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Paraglacial adjustment of sediment-mantled slopes through landslide processes in the vicinity of the Austre Lovénbreen glacier (Ny-Ålesund, Svalbard)

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The climate-induced changes in the high arctic environment influence a wide range of processes, which are rapidly altering the landscape (e.g. glacier retreat, landslide activity). Numerous recent studies are focusing on spatio-temporal characteristics of glacier retreat in the high arctic. However, an exact identification and quantification of landslide processes modifying sediment-mantled slopes in the vicinity of retreating glaciers is in many cases not possible due to the lack of long-term high-resolution spatio-temporal terrain data.

The aim of this study is to investigate terrain changes of sediment-mantled slopes through landslide processes. It focuses on i) the quantitative and spatiotemporal identification of shallow translational debris slides, ii) the failure mechanisms and interaction with a retreating glacier in a high-arctic environment, and iii) the impact of meteorological factors on their formation. The Austre Lovénbreen glacier basin located on the Brøggerhalvøya, Svalbard at 79°N has been chosen to perform these investigations.

Landscape modifications within the basin have been investigated based on: I) high-resolution multi-temporal terrestrial laser scan data (TLS) measured annually from 2012 to 2018; II) images from stationary cameras taken between 2011 and 2018 monitoring the entire basin and; III) two geological field surveys in 2017 and 2018. During the observation period more than 100 distinctive landslide events, with a total volume of approx. 74000 m³ including 84 shallow translational debris slides were identified.

Results clearly show that landslides were the dominant process modifying sediment-mantled slopes during the observation period. Furthermore, deformation and mass waste of these slopes led to the formation of distinctive ice-cored lobate landslide deposits on the glacier. All observed translational debris slides were formed on a distinctive failure surface located at the contact zone

between the talus deposits and a subsurface ice layer. Due to the sliding processes, the ice layer was uncovered locally and thus a spatial extension of up to 150 m in elevation above the present-day surface of the Austre Lovénbreen glacier could be verified.

A significant increase in the annual debris slide activity could be observed during the observation period and the data indicates that meteorological factors (e.g. rainfall duration and intensity during the summer, mean annual summer air temperatures and thawing degree days) are the driving factor for landslide activity in the Austre Lovénbreen glacier basin. The impact of these factors is however dependent on the location and exposition of the slopes within the basin. The results presented in this study contribute to a better understanding of adaptation processes of the highly dynamic arctic environments to changing meteorological conditions.