

Interactive comment on “Long-term changes and variability in a transient simulation with a chemistry-climate model employing realistic forcing” by M. Dameris et al.

Anonymous Referee #2

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The paper describes a transient model simulation of the atmosphere during the period 1960–1999, applying the DLR E39/C model and taking into account trends in trace gas emissions, sea surface temperatures, the solar cycle, QBO, and the three major volcanic eruptions that have occurred during that period. The study is an attempt to reproduce this well-observed 40 year period with a state-of-the-art chemistry-climate model as closely as possible. The focus is on long-term trends in the UTLS region and on the importance of the external forcings considered.

According to the authors, a key question is how deterministic the model’s response to

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such forcings is. In this context, another question is how deterministic the real atmosphere is to such forcings. Can we expect the same atmospheric response for a given external forcing every time it is repeated? If the model, which has little scope for chaotic behavior, reproduces the atmospheric response to these forcings accurately, then the atmosphere seems to be rather deterministic with regard to such forcings. If the authors had these thoughts in mind they may want to add one or two more sentences on this (p.2300, line 25).

After the introduction the authors describe the model and the experimental setup, followed by a discussion of modeled trends in ozone, temperature, zonal wind, tropopause height, and water vapor, i.e. covering most of the 'hot issues' in UTLS research at present. The UTLS region as the main focus is an important point as the model extends only to about 30 km and thus misses some important aspects of the QBO and solar cycle in the middle stratosphere. A few sentences on how little this has to say for the UTLS region (assuming this is the authors' opinion) could prevent criticism.

What follows is a detailed and well-structured discussion of the external forcings mentioned above. However, the authors might consider to strengthen the 'conclusions and outlook' section a little, or rather just call it 'outlook' or 'the way ahead', because as it stands it is a listing of plans and needs rather than a conclusion from the (interesting) findings of the study.

Considering the scope of a typical ACPD publication, the analysis and interpretation of the results as well as the evaluation against different sets of observations, are sufficiently detailed. The performance of the model, but also its deficiencies, are objectively presented and discussed. Obviously, much remains to be done and to be improved in coupled chemistry-climate modeling, but given the current status of this field of research, the paper is certainly worth being published.

I suggest the following minor changes:

p.2298, line 18: What do you mean by 'respective decade'? The 1980's?

p.2298, line 25: change 'suggest' to 'suggests'

p.2299, line 10: change 'must carefully be checked' to 'must be checked carefully'

p.2230, line 25: change to 'For example, a key question is how deterministic the response of a non-linear model system to such forcings is.'

p.2301, line 21: probably better to say 'reduce the use of the steady state approximation'

p.2301, line 25: start a new sentence: 'It does not include bromine chemistry', and include a sentence explaining why and how bromine can be omitted in a study looking at high latitude ozone depletion.

p.2302, line 6: change 'the actual' to 'the current modeled'

p.2302, line 17: change 'which was used in E39/C so far to' to 'which was used earlier in E39/C to'

p.2303, line 4: write 'The simulation aims at reproducing the effects of natural as well as anthropogenic forcings.'

p.2303, line 18: it is not quite clear to me what you mean by a 'careful consistency check'. One or two more sentences might be in order.

p.2304, line 2: change 'inside' to 'in'

p.2304, line 10: change to 'interpolated linearly from 177 to 16 vertical levels and from 18 latitudes to 48 latitudes.' (is it really 177 levels?)

p.2304, line 13: change 'zonally mean' to 'zonally averaged' (or 'zonal-mean')

p.2305, line 1: 'zonally symmetric'... do you mean 'symmetric around the equator'? 'zonally symmetric' would mean little variation along a latitude belt.

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p.2305, line 24: remove 'i.e.'

p.2305, line 28: change 'prescribed due to' to 'prescribed based on'

p.2307, line 2: do you mean "... for the years 1960 and 1999 amount to 0.10 Tg(N) and 0.71 Tg(N), respectively' ?

p.2307, line 30: change 'Figs.' to 'Fig.' (WMO's 1-7 is only one Figure)

p.2308, line 11: insert 'in the same period' after 'polar region'. It's during late winter/early spring, too, isn't it?

p.2310, line 19: remove 'i.e.'

p.2310, line 1: change 'increased NOx emissions' to 'increased emissions of ozone precursors, such as NOx'

p.2311, line 19: remove 'winds' or write 'easterly winds'

p.2312, line 23: 'reflects'

p.2313, line 24: change 'do steadily change to' to 'changes steadily towards'

p.2314, line 5: write 'However, results from time series analysis of the few available...'

p.2314, line 23: increase of tropopause pressure due to tropospheric cooling (?)

p.2314, line 27: MOHp: name could be written out for once here in parenthesis

p.2315, line 11: change 'An' to 'A'

p.2316, line 1: remove 'been'

p.2317, line 10: write 'Microwave Sounding Unit (MSU) channel 4 data (1979-2002)'

p.2317, line 15: change 'occurs' to 'occur'

p.2317, line 17: it is unusual that a model response 'is overestimated'. It rather overestimates, or is an overestimate. Better write: 'From observations it is evident that the

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model overestimates the stratospheric temperature response following the eruptions of ... by about 1 K.'

p.2317, line 20: change 'over observations,...' to 'compared to observations, which they explain by the missing QBO modulation of heating rates and missing ozone depletion in their model configuration (both effects contributing 1 K).'

p.2318, line 26: remove 'additional'

p.2318, line 29: change 'large' to 'long'

p.2319, line 6: change '(Fig. 13a)' to '(top panel of Fig. 13)'

p.2319, line 7: change 'and by the reaction $\text{NO}+\text{HO}_2$ followed by photolysis of NO_2 in those regions in spring' to ', removing NO_x , an important ozone precursor, from the gas phase.'

p.2319, line 10: change 'HOx destruction' to 'ozone destruction due to HOx'

p.2319, line 10: '(not shown)' doesn't the destruction shown in Fig 13 include ozone destruction due to HOx? If not, what does it show?

p.2319, line 12: isn't the NO_x cycle reduced by $\text{N}_2\text{O}_5+\text{H}_2\text{O}$ as well?

p.2321, line 24: change 'results' to 'result'

p.2321, lines 17 and 18: change 'maximum' to 'maxima' (2 x)

p.2321, lines 20 to 28: I'm sure all this makes perfect sense. However, it's not easy to catch it. In the vicinity of the easterly jet, the QBO signal would strongly increase (reduce) upwelling in the shear layer below (above) the jet (i.e. the opposite to what is true for the westerly jet). How and why does this modify NO_y , ozone, and H_2O ? I understand that lower stratospheric O_3 is reduced by increased tropical upwelling, but how about H_2O ? Why is it reduced? You mention a 5-10% decrease in ozone at around 50hPa, and in the next sentence you speak about a 15 to 20% QBO signal

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in 'lower stratospheric' ozone. Isn't 50 hPa in the lower stratosphere? How can we conclude from this that ozone effects the destruction cycles and not vice versa? A few more sentences may help to clarify the cause and effect relation.

p.2322, line 21: change 'has been' to 'was'

p.2323, line 5: write 'feedback processes (e.g. interactive ozone) and the influence of volcanic eruptions.' (volcanic eruptions are not a feedback process)

p.2323, line 8: change 'this year' to 'that year'

p.2323, line 23: I'd remove 'although the coherence seems to be obvious', or divide the whole sentence in two parts: first the speculation, and then add that you cannot conclude definitely, although the coherence may appear be obvious from the data.

p.2324, line 20: change 'promising' to 'worthwhile' or 'to be worth an effort'

p.2325, line 21: remove 'intensively'

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 2297, 2005.

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