Fully Polarimetric ALOS PALSAR Data applications for snow and ice studies

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INTRODUCTON

Mapping of snow and ice covered areas is important for many applications such as prediction of floods, snowmelt runoff modeling, water supply for irrigation and hydropower stations, weather forecasts and understanding climate change. Optical and near-Infrared (IR) remote sensing techniques are proved to be promising for snow cover mapping. But, in the presence of cloud cover and different weather conditions optical and IR fail in acquiring snow cover information. Microwave remote sensing has an advantage over optical and IR techniques due to its all weather capability, penetration through cloud and independence of sun illumination.

Various methods are available for wet snow cover mapping using multi-temporal SAR data. Due to high penetration capability and low attenuation of dry snow cover at intermediate frequency, dry snow cover behaves like transparent media. Hence, discrimination of whole (wet + dry) snow cover using intermediate and low frequency SAR data, still remains an active research field. The fully polarimetric SAR data does contain more information than the corresponding single or dual polarization SAR data. Fully polarimetric data gives an optimization of the polarimetric contrast and other polarimetric parameters which may be very useful for accurate target discrimination between snow and non-snow covered areas.

In this study, the capability assessment of fully polarimetric L-band ALOS PALSAR data has been carried out for snow discrimination from other targets. In addition, this study also discusses the potential of single, dual, quad polarization C-band (5.4 GHz) and L-band (1.27 GHz) SAR data for snow classification. Co-polarized and cross polarized polarimetric signatures have been generated and based on these signatures, polarization fractional value has been calculated for assessing the capability of PALSAR data for snow discrimination.

STUDY AREA AND DATA USED

The present study confines to Badrinath region in Himalayas, and this test site comprises extensive snow cover areas having various degrees of glaciations that act as a huge fresh water reservoir. Snow cover in the Himalayan region play an important role in the Earth's climate system. The test site covering Panpatia, Satopanth, Bhagirath Kharak, Suraji Bank glacier and numerous small sized glaciers also and the neighborhood falls between latitude N 30^{o} 30' and N 31^{o} 15' and longitude between 79^{o} 15' E and 79^{o} 30' E. The elevation ranges between 2000 m.a.s.l to 7000 m.a.s.l. The Alaknanda River, which is the main tributary of Ganga River, originates at the snout of the Satopanth Bank glacier.

In this study, the fully polarimetric L-band ALOS PALSAR data (acquisition date was May 12 and Nov., 12, 2007) have been used for snow classification over Badrinath area, Uttarakhand in Indian Himalayan snow covered region. ALOS-AVNIR data (acquisition date, May 6, 2007) is used to interpret snow area and non snow area and it helps in the selection of the training sample of different features for supervised classification.

METHODS AND TECHNIQUES

In this investigation, Pauli decomposition, H/A/Alpha [1], three scattering component [2] and four scattering component decompostion model [3] have been applied on L-band fully polarimetric ALOS-PALSAR data for extracting the desired information. Using Wishart classifier, ALOS-PALSAR data have been classified into major distinct classes snow cover, vegetation, debries covered glacier, rock and layover/unidentified areas.

User accuracy of the classified classes has been assessed. Polarization signatures of various features have also been generated using polarization synthesis techniques and signatures are represented in 3-D plot. Fractional polarization value [4] has been calculated which gives the polarization purity of return signal from the targets. Results of this investigation show that L-band fully polarimetric SAR data have very good capability to discriminate snow from the other targets.

RESULTS

Polarization signature of various targets were plotted in 3-D. The maximum and minimum intensity values were identified from 3-D plots and the fractional polarization (F) is calculated. F value for co-polarization of snow, vegetation, barren rock and debris covered glacier features are 0.85, 0.59, 0.52 and 0.33 respectively and for cross-polarization 0.93, 0.49, 0.66 and 0.51 respectively. Snow has highest value of fractional polarization as compared to other targets. Eigenvalue calculated polarization fraction image also shows that the snow cover area has high polarization fraction value as compared to other targets. The F value for snow is high as compared to other features, which indicates that the return signal is

polarized or can be said that L- band ALOS PALSAR data is capable of discriminating snow from other targets. The user accuracy of snow classes is also higher than other classes. Hence full polarimetric ALOS-PALSAR data is capable of snow cover monitoring.

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