



# IEEE KW Section



IEEE Aerospace & Electronic Systems Society (AEES)

## Ionospheric Effects on High Frequency Surface Wave Radar Performance

Dr. Ryan Riddolls, DRDC Ottawa

**Date: Jan. 20, 2006**

**Time: 10:00am, EST**

**Location: Davis Center 1304, University of Waterloo**

**Abstract:** Canada currently operates two High Frequency Surface Wave Radar (HFSWR) systems in Newfoundland at Cape Race and Cape Bonavista. These radars can detect, locate, and track ocean vessels beyond the Earth's horizon by taking advantage of the diffraction of electromagnetic waves over the conducting ocean surface. However, long-range ocean vessel detection is confounded by radar clutter comprising echoes from the ionospheric plasma. In this presentation we examine the physics of these echoes, recognizing that the ionosphere is an inhomogeneous, anisotropic, nonlinear medium. Examples are given from the author's previous research. It is shown that ionospheric inhomogeneity produces the largest impact on radar performance for parameters typical of HFSWR. The effects produced by large-scale plasma irregularities, such as fading and scintillation, are described using ray optics theory. However, ray optics fails in the case of small-scale irregularities, where one must consider Thomson scattering by plasma electron and ion species. Having considered the physics, we turn to examining the tools that are available to the radar engineer to mitigate ionospheric effects on radar performance, and the connection of these tools with the ionospheric physics. Particular attention is given to covariance decomposition-type methods for radars with multiple spatial channels, and the extent of what can be achieved with these methods.

**Ryan Riddolls:** Ryan Riddolls received a Ph.D. degree in 2003 from the Department of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology. During 1994 to 2003 he was a Research Assistant in the Ionospheric Plasma Research Group at the MIT Plasma Science and Fusion Center, where he carried out research projects in ionospheric radar, laboratory plasma physics, and extremely low frequency radio. In 2004 he joined the Radar Systems Section at Defence Research and Development Canada in Ottawa, where he currently leads the high frequency radar program. Dr. Riddolls has published a dozen peer-reviewed scientific papers and was a Young Scientist Award recipient at the 2005 General Assembly of the International Radio Science Union in New Delhi, India.

**Invited by, Dr. Reza Dizaji**

**Raytheon Canada Limited**

**400 Phillip Street  
Waterloo, N2T 4K6, ON  
<http://www.raytheon.ca>**