Synthesizing plant phenological indicators from multispecies datasets

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Changes in the seasonality of life cycles of plants from phenological observations are traditionally analysed at the species level. Trends and correlations with main environmental driving variables show a coherent picture across the globe. The question arises whether there is an integrated phenological signal across species that describes common interannual variability. Is there a way to express synthetic phenological indicators from multispecies datasets that serve decision makers as usefull tools? Can these indicators be derived in such a robust way that systematic updates yield necessary information for adaptation measures?

We address these questions by analysing multi-species phenological data sets with leaf-unfolding and flowering observations from 30 sites across Europe between 40° and 63°N including data from PEP725, the Swiss Plant Phenological Observation Network and one legacy data set. Starting in 1951 the data sets were synthesized by multivariate analysis (Principal Component Analysis). The representativeness of the site specific indicator was tested against subsets including only leaf-unfolding or flowering phases, and by a comparison with a 50% random sample of the available phenophases for 500 time steps.

Results show that a synthetic indicators explains up to 79% of the variance at each site – usually 40–50% or more. Robust linear trends over the common period 1971–2000 indicate an overall change of the indicator of -0.32 days/year with lower uncertainty than previous studies. Advances were more pronounced in southern and northern Europe. The indicator-based analysis provides a promising tool for synthesizing site-based plant phenological records and is a companion to, and validating data for, an increasing number of phenological measurements derived from phenological models and satellite sensors.