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Modelling of the electric current and magnetic field structures associated with the polar cusps

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There are two main types of the electric current structures associated with the dayside polar cusps. The first one is a system of diamagnetic currents due to the injected magnetosheath plasma, which envelop the cusps and result in a significant depression of the ambient magnetic field, extending downward from the outer 'throat' of the cusp funnel deep into the dayside magnetosphere. The second current structure has a completely different physical nature, and this is the system of Region 0 field-aligned currents, associated with the azimuthal component of interplanetary magnetic field. The transverse fields associated with those currents may result in a significant azimuthal shift of the cusp field line footpoints. Neither of the above current systems have yet been included in the existing empirical magnetosphere models, and the goal of the present work is to fill that gap. To that end, we have developed a flexible composite model of the cusp diamagnetism, based on an empirical distribution of the plasma magnetization vector. A similar representation of the Region 0 field-aligned currents is also constructed and a combined model of the cusp magnetic field has been tested against first-principle MHD simulation output, which served in that case as a source of artificial 'data'. The ultimate goal of this work is to reconstruct the actually observed cusp structures on the basis of in-situ spacecraft data and to explore their dependence on the state of the incoming solar wind/IMF and on the Earth's dipole tilt angle.