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Opportunistic alpine plant species profit from earlier growing season

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At high elevations, many vital processes (growth, reproduction and nutrient cycling) are shaped by the presence of snow throughout most of the year. Alpine plants therefore have to pass through their phenological cycle within the short growing season of just about three months. While the synchronization of flowering via photoperiod enhances successful reproduction and reduces the risk of early season freezing damage, it also prevents plants from profiting from earlier snowmelt and longer growing seasons. For the future, it is not clear whether snowmelt dates at elevations < 2500 m a.s.l. are going to be advanced due to higher temperatures or whether they are going to be delayed due to more late winter precipitation and a higher snowpack. In a unique snow and summer precipitation manipulation experiment in the Swiss central Alps (2500 m a.s.l.), we explore the consequences of altered onset of the growing season (earlier and later) on the flowering phenology of common species in a typical late successional grassland. The results of three years (2016 - 2018) clearly show a dominance of opportunistic flowering behavior. Most of the commonly occurring species closely follow snowmelt and the onset of flowering is most likely determined by species-specific thermal sums. While relatively low temperature sums trigger flowering in species like Carex curvula (sedge) and Geum montanum (herb), other species as Trifolium alpinum (N-fixing herb) and Helictotrichon versicolor (grass) start flowering at higher thermal sums. Leontodon helveticus (herb) pursues a completely different strategy and starts to flower during a certain time period of the year. The exceptionally early start of the growing season in 2017 (ca. three weeks earlier) reaffirms the existence of these distinct strategies. In late successional alpine grasslands, future timing of snowmelt will therefore evoke a clear response in the timing of the onset of flowering with consequences for plant reproduction in the longer term.