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Evaluation of Radio Beacon Data for Discrimination and Specification of Irregularities in the Equatorial Ionosphere

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The 2019 launch of the FORMOSAT-7/COSMIC-2 satellite system (Constellation Observing System for Meteorology, Ionosphere and Climate-2) presents an unprecedented opportunity for scientific observations of multiple frequency Radio Frequency (RF) Beacon signals from an equatorial constellation. As a supplement to an existing network of ground-based receivers monitoring scintillation activity on geosynchronous communication links, transiting beacon signals from Low-Earth Orbiting satellites allow for the mapping of ionospheric structures across an entire field of view dramatically enhancing the spatial coverage. The FORMOSAT-7/COSMIC-2 constellation, with its six satellites, will provide nearly continual refreshes with spacing such that overflights will be visible every 15-20 minutes in the equatorial zone.

In this study, we evaluate the use of RF Beacon signals from the FORMOSAT-7/COSMIC-2 constellation as a complement to an existing model which tracks the development and propagation of ionospheric plumes from fixed-link UHF signals. Using archived beacon recordings from the Communication/Navigation Outage Forecasting System satellite and new observations from FORMOSAT-7/COSMIC-2, we examine and validate the use of automated techniques to discriminate multi-path and local noise interference from ionospheric-induced fluctuations and analyze the use of the available UHF/LBAND/SBAND tones for improved specification of the scintillation environment during strong scattering conditions.

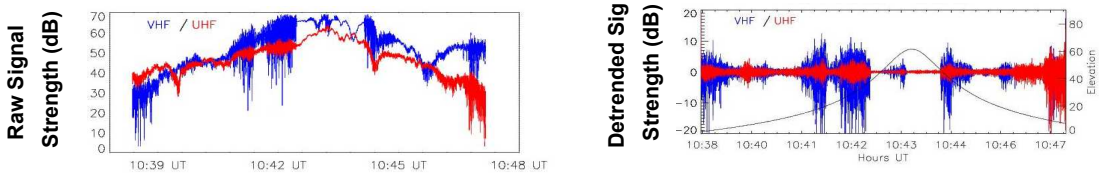

Figure 1. Raw (top) and detrended (bottom) VHF & UHF signal strength from an RF Beacon overflight of a receiver on Kwajalein Atoll. Automated algorithms must distinguish between ionospheric fluctuations (scintillation) and local noise/multi-path.

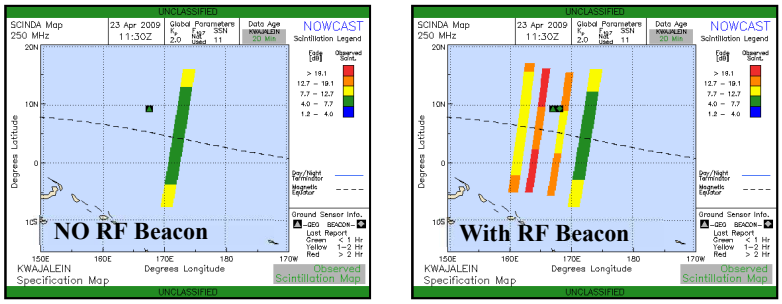

Figure 2. Sample Scintillation Specification Map products from the Pacific highlighting the spatial improvement in coverage provided by RF Beacon observations. The product on the left was fed with ground-based UHF data from a geosynchronous link. On the right, RF Beacon data from the Communication/Navigation Outage Forecasting System satellite beacon were integrated for a high elevation pass.