

Propagation of lightning whistlers in the Jovian ionosphere

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Abstract

Juno collects a growing database of radio signatures of lightning at Jupiter [1, 2, 3, 4]. Analysis of the relative phase and coherency between the electric and magnetic field signals recorded by Juno Waves instrument [5] at frequencies below 20 kHz allows us to determine that these waves propagate outward from the planet and to confirm that their source is at lower altitudes below the spacecraft. These originally short impulsive signals therefore must be modified by their propagation through the plasma environment of the planet into the characteristic form of short-dispersion whistlers.

Comparison of the observed spectral forms of whistlers with theoretical calculations of their frequency dependent group delays can be used to analyze the low-density plasma in the topside ionosphere of Jupiter. However, the observed frequency-time spectrograms of Jovian whistlers also show unusually complex spectral forms, characteristic for peculiar properties of the mode structure and group velocity at extremely low plasma densities.

We use a ray tracing method based on cold plasma dispersion relation to evaluate the group delays at different frequencies with plasma density models based on observations. In this modelling approach we don't have to assume the strictly field aligned propagation of whistlers. We can therefore determine the position where these radio waves entered the ionosphere.

References

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