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Model of the Jovian magnetic field topology constrained by the Io auroral emissions

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Abstract

The determination of the internal magnetic field of Jupiter has been the object of many studies and publications. These models have been computed from the Pioneer, Voyager, and Ulysses measurements. Some models also use the position of the Io footprints as a constraint: the magnetic field lines mapping to the footprints must have their origins along Io's orbit. The use of this latter constraint to determine the internal magnetic field models greatly improved the modeling of the auroral emissions, in particular the radio ones, which strongly depends on the magnetic field geometry. This constraint is, however, not sufficient for allowing a completely accurate modeling. The fact that the footprint field line should map to a longitude close to Io's was not used, so that the azimuthal component of the magnetic field could not be precisely constrained. Moreover, a recent study showed the presence of a magnetic anomaly in the northern hemisphere, which has never been included in any spherical harmonic decomposition of the internal magnetic field. We compute a decomposition of the Jovian internal magnetic field into spherical harmonics, which allows for a more accurate mapping of the magnetic field lines crossing Io, Europa, and Ganymede orbits to the satellite footprints observed in UV. This model, named VIPAL, is mostly constrained by the Io footprint positions, including the longitudinal constraint, and normalized by the Voyager and Pioneer magnetic field measurements. We show that the surface magnetic fields predicted by our model are more consistent with the observed frequencies of the Jovian radio emissions than those predicted by previous models.