

Interactive comment on “The 1816 ‘year without a summer’ in an atmospheric reanalysis” by Philip Brohan et al.

Anonymous Referee #3

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In this study, the approach of the 20th Century Reanalysis is used to reconstruct the dramatic events surrounding the ‘year without a summer’. A set of surface pressure observations is used to constrain the weather model to reconstruct observed atmospheric circulation using the Ensemble Kalman filter (EnKf) technique. The motivation for the study is that climate models, including the changes in atmospheric dust loadings related to the Tambora event, produce a cooling which is too small when compared to in-situ observations. This suggests that a dynamical effect must have been present as well in that period. The results of the current study clearly show the ability of this approach to capture this event. The authors conclude that the atmospheric cooling directly related to the radiative forcing is actually rather small for Europe, while the cooling related to circulation effects, advecting cold air, is much larger. This makes this study a very nice showcase for the ability of the EnKf to constrain simulations.

C1

My main concern with this study is that the largest part of the paper documents the ability of the EnKf to capture the 1816 summer circulation and the dynamically consistent temperature. There is already a large and convincing body of literature that shows the merits of the approach of the 20CR. While necessary for this paper, the study needs more than this result to be ready for publication. The ingredient in this study which makes it stand-out is the attribution. Strangely, the description of this part takes only 9 lines (lines 91-99).

Another issue is that embedding within the literature on the 1816 summer or other data assimilation methods is lacking. I would have expected at least mentioning the volume edited by C.R. Harington (1992). Furthermore, the approach in this study has some parallels with other studies, like that of Rasmijn et al. (2016). The similarity is that in the current study, observed circulation of the 1816 climate with and one without the volcanic aerosol loading is used while in the Rasmijn et al. study observed circulation is simulated in the present and a future climate.

After reading the 9 lines with the attribution, the reader is left with a feeling that there is much more to be discovered in these simulations. Although the increase in correlations in temperature is perhaps not too dramatic (fig. 4), the pressure over the sites with instrumental records improves convincingly. In order to gain a little better understanding, it would be nice to see how pressure upstream of Europe changes in these two simulations (with and without aerosol loading). After all, conditions in the eastern US were as bad (if not worse) in the summer of 1816 than in Europe. It is perhaps possible to identify a tropical source? Even without the volcanic loading of the Tambora explosion, you are doing quite nicely already in capturing the temperature and circulation!

I can agree with the part of the conclusion (line 126-127) saying “the severe weather was influenced by the volcano”, but the preceding part (attributing 1816 coldness to Tambora) is too strong for the preceding analysis.

Other issues the authors may want to look into

C2

One motivation for the study is that new barometric pressure measurements of 1816 have become available (line39-41). My guess is that data is available for a few years around 1816 (rather than just this single year). If my hunch is right, can the authors explain why they do not take the opportunity to produce a reanalysis for a longer period? The reason for focusing on this is that the 1816 summer had low temperatures, but this also holds for the period 1790-1820 which was the last cold episode in the so-called 'Little Ice Age'. For many areas (in Europe), temperature in summer 1816 was not at record low level.

line34-36. Are the Geneva temperatures the only motivation for this analysis or is there more widespread evidence that reconstructions and GCM fail to capture the cooling? I was wondering if the choice to highlight Geneva relates to the poem of Lord Byron "Darkness" written in Geneva in 1816?

line 56-60. There are also sub-daily pressure readings available in e.g. eastern North America (Salem, Ma.) for this year. Why are these not used?

smaller issues

line 26-30. the numbers relating to the drop in temperature seem odd: they are the same while the authors argue that they are different. The sentence is not quite right.

fig. 4 & 5: I realize that Holland is a small country, but approximating Haarlem by Amsterdam is overdoing it.

Harrington, C. R. (ed.) 1992. *The Year without a Summer? World climate in 1816*. Canadian Museum of Nature, Ottawa, Canada

Rasmijn, L. M., van der Schrier, G., Barkmeijer, J., Sterl, A. and Hazeleger, W. 2016. The extreme 2013/2014 winter in a future climate. *J. Geophys. Res. (Atmospheres)*, doi:10.1002/2015JD023585

Interactive comment on *Clim. Past Discuss.*, doi:10.5194/cp-2016-78, 2016.