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Nonlinear Generation of shear flows and large scale magnetic fields by small scale turbulence in the ionosphere

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In the present work, the generation of large-scale zonal flows and magnetic field by short-scale collision-less electron skin depth order drift-Alfven turbulence in the ionosphere is investigated. The self-consistent system of two model nonlinear equations, describing the dynamics of wave structures with characteristic scales till to the skin value, is obtained. Evolution equations for the shear flows and the magnetic field is obtained by means of the averaging of model equations for the fast-high-frequency and small-scale fluctuations. It is shown that the large-scale disturbances of plasma motion and magnetic field are spontaneously generated by small-scale drift-Alfven wave turbulence through the nonlinear action of the stresses of Reynolds and Maxwell. Positive feedback in the system is achieved via modulation of the skin size drift-Alfven waves by the large-scale zonal flow and/or by the excited large-scale magnetic field. As a result, the propagation of small-scale wave packets in the ionospheric medium is accompanied by low-frequency, long-wave disturbances generated by parametric instability. Two regimes of this instability, resonance kinetic and hydrodynamic ones, are studied. The increments of the corresponding instabilities are also found. The conditions for the instability development and possibility of the generation of large-scale structures are determined. The nonlinear increment of this interaction substantially depends on the wave vector of Alfven pumping and on the characteristic scale of the generated zonal structures. This means that the instability pumps the energy of primarily small-scale Alfven waves into that of the large-scale zonal structures which is typical for an inverse turbulent cascade. The increment of energy pumping into the large-scale region noticeably depends also on the width of the pumping wave spectrum and with an increase of the width of the initial wave spectrum the instability can be suppressed. It is assumed that the investigated mechanism can refer directly to the generation of average flow in the atmosphere of the rotating planets and the magnetized plasma.