



Chorus Waves and Their Effect on Energetic Electrons in the Inner-magnetosphere

Dedong Wang⁽¹⁾, Yuri Y. Shprits⁽¹⁾⁽²⁾⁽³⁾, Bernhard Haas⁽¹⁾⁽²⁾, Alexander Y. Drozdov⁽³⁾, and Angelica M. Castillo⁽¹⁾⁽²⁾

(1) Section 2.7 Space Physics and Space Weather, GFZ German Research Centre for Geosciences, Potsdam, Germany

(2) Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany

(3) Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, California, USA

1 Extended Abstract

Chorus waves are suggested to play an important role in the dynamic evolution of energetic electrons [1, 2, 3]. To quantify the effect of chorus waves, we developed analytical models for chorus waves using more than 5 years of Van Allen Probe data [4]. These models depended on L , MLT, magnetic latitude and geomagnetic condition. However, due to the limitation of the Van Allen Probes orbit, these models are confined to magnetic latitude 20° . Previous studies [5, 6] suggested that chorus waves at higher latitudes are capable of producing very fast losses of the relativistic electrons on the scale of one day. Referring to observations from Cluster satellites [7], we extend our chorus wave models to higher latitudes. By performing long-term simulations using the three-dimensional Versatile Electron Radiation Belt code, we find that the variability of chorus waves at high latitudes is critical for modelling of MeV electrons. We show that, decrease in high-latitude chorus waves can tip the balance between acceleration and loss towards acceleration, or alternatively, the increase in high-latitude waves can result in a net loss of MeV electrons [8]. Variations in high-latitude chorus may account for some of the variability of MeV electrons. Based on these knowledge, we perform long-term simulations for the Van Allen Probe era and systematically validate our simulation results against Van Allen Probe observations. We also calculate and parameterize the lifetime of the electrons with an energy range from 1 keV to 2 MeV. By performing simulations, we show the importance of including realistic plasma density model to quantify the effect of chorus waves.

References

- [1] R. B. Horne and R. M. Thorne, “Potential waves for relativistic electron scattering and stochastic acceleration during magnetic storms”, *Geophysical Research Letters*, **25**, 15, pp. 3011–3014, August 1, 1998.
- [2] D. Summers and C.-Y. Ma, “A model for generating relativistic electrons in the Earth’s inner magnetosphere based on gyroresonant wave-particle interactions”, *Journal of Geophysical Research*, **105**, A2, pp. 3011–3014, February 1, 2000.
- [3] R. B. Horne, and R. M. Thorne, “Relativistic electron acceleration and precipitation during resonant interactions with whistler-mode chorus”, *Geophysical Research Letters*, **30**, 10, 2003.
- [4] 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, 2019, doi:10.1029/2018JA026183.
- [5] R. M. Thorne, T. P. O’Brien, Y. Y. Shprits, D. Summers and R. B. Horne, “Timescale for MeV electron microburst loss during geomagnetic storms”, *Journal of Geophysical Research*, **110**, A09202, 2005, doi:10.1029/2004JA010882.
- [6] Y. Y. Shprits, R. M. Thorne, R. B. Horne, and D. Summers, “Bounce-averaged diffusion coefficients for field-aligned chorus waves”, *Journal of Geophysical Research: Space Physics*, **111**, A09202, 26 October 2006, doi:10.1029/2006JA011725.
- [7] O. V. Agapitov, D. Mourenas, A. V. Artemyev, F. S. Mozer, G. Hospodarsky, J. Bonnell, and V. Krasnoselskikh, “Synthetic empirical chorus wave model from combined Van Allen Probes and Cluster statistics,” *Journal of Geophysical Research: Space Physics*, **123**, 2018, pp. 297–314, doi:10.1002/2017JA024843.
- [8] D. Wang, and Y. Y. Shprits, “On How High-Latitude Chorus Waves Tip the Balance Between Acceleration and Loss of Relativistic Electrons”, *Geophysical Research Letters*, **46**, pp. 7945–7954, 2019, doi:10.1029/2019GL082681.