

中間圏における高エネルギープロトンと電子の役割： PANSY レーダーと MF レーダーの観測による複数例イベント解析

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Roles of energetic precipitating protons and electrons in the mesosphere: Multiple event studies based on the PANSY radar and MF radar

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In the lower thermosphere at the altitude of around 100 km, both neutral turbulence and ionization of atmosphere due to solar radiations cause irregularities of refractive index, and as a result back scatter echoes from that altitude are frequently observed by radars on the ground. In the mesosphere, Polar Mesosphere Summer Echo (PMSE) is reported to be a strong echo associated with ice particles, which are produced around the coldest mesopause region in the polar summer, by a number of past radar observations [Cho and Rottger, 1997; Rapp and Lübken, 2004]. It should be also noted that occurrence rate of PMSE is very high (80-90%) [Bremer et al., 2003]. On the other hand, Polar Mesosphere Winter Echo (PMWE) is also known as back scatter echo from 55 to 85 km in the mesosphere, and it has been observed by MST and IS radar in polar region during winter [e.g., Ecklund and Balsley, 1981; Czechowsky et al., 1989; Lübken et al., 2006; Strelnikova and Rapp, 2013]. Due to the lack of free electrons and ice particles in the dark and warm mesosphere during winter, it is suggested that PMWE requires strong ionization of neutral atmosphere associated with precipitations of Solar Energetic Particles (SEPs) during geomagnetically disturbed periods [Kirkwood et al., 2002; Zeller et al., 2006]. However, the detailed generation process of PMWE has not been identified yet, partly because the reported PMWE occurrence rate was quite low (2.9%) [Zeller et al., 2006].

We would like to show occurrence characteristics of PMWE from June 2012 to October 2013 and its relation to Solar Energetic Particles. When PMWE was detected by the PANSY (Program of the Antarctic Syowa MST/IS) radar, highly energetic particle precipitations, either protons or electrons, were frequently observed by NOAA satellite particle measurements above Syowa Station. Especially, the SPE that occurred in May 23, 2013 showed that it played an important role in strong ionization of the lower ionosphere at an altitude of 60-100 km. PMWE and a significant Cosmic Noise Absorption (CNA) of 3 dB were detected by the PANSY radar. MF radar also showed Isolated Lower Mesosphere Echo (ILME) at the same period [Morris et al., 2011], suggesting enhancement of electron density in ionospheric D-regions. Moreover, occurrence of PMWE was likely related to the flux of precipitating electrons in the medium energy range (30-300 keV) during recovery phase of geomagnetic storms.

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