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Modelling climate control on cropland and grassland development using phenologically tuned variables

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Many studies already investigated the impact of climate change and climate variability on vegetation at global and continental scales. Using time series of remote sensing and climate data, Nemani et al. (2003) analyzed trends in Net Primary Production in relation with changes in climate and showed that, between 1982 and 1999, primary productivity increased by 6% globally in response to climate change. This study also stressed the need to take into account the spatial variability of climatic constraints to plant growth when analyzing the climate change impact on vegetation. Others authors described different phenomenon linked with climate change such as increases of seasonal NDVI amplitude and growing season duration in the Northern high latitude or changes in circumpolar photosynthetic activities.

Understanding the interactions between climate and vegetation is also a key issue in our PhD research. Our objective is to identify the meteorological factors which limit the development of croplands and grasslands in relation with their geographical localization. For that purpose, we acquired 10-daily time series of the Normalized Difference Vegetation Index, NDVI, derived from SPOT-VEGETATION and 7 meteorological parameters (Tmean, Tmin, Tmax, Rain, Rad, ETP, Rain-ETP) derived from ERA40 re-analyses and the operational ECMWF (European Centre for Medium-Range Weather Forecast) atmospheric model.

Cross-correlations between NDVI and each one of the meteorological parameters were analysed for a set of 25 regions over Europe and Africa: 15 agricultural regions and 10 regions covered by grassland or savannas. Unlike others studies, we did not consider the vegetation globally but we focussed on two types of vegetation: croplands and grasslands. This is quite important considering the role of phenology on the vegetation cycle and its relation with climate. Moreover the analysis was not realised using yearly estimates but using 10-daily products. In order to avoid stationarity related issue, a specific methodology was developed taking into account the phenological cycle of the vegetation under consideration.

Preliminary results showed that the relation between a meteorological limiting factor, e.g. precipitation, and NDVI can not be considered as linear during the year or even during the growing season. Interactions must to be studied at a smaller time scale than the growing season in order to identify properly the limiting factors to plant growth taking into account its phenology. Moreover the main limiting factors are variable from a region to another. In our analysis we also considered the possibility of a delayed response of the vegetation or a cumulated effect of meteorological events (up to 3 months). Our methodology will be presented during the conference and results will be discussed and illustrated by some test cases.

Reference:
Nemani R.R., Keeling C.D., Hashimoto H., Jolly W.M., Piper S.C., Tucker C.J., Myneni R.B. and Running S.W. (2003). 'Climate-driven increases in global terrestrial net primary production from 1982 to 1999'. Science, 300, 1560-1563.