An Ionospheric Simulation Module for a VHF Distributed Radar Sounder

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Interest in the subsurface structure and processes occurring in the cryosphere has grown over recent decades. Although ground-penetrating and airborne radar provide regional measurements and insights, large-scale observations are still lacking. To fill this gap, the STRATUS [1] mission concept was once proposed in the ESA Earth Explorer program. It aims to use a constellation of satellites enabling distributed radar sounding at 40–50 MHz. Now, in the DistSound ESA study aimed at consolidating this concept, we are developing a simulator and a performance tool to define system architecture and metrics.

One of the main challenges in this mission concept is signal distortion caused by the Earth's ionosphere [2]. This problem has previously been addressed in other low-frequency imaging Synthetic Aperture Radar (SAR) systems at L and P bands. At those frequencies, ionospheric modeling relies on thin-layer and high-frequency approximations.

We are currently developing an accurate simulation of ionospheric effects using a signal propagator. The goal is to replicate the distortion of transmit and receive signals in a distributed radar geometry with a stratified implementation of the split-step solution [3]. This method is typically used to model phase and intensity scintillations for single-frequency signals and single layers. We aim to extend this approach to cover the polychromatic case and simulate all effects using the full Appleton-Hartree refractive index relation. The output of the ionospheric simulation module allows for the generation of synthetic radar sounder data with ionospheric disturbances and supports the development of mitigation strategies.

References

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