Seasonal Dependence of the Global Ionospheric Electric Field Generated by Thunderstorms

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Electric currents flowing in the global electric circuit (GEC) are closed by ionospheric currents. A model for the distribution of the ionospheric potential which drives these currents is constructed. Only the internal electric fields and currents generated by thunderstorms are studied, and without any magnetospheric or ionospheric generators. The atmospheric conductivity profiles with altitude are empirically determined, and the topography of the Earth's surface is taken into account. A two-dimensional approximation of the ionospheric conductor is based on high conductivity along the geomagnetic field; the Pedersen and Hall conductivities spatial distributions are calculated using empirical models. The values of the potential in the E- and F-layers of the ionosphere are not varied along a magnetic field line in such a model and so only the, which are obtained by integrating along these lines, matter.

The main progress in comparison with previous versions of the model (Denisenko et al., 2019, Denisenko and Rycroft, 2021) is due to the usage of the model of the global distribution of thunderstorms obtained from the ground-based World Wide Lightning Location Network (Denisenko and Lyakhov, 2021). The global distributions of the electric potential in the ionosphere are calculated for different seasons. The designed model contains the equatorial electrojets. There are day-time electrojets, the strengths of which are up to 100 A, and night-time ones (which are up to only half this value), while the total current of the GEC is taken equal to approximately 1.5 kA in our model to satisfy the Carnegie curve. The equatorial electrojets of the GEC produce magnetic perturbations on the ground, which are in the 0.1 nT range. In principle, these magnetic perturbations could be measured, especially at the night-time geomagnetic equator where they are not so disguised by other ionospheric electrojets, which are concentrated mainly in the day-time.

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