Comments on the paper „The climate change signal in the Mediterranean Sea in a regionally coupled atmosphere-ocean model"

General comments

The paper describes simulations with a coupled ocean-atmosphere model with the interesting feature that the ocean is in a global set-up coupled to a regional atmospheric model. The analyses are interesting and the paper is generally very interesting for the scientific community.

Still there are many open points to discuss. After re-reading the article Sein 2015, I would like to know how it is possible to give climate change signals of salinity with a precision of two place after the comma? What about salinity restoring? How is this done in this setup and especially in the climate projections? And what is the influence of the North Atlantic on the circulation in the MedSea? And is it important to simulate the Strait of Dardenelles explicitly or is this irrelevant for the circulation in the MedSea? And what are the transports in the Strait of Gibraltar in the spinup and then later in the climate predictions? Is it changing a lot due to the global ocean?

And in the discussion, you mentioned other articles which use bias correction. Then why didn't you do this? This would probably give better relative numbers of SST and SSS changes due to climate change.

Please check the English by a native speaker, there are still some errors in the paper. It would be easier to read.

Comments in details

Abstract: Please skip the second place after the comma altogether, no model is that precise. It gives a false sense of trust.

Line 19: skip the first "the" and it is water instead of waters.

Introduction:

Page 3, Line 21: ROM does not add anything to the driving model. Maybe add "compared to" after the adds or ask a native speaker what would be a better formulation.

Page 4, Line 11: (1984). Here, the spatial….

Line 12: parametrization in the atmospheric component.

Page 5, Line 2: first layer nominal thickness of 8m.

Line 4: until an quasi-equilibrium is reached. Question: which parameter did you investigate to judge whether an quasi-equilibrium is reached?

Line 5: there is a forlorn "e" in this sentence. And please add, which period you repeat with the coupled system (1979-?).

Line 33: behave similarly

Line 34: mean state and its variability.

Page 6, Line 4: instead of some write: of several atmos. and oceanic variables.

Line 8: are derived. Question: What? You derive your own observational data set from whatever is appropriate? Please rephrase in a scientific way.

Line 22: OISST is according to you the best/observed dataset available. Could you show and proof this? And if not could you add a citation? Otherwise, this is hearsay.

Page 7: Section 3.1. Here and ERA-Interim highres simulation is compared to an ERA-Interim lowres simulation. So all the difference should come from the resolution differences, from different physics formulations and parametrizations, or from boundary effects. In Sein (2015) one conclusion is that the Gulfstream separation is improved in that setup. Why is this not the same in your simulations? Where do the differences in MSLP come from? Boundary effects in the atmosphere? This would be a disadvantage of your setup.

Line 20: "may play a role". Please write as a scientist. Either you checked and/or did some experiments or you don't know then you check in the future.

Line 23: I don't see a distinct signal southwest of the IberianPeninsula.

Page 8, Line 5-6: which formulation might this be?

Line 12: colder SST in ROM_P0. Question: why is the SST colder and what is the longterm change in the coupled system during the different spin-ups?

Line 22: So it should rain a lot over the Black Sea, which is not the case. Maybe the explanation is a bit too simple?

Line 24-25: which is not true for the Adriatic Sea.

General Question to section 3.1: there seem to be a strong signal at the eastern boundary of REMO (see Fig 3e,3f) in the same order of magnitude as the signal over the ocean, even stronger in summer. How do you discuss this effect? Is it a reflection at the boundary.

Page 9, Line 14: where is the 0.1 to be seen?

Line 18: how can the internal variability be properly reduced? How can this be done?

Line 23-24: The last sentence seems to be a bit farfetched. I would interpret it is outside the range of the uncertainty of gridded datasets.

Page 10, Line 1: I understand the runoff is smaller than the observed estimates. How does this match with the last sentence of this paragraph (line 4) "also larger than estimates"?

Line 2: I guess it should be SSS instead of SST?

Line 6-7: skip "the" before atmosphere and ocean (native speaker check would be good).

Line 11: Why is the time-averaged SSH compared to the velocity at 31m? The explanation is in the discussion but it should be here when first mentioned.

Line 19: which mesoscale structures are not represented? Should I cross check in the other paper? Somehow weird.

Page 11, Line 16: what is the contribution of the Dardanelles/Black Sea in the mean budget, in the variability and in the climate change signal? How well is the Black Sea represented and how important is it to include this side ocean in the coupled system? And please skip the second number after the comma. 38.02. Come on. Round it.

Line 25: What about the Dardanelles (again) seems also to ne pretty warm and salty.

Line 20: General question: why is it so much saltier in the eastern MedSea? Is the evaporation strongly enhanced in the east compared to the west? Does the intermediate water formation change so the vertical column is differently composed? Compared to Fig 15 I would conclude, the water at the surface gets saltier which is then transported in deeper layers. What is the variability of the intermediate and deep water formation regions (Adriatic and Levantine Sea)? And how does the surface circulation change?

Page 12, Line 2: most pronounced instead of more evident.

Line 7: significant comes in science with a significance test. Did you do one? If not change the wording.

Line 11: skip the “throughout the current century”. And the “the” before temperature and salinity.

Line 15: In the first sentence, you cite Sein 2015 and the next sentence you talk about our model, which gives the impression, these are different models.

Line 18: Instead of “realisitic”, write more realisitic. And Straits with capital S.

Line 20: no, there is no lack of resolution. What should it lack? Really wrong wording, skip it everywhere you ever wrote it. “Due to the coarse resolution” would be better.

Line 22: how can you lose spatial resolution? You could lose benefits or money but not resolution. Without the advantage of higher resolution maybe.

Line 23: Sein 2015?

Line 30: very old citation aren’t there any more recent ones?

Page 13, line 1: to too cold modeld SST. Is this everywhere true? Seems to be a very general statement.

Line 7: when increasing the resolution you get more precipitation? The why in ROM_P0 saltier than MPIESM (Fig 10)?

Line 8: This argument is nonsense but also somehow true. To improve the precipitation in climate model, the parametrizations have to be improved or the convection has to be resolved in very high resolution. And to compare this changes we need urgently observation with a high temporal and spatial frequency. Only the data on its own will not improve any biases. We need the data to improve the models and then to evaluate them.

Line 9: in this strange sentence there is and “are” missing.

Line 10: Where is this shown, the reaction of ROM outside the MedSea region? This would really be interesting to be discussed.

Line 16: skip SSS, it is not discussed in this paragraph at all.

Page 14: Line 1: change would to could.

Line 10: why is the transport through the Straits of Gibraltar lower than other estimates although a global ocean model is used where the circulation is more realistic than in other AORCMs in this region?

Line 12: quasi/permanent. Is this also true for the future? What is changing?

Line 23: Where is the added value of ROM_P0 over other AORCMs?

Line 34: Again, something is lacking. And please change “improves” to “refines”. And improvement would correct the deficits of MPI-ESM.

Page 15, Line 16: as already mentioned above, an LIW discussion would be nice.

Line 21: which benefits? Please skip the word “some” in the whole article. Completely unscientific.

Line 24-25: This setup would improve what? It does improve the…. And how is the ocean component adjusted? Very very strange sentence. Some for the next sentence: global ocean model improves something… without global ocean. Better: the use of a global ocean model could improve AORCMS who prescribed the global ocean as boundary condition.

Line 28: outside the coupled domain: not shown here.

Page 16, Line 4-5: Where is it shown that the exchange through the straits is improved? I understood at least for Gibraltar the transports are too low. And what internal behavior of which ESMs did you discuss? Where?