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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The 2011 Nabro eruption, a SO_2 plume height analysis using IASI measurements" *by* L. Clarisse et al.

Anonymous Referee #1

Received and published: 22 January 2014

The paper by Clarisse et al. contains two major subjects. First, a new method for effective retrieval of SO2 plume heights from IASI measurements is introduced and compared with external data, and, second, the evolution of SO2 plume heights from the Nabro eruption is discussed. The presented work is a timely and valuable contribution which adds new data helping to understand this interesting event. Further the method seems to be well fitted for standard processing of huge amounts of data as in the case of the IASI instruments. My main comments are directed to a better understanding of the method itself, its limits and uncertainties:

- It is mentioned that the altitude-resolution of SO2 stems mainly from the interfering water-vapour lines (P31168 L20). How can it be explained then, that there is such a low sensitivity on the real atmospheric situation as stated on P31169 L28?

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- On P31168 L18 it is mentioned that 'large differences in the Jacobians can be observed up to an altitude of 15 km'. Further, also in Fig. 1 the Z(h) functions are rather smooth, especially those for which the maximum is above 10 km (the blue curve). One would guess that this leads to a larger error in the height determination than suggested by the comparisons with CALIOP. Could you reason why this might not be the case?

- Since in the stratosphere the water vapour is rather low, the altitude resolution of the method for stratospheric plumes (e.g. above 18 km in the tropics) should also be rather bad (if there is even any). Could you make any simulations to show that the method can resolve the altitude of plumes situated clearly above the tropical tropopause? Otherwise one could argue that stratospheric plumes cannot be resolved and even, might be put by the retrieval to an altitude at or just below the tropopause (where a lot of the retrieved SO2-heights lie). Thus, can you really state from your observations how much of the early plume is directly injected into the stratosphere or is the method just not sensitive enough to make such a statement. This should be clearly expressed in the conclusions of the paper.

Specific comments

P 31162 L 14 'Evidence is presented that emissions in the first 15 week of the eruption also contributed to the stratospheric sulfur input.':

This sounds like direct emissions into the stratosphere. Perhaps add 'via slow ascent'.

P 31165 L 27 'to retrieve vertically resolved SO2 columns':

Columns with vertical resolution seem inconsistent. Perhaps use 'profiles' or 'partial column amounts'.

P 31167 L10 Eq. (2) and lines before:

Please clarify if $\hat{x}$ here is not height-dependent, i.e. one number and not a vector.

P31168 L25:

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Do you need other Jacobians in case of clouds (I assume they look different since they shield the H2O-features from below) and if not, could you explain the reason?

P31169 L20 'using average atmospheric conditions':

Which input data have been used to determine these conditions?

P31170 L1 'covariance matrix S we used one million random IASI spectra':

Has there been a selection with regard to cloud contamination? If not, why is it not necessary?

P31170 L5-10:

From the description of the quantitative column retrieval, the SO2 column is retrieved as it would be situated only at the layer belonging to the previously retrieved maximum height. Is it then the case that only the Jacobians from these altitude are used? How does the retrieval result depend on these Jacobians? How do the averaging Kernels of the result look like?

Futher, I assume that the retrieval is linear or do you use explicit forward calculations? In the first case: what is the error due to the linear fit? If an iterative fit is done, could you describe more in detail the forward-model and used input data (e.g. atmospheric profiles). Could you give in any case some error estimation?

P31176 L13:

To get a better overview of how well the plume altitude fits with CALIOP aerosol height it would be good to show a summary of all matches from the single plots in form of a scatter-plot, like Fig. 10.

P31177 L3:

Could you name a source for the MLS data and a reference?

Technical comments

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P31166 L15 Eq (1) and further mathematical expressions:

The ACP convention is that for vectors bold italic fonts should be used. Could you change it everywhere in the manuscript.

P31167 L20:

'residues' -> 'residuals'

P 31174 L16 'east side':

-> 'west side' (?)

P31177 L7:

'height altitude Nabro plume' -> 'high altitude Nabro plume' (?)

P31177 L7:

'becomes' -> 'become'

P31185 Fig. 2:

Could the position of the volcano be indicated more clearly.

P31194 Fig. 11:

Overlapping tick labels in middle row.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 31161, 2013.

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