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Atmospheric Measurement Techniques Discussions

Interactive comment on "An inter-comparison of total column-averaged nitrous oxide between ground-based FTIR TCCON and NDACC measurements at seven sites and comparisons with the GEOS-Chem model" *by* Minqiang Zhou et al.

Anonymous Referee #1

Received and published: 14 January 2019

The manual is clearly written and well organized. It characterizes in detail and explains NDACC vs. TCCON retrieval performance discrepancies for N2O (dry-air column averaged), along with providing insight into CTM model performance in the SH. Although the conclusions presented in the abstract and conclusions sections are supported by the data shown, there are a number of places where the manuscript lacks specificity. I recommend publication after the issues below are addressed.

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Major comments:

Equation 1: SBF stands for? Alpha is a scaling factor, is beta too? Is the functional form of SBF necessary here?

Pg. 5, regularization: “OEM” vs “Tikhonov” is too general, especially since the OEM choice leads to 1 extra DOF in Table 3. Is the OEM prior covariance based on WACCM runs? Is Tikhonov diagonal or with a correlation length?

P7L4: 0.06% is called “relatively small” here for differences in retrievals due to apriori profile, but 0.09% was called “negligible” on P5L24 in regard to differences caused by regularization schemes.

P5L22: you’re really testing for 4 things in Table 4: spectroscopy, regularization, window and apriori profile. Stating this early is less confusing.

P7L9: “apart from spectroscopy causing a bias between different retrieval windows” is imprecise and also confusing w.r.t. to the previous statement that spectroscopy is the same (in a given microwindow). I suggest “apart from the different sensitivity of the forward model to the underlying true state in different microwindows, e.g., on account of spectroscopic differences,”

P8L5, regarding Fig3: “bias . . . increases with time” -> I cannot see this effect in Fig3 Fig 4: The lowest TCCON N2O days occur for shades of orange corresponding roughly to April/May, when PV is low (maybe this is the later 2014 anomaly). What do we learn if we color the scatter plot by PV instead of month of year, or by SZA?

Fig 5: Give n=3 and 40 for inside/outside measurements in caption. State the nature of the error bars. This plot is hard to read, consider splitting into two panels.

Section 5: were the NyAlesund and Sodankyla TCCON data a priori-corrected in the model comparisons? If not, how would including this change Fig. 8/9/10?

P14L3: “except at NyAlesund.” -> and with very high variability at Sodankyla, which

should be noted here as well.

P14L4: In this paragraph, the TCCON-derived trend is stated as “0.8-0.9 ppb/year” and described as “slightly smaller” than NDACC and flask sample trends of 0.9 – 1.0 ppb/year. I put a horizontal line to Fig 8 and find the highest TCCON trend to be ∼0.85 (Wollongong), with all others being lower. Please calculate a single value of the TCCON, NDACC, flask, GEOS-priori and GEOS-posterior trends and be precise in comparing one to another. On L9: updates to the TCCON profile with a 0.3%/yr growth rate: is that updated only at the surface or through a scaling of the whole profile? Give the precise change in the apriori structure and a precise trend value change.

P14L18-19: “there are no full extent of the minimum . . . at NyAlesund in 2007, 2009, 2011” -> it’s hard to see in that figure whether this is due to a lack of data or could it be because polar vortex intrusions were fewer in those years?

P14L20: “comparatively more FTIR data” -> be specific: there is nearly 10X more data at Sodankyla. Also, since this data occurs in the shortest time series, this supports your previous argument about assuming constant growth rates and not worrying about different time series lengths at different TCCON/NDACC stations.

Fig 9: It’s hard to argue that there’s a maximum in FTIR seasonal variations from Aug-Oct and a minimum from Feb-Apr at NyAlesund since there are no measurements in Feb, Sep, and Oct. This statement only holds true at Sodankyla and only for TCCON data (there’s no clear maximum in autumn NDACC data). In this paragraph, the use of “slightly larger” (L6), “much larger” (L7), and “good agreement” (L10) is qualitative and debatable, especially in contrast with the high precision and high accuracy of the NDACC and TCCON data sets that was painstakingly laid out in Section 2. “good agreement” here appears to mean “better than factor of 2”, though it is hard to see for Bremen and Izana. Please quantify. Also, I can’t see an opposite pattern of seasonal variations at Wollongong as compared to the model; to me it appears rather flat, on average.

P16L4: “below 8 km” -> “from 0 to 8 km” will distinguish it from surface flask measurements better

P16L7: while Wollongong and Lauder may have comparable tropopause heights (check and quantify), they are separated by 10 degrees of latitude and exist in different climates, which should not be dismissed too quickly. For example, Fig 10 third row (8-17 km) clearly shows that if stratospheric processes are responsible for the discrepancy with GEOS-Chem, this is a stronger effect at the southern mid-latitude Lauder rather than the sub-tropical Wollongong.

P18L7: “slightly underestimated” -> please quantify

Minor comments:

P2L12: million -> billion

P3L11: “study is [that] to”

P3L29: “of [the] O2 in [the] dry air”

P5L15: “in these two spectroscopy” -> “in these two spectroscopic databases”

P6L4: “difference. Consequently,” -> “difference, consequently,”

P7L18: “are from” -> “range from”

P7L19: “with [the] standard deviations”

P8L10: “autumn” -> autumn

P9L5, L12, L18, L23: “polar vortex” -> “the polar vortex” (also in Fig. 6 and 7 caption and P16L28)

P9L8: “the isolation from mid-latitude refreshing” -> “dynamic confinement”?

P9L13: “[the] mole fractions”

P9L21: “criteria” -> “criterion”

P10L3: “[rapidly] decreases more rapidly”

P10L9: “[and] explaining why”

P14L16: “might be explained by [the lack of measurements;] the fact”

P17, Fig. 10 caption: “second to fourth panels” -> “second to fourth row panels”

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