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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assessing the sensitivity of the hydroxyl radical to model biases in composition and temperature using a single-column photochemical model for Lauder, New Zealand" *by* L. López-Comí et al.

Anonymous Referee #1

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Assessing the sensitivity of the hydroxyl radical to model biases in composition and temperature using a single-column photochemical model for Lauder, New Zealand

López-Comí et al., Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-448, 2016

The authors report a study of the effects on OH of constraining model calculations to observations of ozone photolysis rates and concentrations of ozone, water vapour, CO and methane, as opposed to model derived fields for these variables. The model used is a single column photochemical model, based on the NIWA-UKCA model, and enables a focus on the model chemistry owing to removal of transport and physical

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processes whilst also demonstrating changes in chemical effects on OH as a function of altitude.

My major comment with the paper regards a lack of detail, and insufficient attention given to the wider applicability of the results obtained in Lauder, New Zealand, to global chemistry-climate modelling.

My major comments are:

Abstract: The general trends for changes in OH are described but these should be quantified throughout.

Introduction: The introduction is rather short and lacking in detail. The rationale for studying OH is brief, and the paper would benefit from an expanded discussion of why it is such an important model target. The statement that 'considerable disagreement among . . . models' should be quantified, and given that the abstract describes the possibility of this work explaining 'differences in simulated OH between global chemistry models and relative to observations' some discussion of relevant previous studies is warranted. Differences in model outputs observed in intercomparisons such as ACCMIP could be of interest here, and would help place this paper and its results in greater context of previous work.

The Emmerson et al. papers referenced (line 47) refer to box models, some reference to single-column models, and examples of their use, should be given. There is no reference given for Lauder being 'known for its clean air' (line 49), or much detail given the 'large diversity of available measurements' (line 50). Apart from O3, H2O, CO and CHÂň4, what species are measured? Are there measurements of NOx (what are the average values?) or other VOCs?

Line 173: Please clarify that the changes in modelled O3 (Fig. 2a) are a result of constraining to the observations and not a model result. Is there any explanation for the increases in spring and decreases in autumn compared to the reference simulation?

Or for the altitude dependence?

Line 181: Is the 5 % increase an average value over all altitudes/seasons? Please clarify.

Line 185: The statement that the increases in OH are the result of increases in jO1D seems rather obvious given that this is the only parameter that has been changed.

Line 188: Please explain (and discuss) more clearly what you mean by the statement that the magnitudes of the kinetics and photolysis effects are comparable. Figures 2c and 2d show the changes to jO1D and OH respectively, how do these suggest anything about the O3 bias? The values shown in Figures 2a and 2b, which do correspond to the kinetics effects, are not comparable or similar to those in Figures 2c and 2d.

Line 193: What is the significance of a near exponential relationship? Does it have a physical basis? From the plot it is not clear that there is a near exponential relationship, if there is and it is significant, please show it on the plot and give the parameters describing the relationship. Does Figure 3 show data from all altitudes? The discussion comments on an altitude of 6 km, how does this relate to the data shown in the figure?

Line 199: Again, explain the significance of the exponential relationship and give the parameters describing it.

Line 213: The percentages given in the discussion are given as fractions in the figures, please change one or the other for consistency.

Line 235: What is the fraction of the total OH loss to CH4 and CO in the model? It is not clear from the discussion what fraction of the total OH loss occurs due to reactions with CH4 and CO, what are the implications of the presence of other species, and thus the applicability of the results obtained in this work to more polluted regions. The OH concentrations shown in Figure 3 seem particularly high.

If the CH4 observations are different from the reference simulation by only $\sim$2 % please explain the reported 40 % sensitivity of OH to the change in CH4. The discussion

refers to the percentage changes in OH shown in Figure 6e/6f, but these do not show percentage changes. The discussion should be consistent with the figures in terms of the way the differences are expressed. Please provide some discussion of the use of d ln(OH)/ d ln(CH4) (or CO) in Figure 6.

Line 275: Is OH + CH4 the dominant OH sink in the model? What is the change in the kinetics of the reaction for the temperature change applied to the model?

Line 310: What is the significance of this equation? Can it be applied to other models? Can values for the parameters be tabulated for various altitudes (or can altitude-dependent parameters be given?). How valid is the assumption that the OH response is linear to changes in the forcings? As stated, Figure 8c suggests this is not a valid assumption.

Line 385: Please give some examples (and references!) of underestimated CH4 lifetimes by NIWA-UKCA and comparisons with other accepted estimates. An expanded introduction will help with this.

Minor comments: Line 11: 'Its impact. . .', please change this to 'The impact of O3 . . . ' for clarity.

Line 32: 'in-situ' to 'in situ'.

Line 60: Please spell out NIWA in full.

Line 71/line 135: What determines the concentrations of these species in the model if there are no emissions? Are they constrained to observations? Set to zero?

Page 101: 'Vertically integrated ozone produced here' – please reword, do you mean 'produced in this way'.

Line 161: Please replace 'a' and 'b' with 'k' in keeping with convention, and label the different 'k' appropriately to distinguish between reactions (i.e. ka, kb or k1, k2).

Line 290: Space in '5K'.

Line 329: ‘sky’ to ‘skies’.

Line 336: Please change the word ‘combinedly’.

Line 373: Please change ‘chemical equilibrium’ to ‘chemical steady state’.

Figure 1: Panel e, please remove the degree symbol.

Figure 2: Panel f, presumably this should refer to panels 2b and 2d?

Figure 3: Please remove the titles to the plots and leave just the labels a, b and c. See comments above regarding the exponential relationships - please give the parameters (and fit statistics) for the relationships described if these are important. If they are, why mention them?

Figure 4: The data shown in the plots are given as percentages in the discussion. Please see comments above regarding consistency.

Figure 5: Please clarify in the caption that panels e and f refer to plots a&b and c&d, respectively. The analysis d ln(OH) / d ln(H2O) is not explicitly referred to in the text (likewise for Figure 6).

Figure 6: Figure 6e in the caption is referred to as Figure 6d.

Figure 8: Panel c, please explain the significance of the dashed and red lines.

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