

Interactive comment on “Differing responses of the QBO to SO₂ injections in two global models” by Ulrike Niemeier et al.

Anonymous Referee #2

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General comments

This is an interesting study that explores reasons for different QBO responses to sulfate geoengineering between two models. The paper is very well written with a clear and thorough exploration of the differences. Please see below for minor comments and clarifications.

Although the models have a somewhat similar number of vertical levels (90 vs. 110), is there any major difference in the vertical resolution of the models in the stratosphere and do your results depend on the vertical resolution of the models? It would be useful to know if/how the vertical levels differ between the models and how, in addition to the horizontal resolution, the vertical resolution may contribute to the differences. Do you expect your results to be sensitive to the altitude of the injection?

It would be clearer if 'geoengineering' was included in the title, to avoid confusion with a volcanic SO₂ injection pulse. It would also be useful to add a final sentence to the abstract that highlights the implications of this study.

Specific comments

P2L5: 'higher SO₂ injections' – what sort of magnitude does this refer to?

P2L15: I do not quite follow by what you mean by 'in the steady state' in this context. Could you clarify?

P3L7: Please include the full model names. What is the height to which the WACCM levels reach?

P4L5: You mention that OH values in WACCM are not depleted – I understand this is also the case in ECHAM, so would be useful to mention here also. It would be helpful in the methods to explicitly state why you have chosen to use specified chemistry.

L4L15: Can you add the approximate altitude of the 60 hPa injection? Why was this height chosen?

Table1: Please consider only reporting the number of years used for the averages or state why not all years were taken. It would also be interesting to know how long it takes for the QBO changes to occur – does this differ between the models? Why was a 2 Tg experiment for ECHAM (T63) not included?

P6L9: It would be useful to state the magnitude of the heating

P8L2-4: I did not fully follow these sentences and the use of 'however'. Why are the different heating rates not a reason for different temperature anomalies?

P8L10: What causes this secondary maxima?

P10L1: How would different radii be related to differences in the heating rates? Do the different aerosol microphysical schemes between the models play a role? The different

modes are mentioned in section 4 but I think would be better placed in the methods.

Figure 8: It would be useful to show the control line to compare. How significant are these changes?

P11L14 (and P14L23): Could the extratropical differences in sulfate burden not also contribute to differences in the tropical QBO response? Can you comment on this?

P12L8: Where does the 30% maximum occur? It looks like the largest difference is much higher.

P14L1: It follows that the heating is a consequence of the sulfate burden, but it seems unclear to me by what you mean that it is not a source of the differences since the heating goes on to cause the QBO disruption.

P14L11: It appears the increase is below 30 hPa but not above. Could you clarify which altitudes you are referring to and why? It would also be useful to comment on the overall implications of the differing horizontal resolution results at the end of this section.

P16L20: The study has highlighted that the reasons for the differences in vertical advection are too complex to isolate in this study, but can some recommendation be given for future work to investigate this?

Technical corrections

P2L4: affects → affecting

P2L14: direct → directly, indirect → indirectly

P2L26: 'also' would be better placed after 'strategies'

P2L28: shows → showed. QBO vanishes at → QBO vanishes with a 2.5 equatorial injection

P3L20: value → values

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P4L3: effects of effects. Can this be rephrased?

P4L4: 'additionally' can be removed

P5L5: month → months

P5L7: as in → than?

P6L2: missing word after injections

P8L16: two instances of 'mainly'

P13L5: agrees → aligns?

P16L12: simulation → simulating

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