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アラスカ・レンゲル山脈における山岳氷河の季節的・経年的変化
Seasonal and interannual variations of mountain glaciers in Wrangell Mountains, Alaska

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Recent satellite data have revealed significant ice mass loss on ice-sheets and mountain glaciers (e.g., Garder et al., 2013). GRACE data from 2003 to 2010 show the rate of ice loss in Alaskan glaciers is 65 Gt/yr (Arendt et al., 2013). DEM differencing is also used to estimate the ice thickness change, and Berthier et al. (2010) revealed the changes at the regional scales. Das et al. (2014) estimates the ice thickness changes by DEM differencing and airborne laser altimetry in Wrangell Mountains. While the ice thickness change is -0.07±0.19 m w.e.yr-1 from 1957 to 2000, it increases by up to -0.24±0.16 m w.e.yr-1 from 2000 to 2007. This indicates accelerated mass loss over the Wrangell Mountains during 21st century. However, the glaciers variation following the interannual ice loss remains unclear. Thus, we have examined the spatial and temporal variations of ice speed and terminus position in mountain glaciers in Wrangell Mountains by satellite imageries.

Synthetic Aperture Radar (SAR) data have revealed ice velocity fields of ice sheets and mountain glaciers with high resolution (e.g., Rignot et al., 2011; Yasuda and Furuya, 2013). Near the border of Alaska and Yukon (surrounding the St. Elias Mountains), the ice speed distributions have been clarified (Burgess et al., 2013) and their spatial and temporal changes (Abe and Furuya, 2014). We found significant upstream accelerations at many surge-type glaciers from fall to winter, regardless of surging episodes. Given the absence of upstream surface meltwater input in winter combined with an earlier observation of vertical surface motions (Lingle and Fatland, 2003), we support the hypothesis of englacial water storages that promote basal sliding through increased water pressure as winter approaches.

We expanded the analysis area to Wrangell Mountain in order to examine (1) seasonal speed change, (2) interannual variation (3) whether the winter speed-up is universal or not. The temporal coverage of ALOS/PALSAR is only for 5 years (from 2006 to 2011). This is too short to examine the interannual changes. Thus, we use Landsat optical imageries (1999-2014) to examine the terminus position in addition to SAR intensity images. In terms of interannual change in ice speed, we compare the result shown in Lie et al. (2008). They showed the ice speed of Nabesna Glacier, which is the largest land-terminating glacier in Alaska, by applying InSAR analysis to 5-tandem pairs of ERS 1-2 SAR data acquired from 1994 to 1996.

Our results show the clearly seasonal speed-up is shown at Nabesna glacier, but there seems to be no interannual change between 1995 and 2010. Besides, the proglacial lakes have been extending between 1999 and 2014. At Copper Glacier, we found upstream accelerations from fall to winter at every year. The winter speed-up can be found in the confluences of the tributaries and valley constrictions, where it is likely to form overdeepened bed topography (MacGregor et al., 2000; Hooke, 2005). As comparing with Turrin and Foster (2014), we discuss the relation between overdeepenings and englacial water storage, and its link to surface speeds.

Keywords: Alaskan Glaciers, SAR, Winter speed-up, Overdeepenings, Englacial water storage