Answers to reviewer 1 on the ACPD paper (acp-2017-470)
Changing transport processes in the stratosphere by radiative heating of sulfate aerosols

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We thank the reviewer for the helpfully comments. We added some word of explanation to the description of the composites, changed the font sizes in many figures and added the table of top of the atmosphere forcing values.
Cited text is given in *italic* and new text in blue.

1. One area I would like to see a little more discussion of is the choice of the criteria for the QBO composites. They seem somewhat arbitrary. I would like to see some more justification of the choices the author made and some discussion of the importance of these choices. Key questions for me include: How were they arrived at? Were a range of other values for the criteria tested? Are the results sensitive to these choices?

We are interested in the impact of the changes in the QBO due to climate engineering on the transport of sulfate. Thus, the question behind the composite criteria of the 4Tg60 simulation was to find a criterion which indicates the impact of the prolonged phases of westerly winds in the lower stratosphere. This phase was important in 4Tg60 and even more in 8Tg60.
We tested some variations of the final composite. The final composites gave the clearest signal on differences in transport. We introduced also lower thresholds for the wind velocity of a composite to get clear signals. Therefore the results are robust to small variations in the composite. However, a criterion for easterly winds in the lower stratosphere, as e.g. described in Baldwin (2001) should give a different result. But periods with easterlies at 50 hPa were short and wind velocity weak. A Hovmoeller diagram for this criterion would have been statistically not well based. As the simulations were time consuming, we were not be able to continue the simulation for more than 50 years.
We chang the text to:
Simulation 4Tg60 shows still changing QBO phases, e.g. periods with easterly winds in the equatorial lower stratosphere or phases of easterly shear. This allows to examine the differences in transport between different QBO phases. Our definition of QBO phase composites differs from usual definitions in the literature. Typically the QBO phase is defined by using the equatorial zonal mean wind at a certain level, mostly 50 hPa, but also levels between 45 hPa and 30 hPa are common (Baldwin, 2001). In this study QBO phases change due to the impact of sulfate heating and periods of easterly winds in the lower stratosphere are too rare and weak to base composite onto them. Additionally, our aim was to get composites which cover the main characteristics of the equatorial jets under CE and allow to study the impact of QBO phase changes due to CE on transport processes. The chosen composite criterion allows to study the impact of the extended phase of westerly winds in the lower stratosphere on the transport of sulfate and the vertically extended westerly jet in the 30 hPa case and gave the clearest signal on differences in transport. We apply the composite criterion for each month of the timeseries and calculated a multi-year monthly mean for each composite:

- *Comp West: Westerly winds stronger than 10 m/s at 20 hPa. This composite covers situations in undisturbed QBO and is also close to the situation in 8Tg30.*
- *Comp East: Westerly winds stronger than 8 m/s at 50 hPa and easterly at 20 hPa. This composite covers many of the westerly tails in 4Tg60, easterly shear, and the jets in 8Tg60.*

The criterion for Comp West can be fulfilled under CE (e.g. 8Tg60) but also in an undisturbed QBO. Comp East covers a typical situation under CE conditions but only short periods of an undisturbed QBO. The criteria are chosen to robustly show the impact of CE. Therefore, we also introduce a lower threshold of the zonal wind velocity after testing different composite critria.

2. It would be useful to have a table summarizing the forcing efficiency of the different simulations. This is all discussed in the text but it would be helpful to the reader to have some of the key statistics drawn out in the form of a table, especially since the authors rightly highlight the inefficiencies as a key implication of the study.
We add the table in Section 6.2:

Table 1: Top of the atmosphere radiative forcing [W m^{-2}], calculated from a radiation double call, for simulations with a 39-layer version of the model and injection height at 60 hPa (GeoX) and two 90-layer model simulations with injection heights at 60 hPa (XTg60) and 30 hPa (XTg30).

Simulation	Injection rate Tg(S) yr^{-1}						
	4	6	8	10	30	40	50
GeoX	-0.95	-1.33	-1.67	-2.03	-4.39	-5.24	-5.95
XTg60	-1.00	-1.29	-1.54	-1.78	-4.04	-4.76	-5.18
XTg30	-1.18	-1.51	-1.79	-1.92	-3.81		-4.42

Minor comments

L73 - are the terms 'tropical' and 'equatorial' jets being used interchangeably here?
Yes. We changed tropical jet to equatorial jet to avoid confusion.

L84 - related 'to'
L131 - I think 'imagine' would be a better choice of word than 'assume' here
L176 - month –> months
L185 - 'causes a prolongation' –> 'prolongs'
All done.

L222 - 'the vertical extension of the jet' - which jet is being referred to here? The equatorial jet, I presume?
We added equatorial jet in the sentences as well as in the previous sentence.
L430 - 'thought' –> 'through' L455 - missing the units of temperature
All done.

Figures

1. Figure 1 is missing units on the axes. 2. Figure 2 is missing a title and units on the 'pressure' axis. The font size could also be increased to make it easier to read.
Done, also for the following figures.