

On the importance of the Cowling/polarization mechanism for the electrodynamics of the ionosphere and magnetosphere

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The mechanism of charge polarization is a basic process in electromagnetism and plasma physics. For the ionospheric physics, it is mostly known from the Cowling channel situation. However, this mechanism is not limited to the specific Cowling channel geometry in the ionosphere nor to substorm situations, but can appear at any type of situation when significant ionospheric conductance gradients are present. In this presentation, we will briefly review some theoretical foundations of the polarization mechanism and its effects on ionospheric electrodynamics in a 3-dimensional ionosphere, and present a statistical analysis that shows when situations with a high Cowling efficiency are most likely to occur. Further, we will analyse in detail an event case during a substorm interval, and from the results discuss the relative relevance of current closure via the Cowling mechanism as compared to local current closure for this case, as well as the impacts on magnetosphere-ionosphere coupling.

Keywords: ionosphere, current systems, electric field, M-I coupling, Cowling effect