

## ***Interactive comment on “Detecting volcanic sulfur dioxide plumes in the Northern Hemisphere using the Brewer spectrophotometer, other networks, and satellite observations” by Christos S. Zerefos et al.***

### **Anonymous Referee #2**

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This article provides an interesting assessment of the detection of volcanic sulfur dioxide by Brewer spectrometers in the Northern hemisphere. It uses surface station and satellite measurements as well as trajectory models to evaluate the performance of the Brewer instruments in case of elevated SO<sub>2</sub> levels due to the passage of volcanic plumes. Although the Brewer instruments are not accurate enough to monitor SO<sub>2</sub> on the long term, it is argued, by using trajectory models in order to trace large (VEI>4) volcanic plumes from recent eruptions in the Northern hemisphere, that Brewer instruments can detect the volcanic SO<sub>2</sub> signals. Since the Brewer network set up for the monitoring of total ozone includes a large number of stations, the authors suggest

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to use this measurement capability to forecast the evolution of volcanic plumes and provide a new SO<sub>2</sub> forecasting tool. The paper is correctly written and informative regarding SO<sub>2</sub> measurement capacity of Brewer instruments. I recommend publication in ACP, provided that important comments for improvement are taken into account.

#### Main comments

• The measurement capability of Brewer instruments should be better explained. Since the paper focuses on the detection of small SO<sub>2</sub> signals, the methodology to derive SO<sub>2</sub> total content should be summarized in the paper itself. An assessment of the mean SO<sub>2</sub> values generally provided by Brewer instruments should be provided.

• As optical instruments, the Brewer measurements can be perturbed by ash present in the volcanic plumes. This issue should be addressed in the article.

• For readers not familiar with total SO<sub>2</sub> measurements by Brewer spectrometers, it is rather intriguing to see negative total SO<sub>2</sub> values. So it would be worth explaining why such negative values have to be considered in the general Brewer (and satellite) retrieval.

• Two lagrangian models are used for the analysis: FLEXPART and HYSPLIT. An explanation is needed on why two different models need to be used (paragraph 2.3).

• In the case of the Baraorbunga volcano, the FLEXPART model has been used to simulate SO<sub>2</sub> levels in air masses sampled at Hohenpeissenberg station. But there is no detail on the simulation and on the initial emitted SO<sub>2</sub> levels.

• For the same volcano, it is not completely clear that the elevated SO<sub>2</sub> levels detected by ground stations correspond to the volcanic plume. Also a better explanation should be given on why the plume is not seen in OMI and GOME 2 measurements shown in Figure 5. The case for the detection of this volcanic plume by the satellite instruments over Europe and for the attribution of increased SO<sub>2</sub> levels from these measurements (page 8) is not completely made.

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â€” The fact that the 2011 Grimsvöth volcanic plume was not detected by the European Brewer instrument does not bring much to the article. This paragraph should be removed.

â€” Again for the Eyjafjallajökul volcano, OMI and GOME 2 do not seem to detect the SO<sub>2</sub> signal. An explanation is needed on the lack of detection by satellite instruments. Also, the left panel of Figure 16 is redundant with the right panel.

â€” 2008 Kasatochi case: it is not clear from the article why the plume is not detected in Taiwan by the satellite instruments, contrary to the observations in Europe and North America. This issue should be addressed.

â€” The conclusion should better summarize in which general conditions (SO<sub>2</sub> levels, time after eruption) Brewer instruments can be useful for the detection of SO<sub>2</sub> volcanic plumes. The article is qualitative in general and such a summary would provide a quantified assessment of the measurements capability of Brewer instruments with respect to SO<sub>2</sub> measurements. Comparison with OMI and GOME 2 measurements capacity in similar cases would be useful. It would be also worth mentioning why IASI and AIRS measurements are not included in the analysis.

#### Minor comments

In general, figures' legends should be more informative, with the description of the various plots and the name of the volcano case to which the figure refer (when SO<sub>2</sub> levels are plotted).

Figure 7: can the authors comment on the spot of elevated SO<sub>2</sub> observed between Italy and Greece?

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