

Geosci. Model Dev. Discuss., community comment CC1
<https://doi.org/10.5194/gmd-2021-84-CC1>, 2021
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Comment on gmd-2021-84

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Community comment on "Bedymo: a combined quasi-geostrophic and primitive equation model in σ coordinates" by Clemens Spensberger et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-84-CC1>, 2021

This is a report for the paper "Bedymo: a combined quasi-geostrophic and primitive equation model in sigma coordinates" by C. Spensberger, T. Thorsteinsson and T. Spengler [Paper #gmd-2021-84].

The paper presents the code Bedymo, which aims at implementing as similarly as possible two approximations of the fluid equations that are widely used in atmospheric sciences, namely the quasi-geostrophic and the primitive equations. Although there exists many implementations of these equations in many different codes developed by many different teams, the main interest of Bedymo is to try to make these two implementations as similarly as possible in one single framework, so as to be able to compare as closely as possible the role of the different terms of the equations in shaping the atmospheric flow. The paper is divided in two parts: the first part (section 2) presents the two sets of equations. Although I found this part a bit arid and sometimes difficult to follow, I understand it is due to the nature of that section and the need to be complete, and I have to admit I have no suggestion to make it better...The second part of the paper (section 3) presents a series of standard tests that evaluate and validate the implementation.

The results are interesting and worth publishing in GMD. I have some comments I detail below, but they do not require significant modifications of the paper. The only thing I felt was missing when I read the paper was some sort of "hands-on" section (see also my point 2 below). Such a section could be very useful for students or unexperienced users that would want to try using Bedymo. It could be thought of as some sort of small tutorial that would give the minimal system requirements and illustrate the typical few steps one would have to follow to run a first simple simulation (downloading, compiling, running code and visualizing the results). It would also be a good opportunity to describe and illustrate the graphical user interface that is mentioned in the abstract.

To summarize, I will be happy to recommend publication in GMD after the minor revisions I described below are taken care of.

1/ In the abstract, the authors mention the existence of a "slab ocean model and passive tracer module that will provide the basis for future idealised parametrisation of moisture and latent heat release". Unless I am wrong and missed it, the passive tracer module is never mentioned and is not validated in the paper. I would suggest to remove from the abstract that part of the sentence. It could be briefly mentioned in the paper conclusions though (see my point 8 below).

2/ Likewise, in the abstract, the authors state: "Bedymo has a graphical user interface, making it particularly useful for teaching". The graphical user interface is also mentioned in one sentence at the end of the introduction, where it is said also that the "python bindings (...) provide the basis to watch the flow evolution live while the model is running". This seems like an interesting feature. But again, it is not illustrated in the main body of the paper, which is unfortunate.

This suggests that the author might want to add some sort of additional tutorial section (as already mentioned above), where they could give some sort of cookbook for a student that would want to use the model on a linux platform: how and where should I download and compile the code? how can I setup, in practice, the simplest simulation? and, next, how should I setup and use the GUI interface? This would also be a good opportunity to show a few snapshots to illustrate the GUI interface...I feel such a hands-on practical section is missing for a paper describing a code that is claimed to be user-friendly and easy to use for teaching!

3/ I find the caption of figure 3 unclear. According to the text (line 235-236), I was expecting to see snapshots of different simulations, with different jet speeds. This is the case, isn't it? Yet, if one only reads the caption, it only says that the figure shows the "sensitivity of the downstream development....", but does not say to what....I think the caption should be rewritten, and explicitly says which initial jet speed is used for the different panels. Likewise, it would be useful to mention in the caption of figure 1 the jet speed used for the simulations shown in that figure.

4/ Commenting the result of the rossby wave excited by orography, the authors end section 3.1.3 (line 313) saying that "the response fits qualitatively well to the response expected from linear wave theory" and cite, e.g. the paper by Hoskins & Karoly. Could the authors be a bit more explicit in describing those aspects of the flow that agree with the theory? Likewise, would it be possible to go a bit further and make this comparison more quantitative? For example, by comparing the wavelength of the Rossby wave expected from the theory with that obtained in the simulation? and/or by comparing the Rossby wave path expected from the theory with that obtained in the simulation?

5/ line 351-352: The authors state: "Overall this leads to a slightly larger ocean heat content with the 1.0 layer compared to the 0.5-layer ocean (compare fig.8d and fig.8b)": I find that the comparison between the two mentioned panels of figure 8 is not enlightening....Maybe this is because the difference between the ocean heat content is only "slightly" different, or because the contour levels in figure 8 are not well chosen, but I find this difference is not apparent when I compare fig 8b and 8d. I see the shape of the SST anomaly is different. It is not so clear that the heat content associated with these anomalies is different....Maybe it would be better to compute that difference numerically and give it in the text? It could either be the absolute difference, or the relative difference between the two cases....

6/ There is a problem in the second line of Fig. 8 caption. It says: "the rows show the development of (a) the 0.5 layer model, (b) the 1-layer model, and (c) the 1.25 layer model". It should be: "the rows show the development of (a-b) the 0.5 layer model, (c-d) the 1-layer model, and (e-f) the 1.25 layer model"

7/ For the coupled test in general, and particularly for the 1 and 1.25 layer model, I am a bit puzzled because there is not comparison with any expected results or anything from the literature (as opposed to the 0.5 layer model case). This raises the question of whether these tests are useful at all in the present paper? Except for showing that these two versions of the slab ocean model are running w/o crashing, I don't see to what extent they validate the implementation of these versions of the slab model. Could the authors clarify that point? If the results cannot be validated, I am tempted to suggest to remove them, given the focus of the paper which is to validate Bedymo implementation.

8/ Finally, I would suggest to add a paragraph in section 4 that would be focused on the perspectives of the code: what will be the main use of Bedymo (in its current version) in the next few years? What are the perspectives for its evolution? There, for example, the tracer module and its possible use to implement simple parametrization in the future could be mentioned.