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What is the Energy Source for IAR? World Thunderstorm Centers, Nearby Thunderstorms or Neutral Gas Velocity Fluctuations?

E. Fedorov (1), A.Ju. Schekotov (1), O.A. Molchanov (1), V.V. Surkov (2), M. Hayakawa (3), S. Andreevski (1)

(1) Institute of Physics of the Earth, Russian Academy of Sciences, 10, Bolshaya Gruzinskaya, 124995, Moscow, Russia (Phone: +7-095-254-89-05, fedorov@ifz.ru), (2) Moscow State Engineering Physics Institute, MEPhI, 31, Kashirskoe road, 115409 Moscow, Russia (Phone: +7-095-323-90-38), (3) Department of Electronic Engineering, The University of Electro-Communications, 1-5-1 Chofugaoka, 182-8585 Chofu Tokyo, Japan (tel:+81424435159; fax:+81424435783; e- mail: hayakawa@whistler.ee.uec.ac.jp)

One of the most important problems in the of the Ionospheric Alfven Resonator (IAR) studies is the problem of a generator (or generators) of the IAR oscillations. We consider only the regular sources for IAR oscillations. Non-regular sources such sprites and blue jets cannot supply the continuous energy input into IAR and are not considered here. Electromagnetic emissions from the world thunderstorm centers exist permanently and could be the energy source for the IAR oscillations. But a comparisonof the observational results with the numerical simulations shows that the contribution of the world thunderstorm centers to the mid-latitude electromagnetic field in the frequency range from several tenths Hertz to several Hertz is negligible and cannot provide observed intensity of signal at IAR frequencies. The nearby thunderstorms can also be an energy source for IAR. The temporal evolution of IAR structures is analyzed on the base of observations at Kamchatka. Several pulses following the initial pulse caused by a discharge are observed in the IAR frequency range. The time between the peaks is about two seconds. A model of the IAR excited by a nearby single impulse is developed. The occurrence of several peaks in the azimuthal component is caused by the reflection of the signal from the ionospheric upper boundary. The calculated value of the time between peaks agrees with its experimental value under typical traveling times of an Alfven pulse from the E-layer to the reflection point in the mid-

latitude ionosphere. Thus, nearby thunderstorms can give a non-negligible input to the IAR power spectrum. The fluctuations of neutral gas velocity at the heights of the ionospheric E-layer can be an additional source of energy for the IAR resonant structures. The neutral wind velocity in the E-layer changes from several tens to a hundred meters per second. The neutral gas flux causes the charged component motion and the ionospheric current in the E-layer through neutral-ion and neutral-electron collisions. Fluctuations of the ionospheric neutral component velocity result in the alternating ionospheric current. This current radiates magnetohydrodynamic (MHD) waves into the upper ionosphere and the magnetosphere. The current fluctuations are modelled by a random in time and space process. The calculated power spectrum of the ground magnetic field components is similar to the power spectra of the magnetic field fluctuations observed at the Earth surface at the IAR frequency range.

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