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**Auroral and Midlatitude Radar Studies: Radar Methods for Improved Diagnostics of the HF-Modified and Natural Ionospheres**

Authors: [Frank T. Djuth](#); [John H. Elder](#); [Kenneth L. Williams](#); [GEOSPACE RESEARCH INC EL SEGUNDO CA](#)

**Abstract:** This research program addresses fundamental issues related to the interaction of a high-power, high- frequency (3 - 10 MHz) radio wave with the ionosphere. Data acquired with incoherent scatter radars and a modest (50 kW) VHF radar were examined. The reported observations were made with the Arecibo HF modification facility in Puerto Rico and the Tromsø 'superheater' located in Norway. Particular attention is paid to the excitation of Langmuir and ion turbulence and the development of induced ionospheric irregularities. Within 50 ms of HF beam turn on, the ionospheric plasma behaves as a smooth stratified medium. In this environment, elements of strong Langmuir turbulence are detected near the altitude where the HF frequency matches the local electron plasma frequency. The coupling between Langmuir oscillations and ionospheric perturbations is examined over both intermediate (50 ms to several seconds) and long time scales (tens of seconds and beyond) to elucidate HF energy partitioning in the plasma. An additional investigation focused on the physics of missile plumes in the lower atmosphere is also described. This can be viewed as a lower atmosphere modification experiment in which missile fuel generates a highly collisional plasma. Plume signatures were measured with a VHF radar to help verify model calculations of cross section and spectral content.

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**Description:** Final rept. 28 Sep 92-31 Jan 95  
**Pages:** 71  
**Report Date:** MAR 96  
**Contract Number:** F19628-92-C-0168  
**Report Number:** A999413

**Keywords relating to this report:**

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