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Do fair weather regions contribute to the global circuit support?

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The role of different generators (thunderstorm clouds, mesoscale convective systems, electrified shower clouds etc.) in the maintaining the ionospheric potential (IP) of the global electric circuit (GEC) and its variation is still insufficiently understood. This paper considers possible approaches to the modeling of GEC generators with particular focus on the planetary boundary layer (PBL), or Austausch, generator, operating in the fair weather regions. It is well known that turbulent convection leads to intensive mixing of charged particles in the PBL and, consequently, to the generation of the vertical electric current. As a rule, this current is directed upward if the positive charge is accumulated near the Earth's surface particularly due to the electrode effect. There is still a great uncertainty concerning the contribution of the PBL generator into the global circuit. This is not only for a lack of data, but also due to the difficulties of theory: the intensity of the generator depends upon the IP, so the search for its contribution into the GEC requires solving a self-consistent problem. We suggest an analytical approach for the calculation of the IP induced by the given electric currents in the atmosphere. The obtained expressions and numerical calculations show that convection amplifies the contributions of thunderstorm/shower-cloud sources, while the value of this amplification varies likely from 10 to 20% depending mainly on the square occupied by intensive convection and the mean thickness of the PBL. It is important that the diurnal motion of the convection area on the Earth's surface may cause regular variations into the IP diurnal variation (reflected in the Carnegie curve), superimposed with the thunderstorm/shower-cloud contributions. It is suggested that the contribution of PBL generator into the GEC potential maximizes when the Pacific ocean surface is sunlit because at this time both conditions of its operation are satisfied: the PBL is unstable; the electrode effect forms over the maximum square because over the land surface this effect is often not developed due to radioactive emanations.