Advection, Diffusion, or Confusion

Tracer fluxes in the Southern Ocean

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- Tracers can be moved either by mixing them around, or by advecting them.
- Mesoscale eddies contribute to both processes.
- Which dominates, and how will the balance change in the future?
- Depends where you are, but advection is usually dominant (so far).

A mathematical framework

$$T(C) = \int_0^L \sum_{i=1}^{N} v(x,y,i,t)h(x,y,i,t)C(x,y,i,t)ds,$$

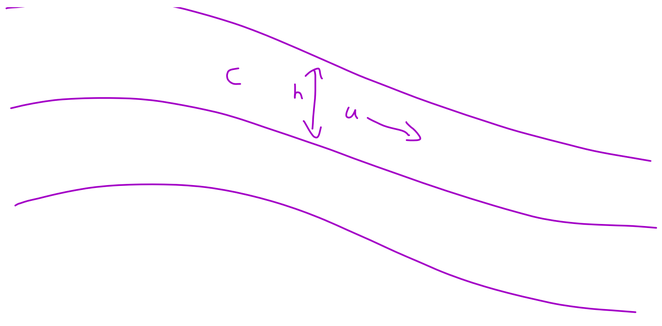
And then, time-average to get:

$$\overline{T}(C) = \int_0 \sum_{i=1}^{N} \left(\overline{v}\,\overline{h} + \overline{v'h'}\right)\overline{C}ds + \int_0^L \sum_{i=1}^{N} \overline{(vh)'C'}ds,$$

Time-mean Advection

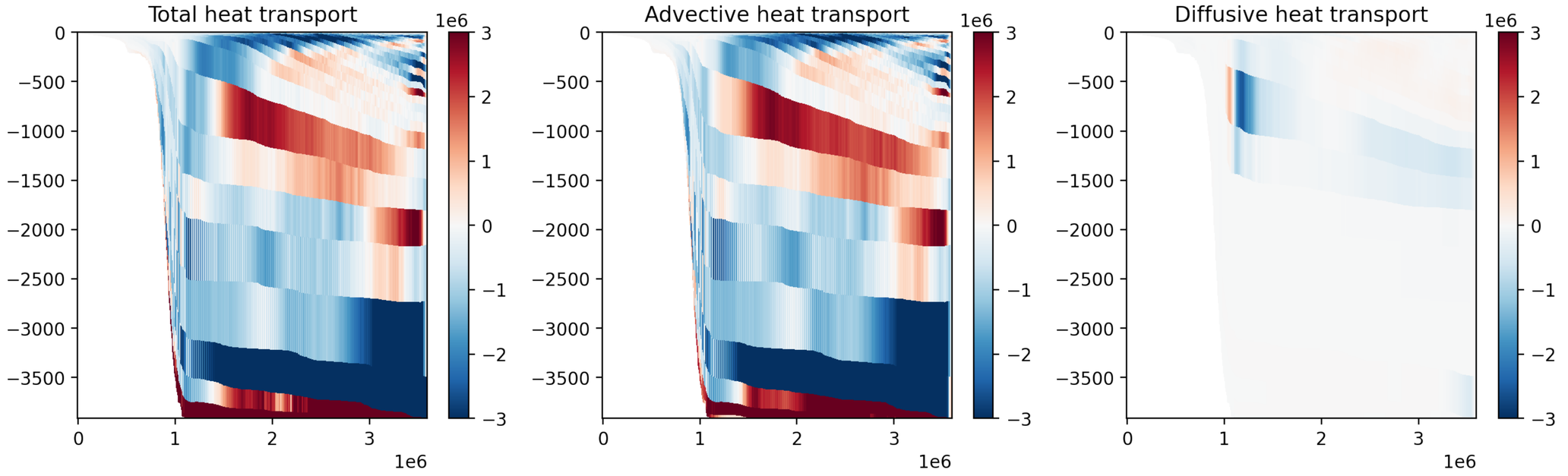
Eddy Advection

Eddy diffusion

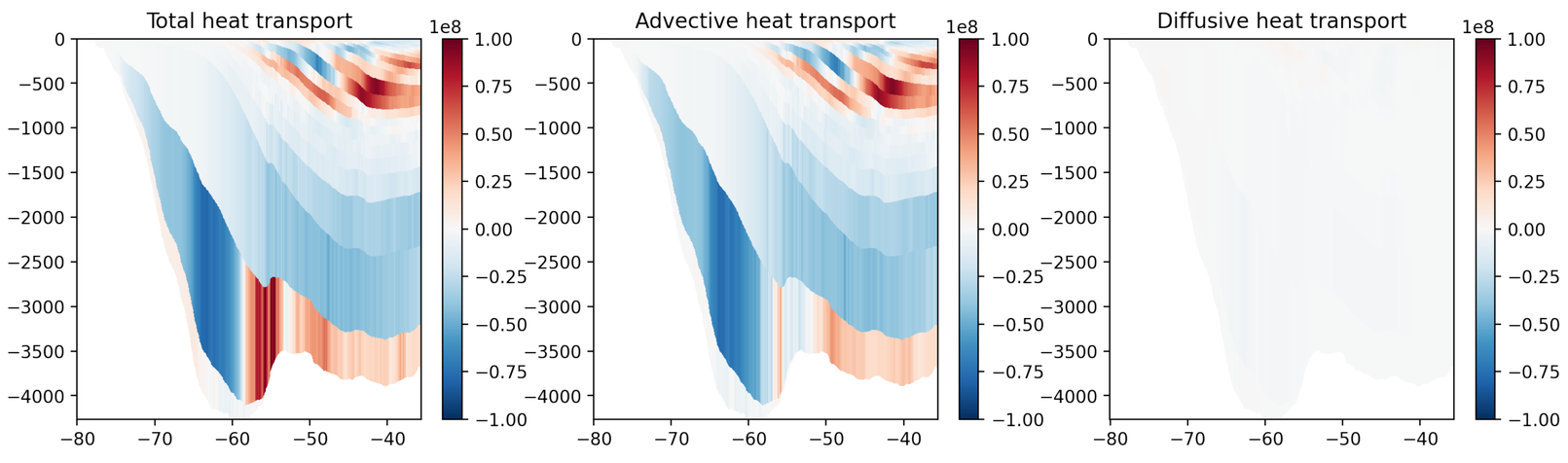


In a channel model

Diffusive transport by eddies only makes a significant contribution in the Antarctic Intermediate Water layers.



Model diagnostics in ACCESS-OM2-025



Again, mostly advection (**enormous caveat**: the temporal and spatial resolution of the output is a problem - I need to redo this using the higher resolution simulations and daily output).

OK, but why do I care?

When eddy diffusion is important, we can transport tracers without a net transport of fluid - we can have surprising amounts of ventilation in upwelling zones.

Tracer transport is a crucial part of ocean ventilation. If you care about carbon, nutrients, heat, salt, or anything that is moved around by the ocean, then you should care about this balance.