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How is snow cover in global mountain area changing? Detection of snow cover and snow phenology changes by using MODIS imagery over 2000 - 2018

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Mountain areas have raised a lot of attention in the past years, as they are considered sentinel of climate changes. Quantification of snow cover changes and related phenology in global mountain areas can have multiple implications on water resources, ecosystem services, tourism, and energy production [1]. Up to now, several studies have investigated snow cover changes at continental scale and there are several indications of snow cover decline over the Northern Hemisphere [2, 3], despite no study has analyzed snow behavior specifically in mountain areas at global level. In this context, this study investigates the changes in the main snow cover parameters (snow cover area, snow cover duration, snow onset and snow melt) over global mountain areas from 2000 to 2018.

To proper monitor the evolution of snow changes at global mountain areas and interlinkages with meteorological drivers (air temperature, snowfall), automatic procedures were developed based on MODIS imagery in global mountain areas over the period 2000-2018 by exploiting Google Earth Engine where the whole time series of MODIS is available at a global scale. MODIS snow cover products have the highest resolution available, 500 m, and with daily global acquisitions. From MODIS snow cover areas (MOD10v6), snow phenology parameters were derived, namely snow cover duration, snow onset and snow melt. Together with snow cover and phenology changes, snow albedo changes were assessed, especially in relation to snow onset and melt variability.

The results of the trend analysis carried with Man-Kendall statistics indicate that around 78% of the global mountain areas present a snow decline. In average, snow cover duration has decreased up to 43 days, and a snow cover area up to 13%. Significant snow cover duration changes can be linked in 58% of the areas to both delayed snow onset, and advanced melt. Few areas show positive changes, mainly during winter time and located in the Northern Hemisphere.

Considering the relationship with meteorological parameters and albedo, air temperature is detected as the main driver for snow onset and melt, while a mixed effect of air temperature and precipitation dominates the winter season. Moreover, snowmelt timing is strongly related to significant changes in snow albedo during March and April in the Northern Hemisphere. Regarding snow onset changes, it has been detected a latitude amplification for the dependency con air temperature, indicating that the sensitivity of snow onset on temperature changes is amplified going from higher to lower latitude.

References

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