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Lightning flashes in the global atmospheric electric circuit

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Quasi-stationary and fast transient processes connected with powerful lightning discharges and large-scale thunderstorm systems are analyzed. We address two aspects of the global electric circuit conception, particularly important from the viewpoint of lightning research. First is a classical aspect of the global circuit as the quasi-stationary current contour supported by the operation of thunderstorm generators over the globe. Another aspect is connected to the energy deposition and dissipation into the circuit, treated as an open dissipative system. Energetic estimates of lightning flashes and thunderstorms are presented. An importance of global circuit conception in terms of the modeling of sprites and sprite-producing clouds is particularly recognized. It was shown recently that stratiform regions of mesoscale convective systems (MCSs) make an especially large current contribution to the global circuit, serving either as an effective generator or as a discharger of the circuit depending on the polarity, magnitude and thickness of the layers of external current. On the other hand, stratiform regions of MCS are characterized by enhanced rate of positive flashes. In a case of MCS the big narrow layers, generated near the 0°C isotherm serve as the source of electric charges for positive CG flashes. We develop a model of a positive charge layer near the 0°C isotherm, based on the hypothesis that the melting-charging mechanism plays a principal role in the formation of the layer. A concept of lightning discharge development through the hydrometeor and cloud particle system in the active part of thunderclouds is suggested.