Description of a formaldehyde retrieval algorithm for the Geostationary Environmental Monitoring Spectrometer (GEMS), Kwon et al., AMT, 2019

General Description:

The authors describe the retrieval algorithm of formaldehyde (HCHO) for the future GEMS instrument and estimate the likely uncertainties and biases relative to OMI and ground-based MAX-DOAS measurements. The content is appropriate for AMT. Suggested changes, comments and concerns are included below.

General Comments:

It's not clear what's unique about the retrieval to GEMS. Seems more like a recapitulation of the OMI retrieval description paper of González Abad et al. (2015). A way to address this would be to assess the implication of the unique temporal component of GEMS (i.e. observations throughout the day) on uncertainties in the retrieval.

Throughout, use the standard symbol ⊗ for convolution. This will help clarify terms in equations that are confusing, as brackets are used to denote dependence, but also operators, e.g. $f \otimes g(\lambda)$ to replace $(f * g)(\lambda)$ in Equation (2) is clearer. Please correct these issues throughout.

Inconsistent use of wavelength dependence in equations. For example, why do I_R and I_0^h not depend on wavelength in Equations (1)-(4), but do in Equation (5)?

Many sub-sections in Section 2.2. are the same as in González Abad et al. (2015). Why not just refer the reader to that paper and only state aspects specific to GEMS and that are different between the two approaches?

It's not clear why Section 2.2.5 is relevant, as it describes bias corrections specific to OMI. Is it anticipated that the same bias corrections will be needed for GEMS? If this section is relevant, the readers could just be referred to González Abad et al. (2015) and this section be kept brief. It's also not clear why data quality flags are provided for a future product. This would only be important for the user when the data is ready for release.

Section 3 appears to just be testing uncertainties inherent in fitting parameters and retrieval terms that would be an issue for all space-based instruments measuring HCHO, rather than being specific to GEMS. Is there anything unique to GEMS (instrument configuration, viewing domain, repeat time etc.) that would increase or decrease sensitivity to these uncertainties relative to other instruments?

Specific Comments:

P2, Line 18: the spatial resolution of TROPOMI is finer than 7 x 7 km^2 for HCHO (De Smedt et al., 2018).

Equation (1): Why are P_{sc} and P_{bl} not dependent on wavelength?

P3, Line 22: Can aerosol optical properties be retrieved across this wavelength and for this type of instrument? Do the authors mean AOD and aerosol index (AI)?

Table 1: add references for these parameters as footnotes to point to consistency with existing retrievals.

P8, Lines 14-17: What about clouds (Millet et al., 2006)?

P18, Lines 8-14: Comment too on the implications of more observations over the same scene per day on uncertainty compared to OMI.

P18, Lines 26-28: Provide an appropriate reference for this statement.

Referencing: some references are missing the doi number (e.g., González Abad et al., 2015).

References:

González Abad et al., Atmos. Meas. Tech., 8, 19-32, 2015, doi:10.5194/amt-8-19-2015.
De Smedt et al., Atmos. Meas. Tech., 11, 2395–2426, 2018, doi:10.5194/amt-11-2395-2018.
Millet et al., J. Geophys. Res., doi:10.1029/2005JD006853, 2006