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Multiscale modeling and nested simulations of three-dimensional ionospheric plasmas: RayleighTaylor turbulence and non-equilibrium layer dynamics at fine scales ALEX MAHALOV, Arizona State University — Multiscale modeling and high resolution three-dimensional simulations of non-equilibrium ionospheric dynamics are major frontiers in the field of space sciences. The latest developments in fast computational algorithms and novel numerical methods have advanced reliable forecasting of ionospheric environments at fine scales. These new capabilities include improved physics-based predictive modeling, nesting and implicit relaxation techniques that are designed to integrate models of disparate scales. A range of scales, from mesoscale to ionospheric microscale, is included in a 3D modeling framework. Analyses and simulations of primary and secondary RayleighTaylor instabilities in the equatorial spread F (ESF), the response of the plasma density to the neutral turbulent dynamics, and wave breaking in the lower region of the ionosphere and non-equilibrium layer dynamics at fi ne scales are presented for coupled systems (ions, electrons and neutral winds), thus enabling studies of mesoscale/microscale dynamics for a range of altitudes that encompass the ionospheric E and F layers. We examine the organizing mixing patterns for plasma flows, which occur due to polarized gravity wave excitations in the neutral field, using Lagrangian coherent structures (LCS). LCS objectively depict the

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