Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-173-RC2, 2020

Geoscientific Model Development Discussions

Interactive comment on "A Meridionally Averaged Model of Eastern Boundary Upwelling Systems (MAMEBUSv1.0)" *by* Jordyn E. Moscoso et al.

Anonymous Referee #2

Received and published: 27 October 2020

In this manuscript, Moscoso et al. present a new numerical approach for modeling the physics and planktonic ecosystems of eastern boundary upwelling systems. Their approach is model variations in two dimensions (depth and offshore distance) while parameterizing some of the important effects of alongshore variability. The effects of cross shore mass fluxes driven by eddies are parameterized using long-standing methods (e.g. Gent and McWilliams). A method for incorporating the effects of an alongshore pressure gradient are also described.

The model is compared with a hydrographic section from the CalCOFI program, demonstrating agreement with general patterns offshore of the continental shelf (upwelling isotherms, subsurface chlorophyll maximum and reasonable values for temperature and nitrate).

This is an interesting and new approach, and it should be useful to the coastal oceanography community. The 2D approach could be used for idealized experiments or as a test bed for additional ecosystem models beyond the NPZD model in this initial version. I can envision adding oxygen or other nutrients. It fills a niche that is distinct from 3D models like ROMS, which can be run in a 2D mode but do not easily allow for an alongshore pressure gradient. The study is interesting, well-executed and clearly presented. However, I do have some points that the authors may wish to consider addressing when discussing the limitations of this simplified approach.

Detailed comments:

p. 6, lines 12-4 – The momentum equations neglect the nonlinear terms. However, in upwelling regions characterized by strong stratification and steep bottom slopes, the momentum advection term can be an important part of the alongshore momentum balance (Lentz and Chapman 2004). This impacts the source depth for upwelling, which in turn affects nitrate concentrations on the shelf (Jacox and Edwards, 2011). The limitations of this assumption should be discussed.

p. 25, last line – numerical methods for calculating the zonal pressure gradient force in sigma coordinates are described in detail. Have associated errors been evaluated for the reference solution? This is often done by running the model with initial stratification but no forcing.

In Section 3.5.2, the methods for imposing an alongshore pressure gradient are discussed in detail, and this is one of the motivations for developing this model. Has the implementation of the alongshore pressure gradient been tested? This might improve the density structure, as well as the meridional velocity. The CalCOFI observations indicate downward tilting isotherms near the continental slope at depths > 150m, a signature of a poleward undercurrent. A poleward pressure gradient can be associated with an onshore geostrophic flow near the surface.

The model output shows a well-mixed region over the shelf, which does not seem

realistic (although the bathymetry differs between the model and observations). This feature should be discussed. It may have to do with the specification of 40m deep surface and bottom mixed layers, which overlap on the shelf. Is a surface buoyancy flux included in the test run?

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