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Evaluation of surface roughness, magnetic permeability and dielectric permittivity using polarimetric SAR data

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Synthetic Aperture Radar (SAR) systems have great advantages of observing the Earth surface regardless of meteorological conditions and detecting crustal deformations by Interferometric processing. Another latest technique, polarimetric SAR has also been widely used through its principle that backscattering intensity differs with polarization mode. However, most applications are limited to image classification. In addition, the evaluation method for surface physical properties has not yet been investigated well. To achieve this evaluation from the viewpoints of geological identification and water-content estimation of soils, this study adopts mdPSAR (**m**agnetic permeability and **d**ielectric permittivity from **P**olarimetric **S**ynthetic **A**perture **R**adar) proposed by Saepuloh *et al*. and tries to evaluate roughness, relative magnetic permeability, and relative dielectric permittivity of the surface materials using the HH, VV, and HV mode SAR data.

As the first step of mdPSAR, the surface roughness is calculated from the backscattering coefficient data at the HV mode and an empirical equation based on an assumption of fractal property of the topography (Campbell and Shepard, 1996). Next, using the Small Perturbation Model (Fung and Chen, 2010) of backscattering coefficient and the Nelder-Mead Simplex method (a method of nonlinear optimization), the relative magnetic permeability and the relative dielectric permittivity are calculated by minimizing the difference between the model and the backscattering coefficient data at the HH and VV modes.

The areas around the Tottori sand dunes were selected as a case study of mdPSAR using two scenes of ALOS PALSAR data acquired on 25 October and 27 April 2009. As the result, the average calculation errors were small as about 1% for both the HH and VV modes and the errors were uniform in general over the scenes. The relative dielectric permittivity values of the Tottori sand dunes were evaluated as 13.4 and 10.6. These values correspond with those of wet sands. It is noted that the value is higher in the scene after raining. Higher values of relative magnetic permeability were evaluated in the sand dunes than the surroundings, which is a reasonable trend because the sands are originated from the weathering of granitic rocks containing magnetite. Consequently, the effectiveness of mdPSAR is demonstrated. However, an improvement is necessary for the surface-roughness estimation of the areas occupied by artificial structures such as buildings. This is because the HH mode intensity becomes strong in them.

Application of mdPSAR to the PARSAR data around Syowa Station, Antarctica is in progress. Its purposes are to clarify distribution of outcrops and snow ice areas, melting state of ices, and development of crevasse topography from the spatio-temporal changes of surface roughness and relative dielectric permittivity.

References

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