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Interpolation of phenological phases on a digital elevation model (DEM)

Thomas C. Schöngaaand Helfried Scheifinger
Central Institute for Meteorology and Geodynamics, Vienna, Austria (thomas.schoengassner@zamg.ac.at)

The main objective of the VegDyn project (a cooperation between Joanneum Research, Institute of Digital Image Processing, LFZ Raumberg-Gumpenstein and ZAMG) consists in quantifying and modelling the relationship between individual growth stages of grassland on the one hand and atmospheric parameters, remotely sensed data and phenological observations on the other. The model simulates the beginning and the end of the vegetation period and the growth stages of grassland with temperature as input variable. Thus it will be possible to explore changes of the timing of the vegetation period and the growth stages of grassland in possible future climate scenarios, which are calculated by climate models.

In the context of the VegDyn project we developed methods for the spatial interpolation of phenological phases on a digital elevation model with a 250 m grid resolution in the complex terrain of the Alps. The final result is a series of maps of long term mean entry dates and maps of entry dates of individual years, which can for instance be related with the Net Difference Vegetation Index (NDVI) parameter maps from satellite observations.

Apart from the yearly input via the conventional observational network based on voluntary observers and the input via the web interface, the Austrian phenological data base is still being supplemented by data from the paper archive. The elevation of the station network ranges from 100 to 1700 m. The station density can reach up to 100 or more stations per phase and season during 1951 – 2009. From more than 280 observed phases including phases from wild (woody and herbaceous) and agricultural plants those have been selected, which are related to cultivated grassland and which can be detected by remote sensing. In order to be selected for spatial interpolation the phase must satisfy a number of criteria: a minimum number of stations and, in order to have a meaningful long term mean entry date, a minimum number of observations per station during 1951 – 2009. If this minimum number is set to 20 years, there remain averagely 129 stations per phase, which fulfil the criterion. An average observer notes about 51 phases. This results in a rather high year to year fluctuation of observing stations and observed phases.

The applied interpolation methods are linear regression with the entry dates as dependent and the station coordinates as independent variables, height reduced inverse distance weighting, and height reduced mean. For the latter two methods the search radius and the number of selected nearest neighbouring stations for interpolation have been optimised via trial and error. Interpolation quality is being checked via spatial cross validation, where the average anomaly, explained spatial variance (correlation squared or RSQ) and the root mean squared error (RMSE) serve as quality criteria. The resulting set of maps contains the interpolated long term mean phenological entry date and the entry dates of a series of individual years (1990 – 2009) for each of the three methods. This enables a comparison of the three interpolation methods and an evaluation of the quality of the results.