Reply on RC1

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In the following we address the reviewers concerns point by point by first repeating the comment in italics followed by our reply and a description of changes performed in the revised manuscript in red.

1 Major concerns

"I didn't really succeeded to catch the time pattern of exchanges. Fig. 5 is supposed to address this issue, but it doesn't explain how exchanges are synchronised with models time stepping, and the frontiers of the time steps. We need a time sketch showing when the different components (models and flux calculator) are working, when they are waiting, etc ..."

We agree to the reviewers concern that the details of the coupling cycle with respect to the time behavior of the individual components are not sufficiently represented in Fig. 5.

We extend the figure, such that is clearly visible where the models perform there original computations and where they are blocked by the communication to or from other components. Further details are then given in the text section *2.3.1 Coupling cycle.*

"In Fig. 2, Fig. 3 and Fig.4, an ocean grid cell is either ice free or fully ice covered. But line 145 reads that fluxes are computed for free ocean and each ice category. Do you consider partially ice covered ocean grid boxes, with several ice categories ? Is so, please show ice fraction and ice categories (by thickness classes ?) in the figures, and give more details in the text about the flux computation over different surfaces."

We do consider partially ice-covered ocean grid cells. The employed MOM5 ocean model distinguishes between liquid water and 5 different ice classes related to the thickness of the ice. The fluxes that are sent to the ocean model are individual fields for each ice class which are then differently treated in the model code.

However, we agree that this can be misunderstood from figures 2, 3 and 4, where the ocean grid boxes look either fully ice covered or entirely ice free.

We change figures 2,3 and 4 such that it becomes clear that the ocean grid cells can be partially covered with ice. However, for the sake of clarity, we omit the visualization of different ice classes in these figures but rather make a clear statement in the text that different ice categories are considered by the employed ocean/ice model.

"Radiation is not computed by the flux calculator. But each ocean grid cell may have different albedos, especially if there is sea ice. Do all ocean grid cells receive the same short wave flux ? Or do you use the albedos of each cell and surface type (water, ice) to redistribute the solar flux ? With no redistribution, the flux can be very unrealistic (for instance very low solar flux toward ocean when the ice fraction is large, very high solar flux on ice when ice fraction is low). Please details that, and address the potential impact of your procedure."

It is true that the flux calculator does not calculate the radiation fluxes. Instead the *downward* radiation fluxes are passed via the flux calculator from the atmospheric to the ocean model. The ocean model then can use its information on the different albedos of different surface categories to distribute the *net* flux (without the reflected part) onto the individual surface constituents.

The atmospheric model, on the other hand, receives the averaged albedo via the flux calculator from the ocean/ice model. With this averaged albedo the atmospheric model calculates its own net radiation flux from the downward flux. It can be shown that the net fluxes calculated by both models are equal if we consider the mean flux applied to an ocean grid cell covered by different surface categories.

We agree to the reviewer that this consideration is not apparent in the manuscript.

We address this discussion on the net radiation fluxes that are calculated by the individual models in section *2.3.2*

Flux formulas of the revised manuscript and will give additional formulas in the supplement. Moreover, in order to provide all the details of the flux calculation we complete the notation of all variables and all flux formulas such that it becomes visible, which of them refer to different surface types. This is done by introducing the index v that labels water and the different ice classes.

2 Minor concerns

"Line 59 "by (Balaji et al. 2006)" -> "by Balaji et al. (2006)""

The citation is corrected accordingly.

"Line 174, 183, 188. The atmospheric wind speed is used in the bulk formulae. In Fig. 5, exchanged variables include Uair, Vair, U10m, V10m. What is the difference, and what variables are used in which flux computation ?"

The intention behind the full names in the figure was to simplify the understanding of the figure at a first glance. However, we agree that the connection between these names and symbols in the flux formulas is not exactly clear.

In the revised manuscript we harmonize the names of the variables in the figure with those from the formulas. In order to still provide fast understanding of the figure, we add a table where all appearing symbols are explained. Together with the revision due to major concern 3 this gives a more rigorous presentation of the involved variables and calculations.

"Line 189 : "It is noteworthy, that the horizontal velocity components of the ocean's water body are negligible compared to the atmospheric ones and are thus omitted". That's true if the model does not resolve the tides. Is it the case ?"

In the current setup tides are indeed not resolved, since they do not play a significant role for the Baltic Sea. Thus, the velocity components of the ocean's surface are in the order of 10^{-2} to 10^{-1}m/s and the atmospheric wind speed is typically one to three orders of magnitude larger. Hence the relative velocity of the wind to the water surface can be safely approximated by the wind speed only.

On the other hand, to include the water velocity in the flux formulas would be indeed possible by sending this information from the ocean model to the flux calculator. However, for historical reasons, we started the implementation of the flux calculation with the formulas implemented in the CCLM, where the water velocity components are simply neglected.

We add the comparison between the order of magnitudes of the different velocities to the revised manuscript and note that tides are not taken into account.

"Line 200 : "Moreover, the presented formulas might be updated to more elaborate schemes using more sophisticated theories e.g. a TKE-based ansatz for the calculation of transfer coefficients (Doms et al., 2011)." As the transfer coefficients are computed in the atmosphere, and not in the flux calculator, it seems not feasible to implement a TKE formulation in the flux calculator. "

The intention of this statement was to underline which possibilities are facilitated by the presented framework. However, we agree to the reviewer that this particular "add-on" is currently too elaborate for the flux calculator.

We modify the statement in the revised manuscript and give a more general perspective on how to experiment with different formulations of the flux calculation.

"Line 219 : time steps are 600s and 150s for the oceanic and atmospheric model, respectively. For the atmosphere I suppose that this is the 'physics' time step, and advection is called more frequently ? A question important for the coupling is the time step of the computation of solar radiation. Is it called at the same pace than the coupling ? Or with a longer time step ? "

With the time step 150s the physics part (e.g. horizontal diffusion, tracer advection etc.) is updated. The dynamical core (advection of the velocity field) is updated more frequently with a smaller time step that is internally calculated from the given 150s to obey the CFL criterion for horizontal acoustic wave propagation via a third order Runga-Kutta scheme. The radiation is only updated every our. Since our coupling time step is 600s, the radiation is updated only every 6th coupling cycle. The small coupling time step of 600s has been chosen to resolve strong wind gusts as it is written in the manuscript. An investigation of the impact of the coupling time step size is planned for future publications.

We detail the description of the time stepping of the atmospheric model in *Sect. 2.4 Simulation setup* of the revised manuscript and provide an outlook for future work including an investigation of different coupling time steps.