3D Model Of Low Latitude Ionosphere - Application To The Atmospheric Gravity Waves Instabilities

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We developped a 3D low latitude ionospheric model to treat the dynamic and the chemical evolution of the plasma composed by electrons and seven ions species (O^+, H^+, H_e^+, O_2^+, NO^+, N^+, N_2^+). This 3D fluid model is based on a system of coupled Euler equations for ions and electrons species with the Maxwell equations for the evolution of electromagnetic field. The ion continuity and the momentum equations are solved for all ions species and the energy balance equations are solved for two ion species (O^+ and H^+). The temperature of the molecular ions (O_2^+, NO^+) and atomic ions (N^+, H^+) is taken to be that of the ion O^+. The altitudes of the ionospheric plasma at low latitude range from 85 km to 2000 km and the terrestrial magnetic field is generalized by a classical approach of a dipolar axisymmetric magnetic field. The Euler potential techniques permit us to define new coordinates whereby the geomagnetic field tube can be seen as a rectangular domain [1]. In our considered altitude ranges, the Hall parameter h (ratio of the cyclotron angular frequency to the collision frequency, $h = \omega_c/\nu$) decrease significatively between 90 km to $\sim$ 180 km where collisions with neutrals become considerably small and the charged particles are magnetized and strongly constrained to move along the magnetic field lines. As the magnetic field affects the charged particles motion, it makes the plasma an anisotropic medium. The numerical treatment of the three-dimensional transport equations with strong anisotropic mobilities (i.e. Pedersen, Hall and field-aligned mobilities) lead to a degenerated solution in the computation of elliptic equation for the electric potential and require the use of more refined grid to compensate the anisotropy [2].

We propose a new model of ionosphere using a new three-dimensional geometry coordinates. The computation of the self-consistent electrostatic field is performed using the asymptoting preserving scheme [2] permitting the choice of coarse grids discretization. We show results of computational times with the new highly parallel hybrid solver MAPHYS. On the basis of the 3D ionosphere model results, we describe the plasma properties and the electrostatic field-aligned perturbations due to the propagation of medium-scale traveling ionospheric disturbances (MSTIDs) and comparisons are made from GPS-TEC and DEMETER satellite data [3].

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