

## Weather Clutter Simulation

### *Detection of Targets in Precipitation*

The early detection, tracking, and engagement of sea-skimming anti-ship missiles are extremely important functions of modern naval radar. X-band phased array radar is currently being developed by naval forces to perform these functions. Operation at X-band frequencies provides good performance in horizon search mode with respect to multi-path propagation. However, target detection using X-band radar can be greatly affected by weather. Thus, reliable methods for detecting small targets in weather clutter with X-band radar are needed. A high fidelity simulation of the weather clutter signals measured by X-band radar has been developed to help address this need. Simulated or real target signals can be combined with the simulated weather clutter signals to provide a controllable source of radar data that can be used to assess detection algorithms.



Detection scenario

#### Features

Based on a parameterized description of the modeled radar system and environment, the simulation produces the digitized radar signal (in-phase and quadrature components) that would be received for each of many range bins along a specified measurement path. The environment is modeled as a stratiform precipitation field (snow, mixed phase, and rain) above a rough spherical sea surface. The missile is modeled as a point target moving at a constant altitude directly toward the radar. The received signals are calculated considering, among other things, the size distribution and thermodynamic phases of the precipitation particles, the wind field, attenuation, turbulence, reflection from the sea surface, statistical fluctuations, and range correlation. A full hemisphere of radar signals could also be generated, assuming that the precipitation structure remains constant over the required measure-

ment time. This would enable the detection of crossing targets to also be investigated.

#### Evaluation

An experimental program has been conducted at DRDC Ottawa to test the simulation's ability to produce realistic weather clutter signals. Atmospheric measurements made by a radiosonde and a Joss-Waldvogel disdrometer were used to provide environmental inputs for the weather clutter simulation. Simultaneous radar measurements were made by the Experimental Array Radar System. The simulated data were found to compare well with the experimental radar measurements in terms of various signal properties. In addition, comparisons of simulated signals with real data published in the literature have demonstrated the weather clutter simulation's ability to generate signals that realistically reflect the thermodynamic structure of the observed precipitation.

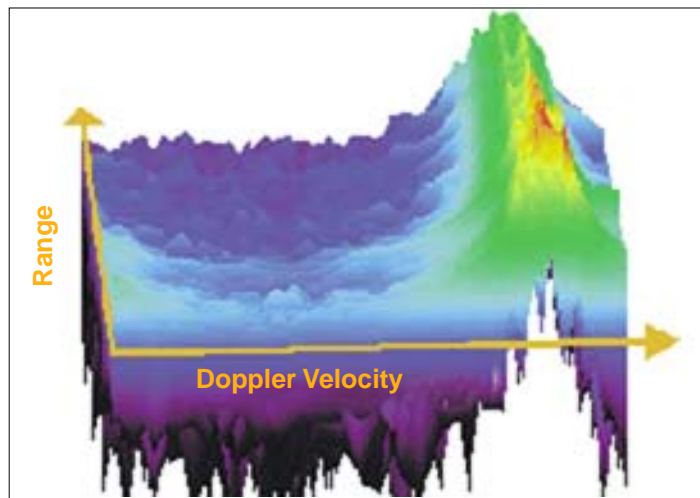
# Weather Clutter Simulation

## Detection of Targets in Precipitation

### Applicability

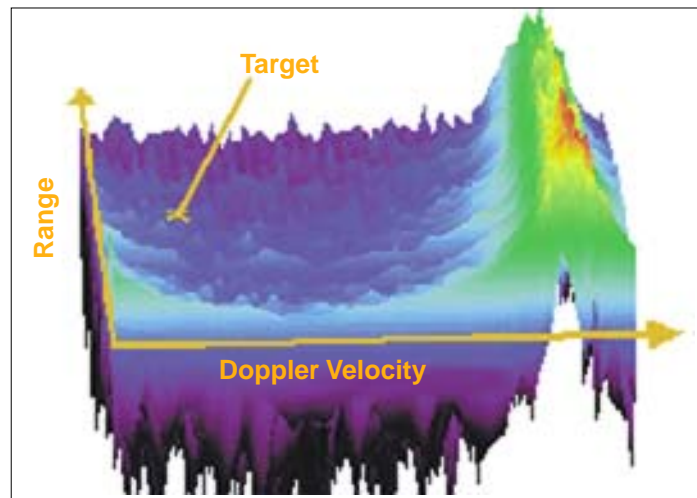
The assumptions and mathematical models used in the weather clutter simulation are also applicable to C- and S-band radar systems. Hence, the simulation may be a useful tool for any applications requiring a source of weather clutter as measured by X-, C-, or

S-band radar. For example, since real measurements of precipitation cannot be made on demand, the simulation could be used to generate weather clutter signals that could be added to previous experimental radar measurements. The effects of precipitation, if it had been present, could then be investigated.



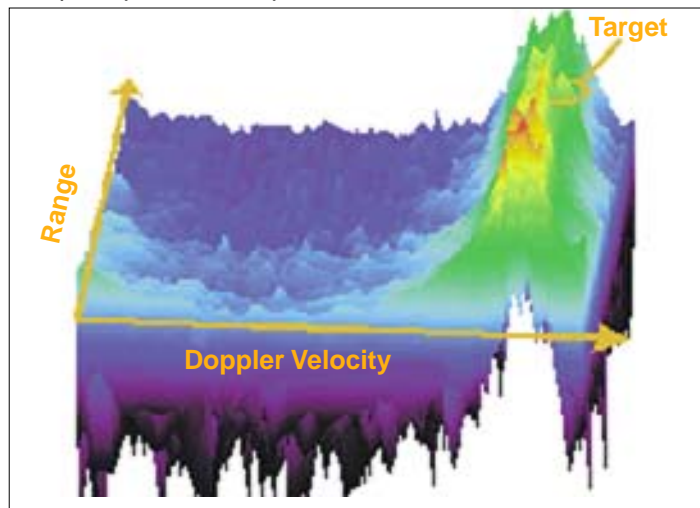
Simulated power spectra for first waveform. Target is completely obscured by weather clutter.

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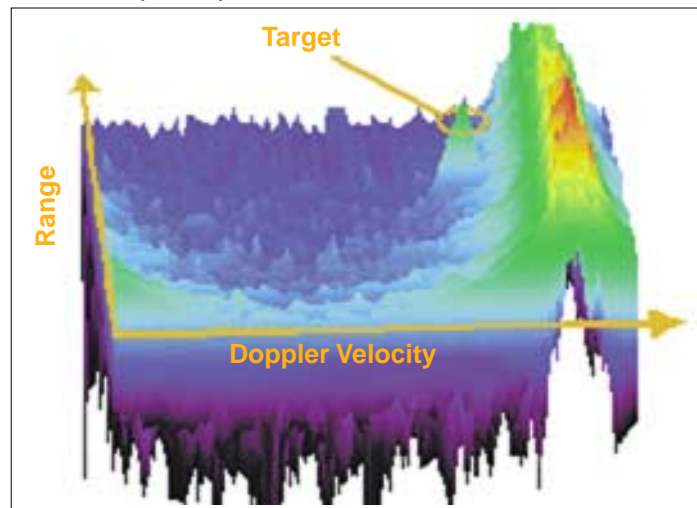
Simulated power spectra for third waveform. Target is obscured by multipath interference.

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Simulated power spectra for second waveform. Target is partially obscured by weather clutter.

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Simulated power spectra for fourth waveform. Target is visible at the edge of the weather clutter.

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### Availability

Weather Clutter Simulation is available to the Department of National Defence and other Canadian government departments, as well as allied nations, industry and academia through a variety of business models. For information, please contact the Business Development Office.

### Technical Inquiries

Head, Radar Applications and  
Space Technology Section  
Email: RAST-ARTS@drdc-rddc.gc.ca

(613) 998-2063

### Business Inquiries

Business Development Office  
Email: collabo-ottawa@drdc-rddc.gc.ca

(613) 998-2203

### Defence R&D Canada – Ottawa

3701 Carling Ave., Ottawa, Ontario K1A 0Z4  
Phone: (613) 998-2127 Fax: (613) 998-2675  
Email: info-ottawa@drdc-rddc.gc.ca  
Web site: www.ottawa.drdc-rddc.gc.ca  
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