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Upwelling Backscatter Plumes in Growth Phase of Equatorial Spread F Observed with the Equatorial Atmosphere Radar

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Equatorial spread F (ESF) or plasma bubbles have been intensively studied with a coherent backscatter technique after the discovery of upward-developing backscatter plumes observed with the Jicamarca VHF radar. Although they are believed to be a result of the generalized Rayleigh-Taylor instability in which the bottomside equatorial F region is raised and grows nonlinearly into the topside, slit-camera-like radar observations could not observe such evolution of plasma bubbles. The Equatorial Atmosphere Radar (EAR) in West Sumatra, Indonesia (0.20S, 100.32E; dip latitude 10.1S) has rapid beam-scanning capability to detect spatial structure of plumes with high time resolution. Nonlinear evolution of plumes observed with the EAR for the first time is presented. The rise velocity of the observed plumes ranged from a few tens to a few hundreds of meter per second. While the plumes appeared in the earlier local time grew more rapidly and reached higher altitude, later ones just drifted eastward with keeping the top altitude. The velocity is similar to nonlinear evolution of plasma bubbles simulated by the previous numerical studies. Importance of sunset terminator transition should be considered because of its comparable rise velocity. Since the observed rise velocity is highly variable, many factors should contribute to growth of plasma bubbles.