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Atmospheric Measurement Techniques Discussions

Interactive comment on "The CHRONOS mission: Capability for sub-hourly synoptic observations of carbon monoxide and methane to quantify emissions and transport of air pollution" *by* David P. Edwards et al.

Anonymous Referee #2

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General comments:

The manuscript 'The CHRONOS mission: Capability for sub-hourly synoptic observations of carbon monoxide and methane to quantify emissions and transport of air pollution' by D. P Edwards at al. describes a new mission concept of satellite remote sensing of both trace gases using a geostationary orbit. The proposed instrument is based on MOPITT instrument heritage. Although having such a mission would provide exciting new measurements, the paper itself provides only little scientific news. The MOPITT heritage is discussed extensively in the literature and the possibility to

observe CO and CH4 using a geostationary orbit is already discussed e.g. by Butz et al., 2015 and O'Brein et al., 2016. Furthermore, the downstream from mission objectives to instrument and product requirements is not always traceable for me. Also from a technical point of view, the paper requires major revision. For example, Sec 2.2 formulates the science objectives and already concludes that CHRONOS meets all the objectives although the instrument, its spectral coverage and product accuracy and precision is discussed much later in the paper. Moreover, the science objectives for CH4 geo observations are not always convincing to me. The science objectives of the manuscript are mainly driven by CO. For methane, climate and emission monitoring relevant question are mentioned but the need for a geo orbit for this purpose is not discussed sufficiently. For example, figure 2 suggests that on hourly time scales only CO measurements provide relevant information and so one may conclude that for this time scale CH4 measurements are of limited use. In section 2.3, the impact of CH4 on air quality is mentioned via its reaction with OH. The expected CHRONOS CH4 precision and accuracy are provided in Tab 2 and meet typical requirements for climate and emission monitoring, however, it is not clear to me if air quality forecast can really be improved with these uncertainties.

Specific comments:

1. Figure 1: What is the spatial coverage of the MOPITT panels? For a better comparison, both MOPITT and WRF-Chem images should use the same color code, which should be indicated in a corresponding figure legend.

2. Figure 3: The figure shows CH4 in situ measurements with significant enhancements whereas changes in the total column is much less (4.9 %). I think this enhancement is given on the spatial sampling of the in situ measurements but do not necessarily represent the CH4 enhancement for a 4x4 km2 sampling of CHRONOS. I can imagine this makes a different.

3. Figure 4 and 12: These figures do not present new material and can be discussed

in the text with appropriate references.

4. Page 23, line 509: To my knowledge, it is not demonstrated that CH4 can be retrieved from real MOPITT data with a cloud coverage of 5 %. I doubt that this is possible considering the strict cloud filtering of GOSAT observations for CH4 retrieval.

5. Page 19 line 414: The aerosol optical depth should be provided at a reference wavelength within the SWIR fit window. Depending on the size of the aerosol parameter, this can be very small.

6. Table 2: I think, a discussion for elevated aerosol layers and cirrus is needed for a better error estimate. From other missions, we know that these are relevant error sources.

7. Table 2: Here a precision requirement of <10 % is given, whereas Fig 2 indicates that urban air quality daily evolution is in the order of 1-2 ppm. I doubt that with this large precision, urban daily evolution can be measured. See also page 17, line 383-385.

8. Page 15 line 335-340. The SCIAMACHY CH4 product is inferred from 1.6 micron measurements, GOSAT also uses the methane sensitivity at 1.6 micron, which in both cases differ from the CHRONOS SWIR window at 2.2 micron.

9. Section 6: I am not sure if I overlooked it, but when discussing synergies with other mission an indication of a launch window is required. I think, also the Sentinel-5 mission and IASI-NG should be mentioned here. I also miss a discussion of GEOCarb, which would measure CO, CO2 and CH4. Because the mission concept is already published, it should not be ignored in this manuscript.

10. Table 3: This table does not provide new information, which is not already discussed in the text. It also does not fit the format of a science publication to my opinion.

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