Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-156-RC1, 2018

Atmospheric Measurement Techniques Discussions

Interactive comment on "Nitrogen dioxide and formaldehyde measurements from the GEOstationary Coastal and Air Pollution Events (GEO-CAPE) Airborne Simulator over Houston, Texas" *by* Caroline R. Nowlan et al.

Anonymous Referee #2

Received and published: 8 August 2018

The paper reports results of the first intensive field campaign (Discover AQ, Texas 2013) of GCAS, a compact 2-channel airborne spectrometer. GCAS NO2 and HCHO retrievals are compared with trace gas columns derived from coincident in situ profile measurements made by instruments on a P-3B aircraft, and with NO2 observations from ground-based Pandora spectrometers, operating in direct sun and scattered light modes. In a previous paper, Nowlan et al. (2016), preliminary GCAS retrievals were compared with GEOTASO retrievals.

The paper provides a detailed overview of all retrieval steps and comparison with co-

incident measurements, including uncertainties, reasons for observed differences, etc. The paper contains useful content for the preparation of validation campaigns for the new generation of air quality sensors, such as TEMPO. These campaigns will likely involve GEOTASO, GCAS and profile flights for the airborne segment and Pandora spectrometers for the ground-based segment. The paper fits well within the scope of AMT, is well-written and well-structured. However, some revisions need to be conducted in the paper before publication.

General comments:

-What is a bit missing in the paper is a geophysical interpretation of the acquired data. Typically there were four similar flights per day over the area which provides a good view on the spatial distribution of NO2 and HCHO. Even if it is beyond the scope of this paper, a section discussing the changes in the trace gas field and possible explanations would be an added-value to the paper. There are a few sentences in Section 5 on this, but it could be more extended.

-Secondly, it is not clear to me why profile shapes from CMAQ model output at 4 by 4 km are used for the AMF calculations, while you have NO2 and HCHO in-situ measurements from P-3B spiral flights available. I can understand this approach for the comparison with P-3B (Sect. 6.1) as you need independent data, but it is not clear why you don't use the P-3B profile shapes instead of CMAQ when comparing to PANDORA spectrometers (Sect. 6.2). I would expect that the CMAQ model does not represent the strong spatial variability of the 3D NO2 field, which you can expect in an urban area, something you mention as well in the manuscript (p.14, L.20). On the other hand, the dependency on the profile uncertainty was assessed in 6.1.3, and seems to be small.

Specific comments:

P3, L10: Please add: Tack, F., Merlaud, A., Meier, A. C., Vlemmix, T., Ruhtz, T., Iordache, M.-D., Ge, X., van der Wal, L., Schuettemeyer, D., Ardelean, M., Calcan, A., Schönhardt, A., Meuleman, K., Richter, A., and Van Roozendael, M.: Intercompar-

ison of four airborne imaging DOAS systems for tropospheric NO2 mapping – The AROMAPEX campaign, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2017-478, in review, 2018.

P4, L1: Please mention also explicitly the swath width at this altitude.

P4, L12: Explain shortly the impact of not having a zenith sky reference measurement capability when compared to GEOTASO or ACAM.

P4, L23: Maybe mention here already that GeoTASO and GCAS were intercompared in the previous paper.

P.5, L1: It would be interesting to mention the main drivers for the chosen flight path in section 3.1. Driven by Sources? Pandora sites? . . .

P.7, L.8: Please specify the vertical resolution (for the part below the aircraft).

P.8, L.10: Note that the spectral performance can be affected by in-flight pressure changes as well: See Kuhlmann, G., Hueni, A., Damm, A., and Brunner, D.: An Algorithm for In-Flight Spectral Calibration of Imaging Spectrometers, Remote Sensing, 8, 1017, doi:10.3390/rs8121017, 2016.

P.9, L13: Maybe I missed it but I could not find back the estimated reference spectrum amount. The estimation also affects the VCD uncertainty and should be mentioned in Section 4.7. You mention it as an uncertainty on P. 21, L6.

P.9, L30: Why is the fitting window 420-465 nm for NO2 and for example not 425-490 nm as proposed by NDACC (for MAX-DOAS instruments)? Please clarify. On p. 3, L27 the wavelength range of the UV/Visible channel is 300-490 nm.

P.11, L8: Please mention the spatial resolution of the MODIS BRDF product.

P.13, L.5: Please specify the impact of the spatial binning on the uncertainty for HCHO.

P. 13, L.32: The aerosol effect is also well explained in Meier, A. C., Schönhardt, A.,

Bösch, T., Richter, A., Seyler, A., Ruhtz, T., Constantin, D.-E., Shaiganfar, R., Wagner, T., Merlaud, A., Van Roozendael, M., Belegante, L., Nicolae, D., Georgescu, L., and Burrows, J. P.: High-resolution airborne imaging DOAS measurements of NO2 above Bucharest during AROMAT, Atmos. Meas. Tech., 10, 1831-1857, https://doi.org/10.5194/amt-10-1831-2017, 2017.

P.14, L.12: Were there no aerosol instruments on the P-3B aircraft? In case not, it would be a real added-value for future campaigns, as you are already doing the efforts to perform spiral flights for NO2 and HCHO profiles. A good knowledge of the AOD profiles can indeed drastically decrease the uncertainties on the AMF.

P.15,L.27: Specify “near-surface” in order to avoid confusion with surface concentrations.

P.16, Figure3: Indication of the average wind direction (and speed) could help interpretation or describe in text if too variable (same for the other maps).

P.18, Figure 5: Please explain the reason for missing data. Sometimes a full across-track scanline is missing which is not related to cloud filtering. Are there other filters applied?

P.20, Figure 7b: Error bars not explained in text?

P.21, L.6: What about the use of the simple geometric AMF for PANDORA (P.6, L3). Could this also contribute (significantly) to the differences observed?

Technical corrections:

P3, L1-L7: This paragraph is a bit too technical and would be better fitting in section 2.

P.15, L13: Change “individual industrial sites” to “single industrial sites” or “single stacks”.

P.20, L13: Change line-of-site to line-of-sight

P.21, L27: Please reformulate as sentence is not clear. Maybe: "...with retrievals from a spectrometer from the Network for the Detection of Atmospheric Composition Change (NDACC) using..." + Please specify also the type of (DOAS) instrument.

P.22, L1: Please put comma after "inputs" and after "columns".

P.24, Figure10: acronym DS is used here for the first time. Should also be used in text and written in full at first appearance.

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