

Atmospheric variability in the Northern Hemisphere winter in a warm past and a future climate

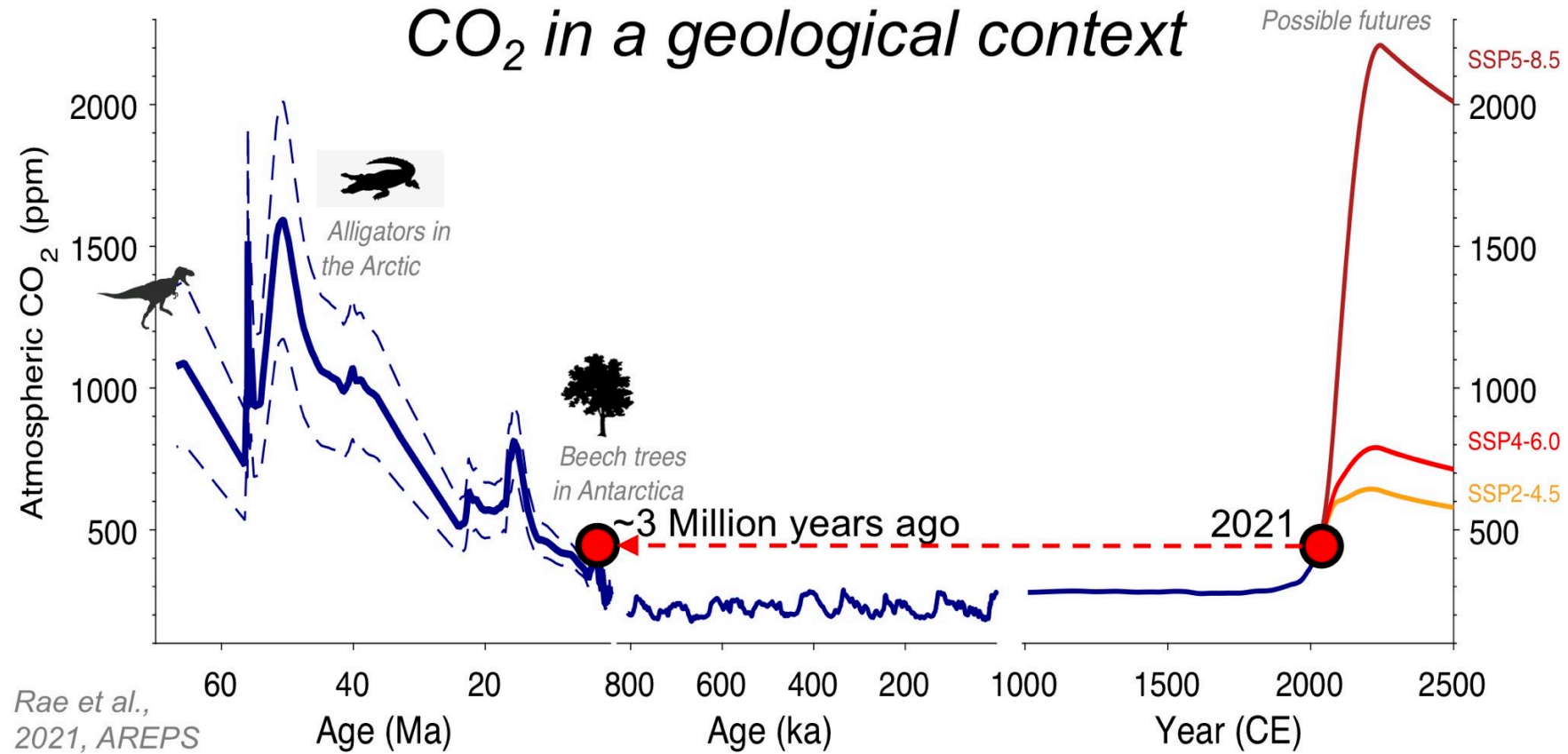
Arthur Oldeman (a.m.oldeman@uu.nl)

Michiel Baatsen, Anna von der Heydt, Aarnout van Delden, Henk Dijkstra

This presentation participates in OSPP



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👉 To what extent can we treat the mid-Pliocene as an 'analog' for a future warm climate?

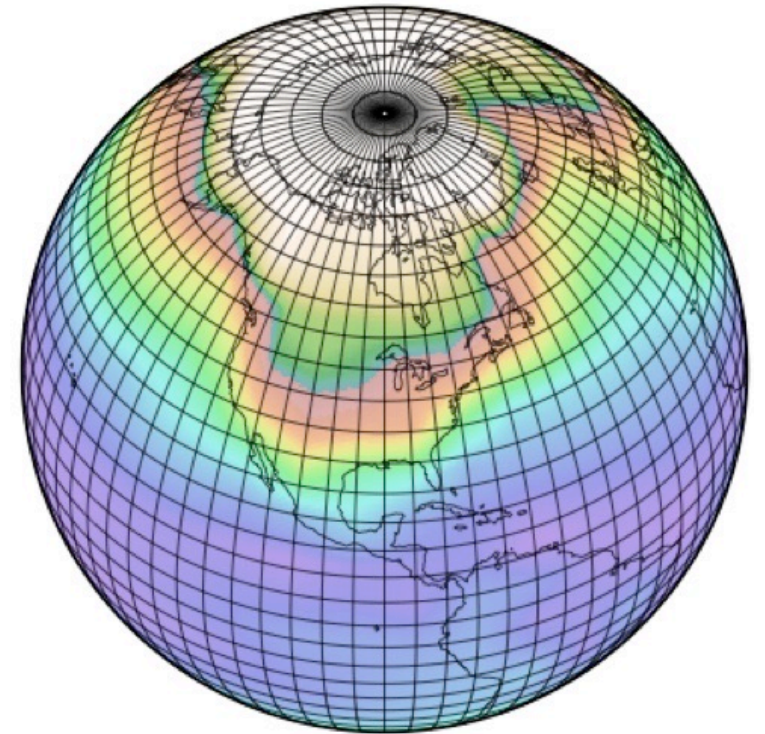
What?

Focus on NH winter atmospheric dynamics.

1. Unclear what changes we can expect in warmer future (IPCC)
2. Biggest differences in geographical boundary conditions

How?

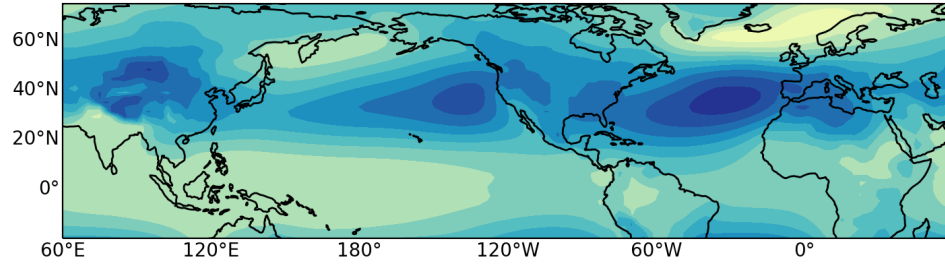
- CCSM4-Utrecht (PlioMIP2)
- January mean data
- Pre-industrial reference (280 ppm)
 - a. CO₂ doubling (560 ppm)
 - b. Mid-Pliocene BCs (280 ppm)



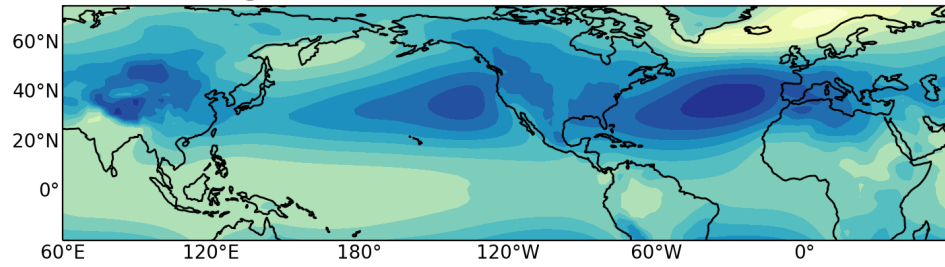
(serc.carleton.edu)

Mean sea-level pressure (MSLP)

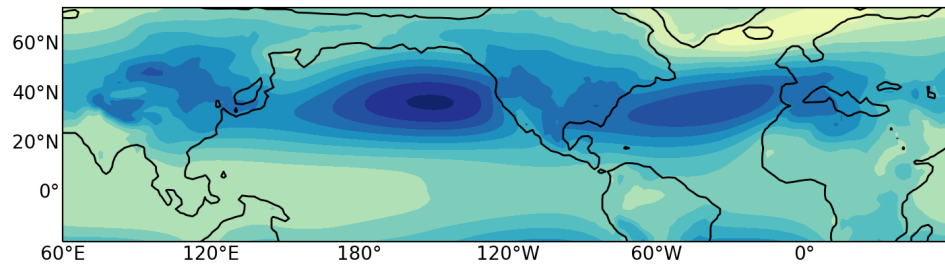
Pre-industrial



CO2 doubling

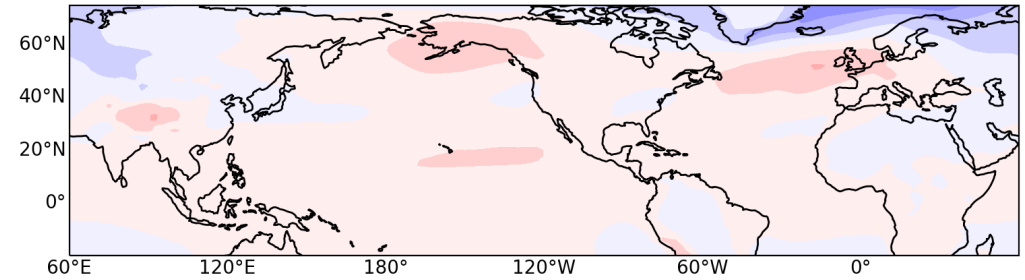


Mid-Pliocene BCs

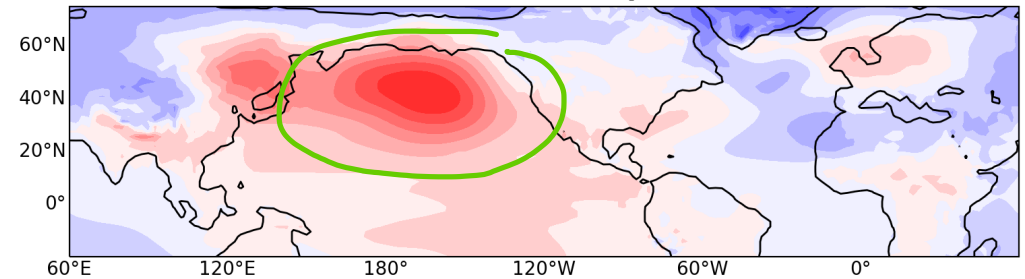


- Mid-Pliocene response shows large increase in MSLP in North Pacific

Response to CO2 doubling

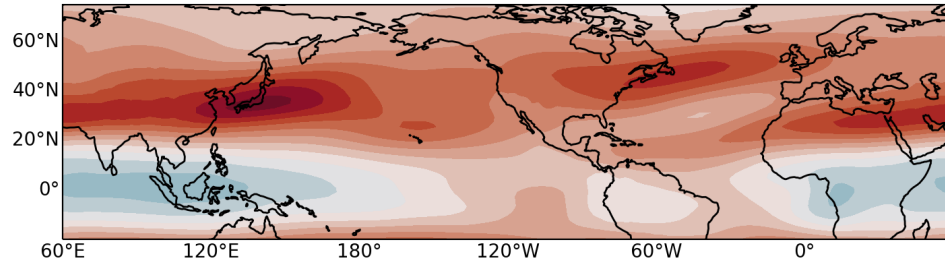


Response to mid-Pliocene BCs

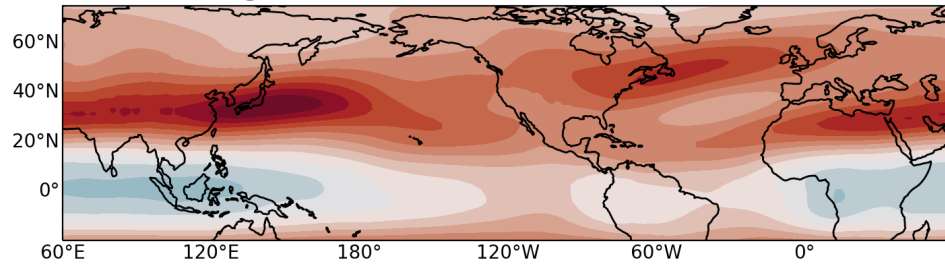


Zonal wind at 200hPa

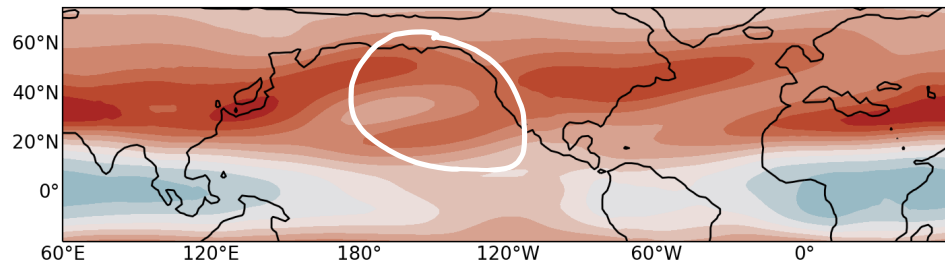
Pre-industrial



CO2 doubling



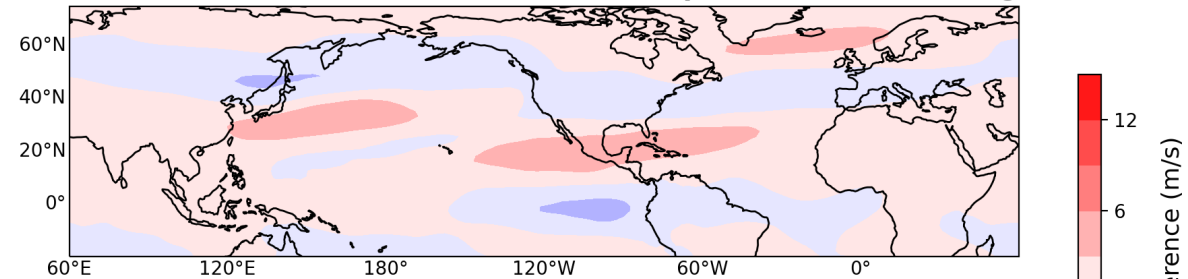
Mid-Pliocene BCs



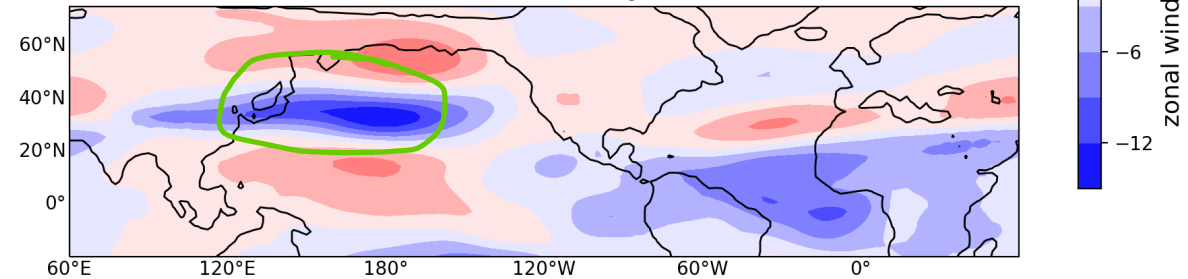
Mid-Pliocene:

- Reduced jet in western North Pacific
- Split-jet in eastern North Pacific

Response to CO2 doubling

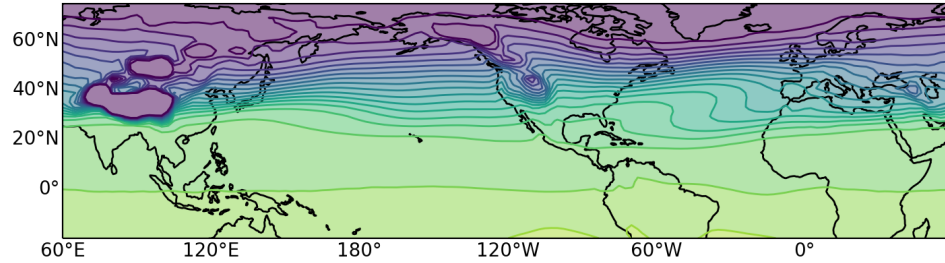


Response to mid-Pliocene BCs

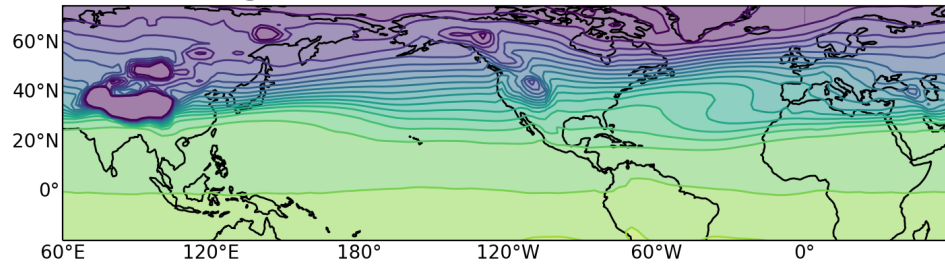


Potential vorticity (PV) at 200hPa

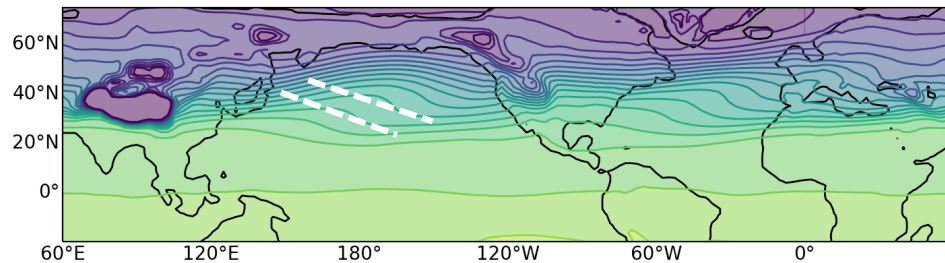
Pre-industrial



CO2 doubling

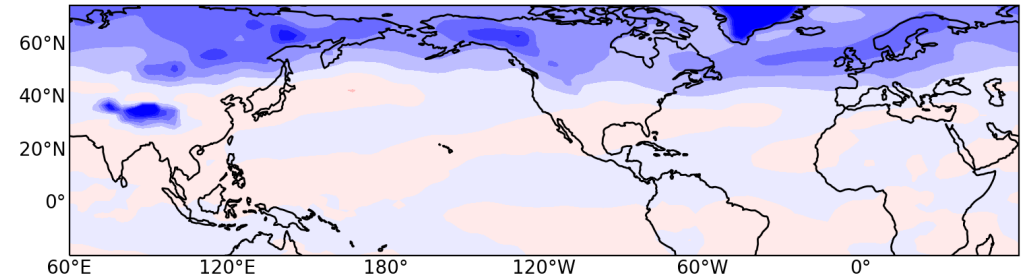


Mid-Pliocene BCs

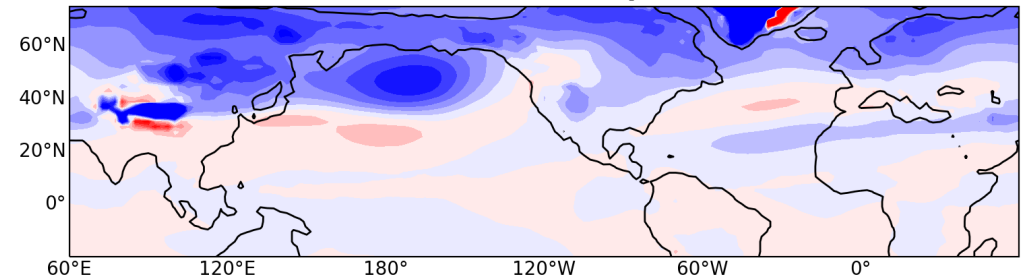


- Mid-Pliocene shows reduced PV gradient in North-Pacific, favoring anticyclonic wave breaking

Response to CO2 doubling



Response to mid-Pliocene BCs



Conclusion

- North Pacific jet exhibits **anticyclonic wave breaking** in response to mid-Pliocene boundary conditions
- Big **impacts** on regional sea-level pressure, but also temperature and precipitation patterns
- No such tendencies in response to CO₂ doubling

👉 mid-Pliocene is **not a good analog for a warm future** climate when considering Northern hemisphere winter atmospheric dynamics.

Abstract:



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Utrecht University

Institute for
Marine and Atmospheric
research Utrecht





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