Role of Magnetospheric Ducts in Observations of Energetic Electron Precipitation in the Conjugate Hemisphere

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Lightning-induced electron precipitation (LEP) events (Voss, H. D., et al. "Lightning-induced electron precipitation." (1984): 740-742.) are induced by Very Low Frequency (VLF) radiation from lightning discharges that are coupled into the Earth's magnetosphere and propagate in the whistler-mode. LEP events are well-established means of loss of the trapped radiation belt electrons caused by resonant whistler wave-particle interactions (Johnson, M. P., et.al., Geophysical research letters 26.23, 1999). LEP events have been actively studied for the last 20 years but due to the non-trivial nature of wave propagation in the ionosphere and magnetosphere as well as the complexity of the cyclotron wave-particle interaction and subsequent energy deposition, the precise effects of LEP events on the ionosphere are not well understood. Recently, it has been shown that the LEP events first produce disturbances in the conjugate hemisphere and then in the hemisphere of the causative lightning discharge (Gołkowski, M., et.al. Geophysical Research Letters 41.2, 2014). Early works regarding whistler-mode wave propagation was focused on ducted wave propagation (Burgess, W. C., et.al., Journal of Geophysical Research: Space Physics (1978–2012) 98.A9, 1993). In ducted LEP events, the whistler-mode wave energy that escapes upward through the ionosphere enters the magnetosphere and follows the ducts of the magnetosphere. More recent works are more biased toward nonducted (oblique) wave propagation (Peter, William B., Journal of Geophysical Research: Space Physics (1978–2012) 109.A12, 2004)

In this work, we reexamine a recently published event (Gołkowski, M., et.al. Geophysical Research Letters 41.2, 2014) and present new data on whistler dispersion analysis and VLF remote sensing. Our dispersion analysis of whistler waves shows that the ducted wave propagation better explains the ground-based observations in the conjugate hemisphere.