Relativistic Electron Precipitation by Whistler-Mode Waves: Potential Role of Wave Ducting

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Precipitation of relativistic electrons into the Earth's atmosphere regulates the outer radiation belt fluxes and contributes to magnetosphere-atmosphere coupling. One of the main drivers of such precipitation is electron scattering by whistler-mode waves. Whistler-mode waves typically originate at the equator, where they can resonate with and scatter sub-relativistic (tens to a few hundred keV) electrons. However, they can occasionally propagate far away from the equator along field lines, reaching middle latitudes, where they can resonate with and scatter relativistic (>500 keV) electrons. Such a propagation is typical on the dayside, but has barely been found on the nightside, where the waves are usually quickly damped along their propagation due to Landau damping. In this presentation, we will overview ELFIN CubeSat observations of relativistic electron precipitation on the night-side. We demonstrate that energies of precipitating electrons may reach 1-3MeV, whereas the precipitating fluxes approach the strong diffusion limit in the entire energy range of 50keV-1MeV. We will discuss possible mechanisms of such precipitation and suggest that the wave ducting around plasma injection regions is the most prospective one. Such ducting can be supported by plasma density gradients around the night-side plasma injections, which are also the primary source of hot, transversely anisotropic electrons responsible for whistler-mode wave generation.

We will also discuss possible datasets that can reveal the role of wave ducting in relativistic electron losses. The first dataset combines low-altitude measurements of precipitating electrons with ground-based observations of magnetospheric whistler-mode waves; this dataset can be obtained from existing low-altitude and ground-based measurements. The second dataset combines low-altitude measurements of precipitating electrons with low-altitude wave measurements, and we will discuss future missions that can provide such a dataset.