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Field aligned currents associated with Jupiter's auroras

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Abstract

Jupiter's aurorae are huge in size, and hundreds of times more energetic than those on Earth. Therefore, intense field-aligned currents accompanied by large magnetic field perturbations were expected, similarly to the Earth, along field lines rooted in the main auroral oval. Here, we present observations of magnetic field perturbations due to field-aligned currents. The nature and the characteristics of the perturbations and consequently of the field-aligned currents are discussed.

1. Introduction

The Juno spacecraft has been orbiting Jupiter since July 4, 2016. It has performed 12 periapsis passes and continues sampling the Jovian environment close up (to 1.06 Jovian radii, Rj) extending to the outer reaches of the Jovian magnetosphere[1]. Juno's polar orbit makes it possible to acquire for the first time direct observations of the jovian magnetosphere and auroral emissions above the poles.

2. Magnetic field perturbations

Juno's vector magnetic field measurements during the first traversal over Jupiter's polar regions revealed a puzzling situation: Jupiter did not show intense field-aligned currents associated with the main aurora. Specifically, strong magnetic perturbations that should have resulted from the expected strong sheets of electric currents were not evident[1]. An extended analysis of Juno's magnetic field observations over Jupiter's polar regions has now revealed that the magnetic field perturbations associated with auroral field aligned currents are weak (maximum up to $\pm$400nT) and are therefore masked by the strong internal field of Jupiter

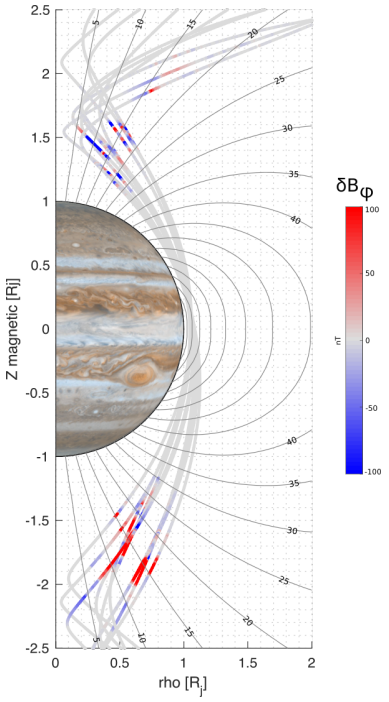

Figure 1: Magnetic field perturbations in the $\mathbf{B}_\phi$ component obtained from Juno's magnetic field observations after removing estimates from JRM09 model[2]. The fiducial field lines, computed from JRM09 model with their associated L-shell values are also plotted.

(typically about 2 Gauss where the perturbations occur). The magnetic field perturbations are extracted from the magnetic field vector data after removing estimates of the internal field from JRM09[2] along Juno's trajectory as well as removing remaining nonlinear trends by fitting a smoothing spline based on a penalized least squares method[3]. Figure 1 shows the

resulting magnetic field perturbations in the $\mathbf{B}_\phi$ component for each periapsis pass. The fiducial field lines, computed from JRM09 model with their associated L-shell values are also plotted. The perturbations are found in transit across field lines rooted to the main aurora. A strong asymmetry between the field perturbations over the north and south polar regions is also evident. Specifically, the field perturbations over the north appear more dispersed showing dynamic fillamentry structures whereas the perturbations over the south tend to get organized in two main regions of positive and negative δB_ϕ suggesting coherent sheets of field aligned currents.

3. Summary and Conclusions

Jupiter presents the most powerful aurorae in our solar system. Images of intense aurorae have been captured by Juno's ultraviolet and infrared imaging spectrographs. Surprisingly, the magnetic field perturbations associated with Jupiter's auroral field aligned currents are weaker than expected. Unlike Earth, Jupiter's field-aligned currents linked with the northern aurora do not seem to flow in organized regions of clearly defined parallel sheets but show dynamic filamentary structures.

4. Acknowledgements

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