Analysis of Magnetospheric ELF/VLF Wave Amplification from the Siple Transmitter Experiment

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Controlled experiments with dedicated ground-based ELF/VLF (0.3 - 30 kHz) transmitters are invaluable in investigating nonlinear whistler mode wave-particle interactions in the Earth's magnetosphere. The most productive such experiment operated between 1973 and 1988 near L=4 at Siple Station, Antarctica, but analysis was limited by the data processing capabilities of the time. A major effort has been undertaken to digitize and preserve a significant portion of the historical data set from the original magnetic tapes, and we present here examples from the compiled data set as well as the processing techniques used to remove artifacts introduced during recording and playback. This digitized data set enables long-term statistical analysis of data from the Siple Station experiment for observation-driven evaluation of physical models of resonant, nonlinear growth.

We analyze a commonly transmitted diagnostic format from 1986 and present statistics on the occurrence and properties of amplified ELF/VLF waves received by a ground-based receiver at the geomagnetic conjugate location to Siple at Lake Mistissini, Quebec. For the interval examined, only 11% of Siple transmissions are successfully received in the conjugate hemisphere with quiet geomagnetic conditions being significantly more conducive to successful reception. The total growth for the set of events examined is estimated to be 5 - 40 dB, and nonlinear growth rates are in the range of 20 - 350 dB/s. The observations show that as the nonlinear growth rate increases, the duration of nonlinear growth decreases. Significant linear correlation is found between the noise floor and the saturation level, with higher noise floors resulting from increases in natural magnetospheric emissions. Finally, we find a lack of correlation between the nonlinear growth rate and the noise, threshold, and saturation levels.