DUAL-FREQUENCY POLARIMETRIC REMOTE SENSING RADAR OBSERVATIONS OF DEEP SNOWPACK IN GRAND MESA, COLORADO

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1. INTRODUCTION

Fresh water stored in snow on land is an important component of the global water cycle. In many regions of the world it is vital to health and commerce. In 2005, the Cold Regions Hydrology High-resolution Observatory (CoReH$_2$0) proposal concept based on X- and Ku-band synthetic aperture radar (SAR) technologies, submitted by the international cold land processes science community to the European Space Agency, was selected for pre-Phase A study [1, 2]. It is currently going through the Phase A study, which is expected for completion in mid 2012. In addition, the Snow and Cold Land Processes (SCLP) mission, also based on the dual-frequency SAR concept, was one of the satellite missions recommended for future NASA implementations in the recent earth science decadal study report [3].

The CoReH2O or SCLP SWE measurements will be made by using dual-frequency radar backscatter measurements at X- and Ku-band frequencies, which respond to the volume scattering from snowpack. The differing response of radar backscatter at two frequencies to snow grain size allows simultaneous retrieval of SWE and snow scattering albedo. The radar SWE measurement principle has been demonstrated by measurements in the 1980s-1990s and more recently the second NASA Cold Land Processes Experiment (CLPX) using airborne Ku-band Polarimetric Scatterometer (POLSCAT) radar in Colorado in 2006-2008 and the POLSCAT together with TerraSAR-X in Alaska in 2007-2008 [4, 5], the SARALPS-2007 and Helisnow-2008 [6] campaigns in Europe.

An example of the baseline algorithm for CoReh2O was applied to the dual-frequency data set acquired using POLSCAT and TerraSAR-X from the CLPX-2 in North Slope, Alaska, where the

snowpack was typically no deeper than 20-30 cm. The comparison with the field measurements reveals an RMSE of 0.7 cm for SWE retrievals [1, 6].

2. DUAL-FREQUENCY CAMPAIGN FOR SNOWPACK

The radar measurements of snowpack in Colorado during the CLPX-2 were limited to Ku-band frequency although the snow depth had reached 1 to 2 meters. To fill the data gap for dual-frequency observations of deep snowpack, we carried out one field campaign in Colorado during the 2009-2010 winter season using the POLSCAT and TerraSAR-X for radar observations. The selected test site was located in Grand Mesa, Colorado. Most of the test site was covered by sage brush, and only a small part was covered by forests. The first set of flights was completed from October 31 to mid November with five POLSCAT aircraft flights on the Twin Otter aircraft and four TerraSAR-X passes. Fig. 1 illustrates the images of radar backscatter for HV polarization. The snowpack on Oct 31 was wet, and had lower backscatter than those from later flights. The intensity of radar backscatter images on Nov 4-8 reflects well the spatial distribution of differing vegetation types in the target site.

The second set of flights is planned for February 2010 with deeper snowpack than early November 2009. This article will describe the characteristics of the Ku-band POLSCAT and X-band TerraSAR-X data acquired from these two sets of flights to illustrate the dependence of multi-polarization radar signals on snow water equivalent at both X- and Ku-band frequencies for deep snowpack in Colorado.
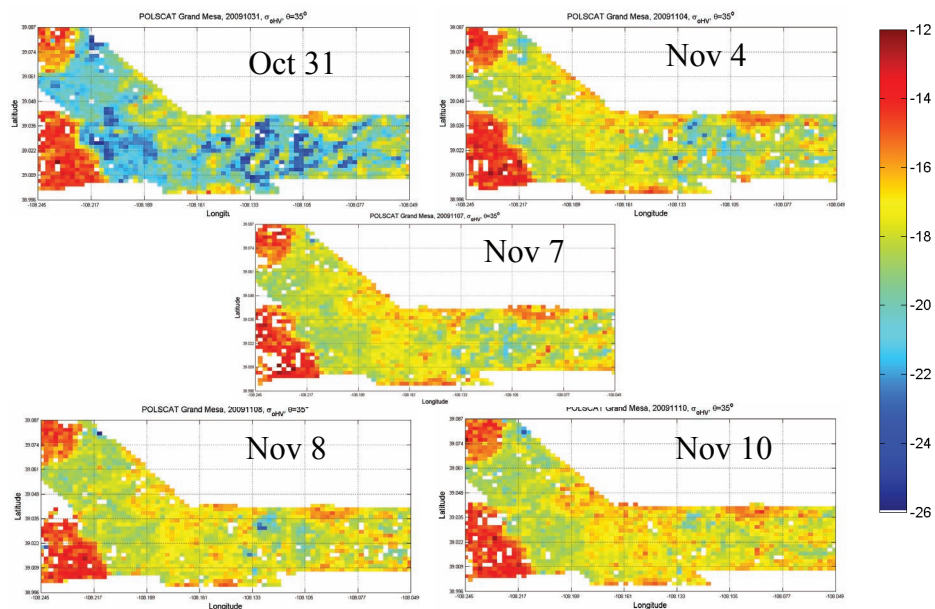

Figure 1. POLSCAT HV radar backscatter images of Grand Mesa, Colorado in 2009.

3. ACKNOWLEDGMENT

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