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Investigation of the Ionospheric Absorption Response to Flare Events during Solar Cycle 23 using Ionosonde and DEMETER VLF Observations

Veronika Barta (1), Dávid Koronczay (2,1), Kitti Berényi (1,2), Árpád Kis (1), Gabriella Sátori (1), and Earle Williams (3)

(1) Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, Sopron, Hungary (veronika.barta@gmail.com), (2) Eötvös Loránd University, Budapest, Hungary, (3) Massachusetts Institute of Technology, Cambridge, USA

Systematic analysis of ionosopheric parameters measured at mid and low latitudes was performed to understand the ionospheric response to solar flares. The lowest recorded ionosonde echo, the minimum frequency (fmin, a qualitative proxy for the “nondeviative” radio wave absorption occurring in the D-layer), furthermore the dfmin parameter (difference between the value of fmin and the mean fmin for reference days) have been investigated. The time series of the fmin and dfmin parameters recorded at meridionally-distributed ionosonde stations in Europe and South Africa were analyzed during 8 X and M class solar flares during solar cycle 23. The solar zenith angle of the observation sites at the time of the selected flares have been also taken into account.

Total and partial radio fade-out was experienced at every ionospheric stations during intense solar flares (> M6). The duration of the total radio fade-out varied between 15 and 150 min and was highly dependent on the solar zenith angle of the ionospheric stations. Furthermore, a solar zenith angle-dependent enhancement of the fmin (2-9 MHz) and dfmin (1-8 MHz) parameters was observed at almost every stations at the time of the flare events. The observed values of the fmin and dfmin parameters show an increasing trend with the enhancement of the X-ray flux.

In addition, we observed attenuation/fade out of VLF signals onboard the DEMETER low Earth satellite, co-temporal with two of the solar flares, occurring on 5th and 6th December, 2006, respectively. This demonstrates a quantifiable change in transionospheric VLF absorption associated with flare events.