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Interactive comment on "On the use of Schwarz–Christoffel conformal mappings to the grid generation for global ocean models" *by* S. Xu et al.

Anonymous Referee #1

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The generation of model grid is one of the most fundamental issues for ocean modeling, since it serves as the framework for discretization and time integration. This paper proposes two new grid generation methods for global ocean circulation models, focusing on Bryan-Cox-Semtner type models which are widely used ocean modeling community for ocean forecast and climate study. Hence this paper is highly relevant to ocean model developers and users.

The authors apply more complicated conformal mappings to the grid generation problem, instead of more commonly used mappings (i.e. Mobius transformation). Compared with traditional methods that only deal with pole relocation and scaling factors, the new methods based on Schwarz-Christoffel mappings aim at multiple new grid de-

sign objectives, i.e. better load balancing, multi-scale ocean modeling. This paper proposes a potential solution to issues like load balancing, computational efficiency, and multi-scaling modeling from the grid design perspective. I think this paper warrants publication in GMD subject to some revisions.

General comments:

1) The proposed grid generation methods are a novel combination of the ocean modeling requirements and conformal mapping construction theories, especially the method discussed in section 3. Moreover, the new grid can be applied to Bryan-Cox-Semtner ocean models, which is a big advantage considering the limited multi-scale modeling capabilities (e.g. nesting) of such type of models, as compared with finite-element models. The applications of the grid in current ocean models are welcome for further evaluation, but not necessarily serve as a part of this paper.

2) A few issues need to be mentioned with respect to the scientific design of the grids.

It is worth noting that the multi-scale ocean modeling cannot be fully achieved by the grid itself. For example, the authors used the global distribution of the first mode of baroclinic Rossby deformation radius as an example to justify multi-scale modeling, but it is still hard to achieve higher spatial resolution in every place where the radius is small (e.g. Sea of Okhotsk) using the grid generated in section 3. Also, under certain circumstances, other internal modes could be potentially important besides the 1st baroclinic mode, which would require even higher spatial resolution. So the grid proposed in the paper serves as a basic framework for the multi-scale modeling problem, rather than a solution for it.

For the design objectives in section 1, the sample grid proposed in section 3 cannot fully meet certain items, i.e. item 4 (concerning the alignment of grid to equator), item 6 (concerning the alignment of the grid to latitude-longitude lines). It seems to me that the sample grid (or the methodology underneath) cannot match these requirements easily. The authors need to point out these issues.

In Figure 8 (the sample grid in section 3), the grid does not include Australia and Antarctica for land removal. These regions are geographically large continental masses and could potentially occupy a large portion of the grid space. Please explain why these regions are not considered for constructing the sample grid.

3) The proposed grid in section 3 removes the continents from the grid space. This solves the load-imbalance problem in traditional ocean models quite elegantly, which is of particular value for the actual simulation. However, the overall efficiency of the ocean models is also be affected by other important factors, such as the smallest step size. Large differences exist between the largest cell edge size and the smallest one in Figure 8. Does the conformal mapping introduce very small spatial scales? If so, how it is compared with traditional grids? This issue should be considered in claiming the overall efficiency of the grid.

4) Relationship between grid generation methods in section 2 and 3 needs to be clarified given that they target at quite different design objectives. I think the reason that the authors put them in one paper is because they are based on similarly formulated conformal mappings.

Specific comments:

1) I think more description about the existing dipolar and tripolar grids should be provided in section 1, including the shortcomings of these grids. This will provide readers with more background of the model grid issues.

2) The description of Schwarz-Christoffel mappings and algorithms is a little bit sketchy and details of the construction algorithms should be provided.

3) Section 2 contains some terms that are not well defined. For example, in section 2.3, the term “scaling factor” is informally defined but it is used well before this definition (in section 2.1). I suggest the authors re-write parts of section 2 to avoid this.

4) Some typos and grammar errors: 1339:7 Delete “an” 1340:23 Change “unused”

to “inactive”, to avoid ambiguity 1342:2 “Conformal mapping” should be “Conformal mappings” 1342:6 Delete “is” after “are” 1343:26 “tricolor” should be “tripolar” 1351:20 Change “design aspect” to “design aspects” 1352:15 “Slits has zero ...” should be “Slits have zero...” 1356:5 Something is needed between “conformal mapping” and “its harmonics behavior” 1356:17 Need definition and references for POM and MOM

Interactive comment on Geosci. Model Dev. Discuss., 8, 1337, 2015.