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SUPPORTING INFORMATION

Assessing Relative Variable Importance across Different Spatial Scales: A Two-Dimensional Wavelet Analysis

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Appendix S1 Additional information about datasets.

Satellite data

The satellite data (NOAA 11, NOAA 14, NOAA 16, NOAA 17) are received and processed at the Meteorological Institute of the Freie Universität Berlin. The NOAA AVHRR Archive used here is the "Mediterranean Extended Daily One Km AVHRR Data Set" (MEDOKADS). The projection was stereographic at a $0.01° \times 0.01°$ resolution, i.e. a projection which preserves the angles. For resampling from the uncorrected image to the output grid the Nearest Neighbour Kernel (NN) was applied. In the resampled output grid, a resolution of 1×1 km^2 only holds approximately. Around 50 % of the pixels had a slightly bigger cell size. In total 19 years (1989-2007) of daily high spatial resolution data were analysed to monitor the seasonal vegetation cycle for the study area. The MEDOKADS dataset has predominantly been used for the analysis of land use change and desertification (Hill *et al.*, 2008; del Barrio *et al.*, 2010; Stellmes *et al.*, 2013). More information regarding data processing can be found in Friedrich & Koslowsky (2009).

Derivation of the vegetation period

Daily NDVI observations were filtered using an adaptation of the Best Index Slope Extraction (BISE) algorithm (Viovy *et al.*, 1992). Knowledge about the phenological cycle in temperate climates and their temporal evolution was used to detect and eliminate cloud contaminated observations in the dynamic filtering procedure. As this algorithm searches forward within daily NDVI observations over one year, decreases were only accepted if no higher values were found within a so-called sliding period. A period of 40 days proved best for reconstructing the true NDVI profile, i.e. accurately capturing short term changes like the NDVI increase in spring without selecting potentially cloudy observations.

After dynamic filtering, gaps between the selected NDVI observations were filled by linear interpolation, reconstructing the 'true' daily NDVI profile. Phenological metrics were subsequently extracted applying a local threshold *LT* which is defined by the intra-annually extracted NDVI maximum and minimum values of a single pixel:

$$LT = NDVI_{min} + (NDVI_{max} - NDVI_{min}) * threshold$$

where $threshold$ is set to 0.65. Green-up date and senescence date were extracted at the point where the NDVI profile runs through *LT* before and after the respective NDVI maximum. This means that *LT* can refer to different NDVI values for the same pixel between years and also to different NDVI values for neighbouring pixels within one year. The length of vegetation period was then derived by subtracting the green-up date (day of year) from the senescence date. Phenological metrics extracted from satellite data were extensively tested against phenological ground observations from the German Weather Service (DWD). The DWD and its volunteer observers provide ≈1500 observations per year and phenophase. For evaluation, we focussed on tree phenology (Beech and Oak) as temperate forest exhibits a clear seasonal signal for a geolocation, constant in time, in contrast to, e.g., crops (crop rotation). We tested different thresholds and found minimal differences of 4-5 days at $threshold = 0.65$.

Climate and land cover data

The following two climate variables have been extracted from the WorldClim database Version 1.4 (Hijmans *et al.*, 2005) at a resolution of 30 arc-seconds: Annual mean temperature (Bio1) and annual precipitation (Bio12). These climate variables are representative for average conditions during the period from 1950 to 2000. The centre points of the WorldClim grid were assigned to the grid used for the vegetation period and the respective climate data were mapped accordingly. Even though, as a general rule, temperature decreases as the elevation increases, in Central Europe this correlation between altitude and temperature is diminished since latitude ranges over more than 10 degrees. That is why in addition to the climate data we also extracted elevation data from the WorldClim data base and assigned them to the vegetation grid in the same manner as the climate data.

Land cover data were extracted from Corine Land Cover 2006 vector data Version 17 (EEA, 2013). The original 44 land cover classes were aggregated into the following seven categories: artificial areas, agricultural areas, forests, grass and scrublands, open surface areas, wet areas, and water bodies. The aggregated vector data were reprojected and subsequently intersected with the grid used for the vegetation period. Percentage cover was then calculated for each aggregated land cover class per grid cell. The land cover categories artificial areas, agricultural areas, forests, and grass/scrublands were used for further analyses. All necessary calculations, reprojections and assignments have been done using ArcGIS Version 10.2.1 (ESRI, 2013).

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