DRIVING THE STICS CROP MODEL BY EXOGENOUS VALUES OF LEAF AREA INDEX. APPLICATION TO REMOTE SENSING.

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Introduction

Leaf Area Index is a key state variable in crop models since it both drives biomass accumulation by intercepting solar radiation and determines plant water and nitrogen requirements. The growth pattern of the LAI is mainly determined by genetic characters interacting with the crop technical schedule, all information not readily available when applying a crop model at regional scale. Moreover, remote sensing techniques allow to derive spatially distributed estimates of an "effective" LAI for radiation interception by a canopy. In this poster we present a method to directly use remotely sensed LAI estimates in the STICS crop model. From space observations regularly performed over the crop cycle, a statistical relationship representing the time course of LAI is fitted. Daily estimates of LAI are then deduced and used as forcing variables in the STICS model. This method is applied to estimate some agronomic parameters on several wheat fields of a 5*5 km² area in South-East of France (Alpilles-ReSeDA experiment).

Materials and methods

STICS is a crop model constructed as a simulation tool capable of working under agricultural conditions. Outputs comprise the production (amount and quality) and the environment. Inputs take into account the climate, the soil and the cropping system. The main simulated processes are the growth, the development of the crop and the water and nitrogenous balance of the soil-crop system.
A variation of the STICS model, called STICS-feuille used the observed LAI data as inputs. This kind of forcing can be very useful when developing the model. Nonetheless, in the case of early stress, the variability of the leaf area index of plants subjected to water and nitrogen deficits is such that the stresses simulated by STICS-feuille can be extremely low. By imposing the LAI, water and nitrogen requirement levels adapted to cope with stress are also imposed.

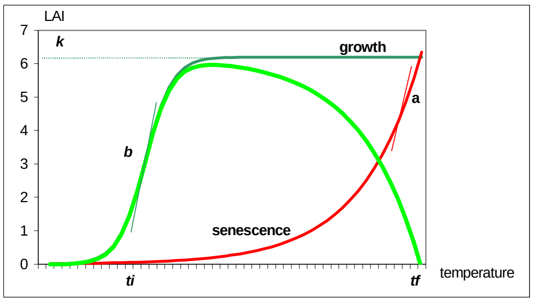
The data set was provided thanks to the ReSeDA campaign (Prevot et al., 1998). The test site was located near Avignon, France (N43°47', E4°45'). Wheat crops were monitored from October 1996 to November 1997. Meteorological data were measured very close to the center of the site. Biological measurements (green leaf area index, dry total biomass) were also carried out every week, during the whole crop cycle. The green leaf area index was evaluated with a planimeter. Remote sensing images (20m resolution) corresponding to different viewing angles were acquired thanks to the airborne POLDER instrument (visible-near infrared domain) at about 10 dates during the crop cycle. The top of canopy reflectance, as a function of viewing angles, and for each wheat crop, was available after radiometric, geometric and atmospheric corrections. We then used a physical approach, based on neural networks (Weiss and Baret, 1999) to derive effective leaf area index from directional reflectance data.

In this 2 examples (biological measurements of LAI and remotely sensed LAI estimates) the function used to obtain daily LAI is :

$$LAI(d) = k * \left(\frac{1}{1 + (\exp(-b * (St(d) - ti)))} \right) - \exp(a * (St(d) - tf))$$

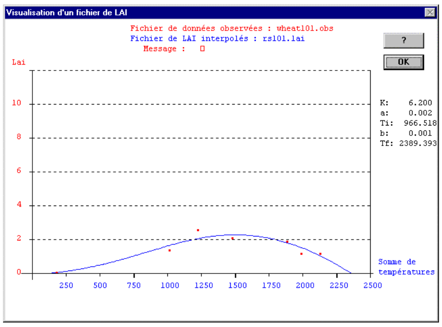
St being the growing degree days since emergence

1 to 5 parameters of this function can be estimated by a non-linear fitting method

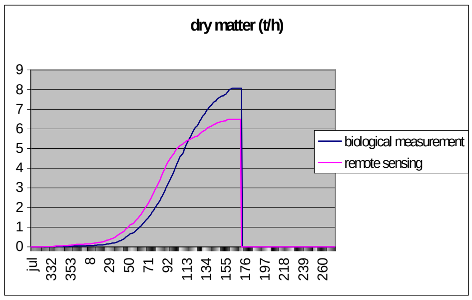


Results

Remote sensing data

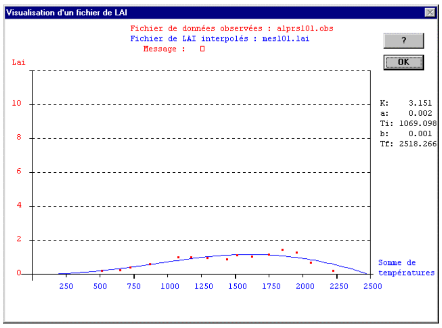


Simulated by STICS

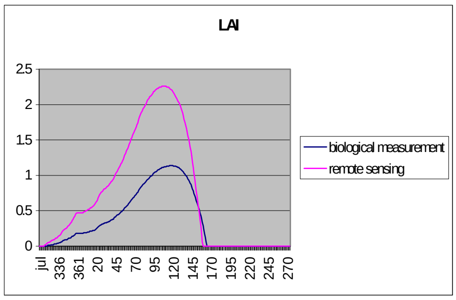


dry matter
yield
Transpiration water
Plant nitrogen

Biological measurement



Simulated by STICS



References

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