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Interactive comment on "Finite-Element Sea Ice Model (FESIM), version 2" *by* S. Danilov et al.

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We are indebted for the comments. Below are the answers and the description of changes made in the manuscript.

Comment: Computation times. In Section 5.3 there is only a global discussion about computing times. In the conclusion is stated that the CPU efficiency is the criterion to select between methods, because the performance of the three methods is rather similar. However, in this paper no CPU times are specified. So, please add a table with actual computation times, for example by specifying total computations times as well as the computing time required by the solver(s) and the evaluation of the right-hand side.

Answer: We were not willing to present such a table because the computational times are rather sensitive to the ice configuration and mesh geometry, and to the fact whether

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the simulations are run to full convergence (which will be done not always in practice). For orientation, the time step of mEVP500 with N_{EVP}=1000 on the mesh used for tests here takes 0.55s on 8 cores of old IBM BladeCenter JS22 to be compared with 0.88 s for VP25p and only 0.065 s for VPb. Since VPb provides a very reasonable solution for ice mean thickness, and its field of Δ is without noise even in the absence of convergence, it can still be used and will be a faster option than mEVP500 with N_{EVP}=1000 (but they will be close to each other if we run mEVP500 with N_{EVP}=120 sacrificing convergence but keeping stability). On meshes that are larger and of more complex geometry, reaching the prescribed tolerance by the iterative matrix solver requires more iterations, making the entire procedure relatively more expensive.

We added this explanation to the text now. Also we would like to note that as a part of FESOM, FESIM takes about 10 to 15 % of the full time step for N_{EVP} about 100-150. It is called on each ocean time step, and is run on the same partitioning, implying that generally many cores are just idle within the ice step. On future finer meshes, N_{EVP} will be increasing, making the cost of ice model comparable to that of the ocean if run on the same partition.

Comment: Potential of unstructured modeling is not fully used. In the setup of the Box test case the islands have been removed in comparison with Hunke (2001); see page 875. Why didn't the authors also conduct simulations with the complete test case including the islands? This is also important since the performance of the solvers seem to depend on the domain complexity; see page 883. Unstructured grid modelling is meant for such applications, but the authors seem to 'avoid' this. At least an explanation is needed why complex geometries/islands have not been tested.

Answer: The potential of unstructured meshes is illustrated by other papers based on FESOM, see, in particular, Wekerle et al. 2013, where ice is simulated on a highly variable mesh of intricate geometry. FESIM is not a brand-new model, and as a component of FESOM it was used in many applications (partly published), which is the reason why we do not concentrate on the "unstructured" issues. In contrast, the numerical princi-

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ples of FESIM were described only schematically. The present paper only intends to fill this gap and demonstrate that mEVP and VP lead to nearly the same result if run to convergence. Keeping islands is not necessary for that, and they were removed. The illustration of the fact that mEVP and VP work similar was included to alert the reader that distinctions between the methods should be interpreted as indication of lacking convergence. The comparison of the performance of VP, EVP and mEVP for realistic geometry on highly variable and high-resolution meshes (up to 4.5 km in Arctic) is a subject of current work and will be published elsewhere when completed.

Comment: Figure of the model grid. Although the applied Box test case has been applied in several earlier papers, a figure with the unstructured model grid of the Box test case will enhance the readability of the paper. So, please add such a figure.

Answer: Such a figure is added now to the manuscript.

Interactive comment on Geosci. Model Dev. Discuss., 8, 855, 2015.

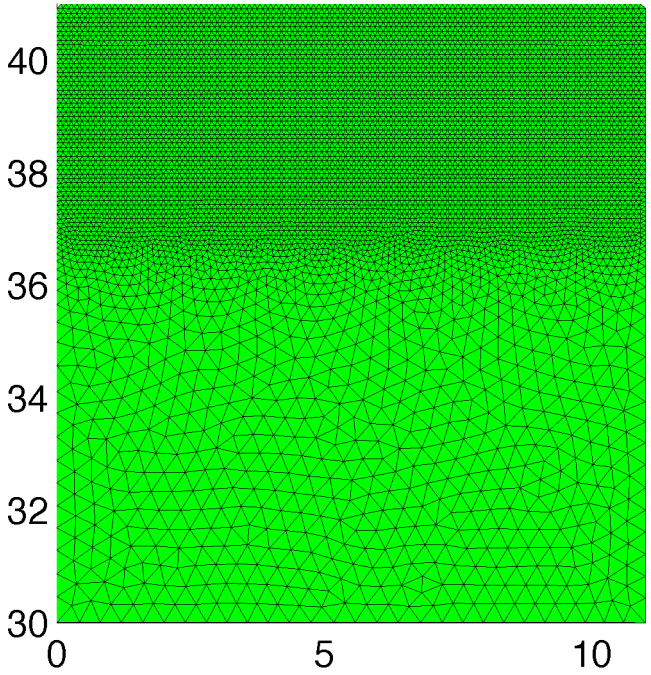

Fig. 1.

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