Airborne remote sensing observations of parameters of glaciers and snow in High Mountains Asia

Zhen Li (airborne remote sensing center at the institute of remote sensing and digital earth, Chinese Academy of Science)

Knowing exactly the internal structure of glacier thickness and snow depth is important for studying the change mechanism of the glacier and snow. However, the poor stability of trajectory from airborne data, the antenna phase center location cannot meet the precision of 3D imaging. Moreover, the propagation speed of electromagnetic wave will change when it penetrates the ice, which consequently changes its propagation direction. The goal of this project is to study the method to detect the multiple types surface parameters from the space, develop the multi-scale and three-dimension collaborative observation technique for sensitive factors of environmental changes, and conduct collaborative observation experiments for environmental elements in “third pole”. Therefore, an improved scheme of data processing is necessary to achieve the correct result of 3D imaging, and we propose to develop a method for data processing of the glacier spatial observation using airborne TOMOSAR technique.

In this project, we use the existing experiment data to analyze the glacier thickness and snow depth from two aspects: characteristics of microwave observation and its response to sensor parameters and form a scheme of parameters selection for snow and ice in “third pole”. The experiments will offer a scheme of parameters selection for snow and ice in “third pole”. Besides, we will establish a three-dimension data processing method based on TOMOSAR observation platform, with a full consideration of the instability of flight platform and the change of medium during the microwave propagation. Finally, we propose to carry out the satellite-air-ground three-dimension observation collaborative experiment, use the TOMOSAR observations to generate the internal 3D structure and key parameters estimations of snow and ice, and validate the results by the field survey data and satellite data.

The specific proposal objectives include:

1) To study on parameter selection technique for space detection of key elements of snow and ice.

For the observation of ice thickness and snow depth, we will use the existing various airborne and spaceborne SAR data from domestic and foreign to extract different characteristics regarding scattering, geometric, textual, polarized, coherent, angular etc., and select the optimal sensor parameter.

2) Develop a key technique of data processing for airborne TOMOSAR three-dimension observation.

To solve the problem of large deviation in the track of TOMOSAR, we design four steps that include: a) Alignment and imaging of each channel data used by the layout

of the corner reflector; b) Phase correction based on multi baseline InSAR phase estimation for carrier and target location; c) Using the 3D TDBP method to complete 3D focus and produce TOMOSAR image; d) Ice velocity correction based on the minimum time law of Fermat, and then obtain the real internal structure.

3) Conduct the Airborne TOMOSAR three-dimension observation experiment in the High Mountain Asia.

Based on the SAR data and high resolution optical data, combined with the field survey data from the research group for many years, we will select the typical glacier in the “third pole” area and design the TOMOSAR flight trajectory, passes and the observation parameters. In this flight test, we will carry out the simultaneous measurement of aviation flight and ground, use the corner reflector for calibration, and select the ground-penetrating radar measurement for route survey and the artificial snow sampling points considering the hard environmental factors and the workload intensity. Then we will use the results of the TOMOSAR data to analyze the 3D structure of typical objects, and validate the analysis results using the measurements from the ground penetrating radar.