Ocean temperature forcings in glacial-interglacial Antarctic Ice Sheet simulations

David Chandler[1],
Petra Langebroek[1], Ronja Reese[2], Torsten Albrecht[3], Ricarda Winkelmann[3]

(1) NORCE Norwegian Research Centre, Bjerknes Centre for Climate Change, Bergen, Norway
(2) Northumbria University, Newcastle, UK
(3) Potsdam Institute for Climate Research PIK, Potsdam, Germany

BJERKNES CENTRE for Climate Research

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PIK

AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

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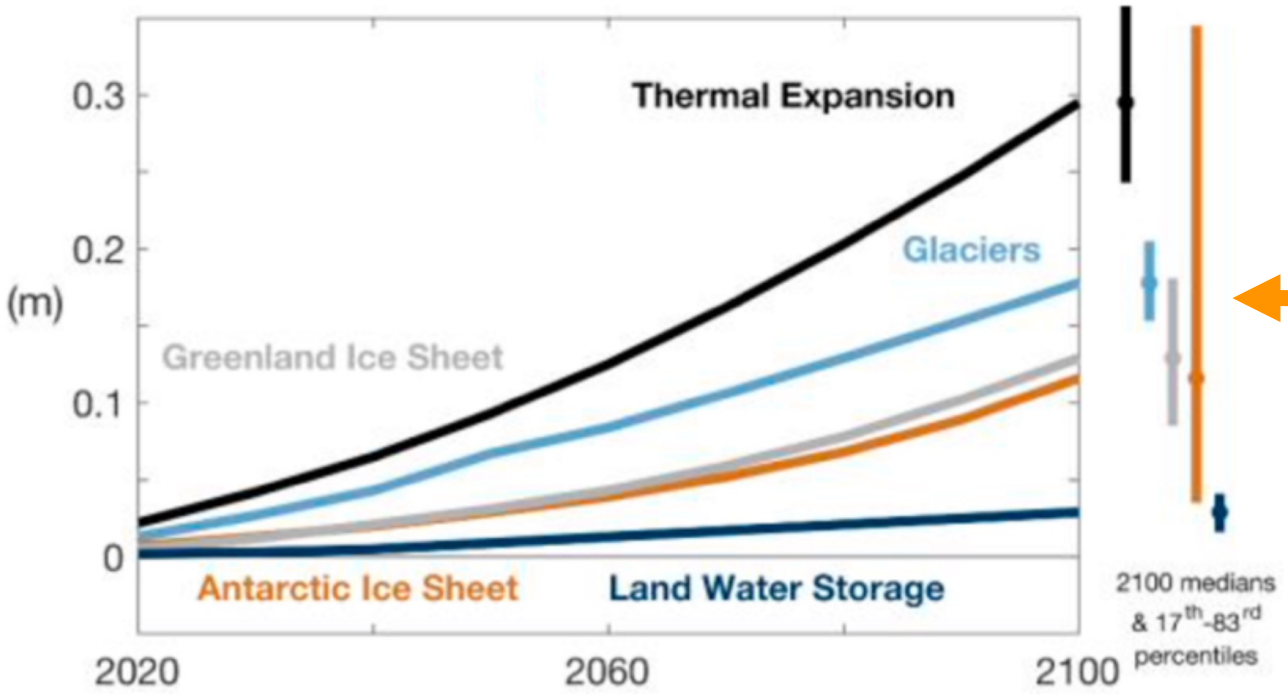
High uncertainty in sea level contribution from Antarctica



Antarctic Ice Sheet sea-level contribution
IPCC AR6: SSP5-8.5

Very large uncertainty by 2100

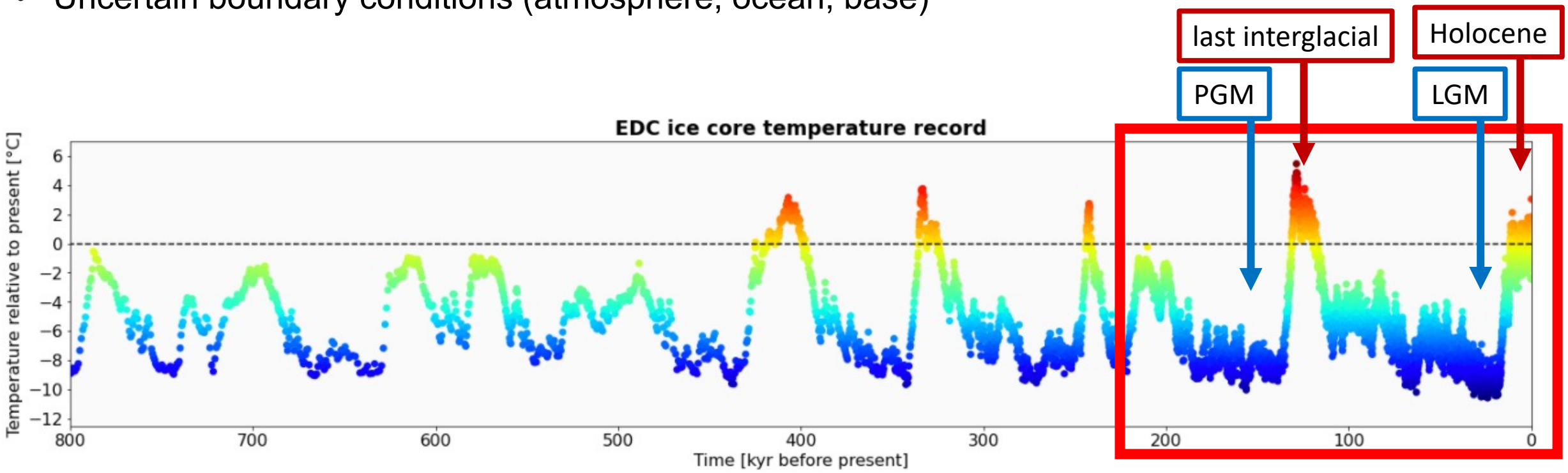
A third of projections still lie *outside* of that error bar

Uncertainty can be reduced using future projections and paleo ice sheet simulations (Different knowns/unknowns)

Paleo ice sheet simulations – last 220 kyr

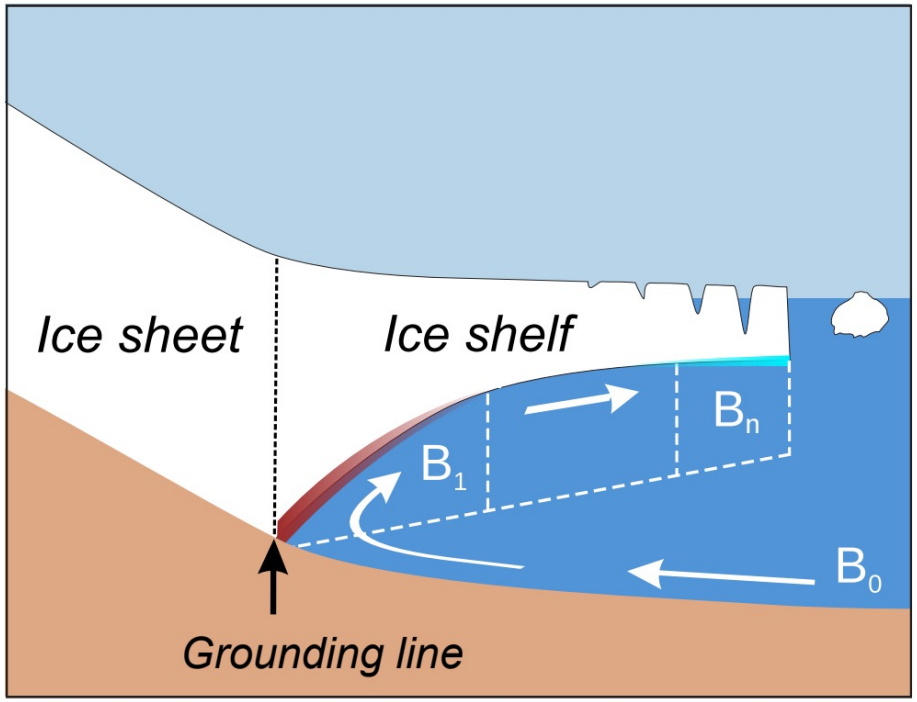
How did ice sheet respond to warm climates in the past?

- Known final state (use to optimise modelling choices)
- Unknown initial state
- Uncertain boundary conditions (atmosphere, ocean, base)



Ice shelf basal melt in long simulations

- Deep ocean temperature is a key influence on the rate & magnitude of Antarctic Ice Sheet changes.
- Lack of deep water temperature reconstructions close to Antarctica. What can we use instead?



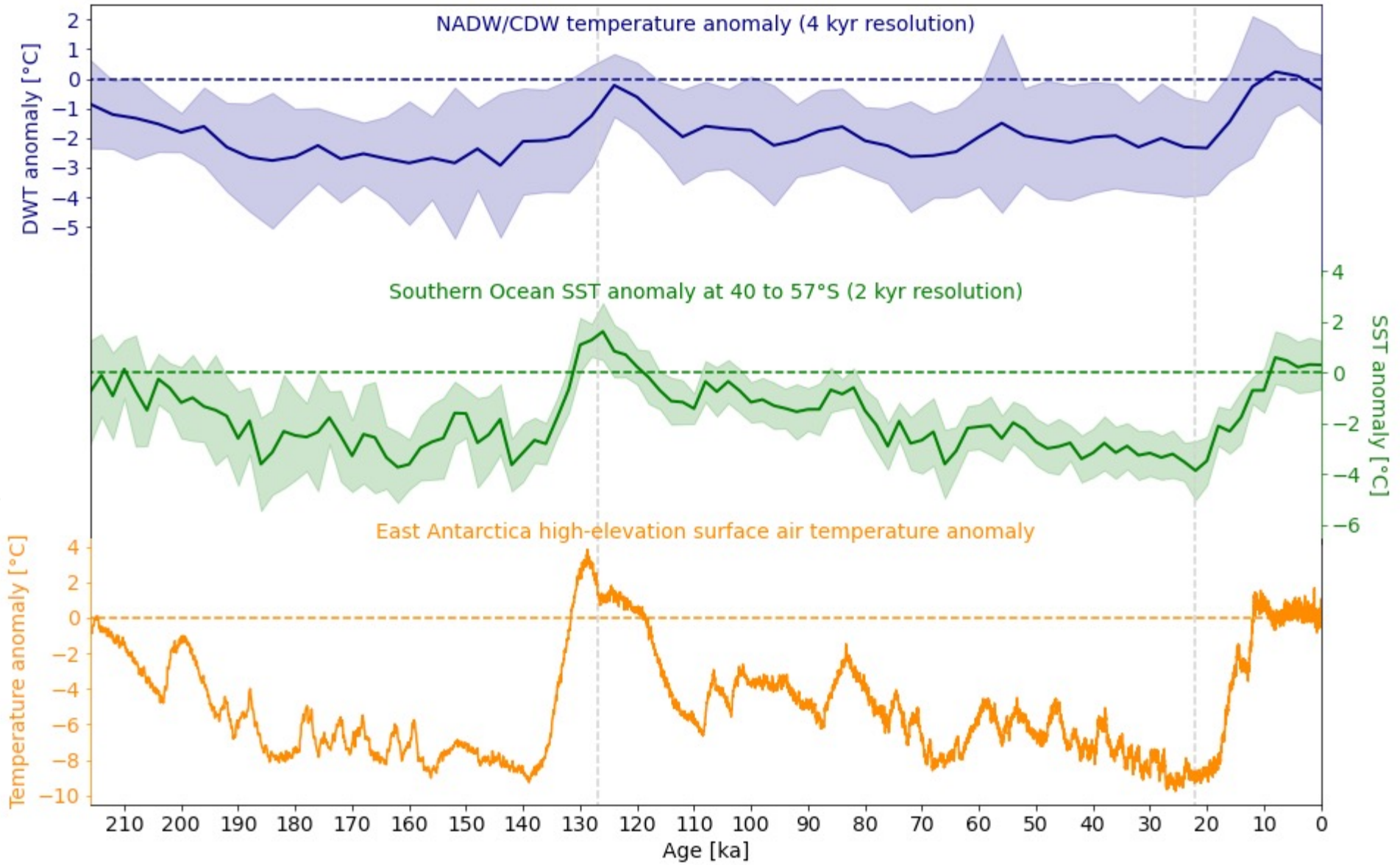
Schematic of the PICO box model
[*Reese et al., 2018*]

Alternative proxy records covering last 2 glacial cycles

Deep water temp
Mg/Ca or $\delta^{18}O$
6 sites 55°N - 43°S
[Cronin et al., 2000; Elderfield et al. 2010; Bates et al., 2014]

Southern Ocean SST
29 sites 40°S - 57°S
[Synthesis by Chandler & Langebroek, 2021]
-> glacial index + CMIP DWT

Antarctic ice sheet air T
5 cores at EAIS ice divides
[Parrenin et al., 2013]
-> Linear response function
[Albrecht et al. 2020]

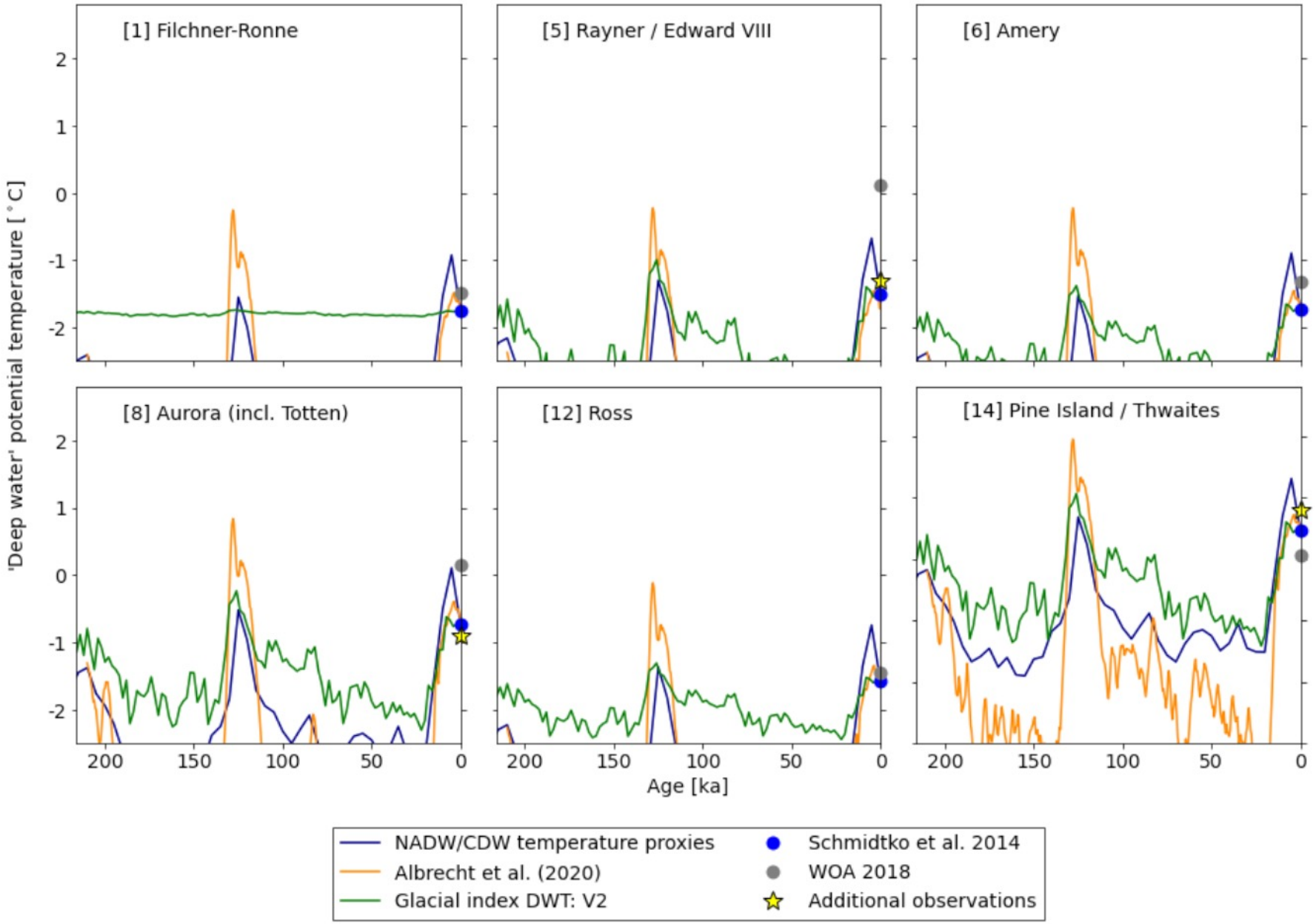


Three methods - - - > three time series for ocean T at each ice shelf

Deep water temp proxies

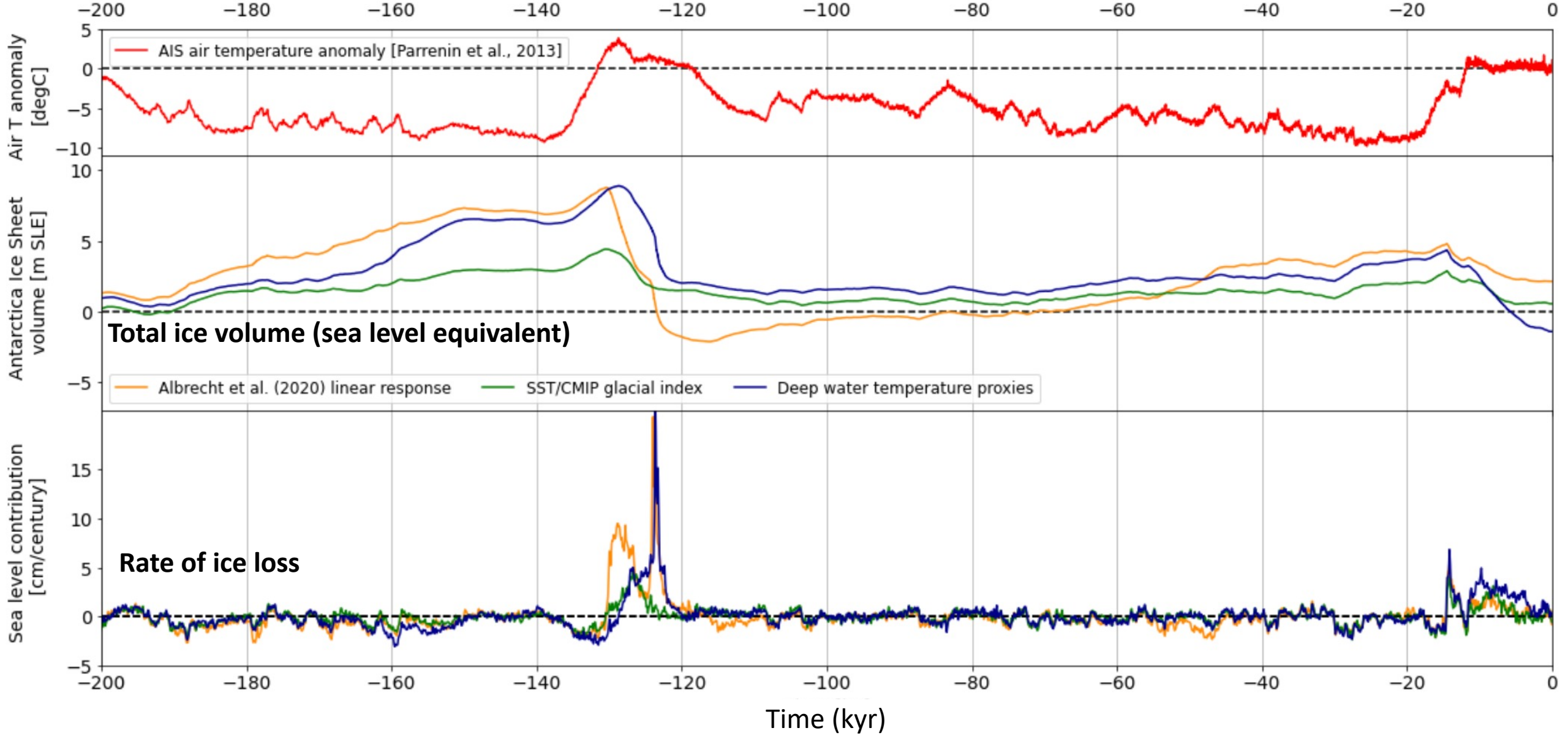
Glacial index (SST + CMIP LIG/LGM)

Linear response function

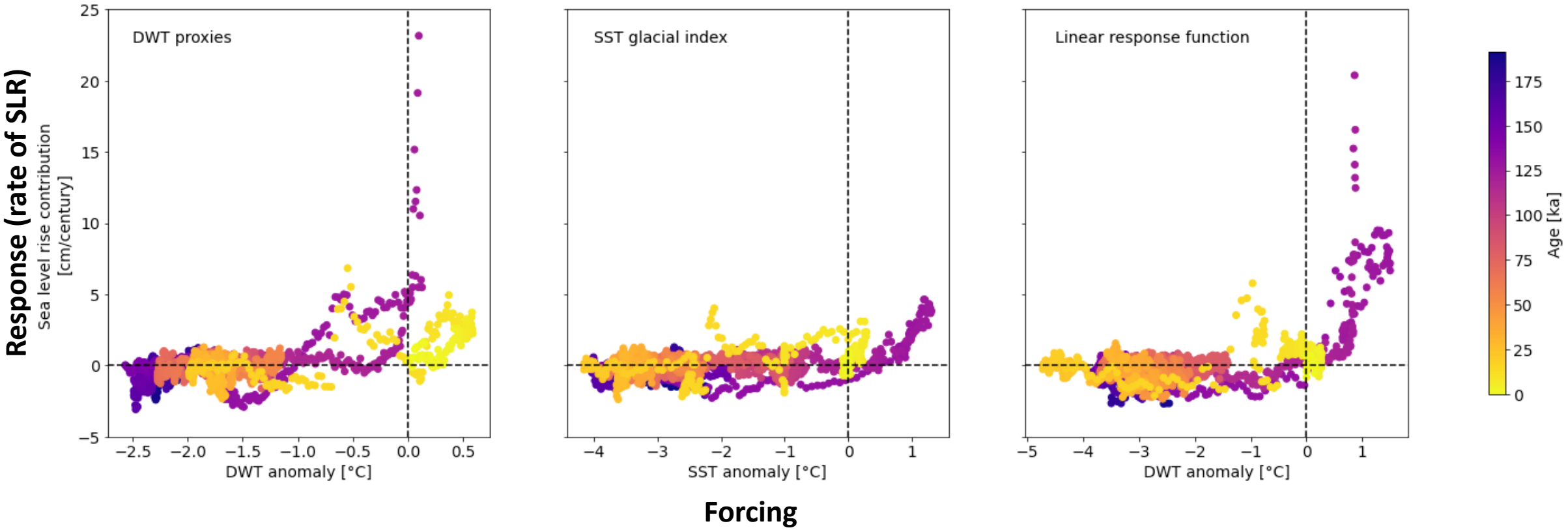


Influence on Antarctic Ice Sheet simulations with PISM/PICO:

Three methods yield quite different simulated ice volumes over the last two glacial cycles.



Influence on Antarctic Ice Sheet simulations with PISM/PICO:
Rapid ice loss at forcing with ~1°C ocean warming



Last interglacial ... purple
Holocene-present ... yellow

Uncertainties…

Several contributions:

- Proxy reconstructions
- CMIP glacial & interglacial climate simulations
- Ice shelf melt: PICO box model & parameterisations
- PISM ice sheet model, many unknowns

Quantify with some error analysis & ensemble runs (in progress)

Summary

- Ocean temperature forcing remains poorly constrained in glacial / interglacial ice sheet simulations.
- Many differences between the three options tried here, but some qualitative agreement.
- For more info email dcha@norceresearch.no

Tipping Points in Antarctic Climate Components

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