

Antarctic ice-sheet melting provides negative feedbacks on future global warming

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Antarctic ice sheet, THC and climate

Can the AIS melt in the future?

What could be the climatic impact of this melting?

Can this melting stabilize the North Atlantic THC?

Are the AIS-climate interactions important for sea-level rise projections?

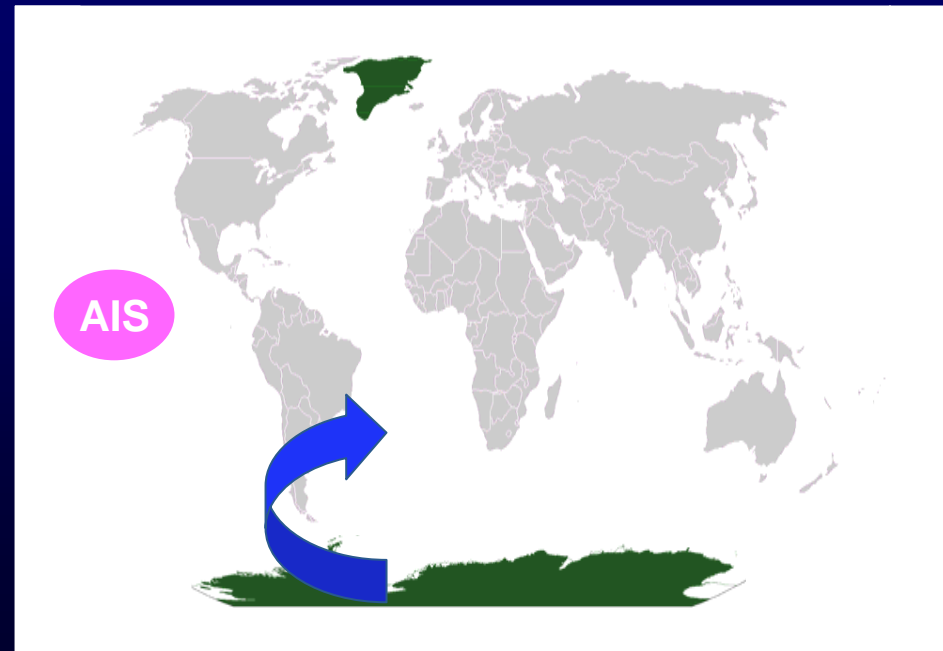
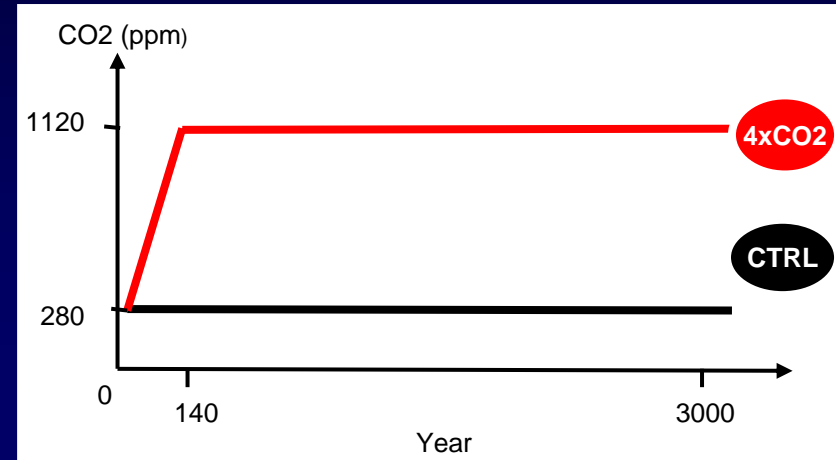
Tool: LOVECLIM earth system model



Experimental design

We analyse several scenario simulations at **4XCO₂**

- **Without** any ice-sheet melting (**fixed**)
- **With** ice-sheet melting from both Greenland and Antarctic ice sheets (**AGIS**)
- **With** melting from Greenland ice sheet only (**GIS**)
- **With** melting from Antarctic ice sheet only (**AIS**)



AIS response

- AIS loses mass after a few centuries
- Important warming over Antarctica after 3000 years
- Lag due to large thermal inertia in the Southern Ocean
- Freshwater input up to 0.14 Sv in the Southern Ocean after 3000 years in AGIS and AIS

CTRL

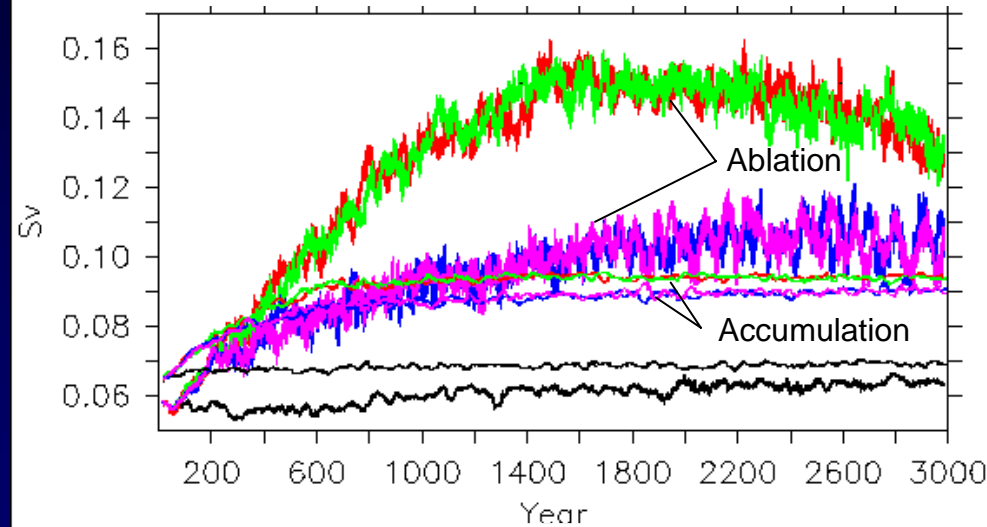
AGIS

fixed

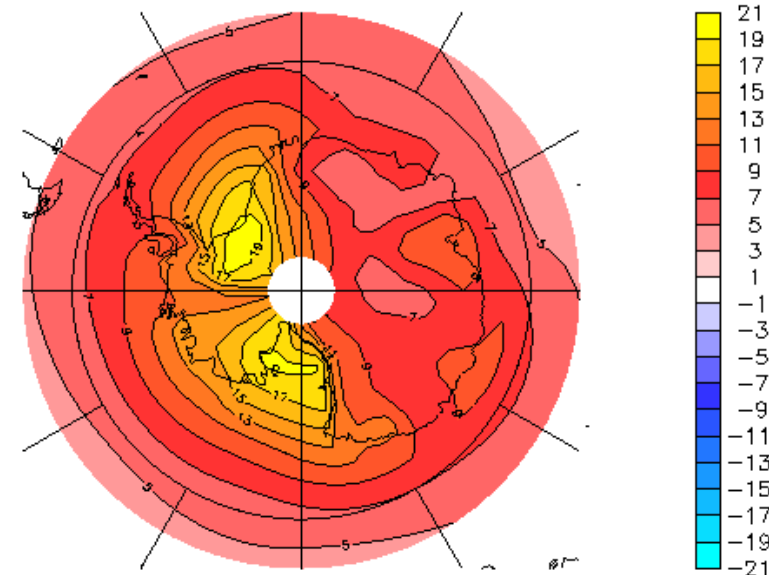
AIS

GIS

Grounded AIS mass balance

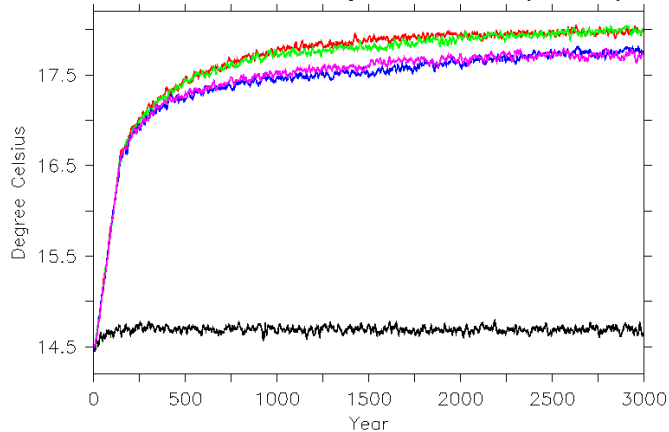


SAT in summer: fixed-CTRL (2900-3000)



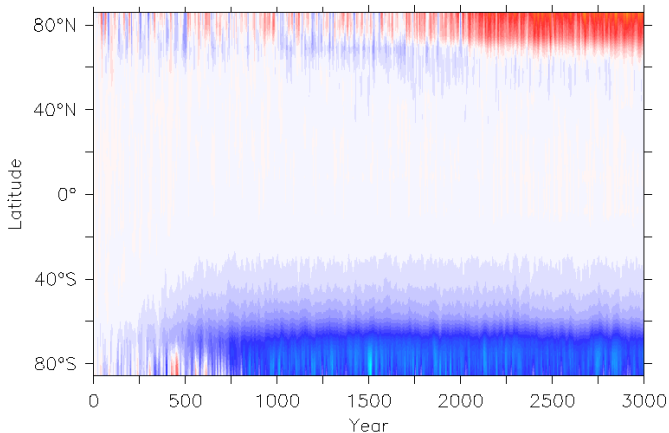
Temperature response in scenarios

Surface Air Temperature (SAT)



AIS melting reduces the Climate Sensitivity by 10%

SAT: **AGIS-fixed**

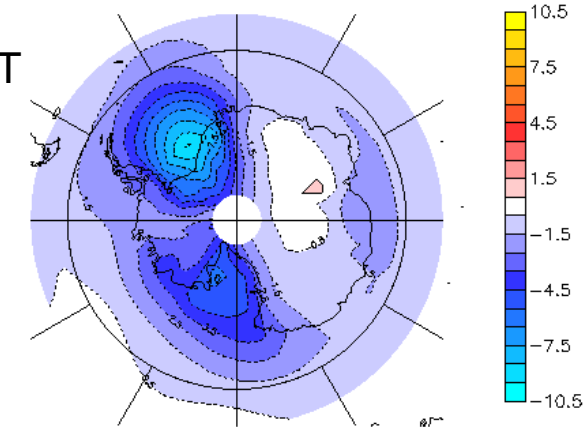


The north is warming, the south is cooling

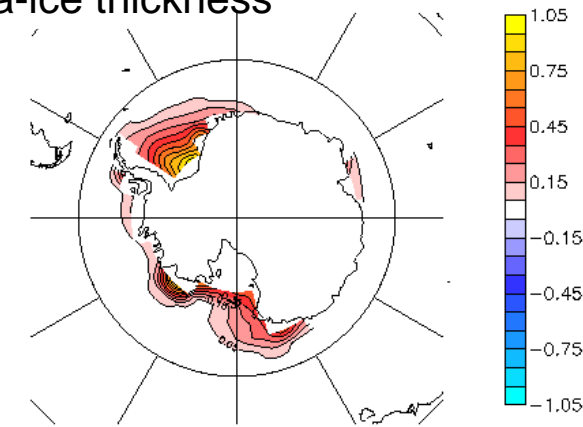
Because of sea-ice differences

AGIS-fixed: years 2900-3000

a) SAT

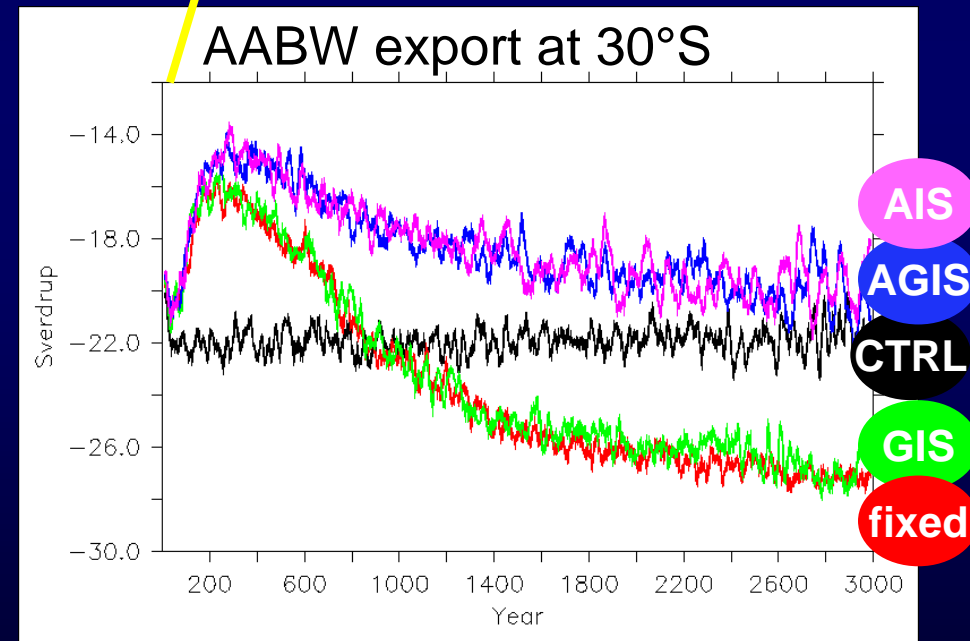


b) Sea-ice thickness

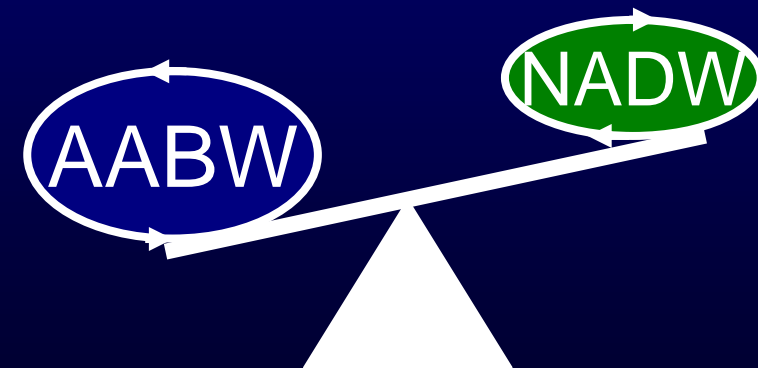
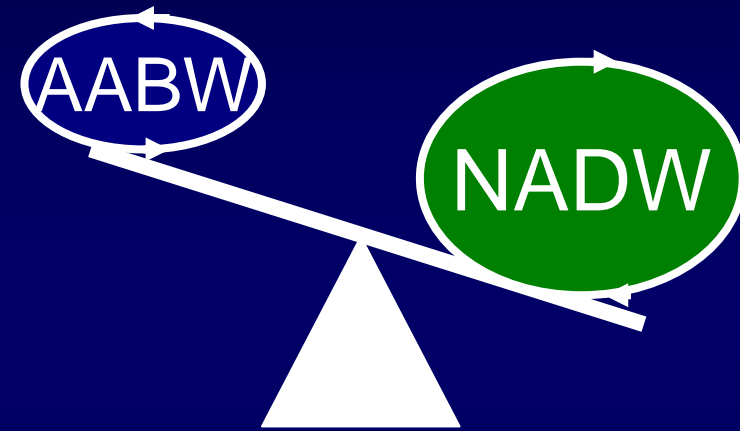
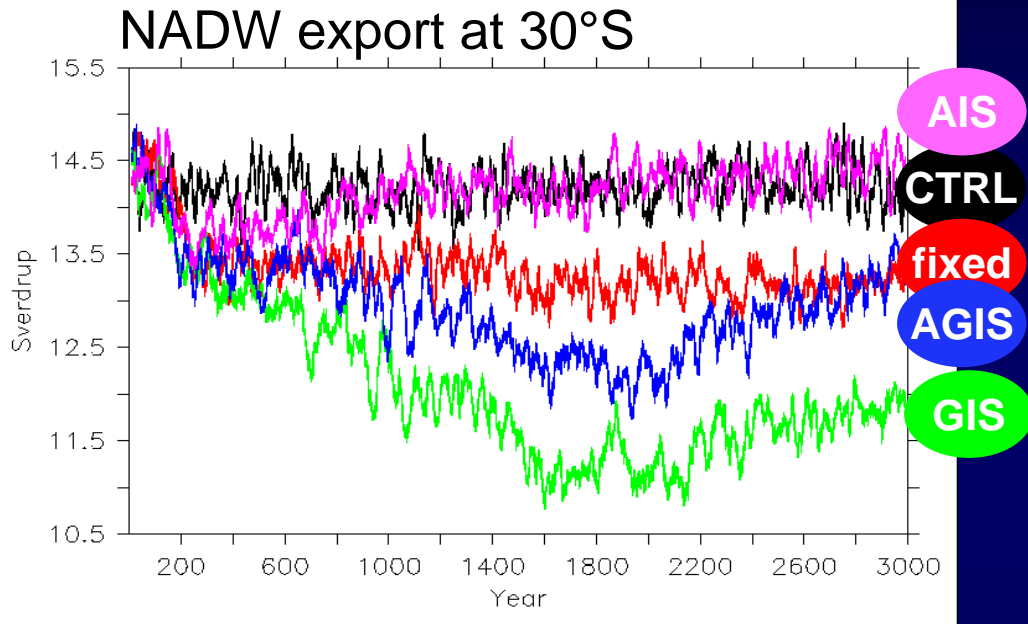


AABW cell response in scenarios

- The AABW cell weakens the first 300 years
- Then it recovers
- It stabilizes around CTRL value with AIS melting
- And 25% over CTRL value without AIS melting



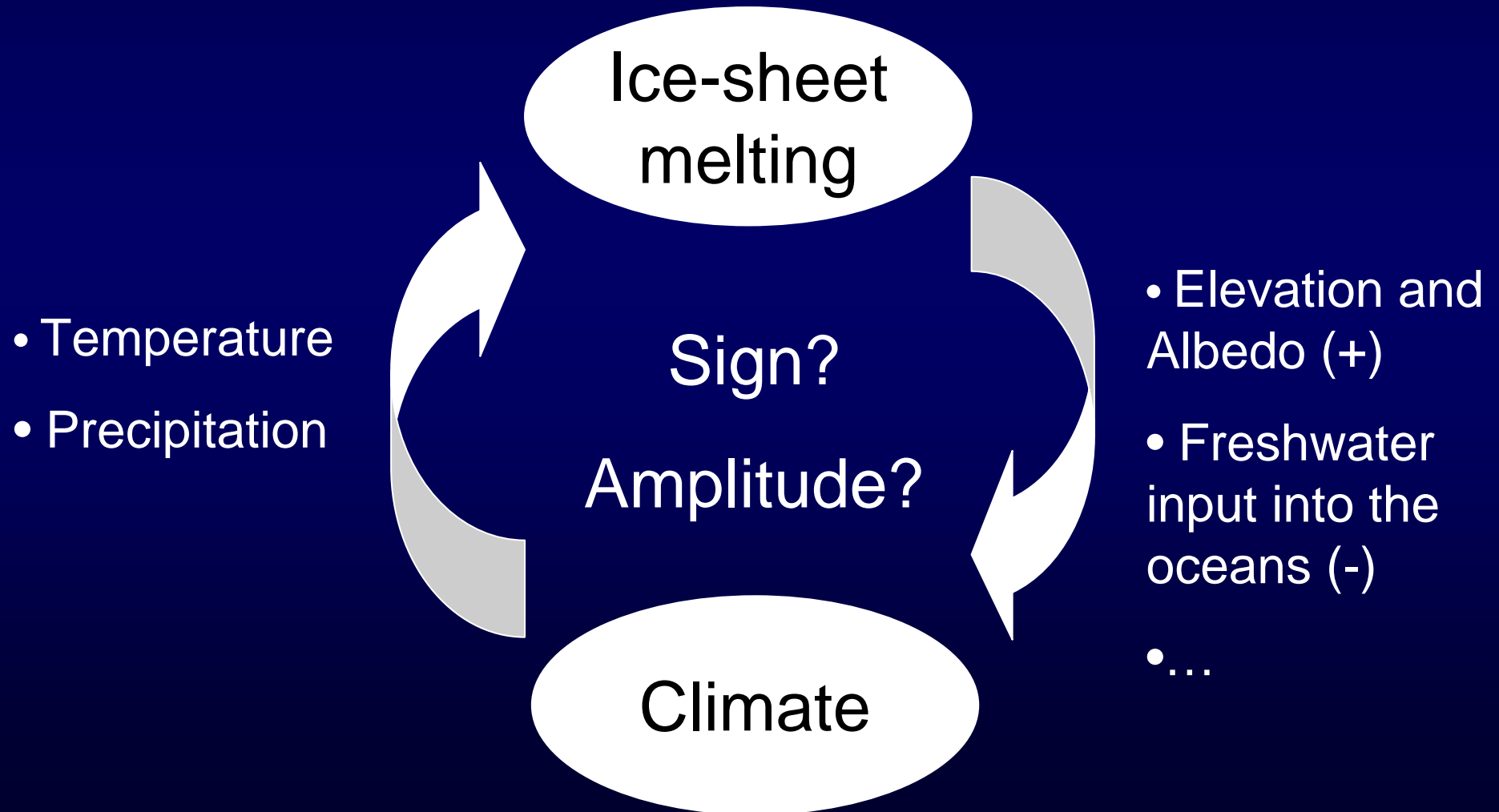
NADW cell response in scenarios



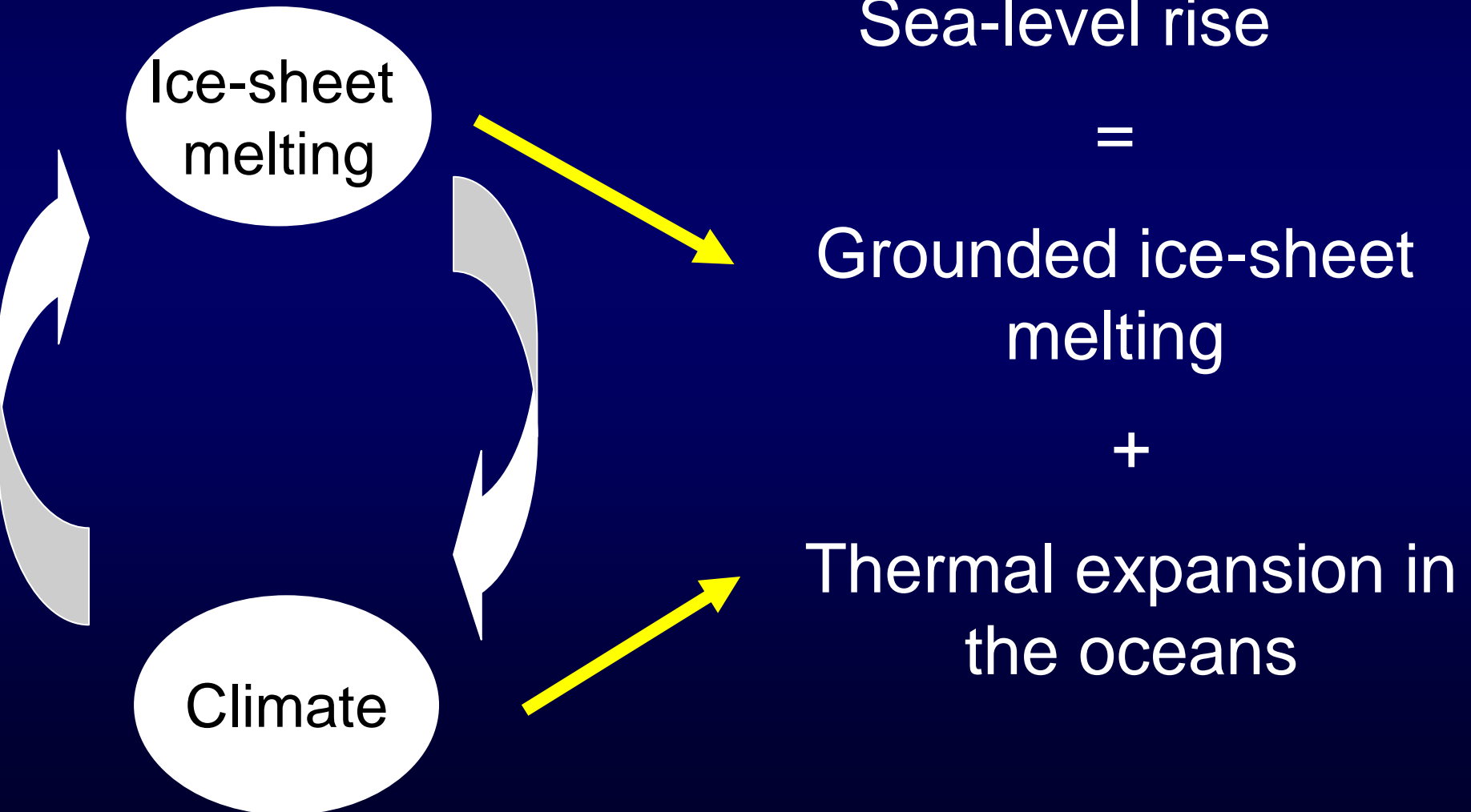
➤ NADW cell weakens more with GIS melting (Driesschaert et al. 2007), while AIS melting reduces this weakening

➤ An illustration of the « bipolar ocean seesaw » process from Stocker et al. (1992)

Climate-ice sheet feedback



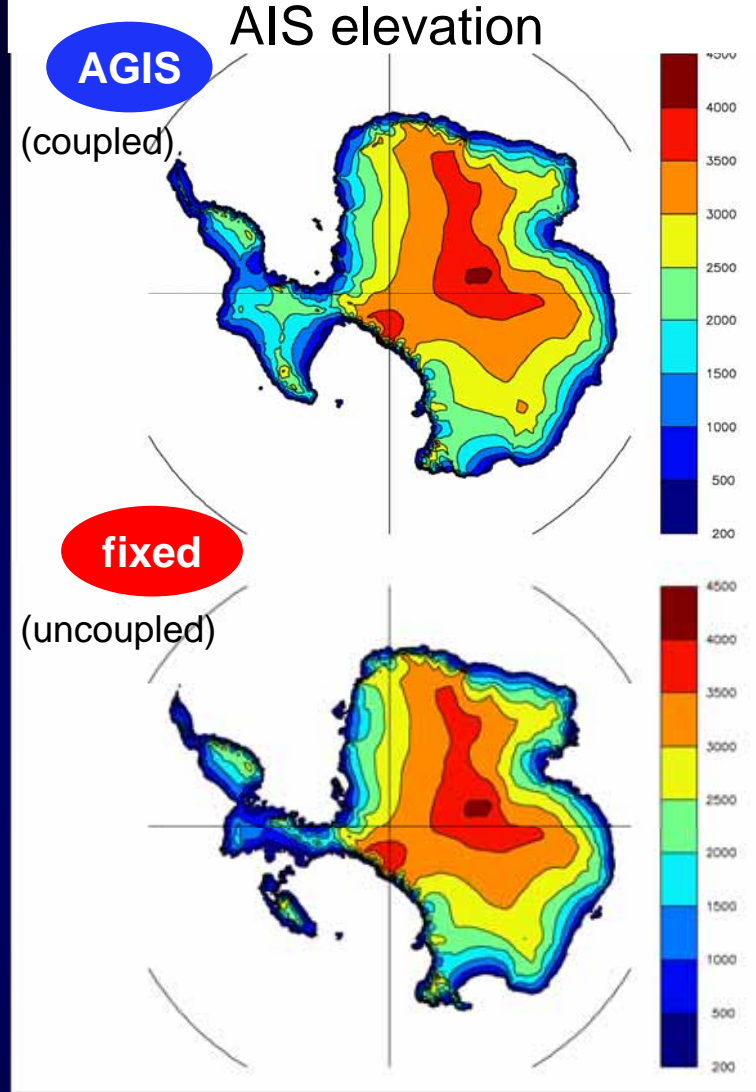
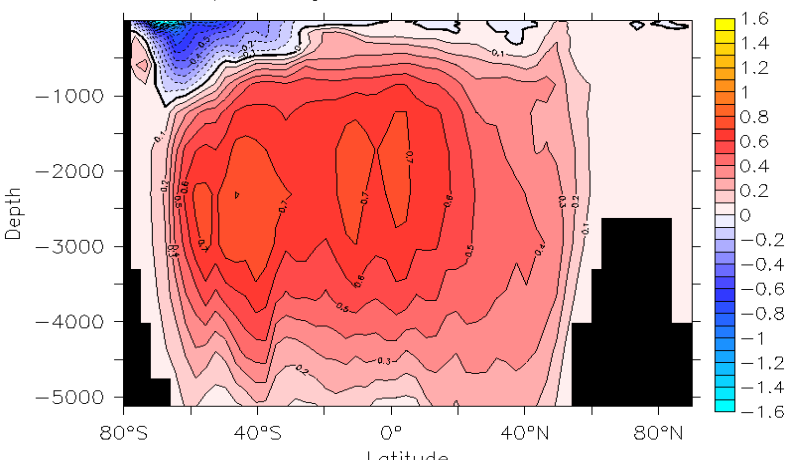
Climate-ice sheet feedback



AIS-climate feedback after 3000 years

- AIS coupled with climate: AIS melts as much as **3.2 m** sea-level rise equivalent
- AIS uncoupled with climate: AIS melts as much as **10.0 m** sea-level rise equivalent
- Strong negative feedback: freshwater input feedback dominates over the others

Ocean Temperature: AGIS-fixed



- Thermal expansion contribution: **2.3 m** when coupled; **1.2 m** when fixed
- Total **negative** feedback of **5.7 m**

Conclusions

- AIS melting reduces global warming especially in the Southern Hemisphere
- AIS melting reduces the Atlantic THC weakening
- AIS melting is governed by a strong negative feedback implying climate interactions
- For all these reasons, AIS has to be coupled interactively in climate models for long-term projections



Thank you !

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