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Atmospheric Measurement Techniques Discussions

Interactive comment on "Model estimations of geophysical variability between satellite measurements of ozone profiles" *by* Patrick E. Sheese et al.

Anonymous Referee #1

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This manuscript investigates the geophysical variability encounter in the comparison of ACE-FTS and OSIRS for different coincident criteria (the spatiotemporal window used to define a coincidence). Geophysical variability is estimated by sampling at the measurement's times and locations 3 model fields (WACCM, CMAM, and EMAC). There are major points that need to be addressed before publication.

Comments:

Page 2 line 24: The authors could include: Toohey et al 10.1002/jgrd.50874 and Millan et al 10.5194/acp-16-11521-2016. Both of these papers characterized sampling biases for ACE-FTS

Page 4 line 32: This section "Another set of output from this WACCM simulation was used in this study, with the same setup, the only difference being that the output model data were sampled at the time and geolocations (with WACCM altitude profiles) of the ACE-FTS and OSIRIS observation profiles (individual profiles were assumed to be at a single time, latitude, and longitude, taken as the 30-km tangent height values). The WACCM data output at the instrument Observed Locations will from here onward be referred to as WACCMOL." is a bit confusing. The way is written, the reader may wrongly infer that, WACCMOL refers to WACCM at (tinst, Zmod, loninst, latinst) since that is what the authors were describing right before. Please clarify this section.

Section 2.3, Please give examples / citations of how good or bad these models capture the geophysical variability. Or give examples of the type of phenomena that have been study with these models.

Page 5 line 13: If I understand this phrase correctly "First, for every instrument profile, the model O3 data closest in time to tinst on either side are isolated and are spline-interpolated in log-space from the native"

It implies that only one side (i.e. only one synoptic time) is used during the interpolations. If that's the case, the interpolation in time is actually extrapolating. The interpolation should be performed as follows:

(tmod, Pmod, lonmod and latmond) grid to a (tmod, Zinst, lonmod and latmond) at the two closest times encompassing the measurement, that is at both sides of the measurement time.

Then interpolate to (tinst, Zinst, lonmod and latmond) using (t0, Zinst, lonmod and latmond) and (t1, Zinst, lonmod and latmond)

and lastly to (tinst, zinst, loninst, latinst)

If that is not the case, i.e. I misinterpret the phrase, please clarify the text, perhaps something like: "First, for every instrument profile, the model O3 data closest in time to

tinst on both sides are isolated and are spline-interpolated in log-space from the native . . . ”

Page 5 line 16, with respect to: “Since OSIRIS does not retrieve atmospheric pressure, the OSIRIS O3, time, latitude, and longitude profiles (in altitude) are spline-interpolated to the ACE-FTS grid and assumed to have the same pressure values as their coincident ACE-FTS profile.” First off, in the model to model comparisons there should not be any usage of the ACE-FTS pressure everything should be done using the model pressure (if needed at all). Secondly, in the INST comparisons, the authors should not use the ACE-FTS pressure for OSIRIS, they should use the interpolated pressure and temperature profiles obtained from the European Centre for Medium-Range Weather Forecasts during the OSIRIS retrieval process. If those pressure levels are not available, at least interpolate the CMAM30SD pressure (which in essence is ERA-Interim) to the OSIRIS measurement times and locations; that would be a much realistic comparison.

Page 5 line 30 (equation 2): Please clarify why are the authors using the overall mean of all ACE-FTS and OSIRIS values at a given altitude in the denominator as opposed to just (MODace_i + MODos_i). That is, why not simply use

reldiff_i = 2N (MODace_i – MODos_i) / (MODace_i – MODos_i) * 100.

which is what is most commonly used for example in validation papers (for example in Dupuy et al 2009 doi:10.5194/acp-9-287-2009 or Bognar et al 2019 doi:10.1016/j.jqsrt.2019.07.014 ACE-FTS validation papers.

Page 6 line 6 (fig 1): Not all models yield profiles with similar patterns in the mean o3 bias; CMAM and EMAC maybe but WACCM shows a clear departure, while CMAM and EMAC mean biases are well within $\sim$1% from 10 to 48km, WACCM can be as low as -3%. This may not sound much but its departure from the other 2 models is clearly visible, is this because the variability in WACCM is greater than that found in the other 2 models.

Also, now that the geophysical variability has been estimated, could you add it to the expected instrument noise variability and see if you can get back the measured variation (the blue line). This assumes that the covariance between ozone and instrument noise is zero, which it presumably is.

Further, how come the bias found in this figure is not similar to the one found in Dupuy et al 2009, figure 7 or the one found in Bognar et al 2019 Figure 2. Both comparing ACE-FTS and OSIRIS. Please mention how the ACE-FTS-OSIRIS biases found on this study compare with the others validation papers and explain any differences.

In page 6 line 20: If WACCM is (tinst, Zmod, loninst, latinst) and WACCM-OL is (tinzt, Zinst, loninst, latinst) there should not be any differences between the coincident ACE-FTS and OSIRIS O3 profiles as determined by WACCM and WACCMOL. Because WACCMOL should be able to be computed directly from the WACCM coincidences, since in the end, you should only need to interpolate from the geophysical variation at Zmod to the geophysical variation at Zinst, which should not induce any bias.

Further, during this test there should not be any usage of the ACE-FTS pressure. The authors are just comparing model values, interpolated to different times and locations (and altitudes for the OL). Hence, the bias points to a bug in the interpolation scheme. and the phrase “and uncertainties introduced by assuming ACE-FTS altitude-pressure values for OSIRIS” should be deleted. If the authors are using pressure at any point of this comparison, they should use the WACCM pressure interpolated either to the times and locations or to the times, locations and altitudes.

Page 7 line 4 (figure 3): It would be interesting to see the results for a 10 or 12 km, where a lot of geophysical variability will be found due to the location of the tropopause.

In page 7 line 22 (or more easily in Figure 5), the optimized criteria is chosen for geophysical variability is less than 10%. However according to page 2 line 6 “Collocated measurements should be close to each other relative to the spatiotemporal scale on which the variability of the geophysical field becomes comparable to the measure-

ment uncertainties", shouldn't then the optimized criteria be for less than the combined measurement uncertainties. According to section 2.1, "on the order of a few percent for ACE-FTS" (please be more specific) and according to section 2.2 within 5% for OSIRIS. Is the combined measurement uncertainty less than 10%, is using the combined measurement uncertainty as criteria to strict? so that only a few coincidences are found? What are the implications of this?

Also, please add in figure 5 the difference in percent so that it is easily comparable with the rest of the figures.

In page 7 line 24-26, the manuscript will be enriched showing an example of the biases that can be induced by having different coincidence criteria per height. Please quantify it.

Page 8 line 14: after "It is also interesting to observe the difference in geophysical variability between the polar NH (poleward of 50°N) region and the polar SH (poleward of 50°S) region" please add: where most of the ozone variability can be found.

I suggest splitting the analysis of Figure 8 into two periods, during polar vortex season and during the offseason. That way, the sentences about stronger descent, SSWs, and in or out the vortex will be more certain. And it will presumably showcase that the coincidence criteria to maintain a given geophysical variability criteria will vary with season.

Also, consider exploring the tropics separately where the tropopause is higher implying difference criteria for lower (tropospheric) altitudes.

Please add the mean of the relative differences panel to figure 9. So that Figure 6 and Figure 9 have the same layout.

Summary or all the manuscript really: Please make clear that the optimize criteria discussed are only valid for the ACE-FTS and OSIRIS pairings used in this study. That is, that a similar analysis will have to be conducted for all pair of instruments to be

compared.

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