Review of Kim et al., 2017: "Impact of high-resolution a priori profiles on satellite-based formaldehyde retrievals"

General comments

The subject of the paper, studying the spatial and temporal variations of a priori HCHO profiles and their impact on AMF, is very relevant for current and future satellite retrievals. For their study, the authors used a regional model with a spatial resolution of 4x4km, at three different time of the day. The use of aircraft profiles and LP DOAS measurement to validate the model is giving to the paper an interesting added value to the paper, although their use is limited.

However, while the title and the abstract promise to the reader for an evaluation of this resolution impact, the paper does not provide a quantitative answer. I would expect to get an estimate of the errors on AMF when the resolution is decreased in space or in time, with a distinction between both effects. What minimal model resolution is needed to capture the natural resolution of HCHO in the AMF (based on the model)?

A number of details are missing about how the AMFs are computed beside the a priori profiles? Angles, albedo, aerosols?

I think that the discussion about the shape factor introduce some confusion. I do not agree with the following sentence in the conclusion = "For similar profile shapes, the absolute magnitude of HCHO concentration is also an essential factor in determining the AMF". The author should clarify the impact of a change at a given altitude, that will modify the shape factor, in opposition to a change at all altitudes (multiplicative factor) that will not modify the shape factor and therefore have no impact on the AMF. See also the detailed comments. I would rather conclude that the AMF are very sensitive to the absolute HCHO mixing ratio in the boundary layer.

I recommend publications after these comments have been addressed.

Detailed comments

P2, l15: please quantify the statement "can better capture"

P2, l16: This sentence is vague. Which operational product (reference?), what does "nearly constant AMF" mean?

P3, l12: please cite Jin, X., Fiore, A. M., Murray, L. T., Valin, L. C., Lamsal, L. N., Duncan, B., Folkert Boersma, K., De Smedt, I., Abad, G. G., Chance, K. and Tonnesen, G. S.: Evaluating a space-based indicator of surface ozone-NO x -VOC sensitivity over mid-latitude source regions and application to decadal trends, J. Geophys. Res. Atmos., 439–461, doi:10.1002/2017JD026720, 2017.

p4, l6-10: HCHO weak absorption in the UV has an impact on slant column uncertainties. AMF uncertainties do not result from the weak HCHO absorption in the UV. Please clarify.

P4, l18: add reference to operational products.

P4, l16: …, while the *a priori profiles* are generally derived from a 3D CTM.

P4, l18: which operational trace gas products? Please provide reference.

P5, l3-4: references are mixing satellite retrievals and inverse modelling papers.

P5, l5-6: It is not clear what is meant by this sentence "these studies …. used the contrast between land and ocean". Please add more explanations.

P5, l10: Please provide a reference for TROPOMI.

P5, l15: Recent model provide a resolution of 1x1°, daily (TM5-MP, TROPOMI)

P13, l1: Please specify to what quantity 35 % refers to. Total AMF, AMF in a certain altitude range?

P13, l10: please provide a number (relative differences between cases a and b in figure A1) in order to estimate the "small" impact of surface pressure on AMF

P16, l15-16: I do not agree with this discussion. I completely agree that the AMF anti-correlates with the HCHO mixing ratio in the boundary layer. But if the absolute HCHO values changes in the boundary layer, and not at higher altitudes, this changes the profile shape quite strongly.

P23, l 8-9: quantify the improvement

P 23, l8-8: It would be an interesting conclusion to provide a minimum resolution is time and in space, to reduce the AMF uncertainty under a given threshold (ex 10%).

Figure 1: Specify the dates in the legend

Figure 3: Please improve the visibility of the colorbar and the inset text.

Figure 4: The altitude above ground level is not shown in this figure.

Figure 7: Please do not use "slope" factor. It introduces confusion. You already use profile shape and shape factor.

After the paper from Palmer et al. 2001, several papers highlighted the importance of the a priori profile shapes on satellite HCHO retrieval: Barkley et al.,2012; De Smedt et al., 2015; Lorente et al., 2017; Wang et al., 2017.

Barkley, M. P., Kurosu, T. P., Chance, K. V, De Smedt, I., Van Roozendael, M., Arneth, A., Hagberg, D. and Guenther, A. B.: Assessing sources of uncertainty in formaldehyde air mass factors over tropical South America: Implications for top-down isoprene emission estimates, J. Geophys. Res., 117(D13), D13304, doi:10.1029/2011JD016827, 2012.

De Smedt, I., Stavrakou, T., Hendrick, F., Danckaert, T., Vlemmix, T., Pinardi, G., Theys, N., Lerot, C., Gielen, C., Vigouroux, C., Hermans, C., Fayt, C., Veefkind, J. P., Müller, J.-F. and Van Roozendael, M.: Diurnal, seasonal and long-term variations of global formaldehyde columns inferred from combined OMI and GOME-2 observations, Atmos. Chem. Phys., 15(8), 12241–12300, doi:10.5194/acpd-15-12241-2015, 2015.

Lorente, A., Folkert Boersma, K., Yu, H., Dörner, S., Hilboll, A., Richter, A., Liu, M., Lamsal, L. N., Barkley, M., De Smedt, I., Van Roozendael, M., Wang, Y., Wagner, T., Beirle, S., Lin, J.-T., Krotkov, N., Stammes, P., Wang, P., Eskes, H. J., and Krol, M.: Structural uncertainty in air mass factor calculation for NO2 and HCHO satellite retrievals, Atmos. Meas. Tech., 10, 759-782, https://doi.org/10.5194/amt-10-759-2017, 2017.

Wang, Y., Beirle, S., Lampel, J., Koukouli, M., De Smedt, I., Theys, N., Li, A., Wu, D., Xie, P., Liu, C., Van Roozendael, M., Stavrakou, T., Müller, J. F. and Wagner, T.: Validation of OMI, GOME-2A and GOME-2B tropospheric NO2, SO2 and HCHO products using MAX-DOAS observations from 2011 to 2014 in Wuxi, China: Investigation of the effects of priori profiles and aerosols on the satellite products, Atmos. Chem. Phys., 17(8), 5007–5033, doi:10.5194/acp-17-5007-2017, 2017.