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Atmospheric Measurement Techniques Discussions

Interactive comment on "Nitrogen dioxide observations from the Geostationary Trace gas and Aerosol Sensor Optimization (GeoTASO) airborne instrument: retrieval algorithm and measurements during DISCOVER-AQ Texas 2013" *by* C. R. Nowlan et al.

Anonymous Referee #1

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General Comments This paper presents an overview of the GeoTASO instrument, retrieval algorithm for NO2 vertical column data, and comparisons of GeoTASO NO2 column amounts to ground-based and aircraft-based NO2 data. GeoTASO was originally conceived as the testbed instrument for the upcoming GEO-CAPE satellite mission, and now also serves as part of mission risk reduction for the GEO-CAPE, TEMPO, and GEMS satellite missions. Thus, it is important to understand the capabilities and limitations of GeoTASO to better understand the capabilities and limitations of the data

products from these future satellite missions, especially for short-lived species with heterogeneous sources such as NO2. The manuscript presents a thorough description of the GeoTASO instrument and NO2 retrieval algorithm, and is well organized. However, further analysis of how GeoTASO NO2 column data compare to the other data sets presented in this manuscript is necessary; therefore, I recommend publication after several major revisions.

Specific Comments – Section 3.2.8: I'm very interested in your use of CMAQ to provide the tropospheric trace gas profiles used in the AMF calculation; I commend your choice! However, please provide a brief explanation of why you chose CMAQ over other regional models or a more traditional global model choice.

– Section 4.6.2: This comment concerns CMAQ specifically. I'd like to see how the CMAQ profiles/shape factors and surface mixing ratios compare to the observations. I agree with your statement that "uncertainties in model surface estimates vary by time of day. . ." and having a figure that demonstrates this (on average or for just one day) might help explain the nuances in your discussion later in the manuscript of how inferred GeoTASO surface NO2 compared to in situ surface NO2. I'd also like to see some comparison of typical profile shapes between CMAQ simulated profiles and the in situ P-3B profiles, to get a feel for where in the vertical CMAQ is simulating the profile and where in the vertical the model struggles. The vertical distribution of a trace gas will go on to affect the shape factor, so this may give a visual indication of how well CMAQ captures the shape factors used in the AMF calculation.

– Section 5.1: The two paragraphs dedicated to the discussion of AOD values seem unnecessary here without some analysis. I'd recommend removing these paragraphs, and keeping only the brief discussion of the effect of aerosols on the AMF computation included in Section 4.6.2.

– Section 5.2.1: The phrasing that correlations "increase with increasing pollution" is unclear to me. It would be helpful to list the four days presented in Fig. 10 in order

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of pollution, along with r values, to demonstrate how correlation between GeoTASO and Pandora column NO2 increases with increasing pollution level (as indicated by column amount). It also seems that Sept. 14 and Sept. 18 give essentially the same correlation for different pollution levels (as indicated by GeoTASO column values): are these correlations statistically different or the same, and, if the same, how does this affect your statement that the correlation increases with increasing pollution? I'd also like to see some discussion of the correlation on the other 3 less polluted days, and what the comparison between GeoTASO and Pandora might mean for our ability to remotely sense NO2 from space under various pollution levels. What is the overall correlation over all 4 days of data between the GeoTASO and Pandora data, in addition to the correlation on individual flight days? Why not also present that analysis, which would also lend itself to some discussion of the variability (at least variability as it relates to pollution level) in the comparison between an airborne, high altitude remote sensor and ground-based instruments, and thus some statement on what this might mean for geostationary satellites. How the Moody Tower data were corrected also needs clarification in the text in this section.

– Section 5.2.2: Similar comments apply to this section as to the previous section. I'd like to see some discussion of the correlation between inferred and in situ NO2 on the other three days presented, as well as of the overall correlation between these datasets. Again, what might this mean for the capabilities of the geostationary satellites?

– Section 5.2.3: As with the discussion of the comparisons between GeoTASO and Pandora or in situ surface data, why the emphasis on only the Sept. 13 flight day? How do GeoTASO and GCAS compare on one of the less polluted days?

– Section 5.2.4: This section seems unnecessary, as very few satellite data were available for this comparison, and the comparison is complicated by several issues. I recommend removal of the comparison to GOME-2 NO2 data.

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Technical Corrections – Page 4, Line 29: add “the” before “. . .x dimension of the array. . .” – Page 26, Line 21: Please omit the second “can” from this sentence.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 13099, 2015.

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