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Climate of the Past Discussions

Interactive comment on "Evolution of the Arabian Sea upwelling in the past centuries and in the future as simulated by Earth System Models" *by* Xing Yi et al.

Anonymous Referee #2

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The present study of Yi et al. uses earth system model experiments to study the evolution of Arabian Sea upwelling in the context of a global warming scenario. First, they use vertical water transport velocity as a parameter to describe upwelling intensity and compare the results over the last millennium to the atmospheric Indian Monsoon Index and the sedimentary record of G. bulloides abundances. This information is then used to run a different set of models under Representative Concentration Pathway (RCP) 8.5 scenario, that finds a decrease of upwelling intensities in contrast to increasing along-shore wind intensities. The topic is potentially interesting for economy and scientific research, but the approach raises several major concerns, preventing me from recommending publication.

1.) I would be very cautious about the choice of the models resolutions to be appropriate to investigate coastal upwelling in the Arabian Sea. The spatial extent (e.g., Figs. 1 a and b) shows that coastal areas are largely blank, especially for MPI-ESM, but also for CESM-CAM5. It is clear from previous studies that coastal upwelling is restricted to the vicinity of the coast, approx. 90 km offshore (Rixen et al., 2000). In fact, the authors mention this issue on p.4 l.3 but miss to discuss what implications this might have on the reliability of the results. It was further discussed by Praveen et al. (2016 Geophys.Res.Lett.), that changes in upwelling under future warming scenarios are regionally limited and spatially inhomogeneous, finding that 1x1 degrees atmospheric resolution is not adequate for studying the coastal current system. The study of Yi et al. uses models with more than four times coarser resolutions and it has to be discussed if a potential increase of coastal vertical water transport might not be obscured by the coarse resolution.

2.) Although the approach of testing the models against observational data seems to be of minor importance in the study, I highly question the approach used here with G. bulloides data. My first concern is, that it is not clear from Fig. 2c) if cores RC2730 and RC2735 are actually within the modelled grid cell or outside. If the stations are covered, they are at the very edge of the models coverage anyway. Secondly, the actual correlation of the two time series, Oman margin upwelling intensity and G. bulloides abundance, is not given in Table 1, where I would expect it. It seems from the colour coding in Fig. 2 c) and d) that it is in the range of r=0.2 to 0.4. However, both models show a significant positive correlation only in the northern part of the basin, an area of open-ocean upwelling and outside the area that was used for calculating the time series. This is not explained in the text and I suppose that it is not appropriate to verify the model results in this manner. I would also expect to see the G. bulloides data parallel to the upwelling time series data, as this would give a more obvious connection of the relationships. Especially as the authors discuss a "flip" at 1550 also be evident in the G. bulloides record, it has to be illustrated in a clearer way.

3.) The finding of increased upwelling favourable winds under RCP8.5 scenario together with a negative trend in upwelling intensity is explained with a likely overriding effect due to increased surface water stratification and warming SST. However, I miss a discussion of the results in context to previous studies of modelled upwelling in the Arabian Sea. Although using historical simulations over a much shorter period of time, Roxy et al. (2016 Geophys. Res. Lett.) for example found decreasing trends of phytoplankton productivity by using a similar set of simulations and also inferred an overriding effect of near-surface stratification as the main cause.

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