Application of ALOS Data in study alpine glaciers on Tibetan Plateau

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Abstract

The application of ALOS data in Tibet glacier monitoring are to be carried out and its accuracy are to be evaluated in this program. However, there are some problems appear during our work. The major one is that there are some holes (failure value) in DEM generated from ALOS/PRISM in the western Himalayas.

Keywords: DEM, ALOS/PRISM, hole (failure value), ALOS/AVNIR-2, scale.

1. INTTRODUCTION

Glacier variations on Tibetan Plateau play an important role in the global climate system and water balance. The successful launch of ALOS (with PRISM, AVNIR-2, and PALSAR instruments) would provide a new prospect on accurate monitoring of variations of glaciers on Tibet. Our research goal in this project is listed in the followings:

- Evaluation of the ALOS/AVNIR-2 imagery in glacier studies on Tibet (Compared with other data by remote sensing and ground observation)
- Generation and accuracy of high resolution DEMs using ALOS/PRISM stereo pair
- Feasible usage of ALOS/PRISM and ASTER for alpine glacier volume variations in Tibetan Plateau using multi-source DEM Data

Based on our previous researches on glacier variations in Mt. Naimona'Nyi region (the highest peak of the south-western Himalayan Mountains, 81°E–81°47'E; 30°04'N–31°16'N) and northern Mt. Qomolangma (also known as the Mt. Everest, located in the middle Himalayan Mountains, 27°59-28°11´N and 86°44´-86°59´E) by satellite images (Table 1), we know that the glacier recessions in the Himalayan regions are dramatic compared with Mt. Geladandong region in the central Tibetan Plateau. Most of the glacier retreat area occurs at the termini of glaciers in the southeastern slopes of the two regions, whereas most of the glacier advance area occurs at the termini of glaciers in the northwestern slopes.

Table 1. Digital satellite images used in the Mt. Naimona'Nyi and Mt. Qomolangma region

Region	Sensor	Date
Mt. Naimona'-Nyi region	Landsat2 MSS	19761206
	Landsat5 TM	19901023
	Landsat7 TM	19991109
	Terra ASTER	20031003
Mt. Qomolan-gma region	Landsat2 MSS	19761219
	Landsat5 TM	19921111
	Landsat7 ETM+	20001030
	Terra ASTER	20031023

As there are no available ALOS data in the Mt. Qomolangma region in Sep.2007, we studied the application of ALOS/PRISM (which was taken in Sep.6, 2006) and ALOS/AVNIR-2 (which was taken in Sep.9, 2007) in Mt. Naimona'Nyi region in this paper.

2. METHOD

2.1. DEM generation

PCI9.1 software .was used in our work. As the software does not have the ALOS module, we try to input all the ALOS data by "reading generic image file" in a project of Ortho-Engine module. For example, the major parameters for the nadir scene of ALOS/PRISM (which was taken in Sep.6, 2006) are showed in Fig.1. We also use the backward scene for stereo pair in DEM generation. GCPs (Ground Control Points) and TPs (Tie Points) were collected manually from the 1:50,000 scale topographic maps in 1974. The RMSe for collected both GCPs and TPs were controlled within 15 m. Parameters for DEM generation are showed in Fig.2.

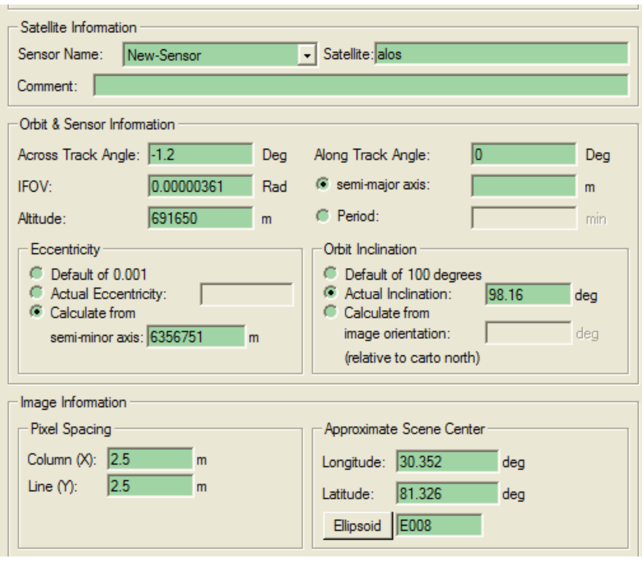

Figure 1. Data read for the nadir scene of ALOS/PRISM (Sep.6, 2006)

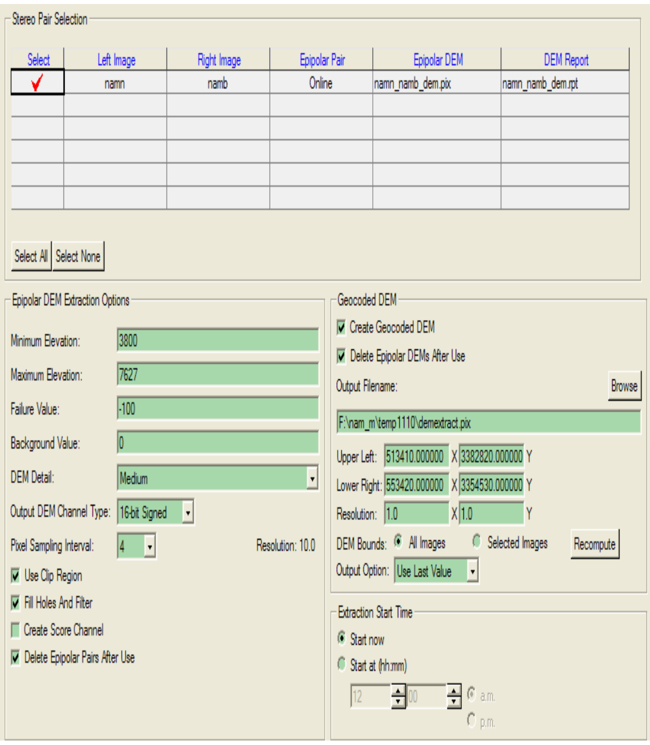

Figure 2. The parameters for DEM generation

2.2. Othorectification of ALOS/AVNIR-2

20 GCPs were collected manually from the 1:50,000 scale topographic maps in 1974. Othorectification are carried out for the ALOS/AVNIR-2 (which was taken in Sep.9, 2007) with the 1:50,000 scale DEM. The RMSe of othorectification was controlled within one pixel, i.e., 10 m.

We use raw image at 1A at first. We found that there were many lines on the images (Fig.3). After orthorectification, the lines at terminus were distorted, which could greatly affect the glacier delineation at the terminus (Fig. 4).

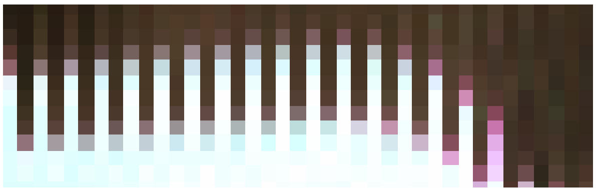

Figure 3. The lines at glacier terminus on 1A image of AVNIR-2

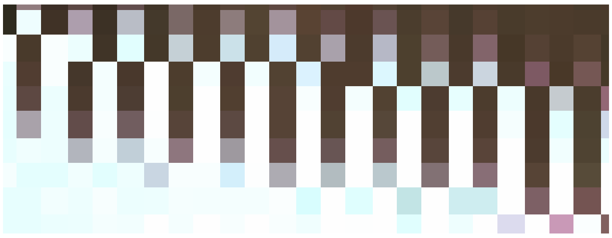

Figure 4. The glacier terminus on othoimage from AVNIR-2 1A (Sep.9, 2007)

In the last PI symposium in Kyoto in November, Dr. Takeo Tadono suggested us using 1B1 or 1B2. The othoimage of 1B2 are smooth and good (Fig.5).

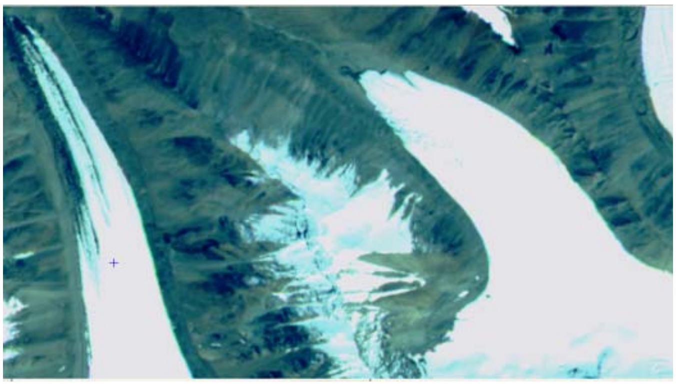

Figure 5. The glacier terminus on othoimage from AVNIR-2 1B2 (Sep.9, 2007)

3. PRIMARY RESULTS AND DISCUSSION

3.1. Holes in generated DEM

There are some holes in the generated DEM from ALOS/PRISM both at 1A (Fig.6) and 1B2 (Fig.7) data level in Mt. Naimona'Nyi region. We also try to decrease the bright saturation of the snow covered regions according to Dr. Takeo Tadono's suggestions; however, the holes are almost the same. We also use ASTER stereo pair (3N and 3B, which was taken in Oct.3, 2003) to generate DEM, there are also some holes in it although the failure value area is much smaller (Fig.8). How could we avoid the holes in DEM generation or how to fill the holes in the generated DEM?

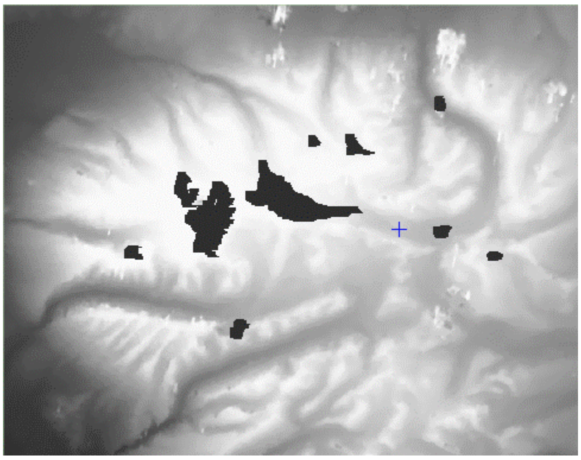

Figure 6. The generated DEM from ALOS/PRISM 1A

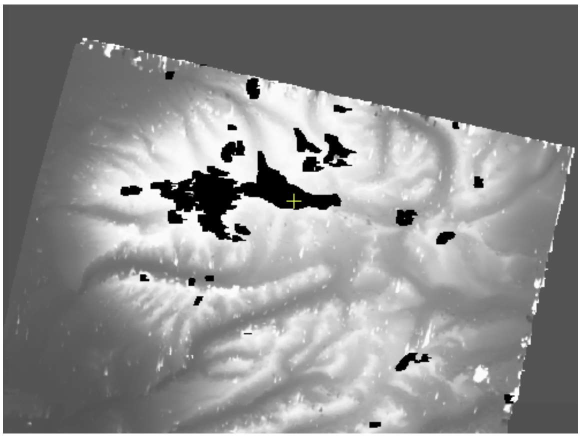

Figure7. The generated DEM from ALOS/PRISM 1B2

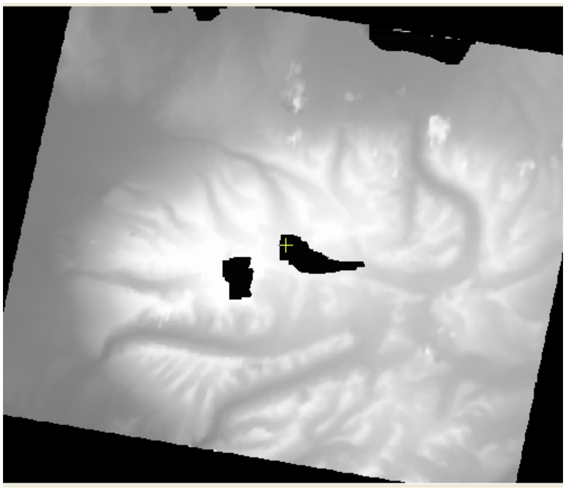

Figure 8. The generated DEM from ASTER L1B

3.2. Classification results from

Supervised classification method was used in this research. The classification scheme was listed in table 2. The supervised classification result was showed in Figure 9.

Table 2. Classification scheme by supervised method

ROI Name	Color	Pixels	Polygons
Vegetation	Red	3,915	8/3,915
Glacier1	Green	1,794	4/1,794
Glacier2	Blue	1,971	12/1,971
Lake1	Yellow	769	5/769
Lake2	Cyan	366	3/366
Shade	Magenta	754	10/754
Cloud	Maroon	983	5/983
terrian	Sea Green	1,668	12/1,668

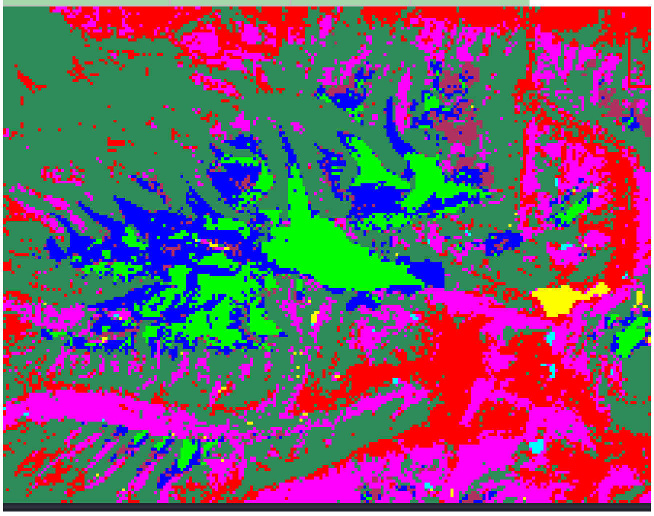

Figure 9. The supervised classification result from AVNIR-2 1B2 (Sep.9, 2007)

The glacier area in this research was 96.54 km^2 that was totaled by glacier 1 and 2 in table 2. It was much larger than the results of previous research (Table 3). The classified results should be verified with expert knowledge and field survey. Another reason maybe caused by the scale factor in high resolution of application of ALOS/AVNIR-2 in glacier monitoring with other resolution satellite images.

Table 3. Glacier area change during 1976－2003 in Mt. Naimona’Nyi region

Year	Area(km^2)	Area Change (km^2)	Percent area change (%)	Rate of change(km^2/a)
1976	84.41			
1990	82.04	-2.37	-2.81	-0.17
1999	80.37	-1.67	-2.04	-0.19
2003	77.29	-3.08	-3.83	-0.77
Total		-7.12	-8.44	-0.26