Modelling climate control on cropland and grassland using phenologically tuned variables

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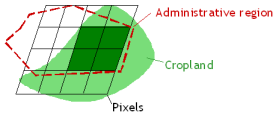
Objective

❑ To better understanding the **interactions between climate variability and vegetation growth during the growing season**;
❑ To set up a **methodology** which optimizes the monitoring of climate control on cropland and grassland development using 10-daily time series of low resolution satellite images and global meteorological dataset.

Data & selection of sites

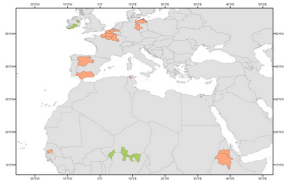
Data: (Source : MARS Unit, IPSC)
• 10-daily time series of **NDVI** from 04/98 till 05/08 derived from SPOT-VEGETATION;
• 10-daily time series of **7 meteorological parameters** (Tmean, Tmin, Tmax, Rain, Rad, ETP, Rain-ETP) from 01/90 till 05/08 derived from ERA40 re-analyses and the operational ECMWF (European Centre for Medium-Range Weather Forecast) atmospherical model.



Regional unmixed statistics calculated for each parameter (see fig.): Time series specifically processed for cropland (or grassland) considering only pixels completely covered by cropland (or grassland) to estimate regional statistics (mean, std).

Specific selection of test sites in Europe and in Africa

! Optimal test sites = regions where the **major part of the NDVI signal variation can be attributed to the climate** and not to other phenomena such as land cover changes (Horion et al., 2007).



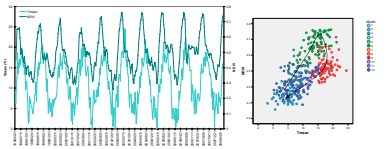
Map of the selected sites for: cropland (red), grassland (green)

Selection based on:
(i) region covered by a dominant LC (croplands or grasslands);
(ii) NDVI signal spatially homogenous within the region for pixels covered by cropland/grassland;
(iii) No land cover change or limited.

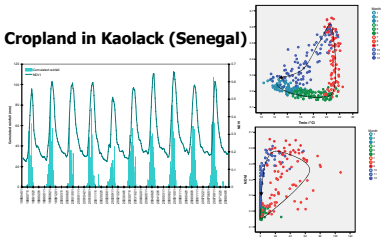
What about the relation between meteo and NDVI?

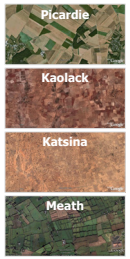
Time series and **scatterplots** of NDVI and different meteorological parameters for 4 sites

Cropland in Picardie (France)



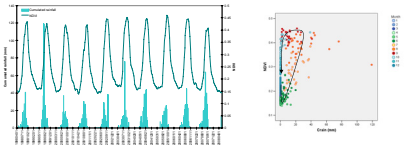
Cropland in Kaolack (Senegal)



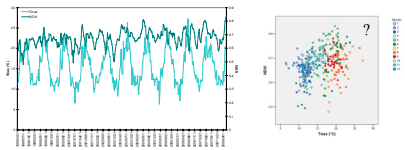


Google Earth quick looks of the sites

Grassland in Katsina (Nigeria)



Grassland in Meath (Ireland)



❑ **Relation not constant during the growing season**
❑ Some phenological stages more sensitive to a given variation of a limiting factor than others
❑ Relation between NDVI and meteo highly depends on the **geographic location** and on the **vegetation types**

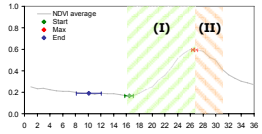
How to identify limiting factors?

By analysing cross-correlations between NDVI and the 7 meteo parameters…

BUT, 3 constrains:

❶ As shown in the previous frame (*"What about the relation…"*), limiting factors may vary within the growth cycle [***PHASE***]

⇨ Use of NDVI metrics (onset of GS, NDVImax) as key events to **divide the growing cycle** into a vegetative phase (from onset to max) and a reproductive phase (from max to maturity)

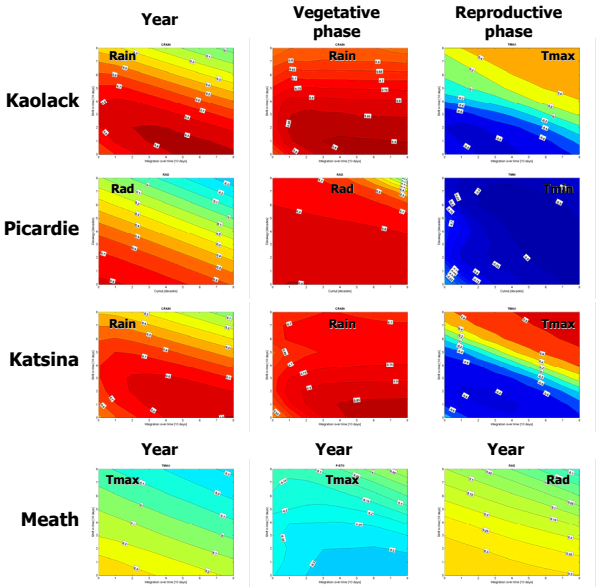


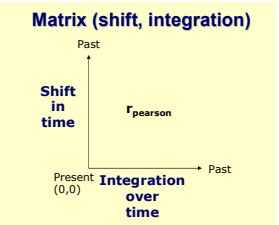
Metrics and phases identified for Kaolack: (I) vegetative phase, (II) reproductive phase

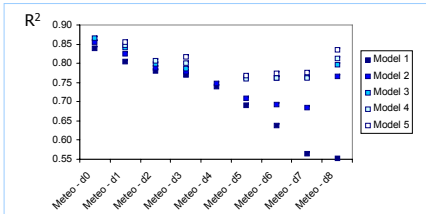
❷ NDVI response to a meteo event may be delayed [***SHIFT***]

❸ Cumul of meteo over a certain period may be more correlated than non cumulated meteo [***INTEGRATION***]

⇨ For ❷ and ❸ : Cross-correlations calculated for each combination (shift, integration)
Delay until 3 months and cumul max over 3 months







1st modelling result for the vegetative phase of cropland in Picardie (France): stepwise regression using only meteorological parameters.

R^2 of the regression (Y-axis) for different models based on meteorological parameters shifted from 0 to 3 months (X-axis) and using from 1 to 5 contributors (Model 1-5).

Discussion and way forward

❑ Limiting meteorological factors are variable during the growing season
❑ Except for grasslands in Ireland, correlations improve in all cases when splitting the analysis into phenological phases (vegetative and reproductive)
❑ **Easy identification of limiting factors** using **matrix (shift, integration)**
❑ 1st modelling results are promising (with and without AR variable)
❑ **Adjustment of the model during the growing season**: several models can give good results depending on the time of the prevision

Further work: analysis of the matrices (shift, integration) and of the modelling results still ongoing

Reference: Horion S., Eerens H., Tychon B. and Cornet Y. (2007). 'Spatial aggregation of low resolution satellite data for the monitoring of vegetation response to climatic stresses: Analysis of the spatial heterogeneity of aggregated entities'. *European Space Agency, (Special Publication) ESA SP-636*, July 2007, 6p.

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