

MOM6 diagnostic consistency on non-native grids (work in progress)

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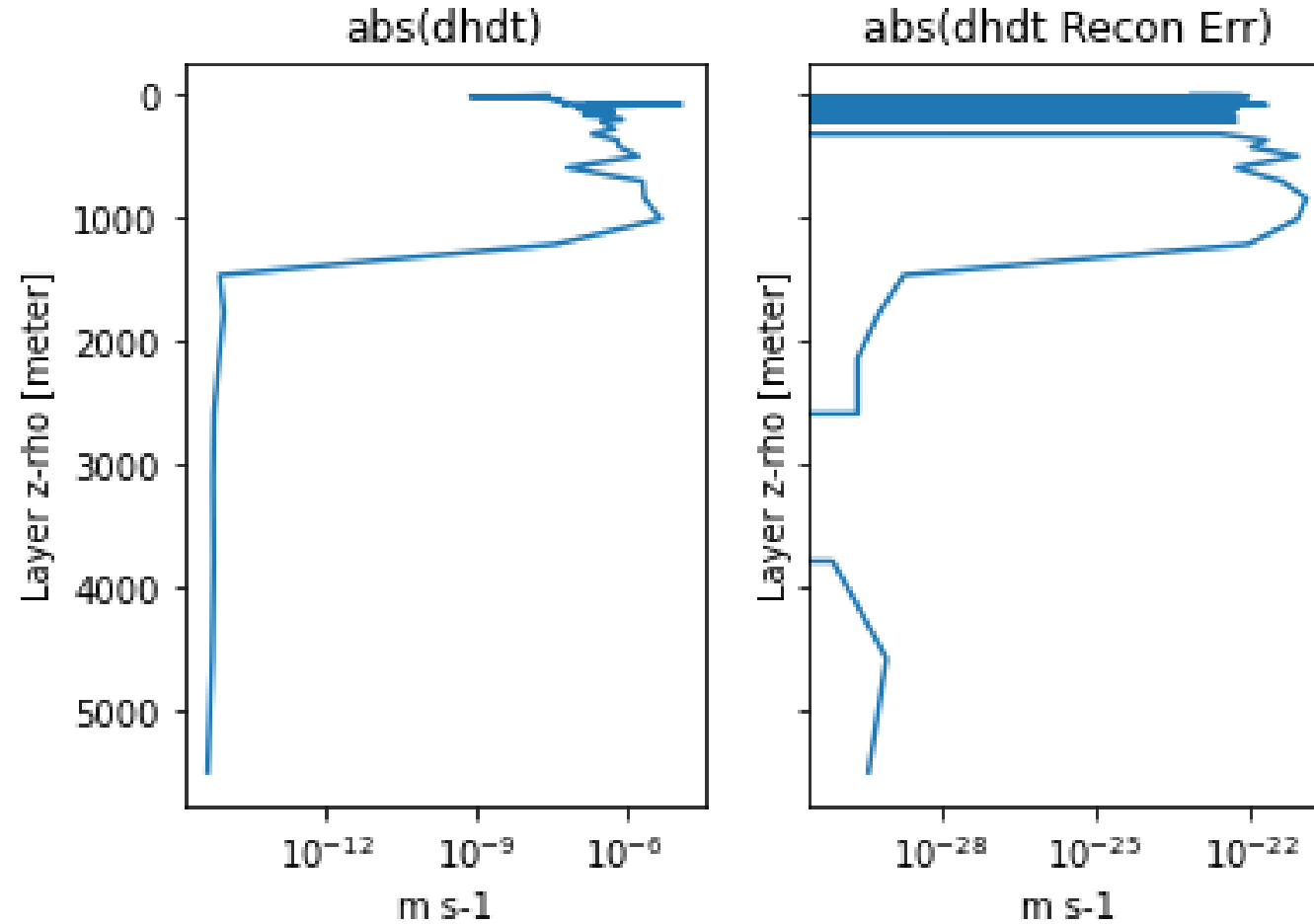
Motivating Application: Diagnostics for Preconditioner in Newton -Krylov based Solver for Tracer Spin -up

- NK spin-up operates on tracers on a fixed z^* grid
 - to ease computation/interpretation of difference $\text{tracer}^{\text{end}} - \text{tracer}^{\text{beg}}$
- Krylov preconditioner based on terms of the form $\partial(\text{tend}) / \partial(\text{tracer})$ for different tracer tendency terms
 - tend and tracer on z^* grid
- Terms computed by computing tendency terms from impulses on z^* grid, generating tendency diagnostics on z^* grid
- Remapped diagnostics didn't work quite as expected...

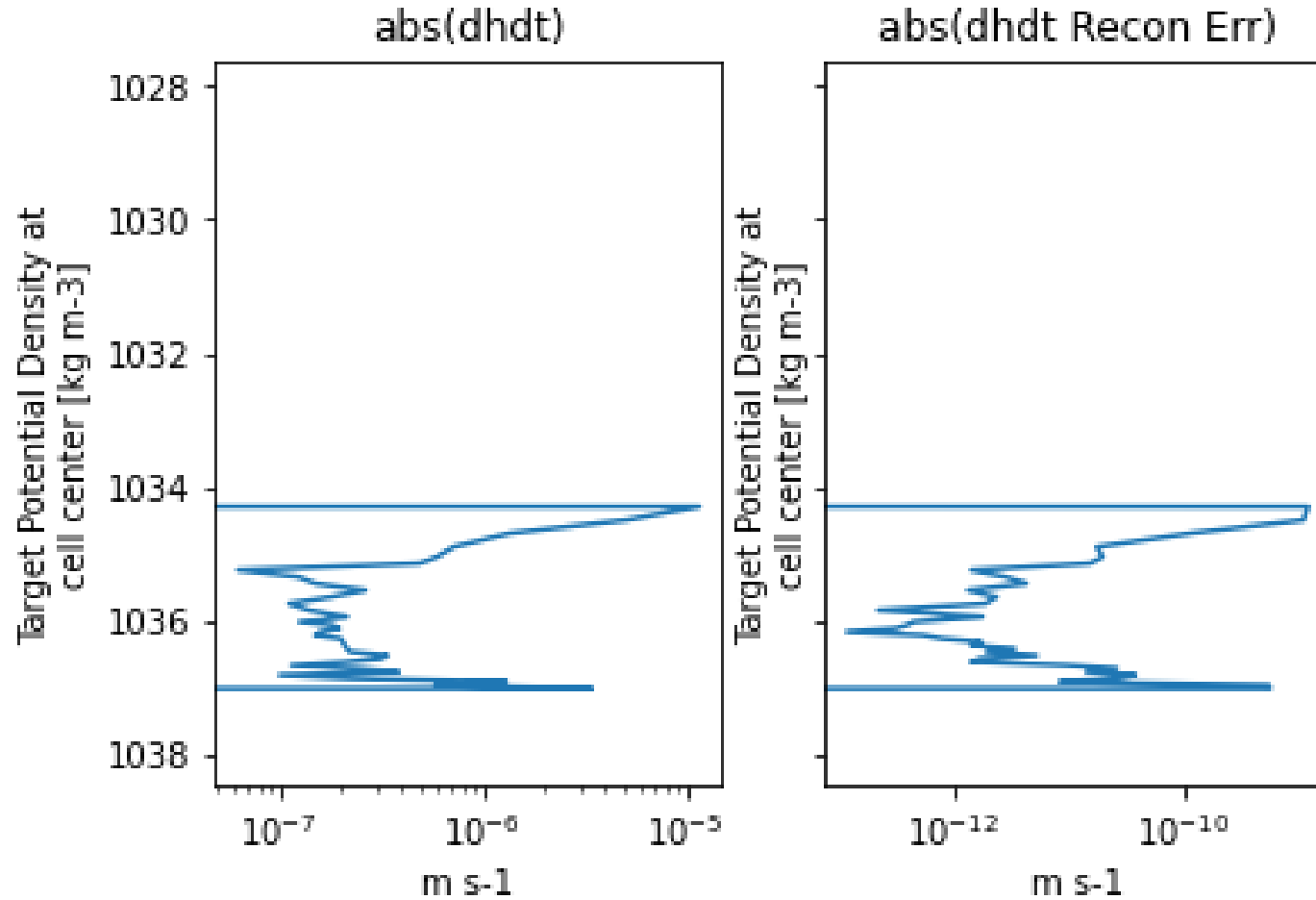
Features of thickness budget desired to hold on non-native grids

1. $\text{dhdt} = \text{boundary_forcing_h_tendency} + \text{vert_remap_h_tendency} + \text{dynamics_h_tendency}$
2. $\int_{t_0}^{t_1} \text{dhdt} dt = h(t_1) - h(t_0)$

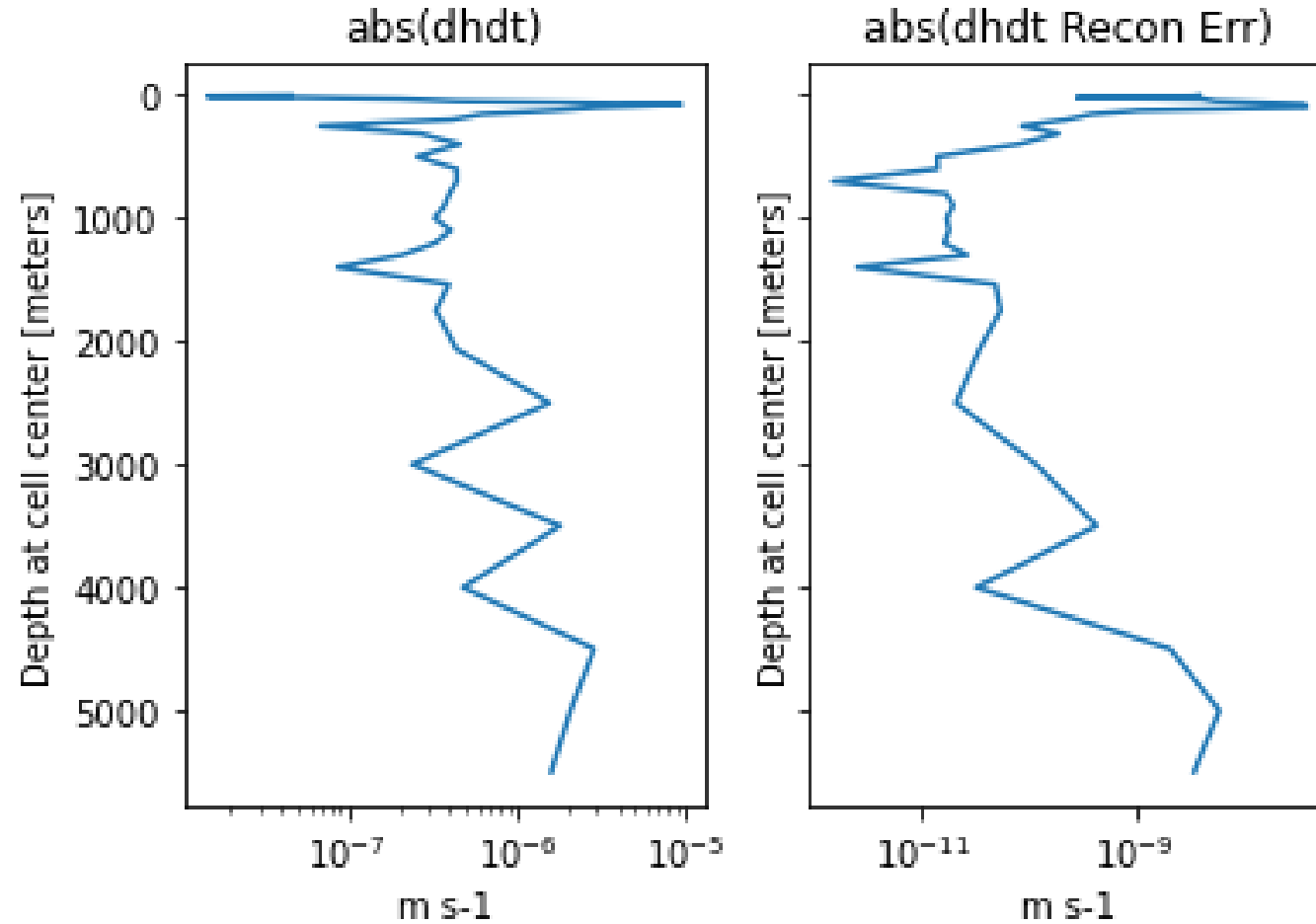
Reconstruct dhdt from terms native grid, daily mean, column in N Pac



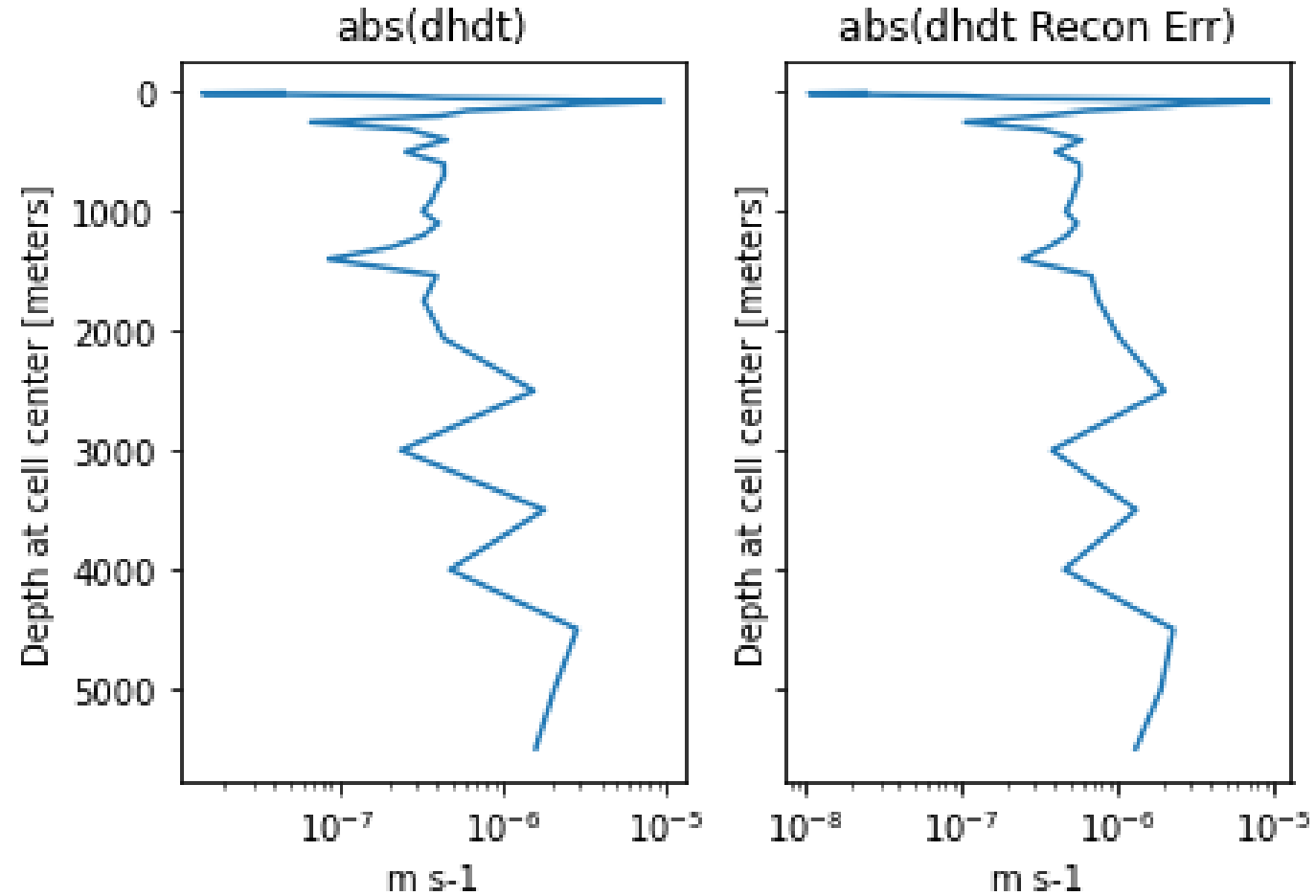
Reconstruct dhdt from terms rho2 grid, daily mean, column in N Pac



Reconstruct dhdt from terms z^* grid, daily mean, column in N Pac



Reconstruct mean dhdt from snapshots z* grid, daily mean, column in N Pac



Remapping Tendency Terms in Mathematical Terms

Consider the tendency of some field F :

$$\frac{\partial F^n}{\partial t} = \frac{F^{n+1} - F^n}{\Delta t}$$

Current approach in MOM6 to remapping this:

$$L\left(\frac{\partial F^n}{\partial t}\right) := L\left(\frac{F^{n+1} - F^n}{\Delta t}\right)$$

L remaps from native grid to diagnostic grid, depending on layer thicknesses on src and dst grids.

Difficulty arises from choosing thickness time-levels

Remapping Tendency Terms in Mathematical Terms

Generalization:

$$L\left(\frac{\partial F^n}{\partial t}\right) := \frac{L^{n,n+1}(F^{n+1}) - L^{n,n}(F^n)}{\Delta t}$$

RHS of adding two successive time steps:

$$\frac{L^{n+1,n+2}(F^{n+2}) - L^{n+1,n+1}(F^{n+1})}{\Delta t} + \frac{L^{n,n+1}(F^{n+1}) - L^{n,n}(F^n)}{\Delta t}$$

For eqn 2 to hold, middle terms need to cancel:

$$L^{n+1,n+1}(F^{n+1}) = L^{n,n+1}(F^{n+1})$$

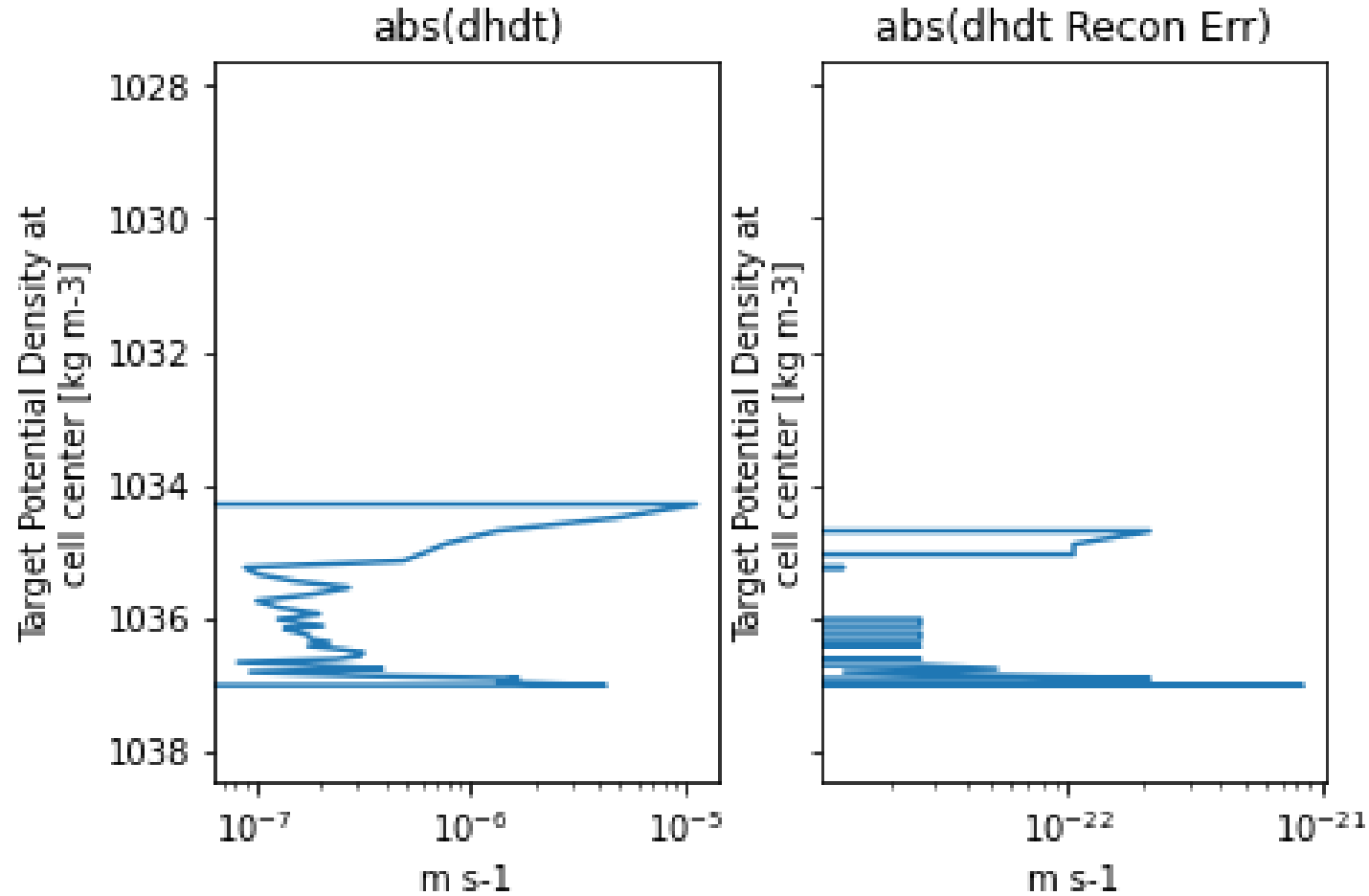
Remapping Tendency Terms in Mathematical Terms

Remapping operator needs to be independent of time - level of tendency, and instead depend on time -level of F being remapped.

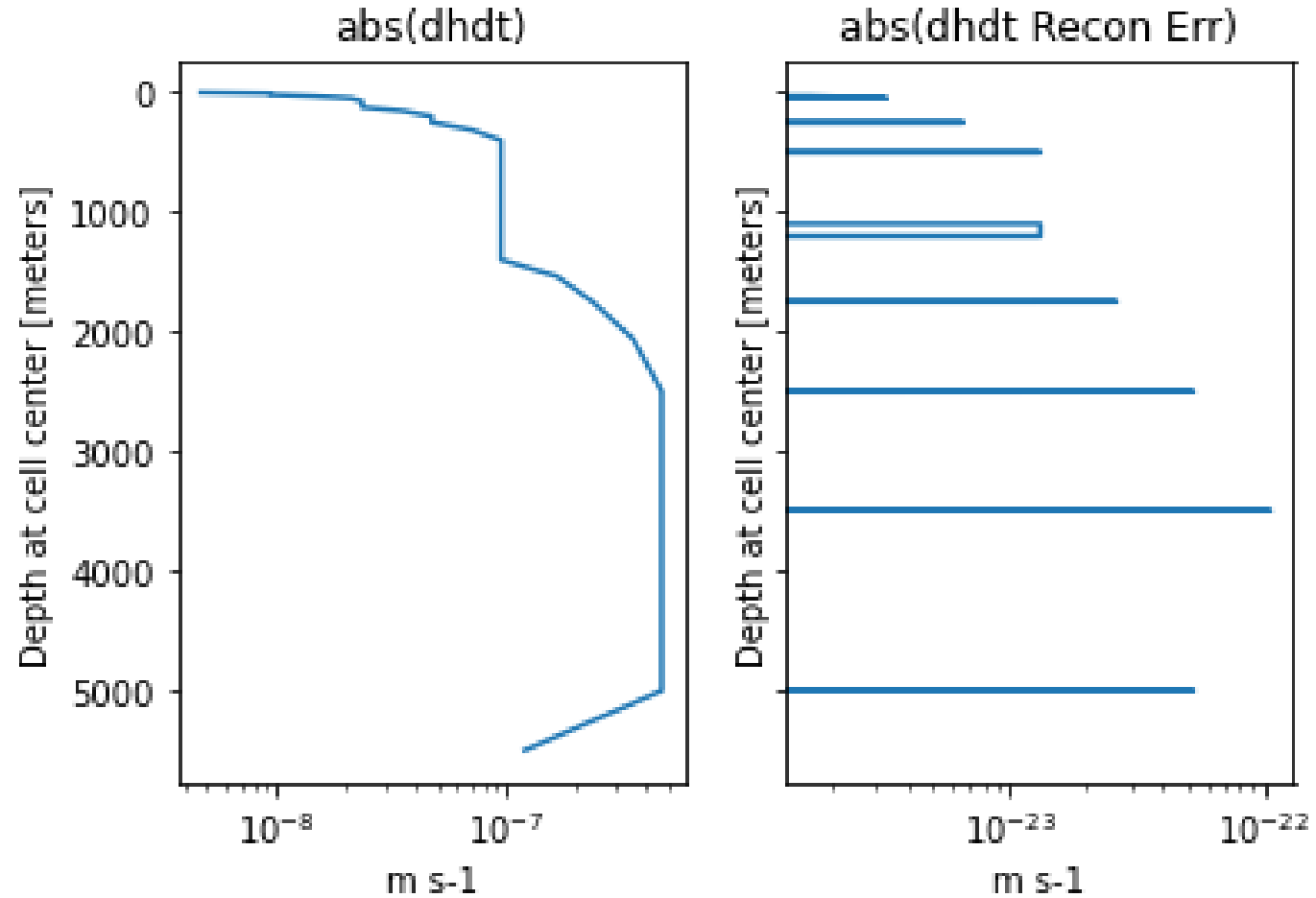
One approach to satisfy this constraint is for L^n to use thicknesses just prior to process related to F is applied, and L^{n+1} use thicknesses just after process is applied.

$$L \left(\frac{\partial F^n}{\partial t} \right) := \frac{L^{n+1}(F^{n+1}) - L^n(F^n)}{\Delta t}$$

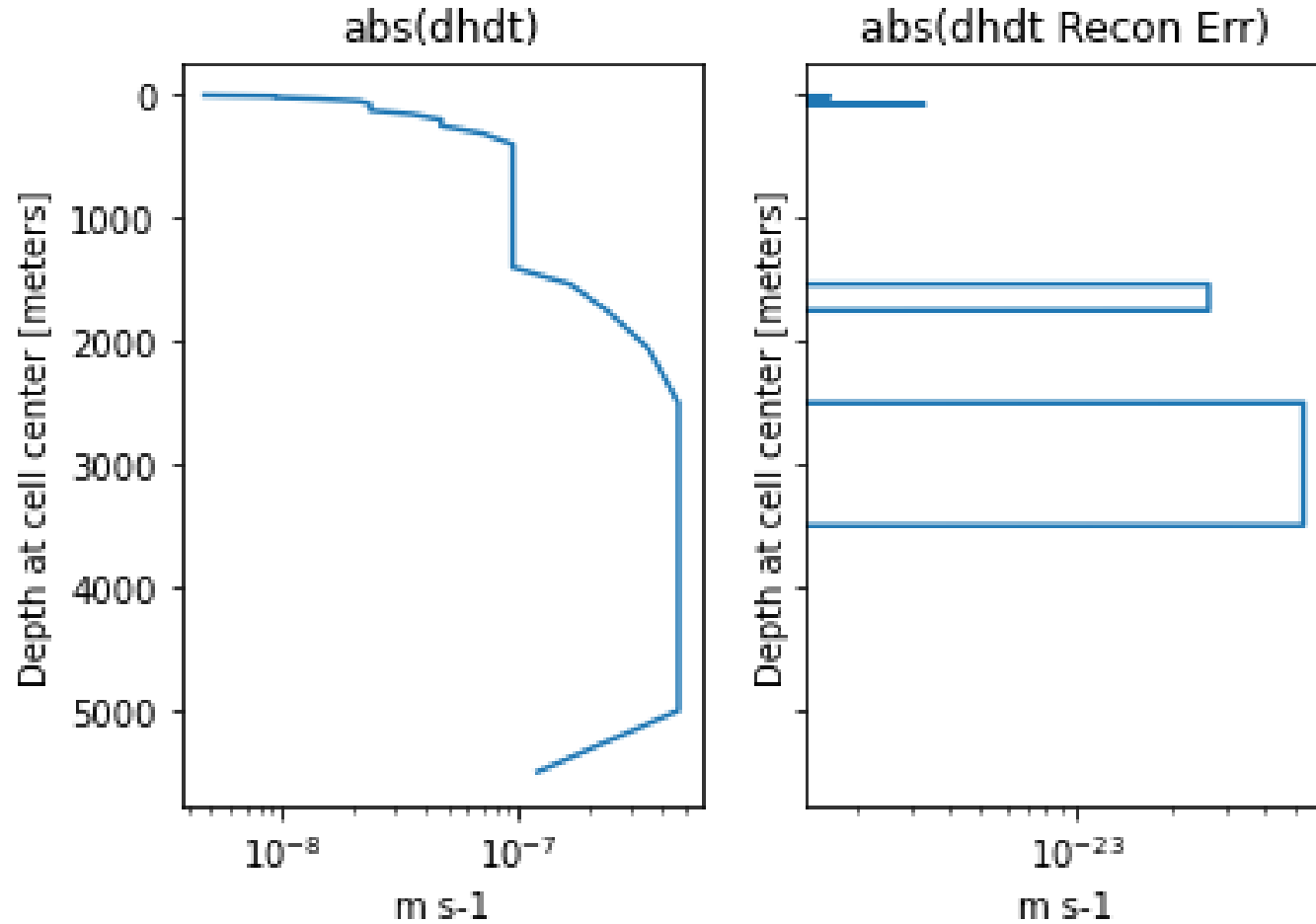
Reconstruct dhdt from terms rho2 grid, daily mean, column in N Pac



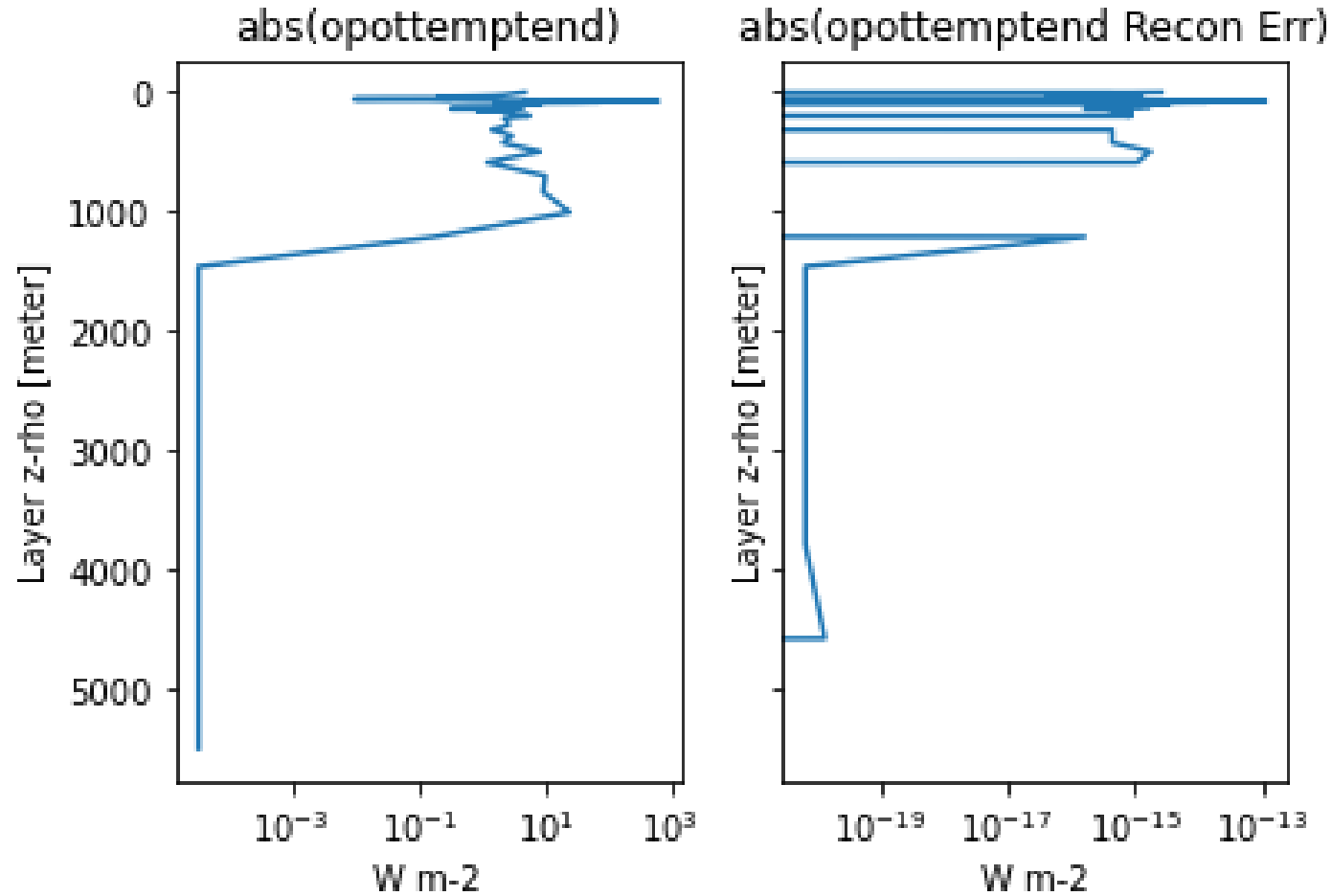
Reconstruct dhdt from terms z^* grid, daily mean, column in N Pac



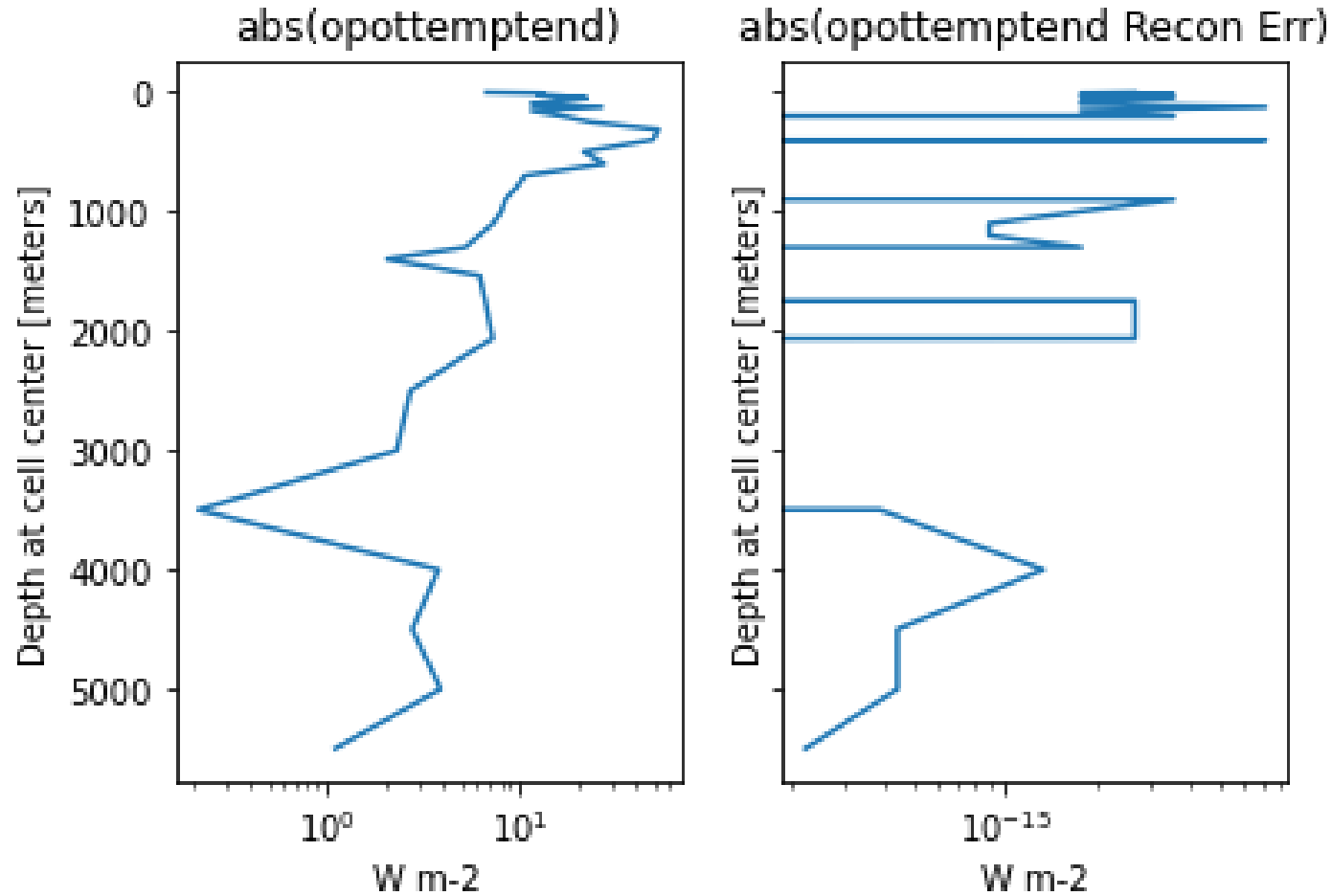
Reconstruct mean dhdt from snapshots z* grid, daily mean, column in N Pac



Reconstruct mean $opotemptend$ from snapshots native grid, daily mean, column in N Pac



Reconstruct mean opottemptend from snapshots z^* grid, daily mean, column in N Pac



Summary and Continuing Work

- Generalizing definition of remapped tendency terms enables reconstruction of thickness tendency by terms and finite differences from snapshots to hold on diagnostic grids.
- Reconstruction of tracer layer content tendency from snapshots works on diagnostic grids. Implementation of remapping tracer tendency terms is in progress.
- Can lateral fluxes be remapped to be consistent with divergence operator on diagnostic grid? not sure