# Measurements and Simulation of VHF and UHF Radar Signals

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**Abstract:**
Synthetic aperture radars (SAR) operating below 1GHz provide a foliage- and ground-penetrating remote sensing or surveillance capability. However, at these low frequencies, ionospheric irregularities forward-scatter the radar signals and this limits the synthetic aperture and bandwidth over which phase coherence can be maintained.

This paper describes a thin phase screen, parabolic equation based, Trans-Ionospheric Radio Propagation Simulator (TIRPS) and measurements made as part of the US-UK Wideband Ionospheric Distortion Experiment (WIDE) using the ALTAIR radar on Kwajalein Island (9.4°N, 166.8°E)

Modelled channel scattering functions (CSFs) are compared to experimental 158MHz and 422 MHz data derived from ALTAIR. TIRPS quantitatively reproduces the experimental results, including the quasi-parabolic profile observed in the measured CSFs under strong turbulence conditions.

Coherency Bandwidth (CB) and coherency time (CT) measurements of the equatorial ionosphere, made using the ALTAIR are also presented as a function of the two-way $S_4$ scintillation index at 422MHz The log-linear regression equations are CT = 1.46 exp(-1.40 $S_4$) seconds at 158MHz and CT = 2.31 exp(-1.10 $S_4$) seconds at 422MHz. CT varies by a factor of 2-3 depending on the effective scan velocity through the ionosphere, $v_{eff}$.

The CT and CB, as a function of $S_4$ have been compared to those from TIRPS. With appropriate values of $v_{eff}$ and mid-range values of phase spectral index and outer scale, the agreement is found to be excellent. Validation of CB is, however, limited by insufficient radar chirp bandwidth. Formulating the model in terms of the two-way $S_4$ index (an easily measurable parameter) rather than more fundamental phase screen parameters (which are difficult to obtain), improves its utility for the systems engineer.