Applications of Lightning Remote Sensing with Low Frequency Radio Measurements

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Passive radio and electromagnetic observations of lightning can provide important quantitative information while employing sensors that can be some distance away from the event of interest. In this presentation, we will describe recent research in which remote radio measurements over multiple frequency bandwidths were combined to provide measurements of different aspects of the lightning. Specific topics that will be covered are the relationship between flash morphology and lightning charge transfer in high peak current negative cloud-to-ground strokes; lightning radio emissions during terrestrial gamma ray flashes; and the relationship between triangulated sprite location, the underlying lightning flash structure, and the cloud-to-ground charge transfer.

1. Summary

Measuring quantitative lightning parameters, such as peak current and charge transfer, is important for answering a number of open research questions related to both lightning fundamentals and its high altitude effects. When the phenomena in question do not occur with most lightning, such as sprites or terrestrial gamma ray flashes, the ability to measure lightning parameters using remote techniques is essential.

Because lightning radiates electromagnetically over a wide range of frequencies, a wide range of lightning can be probed using these radio emissions. Signals in the tens to hundreds of MHz from so-called lightning mapping arrays have proven valuable for measuring the leader structure of lightning flashes [1], but the propagation distance of these signals is a few hundred kilometres at most. In contrast, Schumann resonance band signals of a few tens of Hz provide an integrated measurement of the lightning charge moment change, and can be detected globally [2].

Not surprisingly, one can learn the most about lightning by combining measurements in different frequency bands. In this presentation, we will describe recent research in which multiple radio measurements were combined to provide as complete a picture as possible of the lightning and thus address several fundamental open scientific questions. Specific topics that will be covered are the relationship between flash morphology and lightning charge transfer in high peak current negative cloud-to-ground strokes [3]; lightning radio emissions during terrestrial gamma ray flashes [4]; and the relationship between triangulated sprite location, the underlying flash structure, and the cloud-to-ground charge transfer.

2. References

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