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Transient Luminous Events and Terrestrial Gamma Ray Flashes

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1. Extended Abstract

Although lightning has been studied intensively for hundreds of years, the past 25 years have seen a series of unexpected discoveries concerning both the basic physics of lightning and the different mechanisms behind its impact throughout the atmosphere. These new processes and phenomena were discovered through observations and measurements across the entire electromagnetic spectrum, from radio (for example, compact intra-cloud discharges) to optical (sprites and jets) to gamma ray (terrestrial gamma ray flashes) frequencies. However, measurements of the radio emissions from these processes and any associated lightning have played and continue to play a leading role in illuminating the physics behind these phenomena. These radio measurements span a remarkable fraction of the electromagnetic spectrum, from extremely low frequency (i.e. tens of Hz) to ultra-high frequency (i.e. hundreds of MHz). This enormous bandwidth reflects the similarly wide range of time and spatial scales of charge motion associated with lightning and lightning-driven processes, from the tens of km and hundreds of milliseconds for gigantic jets that span the thunderstorm-ionosphere gap, to the handful of meters and fractions of a microsecond for individual streamers at the tip of a propagating leader. Focusing on radio measurements and radio imaging, this presentation will trace the history of many of these phenomena, highlighting how they are (and are not) connected, and review how the latest measurements are adding to the very complex picture of how lightning initiates, develops, and impacts the rest of Earth's atmosphere.