Position of grounding line at outlet glacier based on DDInSAR analysis

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Grounding lines between outlet glacier and ice shelf are a key indicator of ice sheet instability, because changes in their position reflect imbalance of ice mass flux and affect the flow of inland ice. The USAP and SCAR data show grounding line data in the East Antarctica based on optical images and Interferometric SAR (InSAR) data of ERS-1/2 data taken around 1995-1996 (Konrad et al., 2018). However, the accuracy of the positions is not perfect, because the grounding line may change on the tidal condition. In this study, we try to detect a grounding line at the Langhovde Glacier, located on eastern part of Lützow-Holm Bay in East Antarctica based on satellite data. Although four boreholes were drilled including around grounding line on the glacier, a grounding line has not detected yet.

In the case of usual InSAR processing, the required image acquisition conditions for detecting grounding line are, (1) shorter baseline distance of orbit between two SAR observations effect on coherency and gradient (density) of topographic phase, (2) shorter temporal interval between two observations (effect on coherency and density of glacier flow phase). In addition, it is necessary to consider the difference in tidal movement for each observation. Double Differential InSAR (DDInSAR; Doi et al., 2011), analysis method used in this study is a method to extract phase difference caused by tidal movement for detecting a grounding line by removal of the phases caused by the glacier flow and topography. This method is to prepare for two pairs of DInSAR image and make difference of differential interferogram to remove the phase due to glacier flow and topography. DDInSAR is available using PALSAR, PALSAR-2, TerraSAR-X, and Sentinel-1. After removal of these phases, phase made from tidal motions are shown, which correspond to the position of a grounding line.

DDInSAR image was created using two DInSAR image pairs between 1-15 and 15-29 June 2019. They are two pair of 14 days interval. DDInSAR image could show vertical phase of ice shelf by tidal movement. This result is coincided with the elevation change by GNSS measurement (Sugiyama et al., 2014). The displacement fringe should be shown in ice middle of this image zone which influenced by tidal movement. However, tidal phase was unclear around upstream side of ice shelf. As the reason of this limitation, the observation interval is very close to the cycle of large component of ocean tide, M2 constituent. This means that between 14 days of interval, it shows that almost same tidal amplitude in both observations. The range of the displacement fringe depends on the tidal conditions. To resolve this problem, we created DDInSAR image based on 14-28 April 2016 image pair, and 26 October and 9 Novermber 2017 image pair. We got the range of different displacement fringes at upstream position on two InSAR images (Fig. 1). We show some DDInSAR images using DInSAR image pairs which has several different tidal amplitude phase.

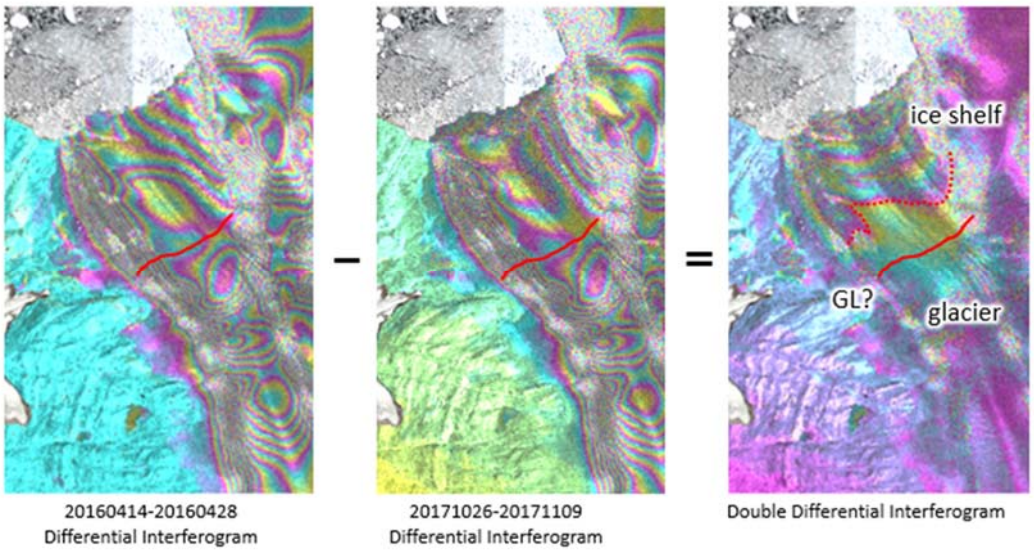

Fig. 1 DDInSAR data based on two DInSAR data.

References

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