Box-model simulation for atmospheric effect of solar energetic particles: variation of trace chemical species in the middle atmosphere

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Recently, the atmospheric effect of solar energetic particles (SEPs) has attracted interests. High-energy protons in SEPs are able to come down to the stratosphere in the polar region and they are considered to induce increase of reactive odd nitrogen species (NOy) due to dissociation of nitrogen molecules. Furthermore, they cause depletion of ozone through the catalytic reaction cycle involving NOy over a period longer than SEP events. The concentration variations of several chemical species have been observed and their simulations have been attempted [1].
We have studied concentration variation of trace chemical species induced by SEP protons through the Box-model simulation. It involves multitudinous reactions of various ionic and neutral chemical species but no transport processes. We simulated the concentration variations for the middle atmosphere in polar region during the SEP event in October-November 2003. In this simulation, we adopt 77 chemical species and 522 gas-phase ionic and neutral reactions. We assume that the prompt products are charged and neutral species generated from nitrogen and oxygen molecules and that the yields of the prompt products are determined only with the energy deposit in the air. These prompt products generated by the SEP protons induce subsequent ionic and neutral chemical reactions (SEP-induced reactions). The production rates of the prompt products were estimated using the G-value [2,3]. The daily energy deposits were estimated from the calculated daily ion-pair creation rate due to the SEP protons [4]. The concentration variation of each species due to SEP protons was estimated as the difference between the result by considering both SEP-induced and photochemical reactions and that only for photochemical reactions under the same initial condition.
In this talk, we will mainly report the results of our simulation for the variations of ozone and reactive odd nitrogen species for the SEP event in October-November 2003.

References
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