

Wave-4 Pattern of the Equatorial Mass Density Anomaly - Evidence for direct penetration of DE3 to upper thermosphere

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The equatorial mass density anomaly (EMA) is an anomalous latitudinal distribution of the atmospheric mass density, with its equinox configuration consisting of a density trough near the Earth's dip equator flanked by density crests around +/-25 dip latitude. As a novel feature, this study it reveals a pronounced 4-peak longitudinal pattern of the EMA, which is in reminiscence of the wave-4 like structure in the neutral wind and the equatorial ionization anomaly (EIA). It is found that the wave-4 modulation in the EMA trough region is in phase with that in the EMA crest region, in contrast to the 180 deg phase reversal for the case of EIA. This difference strongly suggest that although the latitudinal structure of the EMA is principally caused by the EIA via ion drag, its wave-4 pattern likely arises from different sources. The direct penetration of the non-migrating diurnal tides DE3 to the F-region height or thermal budget modulation by the composition NO at lower thermosphere are discussed as plausible candidates. Our results reveal a 4-hour phase lag between the wave-4 patterns in neutral density and wind, and a 2% peak-to-peak amplitude of the neutral density wave-4 pattern. These results find good agreements with theoretical predictions based on direct penetration of the DE3 to F-regions heights, hence strongly support the idea of direct penetration. Our observations thus add further evidence for the influence of tropical deep convection on the thermospheric dynamics.

Keywords: ion-neutral coupling, tropical deep convection, wave-4