Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-179-RC1, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "An assessment of the climatological representativeness of IAGOS-CARIBIC trace gas measurements using EMAC model simulations" *by* J. Eckstein et al.

Anonymous Referee #1

Received and published: 29 May 2016

The study by Eckstein et al. uses the EMAC model to identify the representativeness of CARIBIC aircraft measurements of the "state of the atmosphere" for different atmospheric trace gases. For this, the model is interpolated to aircraft flight tracks and time of the sampling and different statistics are applied to identify whether the interpolated profiles are characteristic of climatological averages.

The paper is well written and organized and the figures are appropriate. However, the question arises if the model can be used as an appropriate tool for the question. I think this question has not been addressed sufficiently in the paper. How well can data from a course model resolution be representative of the state of the atmosphere as described here? The representation of the model climatology vs. flight track interpolation

should depend on the models spatial and temporal resolution. If the grid or time span is too large (likely the case for global models), the model would not be able to represent the variability of the observations. A test would require to average the observations to the same model grid and then compare the variability.

Furthermore, I do not see any evaluation of the model. How well does the model represent the atmosphere? Especially water vapor is a gas that many models are not able to simulate appropriately, which is also the case for NOx and NOy. A discussion on how much this study depends on the performance of the model to represent chemical tracer should be added.

Finally, little has been done to identify reasons for differences between the flight track comparison and the global comparison, based on the atmospheric character of different trace gases dependent on the region for instance. Depending on region, airmasses experience more pollution, convection, stratosphere/troposphere exchange. The Pacific experiences a lot of pollution from South East Asia in some seasons than the Atlantic. Since CARIBIC data do not cover the Pacific, what implication does that have of the representation of the data compared to a global average? I would suggest, plotting a lon/lat map for a certain altitude level, say 1 km below the tropopause. This may help explain why some tracers are representative and why others may be not. Certainty 35-70 degrees is a very large region that covers a lot of different airmasses reaching from the tropics to the polar regions.

Detailed comments:

Page 3, Line 9. The assumption that species in the model show a similar variability has not been supported. A climatology of trace gases from the course model resolution is expected to show a much smaller variability than the observations. Wouldn't you expect a different result if you would run with a high model resolution spatial and temporal?

Page 4, line 15: Why is N2O5 counted twice, please explain.

Page 5: Line 6: is it +-4km (as stated above) or +- 4.25km?

Page 5, Line 17ff: Constraining the data to 35-75 degree N is not really removing different characteristics of tropical or polar airmasses and you would expect a larger variability. Earlier studies discussed differences in the characteristics of UTLS airmasses depending on the location with the jet stream and therefore with the height of the tropopause, which strongly varies with season. I think, constraining the comparison to 35-75 degrees N because of a good coverage of aircraft data would the better argument. There should be some discussion on the variability of the considered region.

Page 5, Line 23, if you define mid-latitude as 35-75deg, then please specify that here.

Page 6: Line 6-7: The temperature comparison for the data is taken from meteorological analysis. Are those the same that were used to nudge the model? That would explain the high correlation coefficient. Please clarify.

Page 7, Line 7-8: HrelTP does not look very similar to me. Distributions in the lower two rows in Figure 1 are more often above the TP than the flight track interpolated data. What implications will this have for the analysis?

Page 7: Line 18. The text describes that the variability of the model data if interpolated to the flight track is only 40-70% of the actual observed data. Further, it is discussed that the variability in the model cannot capture the small scale variability of the data. Then the assumption is made that the variability of the model is similar for all species. I do not follow this conclusion. Why is this the case?

Page 9: Line 19: How does the model represent CO2, N2O and CH4? If those are prescribed as fixed boundary conditions, certainly the model would not identify the variability that exists in the real data.

Page 13: I am not surprised about the different characteristics, since the different coverage of CARIBIC compared to the random distribution is very different, Figure 1 left column, the flight track sample more tropical air masses (being more concentrated

in the south). Furthermore, the Pacific with different characteristic of tracers are not sampled by the CARIBIC data set. It would help to see for example a figure of CO at the altitude considered for example 1 km below the tropopause.

A discussion on differences of the sampling location due to chemical characteristics that are different depending on sampling tropical or polar air masses, or characteristic longitudinal variability in different tracers would be helpful.

Page 17: typo line 2 “while it is can be much”

Page 17: Line 10: models usually have a poor representation of NO and NO2, especially in the UTLS it depends on lightning. Also convection is influencing NOx and can strongly vary with location, which is usually not well represented in models. Couldn’t this be the reason why there is a larger uncertainty?

Line 14: How is the model representing H2O in the stratosphere?

Line 20; C2H6 and C3H8 are considered short-lived species with lifetimes of a few weeks or so.

Section 5.5 I think, the question should be changes for extended to: What would be a better regional coverage improve the statistic? This could be easily addressed within this paper, since one could extend the coverage over the pacific region, but keep the number of flights the same.

Conclusions: Page 21: Line 14: Sentence is unclear.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-179, 2016.