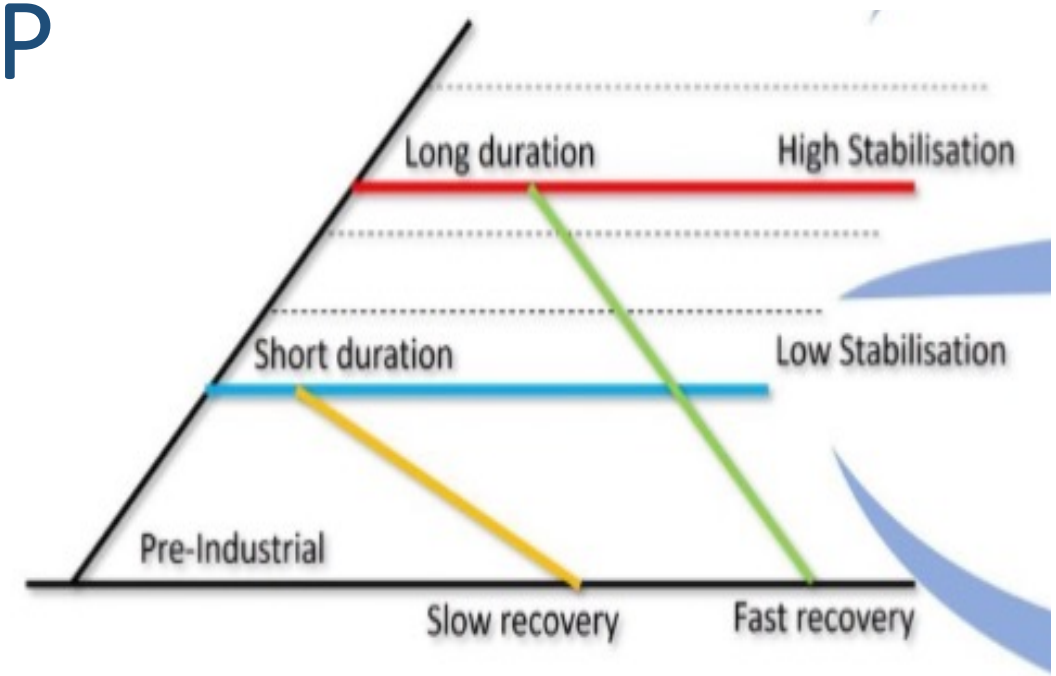
AMOC experiments in TIPMIP

- Building on TIPMIP protocol for ESMs (ramp-up and ramp-down at specific warming level)
- Characterising the proximity of a potential bifurcation where the AMOC might be very sensitive to perturbation in models
- Evaluating irreversibility of an AMOC collapse (building on NAHosMIP for instance)
- Use of “hosing” approaches



Proposition of AMOC experiments

A. NAHosMIP follow on experiments

B. Slowly accelerating hosing

    1. In preindustrial condition

    2. In increasing and stabilized CO2 conditions

C. 8.2 kyr-like event

D. …

A) NAHosMIP follow on experiments

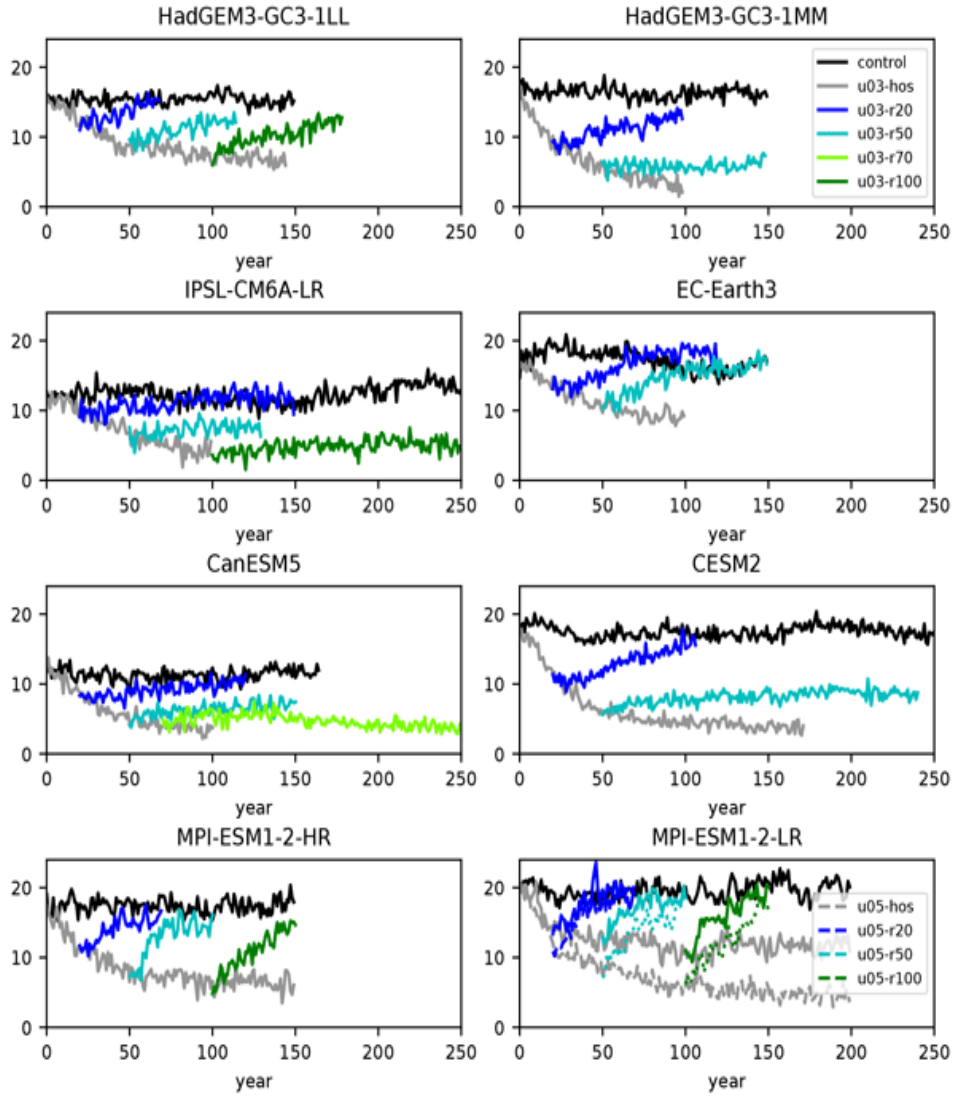
Build on Jackson et al. (GMD 2023)

Objective: Evaluate reversibility of the AMOC in a warmer world by making it collapse through massive freshwater release and then remove the flux to see if it recovers

Experimental design:

- Assume models have already done the basic ESM scenario which includes a ramp up to 2 degrees and then a stabilisation at ~2 degrees with zero emissions
- Repeat the stabilisation run at 2 degrees with 0.3 Sv hosing uniformly over the North Atlantic (>50°N) and Arctic (100 years)
- Spin off with same CO_2 concentrations and no more hosing after 50 and 100 years (2 x 50-100 years)

Cost: ~ 200-300 years. However models may also want to do NAHosMIP run without CO_2 increase which would be another 200-300 years



From Jackson et al. (2023)

B) Slowly accelerating hosing

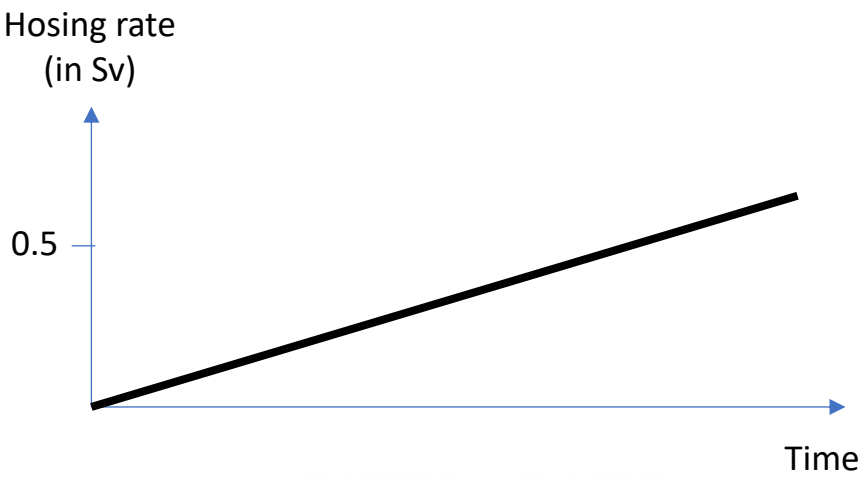
Build on e.g. van Westen et al. (Sc. Adv. 2024)

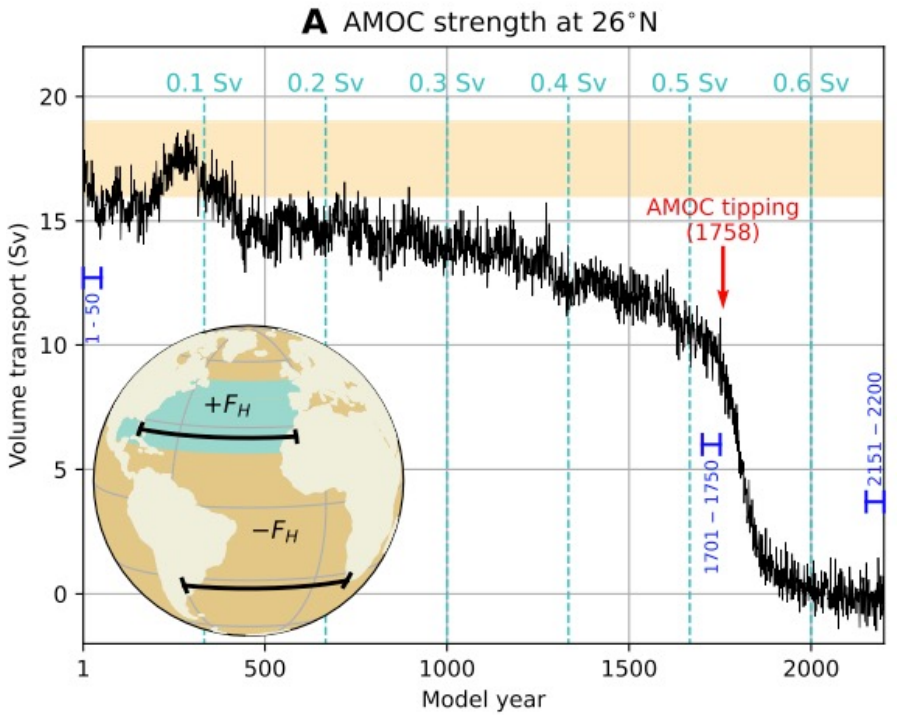
Objective: Assess if there exists a bifurcation in the AMOC response to freshwater release in the North Atlantic in a given model

Experimental design:

- Increase hosing at 0.25 Sv/century for 200 years (reaching 0.25 Sv after 100 years and 0.5 Sv after 200 years) = ~ 8x faster than in van Westen et al. (2024)
- Spin off experiments with zero hosing to see if AMOC recovers (take 50-100 years each). When and how many?.
- Need to discuss region of hosing
- B.1: In preindustrial conditions
- B.2: In the CO2 ramp up/stabilise to 2 degrees. Whether the hosing starts at the start of the CO2 ramp up or at the start of the stabilisation is to be defined.

Cost: ~ > 300 years for B1 and ~ > 300 years for B2





From van Westen et al. (2024)

C) 8.2 kyr-like event

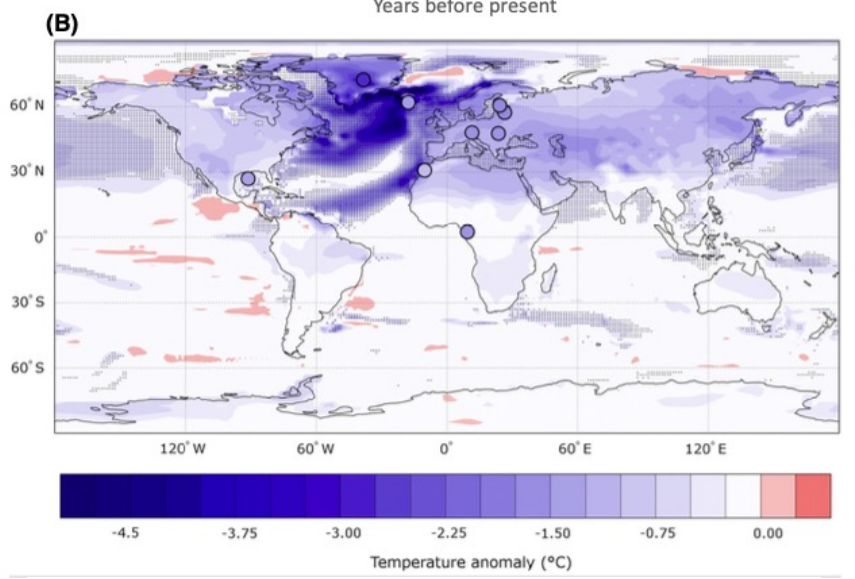
Build on e.g. Gregoire & Morrill (PAGES 2021)

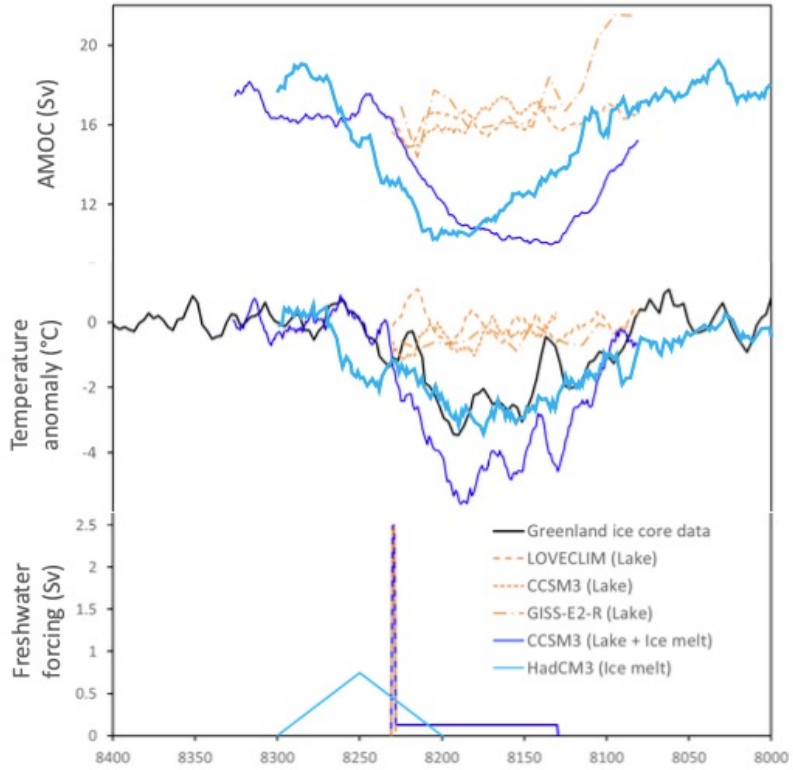
Objective: Assess the sensitivity of AMOC to freshwater release through a comparison with reconstructed climate fingerprints at 8.2 kyr BP

Experimental design:

- Run from preindustrial conditions to keep things simple
- Scenario includes ramp up and down of hosing with 5 Sv.yr over 2 yrs and 15 Sv.yr over a century (roughly equivalent to ramp up reaching 0.3 Sv after 50 years, i.e. about 4x faster than proposition B.
- Putting freshwater in the Labrador or Hudson Bay catchment or uniformly?
- Potential collaboration/interest from PMIP

Cost: ~ 100 years





From Gregoire & Morrill (2021)

Pros and cons for the different experiments

Experiments	Pros	Cons
A	• Comparison with existing experiments • Include effect of global warming	• Participating models may not have done the original experiments. • Some models may not show anything interesting
B	• All/most models should be able to get to a 'collapse'. • Include effect of global warming in B2 • A bit more realistic in terms of water added	• Can be very long to get a collapse in preindustrial while freshwater increase might be too strong/fast for a "real" bifurcation • Costly in terms of time integration (> 500 years for B1+B2)
C	• Short experiment. • Can actually be compared with observations (contrary to future experiments or idealized hosing)	• Would it be too much simplification to do with piControl conditions? • No tipping of the AMOC is expected

Discussions

- Do we plan to have several models? If you can, yes!
- Possibility of including EMIC? No issue with this.
- Using Freshwater from Ice sheet model (from the same TIPMIP project) => good idea, but maybe for a phase 2

Thank you!