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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Increased water vapour lifetime due to global warming" *by* Øivind Hodnebrog et al.

Anonymous Referee #3

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A number of climate model simulations from the CMIP5 intercomparison are used in order to estimate the change in water vapor lifetime with climate change. Water vapor lifetime is shown to increase by about 2 days in the next 100 years. Contributions from different climate drivers are analyzed using simulations from the Precipitation Driver Response Model Intercomparison Project (PDRMIP). Estimates for the combination of all drivers for the past are shown to be consistent with CMIP5 results. Changes in WVL are split into fast and slow responses. Changes in IWV per surface temperature change of different climate drivers are compared to the theoretical 7%/K increase that is expected assuming relative humidity to stay constant. BC shows the strongest increase in water vapor lifetime. The findings are very interesting but the paper is too concise to appreciate results fully. More information, explanations for assumptions and discussion

needs to be added.

1. You calculate contributions from changes in IWV and P to ΔWVL by calculating the ΔWVL twice, with the IWV and P terms held constant one at a time (page 5 line 9-10). This means that you neglect nonlinear terms which needs to be mentioned. It is difficult to judge from the material presented if this is a good assumption, since figure 2a gives the fast WVLS and figure 2b the WVL itself. I suggest plotting the overall WVL change in figure 2b additionally.

2. Could you please give an explanation why it makes sense to scale ΔWVL with RF (page 6 line 17).

3. Water vapor lifetime is increased which is supposed to be connected with a decrease in vertical mass fluxes. But a decrease in vertical mass fluxes should be connected with a moistening of the lower troposphere which appears not to be the case. Is there an explanation for this behavior?

4. Changes of water vapor lifetimes are connected with vertical mass fluxes. For the analysis of WVL changes you use climate models which have problems representing those mass fluxes. In particular convective mass fluxes are known to be a source of large uncertainty within climate models. Surface moisture fluxes may also be problematic. Vertical profiles of humidity may be strongly dependent on entrainment and detrainment rates which are highly problematic. It would be good to add a discussion about how dependent results are on known deficiencies in global models. Original model resolutions need to be given.

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