Mapping the main spatio-temporal patterns of spring onset over Europe

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The study of interannual variation in phenological patterns is relevant for understanding the impact of global change on our planet. Till now, this kind of studies has been done by clustering of spring onset information from phenological models or remote sensing data. Such a clustering identifies regions have similar phenology or phenoclusters. In this contribution we present a novel analysis of phenological patterns based on co-clustering. This method allows the simultaneous analysis of spatial and temporal phenological patterns present in the data.

The analysis is illustrated using the Extended Spring Indices (SI-x), which characterize spring onset by predicting the first leaf dates (FLD) for key plant species from daily maximum and minimum temperatures and latitudinal information (as a proxy for day length). The FLD values were calculated from the European E-OBS temperature dataset, which provides weather data for the period 1950 to 2011 at a spatial resolution of 0.25 degrees After that, the FLD values were clustered using the Bregman block average co-clustering algorithm WU et al. (2015) and the resulting co-clusters were grouped using k-means to identify the main spatio-temporal patterns present in the data.

Results show that there are five main FLD spatio-temporal patterns over Europe. These patterns were named according to their relative spring onset timings as “very late”, “late”, “early”, “very early” and “abnormal”. The first years of the period under study exhibit very late FLD values especially in northern Russia, Scandinavian countries, Iceland and few areas of Western Europe (e.g. the Alps). In recent years, warmer springs (early FLD values) are common particularly in most of the Iberian Peninsula, northern France and Ireland. Results also show that western Turkey had the most intricate temporal patterns as this area belongs to several distinct patterns. This study has also found anomalous FLD values (e.g. Iceland) that might indicate quality issues in the E-OBS temperature datasets.

These results offer a novel view of the long term phenological patterns that exists in Europe and of their temporal dynamics. Thus, we conclude that co-clustering is a promising method to map phenological patterns over large areas.

References:

WU, X., ZURITA-MILLA, R., KRAAK, M.J., 2015: Co-clustering geo-referenced time series: exploring spatio-temporal patterns in Dutch temperature data. *International Journal of Geographical Information Science*, DOI:10.1080/13658816.2014.994520.

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