



Global Scale ELF/VLF Remote Sensing from Antarctica

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Radio observations in the extremely low frequency (ELF, 3-3000 Hz) and very low frequency (VLF, 3-30 kHz) bands are regularly used to remote sense events that occur around the globe, most of which occur within the *D*-region ionosphere (~70-100 km altitude). “Events” can present as transient changes to the electron density and/or temperature of the region produced by, for example, lightning electromagnetic pulse heating, lightning-induced electron precipitation, auroral precipitation, solar X-ray flares, or galactic gamma ray bursts, among others. Observation locations on the Antarctic continent are prized for their low-radio-noise environments from which to observe these types of ionospheric events.

Other types of events can be identified by the properties of the associated radio burst detected in the Antarctic. For instance, gigantic jets, whose conducting channels impulsively connect the tops of thunderclouds to the ionosphere, appear to present with a specific type of ELF radio burst that can be detected from distant locations around the globe. Similarly, radio-quiet Antarctic observations can be used to discern the properties of lightning flashes that tend to successfully inject whistler waves into the magnetosphere.

In each of these cases, Antarctica provides a platform from which to perform the observations of events which tend to occur far from the Antarctic. But ELF/VLF observations also provide a means to investigate energetic interactions within the Antarctic atmosphere itself.

In this paper, we present Antarctic observations that demonstrate ELF/VLF remote sensing capabilities, but provide an additional focus on the ability of ELF/VLF observations to characterize the Antarctic ionosphere specifically. We highlight polar cap proton injection events, auroral precipitation activity, and the curious case of auroral hiss-like radio waves produced above Arrival Heights as a result of the Hunga Tonga explosion.