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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Forcing of stratospheric chemistry and dynamics during the Dalton Minimum" *by* J. G. Anet et al.

Anonymous Referee #2

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Summary: This is a comprehensive, well-written study on what the atmosphere would have been like during a period of reduced solar output and enhanced volcanic activity, which occurred during the late 18th and early 19th century. Using forcings reconstructed from paleo evidence, covering volcanic aerosol, solar irradiance covering whole spectrum, and galactic rays, they use the SOCOL chemistry-climate model to address how different the atmosphere (below the mesopause) would have been under individual or all forcings combined operating, versus a reference simulation without these perturbations. They show that in their model, generally there are significant impacts in parts or all of the atmosphere, and they explain the mechanisms causing these differences. The paper is slightly lengthy; this is explained by the varietry of different factors to consider. Also, the authors address in detail how the forcing data were constructed.

I think the methodology chosen here is sound; I have no major comments to make about the paper. I recommend publication after the minor comments listed below are addressed. The English is good and generally adequate although proofreading by a native speaker would help resolve some minor stylistic issues. I agree with Oliver Bothe's comment that this paper is rather free of comparisons with observational data, but accept that in view of the indirect nature of these data, this should be in a separate paper (in order also not to overload the present paper). The authors should probably elaborate a little more on how probably a new Grand Solar Minimum is to occur during this century, based on published literature.

Minor comments:

P15063L20: "where" → "were"

P15065L19: "halogen-contaminated"

P15067L5: Actually, odd nitrogen (NO_y + HNO_3 + $ClONO_2$) is probably more long-lived than a few days and is indeed distributed globally. I take the "Brewer-Dobson circulation" to mean the diabatic, overturning circulation of the stratosphere which operates on timescales longer than a few days, which indeed affects the distribution of NO_y considerably. There is also the faster adiabatic circulation, e.g. the jets, which transports chemical species around the planet within days. I suggest to be more precise about which circulation and which form of nitrogen you mean here.

P15069L17: Out of interest, why do you not use the IPCC "historic" scenario here, which covers the DM period?

P15072L17: "was" → "were"

P15074L16: I suggest to insert "forming HNO_3 and H_2O_2, respectively," for clarity.

P15076L12: Please put in a reference to where you discuss the mechanism for this, namely warming of the tropical tropopause.

P15080L7: Do you mean the troposphere or the stratosphere here? This sentence is a little strange.

P15080L11: “are going back to an average level” -> “revert to climatology, which is in agreement with Robock (2000).”

P15080L16: “southern pole” → “South Pole”

P15081L25ff: This sentence is difficult to follow. Please rephrase.

P15082L18: “forcings”

P15083L3: “the following effects”

P15084L11: “except for temperature”

P15084L28: “then becomes a threat to life”. In order to make this claim, you have to show that during the Dalton Minimum, there is a substantial change in the incident UV radiation at the Earth’ surface. There would have been some cancellation of effects due to decreased ozone (which would increase UV at the surface) and due to decreased UV at the top of the atmosphere (which would decrease UV at the surface). Short of seeing a plot of what the net UV changes actually are in the model, I am not convinced that the net change, even for a moderately bigger event than the Dalton Minimum, would have been big enough to constitute a threat to life. Life on Earth has been sustained through periods of substantially different solar irradiance from now, thanks in part to this buffering effect of the ozone layer. Of course the buffering effect has been weakened by ozone-depleting substances, but this weakening is set to heal during the coming decades. This claim comes across as somewhat unmotivated by the previous sections which do not focus on impacts on the biosphere. On the other hand, even a limited increase in UV, such as caused by anthropogenic ODSs, does have measurable effects on public health and the biosphere, but it does not quite constitute a threat to “life on Earth”.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 15061, 2013.