

**SATELLITE AND GROUND-BASED DATA EXPLOITATION FOR
NUDET DISCRIMINATION**

**CHARACTERIZING ATMOSPHERIC ELECTRODYNAMIC
EMISSIONS FROM LIGHTNING, SPRITES, JETS AND ELVES.**

FINAL REPORT

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PREFACE

Abstract and Objective of the Contract Effort: Both lightning and nuclear airbursts are well established sources of optical and RF emission observed from satellites and ground stations. Global attempts to detect nuclear airbursts using optical and/or RF techniques often encounter lightning and related phenomena as background “clutter”. As part of the mission to monitor compliance with the nuclear test-ban and non-proliferation treaties, a number of different techniques for detecting and identifying nuclear detonations (NUDETS) around the world have been developed. Recently, a class of atmospheric phenomena, called “sprites”, “elves” and “jets” (Transient Electromagnetic Events, TREMEs) and associated RF signatures have been identified above thunderstorms which exhibit certain potential for introducing uncharacterized backgrounds and clutter for treaty monitoring, as well as a broad range of other system missions, such as surveillance, TW/AA and theater combat.

Improved sensors with increased sensitivity and dynamic range will be required for next-generation detection. Such sensors will be significantly more vulnerable to “confusion” from natural cluttered backgrounds. Therefore, new discrimination algorithms will be required to process the signals recorded by the sensor. Such algorithms must be based on a full understanding and characterization of both nuclear and natural clutter backgrounds. That fusion of ground-based data on lightning and the newly-discovered TREMEs phenomena in the middle atmosphere with data from research and mission satellites on these phenomena and from calculations of NUDETS signatures can form the basis for such algorithms. There are systematic patterns emerging from the data which strongly suggest that discriminating processing algorithms and models can be derived to aid in data analysis and system effects mitigation.

This contract effort was aimed at the full characterization of lightning, TREMEs and associated RF signatures in terms of functional parameters which will allow model development and derivation of the range of discriminating signatures expected from these events. These signature characteristics will form the basis for developing discrimination algorithms for natural events vs NUDETs for treaty monitoring applications. This contract effort was a part of a larger collaborative effort involving many agencies and organizations. Therefore, for completeness we have included in this report all relevant information obtained from all associated and relevant efforts.

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