Estimation of velocity distribution of Shirase Glacier derived from SAR data obtained by ERS-1/2 tandem mission (2)

*Koichiro Doi[1,2], Yuichi Aoyama[1,2], Kazuki Nakamura[3], Tsutomu Yamanokuchi[4], Kazuo Shibuya[1]

1. National Institute of Polar Research, 2. The Graduate University for Advanced Studies, SOKENDAI, 3. College of Engineering, Nihon University, 4. Remote Sensing Technology Center

Shirase Glacier is one of the fastest flowing ice streams in Antarctica flowing into the southernmost of Lü tzow-Holm Bay in Dronning Maud Land, East Antarctica. It is important to clarify the spatial flow rate distribution with a high-resolution to investigate causes of the fast flow and the temporal flow rate changes. In order to make a high-resolution flow velocity map, we can apply a usual interferometric Synthetic Aperture Radar (InSAR) technique to an InSAR pair data. However, since flowing velocity of the ice stream is greater than 2 km/year (Nakamura et al., 2007, Aoyama et al., 2016), it is difficult to estimate the flow velocity by applying the InSAR technique to the ordinal repeat cycle SAR mission data.

Tandem mission by European Satellite of Remote sensing (ERS)-1/2 was conducted in 1996 and 1999. In this tandem mission, ERS-2 had flown after ERS-1 in the same orbit with an interval of one day, and many InSAR pairs with one day temporal baseline were obtained through the mission.

We successfully obtained three SAR interferograms over Shirase Glacier using this tandem mission InSAR pairs acquired at 1996/06/02-1996/06/03, 1999/11/14-1999/11/15 and 1999/12/19-1999/12/20. We estimated surface displacements along range direction (direction of radar illumination) by applying differential InSAR (DInSAR) with a TanDEM-X 90m DEM (Rizzoli et al., 2017) to remove topographic phase. We also estimated displacements along azimuth direction (direction perpendicular to range direction) by applying a split beam interferometry (SBI) (Bechor and Zebker, 2006) technique to the three InSAR pairs. By combining the range and azimuth displacements, spatial flow velocity distributions can be derived with a high-resolution. Since displacements obtained by the DInSAR and SBI techniques contain artificial displacements due to some interferometric phase trends, we estimated the artificial displacement trends from displacements over outcrop rock areas under an assumption that no crustal displacements occurred there for one day, and the trends were eliminated. We show an example of surface ice displacement over Shirase Glacier obtained from the pair 1999/11/14-1999/11/15 in the figure.

We can evaluate accuracies of the obtained ice surface displacements from the displacements over outcrop rock areas after the artificial trends for each pair. The averages standard deviations of the three pairs observed over the outcrop rock areas are 4 cm in range direction and 123 cm in azimuth direction.

We also compared the flow rates and directions with in-situ GNSS measurements situated on a downstream site in Shirase Glacier observed for three years from 2015 to 2017. We found mean differences between the two observations (DInSAR −GNSS) of -0.691 (m/day) in flow rate and 15.7 (deg.) in flow direction.

In the presentation, we will show two-dimensional flow velocity maps with a resolution of approximately 20 m at the three periods and discuss spatial and temporal velocity changes.

Keywords: Shirase Glacier, flow velocity map, ERS-1/2 tandem mission, DInSAR, SBI