Development of a new ISEE Chemical Lagrangian Model to elucidate the atmospheric composition changes in the mesosphere

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Chemical composition in the mesosphere fluctuates significantly due to factors such as temperature, solar UV radiation and energetic particle precipitation from the space. In order to elucidate these mechanisms and evaluate their impacts, we have newly developed a chemical Lagrangian model that can handle from the troposphere to the mesosphere (e.g. Nakanishi et al., JpGU meeting, 2019). In the model, the trajectory of the particle box is calculated by a Lagrangian particle dispersion model which works with meteorological input data, and the chemical reactions in the particle box are also calculated by using a box model simultaneously. As the Lagrangian particle dispersion model, we used the FLEXible PARTicle (FLEXPART) model, which is extended so that the MERRA-2 reanalysis data can be used as input. As a result, we can calculate the trajectory up to an altitude of about 80 km from the surface. The position of the particle box is calculated every 15 minutes. As a box chemistry model, neutral molecule reactions consisting of 156 chemical reactions involving 58 chemical species and ion reactions of 263 reactions involving 77 species are calculated, respectively, using chemical reaction calculation software Kinetic Preprocessor (KPP). The concentration of each molecule in the box is calculated every 10 and 0.1 seconds, respectively. To validate the model calculations, 324 airmass boxes were released from the point at the altitude of 70 km in the polar and mid-latitude regions, and the two-day change in the concentration of ozone and ozone related substances was calculated. As a result, the diurnal variation of mesospheric ozone was qualitatively reproduced, although the value was about half of the value observed with Aura/MLS. In addition, we find that the difference in the ozone concentration in the Arctic region depends on the temperature on the transport route of the airmass. In the presentation, we will report on the details of the developed model, the characteristics of the time variation of the substances in the mesosphere as well as the results of comparison with observations.

Keywords: Chemical Lagrangian model, Mesospheric composition, Trajectory analysis

