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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Analysis of global methane changes after the 1991 Pinatubo volcanic eruption" *by* N. Bândă et al.

Anonymous Referee #2

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The authors use a 1-D chemistry model to integrate the impacts from the eruption of Mount Pinatubo in mid-1991 on the global CH4 budget. This was potentially such a large perturbation to tropospheric chemistry, it is useful to further test our understanding of the important processes involved. None of the ideas presented in the paper are new, but the study is worthwhile to compare this integrated result, accounting for the opposite sign of many near-simultaneous impacts, with observations. Many of the impacts affect CH4 lifetime (e.g., SO2 absorption of UV radiation, aerosol scattering of UV radiation, and heterogeneous loss of stratospheric O3), although they also include impacts of T on reaction rates and emissions, and changes in anthropogenic emissions. The largest effect they find on atmospheric CH4 results from enhanced depletion of stratospheric O3 and its impact on OH. The approach is limited by the use a simple model, and the authors propose using a 3-D atmospheric transport and chemistry

model coupled to a climate model in future to make more realistic simulations. There are some omissions in the discussion of CH4 during this period. First, large amounts of particulates with a short atmospheric lifetime were injected into the atmosphere after the eruption, but these are neither included nor mentioned in this study. Second, while the authors try to account for changing anthropogenic CH4 emissions, the economic collapse of the Soviet Union in 1992 was not specifically mentioned, despite that it was believed to abruptly affect CH4's budget, especially in the northern hemisphere. Third, they do not consider if this large modeled result is consistent with observations of other species whose loss is predominantly by OH. Unfortunately, the quality of writing is low, and this significantly detracts from this work.

General comments: 1. The paper needs editing to reduce excess words and improve clarity of the discussion. 2. Since it is the transient response to the eruption that can be compared with observations, why focus so much on the steady state response? 3. Chemical symbols are used for many species, so why not CH4? 4. What other data are available that could corroborate these results? 5. Figures should be enlarged, and bolder lines and larger fonts used.

Specific comments: P18030,L13: this is vague; what is the effect of stratospheric O3 depletion? P18032,L6: Tg of what? L8: photolysis of what? L26: and a shorter lifetime for anything else whose predominant loss process is reaction with OH. P18033,L17: Soden et al. found... L21: much of the O(1D) produced does not react with water, so I would not say it is immediate. P18034,L8-10: The 13C data responsible for the feature that this claim is based on are not consistent with other data from high southern latitudes. P18037,L12: what is AUTO software? P18038,L24-25: why distribute SO2 globally rather than only in the tropics, consistent with observations? Were sulfate aerosols produced as SO2 decayed to get the timing correct for their impact on photochemistry? Is the increase in AOD from sulfate aerosols only? Were particulates from the eruption considered? P18039,L26: why use a Q10 at the lowest end of the range found in most field studies. P18040,L1: What is the MEGAN-like dependence? L9:

"forcing of the eruption" is vague. L18: The description of Fig 2 is unclear. How are the values plotted in Fig 2 been averaged? Annually and globally? Where is it shown that the model falls within the range of observations? L24: Lightning produces NOx, it does not emit it. Where is it produced? L25-26: These statements about O3 are vague and unclear unless you already know where O3 in these regions comes from. P18041,L4: emissions of O3? L17: "be due to"? P18042,L1: I suggest summarizing the sensitivities used in this study in a table and comparing them with those determined from other studies. L7: Hasn't the sensitivity of CH4 burden to emissions been assessed since the SAR? L19: Cape Grim L27-30: if you believe the sensitivity of atmospheric CH4 to stratospheric O3 is likely too large, why proceed? Is there evidence from other species (e.g., CO or CH3CCl3) that the decrease in CH4 lifetime resulting from stratospheric O3 destruction could be this large? P18043,L5: How did you put measurements from Etheridge et al. and globalview on the same scale? L7: Alert belongs to Environment Canada, not NOAA. L21: Using a CH4 lifetime that was too short would increase the sink and should make atmospheric CH4 too low, not too high. P18045,L7: before comparing growth rates, modeled and observed atmospheric CH4 abundance should be compared in a figure for 1980 or 1990 to present. It is impossible to tell from Fig 3 how well they compare. Also, a more detailed description of how growth rates were calculated for model results and observations is required. It is hard to see how the growth rate in Fig 6b was calculated from the transient curve in Fig 3. P18047,L24: The impact of the strong El Nino in 1997 to 1998 is not shown on the figure, so why discuss it? P18048,L4-5: So you assume that you have all the impacts you've considered exactly right, so any differences between model and observations result from processes not included here or interpolation procedures? L9-11: how would interpolation procedures explain differences between model and observations? L12-14: I do not understand "comparing the sum of the "Pinatubo all" and "Anthrop" curves to the growth rate evolution when including both Pinatubo forcings and changes in anthropogenic emissions, we can find the role of second order effects". Isn't the sum of the "Pinatubo all" and "Anthrop" curves the growth rate including both Pinatubo forcings

and changes in anthropogenic emissions? L28: this uncertainty seems rather small. P18049,L20: in what way is this comparison "remarkable"? L21-22: this conclusion was apparent based on previous studies before this study.

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