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Atmospheric Measurement Techniques Discussions
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Interactive comment on "Limb–nadir matching using non-coincident NO_2 observations: Proof of concept and the OMI-minus-OSIRIS prototype product" *by* Cristen Adams et al.

Anonymous Referee #1

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The manuscript *Limb–nadir matching using non-coincident NO2 observations: Proof of concept and the OMI-minus-OSIRIS prototype product* by Adams et al. is an interesting study about using non-coincident satellite measurements of stratospheric NO_2 to seperate tropospheric from stratospheric contributions to total measured NO_2 slant column densities from the OMI instrumenet. While the concept is pretty straight-forward and not very innovative, this is an important study, especially in view of upcoming geostationary missions. The manuscript is generally written very clearly in good English language.

I recommend the manuscript to be published in *Atmospheric Measurement Techniques* after some minor revisions. In particular, I would appreciate if a revised version of the

Printer-friendly version

Discussion paper

manuscript could address the following points:

- One advantage of the proposed method with respect to the commonly used CTM approaches is that it does not suffer from errors introduced by the CTM's (usually) coarse spatial resolution, leading to photochemical representation errors close to the terminator. While this is not of concrete importance to the present study due to its SZA filter criteria, it would be nice if the authors could add a sentence about this fact.

- The authors should acknowledge the possibility to use both OSIRIS measurements from one day to better constrain the diurnal cycle from the box model. In principle, in those cases when two OSIRIS measurements (morning + evening) per day are available, this could further improve the retrieval method.

- p.3/l.28-29: the authors write of SCIAMACHY limb and nadir instruments. However, the nice thing about SCIAMACHY is that it's *the same instrument*. Maybe better write *measurement modes* or *viewing geometries*.

- p.6/l.10: In the discussion of AMFs, the authors should also write that the AMF depends on the solar and viewing azimuth angles (due to the asymmetry of aerosol phase functions).

- p.6/l.16: Surface reflection is *not* calculated by the radiative transfer models, but it is rather an *input* to RTMs.

- p.6/l.17: Maybe the authors want to say *SCDs* instead od *VCDs*?

- p.6/l.22: The authors should shortly explain why they limit themselves to SZA<75°. What goes wrong at larger SZAs? What are the implications of this limitation for the applicability to geostationary measurements of high latitude (especially relevant for Sentinel-4/UVN over Europe in winter)?

- p.9/l.1: Maybe the word *extrapolated* would fit better than *scaled*?
- p.9/l.27-29: What is the time-step of the box model, what is the spacing of the t_{new} grid?
- p.9/l.30: Don't all ρ also depend on the latitude and day-of-year? Please adjust the Eq. 1 accordingly, to make it more clear to the reader.
- p.10/l.12: All researchers working on the upper atmosphere would certainly appreciate if the authors would acknowledge that 46km is "effectively the top of atmosphere" *only in this context*.
- p.11: The authors talk about "valid" (l.2) and "available" (l.4) NO_2 measurements; maybe it would be more instructive for the reader if they would instead explicitly write *above-tropopause*, or at least that the TPH determines what a *valid* or *available* NO_2 data is.
- p.12/l.5: OMI measures also at SZA>80°; but the authors in this study only *use* the OMI measurements for SZA<80°. This should be clarified.
- p.12/l.13-18: A formula/equation would help to understand the spatial filtering . . .
- p.13/l.3-6: It would be nice if the authors would compare these numbers to other studies of the diurnal variation of strat. NO_2, e.g., the Dirksen et al. paper.
- p.14/l.19: OSIRIS strat. NO_2 VCDs could in principle also be matched to not-bias-corrected OMI SCDs (the resulting VCDs would be wrong, but this is not the point here), so the beginning of the sentence "In order to match" is not correct.
- p.14/l.24: Sect. 3.3 does not describe any OMI SCD bias correction?!
- p.16/l.6-7: This sentence seems to be grammatically not correct ("of the individual the γ-scaled . . . ")

- p.16/l.14: I personally **do** see "enhanced [VCDs] across the northern hemisphere Pacific and Mexico" in the OSIRIS data (orange values over Mexico and just west of the measurement gaps over the Pacific).
- p.21/l.13-14: TROPOMI (on board Sentinel-5 Precursor) is **not** a geostationary instrument! The authors are probably referring to the UVN instrument on board Sentinel-4.
- In all Figures the authors should refrain from using the abbreviation of "mol/cm^2", as "mol" is the unit symbol for the S.I. unit for amount of substance, *mole*.
- In Fig. 6, the caption should explain which statistic (mean, median, ...) the symbols denote, and the applied filter criteria should also be mentioned in the caption.
- In Fig. 9, the caption doesn't match the individual subplots' headings (mix-up of DOMINO and SP).
- In Fig. A1, the caption should say which year these data are taken from.

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