

C/NOFS Satellite Electric Field and Plasma Density Observations of Plasma Instabilities Below the Equatorial F-Peak -- Evidence for ~500 km-scale Spread-F “Precursor” Waves Driven by Zonal Shear Flow and km-scale, Narrow-Banded Irregularities

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As solar activity has increased, the ionosphere F-peak has been elevated on numerous occasions above the C/NOFS satellite perigee of 400km. In particular, during the month of April, 2011, the satellite consistently journeyed below the F-peak whenever the orbit was in the region of the South Atlantic anomaly after sunset. During these passes, data from the electric field and plasma density probes on the satellite have revealed two types of instabilities which had not previously been observed in the C/NOFS data set (to our knowledge): The first is evidence for 400-500km-scale bottomside “undulations” that appear in the density and electric field data. In one case, these large scale waves are associated with a strong shear in the zonal $E \times B$ flow, as evidenced by variations in the meridional (outward) electric fields observed above and below the F-peak. These undulations are devoid of smaller scale structures in the early evening, yet appear at later local times along the same orbit associated with fully-developed spread-F with smaller scale structures. This suggests that they may be precursor waves for spread-F, driven by a collisional shear instability, following ideas advanced previously by researchers using data from the Jicamarca radar. A second new result (for C/NOFS) is the appearance of km-scale irregularities that are a common feature in the electric field and plasma density data that also appear when the satellite is below the F-peak at night. The vector electric field instrument on C/NOFS clearly shows that the electric field component of these waves is strongest in the zonal direction. These waves are strongly correlated with simultaneous observations of plasma density oscillations and appear both with, and without, evidence of larger-scale spread-F depletions. These km-scale, quasi-coherent waves strongly resemble the bottomside, sinusoidal irregularities reported in the Atmosphere Explorer satellite data set by Valladares et al. [JGR, 88, 8025, 1983]. We interpret these new observations in terms of fundamental plasma instabilities associated with the unstable, nighttime equatorial ionosphere.