IONOSPHERIC IRREGULARITY EFFECTS ON P-BAND SAR IMAGERY AND THEIR POSSIBLE CORRECTION USING PGA*

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1. ABSTRACT

Long wavelength Synthetic Aperture Radars (SAR) carried on satellites have enormous potential to provide global measurements of the Earth that are unobtainable by other means. This has excited interest in flying such missions. For example, BIOMASS is a proposed mission for the ESA Earth Explorer Programme that will carry a P-band (68 cm wavelength) radar to measure global forest biomass and provide unique data for carbon cycle modelling. Long wavelength SAR is also a key element in the technology development strategy of other countries. Airborne studies show that the ability to measure forest biomass with radar increases significantly as the wavelength increases. However, if a long wavelength radar is onboard a satellite, it will potentially suffer severe ionospheric effects [1-4]. So, in the context of BIOMASS, we analyse these ionospheric effects, and try to develop a compensation method to correct them. By analysing the effects of ionospheric irregularities on the SAR imagery, it is found that the ionosphere-induced phase errors are similar to those arising from uncorrected platform motions in airborne SAR [1]. As is well known, the phase gradient autofocus (PGA) is a method to compensate for such errors [5]. This paper discusses the use of PGA to try to correct ionosphere-induced phase errors in orbital SAR imagery, with preliminary results obtained for the one-dimensional case. In fact, the phase errors induced by ionospheric irregularities are two-dimensional in structure, but their organization by the Earth's magnetic field means that at equatorial latitudes they can be considered approximately one-dimensional for a polar-orbiting radar. At high latitudes, this simplification is not viable.

The effects of ionospheric structure on the focusing, geometry and radiometry of long-wavelength SAR images are analysed in accordance with the specific configuration of the BIOMASS mission. This involves simulations of phase screen data for ionospheric perturbations with different strength regimes generated by using the Wideband model for ionospheric scintillations (WBMOD). These phase screen data are used to corrupt airborne P-band SAR in order to simulate the likely effects of ionospheric scintillation. The corrupted SAR images are then used to assess the feasibility of correction using PGA and the subsequent image quality is investigated. In the first stage of this study, one-dimensional PGA is used to correct scintillation-induced phase errors generated from slices across the two-dimensional phase screen. The one-dimensional results are very good. We then discuss the correction of SAR images corrupted by two-dimensional phase errors; this involves simultaneous correction in the range and azimuthal directions by use of two-dimensional PGA [6].

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3. REFERENCES

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