Correlation between PMWE and CNA and its height dependance: first simultaneous and common volume observations by the PANSY 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 Luebken*, 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; *Luebken et al.,* 2006; *Strelnikova and Rapp*, 2013]. Due to the lack of 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].

The PANSY (Program of the Antarctic Syowa MST/IS) radar radar alreday observed many PMWE events since it has started mesosphere observations in June 2012 [*Nishiyama et al.,* 2015]. In this presentation, we would like to focus on occurrence characteristics of PMWE during both Solar Proton Event (SPE) and big geomagnetic storms. When PMWE was detected by the PANSY radar, highly energetic particle precipitations, either protons or electrons, were frequently observed by Polar Operational Enviromental Satellite (POES) / Medium Energy Proton and Electron Detector (MEPED) above Syowa Station. In order to estimate background electron denisty for PMWE altitudes, we established an application method of the PANSY radar as riometer using measured temporal variations of background noise level. For example, one event study during the SPE that occurred in May 23, 2013 is presented. After large flux of precipitating protons were observed by POES/MEPED above Syowa Station, sudden appearance of PMWE around 65 km and strong Cosmic Noise Absorption (CNA) of ˜0.8 dB were detected simultaneously. This strongly suggested that energetic proton precipitations triggered electron denisty enhancement at altitudes for 60-100 km. Moreover, a statistical study on a relationship between observed height of PMWE and CNA in May 2013 was done. As a result, strong CNA ($>$0.4 dB) during SPE has good correlations to PMWE below 70 km. Therefore, it is revealed that PMWE for lower altitudes (60-70 km) can be generated when strong ionization enough to observe CNA occurred. However, the most of PMWE occurred without CNA, and therefore, electron density enhancements by precipitations are not necessarily required for PMWE.