2020 CESM OCEAN WORKING
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EVALUATION OF THE ATLANTIC MERIDIONAL OVERTURNING CIRCULATION UNDER HIGH CO_2 EMISSIONS

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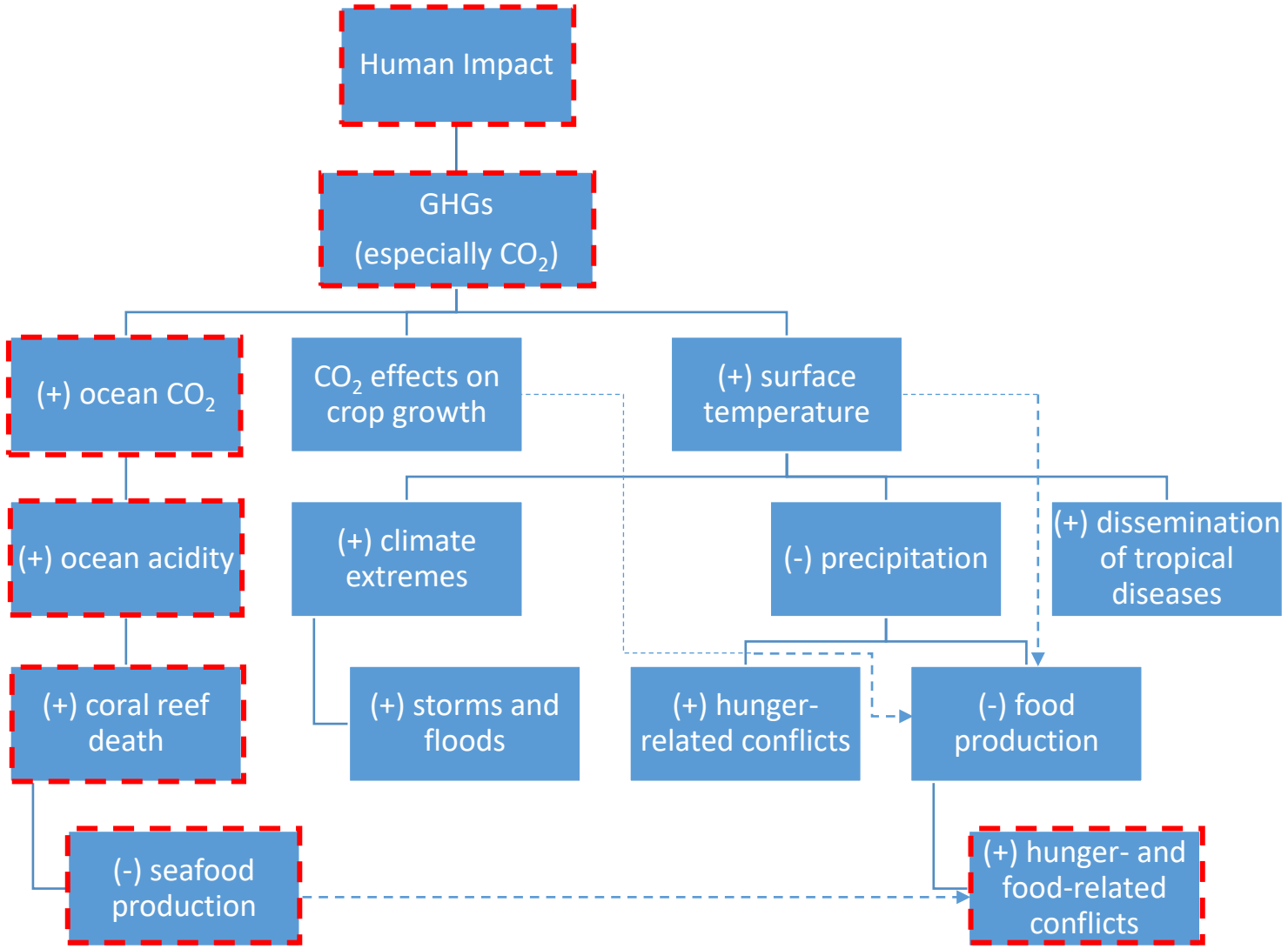
Climate Change and Social Impacts

Cause

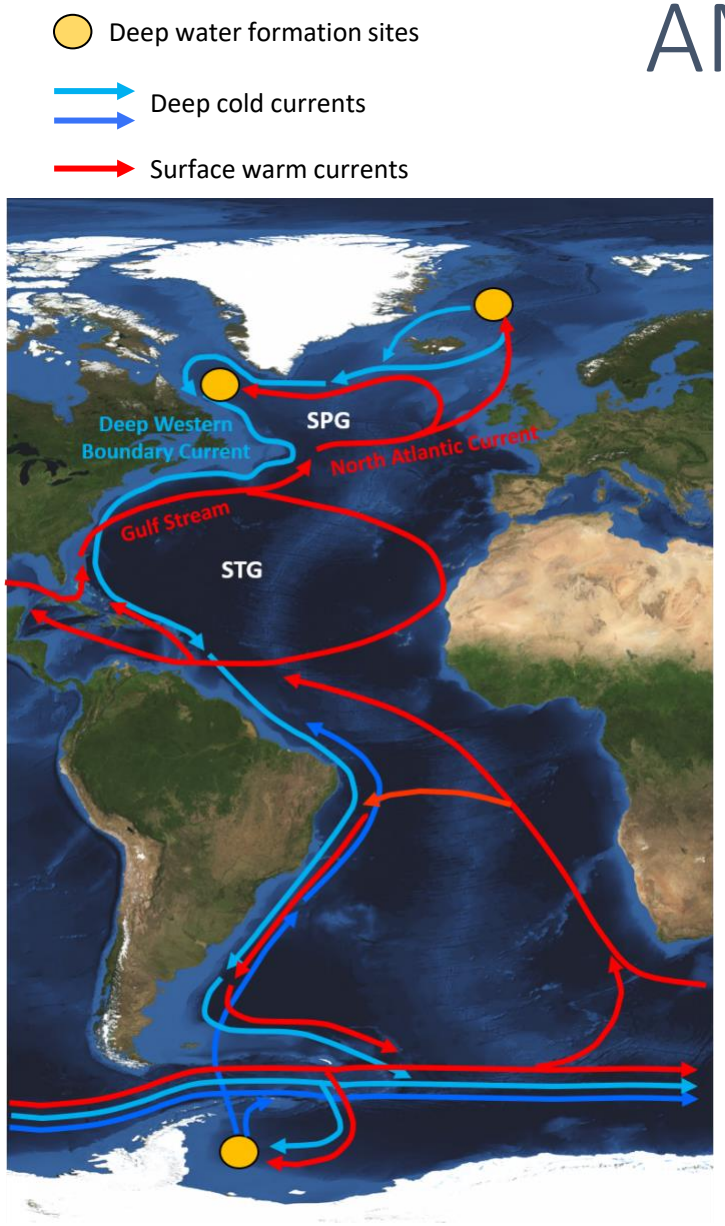
↓

Effect



Modified from Jared Diamond (2019).

AMOC and NADW x CO_2



- Balance in the CO_2 concentration between reservoirs (Houghton, 2008).

↑ Radiative forcing ↑ temperature ↓ CO_2 absorption potential.

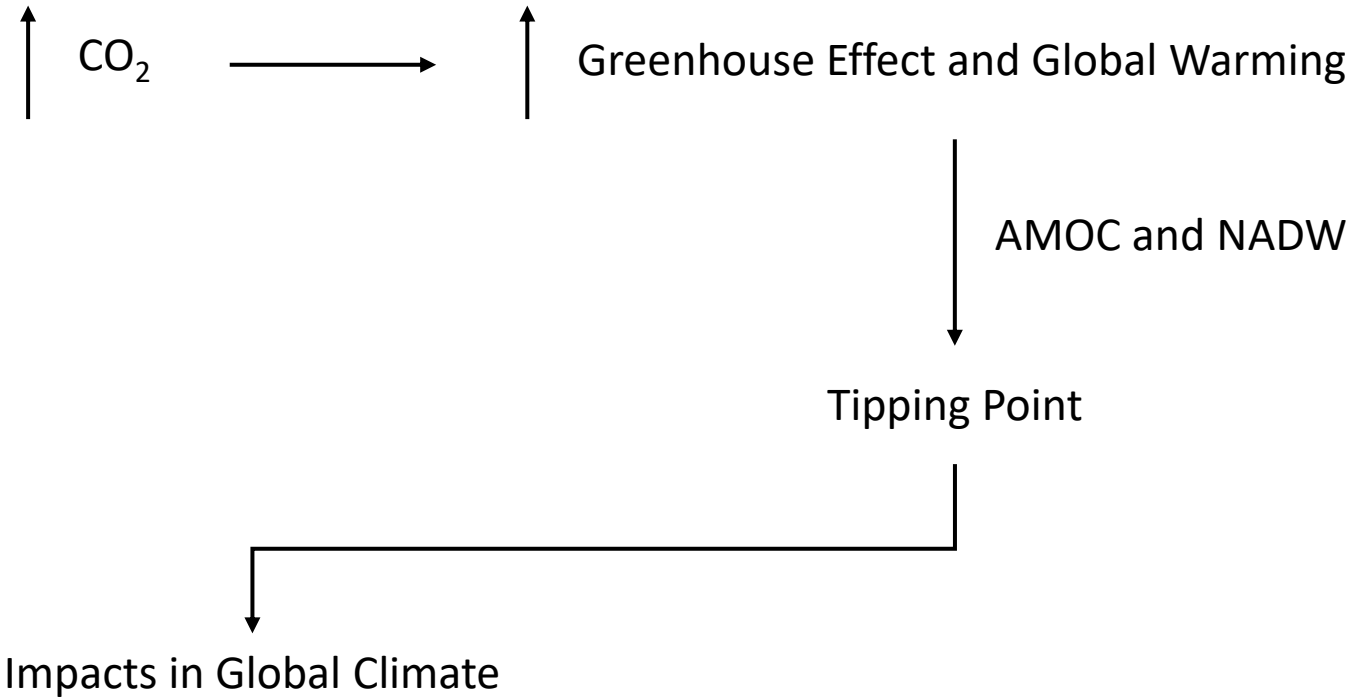
→ Change in the balance between reservoirs.

- A warmer climate is related to a weakened AMOC (Houghton, 2008).

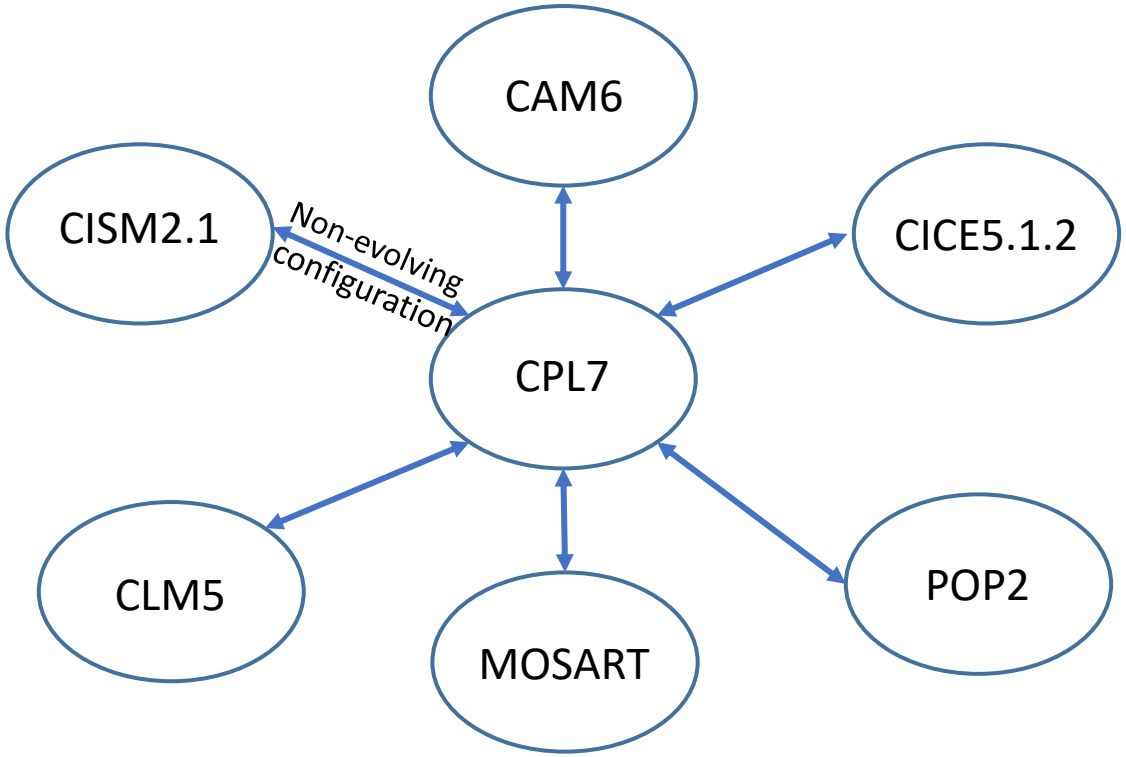
→ AMOC and NADW formation as the drivers of the current stable climate (Ansorgue *et al.*, 2014; Danabasoglu *et al.*, 2019; Tomczak & Godfrey, 1994).

Source: https://race-synthese.de/the-atlantic-meridional-overturning-circulation.

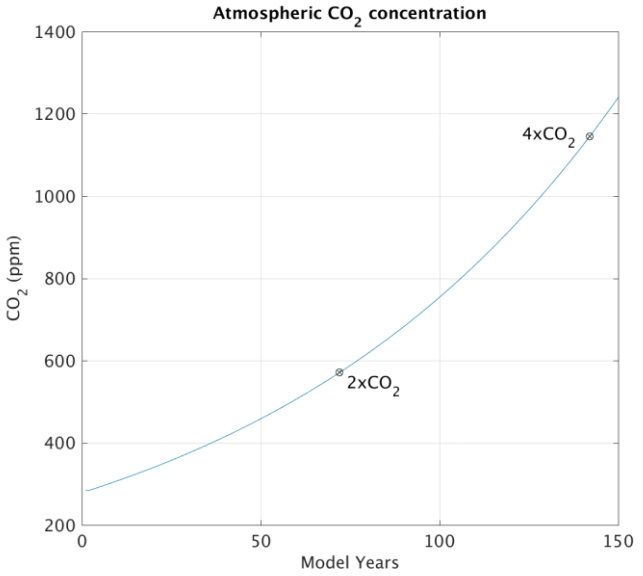
Hypothesis


CO_2
Greenhouse Effect and Global Warming
AMOC and NADW
Tipping Point
Impacts in Global Climate

Methodology – CESM2 and Experiments



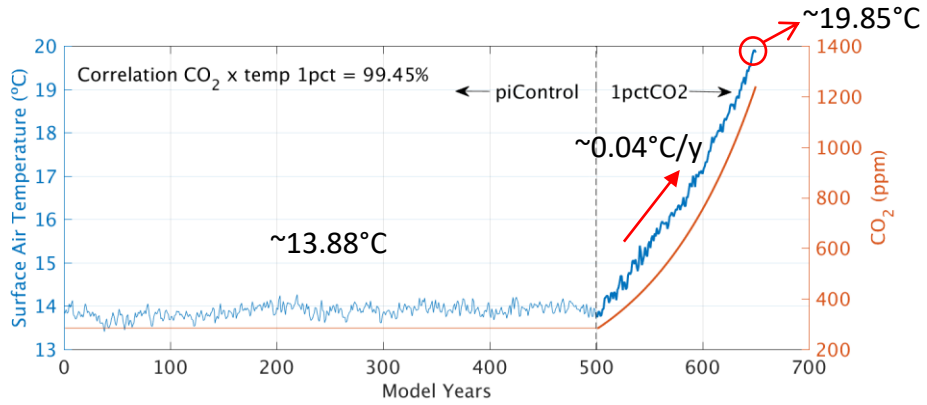
Exp.	Forcings	T. int.	Aims
piControl	Invariant	1200 y	Evaluate unforced variability
1pctCO_2	↑ 1%/y CO_2	150 y	Climate sensitivity and feedback



Grid:
~1° horizontal

Forcing is horizontally uniform

AMOC Tipping point

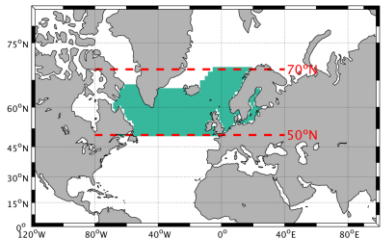


Lenton *et al.* (2008): ✓

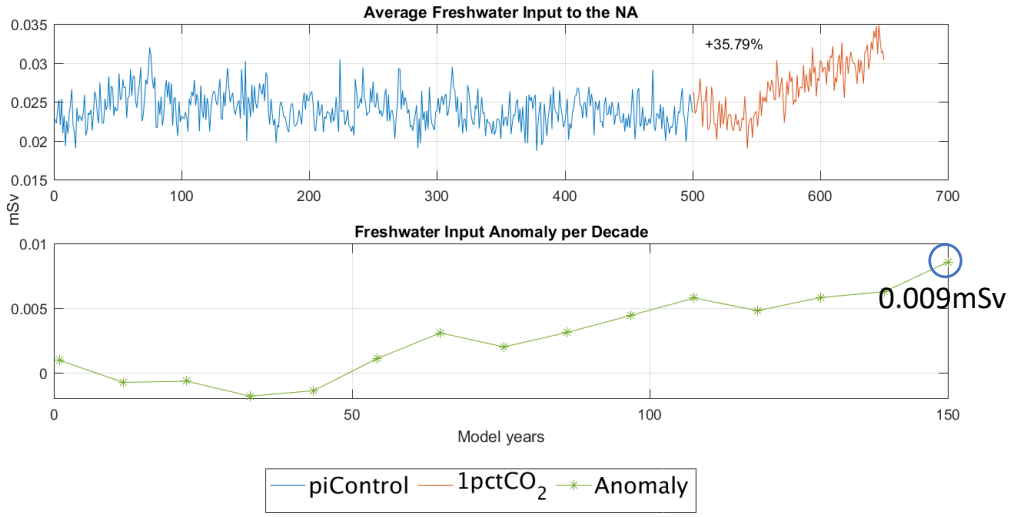
↑ 3-5°C above 14.05°C (1980-1999)

↳ Year 601 – 17.16°C (> 3°C)

↳ Year 637 – 19.14°C (> 5°C)



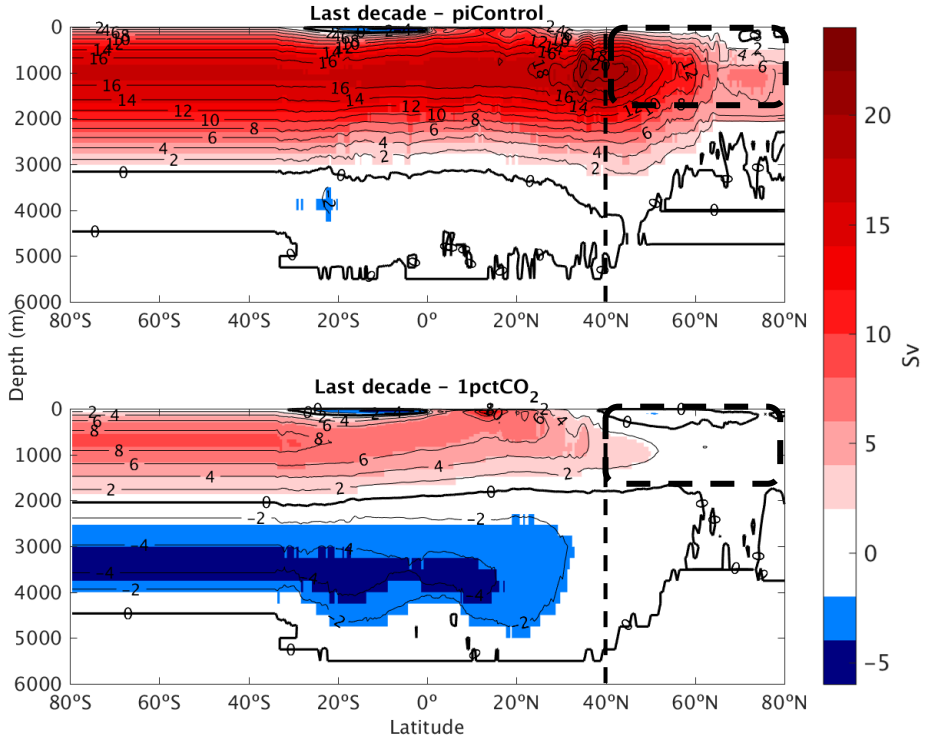
Manabe & Stouffer (1999)

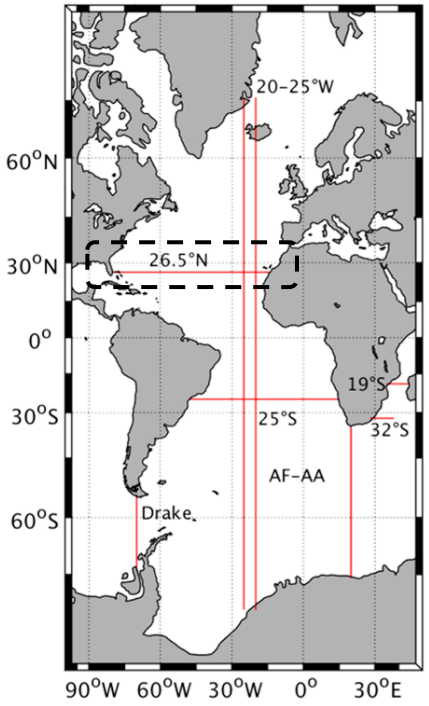


Lenton *et al.* (2008): ✗

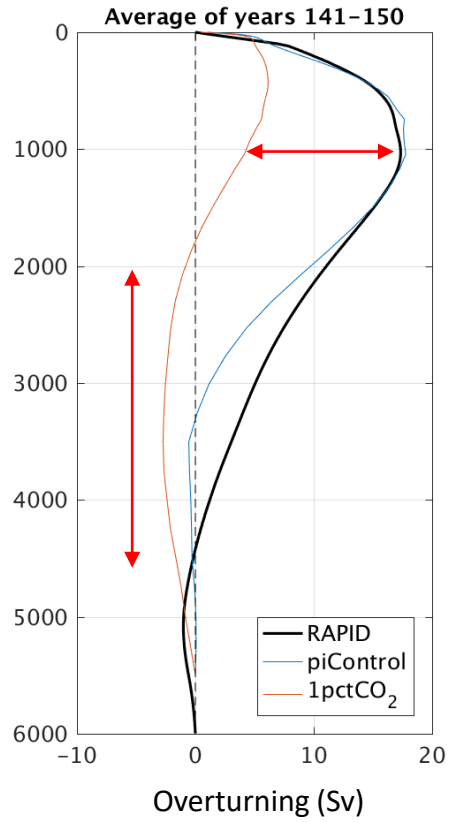
↑ 0.1-0.5 Sv

AMOC Tipping point



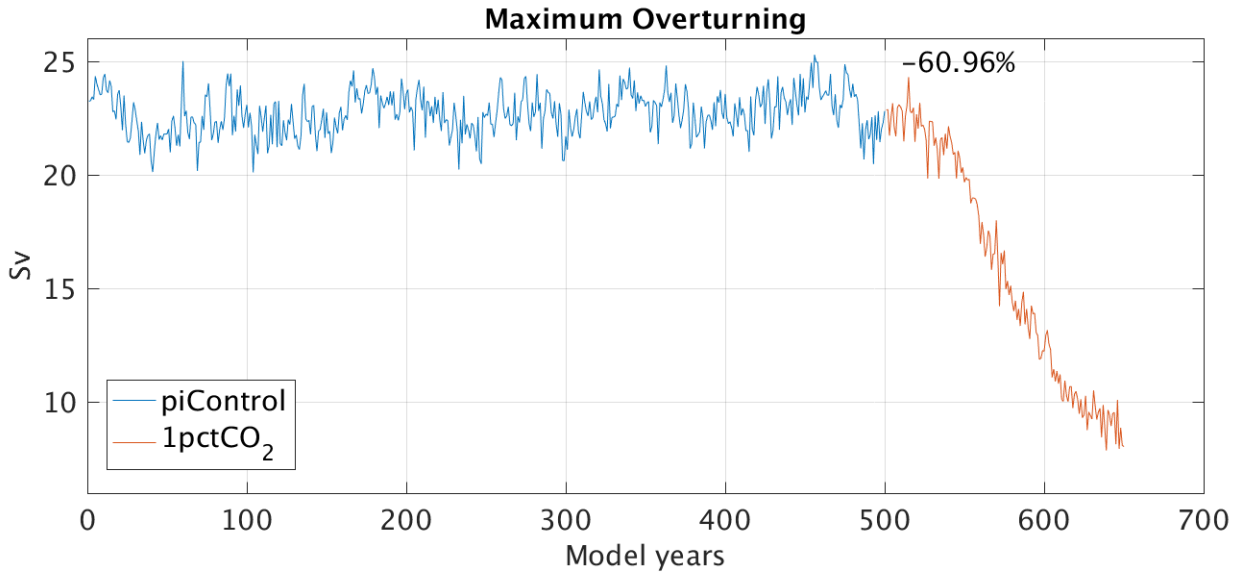


Meridional Overturning at 26.5°N



- ✓ Less heat reaching high latitudes in the North Atlantic.
- ✓ Shallower upper branch.
- ✓ Stronger and broader lower branch.

AMOC Tipping point



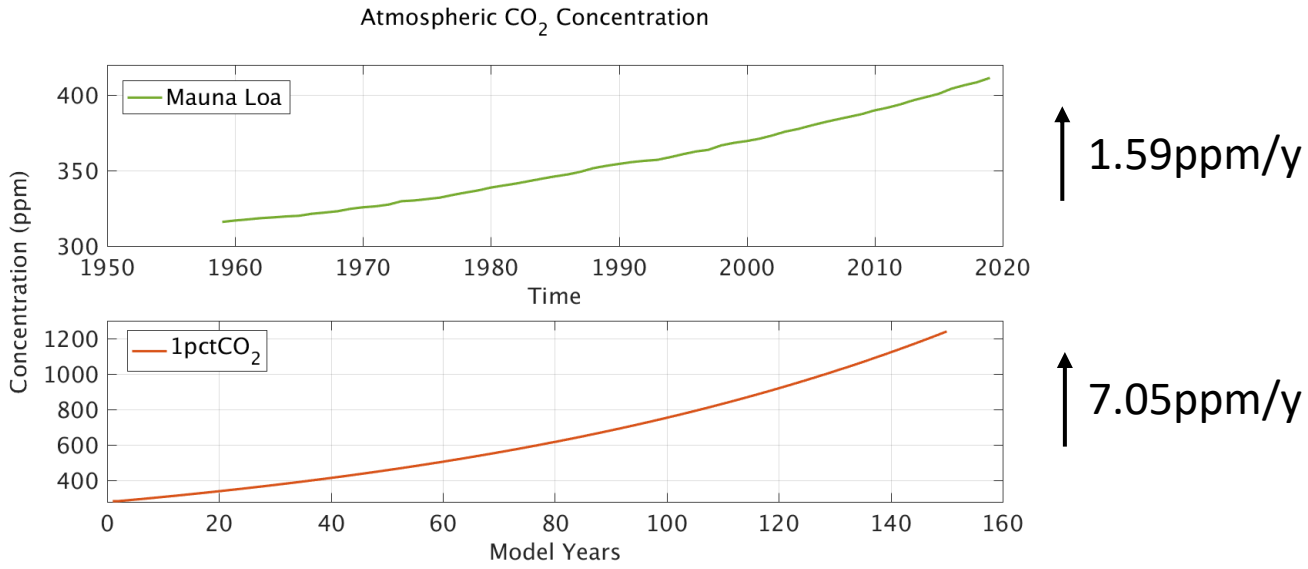
Bakker *et al.* (2016)

90% in the overturning.

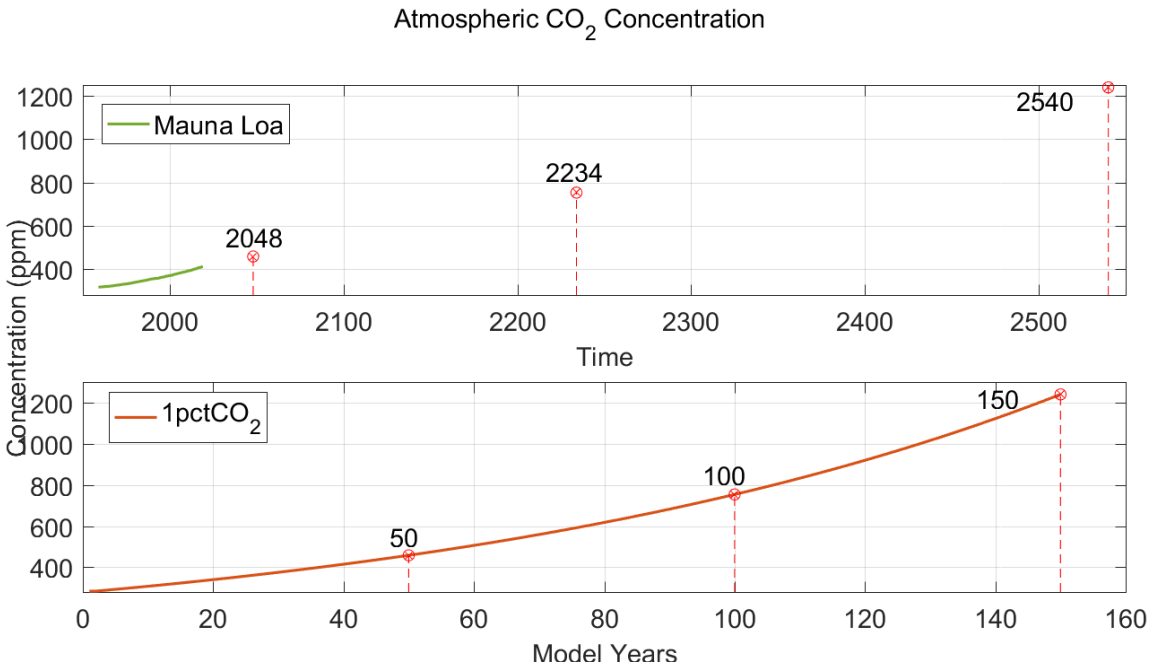
- Other significant changes were observed in the North and South Atlantic that are related with AMOC strength and NADW formation.

Projecting with 1pctCO_2

- 1pctCO_2 → idealized experiment
  - Not a projection scenario.
- Relate observed and simulated CO_2 emissions.
  - Project analyzed 1pctCO_2 changes into the real world.



Projecting with 1pctCO_2



In 2048:

↑ T 1.61°C above pre-industrial levels

↑ FW 2.88µSv → ↓ MLD → ↓ Deep convection: 22% LS
33% NS

↓ NADW formation

→ ↓ AMOC 13.39%

Remarks

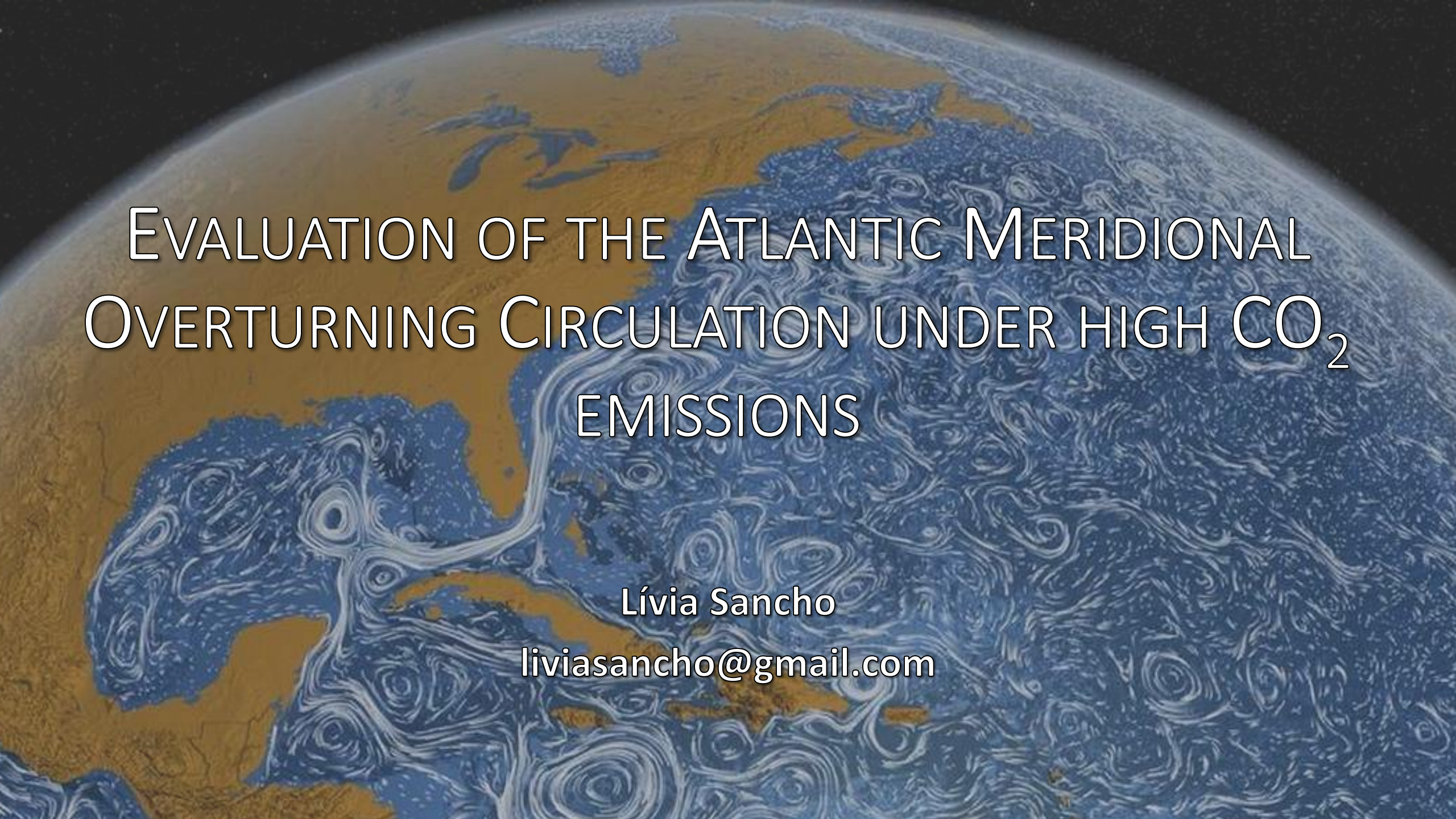
- ✓ Changes on the 1pctCO_2 were diverse and so were the consequences of them. This work made contributions to the knowledge about the mechanisms that govern and may influence AMOC dynamics and NADW formation.

- ✓ Without achieving a tipping point in the AMOC and NADW, the analysis identified several consequences for the Earth Climate System worldwide that arouse from the continuous increase in CO_2 forcing.

Remarks

- ✓ Despite being an idealized experiment, a simple projection into the future made based on measured atmospheric CO_2 showed some relevant consequences for the Earth Climate System in less than 30 years from now. This exercise demonstrated not only the relevance of the results as well as a potential future if nothing is done to reduce GHGs atmospheric emissions.

- ✓ In addition to the environmental consequences due to Global Warming, other studies reveal its consequences for human life like shorter gestational lengths (Barreca & Schaller, 2020), leading to lower birth weights, for example.



Evaluation of the Atlantic Meridional Overturning Circulation under high CO_2 emissions

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