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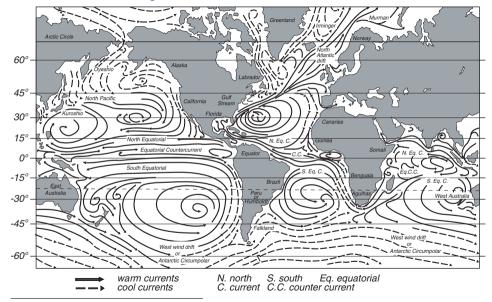
Climate Dynamics (Summer Semester 2018)
J. Mülmenstädt

Today's Lecture (Lecture 8): Meridional overturning circulation of the oceans

#### Reference

Hartmann, Global Physical Climatology (1994), Ch. 2, 3, 6 Peixoto and Oort, Ch. 4, 6, 7, 14, 15 Kuhlbrodt et al. (2007), linked from course webpage

# 2.5 - Meridional overturning circulation of the oceans

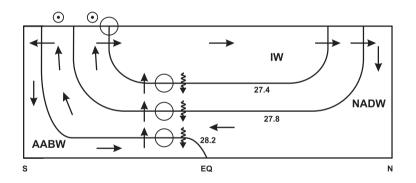


## Meridional overturning circulation

- Definition: meridional-vertical circulation ("meridional overturning circulation" or "thermohaline circulation")
- Function:

meridional heat transport vertical heat storage (also CO<sub>2</sub> storage)

- Structure:
  - Upwelling processes that transport volume from depth to near the ocean surface
  - Surface currents that transport relatively light water toward high latitudes
  - Deepwater formation regions where waters become denser and sink
  - Deep currents closing the loop
- Timescales: millennial



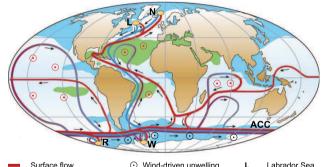
## The global conveyor belt

### Meridional overturning circulation

- Upwelling processes that transport volume from depth to near the ocean surface
- Surface currents that transport relatively light water toward high latitudes
- Deepwater formation regions where waters become denser and sink
- Deep currents closing the loop

#### Deepwater formation

- Density dictates vertical motion
- ► Temperature of all oceans is approximately  $-2^{\circ}$ C at the poleward boundary (ice formation)
- Whether water is dense enough to sink is decided mainly by salinity
- Sufficient salinity is reached in the north Atlantic and under the Antarctic ice sheets (due to brine production during freezing)







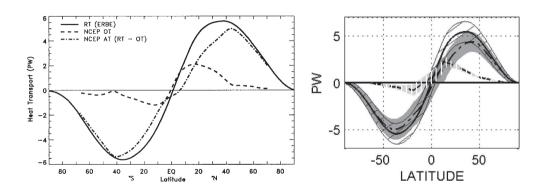




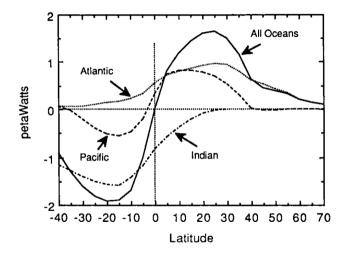




# Partitioning between atmospheric and oceanic transport

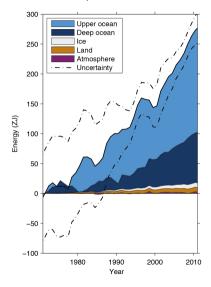


# Partitioning of meridional transport between oceans



Note the anomalous equatorward transport in the South Atlantic Ocean

### Oceanic heat uptake



- Ocean warming dominates the global energy uptake
- Warming of the ocean accounts for about 93% of the energy uptake between 1971 and 2010
- Warming of the upper (0 to 700 m) ocean accounts for about 64% of the total
- Energy uptake is equivalent to 0.4 W m<sup>-2</sup> (global average), or 0.55 W m<sup>-2</sup> (ocean average)