DEMETER Observations of Highly Structured Plasma Density and Associated ELF Electric Field and Magnetic Field Irregularities at Middle and Low Latitudes

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Summary

Since its launch in June, 2004, the DEMETER spacecraft has gathered near-continuous measurements of numerous plasma parameters near 720 km altitude between +/- 65 degree invariant latitude in a sun-synchronous orbit providing local time coverage of ~ 10:30h/22:30h. At low latitudes, the instruments commonly encounter highly structured plasma density regions at night that are equatorward of the Appleton anomaly region (magnetic latitudes < 15-20 degrees) and which are generally associated with equatorial spread-F depleted flux tubes. During severe geomagnetic storms, however, the spacecraft detects much broader regions of nightside plasma density structures that extend to higher latitudes, in some instances from the equator to the sub-auroral regions. These structures resemble spread-F plasma depletions although sometimes, plasma density enhancement structures are present as well. The large scale plasma structures with scale lengths along the spacecraft trajectory of 100's of km display clear, associated electric field irregularities with broad spectra that typically span from less than 1 Hz to ~ 500 Hz (roughly 10 km to 20 m). In addition to the electric field irregularities, in some cases, ELF magnetic field irregularities are also observed. Such AC magnetic signatures are typically observed on the walls of the plasma density structures and appear to be related to finely-structured spatial currents and/or Alfven waves. We analyze the irregularities observed in the electric field and magnetic field data in order to elucidate their generation mechanism(s), using high time resolution, burst memory waveforms when available. The mid-latitude irregularities are compared with those associated with equatorial spread-F as well as with the intense irregularities associated with the trough region that are observed at sub-auroral latitudes during geomagnetic storm periods.