

## ***Interactive comment on “Effect of volcanic aerosol on stratospheric NO<sub>2</sub> and N<sub>2</sub>O<sub>5</sub> from 2002–2014 as measured by Odin-OSIRIS and Envisat-MIPAS” by Cristen Adams et al.***

**Anonymous Referee #1**

Received and published: 13 July 2016

This work investigates the effect of volcanic aerosol on NO<sub>2</sub> and N<sub>2</sub>O<sub>5</sub> in the stratosphere. The study is based on the analysis of OSIRIS and MIPAS measurements, and on photochemical box model runs. It shows that enhanced aerosol optical depth following volcanic eruptions between 2002 and 2014 is generally associated with negative NO<sub>2</sub> and N<sub>2</sub>O<sub>5</sub> anomalies.

The manuscript presents interesting and novel results, but important issues should be addressed before publication. The main one, in my opinion, is that the analysis relies on averages calculated into monthly 10° latitude bins. Using such large intervals in time and space to study quite short-lived and local events such as volcanic plumes can lead to important biases in the results. Please see some questions and suggestions

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below.

### **Specific comments:**

p.2, l.9: "NO<sub>x</sub>" should be defined.

p.4, l.18: Please give more details on the climatological profiles used for ozone and temperature, and explain your choice of using these profiles rather than using directly MIPAS and OSIRIS measurements of O<sub>3</sub> and T.

p.4, 19-20: Please clarify the sentence "All remaining species are calculated to be in a 24-hour steady-state by integrating the model over 30 days, but fixed to a specified Julian day".

p.4, l.22: The effects of polar stratospheric clouds are not considered here. However, these could play a role in the altitude range under consideration, especially in summer, which is the season on which this study is focused. This should be discussed while interpreting the results.

p.5, l.9-10: How the factors 3 and 1/3, used to account for potential errors in your background aerosol surface area, have been chosen?

p.5, l.21: Please clarify "for the five measurement layers from 3-7 km above the NCEP thermal tropopause..." I do not clearly understand which measurement layers you are using.

Section 3: The analysis is based on monthly means calculated in 10° latitude bins. The choice of such large intervals in time and space does not seem to be the most appropriate to study volcanic plumes, which are quite short-lived and local events. A different distribution of the observations from OSIRIS and MIPAS in a given bin might lead to very different results. The same comment is also relevant for the photochemical model, which covers the whole bin in a uniform way, while this is probably not the case for the observations. Was it not possible to perform the analysis using more appropriate bins? In this case, the authors should find a way to estimate the sensitivity of their results to this problem, and this should be thoroughly discussed in the paper. Have the authors try to use only the modelled data in collocation in time and space

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with the observations?

p.8, l.13-17 and Fig.3: Please comment the high AOD levels at southern high latitudes, which are obviously not due to volcanic eruptions. We can read, p.9 l. 5-6, that these are "perhaps due to polar stratospheric clouds". This should be discussed already in the description of Fig.3, and this statement should be explained, or at least associated with a reference.

p.9, l.8: Is the second interval considered to calculate the correlation coefficients 40°N-80°N or 40°S-80°N? The information given in the figure is inconsistent with what is said in the text. Same remark p.9, l.22.

p.9, l.16-18: This could be checked by applying MIPAS averaging kernels to the OSIRIS data. This has already been done in several studies comparing MIPAS data to other data sets characterised by a better vertical resolution.

p.10, l.15-16: Was the vertical resolution of the MIPAS N<sub>2</sub>O<sub>5</sub> profiles also not good enough to look at the effect of volcanic aerosol on this species as a function of altitude?

**Technical corrections:**

p.1, l.24: Remove "of"

p.1, l.25: Please change "relationship" to "anti-correlation"

p.3, l.22, p.4, l.1, p.4, l.14 for example: Please write "lower than" or "greater than" instead of "<" or ">".

p.5, l.19: For the sake of clarity, please add "number densities" after "SO<sub>2</sub>, NO<sub>2</sub>, N<sub>2</sub>O<sub>5</sub> and HNO<sub>3</sub>".

p.6, l.13: "on the same order of magnitude AS the variation..."

p.6, l.27: "...periods that WERE not affected by volcanic aerosol."

p.10, l.17: Please add "percent difference" in "OSIRIS and modelled NO<sub>2</sub> percent difference profiles".

p.10, l.20-23: For the sake of clarity, the given percent different values should be negative (same remark p.11, l.2)

Fig. 3, 6, 7 and 8: These figures would be clearer if there was a limited number

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of colours in the colour bar, so that it corresponds to the colour levels shown in the plots.

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Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-242, 2016.