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An analysis of EEJ meridional currents from ground magnetic data using principal component analysis

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The equatorial electrojet (EEJ) is a prominent eastward geomagnetic current flowing at the magnetic dip equator, primarily recognized through its significant influence on the H (northward) magnetic component as observed from the ground. Besides its main eastward flow, the EEJ encompasses meridional currents flowing perpendicular to the main current, whose effect on the main eastward current is less understood. This study aims to investigate the effects of the meridional currents of the EEJ on the main EEJ itself by employing principal component analysis (PCA) on ground magnetic data, particularly focusing on isolating these effects from other concurrent geomagnetic influences such as the inter-hemispheric field-aligned currents (IHFACs).

Data from several ground magnetic stations near the dip equator was analyzed, revealing that the first principal component of the D (eastward) component predominantly corresponded to the IHFACs and their seasonal variations. The second principal component was preliminarily associated with the meridional currents and the intensification of the EEJ, as well as the global Sq currents. This implies that the meridional currents might be related to the intensification and decay of the EEJ. The longitudinal variation of the second principal component further supports this identification.

These initial findings demonstrate the potential of PCA in distinguishing EEJ-related magnetic signatures from other geomagnetic phenomena in ground-based observation data, offering insights into the three-dimensional structure of the EEJ. Future efforts will aim at validating these results through methodological refinement and comparative analyses with models, satellite data, and other resources.