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Coronal magnetic field modeling using a non-spherical source surface: implications for the global structuring of the corona

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Global models of the solar coronal magnetic field are an essential tool for assessing the global-scale magnetic environment of the corona and its connectivity to the heliosphere. In particular, the Potential Field Source Surface (PFSS) model continues to be a frequently and widely adopted tool in the community despite several well-known deficiencies of the model. For instance, regions of open magnetic field provided by the model often only superficially match the observed coronal holes at EUV wavelengths which has been posited as a possible significant source of error contributing to the limited accuracy of many solar wind prediction models. Recently, a different issue has been highlighted through near-Sun solar wind observations by Parker Solar Probe (PSP), as an accurate PFSS modeling of the solar wind magnetic field polarity has only been achieved for source surface radii typically considered to be excessively low.

In this work, we study whether relaxing the fundamental assumption of the PFSS model of a fixed spherical source surface beyond which the magnetic field is purely radial can alleviate the noted deficiencies of the model. To this aim, we employ magnetofrictional modeling to construct magnetic field models where the coronal magnetic field is selectively opened in regions corresponding to those of observed coronal holes. We compare the resulting model results not only to PFSS, global coronal magnetohydrodynamic modeling and imaging observations, but also contrast the results with PSP in-situ observations. Furthermore, we discuss the implications of the results on the unresolved issue of missing open flux.

Primary authors: Dr POMOELL, Jens (University of Helsinki); Dr HEINEMANN, Stephan G. (University of Helsinki, Finland); ASVESTARI, Eleanna (University of Helsinki)

Presenter: Dr POMOELL, Jens (University of Helsinki)

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