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Snow melt and phenology of a subalpine grassland: analysis through the use of digital camera images.

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Plant phenology is a good indicator of the impact of climate change on ecosystems. On mountain systems the main environmental constraints governing phenological timing are air and soil temperature, photoperiod and presence of snow. Recent studies showed the potentiality of using automated repeat digital photography for monitoring vegetative phenological events.
In the present study, digital images collected with a CC640 Campbell Scientific Camera over 3 years (2009, 2010, 2011) in a subalpine grassland were used to analyse the spatial patterns of phenological events and their relationship with the timing of snowmelt.
Yearly time series of green chromatic coordinates (gcc) were computed from hourly images. In order to analyse the spatial pattern of phenological metrics, gcc time series for each 10x10 pixel region of the target ecosystem were computed and the start of the season for the 10x10 regions was extracted. Based on the same grid dimension a snowmelt date map corresponding to the day of the year in which the snow disappears from the ground was obtained.
Our main result showed that despite the snowmelt occurs rapidly, as maximum in seven days, several distinct spatial patterns were identified. The comparison of spatial patterns of snowmelt and phenological dynamics led to quite unexpected results. In fact, a negative correlation was found between the two variables, meaning that the growing season begins later in convex areas characterized by an early snowmelt, and vice versa in concave areas. A detailed field vegetational analysis revealed that these patterns were related to different plant communities. In particular differences in terms of species abundance seem to be related to convex and concave areas, mainly covered by grasses and by forbs respectively suggesting that different patterns of snow accumulation and of water availability during the growing season due to micromorphology affect the vegetation community and so indirectly phenology. These observations were particularly clear during spring 2011, when an early disappearance of snow, about 40 days earlier than the previous two years, occurred. These results support the possibility of using digital repeat photography to analyze the spatial variability of phenological timing of complex ecosystems such as alpine grasslands.