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Interactive comment on "Changes in extreme regional sea level under global warming" *by* S.-E. Brunnabend et al.

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Below we provide responses to specific comments of Referee 1

Anonymous Referee #1 The study focuses on projections of extreme dynamic sea levels associated with propagation of mesoscale eddies under future warming scenario. The model used here is an eddying ocean version forced with projected surface fluxes from another climate model. It is found that the change in dynamic sea level extremes is mainly caused by the change in ocean eddy pathway. In particular, both the mean and extremes of dynamic sea level in the North Atlantic show significant changes during the 21st century, with important implication of coastal impacts. This is an interesting study, although the results are mainly based on ocean-only model simulations, in which the representation of air-sea feedback may not be complete. The mean and extremes of

dynamic sea level anomalies are analyzed in combination, providing an overall picture about future sea level variability and change. I particularly like the comparison between the high and low-resolution version of the model. It effectively demonstrates the role of mesoscale eddies. The manuscript is written clearly. So I recommend publication of the manuscript after a minor revision.

We thank the reviewer for the careful reading of the manuscript and the useful comments.

Line 17: global mean sea level "rise"

Corrected

Line 76: Such "as"

Corrected

Line 82: Does the model employ any salinity restoring at the ocean surface? It is known that the AMOC simulation is sensitive to different boundary conditions. The potential impact of the boundary condition on AMOC needs some discussion.

The POP model does not include a thermodynamic/dynamic sea-ice component. Therefore, a prescribed climatological flux of heat and salt is included in sea-ice region. However, no salinity restoring is applied outside these regions as even due to a weak restoring the AMOC is artificially constrained. This information is now added to the model description.

Line 111: Please provide reference for the altimetry data (1993-2012).

The altimetry dataset used is produced by Ssalto/Duacs and distributed by Aviso, with support from Cnes. The citation has been included in section 2 in addition to the citation in the acknowledgement.

Line 159 and Figure 3: Figure caption should include model information. It would be better to add the AMOC time series from the low-resolution model for comparison.

We included the model information in the caption and added the AMOC time series of the low-resolution model simulation, including a short discussion, in the manuscript.

Line 164: Is it possible to show ocean bottom pressure changes?

Yes, it is possible. A figure has been included into the manuscript (and discussed) showing mean and STD changes (similar to Fig. 1) in steric height and ocean bottom pressure, separately.

Line 180: The paper by Saba et al. (JGR, 2016) should be cited for the northward shift of the Gulf Stream and the warming of the oceans near the US northeastern coast.

We cited this interesting study when discussing the northward shift of the Gulf Stream and the warming of the ocean near the east coast of the US.

Line 181: This “warming hole” and dipole pattern of SST changes are robust fingerprints of AMOC weakening, consistent with most low-resolution coupled model projections.

This issue is now discussed (with additional references) in the revised manuscript.

Line 196 and Figure 5: Caption should indicate the direction of the heat and freshwater flux, that is, positive value means flux into the ocean.

The direction of heat and freshwater flux has been added at both locations in the manuscript.

Line 197: But cooling also increases density, which tends to strengthen the AMOC. Which process (more cooling vs. less evaporation) is dominant?

The reduced heat loss leads to less cooling but cannot compensate for the overall cooling in this region caused by the reduced AMOC strength and the shift in ocean currents. The cooling also leads to less evaporation and a further freshening of the upper ocean. Therefore, both changes in atmospheric interaction lead to a further reduction of AMOC strength. However, the influence of the cooling in the subpolar

gyre region in the North Atlantic cannot compensate for the impacts of the general warming in the upper ocean. The corresponding paragraph in the manuscript has been reformulated to clarify this.

Line 215 and Figure 7: The corresponding regions of the first three panels should be clarified further in the caption.

The regions that correspond to the first three panels in figure 7 and 8 are now defined in the figure captions.

Figure 7: The shift of PDF is greater in the ocean interior but smaller along the coastal regions. I am curious about how often ocean eddies can actually approach coasts, or they are mainly confined in the ocean interior. The potential impact of energetic eddies on coastal sea levels should be discussed further.

Eddies can come within 100 km of the coast and their maximum sea surface signal is often strongly correlated with that at the coast

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