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Supplement of

Ground-based Multi-AXis Differential Optical Absorption Spectroscopy (MAX-DOAS) observations of NO_2 and H_2CO at Kinshasa and comparisons with TROPOMI observations

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Correction of angular-dependent artefact in KinAero UV spectra

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S1. Problem overview

Checking on the quality of the H_2CO fitting results, we noticed that fitting residuals systematically degraded for low elevation angles. This problem was prominently observed in the UV spectral range where H_2CO is retrieved, but was essentially absent in the visible part of the spectrum used for NO_2 retrieval. The Figure S1 below, panel (a) illustrates the observed dependency. After further inspection, we noticed that the increased residual structure was systematic in nature (i.e. always of the same shape) which points to an instrumental issue. The exact reason for it could not be identified, but it might be related to an angular dependence of the spectral reflectivity of the mirror used to collect the sky light on the fiber optic (possibly connected to polarization effects). In any case we attempted to design an empirical correction to reduce the impact of these spectral features on H_2CO and O_4 retrievals. The approach adopted is described below.

S2. Empirical correction

The idea of the correction is to introduce an additional vector in the DOAS fit, that effectively accounts for the systematic spectral features. This new effective cross-section was empirically constructed from measured residuals (see Figure S2) on a day showing a large variability in the effect (see Figure S1, panel b). To minimize the risk of introducing a systematic bias on the retrieved H_2CO, we constrained the H_2CO differential slant column (dSCD) in the DOAS fit applied to construct the COM residual cross-section using values extracted from surrounding measurements less affected by the artefact (see Figure S1 panels c and d). The resulting COM cross-section was then introduced in the fit for all other measurements resulting in (1) a large improvement of the fit residuals (see Figure S1, panel b), (2) a much smoother diurnal variation of the H_2CO dSCD (see Figure S1 panel d), and (3) the elimination of the correlation between H_2CO dSCDs and fit residuals (see Figure S2, panels c and d). The same procedure was applied in the spectral range used for O_4 retrieval. The impact of the correction on retrieved H_2CO and O_4 dSCDs is illustrated in Figure S4 and Figure S3. The use of these corrected dSCDs in the profiling algorithm MMF resulted in a significant improvement of the stability of the inversion (i.e. the number of rejected profiles was largely reduced), which further validates the approach.

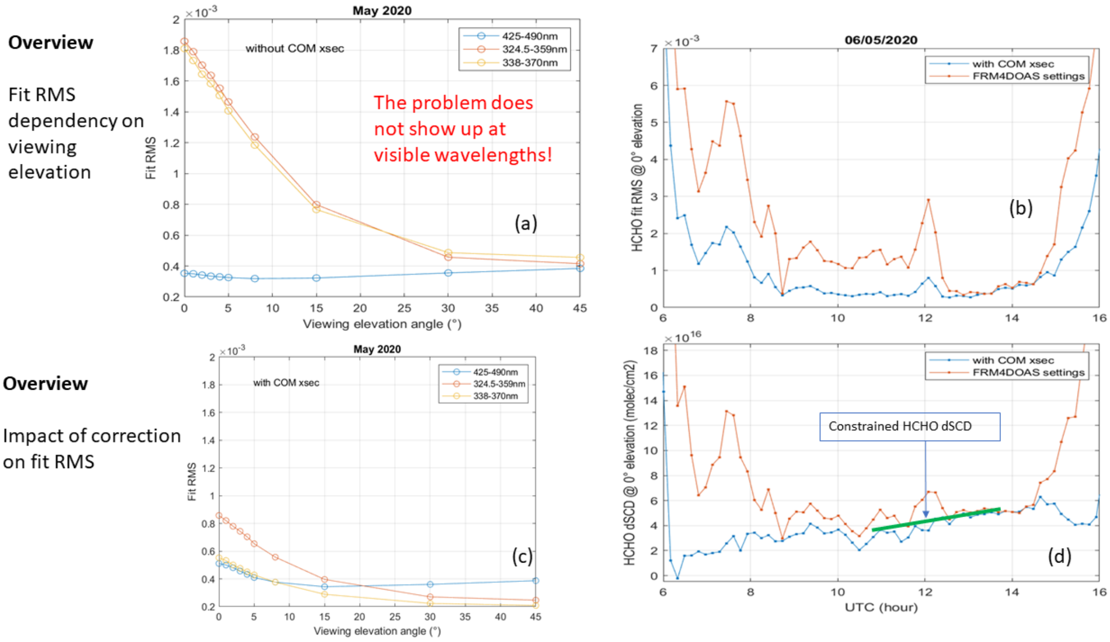

Figure S1: Eliminating H_2CO contamination in COM Cross-section.

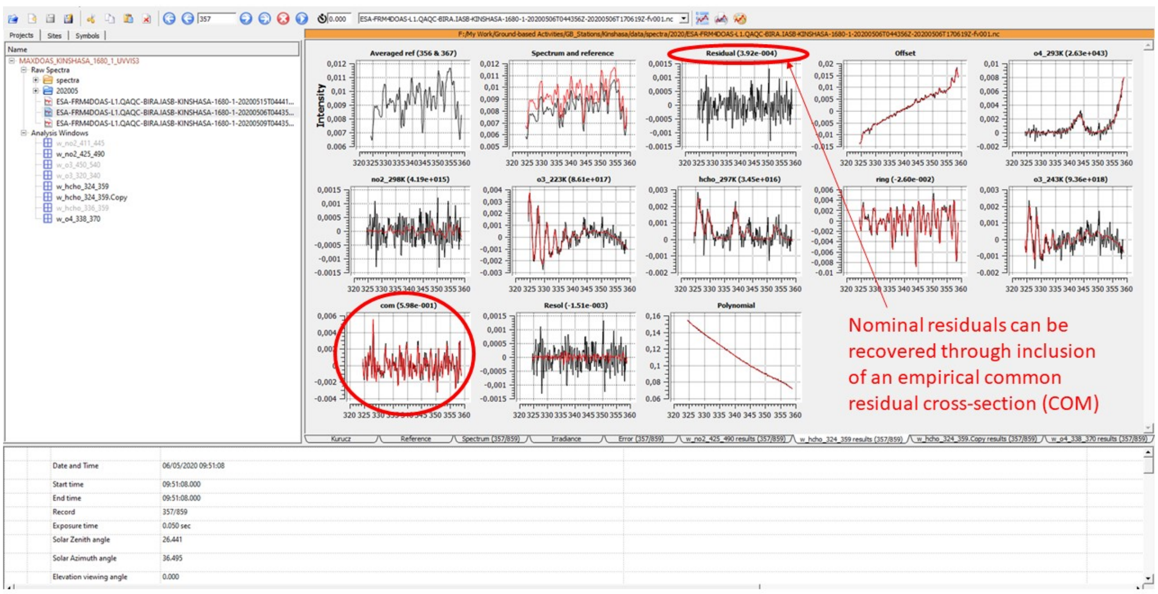

Figure S2: Recovery of Nominal Residuals via empirical Inclusion of a Common Residual Cross-section (COM).

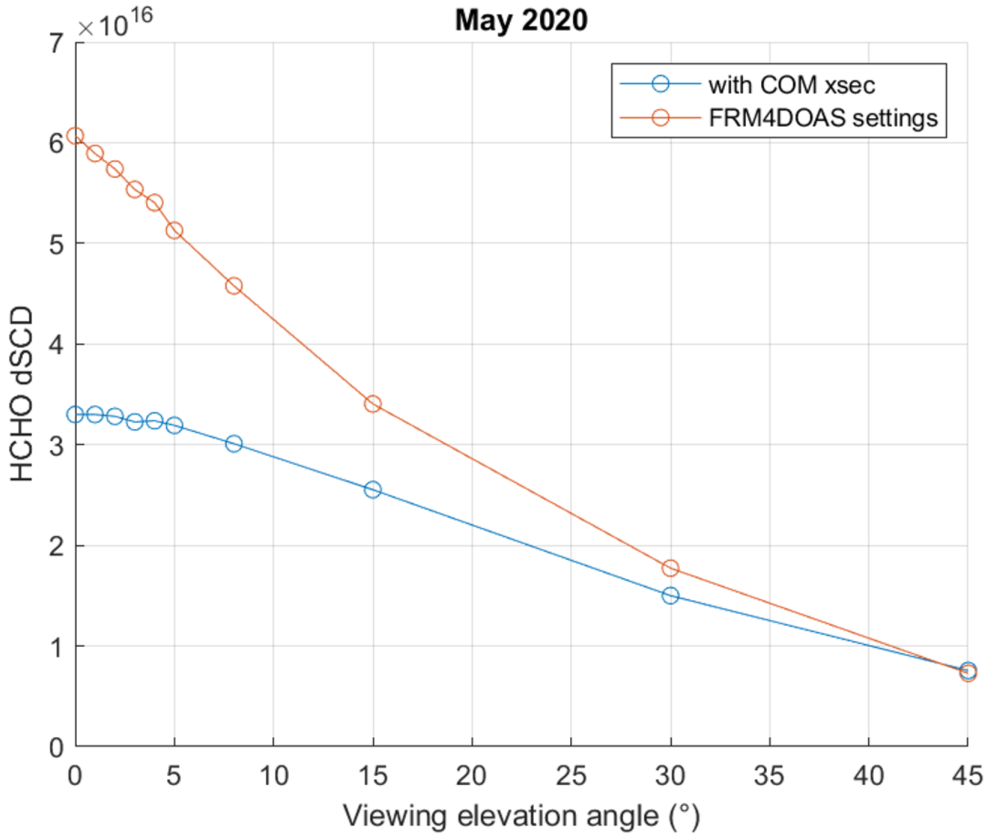

Figure S3: Impact of correction on H_2CO dSCDs. dSCDs reduced by approx. 45% at lowest elevation angles.

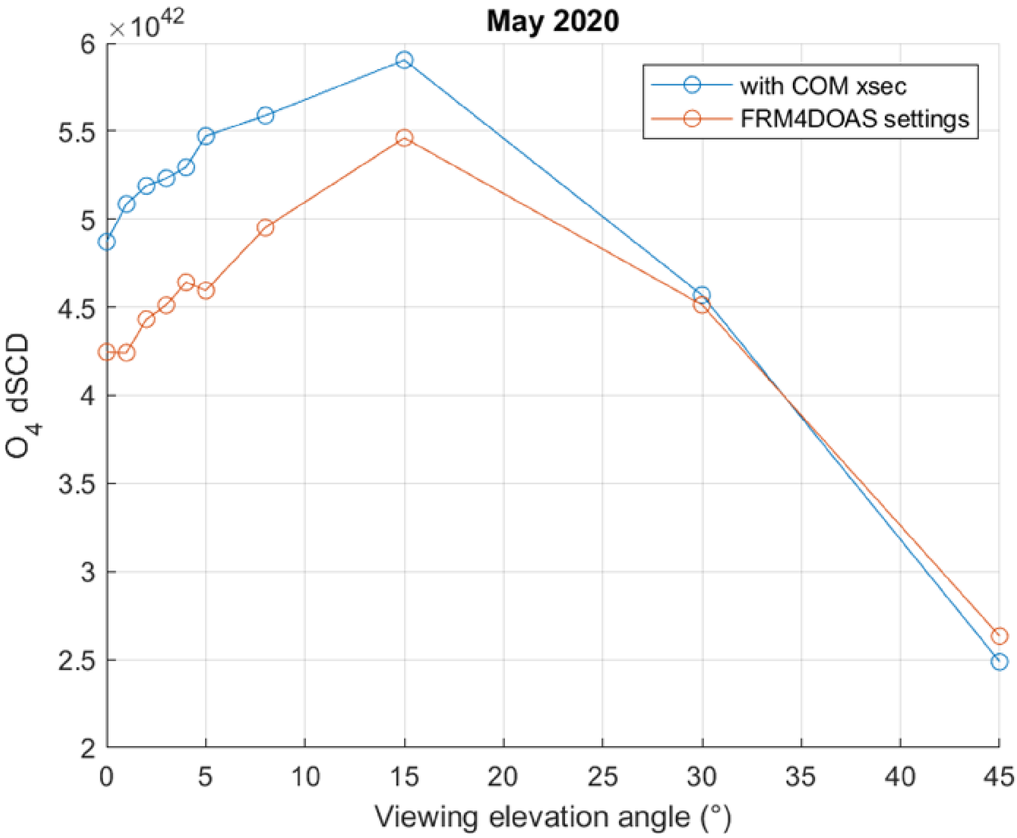

Figure S4: Impact of correction on O_4 dSCDs. Effect opposite to H_2CO, and of reduced amplitude (approx. 20% at lowest elevations)