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Intercalibrated multi-point measurements of whistler mode waves by Van Allen Probes and Arase

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Whistler-mode electromagnetic waves, especially chorus and hiss, can influence the Van Allen radiation belts via quasilinear or nonlinear wave particle interactions, thus playing an important role in complex processes of the energy transfer between different electron populations. To separate temporal and spatial variations of wave characteristics, measurements at different points in space are necessary.

We analyze measurements of the Van Allen Probes and Arase spacecraft at close separations. The inter-calibration of their data is based on a common observation of strong whistlers. The whistlers are generated by lightning strokes with positions known from ground based networks, and propagate along very similar paths to the two spacecraft. Measured amplitudes of the magnetic field fluctuations are the same within ~14%. The electric field measurements show twice larger amplitudes on Arase compared to Van Allen Probes, matching within ~33% once the newest results on the interface of the antennas to the surrounding plasma are included in the calibration procedures.

Based on the intercalibrated data, we investigate correlations of 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. In the analyzed case, Van Allen Probe A (at a magnetic latitude of ~20 °) and Arase spacecraft (at a magnetic latitude of ~30 °) observe the same chorus elements during a short time period of 2 minutes, corresponding to a few hundreds of km, when Arase is located at a lower L than Van Allen Probe A and detects elements with time delays of 0.3 s. Similar sequences of elements are later observed in a broader area but with significant frequency shifts and with a changing character from fallers to risers.

Results of wave propagation analysis suggest an explanation by properties of the whistler mode near the resonance cone, with wave vectors oriented outward (to higher L), consistent with inward Poynting vectors for waves propagating to higher latitudes from the equatorial region.

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