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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric impact of the 1783-1784 Laki Eruption: Part II Climatic effect of sulphate aerosol" *by* E.J. Highwood and D.S. Stevenson

Anonymous Referee #2

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General comments:

This paper is the first to use a climate model of intermediate complexity coupled to a slab ocean model to analyze the climatic impact of the Laki eruption. The scientific approach and applied methods are generally valid, although I am skeptical about the use of a T21 model to validate the geographic pattern as shown in Figure 5. I would encourage the authors to conduct at least one sensitivity study with a higher horizontal resolution. Moreover, many technical details are not described sufficiently which makes it hard to understand why certain assumptions are necessary. For instance, why do you need to use monthly mean data as input for the radiation code, doesn't the IGCM have a much better time resolution? How were the "Hi" and "Lo" scenarios chosen? Why was a

fixed dynamical heating used? I encourage the authors to take these recommendations and the following specific comments into account prior to publication.

Specific comments:

1. P1604, L19/20: How did you choose the “Lo” and “Hi” scenarios? Please justify and add references. Also, over which geographical area are these emissions distributed?
2. P1604, L26: Why is the sulfate aerosol lifetime longer for the Laki cases?
3. P1605, L8-13: Why did you have to use different e-folding times? Couldn’t you just have extended the IGCM run for another 2 years?
4. P1606, L23: Why did you have to assume that the aerosol is dry? Don’t you have relative humidity in the CTM and IGCM?
5. P1607, L2: Why does only the mixing in STE03 have a resolution comparable to T21? What is the horizontal resolution of all the other processes? Why can’t the CTM be run at T21 resolution for all the processes?
6. P1608, L2: Why do you use monthly climatologies of meteorological parameters for input in the radiation code if it’s called every day? Doesn’t the IGCM provide meteorological data on a much finer temporal resolution? What is the timestep of the IGCM?
7. P1608, L4: Why do you use fixed dynamical heating? I seem to be lost, is the IGCM not a GCM that calculates dynamical transport and heating itself?
8. P1609, L9: What causes the secondary maximum in the tropics?
9. P1611: T21 model simulations differ quite a bit in the dynamics from higher resolution simulations. Even though you point that out in the “Uncertainty” section, I

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would suggest to repeat at least the “Hi/Long” IGCM simulations in T30 resolution or better.

10. P1613, L9: Why are you doing the sensitivity tests for July 1983, when you show radiative forcing distributions for August 1783 in Figure 3? I suggest to use the same month for consistency, i.e. either July in Figure 3, or August for the sensitivity experiments.

11. P1614, L23: Everywhere else you use the “Hi” scenario. Even though you explain on the next page that aerosols in the “Hi” scenario would affect mixed and ice clouds more than low level clouds, I would still encourage you to calculate the aerosol indirect effect on water clouds for the “Hi” scenario here for consistency.

12. P1615, L4/5: It’s not true anymore that all the work on the indirect effect has examined only water clouds. The impact of volcanic aerosols on ice clouds was studied, for instance, by Jensen and Toon, GRL, 1992; Kaercher and Lohmann, JGR, 2002; Luo et al., J. Climate, 2002;

13. P161, p15: I seem to be lost again, why should the climate sensitivity parameter for a short duration forcing change the duration of the event rather than the magnitude? Shouldn’t it affect both?

Technical corrections:

1. Abstract, L5: Define "fissure eruption"

2. P1601, L16: Define "effusive"

3. P1606, L10: Define “STOCHEM-Ed”

4. P1608, L18: Delete “which” after Pinatubo

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5. P1609, L19: Add “in the “Hi” scenario after “-20 W/m^2”

6. P1614, L19: For clarity, I would add: “(60% of the factor 2.6)” after “1.6 times”

7. P1615, L6: “nuclei” not “nucleii”

8. Fig 2: The title immediately under the color bar needs to the fixed: delete space between “radiativ” and “e” and add a space between “in” and “W m^{-2}”.

9. Fig 3, Left panel: Add a space between “Low” and “Altitude”

10. Fig 4: The figure is too small, please enlarge. Also, are you sure that the dot-dashed line is the “Hi/long” simulation and not the “Hi/short” simulation? If so, why are the cooling rates larger in the “Hi/short” simulation in years 2 and 3?

11. Fig 5: The statistically different changes are hard to make out. Please try to show them more clearly.

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Interactive Comment