**Atmospheric
Measurement
Techniques**
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Discussions

Interactive comment on "The use of NO$_2$ absorption cross section temperature sensitivity to derive NO$_2$ profile temperature and stratospheric/tropospheric column partitioning from visible direct sun DOAS measurements" *by* E. Spinei et al.

Anonymous Referee #2

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This paper describes a method to take advantage from NO2 XS temperature dependence to obtain a slant-weighted profile of T and to separate tropospheric and stratospheric columns of NO2 using direct sun DOAS measurements. The method is applied to measurements from four different sites and Temperature profile is compared to GMI model. The method works relatively well and has the advantage that not external information from other sources than DS measurements themselves is necessary to in-

fer the temperature profile and make the separation of tropospheric and stratospheric contributions. My opinion is that this work is on the scope of the AMT and should be published after some minor considerations.

Minor comments Abstract. This comment is related only to nomenclature: In the first paragraph of the abstract the magnitudes that can be obtained by using TESEM method are presented, they are: total vertical NO2 column and the slant NO2 profile-weighted temperature (T). In my opinion is not clear if T from here is the profile weighted Temperature of the slant NO2 profile-weighted temperature. Specially when in the second paragraph of the abstract a new magnitude, total column NO2 T, is defined. How should this magnitude be interpreted, as a total NO2 column profile-weighted temperature? Still I cannot understand very well what is a slant column profile-weighted temperature. Later on in the text (lines 9 and 10 pg 5704) these concepts are clarified, but in my opinion this should be clarified in the abstract as well.

Line 14 pg 5697. Here is stated that DS measurements have the same sensitivity to stratospheric and tropospheric absorption for solar zenith angles below 75° but later on in the text (line 2 pg 5701) this magnitude is changed to SZA<80°. Please unify criterion.

Line 16 pg 5697. Please avoid the use of plural of magnitudes as "Ts".

One of the most interesting characteristics of TESEM is that does not need any external information to extract T. This talks by itself, in my opinion the explanation about the traditional fitting of NO2 should be in the introduction, but not in the abstract (this is lines 25-28 pg 5697 and lines 1 to 3 pg 5698).

Figure 1. This figure would be more clear if x axis were solar zenith angle instead time.

Line 27 pg 5699. Seasonal variability of NO2 in the stratosphere is a well-known issue; authors should indicate that is not a result from GMII-CTM model but an expected behaviour.

Line 20 pg 5700 The referente of Hendrick et al., 2011 is for ozone measuerements, but there are loads of references about NDACC data of NO2:

Hendrick, F., Mahieu, E., Bodeker, G. E., Boersma, K. F., Chipperfield, M. P., De Mazière, M., De Smedt, I., Demoulin, P., Fayt, C., Hermans, C., Kreher, K., Lejeune, B., Pinardi, G., Servais, C., Stübi, R., van der A, R., Vernier, J.-P., and Van Roozendael, M.: Analysis of stratospheric NO2 trends above Jungfraujoch using ground-based UV-visible, FTIR, and satellite nadir observations, Atmos. Chem. Phys., 12, 8851-8864, doi:10.5194/acp-12-8851-2012, 2012.

Gil, M., Yela, M., Gunn, L. N., Richter, A., Alonso, I., Chipperfield, M. P., Cuevas, E., Iglesias, J., Navarro, M., Puentedura, O., and Rodríguez, S.: NO2 climatology in the northern subtropical region: diurnal, seasonal and interannual variability, Atmos. Chem. Phys., 8, 1635-1648, 2008.

Pinardi, G. and Lambert J.C., O3M SAF VALIDATION REPORT, SAF/O3M/IASB/VR/NO2/095. 2011.

Line 24 pg 5701, Please change MAX by MAXDOAS and zenith by Zenith sky DOAS.

Line 1 pg 5702. In an ideal case, cross sections must be fitted taken into account the temperature of atmosphere, but usually this not the case (specially because usually the T profile is not known and TESEM method haven't been developed till now), but for its purposes DOAS works relatively well as well only using two different temperatures. In my opinion the sentence should be "cross section should be fitted..." instead "cross sections must be fitted...".

Line 6 pg 5705. Just for homogeneity in the notation through the entire work, please use T in K instead $°C$.

Line 10 pg 5705 and line 16 pg 5706. In the formula of line 10 there are two different T profiles; T of measurements and TREF. The main assumption of the method until now seems to be that REF contribution to ΔDSCD is negligible, and then it is not necessary

calculate TREF, but later on it is demonstrated that TREF can be calculated as well. Please explain this in this point of the text, otherwise that seems that it is a limitation of the method.

Line 2 pg 5706. Maybe this is only a misunderstanding from my part, but I don't understand very well the mean of ΔDSCD T. This is the difference between SCD T and SCDREF TREF?. In the definition of this line it seems that T and TREF are the same. Please explain.

Line 23 pg 5706. To apply this approximation the place should be in principle unpolluted and measurement taken at large solar angles, but if I have understood well, this method is limited to SZA < 75°. This same explanation is given in lines 1 to 3 pg 5708. What large solar angles are involved here? Or, in other words, what is the SZA range of applicability of TESEM.

Formula (4). Please add χSTRAT+χTROP=1.

Line 3 pg 5708 large SZA and low levels of pollution. Please add "low".

line 14 pg 5708, Once all parameters have been calculated using some approximations as low solar zenith angles and unpolluted measurements, calculated magnitudes have been used to calculate other magnitudes affected by these approximations out of the range of applicability of such assumptions. This does not seem consistent to me, because calculated SCDSTRAT and SCDTROP are valid only for previously made assumptions, and could not be used out of the range of assumptions. Please clarify this point.

Figure 7. Residuals are really low, but it would be nice if their dependence with lambda would be shown here as well as the fits. Really good fits by the way. I would expected better fits for unpolluted place (lower residuals) than for NASA/GSFC site, maybe this behaviour is due to the low NO2 column at JPL, is this place at midday representative of free troposphere?

Line 21 pg 5715. Table 3 is Table 4 actually.

Line 7 pg 5716. Please explain what means "more 'dynamic' meteorology" in order to explain the different behaviour of stratospheric NO2 from different sites. Differences in the column could be attributed to different season, but I do not understand very well what means "dynamical meteorology". Is it possible to support this fact using any kind of observation?

Figure 10, axis are missing in some plots. It would be nice if these plots could be larger, it's difficult to see NO2 amounts specially in the first row.

Last paragraph of conclusions. Have authors applied TESEM method to MAXDOAS or zenith sky measurements? In that case, does the method work as well as for DS measurements?

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 5695, 2014.