Revealing snow cover dynamics in the Hindu Kush Himalaya over the past decades

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Knowledge about the snow cover distribution is of high importance for climate studies, weather forecast, hydrological investigations, irrigation or tourism, respectively. The Hindu Kush Himalayan (HKH) region covers almost 3.5 million km² and extends over eight different countries. The region is known as ‘water tower’ as it contains the largest volume of ice and snow outside of the polar ice sheets and it is the source of Asia’s largest rivers. These rivers provide ecosystem services, the basis for livelihoods and most importantly living water for drinking, irrigation, energy production and industry for two billion people, a fourth of the world’s population, living in the mountains and downstream.

The spatio-temporal variability of snow cover in the HKH is high and studies reported average snow-covered area percentage of 10–18%, with greater variability in winter (21–42%) than in summer (2–4%). However, no study systematically investigated snow cover metrics, such as snow cover area percentage (SCA), snow cover duration (SCD) or snow cover onset (SCOD) and melt-out day (SCMD), for the entire region so far. Here, we thus present unique in-sights of regional and sub-regional snow cover dynamics for the HKH based on almost four decades, an exceptionally long and in view of the climate modelling community valuable timeseries, of satellite data obtained within the ESA CCI+ Snow project.

Our results are based on Advanced Very High Resolution Radiometer (AVHRR) data, collected onboard the polar orbiting satellites NOAA-7 to -19, providing daily, global imagery at a spatial resolution of 5 km. Calibrated and geocoded reflectance data and a consistent cloud mask pre-processed and provided by the ESA Cloud_cci project as global 0.05° composites are used. The retrieval of snow extent considers the high reflectance of snow in the visible spectra and the low reflectance values in the short-wave infrared expressed in the Normalized Difference Snow Index (NDSI). Additional thresholds related to topography and land cover are included to derive the fractional snow cover of every pixel. A temporal gap-filling was applied to mitigate the influence of clouds. Reference snow maps from high-resolution optical satellite data as well as in-situ station
data were used to validate the time series.