Observations and Simulations of Whistler-mode Waves inside Density Ducts

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In March of 2014, the Van Allen Probe A EMFISIS instrument observed several whistler-mode waves while passing through the apogee of an orbit on the dayside magnetosphere. These waves were localized in regions of strong density inhomogeneity. The first two waves were observed within enhancements on either side of a depletion in background plasma density. Several minutes later, a wave was observed within the center of a channel formed by a density enhancement. In both cases, the inhomogeneity was on the order of 100 cm^{-3}.

In order to understand the role of density inhomogeneities in guiding whistler waves, we first use the data from Van Allen Probe A to determine the wave properties. Then, we use this data to specify parameters in an electron MHD simulation to model the whistler waves inside the density structures, which are homogeneous along the ambient magnetic field and strongly inhomogeneous across it. These observations and simulations demonstrate how density structures can guide the whistler waves in the earth's radiation belt, a mechanism known as ducting. It has been theorized that whistler waves can be ducted by either an enhancement or depletion, as well as a strong gradient in the background plasma density. This research is part of a larger goal to understand the whistler wave ducting mechanism by comparing observations from the Van Allen Probes with results from numerical simulations which have been developed previously, thereby validating the models. This will have important applications for using whistler waves to remediate energetic particles from the radiation belt.