The authors thank the two anonymous referees for their comments.

Note that in the following text, the comments of the referees are written in dark blue italic and our replies in regular font (in black).

***Anonymous referee #1 (comments received and published: 10 January 2014):***

*The manuscript reports on a web-based service for near real time monitoring of SO2 and ash volcanic plumes, based on UV-Vis and IR satellite sensors. The different satellite sensors are described and their respective capabilities are discussed, in terms of sampling time, resolution, accuracy and sensitivity. Some results based on historical datasets are also presented in order to illustrate the work of the service. The data set is well presented and carefully discussed, and the methodology is properly addressed and referenced, so I think the paper is adequate for publication in NHESS after minor revisions. In particular, I would encourage the authors to address in more detail the potentials and drawbacks of such monitoring service. More specifically, although the alert system uses both NRT ash and SO2 data products, they state that, as the detection of volcanic ash is difficult and exposed to false detection (e.g. in the case of dust) the alerting system at present only uses SO2 data products to trigger and issue plume notifications. They do acknowledge the fact that SO2, although a good proxy for the presence of volcanic ash, may result in false or even misleading alarms due to different ash and SO2 trajectories, different residence times, different intensities of emission from the volcanic sources. Although the effects of these drawback are documented in some of the case studies presented (see as instance fig. 21 to 23), I think the authors should discuss more this particular topic. As I understand, the SO2 alert reduces the number of false positives. It would be interesting, if available, to have figures for false positives for an "ash oriented" alert, and more important, to report the number of ash events that the SO2 alert did not capture, at all or in their geographical location. In the outlook, the author quote a possible improvement due to the availability of superior satellite data products for ash that may be used to operate a new notification system*

*selective for the detection of ash. This should deserve a lengthier discussion. After such minor revision, I think the paper is ready for publication, as the alerting system as the one described provides an important contribution to the early warning and mitigation of such natural hazards as volcanic eruptions, and the paper is effective in providing a well written and exhaustive description of the system, to be used as future reference.*

REPLY: At the time of the paper submission, the SACS notification system was only based on the detection of $SO_2$. In the conclusions of the original manuscript we mentioned our plans "to operate a new notification system selective for the detection of ash using thermal IR instruments". Now this ash notification system has been tested and is operational in SACS since November 2013. It combines ash observations by three sensors: AIRS, IASI/MetOp-A and IASI/MetOp-B. Clarisse et al. (2013) showed that it is possible to discriminate ash absorption signatures from other absorbing aerosols using statistical analysis of the measured high resolution thermal infrared spectra. By using ad-hoc (i.e., fairly conservative) thresholds in the algorithm presented by Clarisse et al. 2013 (and implemented in SACS in NRT), virtually no false alert is induced by dust or other non-volcanic aerosols (the success rate of ash detection is typically 99%). Some ash plumes with low concentrations are missed but this is due to a compromise on the number of false alerts. Based on this algorithm, we have set-up the (first ever) notification system selective for ash.

Consequently, we have decided to review the paper considerably. We now describe the new notification system and we have assessed its performances in the new version of the manuscript. It should be noted that we have also implemented ash and $SO_2$ observations from MetOp-B (GOME-2 and IASI) in NRT in SACS. It does not require additional description of the algorithms (because they are almost identical than for MetOp-A instruments), but we have updated the manuscript with the MetOp-B results.

As an example of event where ash could be detected while $SO_2$ was hardly detectable, we refer to the Eyjafjallajokull eruption on 14-15 April 2010.

We have added one figure that nicely illustrates the performances of our notification system based on both $SO_2$ and ash detection (see below). It shows time series of the number of conclusive detection of ash and $SO_2$ for six years of operation of the IASI-A instrument. It illustrates the ability of the system to characterise different scenarios and volcanic cloud compositions ($SO_2$-rich, ash-rich or both).

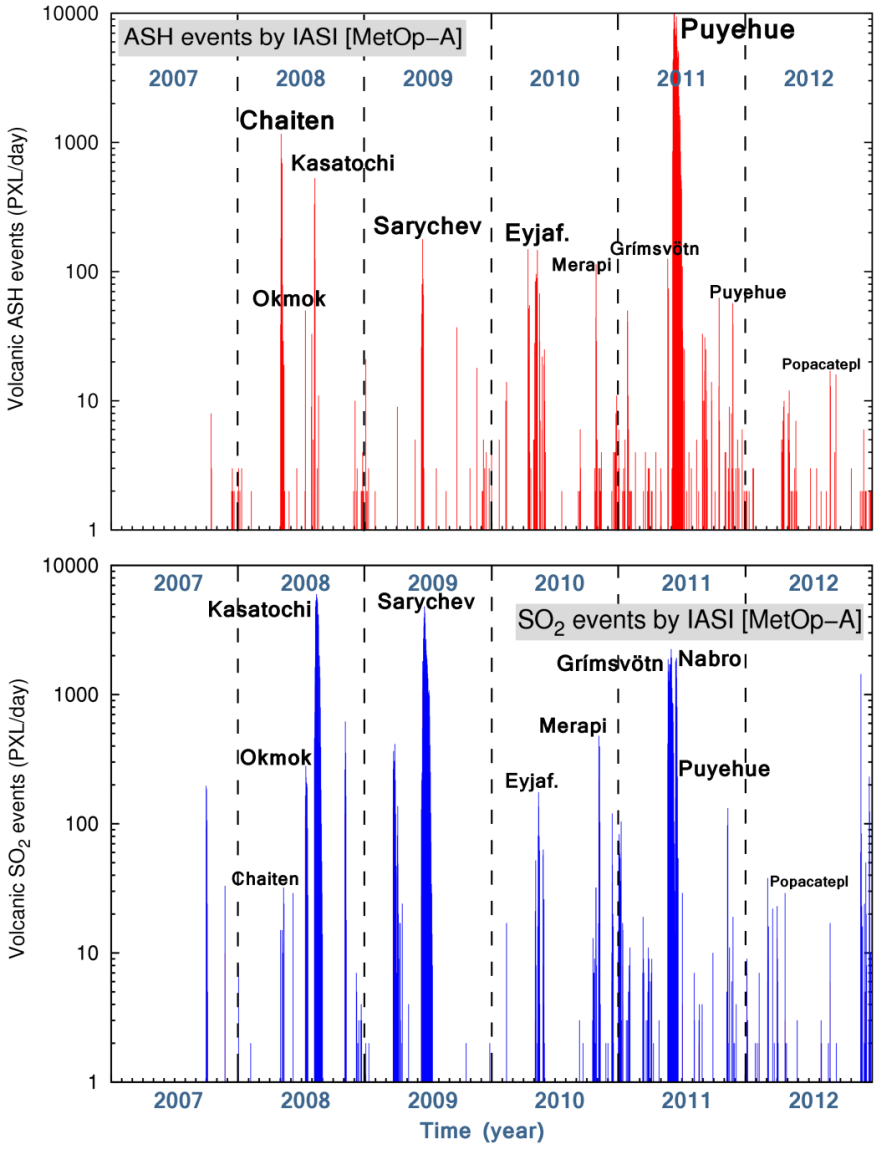


**Figure 26.** Time series of the number of detections per day of ash (upper panel) and $SO_2$ (lower panel) by IASI-A, for the period 2007-2013.

***Anonymous referee #2 (comments received and published: 23 December 2013):***

*Summary*

*The authors compile a series of UV and IR techniques to measure volcanic emissions of SO2 and Aerosol Index (AI)values and IR methods to measure volcanic ash. They couple these methods with an alert system that send messages informing of the detection of SO2.*

*Although the paper mentions that the detection of SO2 does not imply the occurrence of a volcanic eruption and that the presence of SO2 often does not match the location of ash, it understate the fact that an SO2 plumes alone does not pose any safety concerns to the aviation.*

REPLY: In the introduction section, we made it clear that the main concern for aviation safety is ash. Whether sulphur species constitutes a threat is debatable and presently, not so much is known on the subject. However, it is likely that flying in a volcanic plume very concentrated in sulphur may be dangerous for the passengers.

*The Volcanic Ash Advisory Centers (VAACs) have little if any interest in SO2 detection alone and are willing to look into the subject only when coincident strong measurements of AI and ash are also provided.*

REPLY: We all agree with the fact that the first preoccupation of the VAACs is the monitoring of the ash cloud, and not the $SO_2$ alone. As extensively described in the manuscript, our system provides information both on ash and $SO_2$; hence SACS is in line with some of the VAACs needs.

*Having a detection system that only reports on the SO2 presence is unreliable and will show an excessive number of hits because a large SO2 plumes stay in the upper atmosphere for weeks. While travelling around the globe the same plumes are viewed every time a satellite swath passes over them resulting in another alert that has nothing to do with an actual volcanic eruption or with the presence of ash.*

REPLY:

* Our system has been specifically developed to avoid this overflow of notifications.

* The feedback we have from our users is that they prefer to have more information than not enough.

* SACS now features a unique ash plume warning system based on an innovative algorithm that enables truly selective detection of volcanic ash. In this context, please see our reply to the comments of referee #1.

*Since the paper provides very little information on ash detection and no information on the more important ash height variable, their findings have very little use for the VAACs' operational environment. Its value is mostly academic as a description of various SO2 detection technique and their combination into a single system with an alert capability.*

REPLY: We disagree partly with this comment.

SACS is built upon a solid collection of user requirements. At the time of writing, SACS has more than 200 users that subscribe to the notification system and we count many people from many VAACs. SACS proved to be valuable for operational purposes as well as for researchers. Recently, a user survey showed that SACS was

one of the most used services both by operational and research users (see http://vast.nilu.no/media/documents/2013/09/03/nilu-esa-vast-urd-v0.4.pdf).

Regarding the information on ash detection, see our reply to referee #1.

It is true that we currently do not provide information on plume height but it is mentioned in the conclusions section as a plan for the future.

This being said, we don't claim that SACS is able or will be able to provide all the information the VAACs need and we think there is currently not a single system which is able to do so.

*I suggest that the authors change the title of the paper and mentioned "volcanic SO2 plumes" to avoid the confusion with "ash plumes", which is the real subject of interest of the operational organizations tracking volcanic activities to assist the airliners.*

REPLY: There is no need to change the tittle of our manuscript because our service now includes the monitoring and a warning system for both volcanic $SO_2$ and volcanic ash plumes.