Atmos. Chem. Phys. Discuss., 5, S4558–S4563, 2005
www.atmos-chem-phys.org/acpd/5/S4558/
European Geosciences Union

Atmospheric
Chemistry
and Physics
Discussions

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

Anonymous Referee #1

Received and published: 17 December 2005

General Comments:

This work uses a regional atmospheric chemistry model to study the atmospheric loss and transportation of SO2 and PbCl2 emitted by Indonesian volcanoes. The conclusions regarding the impact of meteorological conditions, and the solubility of the emissions on the atmospheric lifetimes are interesting. The paper is within the scope of ACP, and should be suitable for publication following some revisions.

Specific comments:

Since there are 95 volcanoes in the model domain, does this complicate the analysis of the correlation between the meteorological variables and the SO2 loss rates for

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

EGU

any given volcano (V)? If I understand the model correctly, the SO2 emissions from any given volcano (V) are subject to losses by oxidation, deposition and transport. However, would there also be emissions from neighboring volcanoes reaching into the plume at V+2? Could this mask the correlations between the SO2 loss rates and the meteorological variables, despite the fact that you have removed points where the concentration difference between V and V+2 was null or negative? Some discussion related to this concern would be helpful. If you repeated the correlations for a few of the volcanoes, assuming any given volcano to be the only one active in the domain, would this change your results?

Also, could you comment on why between 2 sites distant from the volcano, V+1 and V+2, the sum of the sulphate and dry deposition can be greater than the loss of SO2 as you mention at the end of Section 3.1. This may have to do with there being many SO2 sources. Some discussion related to this would be helpful in interpreting the results, and understanding transport.

You mention that the major tropospheric chemical reactions for SO2 oxidation are used in the model. It would help the work if you explicitly stated these equations, and likewise gave the equations used for deposition. This would help the reader to understand if the oxidation or deposition processes are linked to meteorological variables in the model.

Have there been any field studies to examine the correlation between SO2 loss rates and meteorological variables?

There are a few instances in the paper, such as the second sentence in Section 2.2, where your wording might confuse the reader to think that SO2 and S loss are the same thing. Since the oxidized product, sulphate, does have a lifetime of a few days in the atmosphere one needs to be careful not to confuse SO2 loss and S loss. Likewise, be consistent in references to the ratio of highly soluble products to either one of S or SO2. At the end of the abstract you refer to this as a ratio to S, but then in the second to the last paragraph of the introduction you refer to this as a ratio to SO2. S includes

Full Screen / Esc
Print Version
Interactive Discussion
Discussion Paper

both SO2 and sulphate, and you do note that sulphate is close to 5% of the total S emission, close to the magnitude by which the PbCl2/SO2 ratio changes over 30km.

Section 5 seems to be somewhat repetitive of Section 3. These two sections could be combined into one section to make the work more concise.

Reference to previous, related studies that model the atmospheric transport and deposition of volcanic emissions could be added to the introduction. Also, mention if there have been any previous studies on the impact of meteorological variables on the transport and deposition of volcanic emissions. This will show that your work is a new contribution. Also, in the introduction, could you add a sentence or two to explain the principle of the COSPEC instrument. Also in the introduction, the reference to fumarolic gas sampling, plume particle sampling, and remote sensing might be clearer if you mention the instruments that are used.

Since the paper calls into question the validity of the assumption of a constant [PbCl2]/[SO2] ratio (PbCl2 being much more soluble than SO2), you might state explicitly if this metal was one of those examined in the previous observational studies that are referenced in the introduction. Also, you might comment on how the solubility of the other compounds that are commonly assumed to be constant to SO2 compares to PbCl2.

Looking at the figures, in Figure 4, for the observational data, there appears to be a trend in that the loss rates are lower for volcanoes that are higher into the troposphere. Your data does not show this trend. Could you comment on this?

Figure 5 show correlations with wind speed, did you also consider wind direction?

In Figure 6, in the seasonal comparison, are you able to explain why the loss rate is greatest in the summer in light of the meteorological variables?

Could you consider the correlation of the loss rate with precipitation?

The discussion in Section 3.2 is rather brief and should be expanded and reworded.

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

This section could be combined with Section 5.2 to help this problem. Also, could you give an atmospheric loss rate for $PbCl_2$?

The first paragraph of Section 5.2 seems to discuss Figure 10 so you could mention this figure earlier. Perhaps it would help your discussion to make the point that dry deposition is a less efficient removal process than wet deposition and therefore solubility is an important factor in a domain that is quite moist. The wording of the last sentence of the first paragraph of Section 5.2 is confusing, particularly at the end. You mention a ‘higher concentration of S deposition farther away from the volcanoes’, how far away do you mean, and compared to how close?

Figure 11 does not entirely convince one that the downward trend in the ratio is really enough to prevent one from choosing to approximate the ratio as a constant. Particularly, since you are using infinitely soluble $PbCl_2$ is an extreme case. An overestimation at 30 km of around 5% or less does not seem too large. Maybe you could comment on why an error of this magnitude would be of concern. The rapid wet deposition of a soluble species assumes that there is frequent precipitation - perhaps if the volcano was in a drier domain, solubility would be even less of an issue. You could mention something in regard to the relative abundance of precipitation in your domain compared to other volcanic regions.

Also, have there been observational studies to attempt to confirm if this assumption of a constant ratio is valid?

In the introduction, you say that over distances up to 30km, the ratio to SO_2 is assumed to be constant. Since the distances of V+1 and V+2 are greater and you only have three points, can you really trust the interpolation to 30km? Could a higher model resolution help to make this point better?

On Figure 11, the values for the mean ratio at V+1 and V+2 (89.3 and 83.2 ug/g) do not seem to agree with the lines drawn on the plot, check this. Also, does the Pb/S ratio of 245 ug/g given in Table 3 agree with the $PbCl_2/SO_2$ ratio given at V from Figure 11

(107.7ug/g)?

In the conclusion, you mention no correlation between the meteorological phenomena and SO2 dry deposition, conversion to sulphate, and lateral transport. Were these correlations mentioned earlier in the paper? If not, this should be removed from the conclusion.

The conclusion should mention that the results and conclusions are specific to this Indonesian volcano domain. The high density of volcanoes in the domain gives SO2 sources in many grid boxes, and that might possibly affect the correlation of loss rates with meteorological phenomena. Also, temperature and relative humidity might not vary much in this domain so perhaps one needs to be careful in making this conclusion too broad.

The conclusions in regard to solubility are also specific to this domain with its inherent precipitation patterns. The wording of the present conclusion might be too broad. State that this result was specific to the Indonesian domain. Also, mention the limit on the distance that the field workers would assume this ratio to be constant.

Technical corrections:

Page 11862 Line 3: change ‘emissions’ to ‘SO2 and PlCl2 emitted’ Line 4: change ‘sensitivity of these emissions to meteorological conditions’ to ‘sensitivity of these loss rates to meteorological conditions’ Line 6: change ‘and oxidation to’ to ‘and subject to deposition, transport and oxidation to’ Line 25: change ‘S’ to ‘SO2’

Page 11863 Line 5: change ‘size’ to ‘aerosol size’. Also perhaps add a reference for this line. Line 19: change ‘frequently released continuously for long periods of time’ to ‘released continuously’ Line 24 add ‘by aerosols’ after atmospheric forcing.

Page 11864 Line 3: change ‘(relatively) large’ to ‘considerable’ (add reference here too) Line 7: remove ‘(as described above when released explosively)’ or else add ‘Volcanic’ at the first of the sentence Line 18: change ‘what observed variations’ to ‘if

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

the observed variations' Line 19: change 'and what are' to 'or are'

Page 11865 Line 15: reword this sentence to be clearer - instead of total S, could you say SO2?

Page 11866 Line 4: change 'other volcanic compounds' to 'highly soluble volcanic compounds'

Page 11867 Line 10: Move discussion of two experiments to Section 2.2

Page 11872 Line 18: change 'between individual volcanoes then by' to 'between individual volcanoes than between' Line 24: change 'daily mean dry deposition' to 'annual mean dry deposition' (is that what you meant?)

Page 11878 Line 15: Are the field measurements usually taken near 30km from the volcano and the ratio is assumed to be the same at the point of emission? In which case would this not result in an 'underestimation' of the emission of the soluble species? Likewise can you clarify if this is what you meant in the last sentence of the abstract, 'overestimation or underestimation'? Reading near line 15 on page 11865, it seems that the application of the ratio has to do with estimating the flux of the soluble species from the volcanoes at the emission point.

Figures and Tables: Table 1 Could you mention in the text the criteria that distinguishes whether a volcano is called continuous or sporadic? Table 4 Could you add a sentence or two in the text to say how one determines the percentage of S in peat that can be attributed to volcanoes, and is there much uncertainty with this method? Figure 3 The print version has a strange diagonal line across the lower two subplots in my copy. Figure 10 Did you say why you choose to multiply by 4082?

Thank you for the opportunity to review your interesting work.

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