Atmos. Chem. Phys. Discuss., 15, C13070–C13073, 2016
www.atmos-chem-phys-discuss.net/15/C13070/2016/

Atmospheric Chemistry and Physics Discussions

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15, C13070–C13073, 2016

Interactive Comment

Interactive comment on "Aura OMI observations of regional SO_2 and NO_2 pollution changes from 2005 to 2014" *by* N. A. Krotkov et al.

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Received and published: 7 March 2016

Krotkov et al. reported on long-term observations of SO2 and NO2 pollution using OMI. The paper is well-written, interesting and scientifically justified. I recommend publication in Atmos. Chem. Phys. after minor changes: 1) Introduction, P 26559, L 25-30: - a publication describing the GOME-2 instrument is missing. - OMPS should be mentioned as SO2 results are presented in Supplementary material- "..although with lower spatial resolution and sensitivity to PBL sources". The word 'sensitivity' is misleading as it might be interpreted in terms of lower AMFs (which I believe is not what you meant). Please reformulate.

- Thank you for pointing out missing references. We have added GOME-2 and OMPS

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references and reformulated the sentence starting at line 24 on page 26559 as follows:

"NO2 and SO2 observations are also made by two GOME-2 instruments on EUMETSAT's MetOp-A (2006) and B (2012) operational polar satellites (Callies et al., 2000; Richter et al., 2011; Rix et al., 2012; Valks et al., 2011) and Ozone Mapping and Profiler Suite (OMPS) on board the NOAA/NASA Suomi NPP satellite (Dittman et al., 2002; Flynn et al., 2014; Seftor et al., 2014), which have coarser spatial resolutions and higher detection thresholds for emissions from point sources (Fioletov et al., 2013)."

References added: Callies J., Corpaccioli, E., Eisinger, M., Hahne, A., Lefebvre, A.: GOME-2 – Metop's Second-Generation Sensor for Operational Ozone Monitoring, ESA bulletin 102, 2000 (http://www.esa.int/esapub/bulletin/bullet102/Callies102.pdf) Dittman, M., Ramberg, E., Chrisp, M., Rodriguez, J.V., Sparks, A., Zaun, N., Hendershot, P., Dixon, T., Philbrick, R., Wasinger D. : Nadir Ultraviolet Imaging Spectrometer for the NPOESS Ozone Mapping and Profiler Suite (OMPS), Earth Observing Systems VII, William L. Barnes, Editor, Proceedings of SPIE Vol. 4814, 2002.

Flynn, L., Long, C., Wu, X., Evans, R., Beck, C.T., Petropavlovskikh, I., McConville, G., Y, W., Zhang, Z., Niu, J., Beach, E., Hao, Y., Pan, C., Sen, B., Novicki, M., Zhou, S., Seftor C. : Performance of the ozone mapping and profiler suite (OMPS) products, J. Geophys. Res., doi: 10.1002/2013JD020467, 2014. Seftor, C.J., Jaross, G. , Kowitt, M. ., Haken, M. , Li, J. , Flynn, L.E.: Post-Launch Performance of the Suomi NPP Ozone Mapping and Profiler Suite (OMPS) Nadir Sensors, J. Geophys. Res., doi: 10.1002/2013JD020472, 2014.

2) Section 2.1, P 26563, L 22-26: The discussion on the detection limit is not easy to understand. For 100 cloud-free pixels, the detection limit on annual mean should be 0.5 DU /$\sqrt{100}$ -> $\sim$0.05 DU. Please clarify. The same applies to section 3.1, P26569, L25. In addition, a total error estimate on SO2 VCD should be given (as for NO2 in section 2.2).

-Thank you for pointing this out. The detection limit is estimated to be 4 times the mean error: 4×0.05 DU = 0.2 DU. This has been clarified in the text. We added the total error estimate for SO_2 VCD to the revised manuscript in section 2.1 as follows:

"For a single retrieval over polluted areas, random error due to instrument noise is typically on the order of 50-100%. The systematic uncertainties due to our use of fixed Jacobians are 50-100% for cloud-free scenes. The total error for a single OMI retrieval is 70-150%. For an annual average the uncertainties due to the retrieval noise are reduced to the level of 10-15% of the actual signal, and become insignificant relative to the systematic errors. The systematic errors could be further reduced to the level of 20% applying improved local Jacobians (McLinden et al., 2014, 2016). "

3) Figure 3: it would be good to assess the possible impact of changes in SO_2 profile shape on the trend analysis.

-We agree that systematic changes in the SO_2 profile shape will have impacts on the estimated SO_2 trends. We believe that the impacts are relatively minor for OMI measurements, as the boundary layer is often thick and quite well mixed at the OMI overpass time (in local afternoon). Previous aircraft measurements over northeastern China and the eastern U.S. show that the difference in AMF due to different SO_2 profile shapes over the two regions are very small (within a few percent, see Krotkov et al. 2008 for more detailed discussion). Additionally, given the absence of actual profile information (since actual measurements are very sparse), it would be difficult to infer how profile shape actually changes, and how it may have influenced OMI-derived trend. We do believe that this is a good topic to further explore in future studies.

-We have added discussion about effects of profile shape change in the beginning of section 3: "Another factor that can potentially affect derived long-term trends is long-term changes in the vertical profile shape, because our a priori profiles are constant for the entire mission. We believe that the impacts are relatively minor for OMI measurements, as the boundary layer is often thick and quite well mixed during OMI overpass time (in local afternoon). Our previous aircraft measurements over northeastern China

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and the eastern US show that the difference in AMF due to different SO2 profile shapes over the two regions are very small (within a few percent, see Krotkov et al. 2008 for more detailed discussion). Additionally, given the absence of actual profile information (since actual measurements are very sparse), it would be difficult to infer how profile shape actually changes, and how it may have influenced OMI-derived trend."

4) Conclusions, P26581, L15: 4km by 4 km is resolution at best. S4 UVN will not have such a small footprint.

-Thank you for pointing this out. We have removed specifications for ground resolution and added missing references:

"The space-based capabilities for air quality applications will be further enhanced by the addition of higher-ground resolution hourly observations from the three geostationary satellites over North America (Tropospheric emissions: monitoring of pollution (TEMPO), http://tempo.si.edu) (Chance et al., 2013), over Europe (Sentinel 4 UVN (Ingmann et al., 2012)) and East Asia (Geostationary Environment Monitoring Spectrometer (GEMS) on board the GeoKOMPSAT satellite) (Kim, 2012)."

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 26555, 2015.