Observation of whistler waves by MAGION 5 satellite

J. Chum[1], F. Jiříček [1], J. Šmilauer[1], D. Shklyar [2]

[1] Institute of Atmospheric Physics, Bocni II,, 14131 Praha 4, Czech Republic
[2] IZMIRAN, Troitsk, Moscow Region, 142190, Russia

We review the observation of whistler waves by MAGION 5 satellite. We will show several examples, both of lightning generated whistlers waves and waves generated in the process of wave–particle interaction (chorus emission). We focus mainly on the observation of nonducted propagating waves, and explanation of their features by means of ray tracing method.

Chorus emissions are one of the most intense electromagnetic waves of whistler mode observed in the Earth's magnetosphere. They are generated near the magnetic equator plane and consist of more or less regularly repeating rising (falling) tones. We focus on the propagation of this emission from the source region. Based on plasma density measurement and recent satellite observation, we consider that chorus emissions may in many cases propagate obliquely to magnetic field lines. We study the influence of initial wave normal angle distribution on the chorus propagation. Our special interest is the estimation of ray bundle width. As for the initial dimension of the source, we aply the published values: ~100 km for the transverse dimension (with respect to magnetic field), and the longitudinal extent of ~2000km. We conclude that the merging of the ray bundles corresponding to different frequencies defines the frequency bandwidth of the emission that can be observed at a particular point. We also show that there may be regions, where ray bundle focuses for a specific frequency and a specific initial wave normal spread, leading thus to enhanced energy density at this frequency.

Lightning-generated whistlers strongly affect the pitch-angle distribution of energetic electrons of radiation belts in the inner magnetosphere, leading to significant particle precipitation. A large portion of whistler wave energy propagates in nonducted mode being trapped between conjugate hemispheres due to multiple magnetospheric reflections. We discuss the properties of MR whistler waves in the light of observations by the MAGION 5 satellite, and of numerically simulated spectrograms of lightning-induced VLF emissions. We show that MR whistlers observed in the equatorial region represent a symmetrical phenomenon with respect to the hemisphere of their source. They gradually became asymmetrical, and transform into Nu whistlers as a satellite approaches the region where whistler waves undergo magnetospheric reflection. The Nu whistlers observed on the orbit of MAGION 5 are usually produced by the waves entering the magnetosphere at low latitudes, and their first magnetospheric reflection takes place well below LHR frequency. Waves entering the magnetosphere at middle or high latitudes go into quasi-resonance regime of propagation quite fast, so that their wave normal angle becomes close to the resonance cone. Such waves may propagate only in the region where their frequency is larger than LHR frequency, the latter representing a cut-off where quasi-resonance waves undergo the magnetospheric reflection. Those waves have high dispersion, and may form distinct oblique noise bands above the local LHR frequency on overview spectrograms, provided that the lightning activity is high, and that the plasmasphere is unperturbed by sharp density gradients.