

## ***Interactive comment on “iFit: An intensity-based retrieval for SO<sub>2</sub> and BrO from scattered sunlight ultraviolet volcanic plume absorption spectra” by M. Burton et al.***

**M. Burton et al.**

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Received and published: 14 July 2016

The reviewer’s overall positive assessment, and meticulousness, is appreciated and has resulted in an improved revised manuscript. The key comments on required improvements in the mathematical presentation is clearly understood and will be addressed through revisions to the equations and improved figures to allow reproduction by the community. The intercomparison with other techniques is desirable but is outside the main focus of the paper which is, as the reviewer highlights, to present an approach which is free from a measured reference spectrum. It would be possible to give egregious examples of where the true SO<sub>2</sub> value was miscalculated due to the use of a contaminated reference spectrum, but this is self-evident. As this is the first

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order objective of the paper, this remains the focus, and no direct intercomparison is presented in the revised document. To reflect this, the focus of the paper is revised to exclusively focus on a solution to the reference spectrum problem, with no further claims to improvement over the DOAS approach arising from the intensity spectrum approach. A thorough intercomparison between intensity based fitting and DOAS fitting will be done in a further work.

In response to General comments:

1. As discussed above, the focus of the revised manuscript is on the reference spectrum calculation, and the positive comments on the advantages of the intensity fitting over DOAS have been removed, and addressed in a further intercomparison work.
2. Runtimes are now discussed, and on a modern PC very acceptable.
3. A revised mathematical description has been included.
4. Light dilution comments have been deleted.
5. Language has been tightened up throughout.
6. While the reviewer's use of language such as 'very roughly approximated' is perhaps also suffering from the weakness highlighted in comment 5, we highlight that these residuals are significantly smaller than those produced by neglecting the impact of the flat spectrum. Further details of this residual behaviour and its stability in time and space has been included.

In response to specific Comments:

Points 1-20 Suggestions accepted

Point 21: Ring spectrum could be improved in a final operational version of the algorithm, but as the purpose of this paper is to highlight an effective solution to the reference spectrum calculation the relatively rough but adequate RRS solution presented here is sufficient to address the purpose of the paper. Further developments

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will improve on this point in future work.

Point 22. The pixel by pixel QE of the spectrometer is exactly what is being addressed by flat spectrum characterisation, so this is not the source of the issue.

Point 23. The manuscript has been updated to show that the residual is stable in time and space and therefore offers an effective general solution.

Point 24. Language adjusted.

Point 25. ILS fitting has been described better to reflect the approach used.

Point 26: Optimal estimation was used with no apriori information, and therefore it is effectively a standard non-linear solver.

Point 27, 28 corrected

Point 29. A new K is calculated at each iteration.

Point 30, 31 Clarified

Point 32. I show a lack of temperature dependence for the flat spectrum. Dynamic fitting of the ILS can be used to address a T-dependent ILS. This is beyond the scope of the current work.

Point 33. Improved language

Point 34. Not addressed, there is now plentiful referencing of the relevant literature.

Point 35. If the reviewer had a reference I would use it.

Point 36, 37, 38. The language has been modified.

Point 39 Done

Point 40. Nothing to address

Point 41. Interesting comments, but again the main focus here is on the artificial refer-

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ence spectrum stability.

Point 42. Done

Point 43. If the BrO was not volcanic there would be not be a correlation with SO<sub>2</sub>, notwithstanding the reviewer's assertion to the contrary, as the volcanic signal is changing rapidly and randomly,

Response to technical comments:

1,2 done

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2015-380, 2016.

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