An analysis of ELF sferics produced by rocket-triggered lightning

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Lightning regularly generates ELF radio atmospherics (sferics) in the 5-500 Hz frequency range. The processes that produce ELF sferics have been studied for more than 50 years. Rocket-triggered lightning experiments at the International Center for Lightning Research and Testing (ICLRT) located at Camp Blanding, Florida provide a unique data set for comparing the ELF sferics measured at great (>3000 km) distances to the source characteristics of a lightning return stroke. In this paper, we present experimental observations of the lightning channel-base current measured at the ICLRT together with observations of the ELF sferics detected ~4600 km away at Sondrestromfjord, Greenland. Using these data sets, we provide an estimate of the Earth-ionosphere waveguide transfer function as a function of return stroke properties. These results are critically compared with the model predictions of a modified version of the Long Wavelength Propagation Capability (LWPC) code, which was developed by the Naval Ocean Systems Center over a period of many years. LWPC is an inherently narrowband propagation code that has been modified to predict the broadband response of the Earth-Ionosphere waveguide to an impulsive lightning flash while preserving the ability of LWPC to account for an inhomogeneous waveguide. Modeling performed in the ELF range provides the use of single (QTEM) mode characteristics while attempting to establish model parameters and functionality such as mode coupling and field summation along an inhomogeneous waveguide. The ability to infer source characteristics using observations at great distances may prove to greatly enhance the understanding of lightning processes that are associated with the production of transient luminous events (TLEs) as well as other ionospheric effects associated with lightning. This paper critically evaluates the model predictions of the modified LWPC code with the goal of determining the minimum ELF peak current that produces detectable ELF sferics at great distances (>3 Mm) under various ionospheric conditions.