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Turbulent generation of zonal flows and large-scale magnetic fields by small-scale drift-Alfven modes in the ionosphere

G. Aburjania
M. Nodia Institute of Geophysics

Generation of large-scale zonal flows and magnetic fields by collisionless electron skin depth-scale drift-Alfven turbulence in the ionospheric plasma is examined. Large-scale perturbations of plasma flow and magnetic field are spontaneously generated by short-scale drift-Alfven wave turbulence via the action of Reynolds stress and electromotive force. For a system containing both skin-scale drift-Alfven waves and large-scale structures, small scales are modulated by the larger scale flow and/or by the perturbed large scale magnetic field. As a result, the propagation of small-scale wave pakets is accompanied by the instability of a low frequency, long wavelength components. The nonlinear growth rate of these interaction is a sensitive function of the wave number of the Alfvenic pump wave. This implies that the instability transfer wave energy from the short wavelength regime of the Alfven wave to the long wavelength regime of the large-scale disturbances. Growth rate depends also on the spectrum width of the pump wave packet and eventually is suppressed as the broadening increases. The results of the theory are applied to the satellite observations of the skin-scale drift-Alfven wavy structures in the auororal ionosphere and agreement of the scales, frequencies and explains the observed large amplitudes of the waves is showed.