

Interactive comment on “Validation of satellite SO₂ observations in northern Finland during the Icelandic Holuhraun fissure eruption” by I. Ialongo et al.

Anonymous Referee #2

Received and published: 11 February 2015

This paper provides a study on the validation of satellite SO₂ observations after the Holuhraun eruption.

The paper is well written and structured but I find the conclusions weak. A large portion of the paper is to show that the emitted SO₂ was located in the lower troposphere but this information is superfluous because this was shown many times by several groups and air quality stations. Overall I find the validation results quite limited (one Figure) and qualitative. There are many statements given without demonstration. Therefore, I think this study could be published in AMT, but after addressing the following points.

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Main comments

-Such a validation paper should be a good opportunity to make sensitivity tests/alternative retrievals to solve the discrepancies, but these tests are not done. E.g. one parameter that really limits the accuracy of the satellite retrievals is the (incomplete) knowledge of the shape of the SO₂ vertical profile. The discussion on the latter point is limited to the use of the different baseline products (PBL, TRL, TRM and STM) and the actual radiative transfer is not well modeled. In the text, it would also be good to say if there was snow over Sodankyla and how it could influence the satellite retrievals and validation results.

-Figure 2 gives little information. If I understand correctly, only the pixels containing the Brewer station are shown. Therefore the comparison is statistically insignificant. To increase the statistics, it would be important to redo the analysis by considering all pixels with centers falling in a given area around Sodankyla. It is also not mentioned whether the displayed values are above the OMI/OMPS detection limit and for several data points it is clear there are not. The OMI BRD results for 5&27/09 are far away from the other PBL products and at the same time close to the Brewer. It is hard to know what it means (BRD are not supposed to be better than PCA product). No explanation is given.

05/09 and 06/09: there is a clear bias between ground-based and satellite data (no matter the product selected) but this is not even mentioned by the authors. It is not enough to say that PBL are closer to the truth but the authors should discuss and understand the discrepancy.

- In the comparison with the Brewer data, the authors claim that some differences are due to different solar and viewing angles than assumed in the retrievals. For this paper to be useful, the authors shall demonstrate that.

-Page 6, on precision of satellite data: I don't understand how the STDs in the high latitude box can come any close to the estimates from the README file (equatorial

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pacific). There is a large difference in SZA and it should be reflected in the estimated values. Actually on Fig 1, it is clear that the noise increases at high latitudes.

-Figure 3: it is not clear what the figure brings to the validation exercise.

Minor comments

-Figure 2 is difficult to read. I suggest to split the figures in two (one for OMI and one for OMPS). For a better readability, I also suggest to remove the STL data points (it is clear that this is not a stratospheric eruption).

-P1, l50-57: please specify that this is for UV sensors (there are also space infrared measurements of SO₂ dating back to the mid-seventies). I suggest you chose another reference than Krueger et al. (2008) for the first SO₂ measurement made in the 1980's. Also, please change the reference to Krotkov et al (2006) which is for OMI measurements, not TOMS.

-P2, l73-74: "Quality and timelines of..." It is not clear what 'timelines' means here.

-section 2.2: a detection limit of 1 DU for the Brewer data is given here but no information on possible offsets (bias) is provided. Please give details as it directly impacts the findings of the paper.

-page 5, l300: It is written "the agreement is weaker because of the challenging retrieval conditions (e.g., high SZA and cloudy conditions)" but this is stated with no proof. L345: "This makes the retrieval from satellite more difficult." but it is not explained why and what is the expected effect on the retrievals. Please clarify.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 599, 2015.

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