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Geomagnetic derivation of current strengths and electric fields of three current systems in the ionosphere and magnetosphere.

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Abstract content
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Geomagnetic data are usually a superposition of various different geomagnetic signatures from different source current systems in the ionosphere and magnetosphere. The geomagnetic field (B-field) also generates geoelectric fields (E-fields), which drives geomagnetically induced currents (GIC) in technological conducting media at the surface of the Earth, such as railways, pipelines and power networks. Fourier transforms of B-field measurements were used to calculate the current strengths and ground E-fields directly from a Fourier integral model function and in reverse by the Levenberg-Marquardt inversion technique. The reflection coefficient in the integral is calculated through the underlying surface impedance from layered-Earth profiles, as given and derived from the literature. We concentrate on three current systems [using three corresponding sources of B-field measurements]: the ring currents (RC) [Dst], equatorial (EEJ) [only Addis Ababa minus Dst] and auroral electrojets (AEJ) [northern EO]. The electrojets is at 100 km height in the ionosphere, while the RC is five Earth radii from the surface. It is found that the current strength behaviour accurately follows the variations of the B-fields with high correlations. The current strength time derivative correspondingly follows the variations of the E-fields. The E-field of the AEJ is significantly stronger than the other current systems, due to its unique position under the fields imposed by and energetic particle precipitation received from the magnetosphere. The EEJ E-field is weakest, while the RC is between the two extremes. The EEJ has the weakest current strength, since no field-aligned currents is connected to it, unlike the AEJ. The RC current strength is the strongest. The current strength also serves as the source for developing solar wind empirical models just outside the Earth's magnetosphere.

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