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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assimilation of atmospheric methane products in the MACC-II system: from SCIAMACHY to TANSO and IASI" *by* S. Massart et al.

Anonymous Referee #2

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General comments

This study examines the impact of assimilating different satellite data products into the MACC-II Delayed Mode assimilation system. The authors focus on the spatial and temporal extents of the constraints provided by SCIAMACHY, TANSO and TANSO + IASI, considering the data coverage, averaging kernels and observation errors. This work represents an important step in establishing an operational CH4 assimilation system for global greenhouse gas monitoring as well as for climate studies. I recommend this paper for publication in Atmos. Chem. Phys. after moderate changes.

There is some information missing about how the satellite data products, SCIAMACHY, TANSO, and IASI were assimilated, i.e. what were the resolutions of the products and how were they used in the data assimilation system. For example, the data assimilation system has a resolution of circa 80 km (T255), while SCIAMACHY has a pixel size of 30 x 60 km, TANSO has a field of view of 10.5 km diameter, and IASI 12 km. The only information, I could find was in the caption of Fig. 2, where it states that the observations are at a resolution of 0.7 x 0.7 degrees, but further information should be given in the text in section 2.2. Furthermore, it is not mentioned whether or not data errors were correlated in time and/or space. Even if the data were assimilated assuming no error correlations, this should be stated.

I think the authors should include (even if only briefly) a discussion of previous studies on the comparison of satellite data products of CH4 with ground-based observations (especially TCCON) in section 3.5.2. For example, for SCIAMACHY, the work of Houweling et al. and Bergamaschi et al., which also include a discussion of the latitudinal and seasonal dependence of errors.

English language editing is recommended.

Specific comments

P2555, L12: Suggest that the authors update the reference to the latest version of the IPCC report, i.e. AR5.

P2555, L13: “hydroxide” refers the anion (OH-), whereas, what is meant here is the “hydroxyl” radical.

P2555, L14: From this sentence, it is not clear what is meant by “Its”, do the authors refer to the impact of the concentration of CH4 or to the oxidation by the hydroxyl radical. I suspect it is the former but it is not obvious.

P2558, L25: How is “good enough” precision defined? Could the authors please explain?

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P2562, L14-15: The resolution of the CarbonTracker CO2 mole fractions is not stated, however, the TM5 model used in CarbonTracker is at lower resolution than the that of the SCIAMACHY data and the MACC-II analysis system (T255). Therefore, using the CarbonTracker CO2 to calculate xCH4 requires either smoothing the SCIAMACHY data or interpolating the CO2 mole fractions. It should be stated, which is used.

P2563, L22-23: The authors should state the resolution of the TANSO xCH4 product that was used in the assimilation.

P2565, L5-6: The authors should state the resolution of the IASI product that was used in the assimilation.

P2567, L20-24: I am confused by these sentences. The meteorological parameters were only replaced in the FREE experiment, was this also the case in the analyses? In the FREE experiment, were the meteorological parameters taken from a separate assimilation in which these parameters were optimized? Why was it not possible to have the same meteorological forcing in all experiments, and what are the possible implications of having different forcing?

P2569, L13-15: It seems fairly logical that the SCIA experiment would still have lower xCH4 compared to the FREE experiment in winter, even when there are fewer observations to assimilate due to the time needed to re-adjust to equilibrium. Also it is clear that any difference with respect to the FREE experiment will be propagated with atmospheric transport. Therefore, these two hypotheses are equally valid and not independent from one another.

P2570, L28: I am not sure how this statement supports the previous one. Could the authors please explain.

P2571, L8: The authors should emphasize that this is compared to the TANSO only assimilation (if that is indeed the case).

P2572, L18: Do the authors mean that the global bias between each experiment and

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the observations was subtracted? If so, then this also removes the global offsets between each experiment. Therefore, it can only be the spatial gradients or relative differences that can be compared between experiments.

P2573, L13: This is approximately the same bias as found by Houweling et al., for SCIAMACHY (-37 ppb) and should be referred to here.

P2573, L21: I suggest specifying that this is an underestimate of 7 ppb in FREE and 3 ppb in the assimilation.

P2576, L15: This is not sufficient to say that there is not a latitudinal bias in SCIAMACHY, in fact previous studies have found a latitudinal bias (e.g. Bergamaschi et al. 2009)

Technical comments

P2554 L28: remove the "when" after "TANSO analysis"

P2555, L2: do the authors mean the "methane total column", if so please add this.

P2555, L2: please replace "In terms of. . ." with "Regarding the. . ."

P2555, L12: remove "the" before "tropospheric chemistry"

P2555, L13: remove "the" before "oxidation"

P2555, L13: place commas before and after "therefore" ("and, therefore, in. . .")

P2555, L14: change to ". . .levels of CH4 have increased substantially. . ."

P2555, L19: add "the" before "reconstruction"

P2555, L23: remove the "with" after "and" (". . .and inter-calibration")

P2555, L24: add commas before and after "for example"

P2555, L25: this should be "the annual growth rate of the global atmospheric CH4 concentration"

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P2555, L26: add commas before and after “in particular”

P2555, L25: add “be” after “estimated to” (“estimated to be. . .”)

P2556, L2: do the authors mean “inter-annual” rather than “internal”?

P2556, L2: begin this sentence with “Moreover” (“Moreover, the annual growth rate. . .”)

P2556, L5: “recently” is in the wrong position in the sentence, I suggest: “More recently, in addition to surface networks, monitoring can benefit from remotely sensed. . .”

P2556, L7: “Observations”

P2556, L15: for consistency “mid 1990s”

P2556, L15: “Among” is not used in the correct sense here, suggest changing to: “Some of these instruments were designed to continue monitoring ozone. . .”

P2556, L25: “mimic” is not used in the correct sense, please replace with “emulate”

P2557, L15: “complementary to surface observations to monitor atmospheric CH4”

P2557, L16: “nevertheless” is not correct in this sentence, suggest joining this sentence the preceding one: “. . .to monitor atmospheric CH4, although, they provide only vertically integrated information, which is also associated with notable uncertainties.”

P2557, L19: remove “and to combining them” (“and observing networks with a model..”

P2557, L25: remove “the” before “tropospheric”

P2558, L1: replace “But” with “However,”

P2558, L25: replace “good enough” with “sufficient”

P2559, L12: “assess” (and elsewhere, e.g. P2568, L14)

P2559, L13: please change to: “we also run an experiment for this period without the assimilation. . .”

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P2560, L1: remove “the” before “atmospheric CH4”

P2560, L2: remove the fullstop and join these two sentences

P2560, L8: “the seasonal cycle from Matthews’ monthly. . .”

P2561, L4: “retrieval products”

P2561, L4: do the authors mean: “to lower the level of complexity compared to assimilating radiances”

P2561, L219: pace a comma after “In autumn”

P2561, L20: place a comma after “For example”

P2561, L25: remove “the” before “sunlight”

P2561, L25-26: place a comma after “Early on” and after “June” and join this sentence with the proceeding one (“. . .shifts to the north but the main features. . .”)

P2562, L5: I think the authors mean “dry air” and “mole fraction” (not “molar”)

P2562, L13: “mole fraction(s)” and not “molar fraction(s)” (and elsewhere)

P2562, L14: “At the time of writing this paper,. . .”

P2562, L23: “average value”

P2563, L14: replace “that” with “, which” (“SCIAMACHY, which had..”)

P2565, L11: remove “in average” and add “mean” before “observation”

P2566, L12: “non-satellite”

P2566, L16: place change to: “As the assimilated data are columns, they do not constrain the surface level well in the analysis, therefore, we. . .”

P2568, L10: replace “budget” with “balance”

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P2568, L15: replace “in terms of” with “as a”

P2568, L22: replace “and not” with “but not”

P2569, L3: please change to: “. . .corresponds to a lower CH4 mole fraction in the range from the surface to the lower stratosphere, up to 50 hPa, in the analysis.”

P2570, L4: “mid-latitudes” (plural)

P2570, L4: remove “on” after “further”

P2570, L6: “northern latitudes” instead of “latitudes north”

P2570, L25: “The TANSO data constrain the whole troposphere. . .”

P2571, L13: add commas before and after “however”

P2571, L13: “spreads the information to the higher latitudes”

P2576, L11: “analyses underestimate” (remove “s”)

References:

Houweling et al., Atmos. Chem. Phys. Discuss., 13, 28117-28171, 2013

Bergamaschi et al., J. Geophys. Res., 114, 2009

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 2553, 2014.