Response to Referee #1

This paper describes the EC-Earth3P and EC-Earth3P-HR models developed for the HighResMIP with a lot of details, including optimization (necessary for high-res modeling) technical aspects of scalability, performance, data-storage, and post-processing and documentation of model performance regarding the mean climatology as well as variabilities. The manuscript is generally well-organized and clearly written.
We thank the reviewer about the positive comment on organization and how it is written.

My concern is that I feel it belongs to the "Model description paper" category instead of the "Model evaluation paper". The model results seem not the primary focus and are mainly presented in a documentation manner without more in-depth analysis and scientific insights. As stated in the middle of the text, more extensive analysis will be shown in a future paper. I suggest the authors revise it to better fit the criteria of the model description type and leave more results and analysis in the other paper.
We understand the concern of the reviewer about the category of the paper. We have, however, chosen for the model evaluation category because apart from the description of the model. We provide analysis of the climatology, biases, trends, and the dominant modes of variability such as NAO, ENSO and the AMOC. Due to the space limitation of an article, these analyses are not performed in full depth and might be further analysed in forth coming papers. However, covering this wide range of aspects and phenomena we consider that the editorial board would agree on accepting the manuscript as an evaluation of the model, which indeed could serve as a starting point for further in-depth research.

Specific comments:
Title: The "model performance" can mean either computational performance or the quality of simulation results. Putting in the middle of "description" and "data handling", it sounds more of the former, so perhaps change it to "computational performance". Also change "validation" to "initial validation" to coordinate with the second paper?
Good suggestions. We have changed the title to: **HighResMIP versions of EC-Earth: EC-Earth3P and EC-Earth3P-HR. Description, model computational performance and basic validation**

L87: seems a good place to add resolution info since that info is given for Earth3P-VHR on L89.
We have added the resolution info for EC-Earth3P and EC-Earth3P-HR.

L100: temporal resolutions, time steps?
IFS and NEMO have the same time steps: 45 min in the standard configuration and 15 min at HiRes. The coupling between the model is 45 min in both resolutions. We have included that in the manuscript at L125.

L175-177: It can be a bit misleading to imply the optimization of components and load balance are purely sequential. In practice, they can be parallel, for example in the incidents that component optimization is only possible with a load rebalance.
We understand the concern. Our intention was to briefly explain the process, but maybe it was oversimplified. The idea is doing separate scalability analysis for each component. Then, a point in the scaling curve is chosen so that all the components can run efficiently (depending on the throughput/energy scenario, time to solution or energy to solution, the compromise will be different). Because of the different coupling/output frequencies of the components and because of eventual irregularities in the stepping, it is likely that the configuration has to be further tuned, by increasing the speed of one or other component, and ultimately looking at the load balance (examining the idle/waiting time of each one of the models).

We have modified the paragraph (L177-185 in revised manuscript) to highlight that 1) we are talking here about load rebalance (as the reviewer pointed out) once one of the components has been optimized and 2) the load rebalance is needed because there is a synchronization point at the end of each time-step where both components are waiting for fields from the other component.

Figure 2: change the label "SYPD" to "coupled EC-Earth3P-HR"?
Label has been changed.

L216: Where on Figure 3 can we see the 4 times of communication pattern?
Figure 3 has been modified to highlight the 4 communication patterns inside the coupling process including a new zoom, thank you. Taking into account the new addition, the text has been modified to reference the new zoom.

L225: I am not sure what parts on Figure 3 this paragraph refers to. Please clarify.
Figure 3 does not show this output process because the profiling events were not captured by the profiling tools (Extrae tool). The 30% of the time-step higher has been quantified from the execution time step. This has been clarified in the paragraph.

Figure 3: This figure is too noisy. Perhaps, the authors can replot it to better support the points they want to make with improved labels, organization, and clarity.
A new Figure 3 has been included, where each event is now more clearly distinguishable. Thank you for the advice. Some changes have been included into the text to be consistent with the new figure.

Figure 5: change "hist-1950" to italic
Done

L383: : : : in Table 2
Done

Figure 6: Add the global means and RMS errors (which give some overall ideas about the model performance) and discuss these numbers in the text. Change the title of figures to, for example, ": : :EC-Earth3-HR minus ERA-Int" to be clearer. Add labels (a) and (b). Also make these changes on other figures where applicable.
Thank you for your suggestions to improve this and other figures. We have computed the global means and RMS errors and discuss these numbers in the text. We have also changed the titles and added the labels.
In addition we have replaced ERA-interim with ERA5 because of the better quality of this new version of ERA (Hersbach et al 2020).

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz-Sabater, J., ... & Simmons, A. (2020). The ERA5 global reanalysis. *Quarterly Journal of the Royal Meteorological Society*

L408: change to ": : :Greenland (Fig. 9), which is : : : MSLP bias (Fig. 7a)."
Done.

L413: I would wonder whether enhancing horizontal resolution has a negative impact
on performance. The global mean biases and RMS errors (suggested above) are
helpful to provide some quantitative measure.
As discussed in the next sentence it can have a negative impact on the wet bias over the warm pool.

L430: Perhaps can add some figures to support this point.
The drift during the control run is shown in the figure below. It shows that the drift is very minor. The
largest drift of about 0.5 °C/100 year is in the 100-1000m layer. We have therefore decided not to
include this figure, but to add a sentence in the manuscript describing this minor drift more
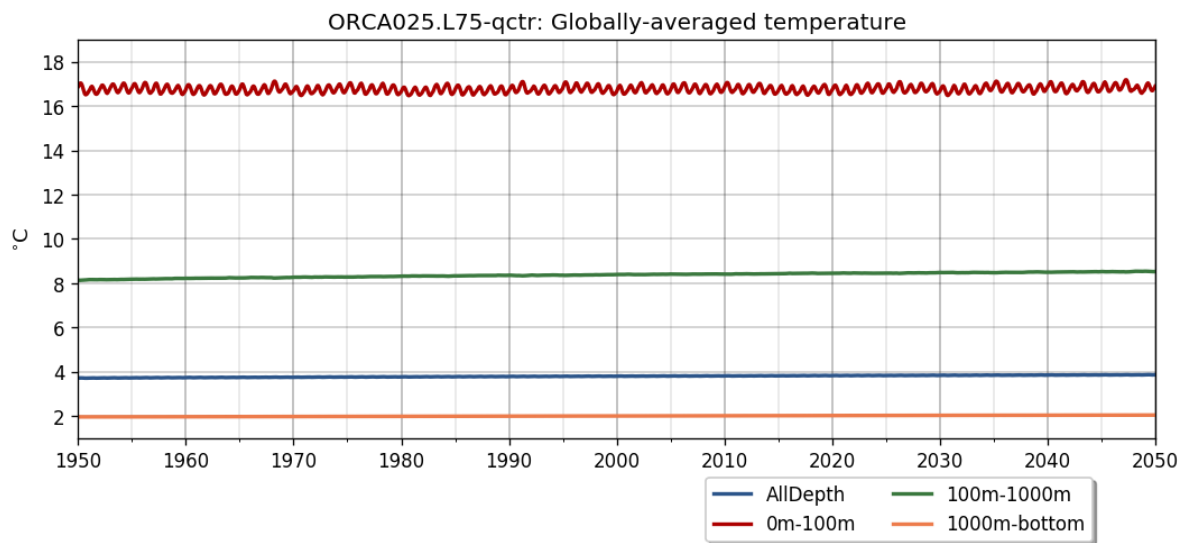quantitively.

Figure R1: Global mean ocean temperature of EC-Earth3P-HR averaged over depth for the control-
1950 simulation.

L444: Any explanations why this activation of deep convection at the Labrador Sea
occurs in the low-res version, but not in the high-res version?
Presently we have no clear understanding of this difference. It may be related to various aspects,
such as differences in meridional heat transport and differences in the resolution of sea-ice and
deep-convection, to mention a few. This is presently under investigation. A few lines to discuss this
are added in the text.

Figure 11: I suggest using different colors for different simulations, but similar ones
for the same resolution – redish for low-res; blackish for high-res. I also suggest the
authors add a panel of net radiation fluxes at the top of the atmosphere to show the
energy balance of the whole Earth system.
We have modified the figure according to the suggestions of the reviewer. We checked the net
radiation fluxes at the top of the atmosphere and they behave similar to the net surface heat fluxes,
which is to be expected due to the small heat capacity of the atmosphere. We therefore decided not
to include them in an extra panel.

Figure 13: Isn't it clearer to compare if the model results are shown in the same manner
(lines instead of bars) as the observation? I find it is difficult to follow the seasonal cycle
of EC-Earth3P – The base changes every month. Please revise it.

Thanks for this comment. We have modified the figure accordingly.

L534: trend -> drift? The trend on this line has a different meaning than the ones towards the end of the paragraph, so should use different words to distinguish.
We have changed "trend" into "drift" in the beginning of the paragraph to avoid confusion. Thanks.

L535: change to ": : :hist-1950 minus control-1950: : :"
Done

Figure 18: I understand the authors scale the right panel to fit the starting point of the curves. But it looks a bit weird to leave large white margins on it. Please revise.
We have revised the figure and removed the large white margins.