Electrodynamics of the Evening Equatorial Ionosphere: Model Simulation of Es-layer Influences on the Prereversal Vertical Drift Enhancement

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The plasma bubbles that occur at the low latitudes ionosphere and the irregularities associated to them are responsible for severe interference that can disrupt trans-ionospheric radio-propagation, up to the GHz frequency range, interfering on communication systems including the Global Positioning Systems – GPS. The general characteristics of spread F and bubbles, such as their variation with season, solar cycle, and magnetic activity, are fairly well understood. On the other hand, we still do not understand completely the cause of the day-to-day variability of the phenomenon, a crucial point when its prediction is concerned. It is well known that the occurrence of the equatorial spread F is associated with the rapid pos sunset rise of the F layer. Vertical and zonal electric fields are generated under the action of the F region dynamo. The eastward electric field is responsible for the vertical movement of the equatorial F region plasma through the ExB drift. The rapid post sunset rise of the equatorial F region layer is largely determined by this vertical plasma drift velocity enhancement, known as prereversal peak. On the other side, longitudinal gradients in the low-latitude E region conductivity, around sunset, strongly influence the development of the F region dynamo electric fields and the prereversal peak amplitude. In this work we use numerical models to investigate the interrelation between the prereversal enhancement and the occurrence of sporadic E layers at low-latitude regions. The first model considers the electrodynamical coupling of the low-latitude/equatorial E and F regions and solves the E region electrostatic potential equation, and the motion equations for ions, electrons and neutral particles in the F region. The E and F regions are coupled by the magnetic field lines. The second model solves the continuity equation for the principal E region ionic species (metallic ions are also considered), and includes the dynamics in order to study the formation of the sporadic E layer and its dependence on the winds and electric fields. The results show that the E region conductivity around sunset, modified by the presence of sporadic E layers at certain latitudes, can affect significantly the development of the prereversal enhancement. Conversely, the vertical F region electric field, mapped to the E region, can inhibit the development of the sporadic E at specific latitudes. Sporadic E parameters taken from ionospheric data obtained during the Conjugate Point Equatorial Experiment (COPEX) conducted in Brazil are used to help to clarify those points.