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Dynamics of the proton aurora and current sheet in the magnetosphere. Ground-based and satellite observations

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The proton aurorae in the emissions of atomic hydrogen arise as a result of energetic proton precipitation and their charge exchange at the heights of ionosphere E layer. The proton precipitation occurs from of the magnetosphere region with an isotropic distribution of charged particle fluxes. Isotropization occurs due to the pitch-angle scattering at the magnetic equator with a large curvature of field lines in the current sheet [1,2]. The low-latitude boundary of particle isotropic fluxes is registered with the low-altitude satellites with a polar orbit. Equatorward of this boundary, the precipitation of energetic protons is sometimes observed as a result of scattering during interaction with EMIC waves [3].

This report presents the results of our observations at the Maimaga station (CGMC: 58°, 202°) of the proton aurora dynamics in the MLT evening sector during a magnetic storm with a minimum of SYM-H ~ -130 nT on December 01, 2023. The main phase of storm began in ~10 minutes after a sharp increase of the electric field dawn-dusk Ey in the solar wind ($-V_x \times B_z$) up to ~11 mV/m at ~1010 UT. At this time, the appearance of broad band in the 486.1 nm emission (H-beta) of atomic hydrogen was registered at the latitudes of diffuse aurora in the 557.7 nm emission. The band moved equatorward from the northern horizon and passed the station zenith at a velocity of ~ 205 m/s. Next, short (~10 minutes) activizations of aurorae were observed throughout the all sky in the geomagnetic latitudes interval of 54-62° with the maximum H-beta emission intensity of ~600 Rayleigh after subtracting of the continuum intensity. Narrow forms of electronic aurorae were sometimes detected in the 470.9 nm N_2^+ emission.

At ~1115 UT, the NOAA19 satellite registered the isotropic boundary of the energetic proton and electron fluxes at the optical observation meridian. The isotropic flux maximum of protons of width ~2° at this boundary coincided with the arc position in the H-beta emission. Mid-latitude magnetic variations and the SYM-H index point to a relationship of the main phase onset of storm to the magnetic effect of the current sheet. We believe that the observed dynamics of proton aurora in this event mapped a rapid motion of isotropic flux boundary of the energetic protons and, correspondingly, current sheet into the inner magnetosphere as a consequence of sharp increase of the magnetospheric convection.

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