Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-269-RC1, 2020

Geoscientific Model Development Discussions

Interactive comment on "ICONGETM v1.0 – Flexible two-way coupling via exchange grids between the unstructured-grid atmospheric model ICON and the structured-grid coastal ocean model GETM" *by* Tobias Peter Bauer et al.

Anonymous Referee #1

Received and published: 7 November 2020

This manuscript documents the coupling of an unstructured-grid atmospheric model (ICON, configured as a limited-area model) with a structured-grid coastal ocean model (GETM). It clearly describes the technical route and the model simulations. The utilization of a community-based coupler (NUOPC/ESMF) is a good example for other people who have similar interests. I believe that this work fits within the scope of GMD and deserves publication. My major concern is about its scientific quality. While I think GMD appreciates technical work and interdisciplinarity, the current manuscript (as a model description paper) does not offer enough information that could be useful to

the general readers. The major conclusion merely summarized what the authors have done: "The demonstration example shows that there is now a coupled model available which allows the investigation of processes at the air-sea interface with high-resolved model simulations." I do believe that the manuscript offers more than that, and it can be further improved. I have some questions and comments which might be helpful to the authors.

1. I find one useful aspect of this manuscript is to offer an example of coupling an unstructured-grid atmospheric model with a structured-grid ocean model, based on a community coupler (NUOPC/ESMF). It would be valuable to put the current work into a broader background. Is there any earlier study that has already explored along this line (including global and regional configuration)? If so, the authors should give a general overview; if not, the present work would be more unique and the authors should explicitly speak out.

2. What is the major challenge of coupling an unstructured-grid atmospheric model with a structured-grid coastal ocean model? Or more general, any unstructured-grid model (atmosphere/ocean) with a structured-grid model.

3. What is the unique aspect of using NUOPC for this particular work? In comparison with other community-based couplers such as OASIS. It's also useful to briefly review the existing coupled models based on NUOPC.

4. It would be useful to give more details on the construction of a coupled model within NUOPC, for instance, showing some prototype codes to allow people who have similar interests to learn from the authors' work (e.g., https://www.earthsystemcog.org/projects/nuopc/proto_codes/). This would be mostly relevant to the value of this work. While I understand that ICON has a license restriction, it would be useful to present the interface of atmosphere/ocean and their positions in the NUOPC/ESMF layer, without freely releasing the actual code of each model component.

5. The added value of two-way coupling for a high-resolution atmosphere/coastal-ocean model is not clearly demonstrated. Such benefits should be explicitly stated in the conclusion to allow the readers better understand the importance of this work. Some of the figures are redundant, and some of them do not give enough information (see minor points). The authors need to better describe the gains of the coupled simulations for atmosphere and ocean, respectively.

Minor points

1. Section 2.1, Line 60: when mentioning “the usage of nonhydrostatic Euler equations on global domains”, I think Gassmann and Herzog (2008) is an important work for ICON and should be cited among others.

2. Lines 65-70: the description here is a little bit disorganized. It would be useful to say something like “The atmospheric component of ICON can be configured to various models (e.g., LES, NWP, climate) by coupling a common dynamical core with different physics packages. The model used in this study is a configuration led by DWD, mainly used for high-resolution NWP applications. Some physics schemes largely inherit the COSMO model."

3. Section 2.1: The YAC library, which is the coupler for ICON-ESM, is also mentioned here. Is it possible for YAC to do the work of this paper?

4. Line 205: pressure levels? It seems to me ICON is using a height-based vertical coordinate.

5. Figures 7 and 8, they are basically telling the same thing as 2-m air temperature is intimately connected with surface temperature.

6. From Fig. 9, it is unclear that the two-way coupled model performs better than the uncoupled one. I understand that after 10 days, temperature is overall enhanced by the coupled model, but such a qualitative comparison is not enough for a scientific journal, especially when demonstrating an issue that is mostly relevant to the value of

this work. I think the authors need some additional quantitative metrics to confirm the improvement (e.g., correlation coefficient, averaged temperature over a certain period).

7. Section 4.1.3, is there any guiding principle to obtain a good load balance in this coupled configuration. How do you draw the current conclusion about the number of cores for ICON and GETM.

References: Gassmann, A., and Herzog, H.-J.: Towards a consistent numerical compressible non-hydrostatic model using generalized Hamiltonian tools, Quarterly Journal of the Royal Meteorological Society, 134, 1597-1613, 10.1002/qj.297, 2008.

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