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The correlation tracking between glacier movement and subglacial water flow using spaceborne data fusion and hydrodynamic modelling

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The changes of ice sheet in Greenland have been traced through various remote sensing observations. However, it was realized that not only the uncertainties in the observed change of ice sheet were not fully addressed, but also the tracking of correlation between outlet glacial movement and subglacial channel activities, which may be the key factor for the understanding of Greenland ice sheet change, is highly challenging. Therefore, in this study, we proposed an investigation method employing hydrodynamic simulation over the channels connected glacier and spaceborne remote sensing tracking the glacier migration. The test area was established in Russell glacier in western Greenland where the change of glacier has been obvious for the last century and significant fluvial flows occur over meltwater outflow channels, such as Akuliarusiarsuup Kuua and Qinnguata Kuussua. Firstly a scheme fusing multiple satellite data for spatially and temporally monitoring the migration of glacier with high accuracy was established. A 2D hydrodynamic analysis utilizing high resolution stereo DTM and bathymetry by multispectral radiometric analysis was then conducted. For the space borne tracking of glacial migration, differential interferometric SAR (D-InSAR) campaigns using ALOS PALSAR pairs were applied to monitor the glacial change. In terms of data fusion aspect, we employed pixel tracking method by co-registration of ALOS PALSAR/PALSAR2 and space borne optical images over target area to compensate for any line-of-sight glacial movement resulted from the D-InSAR analysis. In order to securely trace individual pixel, high accuracy sub-pixel co-registration algorithm was developed. At last, the outputs from analyses were incorporated to build an effective 3D movement tracing over the Russell glacier.
Furthermore, for conducting the hydrodynamic analysis, optical stereo analysis using ALOS PRISM images was applied to extract DTM with 7.5 m spatial resolution over target glacial area. Together with the InSAR DTMs and bathymetry over meltwater outflow channels, 2D hydrodynamic simulation was conducted simultaneously for the tracking of the total discharge and water flow characteristics during the remote sensing observation period.
The overall results in both approaches were inter-compared to infer the correlation of subglacial flows and migration of outlet glacier. The further works employing advanced remote sensing techniques and the higher resolution observations is anticipated for the understanding of long term change of Russell glacier. Based on the output of this study, the proposed method will be extended into a comprehensive scheme to tackle the issues of glacial change occurred in the Greenland costal area.