

***Interactive comment on* “Evaluation of the new UKCA climate-composition model – Part I: The stratosphere” by O. Morgenstern et al.**

O. Morgenstern et al.

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Response to Reviewer 1:

We would like to thank the reviewer for his / her positive and constructive comments. In detail, we respond as follows:

The tropical-tropopause temperature bias: We think that the reviewer’s suggestion to implement a constraint on temperature instead of water vapour to address the temperature bias is equivalent to our fix to the problem, which is to constrain water vapour. We preferred to constrain water vapour because it is possible to introduce model instabilities if temperature in a model region is held artificially fixed. Fixing temperature would also have had an impact on the tape recorder signal. We will investigate the reviewer’s suggestion.

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Wet and dry deposition operate on a number of non-halogen species, as listed in tables 6 and 7 (now merged with table 1). For chlorine and bromine we chose, for this experimental version, not to implement wet and dry deposition for halogen species so that, in the absence of any numerical problems, Br and Cl should remain uniform constants throughout the integration.

Mixed NAT/ice: Indeed they would be predominantly ice, but in the Chipperfield et al. (1999) scheme contribute to denitrification, hence include a fraction of NAT.

Total Cl and Br replacing HCl and BrO: The reviewer's suggestion might lead to a systematic shifting of Cl and Br into their long-lived forms, or away from the long-lived forms. These would have been undesirable effects. Also there are mixed compounds (containing more than one conserved element) which can be rescaled only once. We have therefore chosen to exclude organic halogen and mixed compounds from the rescaling where possible. The remaining inorganic compounds, on a timescale on which transport issues matter, can be regarded as in chemical equilibrium. We thus decided against introducing total chlorine / bromine tracers and instead redefining the most abundant inorganic compounds of either element to mean total Br / Cl for transport. The procedure will become redundant with the next-generation advection scheme under development.

Other heterogeneous reactions are unaffected by a change in aerosol loading because at the time the heterogeneous-chemistry scheme was drawn up, sticking coefficients with sulfuric acid aerosol were unavailable or considered negligible for these reactions.

Thanks for spotting the problem with dehydration. The seasonal averaging had been done incorrectly. The model dehydration signal now has about the right seasonality.

Problem with age of air: We have expanded the discussion of this aspect. The tropical temperature bias affects stratification, which in turn affects upward motion through the tropopause region. Exactly what the causal chain is, we have yet to investigate.

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P390, 1st para: In treating age of air and the speed of upward propagation of the tape recorder signal as equivalent, we make the implicit assumption that exchange with midlatitudes affects both diagnostics in the same way.

P391, I18: Indeed, and the diagnostics available to us do not allow us to rule out either possibility. A sentence to this effect is added.

P392, first paragraph: A sentence is added to relate the findings to the Brewer-Dobson circulation.

P392, last paragraph: We agree with the reviewer that CIO requires a more sophisticated method of intercomparison than we could perform for the purposes of this study. We remove the discussion on CIO because considering the deficiencies in the comparison as stated, it would remain inconclusive.

P394, 1st para: We have removed the sentence about preserving the order of lifetimes.

P395, I14: Wintertime (DJF and JJA, respectively) stratospheric polar temperatures are quite well captured, see figure 1. Biases in other regions are less critical because heterogeneous processes (with associated temperature thresholds) are less important there. The sentence is modified to make this more explicit.

Response to Reviewer 2:

We would like to thank the reviewer for constructive and thoughtful comments.

- The abstract has been expanded to give more detail on diagnostics and results.
- We add a paragraph expanding on which couplings are of interest and which questions can be addressed with a CCM.

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- We expand on which steps should be taken to tackle the problems detailed in the paper.

P382, L2: Done

P383, L13: Done

P383, L14: Header changed according to the reviewer's suggestion

P385, L3: Scattering at short wavelengths was omitted in FAST-J2 because it was considered too expensive for the benefit gained. It is now part of FAST-JX, which supersedes FAST-J2 and which we plan to implement in the model. Neither code is used here. Neu et al. (2007) discuss this in detail. The sentence is expanded.

P385, L13: Following the reviewer's suggestion we have combined tables 1, 6, and 7 into one.

P386, L30: Done

P386, L23: We made it part of the description of the experiment because the feedback of gaseous species can and will easily be changed in future experiments .

P386, L14: All species with prescribed surface mixing ratio, incl. N_2O and CH_4 , are forced only at the lowest model level (20 meters above the surface). The PBL scheme transports this forcing rapidly throughout the boundary layer. The thickness of the boundary layer is of course variable. The text is amended to this effect.

P387, L10: done

P388, L1: done

P389, L20: The sentence is removed.

P389, L25: We have expanded the discussion of this aspect; see reply to reviewer 1.

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P390, L16: We have only used HALOE/MLS and ERA-40 data, and they are inconsistent with each other. Other, newer satellite products (ENVISAT, MLS-AURA, etc) could be used in addition, although climatological products for these satellite data may not (yet) be available. Older data (Chiou et al, 1992) is available; the wording is changed to make this more explicit.

P392, L2. Done

P394, L22: It is indeed better to include the information when Braesicke and Pyle (2003) are first cited. We have restructured the sentences. The numbers relate to the page where the paper is cited and are part of the style of GMDD.

Table 9: Caption rephrased.

Table 10: Merged with table 1.

Table 11: Caption rephrased.

Fig. 4: Caption rephrased

Fig. 8: Done.

Fig. 10: Done.

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