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Climate of the Past Discussions

Interactive comment on "Volcanic impact on the Atlantic ocean over the last millennium" *by* J. Mignot et al.

Anonymous Referee #2

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General comments: This paper discusses the oceanic response to volcanic eruptions in a model simulation with the IPSL model covering the last 1000 years. The authors show that the volcanic eruptions lead to a rapid cooling in the tropics, followed by a penetration of this cooling signal into the ocean interior where it subsequently propagate towards the high latitudes. The authors furthermore focus on a special feature of the simulation, that is the different AMOC responses to volcanic forcing before and after year 1400 AD. After 1400 AD the model show an intensification of the Atlantic merdional overturning circulation (AMOC) about 5-10 years after the eruption in line with previous studies. However, before 1400 AD no such intensification is seen. The authors point to the seasonality of the eruptions in order to explain this difference. This argument is, however, not further substantiated in the text and must be considered highly speculative. I found the paper generally well written and the results are nicely

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presented. Understanding the mechanisms and processes behind decadal variability, and whether they are internally or externally forced, is an important challenge for the climate community. There is currently a growing accept in the community that volcanic eruptions have an important role to play here, not only for short-term variability, but also for more longer-term variability. It is therefore important to report on the diversity of responses to volcanic forcing in different models. The present study thus fits nicely into this picture, and is therefore well worth publishing after some revision. My specific comments are listed below.

Specific comments:

1. My first comment goes on the new implemented radiative module. It is said to mimic the direct radiative effect of sulphate aerosols. However, since the Khodri paper is not listed in the references I have no way of checking the validitiy of this module. I assume both the shortwave and longwave radiation of the aerosols are simulated. Correct? I also assume the volcanic aerosols are only implemented in the stratosphere? How many layers are there in the atmosphere model? 2. You say on page 2521 line 12: "An anomalous warming in the polar region over Eurasia is consistent with the observations (e.g. Robock and Mao 1992) and closely related to tropospheric and stratospheric circulation changes." I have a problem with this statement as I see no clear evidence of a Eurasian warming from figure 4. I rather see a widespread NH cooling. This statement thus requires some additional analysis to be included. I presume the circulation changes you are referring to is the winter warming phenomenon observed after volcanic eruptions? I presume figure 4 only shows annual mean values. Do you see a clearer warming signal in wintertime? If so, this should be shown. This warming is supposedly caused by a more positive winter NAO phase in response to volcanic eruptions. Do you see such a positive NAO response? 3. In terms of the calculated composites. Why did you only use the two years preeceeding the eruption as a reference? Wouldn't this make the composite very sensitive to natural swings in the climate (for instance random ENSO years)? Have you tested using a longer reference period?

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4. A paper was recently published in CD on a similar topic by Zanchettin et al. 2011: Bi-decadal variability excited in the coupled ocean–atmosphere system by strong tropical volcanic eruptions. This study should be mentioned and discussed in relation to the results presented here. 5. You say that seasonality of the eruptions could be important for the difference between the responses before and after 1400. You even mention this in the abstract. This is in my mind highly speculative and should be somewhat more substantiated if you want to keep the statement. For instance have you checked if there are clear differences in the summer and winter responses for the two periods?

Minor issues: 6. Page 2523, line 10: "coma shape exgtension". To me it looks more like a horseshoe shape 7. Page 2523, line 23: "The fact that the response . . .." Unclear sentence. Please rewrite. 8. Page 2524, line27: ". . . shifts to the southern Irminger Sea, consistent with the SLP response" 9. Page 2527, line 9: "The associated negative and positive cells south and north of this latitude have nevertheless a much weaker extension in depth and in latitude." Compared to what? 10. Page 2527, line 23: "It can be shown that the the tropical part of this anomalous cell is associated with an equatorward shift of the subtropical gyre." Why not show it? 11. In figure 3 the bottom panel is "squeezed" compared to the upper two. Please correct this. 12. The figures are generally too small. For instance in Figure 6 the color legend only needs to be shown once. Also there is to much "free space" between the panels. In Figures 11 and 12 you should stack the panels from top to bottom allowing you to increase the size of the panels. 13. I think Figure 16 could be split in two: One for the ML depth and one for the sea ice. Same comment as in nr. 12 goes for this figure.

Interactive comment on Clim. Past Discuss., 7, 2511, 2011.