Modulation of Pc1 wave ducting by equatorial plasma bubbles

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Pc1 waves generally propagate along the ambient magnetic field in the magnetosphere, but turn to oblique or perpendicular directions when they reach the ionosphere. If the waves are continuously observed over a wide latitudinal range, they can be considered as ducting waves. Ducting Pc1 waves can be attenuated by various physical processes such as absorption, scattering, and leakage as they propagate away from the injection region, and the sustainability of wave ducting depends on the ionospheric condition such as conductivity and plasma density. An earlier study from Kim et al. (2018) from the Swarm observations suggested that plasma density variations can affect Pc1 wave propagation within the ionosphere, i.e., wave attenuation can be controlled by electron density structure of the ionosphere. This finding, however, is not yet sufficient to fully elucidate density dependence of wave propagation, because they did not consider wave source variations, and did not discuss in detail possible inter-satellite differences of the wave intensity and electron density observed by the Swarm-A and Swarm-C, which fly in a tight formation.

In this study, we present remarkable relationship between ducting Pc1 wave and electron density based on the Swarm satellites. We show two ducting Pc1 events propagating across equatorial plasma bubbles (EPBs) that occurred on 7 April 2016 and on 27 September 2017. From the observations, we found that the EPBs modulate the Pc1 wave propagation by setting up boundaries and holes in the ionospheric waveguide, which can cause wave reflection and leakage. We also found that changes of Pc1 wave intensities generally follow the electron density variation, and that the intensity is stronger at high-density region than relatively low-density region. From the comparison between Swarm-A and Swarm-C observations, we conclude that ionospheric plasma plays a vital role in Pc1 waveguide even though their density becomes significantly low in EPBs.

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