Atmos. Chem. Phys. Discuss., 10, C8514–C8519, 2010
www.atmos-chem-phys-discuss.net/10/C8514/2010/

Interactive comment on "

Potential impact of iodinated replacement compounds CF_3I and CH_3I on atmospheric ozone: a three-dimensional modeling study" *by* Daeok Youn et al.

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Received and published: 9 October 2010

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Received and published: 15 August 2010

This paper discusses the possibly role of short lived iodine compounds for stratospheric ozone depletion. As there are more surface emissions that previously thought - e.g. from seaweed. There is a chance that tropical emissions sources could reach the

stratosphere. This paper quantifies their ODPs using both a 3D and 2D model and finds them to be very small. This result is of significant interest to the science community. The paper is well written and the research looks sound. My only real suggestion is to expand the discussion and context which I think would make the paper more interesting.

Suggestions below

1. Convective fluxes and how high they go seem crucial to your findings. I find it hard to tell how you find the chemistry of the model to be ok? with two largely unconstrained unknowns - convective mass fluxes and chemistry - how do you really text your model to see what is right/wrong. I think models often do not get any convective overshooting. I know they all have big problems getting strong enough convection and its diurnal cycle over the maritime continent (e.g.) Adding discussion of these points would really help. What would be the consequences if you had the mass flux wrong?

→ Park et al. (2004) showed overall good agreement between satellite observations and MOZART-3 simulations for methane and water vapor in the upper troposphere and lower stratosphere (UTLS). We think that the MOZART-3 simulation in the UTLS region is overall success in simulating the effect of fast convective updraft at global scale, such as large longitudinal gradients at a latitude circle and the maximum tropospheric trace gas concentrations with the overshooting features over land tropical convective systems, although there are significant differences in the observed concentrations of the long-lived species between the continents. They also found clear evidence from both observation and MOZART-3 simulation that air from the monsoon region is transported into the tropics and entrained into the upward Brewer-Dobson circulation in the lower stratosphere, bypassing the tropical tropopause. We note that it is beyond our research scope to quantify the uncertainties in global-scale model calculations since the current horizontal resolution could misrepresent subgrid convective processes along with the uncertain convection parameterization producing overshootings significantly high, rapid and intense enough for penetrating the lower stratosphere. However, the substantial uncertainties in calculations of large-scale vertical transport (and the contribution of overshooting convection) are topics that require more investigation.

Accordingly, in the last paragraph of section 4, we added a paragraph as below:

"In simulating the effect of fast convective updraft at global scale, such as large longitudinal gradients at a latitude circle and the maximum tropospheric trace gas concentrations with the overshooting features over land tropical convective systems, Park et al. (2004) showed overall good agreement between satellite observations and MOZART-3 simulations for methane and water vapor in the upper troposphere and lower stratosphere (UTLS). Therefore, the MOZART-3 simulation in the UTLS region is overall success although there are significant differences in the observed concentrations of the long-lived species between the continents. We note that it is beyond our research scope to quantify the uncertainties in global-scale model calculations in that the current horizontal resolution could misrepresent subgrid convective processes along with the uncertain convection parameterization producing overshootings significantly high, rapid and intense enough for penetrating the lower stratosphere. However, the substantial uncertainties in calculations of large-scale vertical transport (and the contribution of overshooting convection) are topics that require more investigation."

2. Why are 3D and 2D results similar - is the 2D just parameterised from the 3D mass flux or is something else going on?

→ Youn et al. (2009) showed that the differences between time variations of Halon perturbations and ozone changes, simulated by both the 2-D and 3-D models, were found not to give direct and indirect GWPs that are significantly different. Trace gas changes in perturbed model atmosphere for the calculation of ODP are determined with two steady-state (perturbed and baseline) model atmospheres for each scenario so that the limitation of the 2-D model mostly related to zonally-asymmetric features such as tropospheric circulation and stratospheric ozone hole does not signify in this study of evaluating potential impacts on global ozone using the two simulations. Also, the 2-D model is expected to yield similar mass transport to the 3-D model as long as

both large-scale transport features and eddy effects in the atmosphere are reasonably consistent in the 2-D models. In more detail, our 2-D model with a 3-D representation of the propagation of low wave-number planetary waves is indeed “2.5-D model” in the sense that transport and diffusion effects due to the breaking of the waves are self-consistently handled with the zonal wind the residual mean meridional circulation (mass transport circulation). Wave propagation properties and the residual circulation, calculated with climatological data from United Kingdom Meteorological Office (UKMO) data assimilation system for the specific years 1992–2002, are computed self-consistently with the zonal wind, and tracers are transported in the zonal-mean plane by the residual circulation and the diffusion due to the wave breaking (Choi and Youn, 2001; Youn et al., 2009). Therefore, despite known limitations of the 2-D model, the 2-D model with shorter integration time step for simulating the very-short lived compounds was used in this study and proven to be useful.

Accordingly, we added sentences describing the 2-D model in more detail in section 3 as below:

"The UIUC 2-D CRT model includes a 3-D representation of the propagation of low wave-number planetary waves, and thus is called as “2.5-D model” in the sense that transport and diffusion effects due to the breaking of the waves are self-consistently handled with the zonal wind the residual mean meridional circulation (mass transport circulation). Wave propagation properties and the residual circulation, calculated with climatological data from United Kingdom Meteorological Office (UKMO) data assimilation system for the specific years 1992–2002, are computed self-consistently with the zonal wind, and tracers are transported in the zonal-mean plane by the residual circulation and the diffusion due to the wave breaking (Choi and Youn, 2001; Youn et al., 2009)."

We also added discussions in conclusions of section 6 as below:

"Youn et al. (2009) showed that the differences between time variations of Halon perturbations and ozone changes, simulated by both the 2-D and 3-D models, were found not to give direct and indirect GWPs that are significantly different. Trace gas changes in perturbed model atmosphere for the calculation of ODP are determined with two steady-state (perturbed and baseline) model atmospheres for each scenario so that the limitation of the 2-D model mostly related to zonally-asymmetric features such as tropospheric circulation and stratospheric ozone hole does not signify in this study of evaluating potential impacts on global ozone using the two simulations. Also, the 2-D model is expected to yield similar mass transport to the 3-D model as long as both large-scale transport features and eddy effects in the atmosphere are reasonably consistent in the 2-D models. Therefore, despite known limitations of the 2-D model, the 2-D model with shorter integration time step for simulating the very-short lived compounds in this study is proven to be useful."

3. What can your results say about the role of vsl in tropical stratospheric ozone trends, e.g. is the speculation as to the cause of trends in Forster et al, 2007 wrong -

→ Our study is mainly focused on the potential impact of iodine species on atmospheric ozone which turns out to be very small. From the simulation of background CH3I concentration, we found that about 2.6

4. It is worth discussing their role in SOA - however briefly for context?

→ We included the discussion on iodine aerosol formation in the first paragraph of section 4 as below:

"The ultimate fate of gas phase iodine is abstraction to aerosol particles as iodide (I–) and iodate (IO3–) in the troposphere. Unfortunately, most of the existing measurements of iodine in marine aerosols are based on bulk measurement of total iodine, so the individual chemical iodine species contributing to particulate iodine have rarely been measured (O'Dowd and Hoffmann, 2005). Although recent modeling work tried to include aerosol phase reactions with organic substances (Pechtl et al., 2007), any aerosol chemistry was not included in our current study. Therefore, our derived ODPs of iodine species are the upper limit."

Forster, PM; Bodeker, G; Schofield, R; Solomon, S; Thompson, D (2007) Effects of ozone cooling in the tropical lower stratosphere and upper troposphere, GEOPHYS RES LETT, 34, . doi:10.1029/2007GL031994

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 16659, 2010.