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How much can we benefit from the combination of numerical simulation and in situ observations? A case study on an Arctic polythermal valley glacier

Songtao Ai[1], Zemin Wang[1], Jiachun An[1], Yuande Yang[1], Chunxia Zhou[1], Tingting Liu[1], Hao Ke[1], Weifeng Hao[1], and Hong Geng[2]

[1]Chinese Antarctic Center of Surveying and Mapping, Wuhan University, Wuhan, China (ast@whu.edu.cn)

[2]School of Resource and Environmental Sciences, Wuhan University, Wuhan, 430079, China.

Ice flow velocity is sensitive to glacier variations both controlling and representing the delivery of ice and affecting the future stability of ice masses in a warming climate. Austre Lovénbreen (AL) is one of the poly-thermal glaciers in the high Arctic and located on the northwestern coast of Spitsbergen, Svalbard. The ice flow velocity of AL was investigated using in situ global positioning system (GPS) observations over 15 years and numerical modelling with Elmer/Ice. First, the ice flow velocity field of AL along central flow line was presented. While AL moves slowly at a speed of approximate 4 m/a, obvious seasonal changes of ice flow velocity can be found in the middle of the glacier, where the velocity in spring-summer is 47% larger than in autumn–winter in 2016, and the mean annual velocity variation in different seasons is 14% from 2009 until 2016. Second, the numerical simulation was performed considering the poly-thermal character of the glacier, and indicated that there are two peak ice flow regions on the glacier, and not just one peak ice flow region as previously believed. The new peak ice flow zone found by simulation was verified by field work, which also demonstrated that the velocity of the newly identified zone is 8% faster than the previously identified zone. Third, although our field observations showed that the ice flow velocity is slowly increasing recently, the maximum ice flow velocity will soon begin to decrease gradually in the long term according to glacier evolution modelling of AL.