Simulating the ice-sheets during the Mid-Pleistocene Transition

A dance of ice, CO_2 and orbital cycles

Meike Scherrenberg, Constantijn Berends and Roderik van de Wal

Utrecht University | Institute for Marine and Atmospheric research Utrecht | NESSC Netherlands Earth System Science Centre

Email: **m.d.w.scherrenberg@uu.nl**

This presentation participates in OSPP

EGU Outstanding Student & PhD candidate Presentation contest

1 Main goals

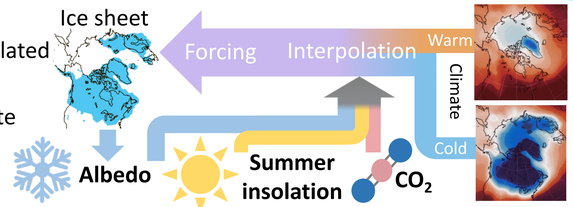
Glacial cycle periodicity changed from **40 to 100 thousand years** during the Mid-Pleistocene transition (~1 million years ago).

What is the role of **CO_2**, **insulation** and **albedo** for ice sheet evolution?

2 Methods

Northern Hemisphere ice sheets are simulated using IMAU-ICE, our ice-sheet model.

Forcing is derived from interpolated climate time-slices. This interpolation depends on **albedo**, **summer insolation** and **CO_2**.



Simulations

Baseline

Temperature is driven by **insolation**, **CO_2** and **albedo**.

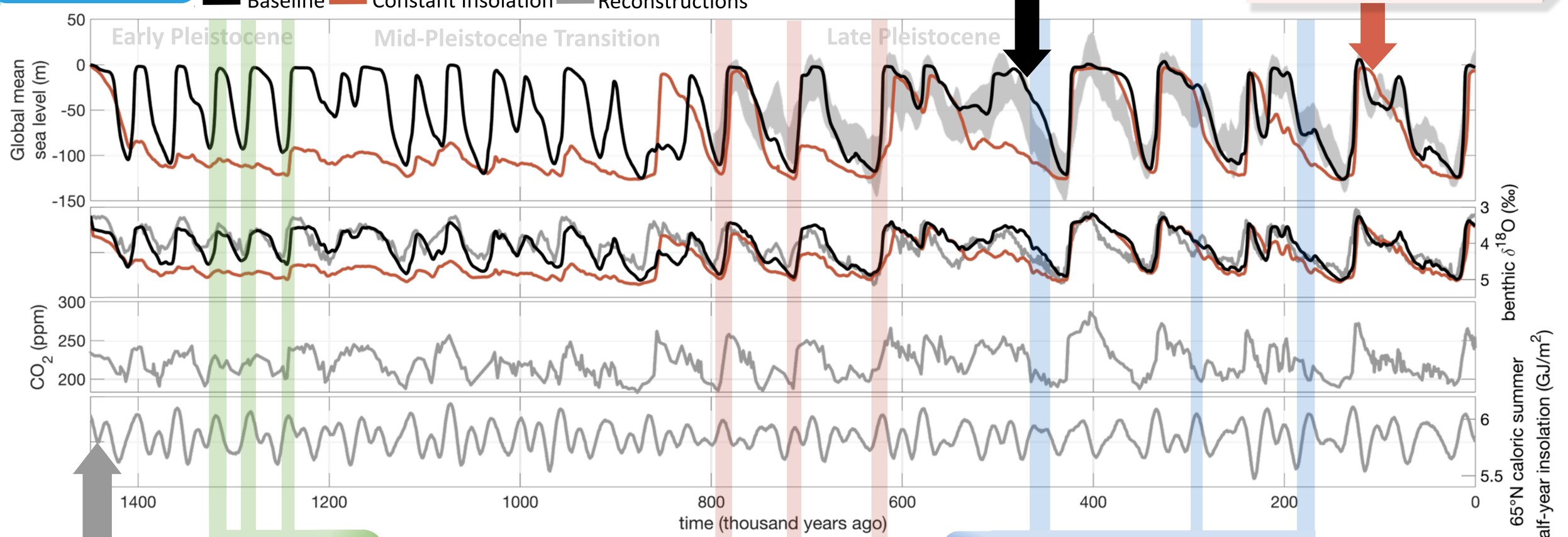
If CO_2 is high enough during a summer insolation maximum, there will be a termination.

Constant insolation

Summer insolation is kept constant at 5.8 GJ/m^2. Temperature change is caused by CO_2 and albedo.

CO_2 alone cannot capture Early Pleistocene glacial cycles. It also less closely follows sea level reconstructions.

3 Results



Reconstructions

Reconstructions are shown in grey:

- Sea level	Spratt and Lisiecki et al. (2016)
- $\delta^{18}O$	Ahn et al. (2017)
- CO_2	Yamamoto et al. (2022)
- Insolation	Tzedakis et al. (2017)

Early Pleistocene

- Terminations at obliquity maximum
- CO_2 roughly 230 ppm

Late Pleistocene Terminations

- Insolation maxima
- CO_2 at least 240 ppm.
- CO_2 and insolation high at the same time

Failed Terminations

- Insolation maximum
- CO_2 generally below 220 ppm.
- Low CO_2 compensates insolation maximum.

4 Conclusions

- The Mid-Pleistocene Transition can be simulated with **only** CO_2 and summer insolation as forcing.
- Deglaciations can be **skipped if CO_2 is low enough**.
- The **carbon cycle** controls CO_2 and therefore has a **key role** in the Mid Pleistocene Transition.