Comparing modelled and remotely sensed leaf area dynamics in an Aleppo pine semiarid forest

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Instituto de Ingeniería del Agua y Medio Ambiente

UNIVERSITY OF CAMBRIDGE

Marta Pasquato (marpas@posgrado.upv.es), Chiara Medici (chme1@dihma.upv.es),
Andrew D. Friend (adf10@cam.ac.uk) and Félix Francés (ffrances@hma.upv.es)

ABSTRACT

The performance of a parsimonious dynamic vegetation model is tested against MODIS NDVI and EVI satellite information for a semi-arid Aleppo Pine forest area in the SE of Spain.

The model succeeds in reproducing the vegetation dynamics inferred from the satellite data.

INTRODUCTION

In water-controlled ecosystems soil moisture and vegetation processes are tightly linked [5]. It is therefore important to model vegetation dynamics along with the hydrological cycle. Parsimonious models show the advantage of a low number of parameters to be estimated, which makes them suitable in operational hydrological applications.

Satellites are a valuable source of information that can be used to assess vegetation condition and models performance. Remote-sensing data, however, supply indirect information that need to be carefully interpreted.

MODEL

$$\frac{dB}{dt} = \left(LUE \cdot \varepsilon \cdot APAR - \mathrm{Re}\right) \cdot \varphi - k \cdot B$$

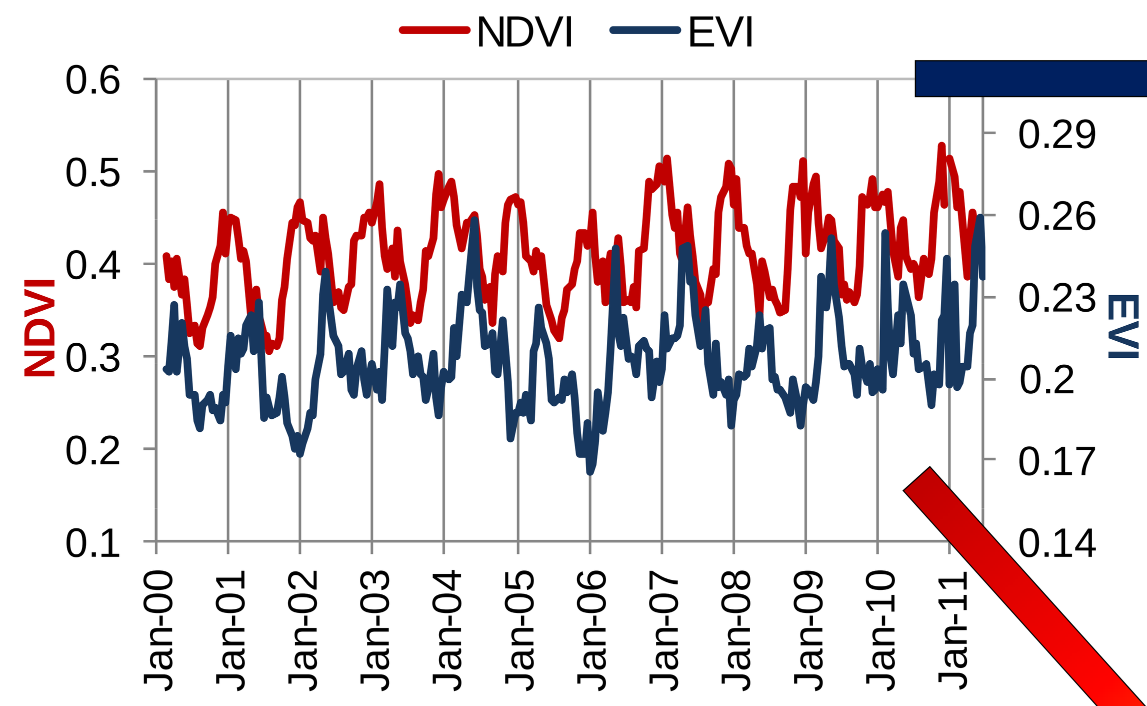
$$\varepsilon = 1 - \zeta \qquad \varphi = 1 - \frac{LAI}{LAI_{max}}$$

Connection with hydrological model

$$LAI' = B \cdot SLA \cdot f_t \qquad LAI_r = LAI' \cdot \left(1 - \overline{\zeta_{10}}\right)$$

B: leaf biomass [kg DM m^{-2} ground]
LUE: light use efficiency [kg DM MJ^{-1} m^{-2}]
APAR: absorbed photosynthetically active radiation [MJ m^{-2} d^{-1}]
Re: maintenance respiration [kg DM m^{-2} d^{-1}] [6]
φ: fractional leaf allocation
k: leaf turnover factor
ζ: water stress [4]; $\overline{\zeta_{10}}$: 10-days average water stress
LAI_{max}: maximum LAI supported by the system
f_t: fractional vegetation cover
SLA: specific leaf area [m^2 leaf kg^{-1} DM]

SATELLITE DATA

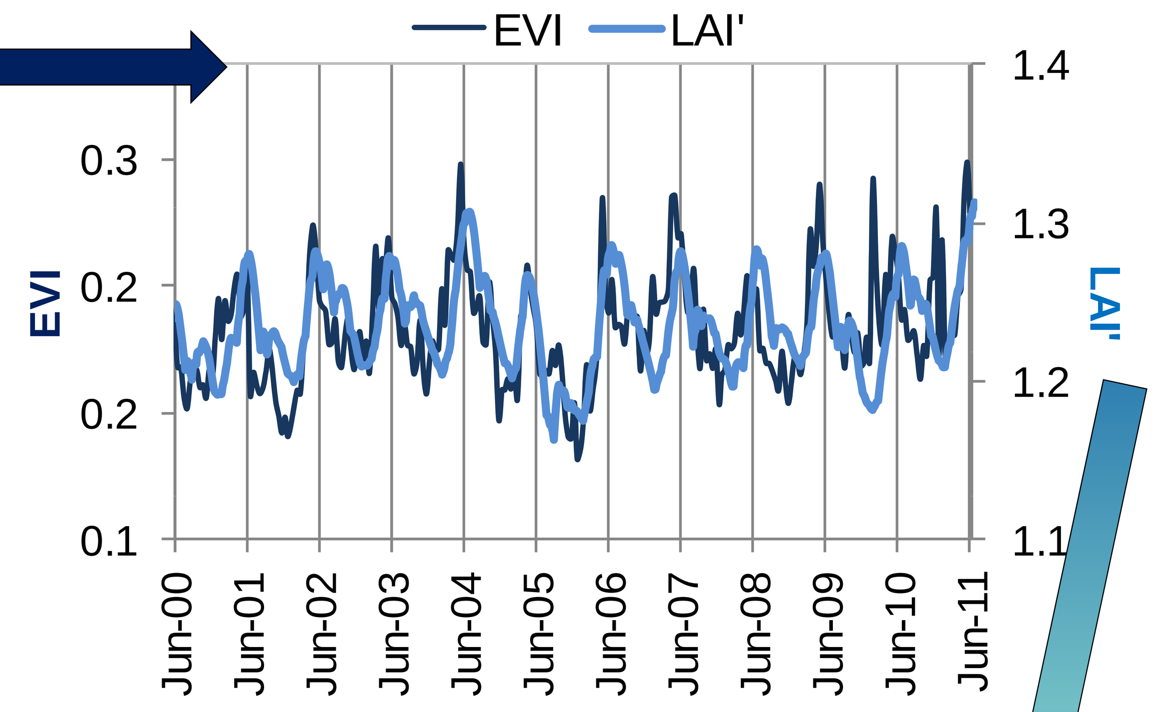


NDVI
maximum values → winter
minimum values → summer
Related to chlorophyll content [2]
To be compared with LAI_r (chlorophyll is sensitive to water stress [1])

EVI
maximum values → spring
minimum values → winter
Related to vegetation structure and LAI [2]
To be compared with LAI'

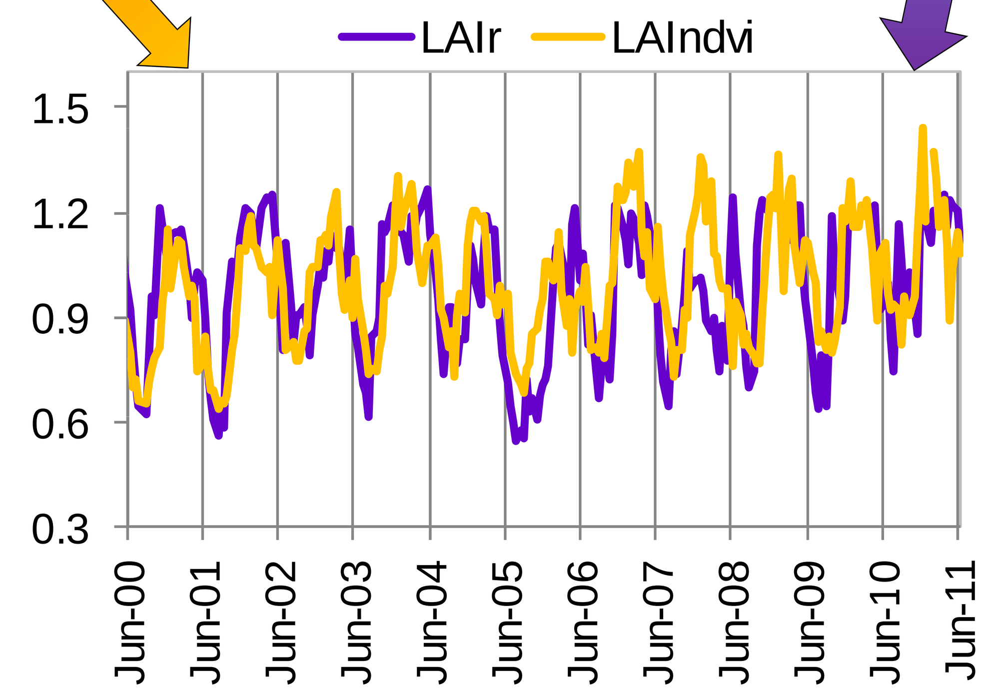
RESULTS

EVI



$$LAI_{NDVI} = -\frac{1}{k}\ln\frac{NDVI_{can} - NDVI}{NDVI_{can} - NDVI_{back}} \quad [3]$$

$$LAI_r = LAI'\left(1 - \overline{\zeta_{10}}\right)$$



Pearson correlation coefficient:

LAI' vs. EVI → r = 0.57

LAI_r vs. LAI_{ndvi} → r = 0.59

LAI' reproduces the behaviour and timing of EVI, and LAI_r of LAI_{ndvi}.

CONCLUSIONS

- EVI dynamics are known to reflect LAI changes. In fact, in the study area peaks were registered in spring, in accordance with Aleppo Pine local phenology;
- NDVI is related to chlorophyll, which is sensitive to water stress in the analyzed vegetation, resulting in minimum values during summer;
- The tested vegetation model managed to reproduce LAI (and EVI) evolution through the variable LAI';
- Taking into account water stress dynamics, the model output LAI_r satisfactorily reproduce NDVI behaviour .

WHAT IS NEXT?: Analysis and contrast of SMOS and modelled soil moisture data.

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the Spanish Ministry of Economy and Competitiveness through the research projects FLOOD-MED (ref. CGL2008-06474-C02-02), SCARCE-CONSOLIDER (ref. CSD2009-00065) and ECO-TETIS (ref. CGL2011-28776-C02-01), from the "Programa VALi+d para investigadores en fase postdoctoral APOSTD, GVA" and from the European Community's Seventh Framework Programme (FP7 2007-2013) under grant agreement n° 238366. The MODIS data were obtained through the online Data Pool at the NASA Land Processes Distributed Active Archive Center (LP DAAC), USGS/Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota (https://lpdaac.usgs.gov/get_data). The meteorological data were provided by the Spanish National Weather Agency (AEMET). The authors thank Antonio Del Campo García and María González Sanchis at the Universitat Politècnica de València for their support.

REFERENCES

[1] Baquedano, F.J. & Castillo, F.J. (2006) *Trees-Structure and Function*, **20**, 689–700.
[2] Huete, A.R., Didan, K., Miura, T., Rodriguez, E.P., Gao, X. & Ferreira, L.G. (2002) *Remote sensing of environment*, **83**, 195–213.
[3] Lacaze, B., Caselles, V., Coll, C., Hill, J., Hoff, C., De Jong, S. & Mehl, W. (1996) Environmental Mapping and Modelling Unit, Space Applications Institute, Ispra, Italy.
[4] Porporato, A., Laio, F., Ridolfi, L. & Rodriguez-Iturbe, I. (2001) *Advances in Water Resources*, **24**, 725–744.
[5] Rodriguez-Iturbe, I., Porporato, A., Laio, F. & Ridolfi, L. (2001) *Advances in Water Resources*, **24**, 695–705.
[6] Sitch, S., Smith, B., Prentice, I.C., Arneth, A., Bondeau, A., Cramer, W., Kaplan, J.O., Levis, S., Lucht, W., Sykes, M.T. & others (2003) *Global Change Biology*, **9**, 161–185.

European Geosciences Union
General Assembly 2013
Vienna | Austria | 07 – 12 April 2013