Submitted Abstract

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Abstract

The impacts of changing climate on alpine vegetation have already been intensively investigated and findings indicate that alpine grasslands will undergo substantial changes, especially due to increasing temperatures and changes in snow dynamics. Snowbeds comprise a complex microclimatic and topographic mosaic and facilitate the growth of species with diverse phytosociological optima and survival strategies. Many snowbed species are highly specialized to short vegetation periods, e.g., through their phenological cycle. Hence, climate change is expected to have a large impact on alpine plant communities and will lead to substantial changes by favoring some species and penalizing others.

To identify those key-species and to assess the effects of increasing temperatures and changing snow-dynamics on snowbed-communities, we set up permanent observation plots in ten snowbeds at two study sites in the Italian Alps (Cimalegna and Mazia), that mainly differ in snow dynamics and growing season length. We monitored the phenological development of six species present for three years by a standard protocol for phenological phases (BBCH) and for one season by an IR/RGB-phenocam. We related the phenological stages to the season- and climate-related variables Day Of Year (DOY), Days From Snow Melt (DFSM), and Thawing Degree Days (TDD) and compared results from the early snowmelt site (Mazia) with those from the late snowmelt site (Cimalegna). We further used Generalized Additive Mixed Models (GAMM) to predict changes in phenology under advancing snowmelt.

Our results indicate that phenological development in general correlated better with TDD and DFSM than with DOY. Furthermore, we found substantial differences in the phenological timing of the species. In 2020, early flowering species like Salix herbacea completed the phenological cycle around DOY 234, while late flowering species like Euphrasia minima took until DOY 260. Also, vegetative indices (green chromatic coordinate GCC, and excess greenness ExG) between the study sites differed considerably due to different cover: GCC at Cimalegna peaked three weeks later than in Mazia, while reaching up to 10% higher values. Furthermore, our models demonstrated good predictive quality simulating the phenological cycles of Salix herbacea and Poa alpina under decreasing snow cover but performed poor for Gnaphalium supinum and Agrostis rupestris. This suggest that some species might be able to adapt to changing climatic conditions better than others, giving them advantage in a warmer future.