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Modern spatial distribution of diverse retrogressive thaw slumps in West Siberia

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Regressive thaw slumps (RTSs) are permafrost landforms formed by the thawing of ice-rich permafrost or the melting of massive ground ice. The West Siberian Arctic (Yamal and Gydan peninsulas) is an area with widespread distribution of RTSs due to continuous permafrost and massive tabular ground ice close to the surface. The initiation of RTS in the region strongly affects the environment by altering vegetation and topography and releasing carbon. Roads and railways are also affected by RTS occurrence.

There is still no complete understanding of the true RTS distribution and its environmental controls in the West Siberian Arctic because of the remote location of the region. A remote sensing technique can be used to enhance our understanding of the characteristics of RTS over a large area. However, automated mapping of RTSs has certain limitations, including the lack of ground truth data, the large number of false-positive detections, and the ambiguity in interpretation. Moreover, the polycyclic nature of RTS development leads to a very complex spatial aggradation with numerous overlapping or nested RTSs. This poses additional challenges for mapping.

Based on theoretical and field studies, we developed a classification to capture the main morphological and environmental parameters of RTS nature visible on satellite imagery. To minimize false-positive detections we performed in-detail manual mapping of the RTSs in West Siberia using multiple sources including the ESRI satellite base map, Google Earth satellite base map, and Yandex Maps satellite base map. Each point was classified by several parameters: morphology, spatial aggradation, concurrent cryogenic processes, terrain position, and attachment to the base level. Field experience and data at the key sites, as well as a helicopter-based inventory, helped to perform verification and estimate accuracy.

We identified more than 4000 RTSs. The spatial distribution of identified RTSs demonstrates clusters over the western Yamal Peninsula and central-northern Gydan Peninsula. This research aims at a comprehensive analysis of the spatial distribution of classified RTS concerning regional geological, climate, and other available environmental data. Our results are valuable for

understanding the nature of this widespread phenomenon in the Arctic.