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# Analytical Chorus Wave Model Derived from Van Allen Probe Observations and Combination with Other Satellites at High Latitudes

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Chorus waves play an important role in the dynamic evolution of energetic electrons in the Earth's radiation belts and ring current. Using more than 5 years of Van Allen Probe data, we developed a new analytical model for upper-band chorus (UBC; 0.5fce < f < fce) and lower-band chorus (LBC; 0.05fce < f < 0.5fce) waves, where fce is the equatorial electron gyrofrequency. By applying polynomial fits to chorus wave root mean square amplitudes, we developed regression models for LBC and UBC as a function of geomagnetic activity (Kp), L, magnetic latitude, and magnetic local time (MLT). Dependence on Kp is separated from the dependence on $\lambda$, L, and MLT as Kp-scaling law to simplify the calculation of diffusion coefficients and inclusion into particle tracing codes. Frequency models for UBC and LBC are also developed, which depends on MLT and magnetic latitude. This empirical model is valid in all MLTs, magnetic latitude up to 20 degree, Kp $\leq$ 6, L-shell range from 3.5 to 6 for LBC and from 4 to 6 for UBC. The dependence of root mean square amplitudes on L are different for different bands, which implies different energy sources for different wave bands. This analytical chorus wave model is convenient for inclusion in quasi-linear diffusion calculations of electron scattering rates and particle simulations in the inner magnetosphere, especially for the newly developed four-dimensional codes, which require significantly improved wave parameterizations.

In our chorus wave model published in 2019 [1], RMS amplitudes of nightside lower-band chorus waves are decreasing with latitude, and they are confined to low latitudes, while dayside lower-band chorus waves can extend to high latitudes, which is consistent with previous studies. We extend the dayside chorus wave model by combing measurements from ERG and Cluster, following the method similar as in [2].

## References

[1] D. Wang, Y. Y. Shprits, I. S. Zhelavskaya, O. V. Agapitov, A. Y. Drozdov, and N. A. Aseev, "Analytical choruswave model derived from Van Allen Probe observations," *Journal of Geophysical Research: Space Physics,* **124**, pp. 1063–1084, doi:10.1029/2018JA026183.

[2] O. V. Agapitov, D. Mourenas, A. V. Artemyev, F. S. Mozer, G. Hospodarsky, J. Bonnell, and V. Krasnoselskikh, "Synthetic empirical chorus wave model fromcombined Van Allen Probes and Cluster statistics," *Journal of Geophysical Research: Space Physics*, **123**, 2018, pp. 297–314, doi:10.1002/2017JA024843.