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Identifying evolving/non-evolving plasma bubbles from SWARM observations

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Equatorial plasma bubbles (EPBs) are generally caused due to the Rayleigh–Taylor instability. During the initial phase of the growth of the instability, the bubbles are associated with perturbation electric and magnetic fields. We call this the evolving (active) phase of the EPB. Over time, these electric field fluctuations decay in amplitude and the bubble, embedded in the neutral atmosphere, drifts eastward without much temporal evolution. We call this the non-evolving phase. Both phases can be distinguished in ground based VHF spaced receiver scintillation observations. In the evolving phase, the cross correlation between the signals from the two receivers is significantly less than one because of rapidly evolving perturbation electric fields. However, after some time (~2 hours) as the perturbation electric field decays, the cross correlation reaches almost 1 implying very slow temporal changes. This technique is applied to identify fresh generation of post-midnight plasma bubbles during magnetically disturbed conditions. From in situ satellite observations, the EPBs are generally identified as sudden depletion from background electron density, associated with magnetic fluctuations. In fact, the plasma bubble index produced from data of the ESA Swarm mission utilizes this same criteria of concurrent density depletions and magnetic fluctuations to identify the plasma bubbles. However, it is not so straightforward to distinguish evolving and non-evolving phases of the plasma bubbles in the SWARM plasma and magnetic observations. We look into near simultaneous in situ observations of SWARM and ground based VHF spaced receiver scintillation to identify a standard criteria for distinguishing evolving/non-evolving bubbles in SWARM observations. The results suggest that the presence/absence of magnetic fluctuations associated with the depletion in electron density can be used as a criteria for evolving/non-evolving bubbles. Ideally, the electric and magnetic field fluctuations should be present simultaneously and as a result should decay simultaneously. We have looked into one year (2014) of SWARM observations of EPBs and VHF spaced receiver scintillation data from Indian equatorial station Tirunelveli. A few case studies during both magnetically quiet and disturbed conditions are discussed.