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Seven years of systematic measurements of chorus and hiss emissions by the Van Allen Probes mission

O. Santolik [1,2], G. B. Hospodarsky [3], W. S. Kurth [3], C. A. Kletzing [3],
(1) Department of Space Physics, Institute of Atmospheric Physics, Czech Acad. Sci., Prague, Czechia
(2) Faculty of Mathematics and Physics, Charles University, Prague, Czechia
(3) University of Iowa, Iowa City, Iowa, USA

The Van Allen Probes mission provides us with an unprecedented data set of measurements in the Earth's inner magnetosphere collected during seven years of successful operations from 2012 to 2019. We present results of a systematic analysis of all available survey data obtained from the Waves instruments of the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) onboard the Van Allen Probes. We use this data set to investigate whistler-mode emissions of chorus and hiss in the region of the Earth's radiation belts.

Identical EMFISIS Waves instruments were carried onboard two Van Allen Probes and both provided us not only with high cadence burst measurements but also with systematic results of survey-mode analysis of fluctuating electric and magnetic fields. Measurements of three magnetic field components and three electric field components were captured in intervals of 468 ms with a repetition period of 6 s and subsequently transformed into the frequency domain using the Fast Fourier Transform. As a result of this complex onboard procedure, averaged spectral matrices were calculated in 65 logarithmically distributed frequency bins from 2 Hz up to 12 kHz. This data set was obtained by both spacecraft with a nearly 100% coverage, and it allows us to analyze not only the wave intensity, but also the wave polarization and propagation properties, including the ellipticity and planarity of the wave polarization, wave vector direction and the Poynting vector.

The Waves survey data give good orbital coverage in L, latitude, and magnetic local time (MLT) for whistler-mode plasmaspheric hiss and chorus. We analyze this large data set as a function of position and geomagnetic activity. 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.

The two point measurements allow us to compare wave properties over a range of separation vectors of the two spacecraft, allowing us to separate temporal and spatial variations. We can, for example, investigate temporal variations of the whistler-mode wave power and wave vector directions occurring when the two spacecraft arrive to the same place at slightly different times. Results show that the 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. We can also investigate spatial variations of the whistler-mode wave power and wave vector directions occurring at the same time at different places. 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.