Van Allen Probes Observations of Electromgagnetic Ion Cyclotron (EMIC) Wave Rising Tones

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We are conducting a study of electromagnetic ion cyclotron (EMIC) wave rising tones observed by the Van Allen Probes between L=2-6 R_E. EMIC waves occur below the proton gyrofrequency in three bands: a hydrogen band between the He^+ and H^+ gyrofrequencies, a helium band between the O^+ and He^+ gyrofrequencies, and an oxygen band below the O^+ gyrofrequency. EMIC waves are important to radiation belt dyanamics due to their potential for scattering relativistic electrons and contributing to losses during electron flux drop-outs. Using data from the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) fluxgate magnetometers on both Van Allen Probes, we identified orbits with EMIC wave events from the first four years of the mission (2012-2016). Orbits with EMIC wave events were further examined for evidence of rising tones. We will present examples of EMIC wave rising tones in Fourier time-frequency power spectrograms, show results from wave normal analysis of the magnetic fields, and discuss the occurrence statistics of EMIC wave rising tone events compared to ordinary EMIC wave events. Most EMIC wave rising tones occurred in H^+ band EMIC wave events. In time-frequency power spectrograms of the fluxgate magnetometer data, H^+ band rising tones generally appear as triggered emission type events, with discrete rising tone structures that rapidly rise in frequency out of the main band of observed H^+ EMIC waves. A smaller number of EMIC wave rising tone events were found in the He^+ band, where rising tones usually take the form of discrete structures with a positive slope embedded within the main band of He^+ EMIC waves, similar in appearance to whistler-mode chorus elements. Understanding the occurrence rates and properties of rising tone EMIC waves will provide observational context for theoretical studies indicating that rising tone EMIC waves are more efficient at scattering radiation belt electrons than ordinary EMIC waves.