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Interactive comment on "The Finite-volumE Sea ice–Ocean Model (FESOM2)" *by* Sergey Danilov et al.

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General Comments:

The main contribution from this paper is the presentation of FESOM 2.0 which is argued to provide a major step forward in establishing unstructured-mesh models as valuable tools in climate research. The previous, finite element version of FESOM has already proven itself as a well established global ocean model and provided evidence for the viability of unstructured mesh methods in this field, with algorithms that are efficient enough to make long-term time-integration feasible. Since this paper shows that the finite-volume FESOM 2.0 model brings a further big improvement in efficiency, I fully agree with this main conclusion and regard the paper to bring a significant scientific contribution.

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Discussion paper

The paper is generally well written, but some of the numerical details are a little hard to follow. This is to some extent to be expected, as a fully featured, complex model as FESOM brings together a whole range of different methods and techniques. There is an honest discussion of the advantages and drawbacks of the methods that were chosen. I would however have preferred some more focus on the verification and validation of the model. There are many statements on the theoretical properties of the schemes, such as conservation properties, the second order accuracy of the scalar equations, etc., but the paper does not provide benchmarks that test these properties individually. Such tests are important to show a correct implementation, and also that the underlying assumptions of the theory are valid in the relevant regime. Although many details on the numerical discretisation are provided, other important model implementation details are only summarily discussed, for instance the solution strategy for the external mode which, as indicated, has a significant impact on the overall performance and scalability of the model. Also a more in-depth parallel scaling analysis would be of interest.

I realize that at this stage, my recommendations would only add to an already lengthy manuscript and therefore merely suggest to address these in further publications. The main validation of the model, showing that global modelling results of FESOM 2.0 are of at least the same quality as that of FESOM 1.4, but with a significantly increased computational efficiency, is convincing. I only have some very minor comments and corrections that I ask to be addressed.

Specific Comments: - figure 1 is unclear. I think it purports to show both the control volume around a vertex and the vector ‘l‘ directly connecting two cell centres (which doesn’t coincide with the control volume edges). It would be better to show these in two separate figures instead. - Although it is understood that the details of the spherical coordinate system are left out, he current paragraph (lines 102-107) is a little hard to parse. Phrases like "The metrics is taken cell-wise constant", "vectors l are stored in radion measure" are just not clear. - this might be obvious, but could you explain why

"In this case the only safe option is to use no-sip boundary conditions" (first paragraph section 2.3, unnumbered for some reason) - the indices indicating column and layer are some times omitted for brevity. However equations (1-2) would become a lot clearer if the k subscripts were included - I do not understand the sentence "However, for this expression..." (line 365) in relation to the previous sentence. - It is claimed (line 415) that Ringler and Randall's ZM discretisation does not ensure momentum conservation. Is that correct? As far as I can see, it is perfectly possible to write down a local discrete momentum balance based on the triangles surrounding the vertices of the hexagon in which the velocities are stored, with fluxes between the triangles that are clearly defined.

Technical comments: Some minor corrections: - page 8, line 211, just before eqn. (4): "layer-intergated" should be "layer-intergrated" - page 7, line 159: "The components of *the* 3D gradient.." - page 19, line 449: "As *a* result..." - page 24, line 565: "at the same time, error*s* become larger ..." - page 12. line 275 garantee -> guarantee - page 19, line 448: "As *a* result" - page 19, line 450: logics -> logic - page 25, line 612: subtropial -> subtropical - page 29, line 711: discretization - line 829: becames -> becomes

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