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Impacts of Directional Noise on Modelling of OTH Radar Performance

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Extended Abstract

Skywave over-the-horizon radar (OTHR) is a HF radar technology that exploits the Earth's ionosphere to enable long range beyond horizon propagation of HF radar signals for the purpose of wide-area surveillance of aircraft and maritime vessels. The ionosphere is a highly variable medium and this variability greatly influences the operational performance of a skywave OTHR. Considerable care in selecting radar operating parameters is required to achieve optimal performance for the required mission and sophisticated modelling of OTH radar networks may be used to this end.

The performance of OTHR is governed by many factors. These are the propagation environment (the ionosphere), the physical radar equipment (transmitter power, transmit and receive antenna gains), the target scattering cross- section (RCS), clutter from ground (or sea) back-scatterer (which may be spread in Doppler due to ionospheric disturbances), the external noise environment of radar receiving system, RF interference from other transmitters, the choice of radar waveform, the signal processing and target tracking algorithms, and the allocation of the radar resources. In previous papers [1, 2], we developed a Radar Network Design Methodology, with reference to the above factors, and detailed the associated metrics used to assess proposed OTH Radar network designs. The ionospheric propagation is modelled using the 2D numerical radio wave ray tracing engine of the PHaRLAP raytracing toolbox (developed by DST Group) through the International Reference Ionosphere (IRI). The Zurich smoothed sun spot number (SSN) is used as measure of the solar activity. Propagation lookup tables are generated which take the form of predicted received power for the strongest propagation mode from a 1 Watt (W) radiator assuming a one second (1s) coherent integration time (CIT), and a target with 1m^2 radar cross section (RCS). The tables are parameterised by radar-to-target region range and radar operating frequency, with transmit and receive array gains included. Standard radar signal processing techniques are used to calculate the probability of detection and false alarm rate for the targets not obscured by clutter and a simple M detections out of N observations model is used for tracking

Our previous work employed the International Telecommunication Union (ITU) noise reference for the background noise at the radar receive sites. While widely used, the ITU noise refence has several limitations: It 1. does not take in to account solar cycle variations, 2. tends to over predict noise levels in the remote Australian regions, and 3. is omni-directional *i.e.* the directionality of the noise field is not accounted for. In this paper we use a more sophisticated directional noise model, SPINE [3], which accounts for these 3 factors. We explore the importance of using appropriate directional noise models on the overall modelling of OTH Radar performance and how that may impact decisions regarding the design of a suitable network to achieve the mission requirements

References

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