The Bulk Vertical Flow in Equatorial Plasma Depletions

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Abstract
A preliminary investigation of equatorial bulk vertical flow within regions of depleted plasma is presented. Since 2013 the C/NOFS satellite has orbited the Earth at altitudes between 350 km and 700 km in the equatorial region of the ionosphere. Using data from the Coupled Ion Neutral Dynamics Investigation (CINDI) we are able to detect discrete plasma depletions with spatial scales greater than 50 km along the satellite track. Each depletion is identified by profiles in plasma density and velocity and each may be described by a characteristic width in apex longitude, relative density reduction and vertical flow velocity. Here we describe the distribution of plasma depletion parameters as a function of location, with a goal of discovering the relationships between these key parameters and the evolution of the depletions.

Method
• Here Coupled Ion Neutral Density Investigation (CINDI) data from the IVM on C/NOFS satellite between altitudes of 300 to 700 km is used.
  • 2013 winter equinox F10.7 solar activity F10.7 from 116 to 136 s.f.u.
  • Looking for depletions with scale sizes >100km. A running average of the RPA ion density over ~50km is taken to remove features below the scale size of interest.
  • A depletion is a bite out in the density with a leading edge and a trailing edge.
  • The density data is traversed from 17:00 to 24:00 and locations where ΔNi/Ni is less than or equal to ~0.40 are stored as leading edges. Then the data set is then traversed from 24:00 to 17:00 to detect trailing edges in the same way.
  • The edges now become references to the boundaries in the entire ion Velocity Meter (IVM) data set from which all other measured quantities can be extracted.
  • In this initial study we examine the following key parameters for regions observed in the nighttime sky from 17:00 to 24:00 within 28° magnetic latitude.

Introduction
• Irregularities form on the bottom side F region where there is a sharp density gradient.
• They are the result of an initial perturbation that drifts upward under the action of Rayleigh-Taylor instability as a depleted flux tube. [Kelley, 2009]
• The magnitude of the initial perturbation and initial conditions determine the evolution of the depletion.
• The drift velocity depends on the content of the depleted flux tubes and the background conditions in which they occur. [Hanson and Bamgbode, 1984; Sekar and Kherani, 1999]
• The objective of this investigation is to describe relationships between the depletion characteristics and the background.
• This investigation requires an objective description of the key depletion characteristics.

Initial Results
• The discrete detection of plasma depletions yields expected spatial and temporal distributions. [e.g. Kill and Heelis, 1998; Maruyama and Matuura, 1984; Haaser et al., 2012]
• The distribution of depletions in longitude is seasonally dependent.
• The distribution of depletions in local time does not have a strong seasonal dependence.
• Peak detection in South American sector during winter and in the African sector during equinox.
• There is a peak in the number of depletions near 21:00 and an almost linear decay decay through midnight.
• Prefer location when terminator & magnetic meridian are aligned.
• Maximum upward drift in winter is smaller and occurs later in local time than equinox.
• Largest upward drift velocities occur for the largest depletion depths.
• Most depletions have a ∆Vz less than 50 m/s

Conclusions
• The efficacy of this approach to depletion identification has been demonstrated using previous results to support the method presented here.
• Average vertical velocities of 100 to 200 m/s are observed early in the evolution of the depletion.
• Depletions with depths from 60% to near 100% are seen with equal probability in the evening sector.
• The largest upward plasma velocities are seen in the African and Pacific sectors during equinox months.
• The largest upward plasma velocities are seen in the South American sector during the winter months.
• The largest depletion velocities usually accompany the deepest depletions.

References