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Direct downscaling of phenological entry dates in Central Europe

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The last decade's increasing temperatures have already exerted an observable impact on Europe's plant phenology. As a result, possible future climate trends and their effect on ecology are of great concern. Only reliable local climate information that includes levels of uncertainties shall allow for a proper assessment of possible future developments. Although the spatial resolution of climate models (GCMs) has steadily been increasing, the modelling of local scale climate impact on the biosphere still requires downscaling of climate variability from the GCM-scale.

Common to most downscaling studies dealing with biological processes is a 2 step procedure: in the first step large-scale atmospheric fields are downscaled via a dynamical, an empirical or a combined approach to individual sites or a limited area. In the second step these localised atmospheric variables serve as independent input variables for models simulating the effect on the regarded biological processes. Here we apply 'direct downscaling', which directly links the local-scale phenological entry dates with large-scale atmospheric variables by means of a CCA (Canonical Correlation Analysis).

The phenological data base of the ZAMG (Zentralanstalt für Meteorologie und Geodynamik, the Austrian National Weather Service) provides about 45 phases at up to 73 stations for a period of 55 years (1951 – 2005). Because of the large number of phases just essential stages of the vegetation period are considered. The stations cover an elevational range of 1400 m, which permits conclusions about the spatial behaviour of the phenological phases.

Relative topography (500 hPa – 850 hPa) and specific humidity in 850 hPa serve as large-scale atmospheric input variables. For the observation period these are extracted from the NCEP/NCAR reanalysis databases and for the scenario period (2006—2100) these are taken from ensemble experiments carried out with ECHAM5/OPYC3 for two IPCC emission-scenarios (B1 and A1B).

The performance of the CCA models is rather low with explained variances ranging from 0.1 to about 0.4. Poorest performance is generally to be found for autumn phases. Within the annual cycle one can distinguish amongst three time sections, each with a characteristic shift in the phenological entry dates throughout the scenarios. Spring (yearday 50 – 180) features an advance of the mean entry dates of 5 to 10 days, summer (yearday 180 – 230) ripening phases occur up to 15 days earlier and autumn phases (yearday 230 – 300) do not show any clear temporal shift.

Another important result is the observation that trend values of occurrence dates calculated over the whole scenario period of about 100 years are much smaller than the observed trend values over the last 20 years. Without looking into that fact any deeper, it is difficult to evaluate this result. So, right now, we can only speculate about its causes. It could mean that the shift to earlier occurrence dates during the last 20 years has, because of its shortness, a strong random component, which will be counterbalanced by future opposite random fluctuations.