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Seasonal and Interhemispheric Effects on the Diurnal Evolution of EIA: Assessed by IGS TEC and IRI-2016 over Peruvian and Indian sectors

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The global total electron content (TEC) map in 2013, retrieved from the International Global Navigation Satellite Systems (GNSS) Service (IGS), and the International Reference Ionosphere (IRI-2016) model are used to monitor the diurnal evolution of the equatorial ionization anomaly (EIA). The statistics are conducted during geomagnetic quiet periods in the Peruvian and Indian sectors, where the equatorial electrojet (EEJ) data and reliable TEC are available. The EEJ is used as a proxy to determine whether the EIA structure is fully developed. Most of the previous studies focused on the period in which the EIA is well developed, while the period before EIA emergence is usually neglected. To characterize dynamics accounting for the full development of EIA, we defined and statistically analyzed the onset, first emergence, and the peaks of the northern crest and southern crest based on the proposed crest-to-trough difference (CTD) profiles. These time points extracted from IGS TEC show typical annual cycles in the Indian sector which can be summarized as winter hemispheric priority, i.e., the development of EIA in the winter hemisphere is ahead of that in the summer hemisphere. However, these same time points show abnormal semiannual cycles in the Peruvian sector, that is, EIA develops earlier during two equinoxes/solstices in the northern/southern hemisphere. We suggest that the onset of EIA is a consequence of the equilibrium between sunlight ionization and ambipolar diffusion. However, the latter term is not considered in modeling the topside ionosphere in IRI-2016, which results in a poor capacity in IRI to describe the diurnal evolution of EIA. Meridional neutral wind's modulation on the ambipolar diffusion can explain the annual cycle observed in the Indian sector, while the semiannual variation seen in the Peruvian sector might be due to additional competing effects induced by the F region height changes