The Importance of North Pacific Basin Geometry on Atlantic Overturning

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Ocean general circulation is driven by density (salt + heat) and wind. The ocean currents are made up of turbulent eddies, filaments, and fronts. We can simplify it and approximate it as a global overturning circulation.
Circulation asymmetry between Atlantic and Indo-Pacific

Atlantic Meridional Overturning Circulation (AMOC) linked to elevated salinity of Atlantic basin

Ferreira et al, 2018
AMOC is important for the Earth’s response to climate change.

Transports heat northward at all latitudes in the Atlantic:

Implications for climate in Europe compared to same latitudes in North America

Motivating Questions:

- What causes hemispheric circulation asymmetries in the ocean and atmosphere?
- How does ocean basin geometry impact the localization of meridional overturning circulation (MOC)?
  - Land distribution in the North Pacific is key to location of deep water formation
Idealized modeling: a hierarchy of simpler models (Held, 2005)

- Human
  - Prokop, 2015
- Mouse
- Fruit fly

Earth's Climate

Climate Model

Aquaplanet

Figures from Xiaoning Wu
Idealized modeling: a hierarchy of simpler models (Held, 2005)

Human

Prokop, 2015

Mouse

Figures from Xiaoning Wu

Earth’s Climate

Climate Model

Aquaplanet

Fruit fly
Results differ from previous work: size of basin not sufficient for MOC location.
Geometry of North Pacific basin key for pattern of overturning circulation

EN4 Observations

Double Drake

North Pacific Double Drake
Don’t need land in the North Pacific, just a latitudinal barrier
Where dense water at the surface is exposed to cold air, it sinks.
Ocean basin geometry and surface fluxes in the Pacific play an important role in overturning circulation and AMOC localization.

Ocean takes up heat at low latitudes and must deliver it to high latitudes, but is indiscriminate about the region where heat loss occurs.

**Key takeaways:**

- Basin width is not sufficient to generate an AMOC in our model.