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Ocean Science Discussions

Interactive comment on "A practical scheme to introduce explicit tidal forcing into OGCM" *by* K. Sakamoto et al.

Anonymous Referee #2

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Synopsis

This paper proposes solving the tidal barotropic mode separately from the general circulation barotropic and baroclinic modes during each model time step. As a result, superposition of general circulation and tidal components is assumed for the barotropic ocean velocity at the end of each model timestep.

An advantage of solving the equations of motion using superposition is that one is able to explicitly treat the sea surface gradient forcing of tidal and non-tidal terms separately. This is also true of linear dissipative terms. A disadvantage of this method is that the authors are forced to make certain assumptions about non-linear terms. In particular, equation 10 [Tau(total barotropic) = Tau(barotropic) + Tau(equilibrium tide)] is strictly incorrect unless Eularian bottom stress is used for Tau, or unless stress for each indi-

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vidual term on the right hand side is a function of both U(barotropic) and U(equilibrium tide), something not implied by the notation. As a minor point, a comment should be added after equation 10 to clarify this intricacy, even though it becomes clear later in the paper. More broadly, I would like to comment on ramifications of equation 10, as an example of the difficulties posed by assuming superposition.

Conclusions in this paper state that "reproducibility depends sharply on the configuration of the viscosity related to topography", however bound up in the topographic interaction is the bottom stress provided by bathymetric features. Equations 17 and 18 provide terms for Tau(barotropic) and Tau(equilibrium tide) that do result in the correct overall stress specification, even though each term is a function of both U(barotropic) and U(equilibrium tide). The authors take steps to ensure that the direction of the bottom stress aligns with U(barotropic) and U(equilibrium tide) for the respective barotropic equations. However due to the approximations used, it is unclear how the magnitude of the bottom stress, affected by sqrt(U(barotropic)+U(equilibrium tide)) in each friction velocity term, may affect the solution. Greater clarity could be brought to the paper by investigating this further. It is unclear that a 40-day integration is sufficient for the purpose.

The paper is no doubt interesting, and should be accepted, but a more compelling case to support the suggested explicit tidal forcing approach could exist if longer integrations were presented. The work, as it stands, seems not quite complete, and a dearth of time evolution analysis is a weakness of the paper. The problem of barotropic to baroclinic conversion should be better addressed. Therefore I would like to suggest that the paper is accepted with major revisions, but that the authors present longer integrations, with more detailed diagnostics of the time-evolution of the solution. Of particular interest is the sensitivity to treatment of non-linear terms. As part of this work, an integration using an alternate approach to equations 17 and 18 would be useful to test sensitivity to the current bottom stress assumptions for the solitary earth and celestially-forced barotropic components, as an example of the robustness of the

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superposition approach.

Technical Points noted during this review

1) Title: OGCM should be OGCMs, or, strictly, expanded to “Ocean General Circulation Models” 2) Page 475, Line 15: “for a long period” could have at least three different meanings in this context. Please word this sentence differently. 3) Page 476, Line 5: Australian is spelt incorrectly. 4) Page 476, Line 12: Remove “and so on” or replace it with another specific example. 5) In equation 1, I’m not sure the mathematical symbol for “implies” is used correctly in this context. 6) Page 477, Line 9: “model can represent” should be “a model can represent” 7) Page 477, Line 12: “(Niwa and. . .” should be “(e.g. Niwa and. . .” 8) Page 477, Line 24: change to “are not the same”. 9) Page 477, Line 25: Swap around to change to “simply replace” 10) Page 477, last line: Throughout the entire paper, it would seem more readable to use OGCMs if you are talking about them in general, rather than OGCM as a plural acronym. 11) In equations 7-10, and subsequently, it would be clearer if “b” and “lt” subscripts were in italics. 12) Page 485, Line 1-2: “executed somewhat straightforward under” should be changed, perhaps to “executed in a straightforward manner using”. 13) Page 495, Line 18: swap to make “hardly affected”

Interactive comment on Ocean Sci. Discuss., 10, 473, 2013.