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Evaluation of Interferometric Coherence over Polar Regions with Space-based Quadruple Polarimetric Synthetic Aperture Radar

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Hide abstract

There is concern that the global warming is being accelerated by the increase of the greenhouse gases. The polar region plays an important role for heat balance in the Earth system. Glacier has been identified as sensitive indicators of global climate change. The loss of snow and ice in glaciers and ice sheets affects sunlight reflection which is quite correlated with the albedo effect. It is evident that the continuous retreat of glaciers and loss of sea ice, as reported in the recent polar research [1]. Hence, the changing climate accelerates change of temperature and precipitation, which affect the total mass loss of glaciers. Thus monitoring on glacier can be very useful to understand the effects of global warming.

Recently space-based synthetic aperture radar (SAR) system with various polarizations have been launched and operated successfully. Interferometric SAR (InSAR) application has been widely used to monitor surfaces' displacement as well as to extract topographic information for various geodetic applications. Especially space-based SAR observation over polar regions has been very useful resource to detect surfaces' change such as movement of glacier, etc [2-3]. In the InSAR application, coherence is considered as a very critical parameter to evaluate the quality of an InSAR observation. However the InSAR application has been somewhat limited because of severe temporal decorrelation effect over snow or ice-covered regions. In this study, we evaluate interferometric coherence using quadruple polarimetric (quad-pol) TerraSAR-X (TSX) X-band observations over the polar regions. The quad-pol TSX datasets were acquired during Dual Receive Antenna (DRA) campaign period from April to May 2010. Total 57 images over 20 swaths above 60 degrees north latitude are retrieved. The temporal baselines of all interferometric pairs range from 11 to 22 days which are suitable to maintain high coherence level in the short wavelength X-band observations, and small geometric baselines of 12 ~ 226 m are discovered.The data were processed using the commercial GAMMA software, which calculates interferograms and coherence. Multi-looking was applied to reduce undesirable phase noise. The interferograms processing contains phase filtering to enhance the signal to noise ratio of the phase.

Our results represented high coherence in all polarization modes from 0.38 to 0.57, with highest values in VV, then HH, and lowest in HV or VH. It is very surprising that the short wavelength X-band SAR observations can maintain such a high coherence level, even though the temporal baseline is quite short. Also all the quad-pol interferograms showed very similar fringe patterns regardless of the polarization type. It is interesting that the highest value of coherence was found in the VV-pol. In general land application, the coherence of HH-pol is better than that of VV-pol. It implies that the scattering behavior in the medium of snow or ice is different from that of the vegetation covered land area. We suggest that the VV-pol could be chosen for the InSAR applications over the polar regions, if we can select the polarization at the SAR acquisition.