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Interactive comment on “Development and characterisation of a state-of-the-art GOME-2 formaldehyde air-mass factor algorithm” by W. Hewson et al.

Anonymous Referee #2

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The subject of the manuscript is suited for AMT. The manuscript is well written, and the work and results are explained clearly. The most interesting results are the model resolution effect illustrated over South America and the full RTM error calculation. The other improvements have minor impacts on the final AMFs. However, some aspects of the baseline UoL AMF algorithm, namely the aerosol correction and to a lesser extent, the full radiative transfer calculation for each observation, are not described in this study, while they are specific to the Leicester algorithm. I think that the authors missed the opportunity to extend their previous studies over South America to the global scale. As I can understand the difficulty to run more sensitivity tests at the global scale, I

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recommend publication after minor revisions.

Introduction: Lines 14-22: “There is, therefore, a pressing need to improve AMF calculations and reduce uncertainties wherever possible. Accordingly, this paper details a new algorithm, which attempts to improve the accuracy of HCHO AMFs by performing scene-specific full-radiative transfer calculations and through more advanced treatment of the input a priori information.”

I agree with the first sentence. However, the improvement of the AMF accuracy by performing full RTM calculations is not addressed in this paper. In Barkley et al. 2012 and 2013, a LUT was used (as reported in Table 1). So this is an improvement that deserves to be described (it is mentioned in the abstract, the introduction and the conclusion).

Section 2: I suggest merging section 2 with section 3 and shortening the theoretical explanations, especially as they have already been published before (for example equations in Section 2 can be found in Gonzalez Abad et al., 2015).

Section 3: Table 1: please add a column with the baseline AMF calculation from this study. Line 19: please note that a GOME-2 albedo dataset is under development (see http://www.knmi.nl/~tilstra/Reports/GOME2_surface_LER_ATBD_v1.6_20141113.pdf)

Lines 26-33: AMF and error calculated using look up tables are also scene-specific, as the surface altitude, albedo, cloud properties, profiles, geometry, etc. . . are taken into account for each individual observation. However, LUTs entail interpolation errors. Please reformulate.

Section 4 I acknowledge the authors for the details that have been added about the aerosols. It improves the manuscript.

Section 5 Overview: I suggest to follow the same order as in the following sections, and therefore to swap points (3) and (4).

Section 5.2: Please add a figure showing the HCHO and AOD profiles at the model

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resolutions of $4^\circ \times 5^\circ$ and $0.5^\circ \times 0.667^\circ$, for a particular location and month. The resolution of the CTM has one of the largest impacts on the total AMFs. Therefore, I think it is important to extend this section, showing plots of vertical profiles at different spatial resolutions, and above emission areas.

Figure 3: What is the reason for the AMF enhancement in March, North of the Amazon at the Guyana border? If this is altitude, I wonder why this effect disappears in August.

Section 5.4: At the global scale, a model resolution of $0.5^\circ \times 0.667^\circ$ is not realistic. Therefore, I would like to see the improvement brought by the area weighting and surface pressure correction of the profiles, when working with a model at a lower resolution. For example, is it possible to add a line on the histogram of figure 3, corresponding to $2^\circ \times 2.5^\circ$, pressure corrected?

Equations of section 5.4 are from Zhou et al. and could be skipped.

Figure 4: please specify in the caption the model resolution that has been used. If this is $0.5^\circ \times 0.667^\circ$, then please add a third line with $4^\circ \times 5^\circ$.

Section 5.5, Line 8: Figure S1 Section 5.7, Line 11: Figure S2

Section 5.7: The use of O3 profiles climatology is rather new for HCHO AMF calculations, and deserves to be published, even if the impact is negligible. Please explain how differences in ozone profile compared to US atmosphere lead to a diminution of the AMFs over regions of moderate to high surface elevation.

Section 5.8, lines 7-15: Aerosols and model spatial resolution effect. This is interesting and could be further developed, maybe with a figure showing the AOD profiles at 2 different model resolutions, as suggested for section 5.2.

Section 6 In equation 6.1: all the input parameters used in the AMF calculation should be included in this equation. Where is the term for aerosols?

Line 21: I would rather say that the greatest source of AMF uncertainty is associated

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with the HCHO profile shape and its relative vertical distribution compared to cloud altitude and AOD profile (same comment for the conclusions).

Section 6.1, line 26: distributed.

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