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Ground-based geomagnetic data to reveal the equatorial counter electrojet: How the detection method can affect the results?

Yosuke Yamazaki (1), Gabriel Soares (2), Jürgen Matzka (1), Katia Pinheiro (2), and Achim Morschhauser (1)

(1) GFZ German Research Centre for Geosciences, Potsdam, Germany, (2) Observatório Nacional, Rio de Janeiro, Brazil (soaresbrando@gmail.com)

The diurnal variation of the geomagnetic field near the magnetic equator is affected by an additional electric current in the ionospheric E-region, namely the equatorial electrojet (EEJ) and its equatorial counter electrojet (CEJ). The EEJ flows eastwards along the magnetic equator, leading to an enhancement of the horizontal (H) component of the geomagnetic field at ground stations. CEJ refers to periods of westward current (opposite to the normal EEJ), leading to a depression of the H component. Typically, these CEJ events are observed in the morning hours (morning CEJ, MCEJ) and in the afternoon hours (afternoon CEJ, ACEJ).

The occurrence of CEJ events during magnetically quiet times has been extensively investigated since the 1960s. Some early studies used magnetograms from a single equatorial station to detect depressions in the H component below the quiet night time level, which indicate the occurrence of CEJ events. Many recent studies use the station pair technique, where the difference between the H component measured at an equatorial station and a low-latitude station is used to isolate the EEJ/CEJ signals from other sources, namely Sq and magnetospheric currents. CEJ events are here identified when this difference is getting below the quiet nighttime level.

Some of these studies give contradicting results (e.g. in their MCEJ and ACEJ climatology) and we investigate here, if this could be explained by a methodological bias arising from the CEJ detection method. Also, we are interested to investigate if there are actually different physical processes that are addressed by the different methods. To this end, we use other observations of the EEJ/CEJ including equatorial vertical plasma drift velocities from the JULIA radar and the ROCSAT satellite, and data from the geomagnetic field missions CHAMP and Swarm.