# Global prediction of inner radiation belt energy deposition caused by lightning

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It has been suggested that whistler-induced electron precipitation (WEP) may be the most significant inner radiation belt loss process for some electron energy ranges. WEP losse from the Van Allen radiation belts occurs as a result of coupling between the troposphere and the magnetosphere. The energetic electron precipitation arises from lightning produced whistlers interacting with cyclotron resonant radiation belt electrons near the equatorial zone. Pitch angle scattering of energetic radiation belt electrons by whistler mode waves drives some resonant electrons into the bounce loss cone, resulting in their precipitation into the atmosphere. An important parameter for determining the overall importance of WEP to radiation belt losses is the magnitude and occurrence frequency of "typical" WEP events.

In this study we examine the global distribution of energetic electron precipitation driven by lightning, in order to determine the energy deposited into the middle atmosphere. Previous studies have made use of lightning-driven precipitation burst rates calibrated by observations from Faraday, Antarctica, to estimate losses from the inner radiation belts. In order to confirm the reliability of those rates and the validity of the conclusions drawn from those studies, we have analyzed New Zealand data to test our global understanding. We examine about 10,000 hours of AbsPAL recordings, and analyze subionospheric VLF perturbations observed on transmissions from VLF transmitters in Hawaii (NPM) and western Australia (NWC). These observations are compared with previous reports from the Antarctic Peninsula.

The perturbation rates observed in the New Zealand data are consistent with those predicted from the global distribution of the lightning sources. A typical precipitation burst at $L$~2.3 will have a mean precipitation energy flux of ~$1\times10^{-3}$ ergs $cm^{-2}$ $s^{-1}$. The precipitation of energetic electrons by these bursts in the range $L$=1.9-3.5 will lead to a mean rate of energy deposited into the atmosphere of $3\times10^{-4}$ ergs $cm^{-2}$ $min^{-1}$, varying from a low of zero above some ocean regions to a high of ~$6\times10^{-3}$ ergs $cm^{-2}$ $min^{-1}$ above North America.