Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-203-RC3, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modeling Trans-Pacific Transport using Hemispheric CMAQ during April 2010: Part 1. Model Evaluation and Air Mass Characterization for the Estimation of Stratospheric Intrusion on Tropospheric Ozone" *by* Syuichi Itahashi et al.

Anonymous Referee #2

Received and published: 12 June 2019

This manuscript is the first part of at least two parts of a paper series dedicated to the analysis of trans-Pacific transport. This first part is focused on the evaluation of the WRF / H-CMAQ model configuration and on the analysis of stratospheric intrusion.
The thorough analysis in the manuscripts has two flaws:
First, the model simulation uses a horizontal grid spacing of 108 km, which is a very coarse resolution to realistically simulate stratospheric intrusions.
Second, unfortunately, the authors are omitting vital information about their most

important diagnostic tool, the O3PV tracer. On the definition provided in the article the diagnostic method described in Sect. 3.2 seem to be not fully applicable and thus I doubt the results of Sect. 3.3.
Therefore, depending on the real definition (in contrast to my unterstanding of the description in the manuscript) of O3PV I am rating the manuscript as either reject or major revisions.

Major Issues

- p. 4 l. 15-20: Looking at the very coarse horizontal resolution of 108 km, it might be nice, that the 44 layer version represents STT better than the 35 layer version. However, the horizontal resolution is much too coarse to expect a good representation of the downward mixing during STT events. (e.g., Gray 2003, Cristofanelli et al., 2003).
  This alone compromises the usefulness of this study.
- p. 4 l. 25: "The value of PV generally increases with altitude ...": depending on the shape of the stratospheric intrusion / the PV streamer this is precisely not necessarily the case.
- p. 4 l. 30 - p. 5 l. 4: The definition of the O3PV tracer is not clear. How is this tracer initialised? When (at initialisation, each step ...) and where (free tropopause, stratosphere ...) is this O3-PV relationship used to define the O3PV tracer and how (is O3PV set to O3 in respective regions)? All this is essential for the information this tracer is carrying, thus a much more detailed explanation is required here.
- p. 7 l. 2/3 What about high-PV structures in the free troposphere? Are they simply declared to be stratospheric?

- p. 9 l. 2-4: “Generally, O3 and O3PV mixing ratios are very similar in the upper layers, especially above the 2.0 PVU line, indicating that O3 mixing ratio in these layers are dominated by stratospheric air mass. “
  I thought that is the definition of the O3PV tracer, how could these tracers not be very similar?
- p. 10 l. 9/10: more importantly the horizontal resolution needs to be increased.
- p. 10 l. 11-21: What do you expect? RH is a diagnostic quantity which is dependent on a bundle of prognostic variables and sensitive parametrisations. Thus RH is a very difficile variable to base further analysis on.
- p. 10 l. 22-30: You show here that RH is far from realistic in the model but still the new analysis method in 3.2 is based on this diagnosed quantity?
- p. 11 l. 10-20 / Fig. 7: I can not agree, that the model captures the observation well. The only thing that is correct is the location of the maximum over the Pacific Ocean.
- Sect. 3.2
  - p. 11/12 / Fig. 8 / Table 5: From the data provided here, I can not agree to the method how the relationship between PV and RH is established. There is no proof, that the exponential fit is the best one. Table 5 does not provide any statistical measures to assess the quality of this fit. Maybe an elephant might have been an option too?
  - I can think of low humidity conditions without stratospheric influence (e.g. above deserts).
  - p. 12, ll. 9ff.: How do you deal with high-PV structures in the troposphere. Where is the tropopause diagnosted in these cases?

  - p. 12/13: too understand this method it is essential to understand how the O3PV tracer is initialised. As explained above, the description provided in this manuscript is not self-explanatory. I assume: the O3PV tracer is set every time step to O3 where PV is higher than 2 PVU (this might include high-PV structures in in the troposphere) and might blur the signal of “real” stratospheric air.:
  - Additionally, as the O3PV tracer is transported and depositioned due to its own gradients many deviations between the Ozone and the O3PV tracer might be caused by differences in transport and sinks and not in photochemistry.
  - Fig. 10 and corresponding text: The description of you results reads as if stratospheric ozone would be inert and only tropospheric ozone would take place in photochemistry. The fastest process of all are the autocatalytic cycles of ozone production and destruction. Therefore, the amount of stratospheric ozone influences directly the photochemisty. How is this stratospheric ozone mass calculated? Is it the integral over O3PV? In that case, I would say that the assessment is wrong as you miss its photochemical sink. (provide more details about the calculation p.13, ll.12-14)
  - From the current knowledge about the method I would say, that a continuously initialised stratospheric tracer could be a diagnostic tool to diagnose stratospheric influence. But the quantification diagnostic introduced in Sect. 3.2. does not work, unless the authors omitted to provide a lot of vital information about their method.
- Sect. 3.3: As I question the diagnostic method explained in Sect. 3.2, I have to doubt the results of this section as well. Of course you can say, whether the air is influenced by stratospheric air, but the percentages provided in Fig. 11 mean nothing.

- p. 15 l. 30-33: Due to the coarse horizontal resolution of the model it was not to be expected that stratospheric ozone is transported downward efficiently enough to reach the surface.

Minor Issues

- title: should contain the model version, as evaluations are always specific for the used model version. Additionally, the title is misleading as the authors miss to point out the interdependencies between STT and trans-Pacific transport.
- p. 1 l. 29/30: not clear what the message is. Where else could STT impacts come from?
- p. 2 l. 1: as STT is event based I doubt that the impact is near constant.
- p. 2 l. 17: “acceleration of anthropogenic emissions” ? emissions are not accelerated. They might increase and their increase might be accelerated ...
- p. 4 l. 21: What is cb05e51? A GIT tag ?
- unify “O3/PV” vs. “O3-PV” relationship.
- Sect. 2.1: Are these (WRF and H-CMAQ) continuous simulations or are they re-initialised?
- Sect. 2.2.3 It is really necessary to talk about un-used flight data?
- Fig. 1: Usage of lighter colors would make it easier to see the symbols. The grey aircraft symbol is hard to distinguish from the grey map lines.
- longitude / latitude information is missing in all maps

- Fig. 4: thick line not identifyable, black lines are distinguishable only at 300 % zoom and more.
- Table 1: The tables content is not understandable without providing more details, e.g.:
  - What does “ranged” and “zero-out” mean?
  - “tagged O3”: which tagging method?
  - “tropopause tracer”: How defined / initialised?
  - Table 1: the descriptions of the “Estimated impacts” are completely messed, e.g., “5-7 ppbv (17 April- 15 May 2006; INTEX-B), increased by 1-2 ppbv from April-May 2000” What does this mean? The estimate stems from a measurement in 2006 during the INTEX-B compaign and is compared to a 2000 value, where we do not know anything about? And do you mean that it impact increased by 5-7ppbv?

Literature:

- Cristofanelli, P., Bonasoni, P., Collins, W., Feichter, J., Forster, C., James, P., Kentarchos, A., Kubik, P., Land, C., Meloen, J., Roelofs, G., Siegmund, P., Sprenger, M., Schnabel, C., Stohl, A., Tobler, L., Tositti, L., Trickl, T., and Zanis, P.: Stratosphere-to-troposphere transport: A model and method evaluation, J. Geophys. Res., 108, 8525, doi:10.1029/2002JD002600, 2003.
- Gray, S.: A case study of stratosphere to troposphere transport: The role of convective transport and the sensitivity to model resolution, J. Geophys. Res., 108, 4590, doi:10.1029/2002JD003317, 2003.

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