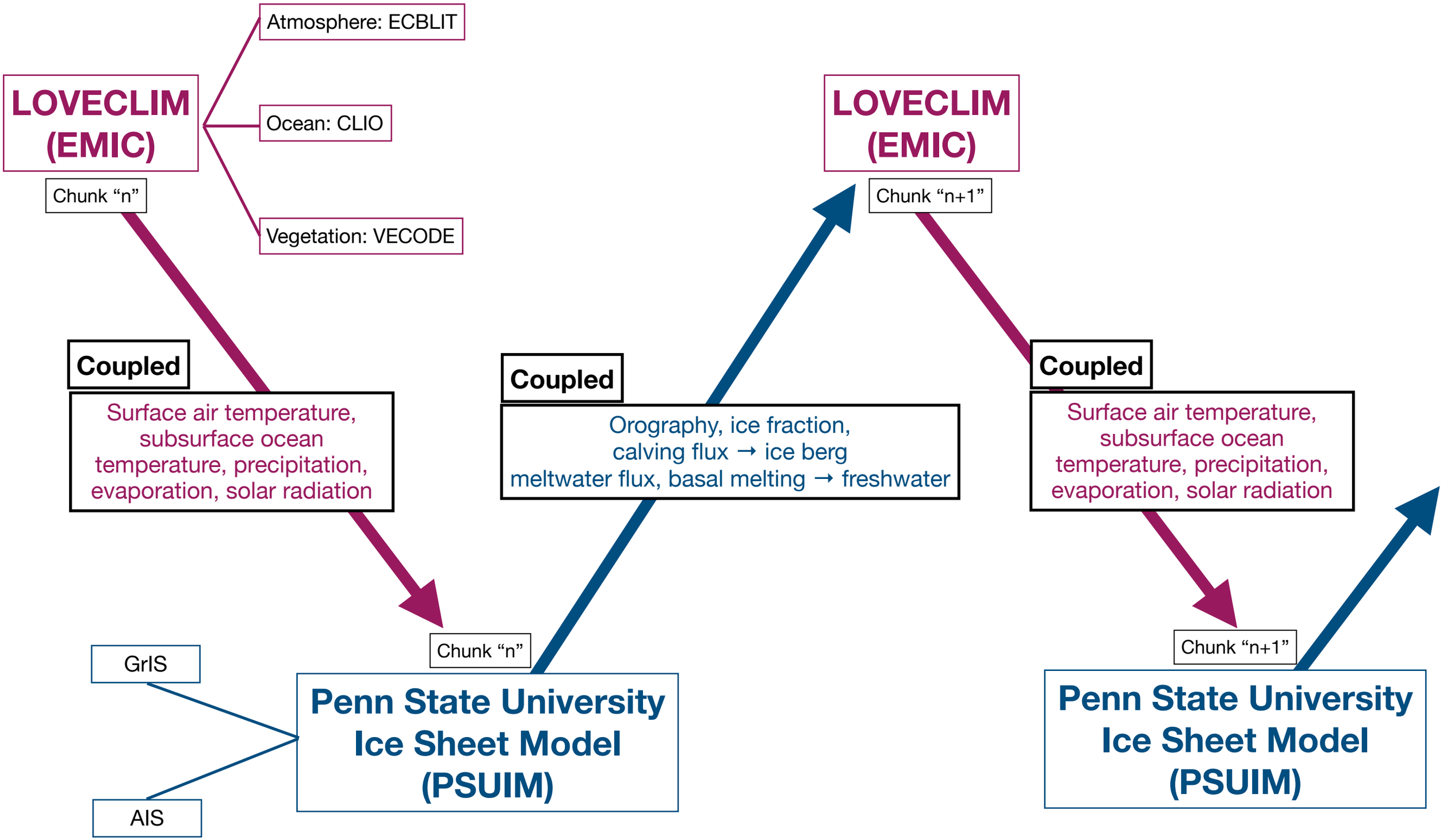
Motivation

- One of the largest uncertainties in projecting future global mean sea level (GMSL) rise in response to anthropogenic global warming originates from the Antarctic ice sheet (AIS) contribution.

- However, crucial climate-ice sheet interactions and feedbacks can only be modeled by using bi-directionally coupled global climate-ice sheet models.

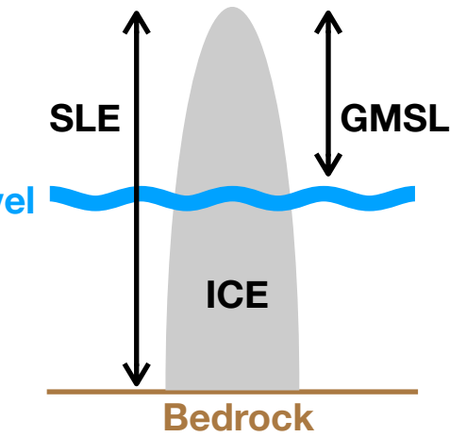
- Here, we explore future GMSL projections using a three-dimensional coupled climate-ice sheet model (LOVECLIP) that simulations ice sheet dynamics in both hemisphere forced by increasing CO_2 concentrations following the Shared Socioeconomic Pathway (SSP) 1-1.9, 2-4.5 and 5-8.5 scenarios.

Coupling algorithm of LOVECLIP

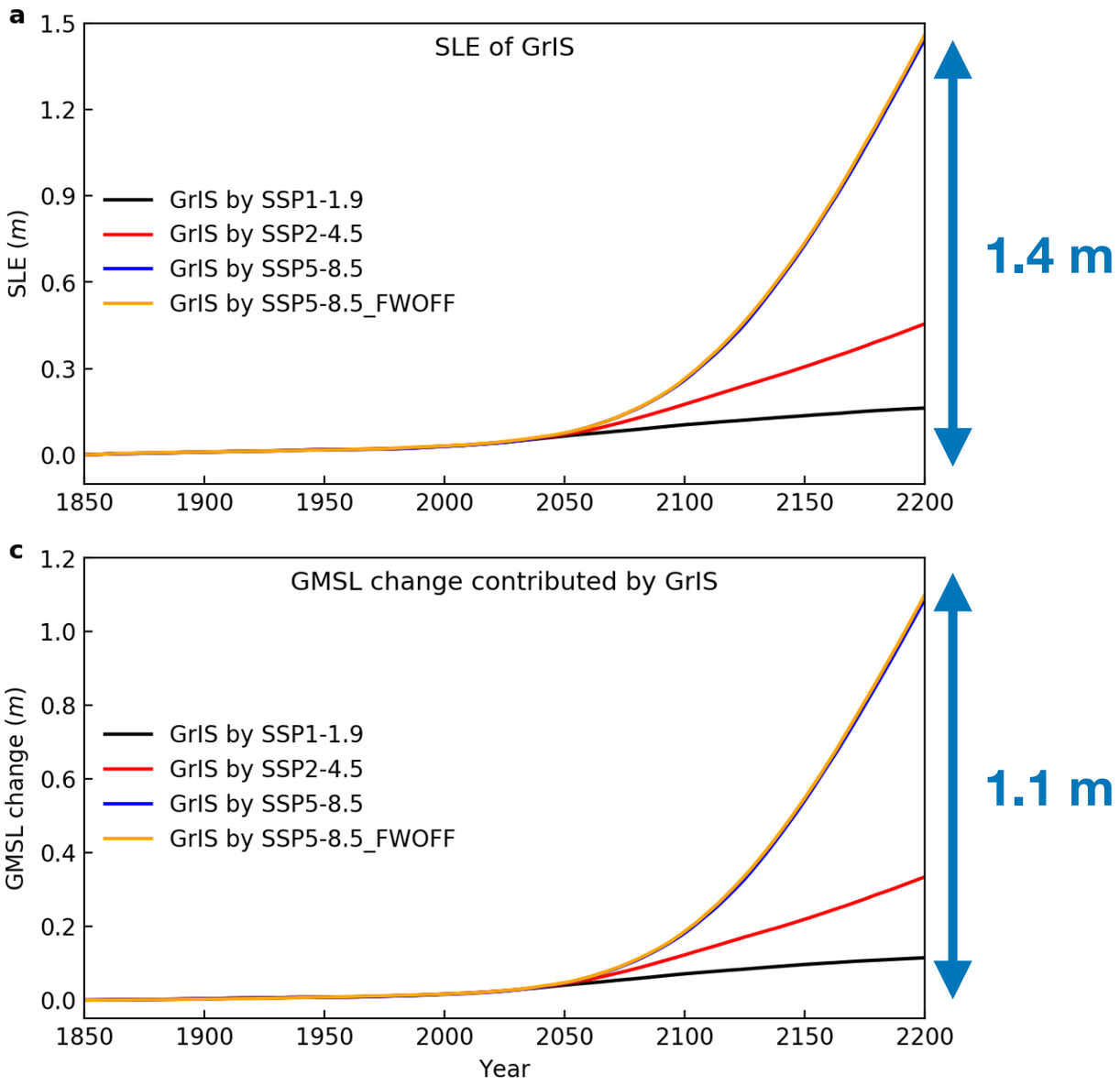


• LOVECLIP exchanges variables and boundary conditions between LOVECLIM and Penn State University Ice Sheet Model (PSUIM).

Sea level equivalent (SLE) and GMSL rise

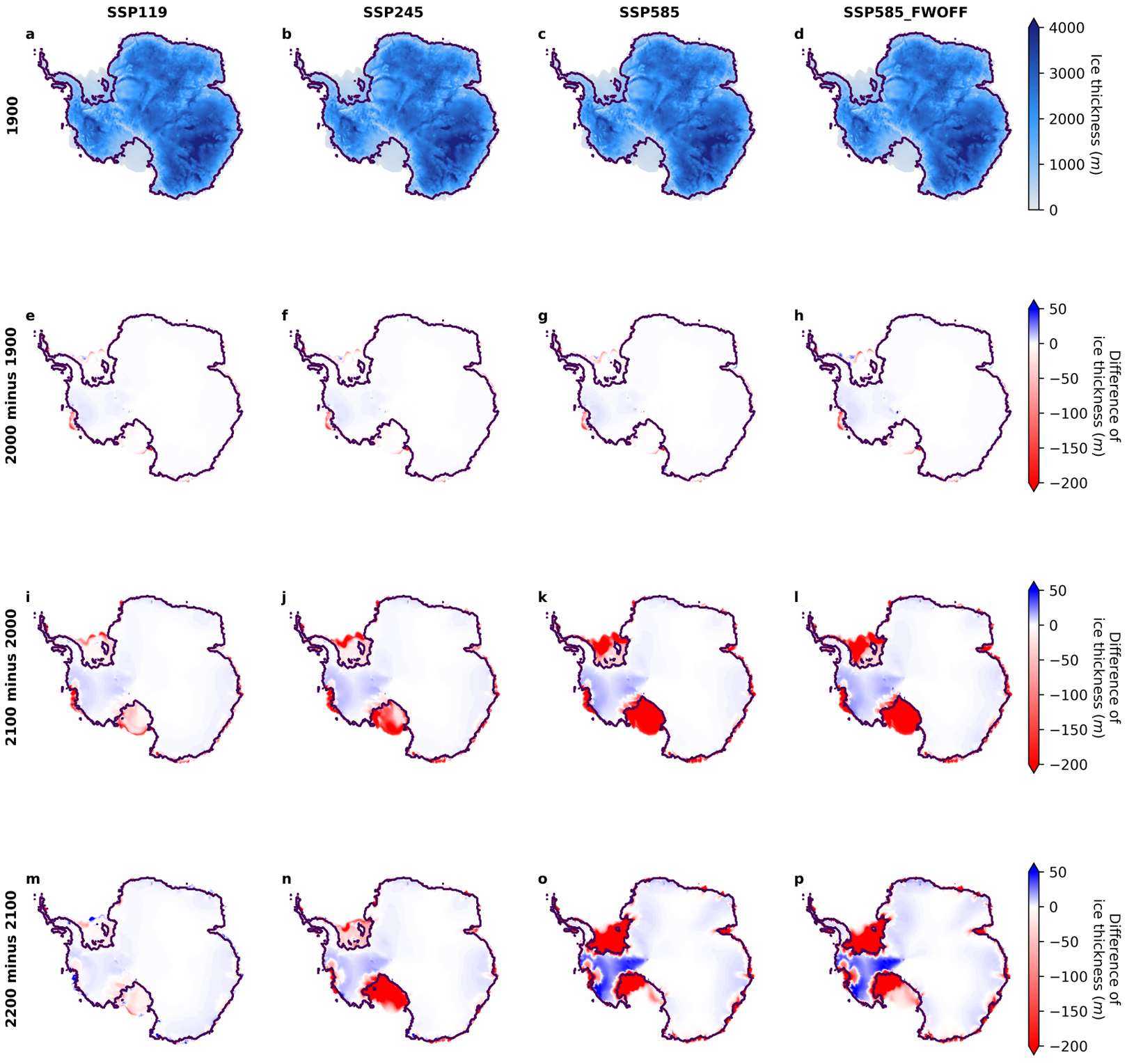


• Time series of the total ice volume in SLE of Greenland ice sheet (GrIS) (a) and AIS (b), and actual GMSL change contributed by GrIS (c) and AIS (d) from the year 1850 to 2200.



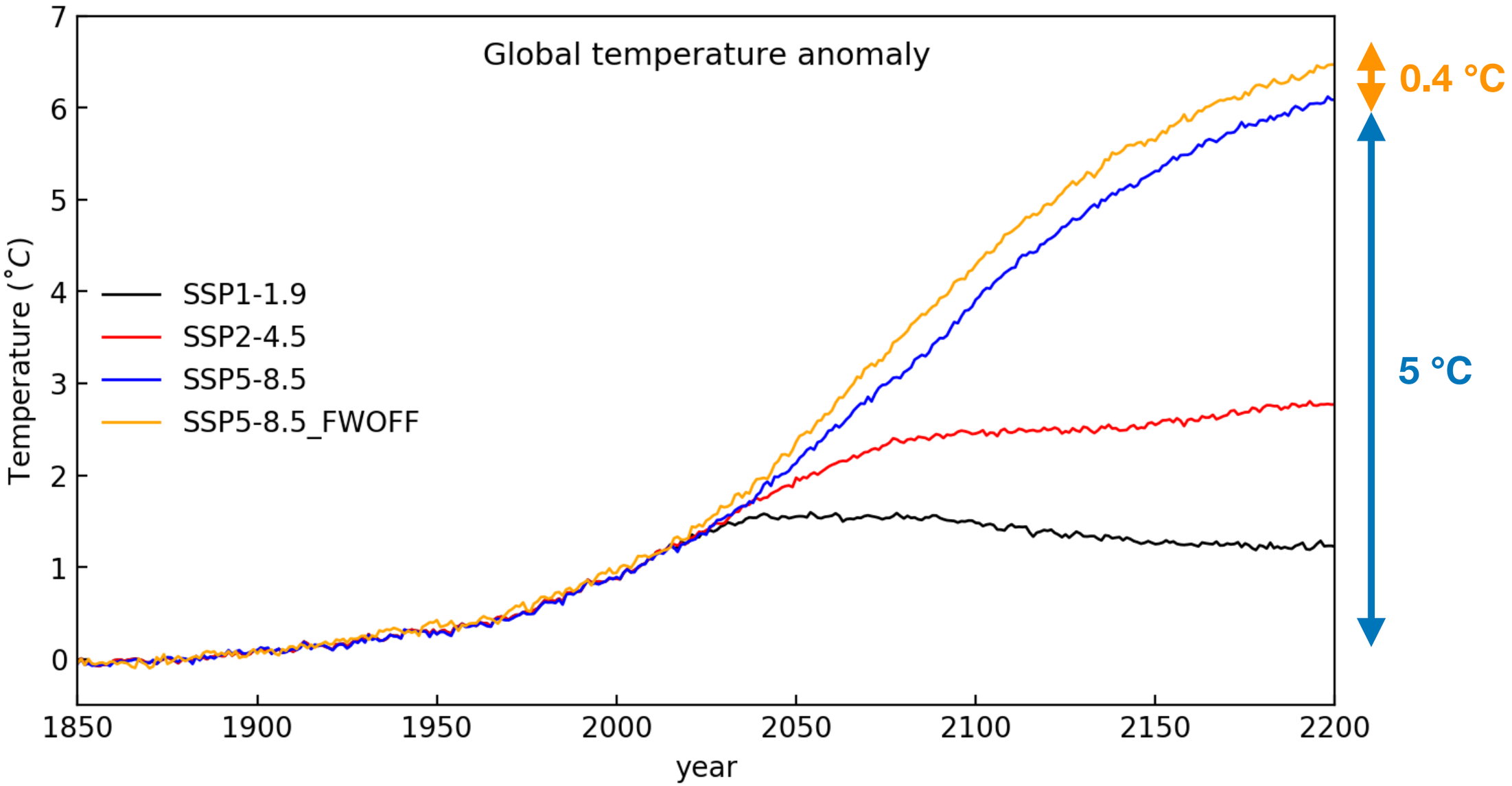
• Although the net ice volume loss of AIS in terms of SLE is predicted to be 4 times that of GrIS, GrIS shows a larger contribution to GMSL rise.

Ice thickness of the AIS



• AIS ice thickness in the year 1900 (a-d), 2000 minus 1900 (e-h), 2100 minus 2000 (i-l) and 2200 minus 2100 (m-p). Black contours indicate the grounding-line.

Global mean surface temperature anomaly



• Time series of the annual global mean surface air temperature anomaly simulated for each scenario from the year 1850 to 2200.

• Increased AIS meltwater flux in response to the SSP 5-8.5 CO_2 concentrations causes subsurface Southern Ocean warming which leads to an additional 20% AIS melting and a reduction in Southern Hemispheric future warming.