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Interactive Comment

Interactive comment on "Modelling global-scale climate impacts of the late Miocene Messinian Salinity Crisis" *by* R. F. Ivanovic et al.

Anonymous Referee #2

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In this paper, Ivanovic et al. use the HadCM3 model to test the impact of the MOW on the global ocean circulation and on the global climate. Starting from a Pliocene experiment, the authors modulate the exchange flux between the Mediterranean Sea and the Atlantic Ocean by imposing the global salinity of the Mediterranean Sea. The idea is to mimic the effect of highly saline and highly fresh Mediterranean water flowing into the Atlantic Ocean. The paper is generally well written but with too much details being unsupported by clear illustrations. The authors try to go deep into the details for explaining the response of their model but it is often hard to follow. The effect of the MOW remains weak in HadCM3 despite the efforts of the authors to find a well distinguishable signal in their runs. I have several comments listed below that require a substantial work from the authors before this paper could reach the standards of the journal. I think that this paper will be better in a shorter format and that, as it stands, it

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Interactive Discussion
Discussion Paper

is too long, with too many details to provide explanations on very small signals.

Comments:

P. 4813, please provide a figure - with a focus on the Gibraltar straits - with the ocean grid resolution - in order the reader can understand which ocean grid points are concerned by the equation (1). Indeed, you are referring to 4 points for the mean of each tracer field but it is not clear where they are located. Also, why are you using a pipe of 1 km whereas today, the Gibraltar strait reaches 300 meters? Are there geological evidences? Please expand the discussion here.

P. 4814, Figure 3 is described. Miocene and CTRL simulations are used to show salinity and temperature anomalies. I have an issue here, what are the boundary conditions used? What makes Miocene different than the CTRL?

P.4815, Additional information about the boundary conditions (CO2, CH4, orbital parameters, solar luminosity) should be added here. Perhaps this information can be found in Lunt et al. (2008) but it is so fundamental for our understanding that it should be included here. ! The informations are on the next page in fact, l.16-20, perhaps, you could move these sentences on the previous page. !

P. 4816, what is the change in the land area induced by a 25 m higher sea level? Is it significant given the spatial resolution of the model?

P. 4818. l. 11-13, even if the method is described in your previews paper, can you say some worlds in this paper in order the reader can follow what you did without being forced to read all your previous contributions.

P.4818, Table1, what are the reasons that led to the choice of the values used for the coefficient of exchange. Why a quarter, than a half and then a doubling. It seems that this may be due to the decrease of the depth of the Gibraltar Strait, more saline water being equivalent to less water in the Mediterranean basin. Am I right? Please write it more explicitly in the paper.

P.4820, l.2-9, how do you follow a water mass in a eulerian OGCM? It is not clear to me. Can you expand the discussion here and/or provide convincing figure?

P. 4820-4821 / l.26-6. This paragraph is hard to follow. The link between the NADW and the AABW is new for me and not straightforward, I am more used to seesaw in OAGCM, i.e. less NADW produces more AABW. Here the authors suggest a mechanism by which the decrease in NADW will produce the inverse. This is not convincing at all, please remove or expand. In addition, in the last sentence is wrong. Indeed, Fig. 5b show the meridional overturning in the Atlantic Ocean (AMOC). The authors refer to the Pacific Ocean. Please be careful.

The following paragraphs are also hard to follow. Again the authors describe many processes being causally linked but not always easy to follow. In particular they may at least change the figure 6 by zooming on the area of interest where there is oceanographic signal in their runs, the Central and the North Atlantic.

P.4822 l6-21. Concerning the salinity events, I would say that it would be more pertinent to compare the results from the simulations with the same exchange flux because here you change two factors, the salinity and the exchange flux. Otherwise, the authors could calculate the salinity exchange flux for each simulation and use these values to choose their run or to make their case more convincing. In fact, they do that in the next paragraph. So, provide us with salt export for each run shown in Table1.

P.4823 l1-2, can you explain the cooling induced by the salt export? 2 and 1.8 °C?

L3-8, I do not see a more predominantly spreading of the MOW southward on figure 7. How can you state that the MOW is entrained in the ACC? Once again, I do not think that it is so easy to follow water path in an OAGCM.

L15 – l4(next page) / this paragraph is hard to follow, please remove it or rewrite it with a better choice of figure to support your logic.

P. 4824. L. 5-15 / The mid to high latitude SATs decrease by up to 4°C . . . in reality, I

CPD
9, C2446–C2449, 2013

Interactive Comment

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Discussion Paper

see a pattern closer to -0.5 to -1. Please avoid overstatement.

L16-24 / the SAT increase of 1.5 °C (fig. 8c) is almost invisible . . . once again, your figure are not supporting your text.

L 25 – l12 (next page) lot of things are written here, once again very hard to follow, please remove or add diagnostics making your case more convincing. The elevated salinity (which is not visible) can explain both cooling and warming. The cooling is linked to more upwelling, the warming to a deeper mixed layer. All these explanations for changes in temperature of plus or minus 1°C . . .

Figure 5 : A) it is strange, No intermediate waters goes south of 20 °N ? why that , the NADW should reach the southern hemisphere. Can you explain ?

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