On the superposition of mean advective and eddy-induced transports in global ocean heat and salt budgets

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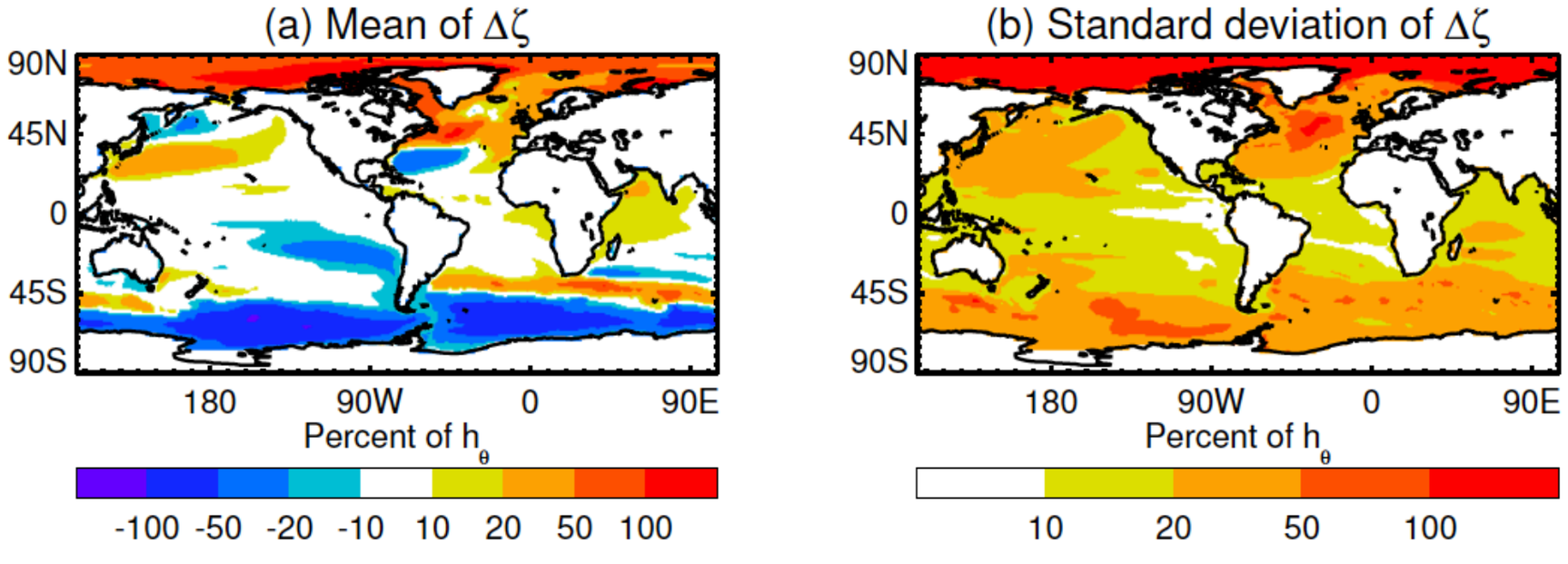
Motivation



Gregory et al., 2016

- Thermal expansion of the seawater corresponds to ~30-50% of the sea level changes
- One of the main sources of uncertainties in projections
- No improvements since last CMIPs
- Lack understanding of the processes behind ocean heat uptake and vertical heat transport

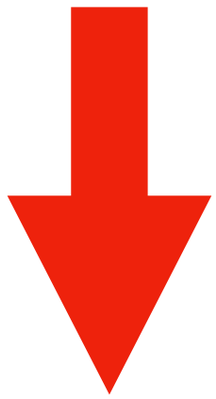
Ocean heat budget

$$Cp\ \rho_0\ \partial_t\ \Theta\ dz \quad = \quad -\nabla_s\ F\ dz$$

$$F \quad = \quad ADV + DIA + KPP + SWP + EIT + SUB + CON + PME + RIV + FRZ$$

- Explains ocean heat content changes due to different processes
- Explicitly represented or parameterised
    - Depend on model resolution/computational resources
- Current generation (1degree ~ 100km)
    - only resolves large-scale circulation (advection)
- Current knowledge:
    - Southern Ocean (south of 30°S) dominates the vertical transport:

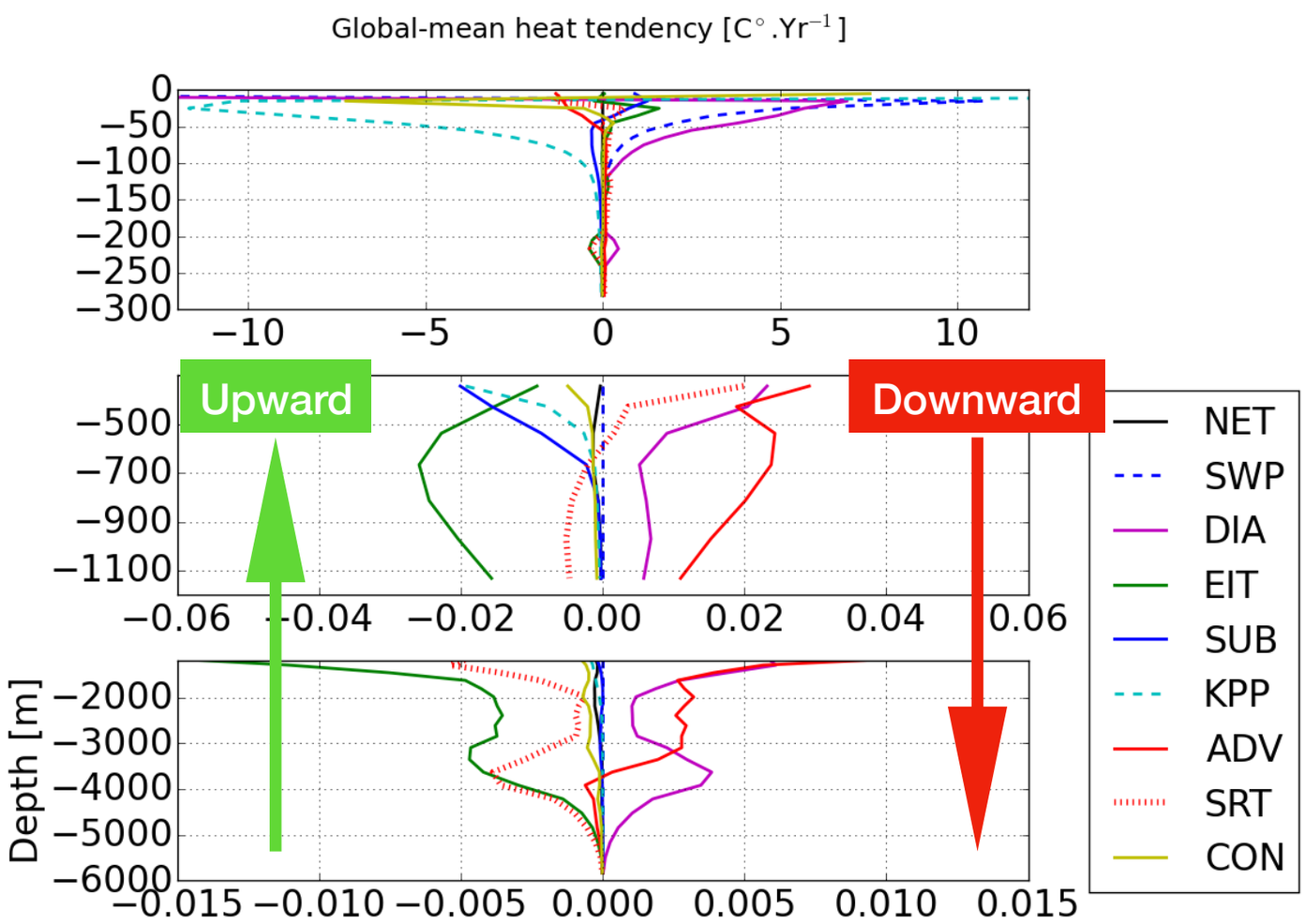
Mesoscale eddy-induced transport



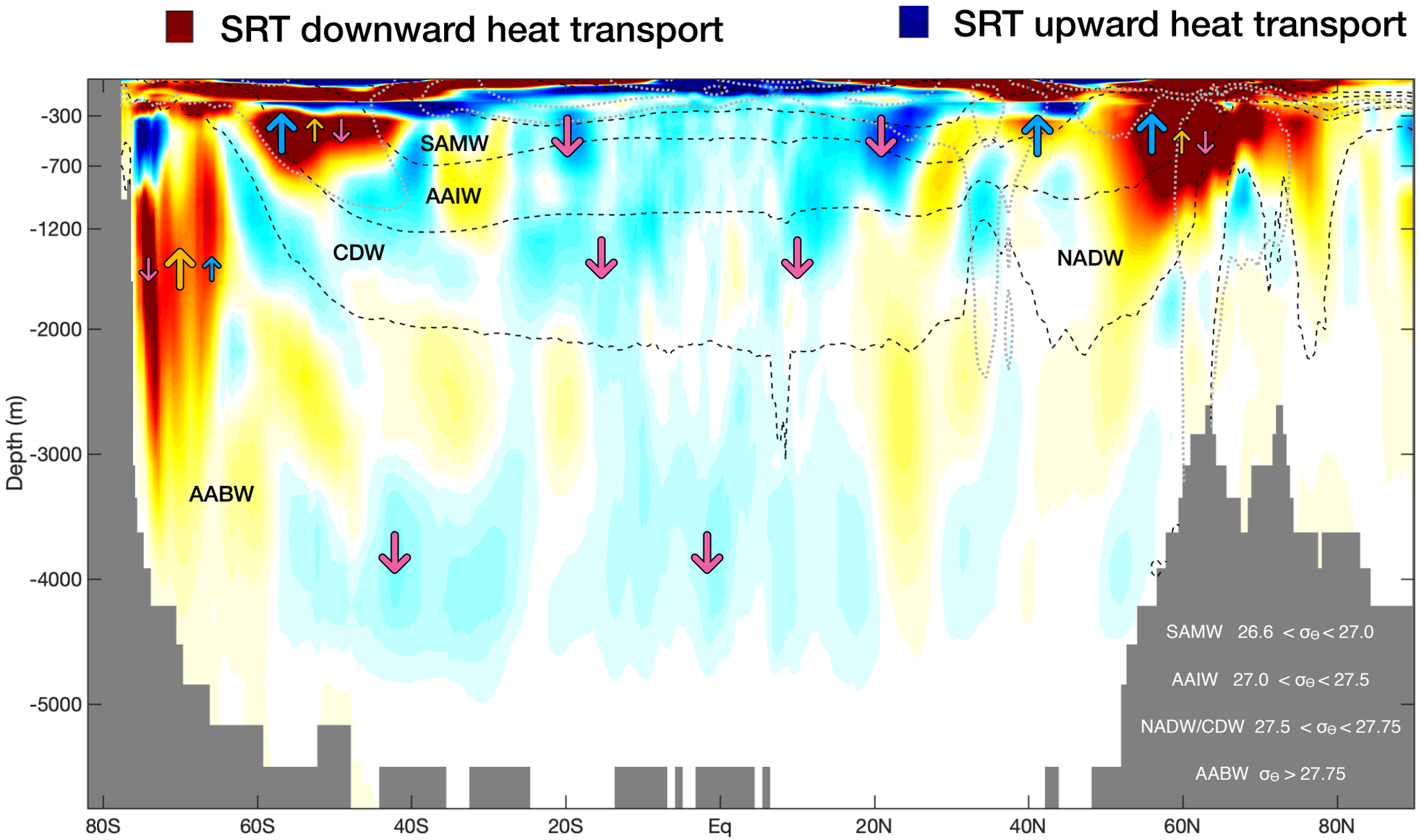
Large-scale advection

Global vertical heat balance

- Near-stable 1000-yr **ACCESS-OM2** run forced with JRA55-do RYF
- New framework:
    - combine large-scale advection + eddy-induced transport = SUPER-RESIDUAL TRANSPORT (dashed red line)
    - reveals two depth-based regimes:
        - (a) mixed layers
        - (b) ocean interior



Super-residual framework



Upward heat transport by **non-local KPP**

Upward heat transport by **Deep Convection**

Downward heat transport by **Dianeutral diffusion**

Impact of the framework

- Link between largest processes and small-scale mixing
    - formation and spread/destruction of dense water masses
- Intermodel comparison - independent of model resolution
    - Large-scale and mesoscale processes combined
    - Eddy-permitting -> inconsistency resolved or parameterised
- Calibration of simple climate models: advective-diffusive balance