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Motivations, successes, and problems, with the Lagrangian-remap dynamical core in MOM6

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The sixth version of the Modular Ocean Model, MOM6, uses the vertical Lagrangian-remap method as the basis of its dynamical core. One of the driving motivations for this approach was to permit generalized vertical coordinates and reduce the numerical mixing associated with the use of Eulerian vertical coordinates. The inspiration for the approach can be traced back to the isopycnal layer models that have their own limitations but do have excellent preservation of water masses and can represent dense overflows with high fidelity. In several studies, many idealized, the role of vertical coordinates in controlling spurious heat uptake has been established with confidence, and the utility of both generalized vertical coordinates and the Lagrangian-remap method demonstrated to be advantageous in reducing numerical mixing. The spurious mixing problem was known to be most dire for eddy-permitting models in which high grid-scale energy exacerbates the numerical mixing. Despite this, the ¼ degree OM4 model (using MOM6) has a well controlled global heat uptake by virtue of using hybrid vertical coordinates, and we consider this a success of the Lagrangian-remap and general coordinate approaches. However, one aspect of the solution is particularly unsatisfactory: the solution has a shallow Atlantic meridional overturning circulation which is reminiscent of the earlier Eulerian vertical coordinate models. The reasons for this bias are unclear and the result is at odds with the rationale behind developing MOM6. We will review the motivations behind adopting general vertical coordinates, illustrate the methods and algorithms used in MOM6 and discuss the outstanding conundrum of the shallow overturning circulation.

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