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Evaluating the Extended Spring Indices over Europe using cloud computing

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Global warming is altering the onset of spring. This alteration affects both natural and agricultural systems. An advancement or delay of spring affects plant productivity as well as -directly or indirectly- animal populations, migrations and interactions. Thus, the study of spring onset is fundamental in several fields.
Spring onset can, for instance, be monitored using a suite of regression-based models called the Extended Spring Indices (SI-x). For instance, the SI-x models, which were developed by Schwartz et al. in 2013, only require daily maximum and minimum temperatures since January 1st to predict the timing of first leaf and first bloom day of each year. Previous studies based on the SI-x models have been developed either using point data (e.g. Ault et al. (2013)) or using gridded data (e.g. Izquierdo-Verdiguier et al. (2018)). The former provides the SI-x product values from single weather stations, whereas the latter obtains continuous fields of the spring onset products. Both studies focus on the contiguous United States. However, it is now possible to obtain gridded climate data at high spatial resolution covering Europe. This allows us to map spring onset over this continent.
A downscaled European climate dataset was created by Moreno et. al, 2015, by combining the European Observation dataset (maximum and minimum daily gridded temperature products at 25km) and WorldClim (monthly climate data at 1 km). This dataset covers the entire European continent and provides long-term records. Because of its size, this dataset poses a computational challenge to run the SI-x models. However, cloud computing allows to process big volumes of data. In this study, we use Google Earth Engine to calculate the SI-x over Europe at 1km. We also present a preliminary analysis of this novel product, which consists of two primary variables (first leaf and first bloom) and two derivative products (Damage Index and Last Freeze Day) from 1950 to 2017. This product allows to map phenological changes, trends and dynamics over the European continent. We relate observed patterns and trends to MODIS derived SOS obtained at the same spatial resolution, but only covering 2002-2017. Finally, a spatial-temporal phenoregion analysis is also presented to understand the relationships between the first leaf and first bloom indices and the European ecosystems.