



Radar penetration depth of glacier debris cover in HMA and its influence on ice mass balance estimation

Chao Li (1,2), Liming Jiang (1,2), and Lin Liu (1)

(1) Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Wuhan, China (lichao@asch.whigg.ac.cn), (2) University of Chinese Academy of Sciences, Beijing, China (jlm@whigg.ac.cn)

Radar penetration correction is an essential part in glacier mass balance estimation using DEM differential methods. Previous studies have shown that radar penetration depth is different for clean ice and glacial debris, which is widely distributed in High Mountain Asia (HMA), especially in Pamir and Karakoram. However, few studies are conducted on this subject-area. Up to now, we know very little about the effects of radar penetration depth on the estimation of glacier mass balances in these two areas. This study focuses on estimation of radar penetration depth of the clear ice and debris cover in glaciers in HMA and evaluation of the potential effect of radar penetration of thick debris cover on glacier mass balance. Specifically, the differences between C band and X band SRTM DEMs are quantified to estimate the radar penetration depth of glacier debris covers in Hissar Alay, Pamir and Karakoram. Furthermore, we analyze the penetration depth differences in each 50-m elevation bin and establish a linear or polynomial model between elevation and radar penetration. Our experimental results show that the average penetration depth differences in the Hissar Alay, Pamir and Karakoram glacier regions are $2.42\text{m} \pm 0.23\text{ m}$, $0.41\text{m} \pm 0.12\text{ m}$, and $2.05\text{m} \pm 0.17\text{ m}$, respectively. The penetration depth of surface debris covered area is about 1.0 m less than that of clean ice area. Penetration correction of the debris-covered ice and clean ice can effectively reduce the systematic error in glacier mass balance estimation, which should be considered to obtain a robust estimate of glacier mass balance in HMA.