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Spatial and temporal variation of snow cover in the Himalayan and Karakorum region using MODIS data (2000-2019)

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The Himalayan and Karakorum (H-K) region comprise the highest amount of snow and ice cover outside the Polar Regions. The H-K region is grouped into four-part, i.e., the Karakorum (KK), Western (WH), Central (CH), and Eastern Himalayas (EH), based on climate and geographic location. The EH and CH mainly feed by summer-monsoon snowfall, whereas the KK and WH are winters accumulated. This regional variability of climate will affect the water availability for hydropower generation, agriculture, and ecosystem. Therefore, the mapping and monitoring of snow cover change over the study area played an essential role in the context of climate change. The snow cover area (SCA) was observed using Moderate-resolution Imaging Spectroradiometer (MODIS) daily snow cover products version 6 during 2000-2019. Different cloud removal techniques (e.g., multi-sensor, temporal, spatial, regional snow line, multiday backward) are applied to reduce the cloud cover pixels over snow pixels of the MODIS data. The mean annual SCA of the H-K region is 26.4% of the total geographical area during the study period. The statistical trend analysis of mean monthly, seasonal, and annual SCA is examined using Mann-Kendal and Sen's slope test. The mean yearly SCA of the H-K region shows an increasing trend during 2000-2009 and start decreasing significantly during 2009-2019. Similar results are observed in the KK, WH, CH, and EH, which shows a decreasing trend of mean annual SCA since 2009. The mean seasonal SCA shows a significant decreasing trend in summer (June to September) and winter (December to February) since 2009, suggesting a seasonal shift or change in snow cover. Overall, the winter shows an insignificant decreasing trend in comparison to the other seasons during 19 hydrological years (2000-01 to 2018-19). The mean monthly minimum SCA observed in August for the KK and WH, July for the CH, and June for the EH. However, the mean maximum SCA in February for the KK, WH, CH, and March for the EH. The snow cover depletion curve suggests that the maximum SCA in February and minimum in August of the entire region during the study period. The seasonal variation of SCA can be highly related to the influence of monsoonal patterns in the region.