

Interactive comment on “Sensitivity of formaldehyde (HCHO) column measurements from a geostationary satellite to aerosol temporal variation in East Asia” by H.-A. Kwon *et al.*

Review 2

The authors have substantially modified and improved the original manuscript addressing all my questions and comments. In particular, I am satisfied now to see a better distinction between aerosol optical properties and their vertical distribution impacts on HCHO AMF variability. I thank them for these works.

I have some remaining more minor comments or questions listed below. They mostly concern some needs, on my side, to clarify news statements or analyses written in the updated manuscript.

Main comments:

- 1) P10 & 11: The analyses now clearly separate and investigate each important parameter affecting the variability of the HCHO AMF: HCHO profile, aerosol profile and aerosol optical properties. However, I feel that a few clarifications should be more emphasized or added to clarify the key messages here. These messages are somehow there but a bit complex to extract or properly summarize. Please, find my own deduced conclusions here below and see whether you (more or less) agree with them and how you can more emphasize in your respective section:
 - As you somehow mentioned on p10 l31, impacts of HCHO and aerosol profile are quite correlated. This makes sense as overall, we are looking at the resulting enhancement or shielding effect. What really matters at the end is the relative altitude between HCHO and aerosols, more than the absolute altitude of HCHO or aerosols themselves. Therefore, to properly take into account the variability of aerosols, not only their vertical distribution and optical properties have to be included but also the HCHO profile variability. This is confirmed by the numbers that somehow present same order of magnitude when looking at the differences between the AMFs. This should be properly emphasized.
 - I liked the Figure S1 that you show in your answer (AOD profiles over Eastern China). I think it is really important. Why isn't it in your manuscript? It should be there I believe. Furthermore, following my previous remark, could you add (in black for example) the vertical HCHO profile given by your model? We need to know where HCHO tropospheric bulk is located and the importance of its variability.

- 2) P14, l5-6: I am a bit confused here. Perhaps I am wrong but you said that the ratio of AMF without aerosol to AMF with aerosols increases. But on Fig9 3rd row, we clearly see that most of the area is blue (thus values below 1). Thus, this ratio looks like decreasing for me, not increasing. Am I right?
Moreover, Figure 8 shows that the difference AMF aerosol – AMF no aerosol is higher than 0 (red colour). So that confirms that AMF with aerosol is larger. So why do you state or interpret the contrary? By the way, what is the added value here of this Fig8 compared to the Fig9? They both depict the same messages no? I think it is better to keep only the figures focusing on your selected case study (*i.e.* the days of dust storm).

P14, l10-11: I do not understand how you can see that absorbing aerosols increase VCDs while scattering aerosols decrease VCDs. Which figure does show this? Such a conclusion is not that clearly visible for me on Fig.9 Moreover, what would be the reason from physics point of view. As discussed in my former comments, and as shown in your analyses in the previous section, the key factor that determines shielding or enhancement effect is the relative altitude of HCHO – aerosols. Whether particles are more scattering or more absorbing will mostly drive the magnitude of this shielding or enhancement effect.

Also, I think you should keep in mind that your computed AMF are based on your GEOS-Chem (average or hourly) aerosol profiles. If you take aerosol profiles from another model or from observations, they may differ and therefore change our AMF values, and perhaps even transform a shielding effect into an enhancement effect (or reciprocally)... Or do you mean, that, on average, scattering particles are usually elevated while absorbing aerosols are more located close to the surface (and thus below HCHO bulk)?

Please clarify here your statement, or provide elements supporting such a principle.

Technical comments

1) p2 l4: It should be precised that "aerosol hourly / daily variability uncertainty" cannot be neglected for Geostationary, not simply aerosol variability...

2) p4 l1-2: please check sentence, it is not clear here what you exactly mean (used words are not appropriate I believe).

p4, l4: "such as HCHO": you mean HCHO profile right? Please clarify

Moreover, you should clearly mention which input parameters you investigate in terms of temporal variations (aerosols profile, optical properties, HCHO profile). So then no ambiguities are left.

3) At several places, "achived" should be changed in "achieved". Please correct it thorough the manuscript.

4) p9, l13: "AMFmh changes hourly" => "AMFmh changes every hour"

p9, l14: "to retrieved HCHO SCDs": Please change "retrieved" into "derived" (or something similar) to avoid to duplicate the word "retrieved" already further written in the same sentence...

5) p11 l12-14: Chimot *et al.*, (2016) did not specifically investigate the impact of aerosols on HCHO but on NO₂. However, the findings there are, I believe, similar to any trace gas in UV-Vis. Quantitatively, numbers may vary of course. Please correct then accordingly.

6) p11, l15: "by aerosol backscatter": Please be more specific like for instance "by additional scattering effects, and thus more photons sampling the upper atmospheric layers, due to the presence of aerosols in the observed scene".

7) p13 l6: "AMF look-up table is not a function of aerosol layer heights": Perhaps to avoid any confusion for the reader, you should clearly say something like "aerosol layer heights is not an explicit input parameter of the LUT as the HCHO AMF values are based on average aerosol profile given by the GEOS-Chem simulation". On the previous page, you just mention "monthly mean data" but I believe you should explicitly refer to the aerosol profiles.