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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric transport and deposition of Indonesian volcanic emissions" *by* M. A. Pfeffer et al.

M. Halmer (Referee)

Martina.Halmer@bristol.ac.uk

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Referee #2

General comments: I agree with referee #1 that this work is trying to workout a realistic model considering regional atmospheric chemistry data in order to calculate volcanic SO2 and PbCl2 loss during transport processes. The study demonstrates that the regarded meteorological parameters are less important to SO2 loss than they might have been assumed to be in past studies. I consider this paper in the scope of ACP, and it should be suitable for publication after some revisions. However, I suggest the authors should consider to consult a native-english speaker to significantly improve the readability of the manuscript.

Specific comments: Page 11863 Line 7: The term ‘diffuse eruptions’ is irritating. I suggest to use ‘mild eruptions’ or ‘mild explosive style of eruptions’ instead.

Page 11863 Line 9: I do not agree with the numbers taken from Andres and Kasgnoc (1998). It seems to be a misinterpretation of the original source. I suggest to reassess the percentage values in the paper again.

Page 11863 Line 12: There are as well other and more recent estimates considering volcanic plumes reaching the stratosphere such as Halmer and Schmincke (2003) The impact of moderate-scale explosive eruptions on stratospheric gas injections. Bull Volc. (e.g., 54 eruptions/yr inject gas into the atmosphere while ca. 14 eruptions/yr out of the 54 can inject their gas into the stratosphere (Fig. 6), a much higher percentage than the 1-2 eruption(s)/yr postulated by Simkin (1993)(Halmer and Schmincke (2003)).

Page 11863 Line 17: The tropospheric volcanic emissions can be very efficient on a local to regional scale due to the constant supply of volcanic gases via silent or steady degassing processes.

Page 11868 Line 13: The index of Schnetzler et al (1997) underestimates the SO2 emission as shown by Halmer et al (2002). Halmer et al (2002) calculated a SO2 emission based on the original VSI (Schnetzler et al., 1997) and multiplied the values of the original VSI with a factor of approximately 2 to match the values of measured SO2 emission. The VSI is based on the quantity of volcanic SO2 produced by explosive eruptions and is scaled in different degrees of SO2 emission (in kilotons, kt = 109 g) based on the VEI scale. Schnetzler et al. (1997) developed the VSI using the relationship of the average sulfur dioxide emission and the VEI of volcanic eruptions for their index. Then modified the VSI by the factor 2 because it significantly underestimated the quantity of degassed SO2. In some extraordinary sulfur-rich eruptions such as El Chichón (1982) the modified VSI still slightly underestimates the SO2-emission. The index is quite appropriate, however, for average sulfur-rich eruptions. Then related the eruption frequency to VEI from 1900 to 1972 for the time series analyses prior to

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1972 and determined the annual eruptive activity for each VEI category. Multiplying the new VSI-value (average quantity of SO2 degassed during an explosive eruption scaled with VEI) by the number of annual eruptions results in a total annual global volcanic SO2 emission from explosive eruptions for a certain year. The annual global volcanic SO2 emission from 1972 to 2000 was first calculated with the original VSI by Schnetzler et al. (1997). The result was then compared with our estimate of global volcanic SO2 emission based on 50 directly monitored volcanoes and the 310 extrapolated volcanoes. Halmer et al. (2002) modified the VSI by a factor of 2 for calculating the SO2 emissions by volcanic eruptions prior to the period of monitoring by COSPEC and TOMS because the original VSI calculates a minimum quantity of the SO2 emission based on the 50 directly monitored volcanoes. The modified VSI is very useful to quantify the sulfur yield of volcanic eruptions and is used as a base for our minimum estimate of the quantitative volatile input into the stratosphere for historic eruptions, especially from 1900 to 1971. Currently, there is a paper under revision from Halmer and Schmincke (2005) considering two new indices called Volcanic Gas input into the Atmosphere (VGA) as well Volcanic Gas input into the Stratosphere (VGS). If the authors are interested I can provide them with a copy of the submitted manuscript.

Page 11869 Line 4: You should add the reference or an explanation for the chosen percentages of SO2 and SO42-

Page 11871 Line 23: You compare volcano height together with the height of volcanic plumes. I do not believe that you really can set this into a simple relation with each other since there seems to occur no significant agreement in between those two types of data (Figure 4).

Page 11872 Line 11: Most of your volcanoes are located on the Southern Hemisphere, therefore I would suggest that you want to use either only months or add as well the Southern Hemispheric seasons instead of the Northern Hemispheric seasons. This might be important to understand changes in meteorological parameters.

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Page 11874 Line 1: There occurs a huge variance in your data of Table 4 between measured S and modeled S. The range is larger than 1 magnitude between measured and modeled data. Further, the percentage of volcanic S increases with increasing distance, but there is no satisfying explanation given in the manuscript.

Page11874 Line 14: You should explain in more detail that the assumption of similar C14 ages for close-by peat cores to the analysed core could be another important source of error, which might be incorporated into the model later on.

Page 11876 Line 1-5: Nowadays, SO2 monitoring is mainly used directly above the volcano vent where one expects the least changes in the volcanic gas composition. These data should show minimal sulfur loss caused by winds, etc.

Technical corrections: Page 11861 Line 8: Add ‘Indonesian’ to ‘each active volcano’

Page 11861 Line 23: Change ’when making observations of SO2’ to ’whilst observingĚ’ and ‘and relating’ to ’in order to relate’

Page 11863 Line 3: Change ‘dependent’ to ‘depending’.

Page 11863 Line 4: Change to ‘Emission transport is influenced by characteristicsĚ, i.e. the emission-releasing-height, wind speed, and precipitation.’

Page 11863 Line 11: Change to ‘Moderate to major size eruptions can inject.’

Page 11863 Line 13: Change to ‘Volcanic plumes reaching the stratosphere can causeĚ.’

Page 11863 Line 15: Change to ‘Volcanic emissions released into the troposphere, however, are rapidly deposited locally as well as regionally.

Page 11864 Line 6: Add ‘significant on a global scale’

Page 11864 Line 10: Delete ‘successfully’ and change to ‘improved understanding of emission compositions and quantities due to variations in time and in between different

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volcanoes.'

Page 11864 Line 17: Change to 'It is possible to detect variations in the degassed SO2 emission with remote sensing instruments, but it is not possible if changes in the volcano itself or changes of meteorological conditions are causing the differences.'

Page 11864 Line 19: Delete sentence 'It can also be Ĕ.'

Page 11864 Line 23-29: Please rewrite these sentences. They are not very clear.

Page 11865 Line 3: Delete ' in light of' and replace with 'for'

Page 11865 Line 4: Change 'are held' to 'remain'

Page 11865 Line 5: Change to 'volcanic emissions rates, in order to study the role of atmospheric transport variations are due'

Page 11865 Line 21: Delete 'for example'

Page 11865 Line 27: Change to 'used to gain knowledge of the quality of monitored SO2...volcanic plume set into relation to other volcanic compounds.'

Page 11866 Line 2: Change 'the two' to 'these two'

Page 11866 Line 8: Change to 'erupted during the past'

Page 11866 Line 22: Delete 'and'

Page 11867 Line 28: Change to 'volcanoes are routinely monitored for SO2 emissions.'

Page 11867 Line 28 -Page 11868 Line 2: Delete sentence

Page 11868 Line 2: Change to 'The division of continuous emissions between all active volcanoes results in a mean for continuous.'

Page 11868 Line 8: Add 'and eruption strength'

Page 11868 Line 9: Add 'assigned to volcanic' and delete 'strength', and change to

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‘Ěindicator of eruption strength of a volcanic eventĚ’

Page 11868 Line10: Change to ‘All of the eruptions recorded...were summed to assemble the sporadic emission inventory.’

Page 11869 Line 9: Change to ‘performed in order to replicate the analysis of field measurements for tropospheric’

Page 11870 Line 4: Delete ‘than at’ replace with ‘compared to’

Page 11870 Line 13: Delete ‘so’

Page 11870 Line 17: Change to ’however, to use it as a proxy.’

Page 11871 Line 10: Add numbers to the figures

Page 11892 Figure 5: Change ‘height of each volcano’ to ‘volcano vents’

Page 11892 Figure 6: Change Northern Hemispheric seasons to Southern Hemispheric season or best use simply the months. Explain why there occurs a higher peak during summer compared to the remaining seasons.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 11861, 2005.