Systematic Evaluation of the Characteristics and Generation of Low-Frequency Plasmaspheric Hiss

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Plasmaspheric hiss emissions, which are typically observed inside the plasmasphere, are known to play an important role in controlling the overall structure and dynamics of the Earth's radiation belts through pitch angle scattering. Although the characteristics of hiss have been studied using previous satellite data, the statistical results need further improvement due to the limited frequency coverage and resolution of previous satellites, and the difficulty of differentiating hiss from other types of emissions in the inner magnetosphere. Moreover, despite its recognized importance, the generation of plasmaspheric hiss has been a topic of intense debate for over four decades since its discovery.

Recent observations by the Van Allen Probes reported that hiss emissions could have much lower frequencies than the previously adopted values (0.1−2 kHz) from CRRES statistics. Our recent observation using Van Allen Probes wave data [*Li et al., Geophysical Research Letters*, **40**, 2013, pp. 3798-3803] reported unusually low-frequency hiss emissions extending down to ~20 Hz. We demonstrate that the intensification of such low-frequency hiss emissions was associated with energetic electron injection and the calculated minimum resonant energy agrees remarkably well with the upper energy of the injected electron energy spectrum. We further calculate linear growth rates using observed electron distributions and find that they show instability at these low frequencies, although they are insufficient to lead to observed hiss wave intensity. Therefore, we suggest that this low-frequency hiss is likely to be locally excited by the injected anisotropic electrons into the outer plasmasphere with energies above ~100 keV, but additional wave amplification is required to reach the observed wave amplitudes.

We extend this analysis and systematically evaluate the preferential region of these low-frequency hiss emissions, quantify their occurrence rates in different L-MLT regions, and determine their relation to the levels of geomagnetic activity. This analysis is performed using newly available Van Allen Probes wave data over > 2 years, which provide extensive coverage and comprehensive wave polarization properties over the frequency of 10 Hz – 12 kHz in the entire inner magnetosphere. Our statistical results show that low-frequency plasmaspheric hiss (< 100 Hz) is observed quite often particularly in the outer plasmasphere on the dayside during geomagnetically disturbed periods. Moreover, for these low-frequency hiss wave events we systematically evaluate the energetic electron pitch angle distributions measured by Van Allen Probes, which are potentially responsible for the wave excitation. We further calculate linear growth rates using the observed electron distributions and plasma parameters to determine whether the observed electron distributions are sufficiently unstable to excite the observed low-frequency plasmaspheric hiss.