RECENT RESEARCH ACTIVITIES

Mesospheric ozone variations during the solar eclipse

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Atmospheric ozone (O_3) plays an important role in determining the thermal and dynamical structure of the middle atmosphere through radiative and chemical processes. To monitor the global distribution of O_3 and related trace gases, the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) was developed and deployed on the Japanese Experiment Module (JEM) of the International Space Station (ISS) [1]. The SMILES successfully observed vertical distributions of O_3 concentration in the middle atmosphere during the annular solar eclipse that occurred on 15 January 2010. In the mesosphere, where the photochemical lifetime of O_3 is relatively short (ca. 100 s), altitude-dependent changes in O_3 concentration under reduced solar radiation and their temporal variations were clearly observed as a function of the eclipse obscuration (Figure 1). This study reported for the first time the vertical distributions of mesospheric O_3 during a solar eclipse event, and analyzed theoretically the eclipse-induced changes. Full text of this report will be found in the journal article [2]. We showed that simple analytical expressions describing the daytime O_3 concentration under photochemical steady state approximations can be used to analyze the eclipse-induced changes in O_3 concentration, providing a unique opportunity to verify our current knowledge of the key chemical processes involving odd oxygen and HO_x radicals in the daytime mesosphere. Hitherto, testing our understanding of the mesospheric photochemistry mostly involved evaluating the consistency of day-to-night variations in O_3 and HO_x concentrations between the observations and model calculations. This study has highlighted that highly sensitive, altitude-resolved measurements of mesospheric O_3 under reduced solar radiation can provide valuable data to test our understanding of the chemical processes in the daytime mesosphere.

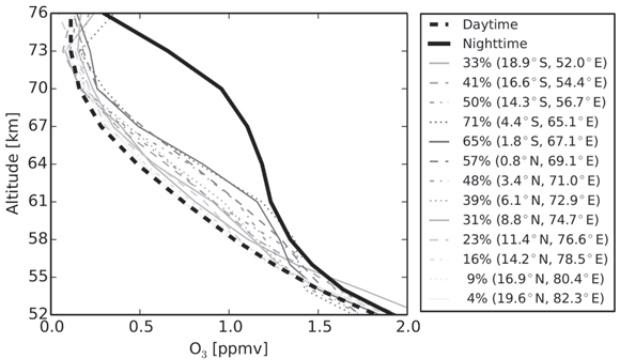

Figure 1. Vertical profiles of O_3 during the eclipse. Profile location and corresponding eclipse obscuration are shown in the legend; the dashed lines are for the southern part of the eclipse center. The black solid and dashed lines are the mean daytime and nighttime profiles of O_3 concentration, respectively. (Courtesy of Dr. Koji Imai)

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References

[1] Kikuchi, K., Nishibori, T., Ochiai, S., Ozeki, H., Irimajiri, Y., Kasai, Y., Koike, M., Manabe, T., Mizukoshi, K., Murayama, Y., Nagahama, T., Sano, T., Sato, R., Seta, M., Takahashi, C., Takayanagi, M., Masuko, H., Inatani, J., Suzuki, M., Shiotani, M. (2010), "Overview and early results of the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)", *J. Geophys. Res.*, 115, D23306, doi:10.1029/2010JD014379.

[2] Imai, K., Imamura, T., Takahashi, K., Akiyoshi, H., Yamashita, Y., Suzuki, M., Ebisawa, K. and Shiotani, M. (2015), "SMILES observations of mesospheric ozone during the solar eclipse", *Geophys. Res. Lett.*, 42, doi:10.1002/2015GL063323.