The DC and AC global atmospheric electric circuits as central tenets in Earth system science today

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The European Geosciences Union encourages a broad phenomenological approach to the study of the Earth and space sciences, in the form of interdisciplinary research termed Earth system science. This concept considers the Earth's atmosphere, biosphere, surface and oceans - supporting humankind - as a closely interacting system. The DC global atmospheric electric circuit (GAEC), a central concept in atmospheric electricity, is clearly a prime example of such an interdisciplinary system. Its modus operandi is described in terms of thunderstorm/shower cloud current generators, the equipotential ionosphere, the fair and semi-fair weather downward return current of ~ 2 pA/m2 and land/ocean surface currents and point discharge closure currents below the generators. On the other hand, the AC global atmospheric electric circuit is associated with electromagnetic (Schumann) resonances of the Earth-ionosphere cavity at 8, 14, 20 ... Hz. The first sentence of B.F.J. Schonland's (1932, 1953) small and slender book Atmospheric Electricity (published by Methuen) is: "The electrical conductivity of the air ... plays an important part in all the phenomena included under the title Atmospheric Electricity". Progress made in the last few years on a) finding a good representation of the atmospheric conductivity profile consistent with both DC and AC observations, and b) understanding the distribution of positive charge in the atmosphere will be outlined. Some outstanding problems in the subject will be mentioned; these include deriving the numerical value of the negative charge on the Earth's surface and building a physics-based model of the GAEC which can be used to investigate the effects of climate change on it.