Cold heavy ion composition in the lower plasmasphere estimated from lightning induced EMIC waves

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Ion cyclotron whistler waves are electromagnetic ion cyclotron (EMIC) mode waves induced by lightning discharge. Propagation properties of ion cyclotron whistler waves strongly depend on the local cold heavy-ion composition. Crossover frequency is an important frequency for the ion cyclotron whistlers, which is a function of the ion composition. In this study, we examine the variation in the crossover frequency of heavy ion band ion cyclotron whistler waves observed by the Van Allen probes and the Akebono satellites. We found that the crossover frequencies of the observed events decreased with increasing altitude. This suggests the total heavy-ion composition is high at low altitudes and decreases with increasing altitude around lower plasmasphere. We can determine the composition of three species of ions by measuring two crossover frequencies. We focus on H^+ band and He^+ band ion cyclotron whistler waves, and estimate proton-helium ion ratio ($n(He^+)/n(H^+)$) and proton-oxygen ion ratio ($n(O^+)/n(H^+)$) in the lower plasmasphere. This wave-based approach used in this study can also be a useful means of estimating unknown cold-ion distributions in the inner magnetosphere.

Keywords: Ion cyclotron whistler, EMIC wave, heavy ion

