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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Derivation of the Reduced Reaction Mechanisms of Ozone Depletion Events in Polar Spring by Using Concentration Sensitivity Analysis and Principal Component Analysis" *by* Le Cao et al.

Anonymous Referee #1

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By applying two mechanism reduction approaches in a photochemical box model, i.e., concentration sensitivity analysis and principal component analysis, Cao et al. simplified the complex chemical mechanism of the ozone depletion events (ODEs) in polar boundary layer, theoretically. Although the two methods are commonly used in ruling out unimportant reactions, they are first used to the ODEs as of my knowledge. For this I think this paper is worth publishing. Especially, the simulation results from the simplified reaction mechanisms are much agreeable with those from the original (complete) reaction mechanism, it is more convincing that this paper will serve as a useful reference for the theoretical analysis of ODEs. However, despite the good merit of

this paper there are some points worth exploring further. Therefore, I suggest revision before publishing in ACP. My concerns are listed below.

My major concern would be the limitation of the 0-D photochemical model used in the paper. As we know, chemical constituents are determined by both transport and chemical production/loss. Since the horizontal advection and the vertical mixing cannot be considered in the box model, I am worried about / interested in the role of transportation in redistributing ozone concentrations. The authors should also talk about the lifetime of ozone in polar boundary layer, in which we can roughly tell the importance of transport and chemical production/loss. This part could be jammed to the discussion part in section 4.

Another major complain is that the introduction is too long and it has less focus on the topic of this study. The authors used a lengthy context to introduce the historical finding of the ODEs while they really should have focused on is to introduce the efforts that have been taken in simplifying the reaction mechanism and why they decide to use the two methods towards ODEs. To me, the proper introduction starts since page 7, not page 2.

Other comments: P13, L2: It seems that fixed photolysis rates are applied to the mechanism. Then how is the photolysis frequencies actually specified in the model? Would the simulation result totally be different if the diurnal change of the photolysis rate is included? Please justify this as there is no convincing evidence in the present paper.

P13, L4: There are not enough details about the parameterization of the heterogeneous reactions in the mechanism. Those surface reactions are crucial to the depletion of ozone so detailed description could be helpful in understanding the bromine recycling processes. Apart from this, it will be helpful if the authors can discuss if the changes of the meteorological fields will affect their conclusions. For example, will the "redundant" reactions still be considered redundant if wind speed is increased?

Since the objective of this paper is to simply the reaction mechanism, I am wondering

if there are any quantitative measures of the numerical efficiency before and after the simplification?

Color bar is needed for Fig. 6 and Fig. 7. Although blue and red represent unimportant and important reactions, then what importance does green and yellow measures?

Supplements: reactions R14 and R15 in Table A1, what are the meanings of the parameters r, Dg, . . . shown in the column of k? Please specify them in the caption of the table.

Comments on wording:

This paper could be tremendously shortened. Besides the much lengthy introduction that is less focused on the study, there are many redundant expressions (some used unnecessary clauses) to express an otherwise simple meaning. For example, âĂć "The criterion shown in Eq. (5) means that" could be changed to "The criterion in Eq. (5) shows that"; âĂć "components ... are thus obtained which are listed in Tab. 4" could be shortened as "components ... are listed in Tab. 4";

Also, in many clauses "which" should be replaced with "that".

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