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Signature of St. Patrick Geomagnetic Storm on Schumann Resonances

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The St. Patrick geomagnetic storm on 17 March 2015 injected unusual flux of particles up to low radial distances in the radiation belts followed by intense precipitation of electrons, observed by GOES and POES satellites. During the storm the electron-ion production in the lower ionosphere (below 100 km), which is also the upper boundary of the Earth-ionosphere cavity resonator, over high latitudes is mainly controlled by precipitating energetic particles. Hereby, the lightning induced electromagnetic resonance phenomenon in the cavity, known as Schumann Resonance (SR), can be affected by particle precipitation. In the present study, the possible effect of electron precipitation on Schumann resonance intensity was investigated in a quasi-meridional chain of SR stations from high (polar) to lower latitudes based on the measurement of the north-south and east-west magnetic field components by four SR stations in the Northern Hemisphere: Hornsund (77.0N, 15.6E), Belsk (51.8N, 20.8E), Hylaty (49.2N, 22.5E) and Mitzpe Ramon (30.6N, 34.8E) and one SR station: Maitri (70.77N, 11.72E), in the Southern Hemisphere.

Dynamic spectra of the first three SR modes were computed for both field components at each station and separately for day-time and night-time hours in the period of March 5-31, 2015. A normalization procedure of spectra was performed based on the geomagnetically undisturbed period of March 5-15 to make comparable the different SR stations. We used global lightning counts data from WWLLN (World Wide Lightning Location Network) to filter out the random-like and systematic (seasonal) changes of lightning intensity. It can be stated that the increase of lightning intensity was not larger than $\sim$ 40% (apart from a single day of March, 28) during the investigated period.

The latitude dependent variations of SR intensities show the effect of precipitating electrons superimposed on the intensity changes due to the lightning source intensity variations. The highest percentage variations of SR intensity ($\sim$ 140%) can be observed at the north polar station, Hornsund, in several days of the recovery phase of the St. Patrick event and at the south polar station, Maitri, already during the main phase of the storm (March 17, 2015) up to the end of the month, mainly in the day-time hours. The percentage intensity variation decreases with decreasing latitude but it still has higher values in the mid-high latitude SR stations Belsk and Hylaty than the percentage variation of lightning source intensity. The latitude of Mitzpe Ramon seems already “free of the precipitating particle effect” and the SR intensity variation there indicates only the seasonal increase of lightning activity in the second part of March, 2015. Based on our initial findings we presume that several characteristic properties of geomagnetic storms could be identified in SR measurements which is the task of our ongoing research.