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Atmospheric Measurement Techniques Discussions

Interactive comment on "DOAS measurements of NO_2 from an ultralight aircraft during the Earth Challenge expedition" *by* A. Merlaud et al.

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We thank the second referee for his positive review and useful comments which help to improve the paper. The manuscript has been English-corrected by a native English speaker who was added in the acknowledgements.

"There have been many papers comparing satellite NO2 observations with ground based DOAS measurements. Authors should consider including some of them as reference. For example Herman et al. (JGR, 2009), Shaiganfar et al. (ACP, 2011), Kramer et al. (JGR-Atmos., 2008) to name the few of the recent ones."

We have included the three papers in the introduction.

"Solar zenith angle (SZA) is considered as a constant for AMF calculations. It would have been fairly easy to change SZA in AMF calculations and I am surprised that the authors decided to treat it as a constant. AMF is dependent on SZA especially at high SZA and could result in higher error than due to NO2 effect, surface albedo and pitch. It is very much possible that most of the ïňĆights were at lower SZA and is not a big source of error but an explanation on why it was treated as a constant would be helpful."

We had not taken into account the sza variation since while flying above the zones where the signal is significant (Po Valley, Riyadh's plume), the sza does not vary that much. The error on the AMF, considering our other hypotheses, is under one per cent in these two polluted zones. However, for the data above Rajasthan, the AMF variation (45 to 51 degree) leads to a 2.5% variation in the AMF, which is superior to the smallest error we consider (1%), which was indeed not logically consistent. We have thus recalculated all look-up tables including the sza. Doing so, we found a mistake in our radiative transfer calculations which affected the AMFs and vertical columns more than the fixed sza. The plots have been redone and the values corrected in the text.

"With regards to soil structure, it would to interesting to see how a reference spectrum from over water (e.g. Gulf of Oman) changes the soil signal over land covered by vegetation (Italy) and sand (Saudi Arabia). Authors mentioned that they did not observe soil signal over Italy but it could be due to the fact that the reference spectrum comes from Italy. It would also be interesting to look into soil signature over Rajasthan. From Fig. 3 it seems that the plane crossed the Thar Desert. The contrast in soil signature over different land forms could be a strong indication for a need to include soil signature for DOAS retrieval over barren lands. The authors could also add a comment on effect of a higher order polynomial on the soil signature and retrieval."

We had checked the soil signal above Italy with a reference spectrum recorded over the Mediterranean Sea during the previous flight, to minimize instrumental effects, (1 December 2009) and we did not see any signal. The aircraft were not directly above the Thar Desert. Nevertheless we detect the sand signal associated to what seems

episodes of low visibility from O4 DSCDs above Rajasthan, Egypt and Karachi. This was added in the text. Using a higher order polynomial reduces the soil signature optical density but the latter does not vanish. This is expected from the broad-band structure of the soil signature. Moreover, plotting the series of the high order component shows that the sand episodes of our figure 15 are coincident to increase of the component which gives confidence in the geophysical origin of the signature. This was added in the text and we give a figure in supplement to show this.

SpeciïňĄc comments: Page 1949, line 21: replace “yet” with “so far” Done. Page 1949, line 26: mention what ULM-DOAS stand for. Done.

Page 1951, line 16: change “time” to “season” Done.

Page 1951, line 18: change “sea rising” to “sea level rising” Done.

Page 1951, line 25: “Gulf of Oman” is the proper name. Replaced.

Page 1952, line 2: typo “where” Corrected.

Page 1952, line4: “expected” in place of “expectable” Replaced.

Page 1953, line 17: it should be “four panels” not “three panels” Replaced.

Page 1953, line 21: “expected” in place of “expectable” Replaced.

"Page 1955, line 17: It is not clear why each SCD is the weighted mean of 13 SCDs. Is it because the radiative transfer program does not consider large ïňĄeld of view of the telescope for AMF calculation?"

Indeed. But we think it is explained in the first part of the sentence: “To take into account the numerical aperture of the optical ïňĄber”. Page 1959, line 6: “negligible” in place of “neglectable” Replaced. Page 1959, line 16: It might be helpful for the readers to include the NO2 value from GOME-2 for Po Valley in the text. Added. Page 1960, line 3. Replace “in desertic areas” with “over deserts” Replaced. Page 1961, line 8. It might be better to say “one of the largest city” rather than just saying “largest city”

as one can ïňĄnd conïňĆicting results regarding the largest city in terms of population. Replaced.

Page 1962, line 25. Typo “attitude” stabilization? Do you mean altitude or elevation angle stabilization? Also in line 9, Page 1948.

Attitude, in the context of aircraft, defines the vehicle’s orientation, defined by the pitch, roll and yaw angles. In a previous experiment (Merlaud et al. ACP, 2011) with a smaller field-of-view, we were recording accurately the plane’s orientation during the measurements and this was included in the AMF calculation. Other airborne instruments control automatically the telescope angle so that it compensates for the plane movement (Baidar, oral at AGU, 2011). With the large field of view of our instrument, the plane orientation is less important since its effect is averaged. We have added pitch, roll, and yaw between parentheses after attitude in the introduction.

Table 3. The number in table 3 for Rajasthan does not agree with the values in Figure 8. The table reads the max NO2 vcd as 3.4+/-1 e15 but values in ïňĄgure are less than 3e15. It is probably better to leave a blank space than ? for the unavailable data for Chittagong in the table.

We replace the interrogation mark with n/a. The table has been revised according to the new look-up tables. Figure 5, 6 and 7. Could you include conditions for the AMF calculations.

Done.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 1947, 2012.

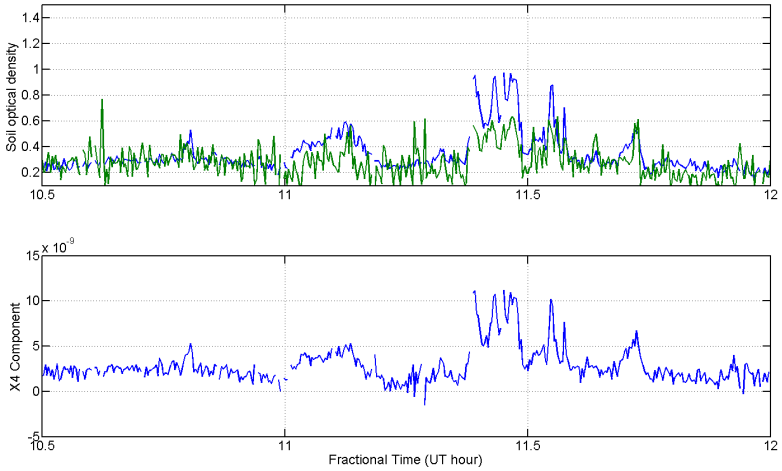
Soil optical density
1.4
1.2
1
0.8
0.6
0.4
0.2
10.5
11
11.5
12
x 10^-9
X4 Component
15
10
5
0
-5
Fractional Time (UT hour)

Fig. 1.