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Analysis of a multi-species spring phenology data set in the Alpine Region with respect to Climate Change

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A vast number of studies have highlighted an earlier onset of phenological spring events in response to climate change. However, all these studies were confined to one phenological phase stemming from different locations.

In this contribution we present a multispecies dataset of fifteen different phenological phases of the COST action 725 database from 1971 to 2004 covering the Alpine region from 45 to 49°N and from 6 to 17°E. This data set has been subjected to Principal Component Analysis (PCA) in order to identify dominant spatial patterns and their relation to topography. Furthermore, to determine the impact of climate parameters such as temperature and precipitation on phenological observations linear regression analysis has been applied on the time series of the principal components.

From 1971 to 1988 phenological spring events occurred on average 2.2 days later than the long term average. In the period from 1989 to 2004 earlier appearance dates of 2.4 days were noticed. Therefore, the average beginning of the growing season in the Alpine region has over all advanced by 1.8 days per decade. The corresponding leading PCA pattern is homogeneously distributed with consistently negative trends. Temperature is found to be the main driving factor for this overall observed change in season.

Regionally important, the second PCA phenology and temperature patterns are clearly dominated by altitudinal gradients, meaning that plants at higher elevations tend to later appearance dates in the year using effectively less ‘temperature’ (growing degree days) than plants in the lowlands. Finally, an obvious north-south pattern with fewer days of rain in the Alps and in the South of the Alps and more precipitation in the North of the Alpine region is detected in the third PCA precipitation pattern.

A similar study had earlier been performed for phenological data from Switzerland alone. The present results for the entire Alpine region are largely comparable to those for Switzerland alone. This is particularly true for the climate change signals thus indicating the robustness of the applied method on the one hand, and the value of phenological observations with respect to detecting climate change, on the other hand.