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Understanding the balance between plasma and magnetic pressures across equatorial plasma depletions using Swarm data

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Equatorial plasma depletions (EPDs) are a post-sunset phenomenon in the equatorial ionosphere well-known for its adverse effect on radio waves. A fundamental question to understand the evolution in space and time of EPDs is the balance between both magnetic and plasma pressures. In this study, we make use of nearly five years of continuous measurements of the magnetic field and electron density from the ESA Swarm constellation mission to assess the spatial and temporal characteristics of low- and high-pressure EPDs. The criteria to define EPDs as of low- and high-pressure lies in the orientation of their related diamagnetic currents. In detail, we report the first observational evidence of high plasma pressure associated with depleted density regions in the ionosphere. They correspond to EPDs with a decrease of the ambient magnetic field within the depleted structure. Among the total number of events, low-pressure EPDs occur more, with 81.7% of the cases against 18.3% of high-pressure EPDs. Nevertheless, the latter shows a very particular longitudinal and magnetic local time dependence. They occur almost exclusively over the Atlantic region with a preference for midnight and later hours. In this paper, we discuss possible mechanisms to explain the increase in the plasma pressure within these depleted density structures and suggest some future work to test the proposed hypotheses.