THE EFFECT OF LIGHTNING ON OUTER-BELT ELECTRONS

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ABSTRACT

The electron population of the outer belt exhibits significant variation on a time scale of days. It expands sharply during periods of geomagnetic activity, then decreases several orders of magnitude over the course of the following week. Lightning is the primary cause of electron transfer from the trapped population to the top of the atmosphere; electromagnetic energy generated in lightning couples with moving trapped electrons such that the pitch angles of the electrons are lowered. Some electrons are precipitated directly into the atmosphere by these wave-particle interactions, but most of the scattered electron population remains trapped at smaller pitch angles, and as is the case for all trapped electrons, move eastward under the influence of gradient and curvature drift. Due to the effect of offset and tilt of the geomagnetic field, the smallest equatorial pitch angle for a stable trapped outer-belt electron (around an L-value of 4) occurs in the southern hemisphere in the region of the Weddell Sea. Electrons can be trapped temporarily at smaller pitch angles, but eastward drift causes them to precipitate by encountering the atmosphere over the Weddell Sea. (This region of temporary trapping is referred to as the drift loss cone.). Thus, small anomalies in the geomagnetic field cause a large anomaly in the pattern of energetic electron precipitation from the outer belt: it occurs mainly in the southern hemisphere and at longitudes near the Weddell Sea. The dawn-to-dusk gelelectric field also plays a role in energetic electron precipitation from the outer belt. As eastward drifting electrons traverse the dawn-noon-dusk portion of their trajectories, they lose energy and consequently move to higher mirror points; and during their dusk-midnight-dawn trajectories gain energy and move to lower mirror points. Thus, electron precipitation is favored on the night side of the Earth. Further temporal modulation in electron precipitation via the drift loss cone is caused by the diurnal variation in worldwide thunderstorm activity. The effect of longitudinal and temporal modulation of energetic electron precipitation on other geophysical phenomena will be discussed.