Measurement of ionospheric scintillation parameters from Synthetic Aperture Radar and their comparison

S. Mohanty* [(1)], C. Carrano [(2)], and G. Singh[(1)]
(1) CSRE, Indian Institute of Technology Bombay, Mumbai, India
(2) ISR, Boston College, Boston, MA, USA

Space-borne synthetic aperture radars (SARs), operating at low frequencies of L- and P- bands, are prone to being affected by the ionosphere. The irregularities arising in the post-sunset equatorial ionosphere cause scintillations, or distortions of the radar signal's amplitude and phase. Recent literatures have widely discussed the effects of scintillations on such low-frequency sensors. However, there still remains a need to correctly quantify the ionospheric parameters for characterizing the scintillation phenomenon. This present work, thus, compares the existing techniques used for computing scintillation parameters from different instruments, such as space-borne SAR, Global Positioning System (GPS) satellites and VHF/UHF radar signals.

Of the many parameters needed to characterize ionospheric scintillations, the integrated strength of turbulence at 1-km scale size (C_kL) and slope of the power law spectrum (p) are most important to describe the size distribution of the ionospheric irregularities. Until the recent past, space weather scientists relied on VHF/UHF radio signals or GPS signals affected by scintillation to calculate these parameters. However, SAR sensors operating at L-bands affected by scintillations are also being used to quantify these scintillation parameters and irregularity characteristics (Belcher et al., DOI 10.1109/TGRS.2017.2717081).

In this current work, the authors compare results of scintillation parameter estimations from several available sources. In this regard, Ascension Island, situated in the South Atlantic Ocean, close to the equatorial anomaly crest, is a suitable test site for scintillation studies. Data from the PALSAR-2 sensor onboard ALOS-2 satellite in spotlight-mode (1m resolution) acquired over the site, on two dates of varying ionospheric activities, have been used. The C_kL and p are estimated from the SAR clutter and phase power spectral density (PSD) of the corner reflector (CR) in the image respectively, using the techniques described in (Belcher et al., DOI 10.1109/TGRS.2017.2717081). These parameters are compared with those inferred from GPS and VHF scintillation data from the SCIntillation Network Decision Aid (SCINDA) network. A high degree of correlation is observed between the results from all measurements. The parameters, thus obtained from the SAR sensor, may be used to calculate the 2-D power spectrum of the ionospheric phase screen. This phase screen is a necessary input for modeling approaches that aim to simulate or mitigate the effects of scintillation in SAR for accurate earth observation.