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Further insights into glacier changes derived from declassified reconnaissance imagery (Corona and Hexagon)

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The variable and often complex dynamics of the glaciers in High Mountain Asia have recently been studied intensively from satellite imagery. Time-series of optical and SAR imagery revealed rapid changes and strong trends in glacier extent and surface flow velocities as well as elevation changes from differencing of DEMs and altimetry sensors over the 1990 to 2015 period. In contrast to nearly all other regions in the world, especially glaciers in the Karakoram had balanced budgets and often rapidly advanced during surge events and retreated thereafter. This complicates the interpretation of climate change impacts on the glaciers in the region and leaves high uncertainties for calculation of future glacier and run-off development.
A key for an improved understanding of glacier dynamics in this region is an extension of the observation period. This can be achieved using Corona and Hexagon reconnaissance satellite imagery from the 1960s and 1970s providing a comparably high spatial resolution between 2.7 and 7.6 m. Thereby, the keyhole satellites allow both, determination of glacier extents and calculation of DTMs from stereo image pairs that can be used to determine geodetic volume/ mass changes. The latter has already been performed on a regional scale for glaciers in the Himalaya and Tien Shan using Hexagon and Corona imagery with high accuracies. However, due to a particular camera model and complex distortion effects, which is especially the case for Corona images, the analysis is a challenging task.
Therefore, we have developed a workflow to generate DTMs and orthophotos from Corona that considers the complex camera model. This study will present the workflow with its limitations, challenges and the obtained accuracy over stable ground. With our generated DTMs and Orthophotos, we already calculated mass balances and length changes for the Ak-Shirak range in Tian Shan and currently adapting the workflow to the Karakoram and Pamir mountains. Furthermore, the DTMs help us to detect glaciers of surge-type behaviour and to reconstruct full surge cycles with the extent to the early and mid 1960s.