Atmos. Chem. Phys. Discuss., 15, C6739–C6742, 2015
www.atmos-chem-phys-discuss.net/15/C6739/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the emissions and transport of bromoform: sensitivity to model resolution and emission location" *by* M. R. Russo et al.

Anonymous Referee #2

Received and published: 10 September 2015

Review for "On the emissions and transport of bromoform: sensitivity to model reslutionand emission location" M. R. Russo, M.J Ashfold, N.R. P. Harris and J. A. Pyle ACP-2015-442

Summary

The manuscript by Russo et al. presents the results of different model resolutions and emission scenarios for simulated bromoform distributions in the tropical transition layer. Bromoform is a species with a very short life time, which is assumed to play a significant part of the stratospheric bromine budget, which in turn influences the

global stratospheric ozone budget. The main sources of bromoform are believed to be emissions from the oceans, with uncertainties regarding the importance of costal areas and the open sea.

Due to the short life time, the transport of bromoform from its surface-near source regions into the tropical transition layer is strongly determined by convection. In order to investigate the effects of grid resolution on the simulation of convective transport, the authors use the UKCA model, which is coupled with the UKMO Unified Model, with two different configurations, i.e. a coarse resolution commonly used by chemistry climate models and a high resolution optimized for weather forecast models. Two emission scenarios were designed, the first comprising of uniformly distributed emissions in ocean grid boxes, and a second one with emissions in shallow sea grid boxes.

The results from a 10-year simulation (for the Coarse Run) and 5 one-month highly resolved simulations show different convection characteristics. The high resolution simulations resemble the patterns and gradients of OLR and precipitation from observational data more realistically than the coarse resolution simulation.

The analysis shows significant differences between the coastal and the uniform emission scenarios, especially over the maritime continent, a region where strong convection and strong emissions coincide, indicating that for short-lived species precise emission locations and high resolution modelling are important to simulate their distribution in the tropical tropopause layer and their potential impact on stratospheric chemistry.

General

In general the manuscript is an organized and methodical sound paper. Starting from an introduction that embeds the studied processes into the current scientific background regarding the importance of bromoform for the stratospheric bromine budget, the authors focus on the role of the representation of vertical transport in models, the related problem of unresolved small-scale features in horizontal transport and the problem of unknown source emissions.

Aiming at this issues, the author use a model in two different configurations with different horizontal and vertical grid spacing, and different emissions scenarios. The highly resolved model produces better and more realistic results concerning vertical transport, which fits into what is expected. Used as measures for quality are observations of OLR (AIRS) and precipitation (TRMM). Especially in the area of the Maritime Continent convection seem to be represented better.

A comparison between the different emission scenarios show significantly different results between the uniformly distributed ocean sources and the coastal sources for both models. Focusing on the horizontal level of 15.7 km, taken as representative for the TTL, the highly resolved model shows higher mixing ratios of a factor of 2 for bromoform over the Maritime Continent for the coastal tracer. The mean vertical profile of bromoform for the whole tropics only show slightly enhanced bromoform values for the coastal tracer. This results from the coincidence of strong convective transport and strong emissions in this area. Furthermore the maximum in the tropical vertical profile for the uniform tracer is about 2 km lower than the one for the Maritime Continent (Fig. 4c). This not the case for the coastal tracers. This may be due to the fact, that the impact of the coastal tracer over the Maritime Continent is dominating the tropics much more than the uniform tracer. But I think this is not discussed in the paper.

A further comparison between the highly resolved and the coarse model show only little differences regarding the uniform tracer, while the coastal tracer shows a much higher maximum in the TTL in the high resolution run. Interestingly the maximum in the bromoform distribution does not coincide with the minimum in potential temperature on this geometric height level. The authors mention the possibility of horizontal advection, since the isentropic levels where these maxima occur can not be reached by convection directly. How would the distribution look like, if it was shown on physically more meaningful isentropic levels? Likewise it would be interesting to see the vertical profile plotted against an axis with potential temperature.

Within the concluding section the main results are summarized clearly, followed by

implications of the papers findings for global emission estimates for short-lived species and the sensitivity of transport of short-lived species to model resolution. The authors note, that the bromoform mixing ratios in global TTL are similar for the coarse as well as the highly resolved model, implying that the grid resolution of coarse climate models is sufficient for studies on bromoform transport into the stratosphere, but not acceptable for the simulation of transport pathways modified due to climate change. This is another important statement regarding the evaluation of current chemistry climat models..

The paper is well-written and presents an important contribution to the modelling of transport and chemistry of the short-lived species. It should be published after some minor revisions.

Specific Comments

There are a few additional remarks:

1. The authors use geometric height to describe the distribution of bromoform. I would suggest to use a physical more meaningful coordinate like potential temperature (or pressure). As I mentioned above, it may change the view on at least the horizontal distribution of bromoform in the TTL. 2. In section 4.2.2 the contribution of extra-tropical emissions to the TTL mixing ratio is mentioned to be small. How do you distinguish between tropical and extra-tropical contributions? 3. In Fig. 3d and 5d the maximum value of the bromoform tracer near the surface is not shown. Maybe this value can be mentioned in the figure caption. 4. All vertical profiles for the Maritime Continent feature a small peak at about 5 km height. Can you comment on this? 5. The contour lines for potential temperature in Figure 4 and 5 are not described in the figure caption.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 20655, 2015.