Review of **Improved retrieval of global tropospheric formaldehyde columns from GOME-2/MetOp-A addressing noise reduction and instrumental degradation issues**, by I.De Smedt *et al.*

AMTD 5, 5571-5616, 2012

General Evaluation

De Smedt et al. present work on their latest retrieval of formaldehyde (H_2CO) from GOME-2 observations. The authors describe the various improvements in processing, partly necessitated by the advanced degradation in the instrument, and comparisons to previous GOME-2 H_2CO products. The GOME-2 formadehyde is included in existing data records from GOME and SCIAMACHY, for a total of 16-year time series of space-based global H_2CO measurements.

The subject of the paper is well suited for publication in AMTD. The manuscript is well written, and he subject is clearly presented. The included figures support the arguments of the study well. The scientific approach to GOME-2 H_2CO retrievals appears sound, though I would like to see a few clarifications on details of the retrievals and the obtained results. Overall, this manuscript can be published with very minor modifications.

Specific Comments

First of all, I would like to compliment the authors on the successful creation of a 16-year H_2CO data record from multiple sensors. Formaldehyde is an extremely challenging atmospheric constituent to retrieve, and to do it consistently not only on a global scale but across platforms is quite a feat. I fully appreciate the GOME-2 specific modifications that had to be made to the retrieval approach. There is no "one-approach-fits-all-sensors" for small absorbers like formaldehyde, as instrument idiosyncrasies can easily introduce spectral features on the order of (or larger than) the H_2CO absorption features themselves. I am sure that this data set will find wide use in air quality research.

(i) My main questions regarding the retrieval approach for GOME-2 relates to the issue of BrO pre-fitting, as introduced in section 3.2, "Firstly, BrO slant columns are fitted in a wide wavelength interval (328.5-359 nm) that includes six BrO absorption bands and minimizes the correlation with H_2CO":

1. Was H2CO used as interfering absorber in the determination of BrO? The phrasing of the sentence seems to hint at that, but it isn't clear. The problem is, of course, that over strong H_2CO source regions like the Amazon or Indonesia (biomass burning), H_2CO can strongly correlated with BrO. If not simultaneously fitted, the derived BrO can be seriously over or

underestimated and, when used as fixed input to a subsequent H_2CO fit, can lead to significant errors in formaldehyde.

2. Independent of whether H_2CO was used in the BrO retrievals, have the resulting BrO columns been checked for residual correlations with H_2CO, e.g., over strong H_2CO source regions? The (co-)authors of this manuscript have a strong history in BrO retrievals, so a comparison against the prime BrO product should be easy enough to do.

3. How are the BrO uncertainties used, either in the H_2CO fit itself or the quantification of errors of the final H_2CO product? Ideally, the H_2CO fit would be performed with linear constraints, where the pre-fitted BrO is allowed to vary within 1-2 σ fitting uncertainties. Very few retrieval codes have that option though. However, at a minimum, the BrO uncertainties have to be considered in the total H_2CO error.

(ii) In section 4 Air mass factors, a reference to cloud screening of "cloud fractions exceeding 40%" is made. It should be specified whether this is "effective", "radiative", or "geometric" cloud fraction.

Editorial Comments
(comments follow the page numbers of the manuscript)

Page 5575, line 4: "and retrieved consistently"

Page 5581, line 8: "orbit on"

Page 5585, line 20: "10%"

Page 5589, line 7: "cloud and aerosols"

Page 5592, lines 8, 16: "H_2CO"

Page 5593, line 19: delete "an" in "an excellent"