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Van Allen Probes and Arase measurements of whistler mode waves in the Earth's radiation belts

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Natural emissions of whistler-mode electromagnetic waves, especially chorus and hiss, can influence the dynamics of the Van Allen radiation belts via quasilinear or nonlinear wave particle interactions. They can play a role in complex processes of the energy transfer between different electron populations. Average intensities of chorus and hiss emissions have been found to increase with increasing levels of geomagnetic activity but their random variations in individual spacecraft measurements are usually stronger than these large-scale temporal effects. To separate temporal and spatial variations of wave characteristics, measurements at different points in space are necessary.

We use two-point measurements of the Waves instruments of the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) to investigate whistler-mode emissions in the Earth's radiation belts. Identical instruments are carried onboard two Van Allen Probes. We systematically analyze their large data sets which have been collected since 2012 over a range of separation vectors of the two spacecraft. We investigate similar variations of the whistler-mode wave power occurring at the same time at different places.

The Waves survey data give good orbital coverage in L, latitude, and magnetic local time (MLT) for whistler-mode plasmaspheric hiss and chorus. The results show that average and/or median wave power exhibits a flat peak at MLT ≈ 8-17h and L ≈ 2-4 and that these characteristic values generally increase with geomagnetic activity while observed random variations are still comparable to the effects of systematic trends.
Wave power of time shifted data shows rapidly increasing variability on time scales of minutes which is higher for low frequency outer zone chorus and lower for the low frequency hiss. Power variations from simultaneous spatially separated measurements are dominated by separations in MLT at scales below 30 min, with a weaker influence of separations in L or magnetic latitude. Hiss measurements made closely in space show temporal variations at time scales of tens of minutes.

We also use measurements of the onboard two Van Allen Probes to analyze these waves during conjunctions of one of the Van Allen Probes spacecraft with the Arase spacecraft at close separations. We investigate correlations of the observed chorus wave packets as a function of the separation vector, while the collected multicomponent measurements allow us to determine detailed polarization and propagation characteristics as a function of time at each spatial point.

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