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The linkage between solar activity, atmospheric electricity, cloud microphysics, and climate change

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There are well understood links between solar activity and the global electric circuit, via cosmic rays and other energetic space particle fluxes, and the direct penetration of solar wind electric fields into the magnetic polar caps. Observations and theory show that the changing ionosphere-earth current density Jz in the global electric circuit deposits varying amounts of charge in clouds in accordance with Ohm's and Gauss's Laws. Observations and theory show that the changing space charge in clouds changes the rate of scavenging of aerosol particles, most importantly cloud condensation nuclei and ice-forming nuclei, which causes changes in precipitation and cloud cover (Tinsley, Rep. Prog. Phys., 71, 066801, 2008).
Correlations and theory show changes in the intensity of winter storms are associated with such changes in the microphysics, produced by changes in Jz, mainly in the cyclogenesis regions at high geomagnetic latitudes. Also, low-latitude low-altitude cloud cover changes, as observed by Svensmark, can be explained by Jz changes. Observations and theory show changes in the general circulation over Europe are associated with increased cyclogenesis in the Icelandic Low region, and downstream anticyclonic blocking, producing advection of cold polar air to lower latitudes. More extreme changes have been inferred from reconstructions of the changed circulation over Europe during the Maunder minimum, and suggest similar cold winters would be a continuing feature of the current extended solar minimum.
The complexity of the cloud microphysics and the natural and anthropogenic variability of global aerosols and the presence of dynamic feedback have made it difficult so far to put the cloud microphysical responses into quantitative cloud resolving models.