Three-Dimensional Simulation of Equatorial Spread-F with Wind Effects

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We use the NRL SAMI3/ESF three-dimensional simulation code [Huba et al., GRL, 35, L10102, 2008] to examine the effects of specified zonal and meridional winds on the growth and/or suppression of equatorial spread-F (ESF). The simulation geometry conforms to a dipole field geometry that extends up to 3200 km at the equator and down to and altitude of 85 km, but extends over only 4 degrees in longitude. The full SAMI3 ionosphere equations are included, providing ion dynamics both along and across the field. The potential is solved in two dimensions in the equatorial plane under a field-line equipotential approximation. The SAMI3/ESF potential equation includes Hall and Pedersen conductance terms as well as both gravitational and wind-driven source terms. The resulting ESF depletions, or "bubbles," are elongated with the geomagnetic field; the "legs" of these bubbles can extend as far as ±30 degrees in magnetic latitude.

We show that a constant meridional wind can reduce ESF growth rates and that a steady 60 m/s wind is strong enough to stabilize ESF, which is consistent with theory [Krall et al., Ann. Geophys., submitted]. We further show that zonal winds can reduce upward ESF velocities and that converging zonal winds can disrupt ESF [Krall et al., GRL, submitted]. We explore this and other methods by which the upward motion of an ESF bubble can be halted, leading to a "dead" or "fossil" bubble. Additionally, we investigate transport of molecular and hydrogen ions. Simulation results will be used to generate proxies for observed quantities. Model results will be compared with data from satellites and ground stations (e.g., C/NOFS, radar, all-sky images).