Influence of vegetation dynamic modelling on the allocation of green and blue waters

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European Geosciences Union
General Assembly 2015

Vienna | Austria | 12 - 17 April 2015

- **The vegetation plays a key role** in a catchment's water balance particularly in Mediterranean areas (Laio et al., 2001)
- In these water-controlled areas, the vegetation controls the water cycle through (Rodriguez-Iturbe et al., 2001):
  - Interception
  - Infiltration
  - Evapotranspiration
  - Surface runoff
  - Consequently, groundwater recharge

In some Mediterranean regions, the evapotranspiration may account for more than 90% of the precipitation → The proper knowledge of this process is vital (Andersen, 2008)

Introduction

- Traditionally, very few hydrological models had incorporated the **vegetation dynamics**
- But, in the last decades, the number of hydrological models taking into account the vegetation development has increased substantially

COMPLEX MODELS	SIMPLE MODELS
➢ Accurate description of the processes ➢ Sensation of total reliability ➢ High number of parameters ➢ High data requeriment	➢ Processes are schematised ➢ Low number of parameters ➢ Low high data requirement + Remote Sensing Data

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Research questions

- Is a parsimonious and simple model suitable to reproduce vegetation dynamics in semi-arid environments?

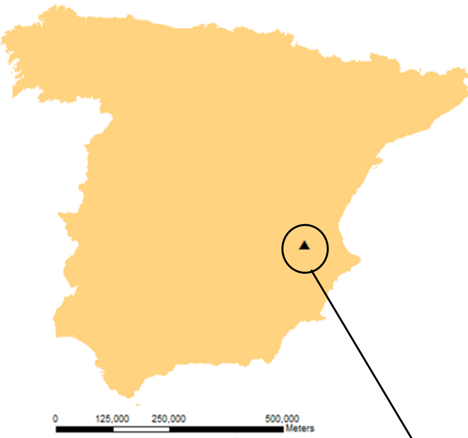
- Is a parsimonious and simple model suitable to reproduce properly the fluxes of the water cycle?

- Can satellite data be used as alternative when field data is not available?

Methodology/outline

- Description of the case study:
  - **Study area**: Aleppo pine experimental plot in La Hunde forest (East Spain)
  - Proposed **parsimonious vegetation model** (LUE-Model)
  - Selected **complex vegetation model** with successful results in the study area (Biome-BGC)
- Implementation of both models:
  - LUE Model: with only NDVI (**satellite information**)
  - Biome-BGC: with **field data**
- Analysis of **results and conclusions**

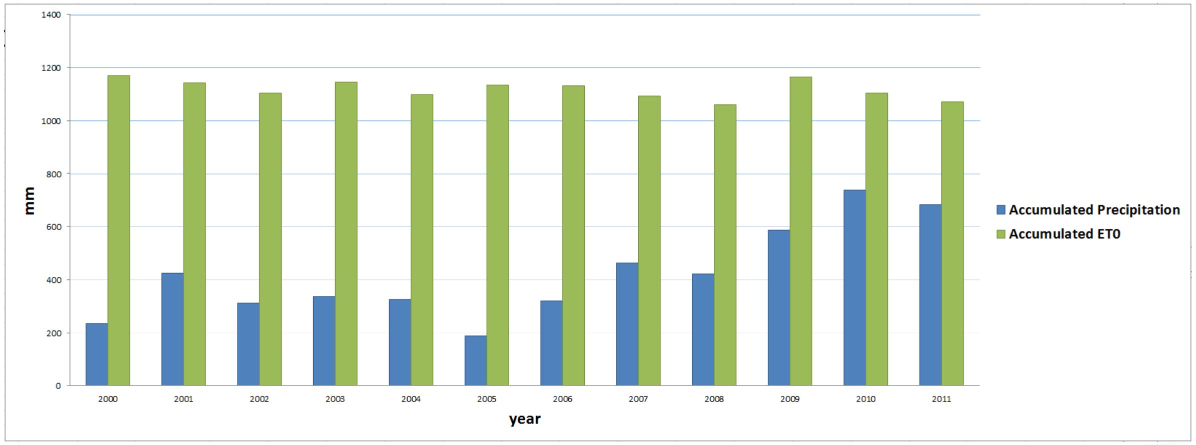
Study Area



- Mediterranean semiarid climate:
  - Water-controlled area
  - Seasonality
- Aleppo pine

Experimental plot location

Annual average **precipitation** → 419mm
Annual average **ET_0** → 1,118mm



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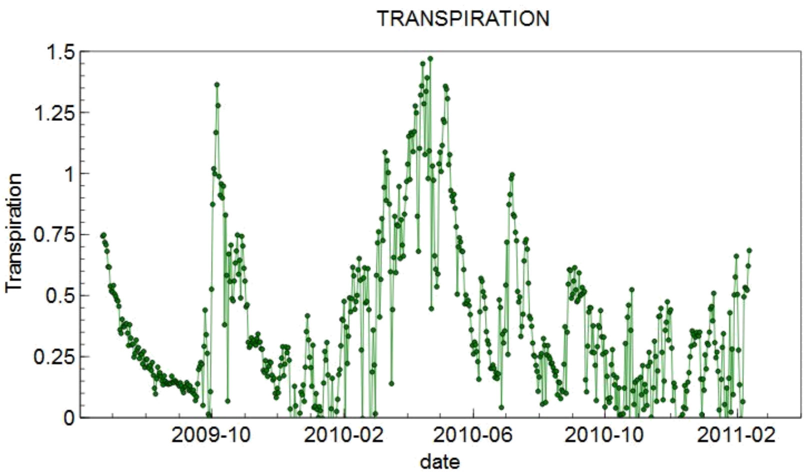
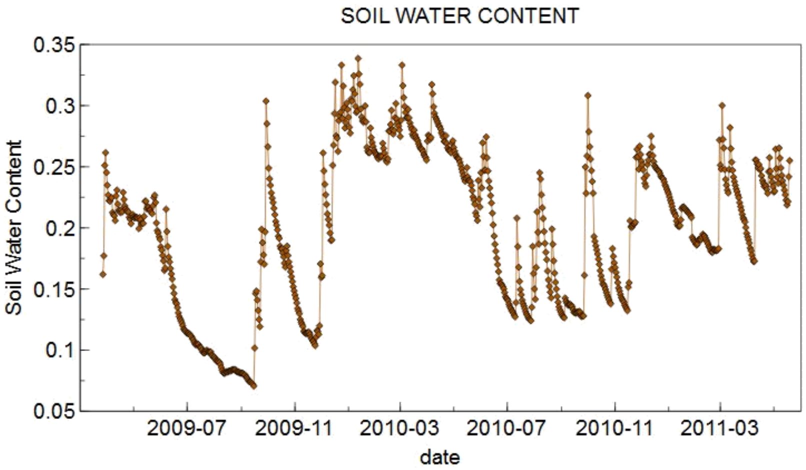
Field data





TRANSPIRATION

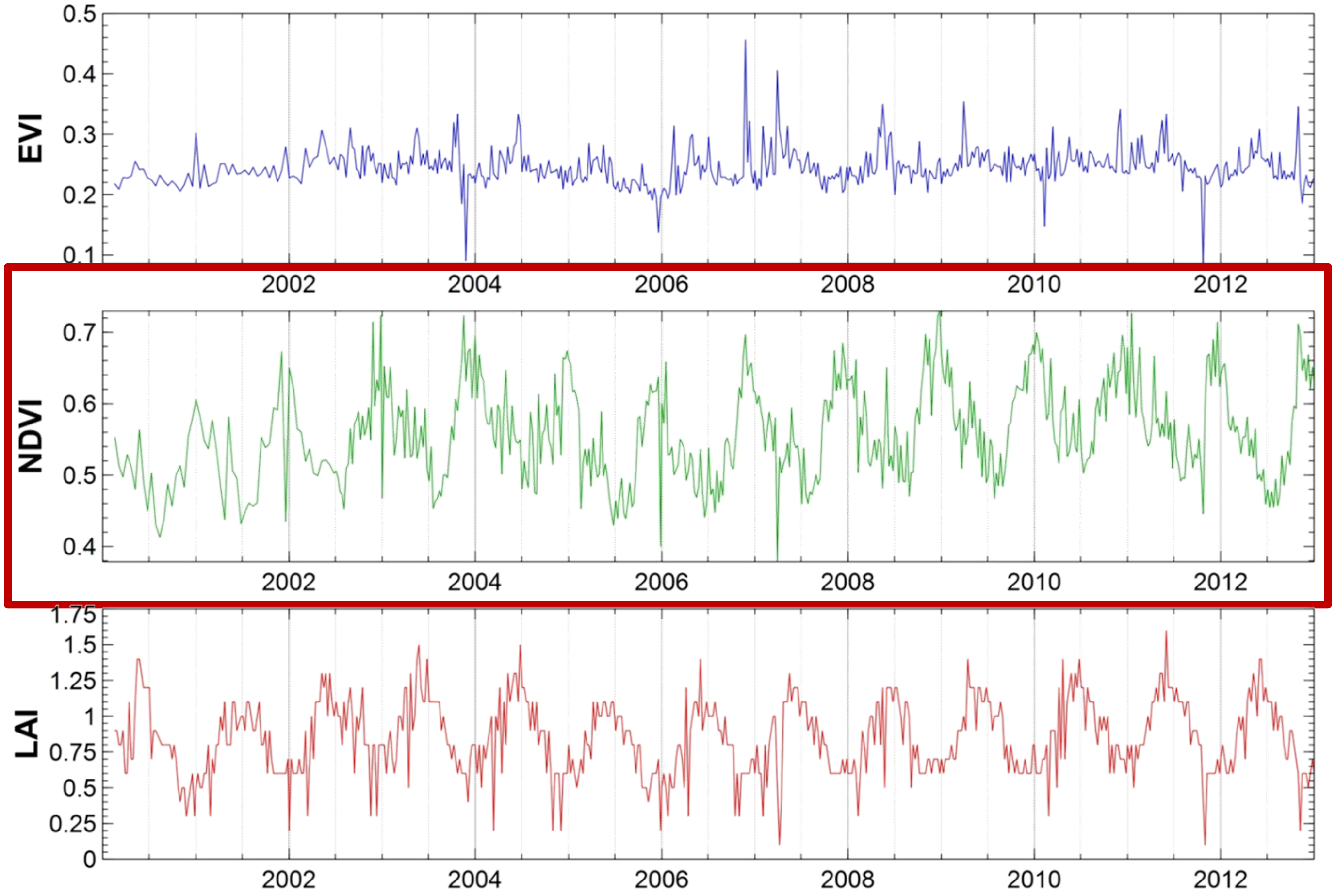
- Sap flow sensors → Heat-Ratio Method
- Three theoretical diameter classes

SOIL WATER CONTENT

- Soil Moisture sensors
- 30cm depth
- 9 sensors: 6 with tree's direct influence and 3 without

Satellite Data

MODIS PROCESSED DATA BY NASA:

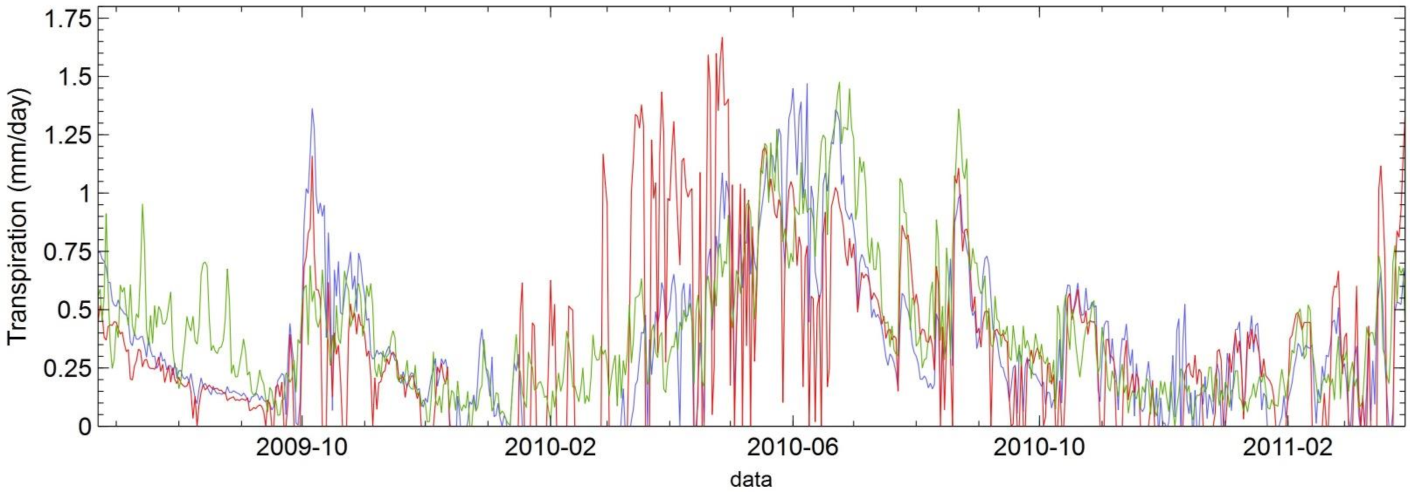


EVI
250m; 16days
No sense!

NDVI
250m; 16days
max_1: Nov/December
max_2: April/May
min: July/August

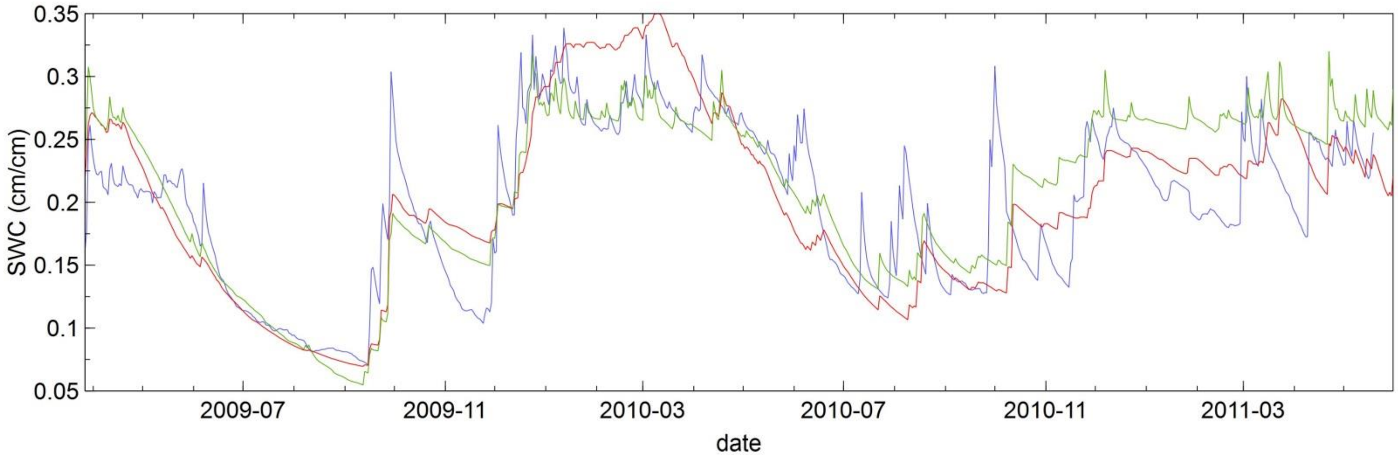
LAI
1km; 16days
max: March/May
min: Nov/January
Inconsistent with field data!

Implementation of the models



LUE-MODEL
RMSE= 0.360 E=0.34

BIOME-BGC
RMSE= 0.282 E=0.64



LUE-MODEL
RMSE= 0.06 E=0.42

BIOME-BGC
RMSE= 0.05 E=0.517

FIELD	BIOME	LUE

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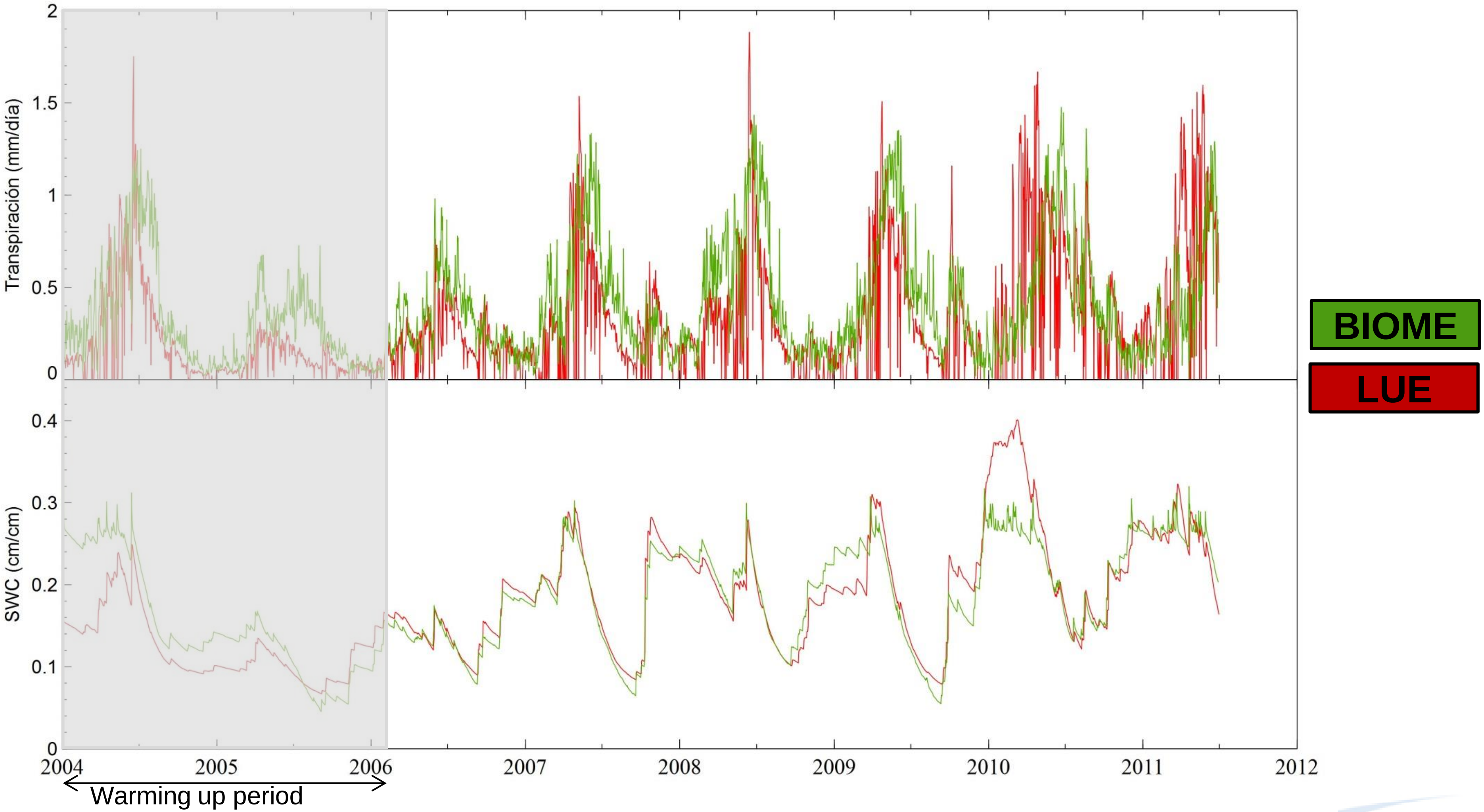
Comparison between models



Comparison between models

LUE-MODEL
Applied at plot scale

Flows	Dry year (2005)		Wet year (2010)	
	mm	%	mm	%
Ppt	188		739	
ET (EI+T+Es)	165.18	87.86	431.87	58.44
Excedence	16.34	8.69	326.93	44.24
Blue/Green	**0.098**		**0.757**	

BIOME-BGC
Average of various trees

Flows	Dry year (2005)		Wet year (2010)	
	mm	%	mm	%
Ppt	188		739	
ET (EI+T+Es)	156.30	83.14	408.80	55.32
Excedence	16.34	8.69	330.10	44.67
Blue/Green	**0.104**		**0.807**	

Comparison between models

- Is a dynamic vegetation model really necessary?

DYNAMIC

Flows	Dry year (2005)		Wet year (2010)	
	mm	%	mm	%
Ppt	188		739	
ET (EI+T+Es)	165.18	**91.0**	431.87	**56.9**
Excedence	16.34	9.0	326.93	43.1
Blue/Green	**0.098**		**0.757**	

STATIC

Flows	Dry year (2005)		Wet year (2010)	
	mm	%	mm	%
Ppt	188		739	
ET (EI+T+Es)	147.00	**81.4**	385.37	**50.9**
Excedence	33.47	18.6	370.99	49.1
Blue/Green	**0.227**		**0.963**	

Conclusions

- Reliable estimates of spatial and temporal variations of actual evapotranspiration as well as precipitation are vital to obtain reliable estimates of the available water resources

- A parsimonious model is able to adequately reproduce the dynamics of vegetation and also reproduces properly the soil moisture variations

- A simple model together to satellite information can be used as alternative when there are not available information to implement a complex model

Thanks for your attention

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This work has been funded by the Spanish Ministry of Economy and Competitiveness through the research project INTEGRA (ref. CGL 2011-28776-C02). The MODIS data were obtained through USGS/Earth Resources Observation and Science (EROS) center (https://lpdaac.usgs.gov/data_access). The meteorological data were provided by the Spanish National Weather Agency (AEMET).