

The Effect of Lightning Return Stroke Speed on Earth-Ionosphere Waveguide Excitation

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Model predictions of lightning event characteristics such as the lightning current waveform and lightning return stroke speed are modeled and evaluated with attention to their effects on Earth-Ionosphere waveguide excitation. 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. The modeling of the sferic waveform is carried out using a modified version of the Long Wavelength Propagation Capability (LWPC) code 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 when attempting to establish model parameters and functionality such as mode coupling and field summation along an inhomogeneous waveguide. ELF observations performed in Alaska, California, Antarctica, and Greenland may prove useful in the examination of the lightning characteristics predicted by this model in comparison to the lightning waveform signature and return stroke speed observed during rocket-triggered lightning experiments at the International Center for Lightning Research and Testing (ICLRT) located at Camp Blanding, Florida. The lightning current waveforms directly measured at the base of the channel (at the ICLRT) can be used together with photometric measurements of the optical return stroke speed to provide experimental evidence of the lightning return stroke speed's effect on Earth-Ionosphere waveguide excitation. This paper critically evaluates the model predictions of the modified LWPC code with the goal of determining the minimum ELF peak current and the minimum ELF return stroke speed that produces detectable ELF sferics at great distances (>1 Mm).