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Interactive comment on "A high-resolution and observationally constrained OMI NO_2 satellite retrieval" *by* Daniel L. Goldberg et al.

Anonymous Referee #2

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The paper by Goldberg et al. provides an interesting study of using high-resolution CMAQ, vertical profile observations and data sampling techniques to better estimate NO2 VCDs at small scales. The paper is well written, and I have a few suggestions below.

Recent studies have revealed NO2 retrieval uncertainties related to structural errors (Lorente et al., 2017 and references therein), including treatments of clouds and aerosols (Lin et al., 2015). These errors are relevant to explanations of errors even in OMI_CMAQ_OD. A review of such works is necessary.

The spatial and temporal matching between CMAQ and OMI is discussed in many places, and sometimes there appears inconsistency [For example, Sect. 2.1 says 'The satellite product was oversampled for June & July over a 5-year period (2008-2012)

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by re-gridding to the CMAQ 1.33 km model grid and then averaging the data over the 10-month (two months × five years) period.', but Sect. 2.4 says ' To ensure a fair comparison, we average model information to the pixel size.'] Please provide a paragraph in the method section dedicated to data mapping/sampling, including proportioning of pixel-based SWs to CMAQ grid, and refer to this section when mentioning in later sections.

Please describe the model setup (e.g., soil and lightning emissions, vertical layers, model PBL scheme, convection, upper boundary) in Sect. 2.4. This will much help understand the model vertical profiles. The missing soil emissions are not discussed until the line (P14, L1) embedded in Section 3.5.

Can you compare CMAQ and GMI lightning emissions? I wonder how much of the vertical profile differences are due to lightning (convection) parameterization rather than due to resolution.

That model profiles in June/July 2011 are applied to all years needs to be described more clearly in Sect. 2.4. The writing is vague at its current form. Some of the writing on relevant method in the first paragraph of Sect. 3.3.1 should be included in Sect. 2.4. The uncertainty due to interannual variability needs to be discussed.

At the end of 'Introduction', a summary paragraph showing the novelty of the present study will be very useful.

P3, L17 – NO2 is a weak absorber.

P5, L1 – POMINO does not just provide a higher-resolution retrieval, but it also includes various improvements such as explicit treatment of aerosols and re-calculation of cloud parameters.

P5, L19-20 – SCD represents light path from the sun to surface/atmosphere and to the instrument.

P5, L25 – the effects of aerosols are also important.

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P8, L34 – how to determine the ‘best estimate’. I appears that if a 65% overestimate is assumed, the OMI_GMI result would be closer to EPA values.

P11, L9 – should be ‘consistently larger’

P12, L19-26 – much of the discussion on ‘rural’ and ‘urban’ definitions here applies also to discussion in previous sections (i.e., Sect. 3.1) on these environments.

References: Lorente, A., Folkert Boersma, K., Yu, H., Dörner, S., Hilboll, A., Richter, A., Liu, M.-Y., Lamsal, L. N., Barkley, M., De Smedt, I., Van Roozendael, M., Wang, Y., Wagner, T., Beirle, S., Lin, J.-T., Krotkov, N., Stammes, P., Wang, P., Eskes, H. J., and Krol, M.: Structural uncertainty in air mass factor calculation for NO2 and HCHO satellite retrievals, Atmospheric Measurement Techniques, 10, 759-782, doi:10.5194/amt-10-759-2017, 2017.

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