Using magnetic observatory data to investigate the longitudinal and seasonal variability of the counter electrojet

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The equatorial electrojet (EEJ) is an eastward ionospheric current system that occasionally reverses during morning and afternoon hours, leading to periods of westward current in the ionospheric E-region known as counter electrojet (CEJ). Here, we present the first analysis of CEJ based on an extensive ground-based dataset for the Brazilian sector (data from 2008 to 2018) and we compare it to the Peruvian, African, Indian and Philippine sectors.

Data from magnetic observatories placed near the magnetic equator can be used to study the equatorial electrojet (EEJ) and its reversal, the so-called counter electrojet (CEJ). The EEJ is an ionospheric current that flows eastwards at E-region heights within a narrow band of about 4° from the magnetic equator. It causes an enhancement of the normal daily Sq variations in the geomagnetic horizontal component H. The westward current during CEJ events can last for a few hours and causes a depression in the H values. One method to isolate the EEJ/CEJ signal from other external and internal sources of the geomagnetic field is by taking the difference of H measured at an equatorial station and at a low-latitude station with a similar longitude, but outside the influence of the EEJ (Stolle et al., 2008). Here, we consider only geomagnetically quiet periods (Kp <= 3o).

In this work we provide the longitudinal and seasonal variability of morning and afternoon CEJ events (MCEJ and ACEJ, respectively) by using geomagnetic data from the Peruvian sector: Huancayo observatory (HUA, INTERMAGNET) and Piura station (PIU, LISN network), the Brazilian sector: Tatuoca (TTB, Observatório Nacional) and Kourou (KOU, INTERMAGNET) observatories, the African sector: Samogossoni station (SAM, WAMNET network) and Tamanrasset observatory (TAM, INTERMAGNET), the Indian sector: Tirunelveli (TIR, WDC-Mumbai) and Alibag (ABG, INTERMAGNET) observatories, and the Asian sector: Davao (DAV, MAGDAS network) and Muntilupa (MUT, MAGDAS network) stations. All stations are shown in Figure 1, in addition to the position of the magnetic equator for different epochs. Figure 2 shows the total MCEJ and ACEJ occurrence rates for all longitude sectors. The white boxes with numbers represent the respective MCEJ (left) and ACEJ (right) occurrence rates. The CEJ longitudinal dependence is evident, with the highest rates observed for the Brazilian sector.

In addition, we found a CEJ dependence on solar flux and lunar phase in the Brazilian sector similar to that observed for the Peruvian sector. Concerning the CEJ climatology, Singh et al. (2018) indicated the ACEJ modulation by non-migrating tides. However, we performed simulations with the EEJM-2 and TIEGCM models (not shown here) which indicate that the longitudinal differences of both MCEJ and ACEJ climatologies found in our results are strongly related to the EEJ modulation by atmospheric winds (affected by both tidal non-migrating and migrating oscillations).

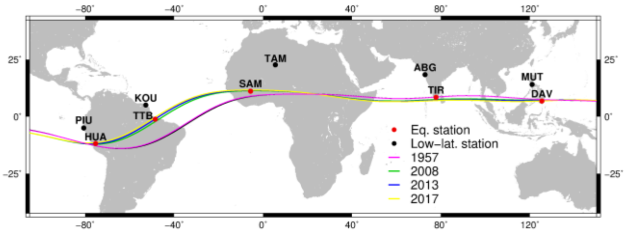

Figure 1: Location map of the equatorial and low-latitude magnetic observatories and stations used in this study. The magnetic equator lines for 1957, 2008, 2013, 2017 were calculated by using the IGRF-12 model.

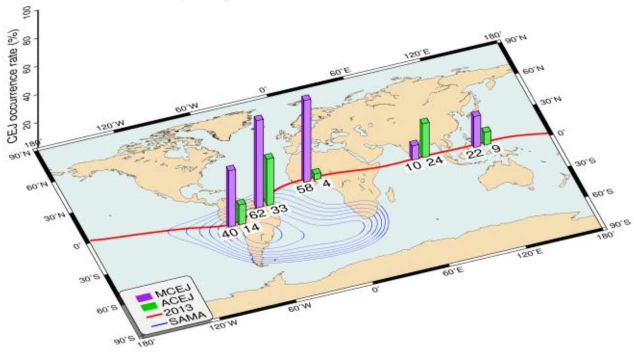

Figure 2: Total CEJ occurrence rates (in %) for MCEJ (purple) and ACEJ (green), for the Peruvian (HUA), Brazilian (TTB), African (SAM), Indian (TIR) and Philippine (DAV) sectors. Magnetic equator for 2013 is shown in red. SAMA (blue lines) contours are shown (inner contour: 23000 nT, outer contour: 30000 nT).

Lastly, we emphasize that a better understanding of the mechanisms that control the longitudinal difference of CEJ occurrences is important for further studies of the whole EEJ/CEJ system.

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