Dissipation Rate of Kinetic Energy of Turbulence Inferred for the Upper Atmosphere from Sporadic-E Parameters

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Sporadic-E is a thin layer of enhanced ionisation in the E-region ionosphere. The mechanism of the layer formation is explained by wind-shear theory [1, 3, 10]. According to the theory, the sporadic-E results from the interaction of plasma embedded in the neutral wind with the geomagnetic field under appropriate vertical profile of the horizontal wind velocity. The sporadic-E ion composition differs from that of the normal E-region. The ions in the layer are metallic with a very slow recombination reaction [3, 4, 10]. It is known that atmospheric turbulence exerts an essential influence on the layer if its height is below the homopause [2, 3, 10]. The homopause (or turbopause) can be defined as the level where the energy dissipation by molecular processes becomes larger than that of turbulent processes. At the homopause, mixing stops and diffuse separation sets in. The turbulence defines mean characteristics and fine structure of the layer [2, 3, 7, 10]. Intensification of the turbulence leads to reduction of the peak amplitude of the layer and to the increase in the sporadic-E thickness. From sporadic-E parameters one may derive parameters of the turbulence. The mean rate of turbulent energy dissipation is a basic parameter of turbulence [5, 6, 8]. Determination of the rate from sporadic-E parameters is the purpose of this report. The results of wind-shear theory [1, 3, 10] and the Richardson-Obukhov law for turbulent diffusion [8] were used to obtain an expression that connects the dissipation rate with sporadic-E parameters. The obtained expression has allowed us to estimate the dissipation rate when the sporadic-E was formed by a neutral wind with a sinusoidal vertical profile (under the amplitude velocity u=70 m/s and the wavelength L=10 km) near 100 km altitude of mid-latitude ionosphere (the magnetic dip angle of 52.5 degrees) [9], for two variants of the sporadic-E ion composition (the mean ion mass took values 31 and 51 a.u.m.) [4]. Estimates were made for the layer under variation in plasma density of its peak from 1 to 5 times relative to the background E-region. It was shown that in the first case of ion composition the rate changed from 104.8 to 4.2 mW/kg, and for the second from 23.5 to 0.9 mW/kg. The obtained results do not contradict to experimental data [5, 6].

Key Words: Turbulence; Upper atmosphere; Ionosphere

References


