



Localized mesospheric ozone destruction induced by magnetospheric EMIC waves

Mitsunori Ozaki^{(1)*}, Kazuo Shiokawa⁽²⁾, Ryuho Kataoka⁽³⁾, Martin Mlynczak⁽⁴⁾, Larry Paxton⁽⁵⁾, Martin Connors⁽⁶⁾, Satoshi Yagitani⁽¹⁾, Yuichi Otsuka⁽²⁾, Satoshi Nakahira⁽⁷⁾, and Ian Mann⁽⁸⁾

(1) Kanazawa University, Kanazawa, Japan; e-mail: ozaki@is.t.kanazawa-u.ac.jp

(2) Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan.

(3) National Institute of Polar Research, Tachikawa, Japan.

(4) NASA Langley Research Center, Hampton, VA, USA.

(5) The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA.

(6) Athabasca University Observatories, Athabasca, AB, Canada.

(7) Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagami-hara, Japan.

(8) Department of Physics, University of Alberta, Edmonton, AB, Canada.

Mesospheric ozone destruction can be directly caused by relativistic electron precipitation (REP) from geospace through resonant interactions with electromagnetic ion cyclotron (EMIC) waves. However, the localization of the mesospheric ozone destruction is poorly understood, because the identification of REP in the spatial localization and temporal duration is difficult only in single-probe satellite observations. In this study, we overcome this difficulty using coordinated multiple satellite and ground observations. The MAXI/RBM on board the International Space Station, the MEPPED on board POES satellites, and the SSUSI aboard DMSP satellites are used for spatial localization of energetic particle precipitation, ground-based magnetometers are used for EMIC/Pc1 geomagnetic pulsations for temporal duration of wave-induced REP, and the mesospheric atmosphere during the EMIC wave activity is measured by the SABER aboard the TIMED satellite. We found localized mesospheric ozone destruction on a spatial scale of ~400 km in the magnetic north to south direction and rapid ozone destruction of 10-60% within 1.5 hours of the initiation of REP from these combined particle, wave, and atmospheric data analyses [1]. In particular, EMIC waves in the oxygen ion frequency band were detected in the obvious mesospheric ozone destruction events. The O⁺ EMIC waves can effectively resonate with ultra-relativistic (>2 MeV) electrons in comparison with typical EMIC waves in the H⁺ and He⁺ frequency bands. The finding of events of mesospheric ozone destruction during the EMIC wave activity may show atmospheric impacts dominated by precipitation of a much smaller population of ultra-relativistic electrons than that by a much larger population of sub-MeV to relativistic electrons. In this presentation, we will discuss the atmospheric impacts from REP induced by EMIC waves using the multiple satellite and ground data and the particle loss efficiency by EMIC waves in different ion frequency bands.

References

- [1] Ozaki, M., Shiokawa, K., Kataoka, R. et al. Localized mesospheric ozone destruction corresponding to isolated proton aurora coming from Earth's radiation belt. Sci Rep 12, 16300 (2022). <https://doi.org/10.1038/s41598-022-20548-2>