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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Inverting for volcanic $SO_2$ flux at high temporal resolution using spaceborne plume imagery and chemistry-transport modelling: the 2010 Eyjafjallajökull eruption case-study" *by* M. Boichu et al.

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**General comments**

This article presents a method of reconstructing $SO_2$ emission flux during volcanic eruptions via the combination of satellite observations of the plume and atmospheric chemistry-transport modelling. The focus is on the infrared instrument IASI, and the May 2010 eruption of Eyjafjallajökull, though in theory the method is applicable to other satellite-based sensors and indeed other volcanic eruptions. The authors stress that the study of smaller, more regular volcanic eruptions and persistently degassing vol-



canoes is important for assessing the complete impact of volcanism on Earth's atmosphere – this emphasis is very welcome. Since the method presented does not require any initial knowledge of volcanic emission flux, there are obviously many potential future applications to other remote or poorly-monitored volcanoes. The agreement between model simulations and the satellite dataset is very encouraging, and indicative of the method's robustness. Generally the article is well-written and laid out. Although I think it would benefit from more detail in a few areas, I have no hesitation in recommending this article for publication, with only a few minor revisions in response to points discussed below.

**Specific comments**

- The neglect of atmospheric chemical processing of the $SO_2$ may be valid in this case, but is less likely to be so at many other volcanoes, particularly those in lower latitudes. A little more discussion of the implications of this would be welcome.
- Connectedly, $SO_2$ lifetimes are described on the order of days. Some brief comparison between this eruption and other high latitude eruptions where plume lifetime has been estimated would be nice to see.
- The common trends in $SO_2$ and ash emission are interesting to see, but I would like to see more discussion of how typical this is. On 6569, line 24, the remark "During any explosive eruptive episode, both $SO_2$ and ash release generally tend to broadly follow the same trend" should be better supported, with citations. In which other eruptions has this been documented? Otherwise, I am not sure that similar trends in ash and $SO_2$ are a rigorous means to validate your $SO_2$ reconstruction. Furthermore, closer links could be made between the satellite observations and contemporaneous observations of volcanic activity made on the ground throughout the eruption.
- It is remarked that the method could be applied to other satellite sensors – in what

ways would this improve or limit the effectiveness of the method? For example, UV sensors would only see the plume once per 24 hours, rather than every 12. Conversely, an instrument like OMI could potentially detect $SO_2$ at lower altitudes.

- In common with reviewer 1, I agree that some comparison with other satellite datasets would be welcome, if available. I appreciate however that differences in overpass time, sensitivity, detection limit, spatial resolution, etc, may not facilitate straightforward comparison.
- Total mass of the emissions (ie. integral of the flux history) is mentioned but not quantified (6562, line 09). Some estimate of the total mass of the eruption would be welcome, and could be compared to previous estimates achieved using other methods. Total $SO_2$ mass release is an important parameter for assessing the climatic impact of eruptions.
- Cloud cover masking the $SO_2$ plume is mentioned as a potential source of error (6564, line 05) but is not discussed further. Does any information on cloud cover at the time of IASI overpass exist?
- Similarly, on 6565, line 01 onwards: has the impact of ash in the plume on the IASI retrieval been quantified or accounted for on each day? Are the days where large ash releases are also observed less reliable?

**Technical comments**

- 6557, line 24: consider "repeatedly disrupt"
- 6557, line 25: consider "for" instead of "during"
- 6558, line 15: Due to the limited scope of the forecasting demonstrated herein, perhaps consider "may yield"



- 6559, line 24: consider "has provided, since 2006,"
- 6560, line 14: alternative to "restituted"?
- 6561, line 21: sentence beginning "No a-priori" is confusing
- 6564, line 09: consider "regular" instead of "redundant"
- 6564, line 10: consider "travels" instead of "transits"
- 6568, line 03: consider "after travelling" instead of "after a long travel of"
- 6569, line 17: "in detail" not "in details"
- 6570, line 14: Following on from a point made earlier use of "strong similarity" needs more support, and seems contradictory to "broad similarities" (6570, line 07)
- 6573, line 25: "should make **it** possible"

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