

## ***Interactive comment on “A new version of the CNRM Chemistry-Climate Model, CNRM-CCM: description and improvements from the CCMVal-2 simulations” by M. Michou et al.***

**Anonymous Referee #3**

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This paper is a very comprehensive discussion of improvements in the CNRM chemistry-climate model following biases discussed in the CCMVal-2 papers and report. This is a very nice application of what model intercomparison exercises can provide. I think this paper is in quite good state already. I only have a few major comments and additional minor ones.

Major comments

1. The discussion of model improvement and comparison to previous version is quite lengthy. It might therefore be useful to try to summarize it, possibly in a Taylor diagram that would show where the improvements were concentrated.

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2. It is mentioned in several sections that the change in radiative transfer scheme is, at the very least, a strong contributor to the improvements. It would therefore be very useful to have a better understanding of what the switch to RRTM provided. In particular, it might be useful to provide a zonal-mean distribution of heating rates from both schemes for the same conditions. This would enable the reader to understand those changes in a no-feedback framework.

Minor comments

1. Section 2.1.1. should include a description of the gravity-wave drag. It is very possible that some of the biases in the dynamical field could also be related to misrepresentation of GWD in the model. Some discussion of this would be useful.

2. It is unclear of the 560 hPa values of chemical species (section 2.1.2) are specified. Are those constant, climatological? Where does the Ox/O<sub>3</sub>/CO come from (since they will be strongly affected by tropospheric chemistry)?

3. Page 1134, line 15: What time constraints are being discussed?

4. Page 1135, line 25: spell out CMIP5 and include reference (Taylor et al., 2009)

5. Page 1141, line 17: if the radiative scheme is not the only thing acting, what else contributes?

6. Page 1143: it would be useful to include a zonal-mean figure of the zonal-mean wind. This would clearly indicate where some of the U biases are located.

7. Page 1146, line 5: the water vapor has a small seasonal cycle. Any explanations for this behavior?

8. Page 1147: it is quite significant that the model does not seem to have a tape recorder (based on the bias at 50 hPa, Fig. 7e). It would be nice to comment on this significant bias. Is that related to my previous comment?

9. Page 1147, line 24: typo in H<sub>2</sub>O

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10. Section 3.2.8: it is quite amazing how strong the SH ozone hole is at 50 hPa in October. Since the temperature bias is most likely gone or reversed, why is the ozone hole so strong?

11. Page 1153, line 5: is it possible that the photolysis in the upper part of the model is too strong? Do you include some O<sub>3</sub>/O<sub>2</sub> above the model top?

12. Page 1153, line 25: I'm not sure "satisfactory" is the correct term here. These seem like large negative ozone biases. What is the vertical structure of the ozone hole (again, possibly a zonal mean figure would help)

13. Page 1154, line 5: change "had" to "has"

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