Analysis of Performance in the Retrieval of 2-D Ionospheric Irregularity Maps in the Biomass Mission

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Low-frequency Synthetic Aperture Radar (SAR) images are affected by the impact the ionospheric propagation on the radar waves. 2-D maps can be obtained as product of the ionospheric corrections allowing for imaging of ionospheric irregularities at very high resolution or broader coverage when compared to other sensing technologies (e.g., GNSS, ionosondes, etc). We analyze in this paper the case of Biomass and characterize the errors in the imaging of the ionosphere resulting from the calibration algorithms foreseen for its Ground Prototype Processor, a Faraday rotation based and an autofocus approach. The methodology of the analysis relies on a turbulent power law Rino model for the perturbations of the ionosphere and the consideration of the spectral behavior of the algorithms. The final estimates provide imaging with sub-kilometric resolutions and relative errors between 10 and 50% for the analyzed cases and algorithms, reconstructing the phase screen from the data.

\[ \Phi_\phi(f_a) \]

\[ B_a \]

\[ \text{PRF} \]

Figure 1. Sketch of the power spectral density of the phase advance error as observed by the SAR. The green box describes the processed bandwidth of the radar images. The blue, magenta, and red lines correspond to the intrinsic errors in the SAR observation caused by aliasing (blue), limited bandwidth (magenta), and thermal noise (red).

(a) Recovered TEC map (b) Error map from FR estimation. (c) Recovered TEC map from Autofocus. (d) Error map from Autofocus.

Figure 2. TEC and TEC error maps with proposed calibration algorithms for Biomass.