SWAT LAI calibration with local LAI measurements

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Overview

Overview

- Study area

- Input data (soils, land use, meteorological data, topography)

- Model calibration

- Field measurements

- Results: Impact on LAI, Biomass and Evapotranspiration

- Conclusions

- Future work

Material and Methods

Study area description

- Sorraia Valley in Portugal

- Irrigated area

- With 15 500 ha is the largest area of irrigated agriculture in Portugal, especially corn, tomatoes and rice

SWAT description

- LAI is simulated as a function of heat units:

$$fr_{PHU} = \frac{\sum_{i=1}^{d} HU_i}{PHU}$$

$$fr_{LAImx} = \frac{fr_{PHU}}{fr_{PHU} + \exp(\ell_1 - \ell_2 \cdot fr_{PHU})}$$

$$\Delta LAI_i = \left(fr_{LAImx,i} - fr_{LAImx,i-1}\right) \cdot LAI_{mx} \cdot \left(1 - \exp(5 \cdot (LAI_{i-1} - LAI_{mx}))\right)$$
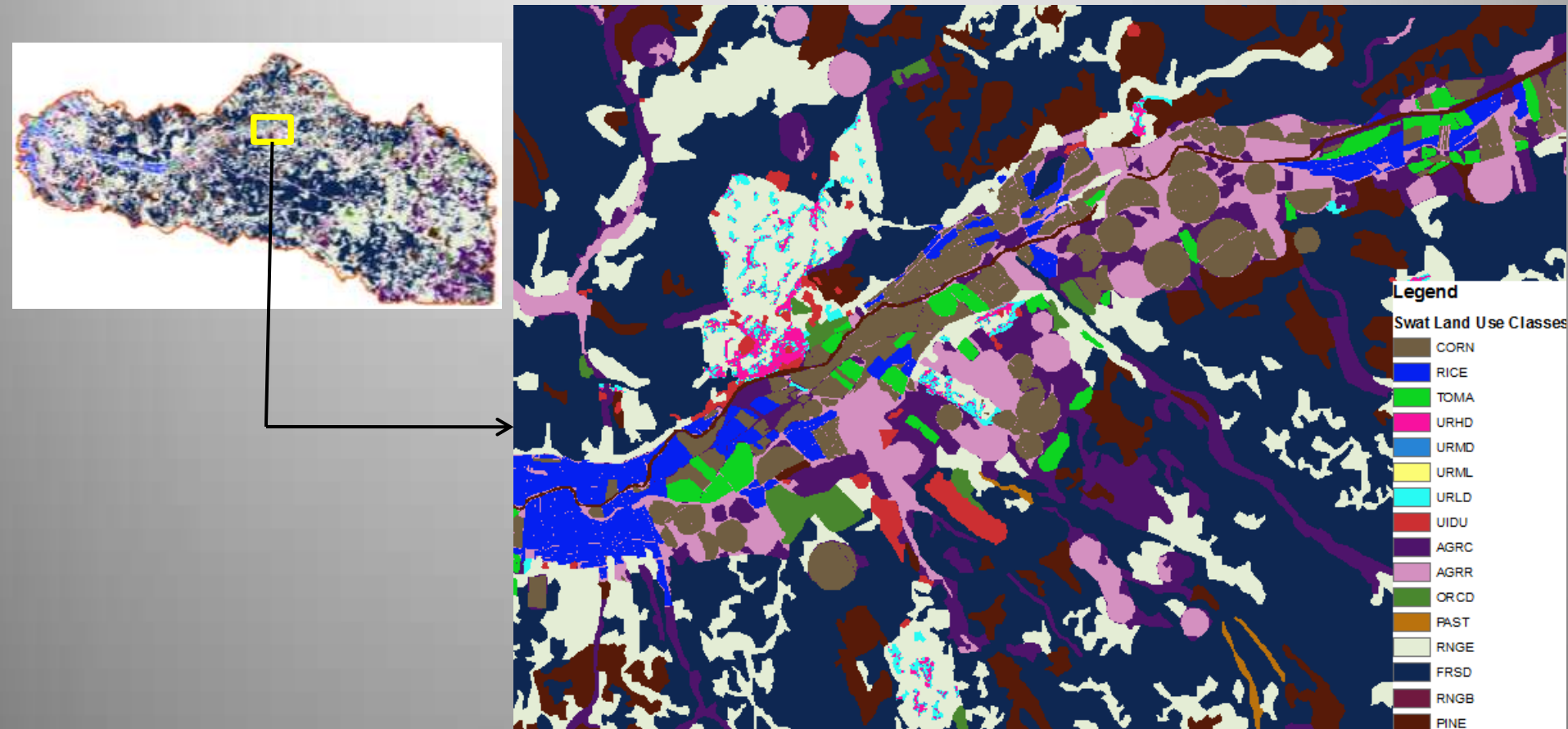
$$LAI_i = LAI_{i-1} + \Delta LAI_i$$

LAI at the senescence period

$$LAI = LAI_{mx} \cdot \frac{(1 - fr_{PHU})}{(1 - fr_{PHU,sen})}$$

Land use data

- Corine 2006 + information from farmers

Legend
Swat Land Use Classes

- CORN
- RICE
- TOMA
- URHD
- URMD
- URML
- URLD
- UIDU
- AGRC
- AGRR
- ORCD
- PAST
- RNGE
- FRSD
- RNGB
- PINE

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Topography data

- *Shuttle Radar Topography Mission* (SRTM) 90 m Digital Elevation Data

- Service Recognition and Agrarian Planning (SROA) based on "soils classification in Portugal"

- ARBVS (Associação de Regantes e Beneficiários do Vale do Sorraia) and solar radiation from MM5 model
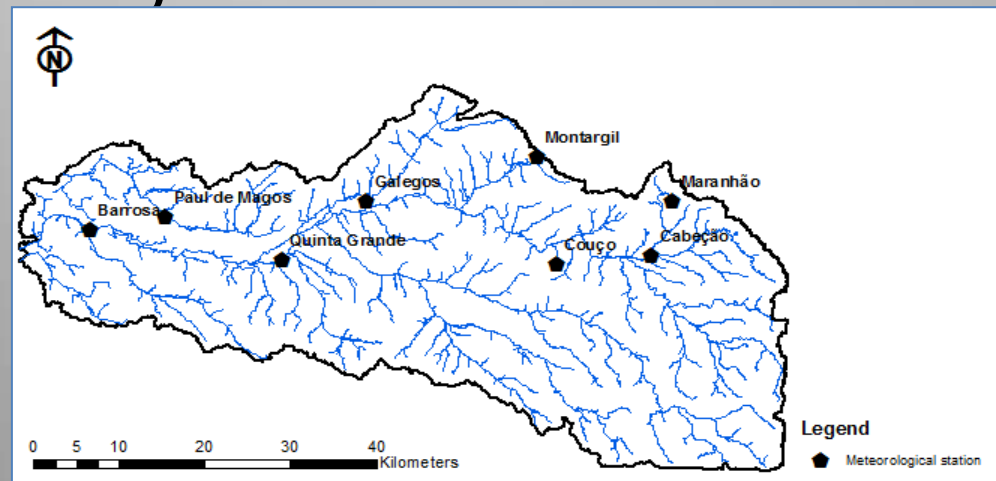
Management data

Management operation schedule

Real user schedule with (Field I user):

- ✓ Planting date (May 23)
- ✓ 16 Irrigation events with (560 mm)
- ✓ 7 Fertilizations
- ✓ Harvest date (October 10)

Field measurements

- During the corn crop campaign - between May and October

- 5 campaigns in 3 farmer fields (Field I, Field II and Field III)

Hemispherical photographs

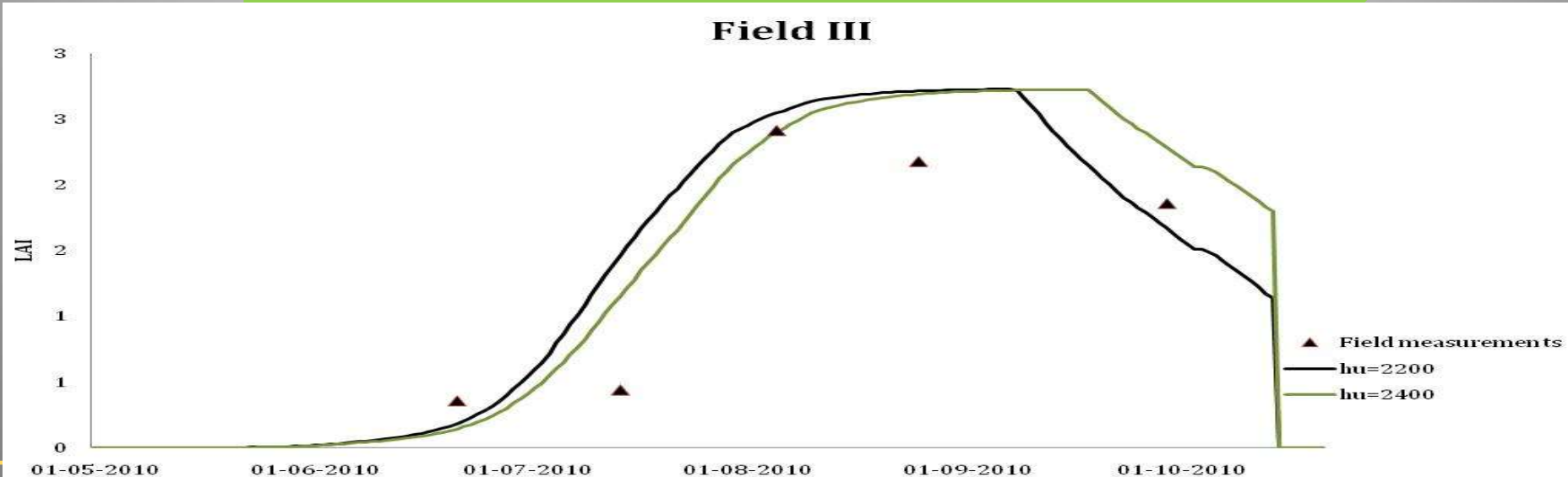- Hemispherical photographs were used to estimate Leaf Area Index (LAI)

Were used:

✓ a camera (either digital of with film)

✓ a fish-eye lens adapted to this camera

Hemispherical photographs

- Crop development throughout the corn crop campaigns

Field III

Hemisfer software

- Estimate the leaf area index (LAI) from hemispherical photographs

- Based on the classification of pixels to either white (=sky) or black (=canopy) by applying a brightness threshold to the analyzed picture
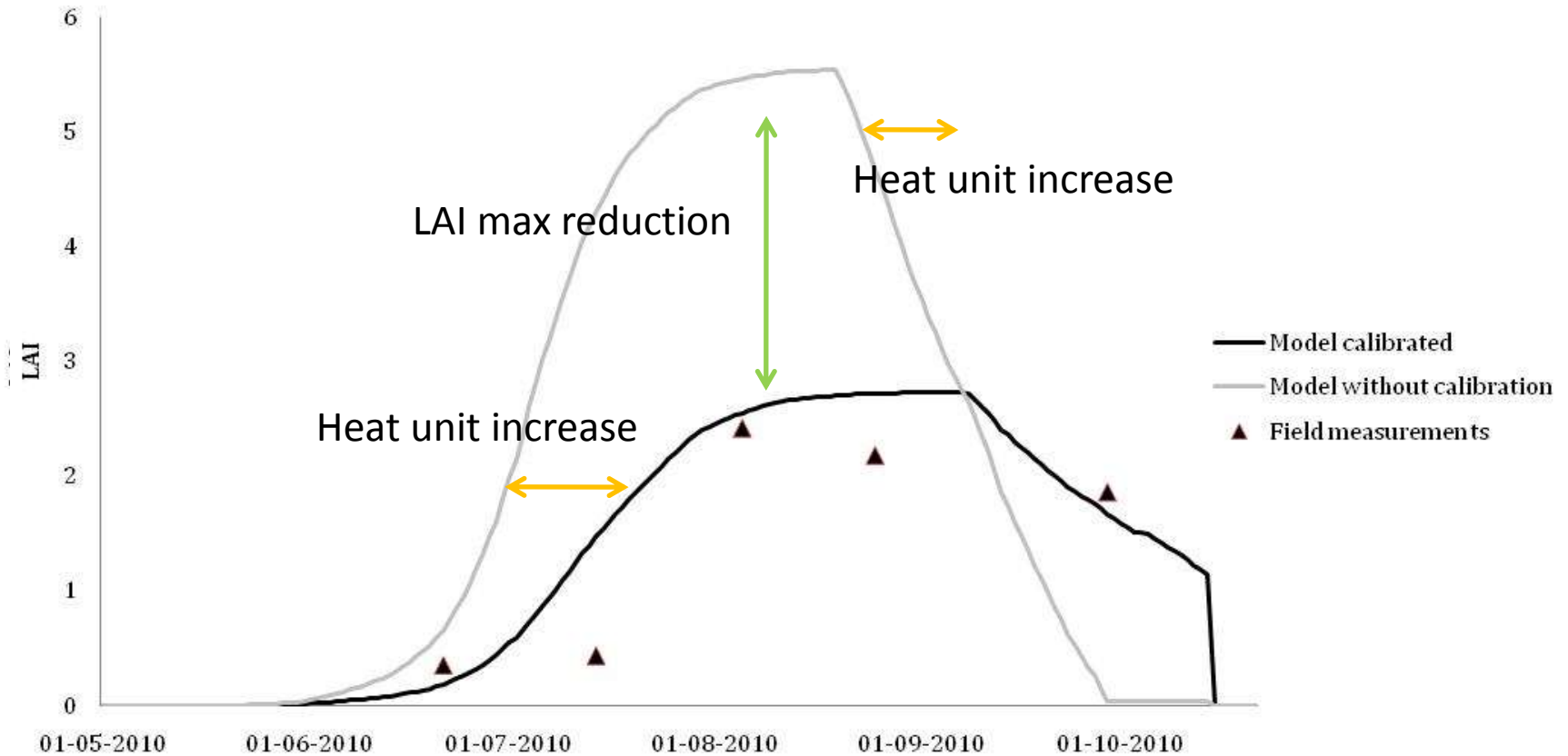
Results

Model calibration

- *BLAI* – corn maximum leaf area index modified to 3 instead of 6

- Corn crop *heat units*

	Initial Heat Unit	*Calibrated Heat Unit*
Field I	1800	2400
Field II	1800	2400
Field III	1800	2200

LAI calibration results

Field III

Chart showing LAI over time (01-05-2010 to 01-10-2010) with:
- LAI max reduction
- Heat unit increase (two locations)
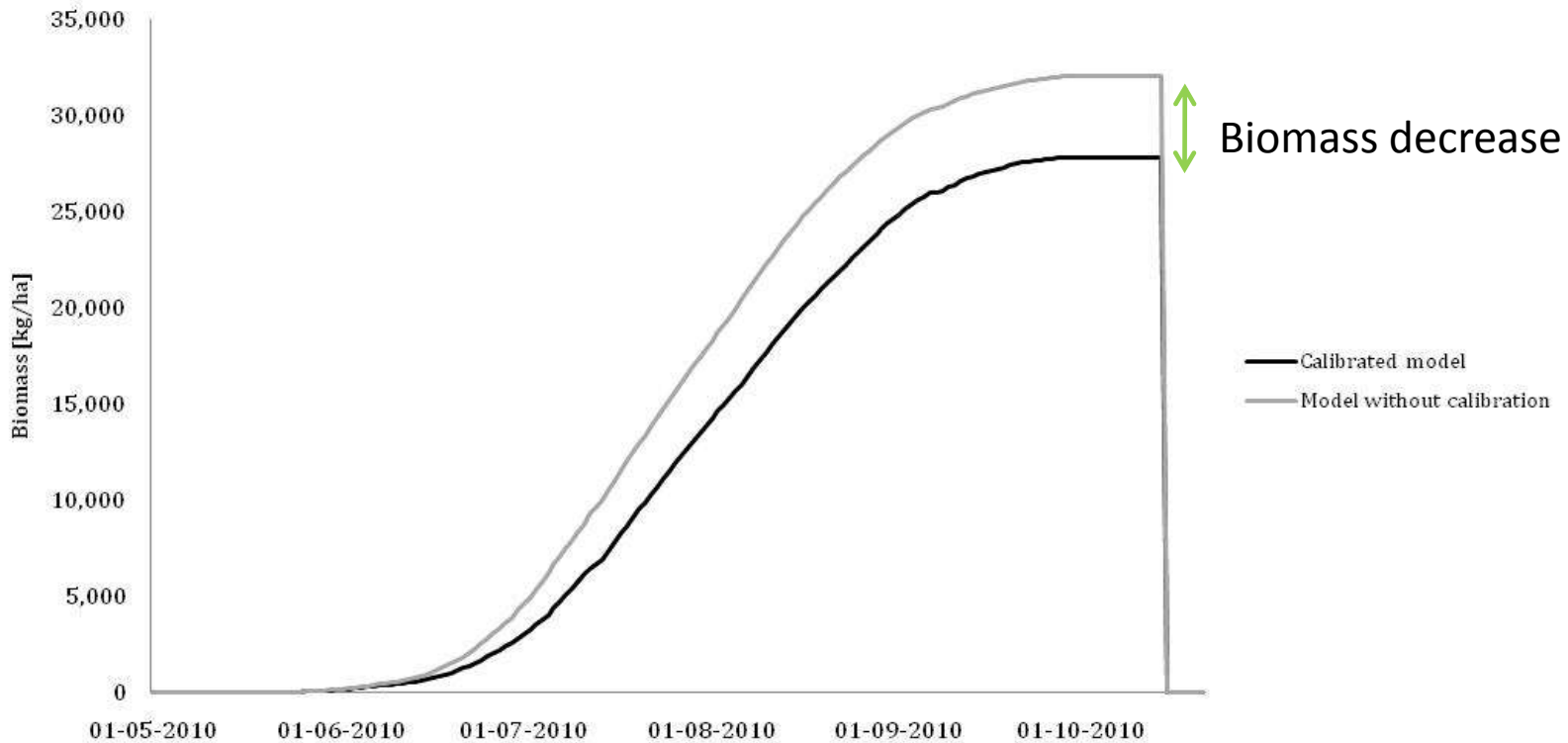- Model calibrated
- Model without calibration
- Field measurements

LAI calibration results

- Why use 2200 instead of 2400

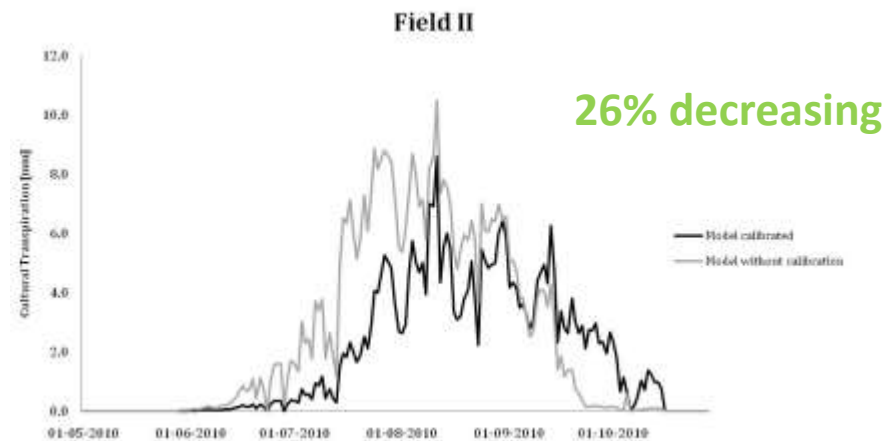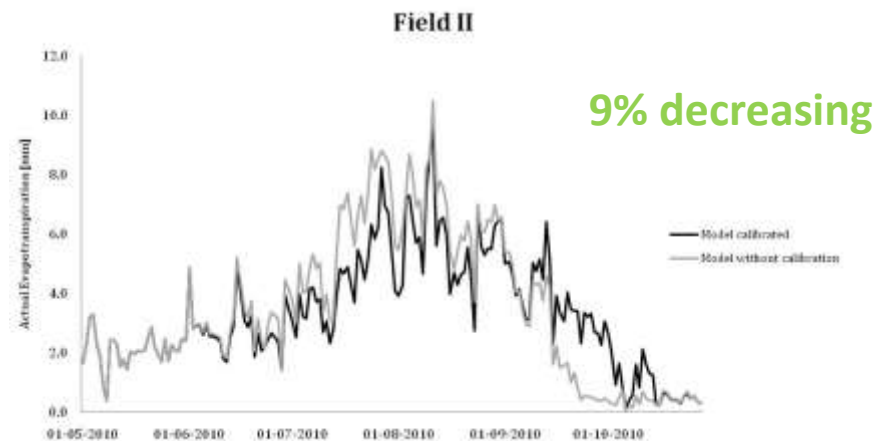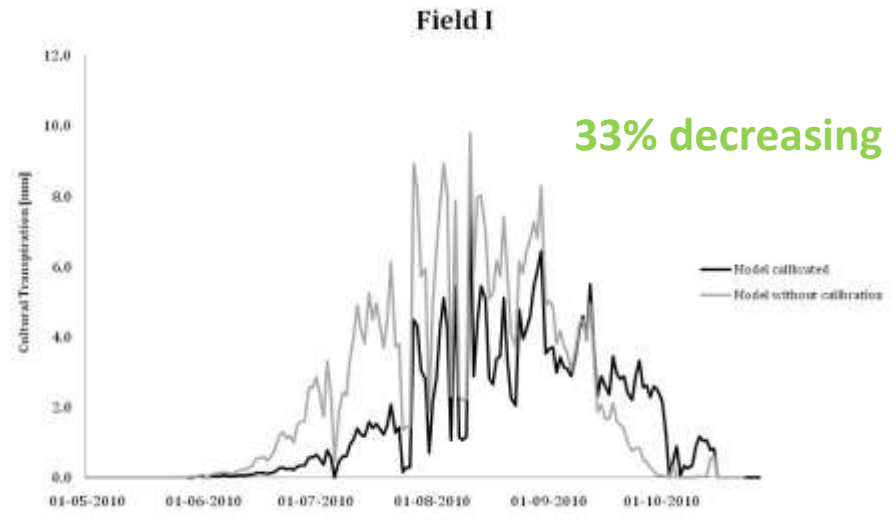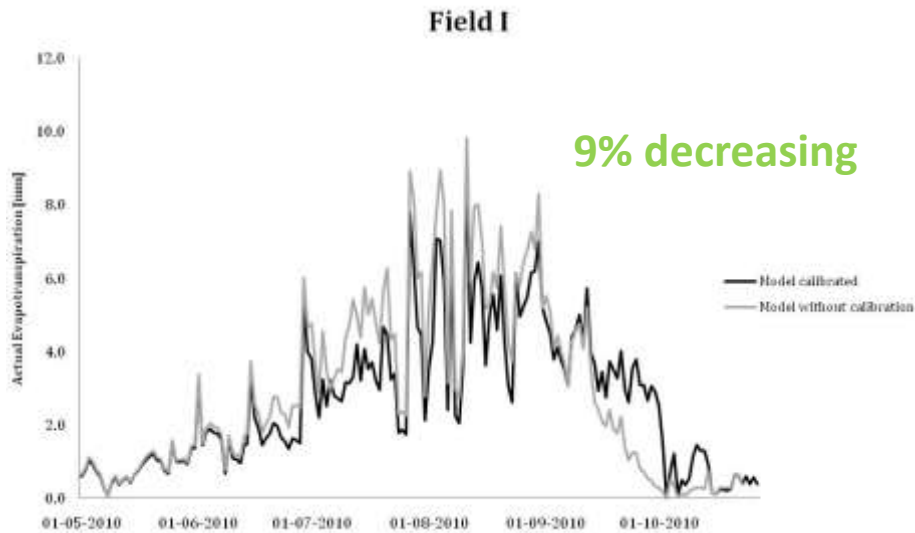Field III

Senescence period
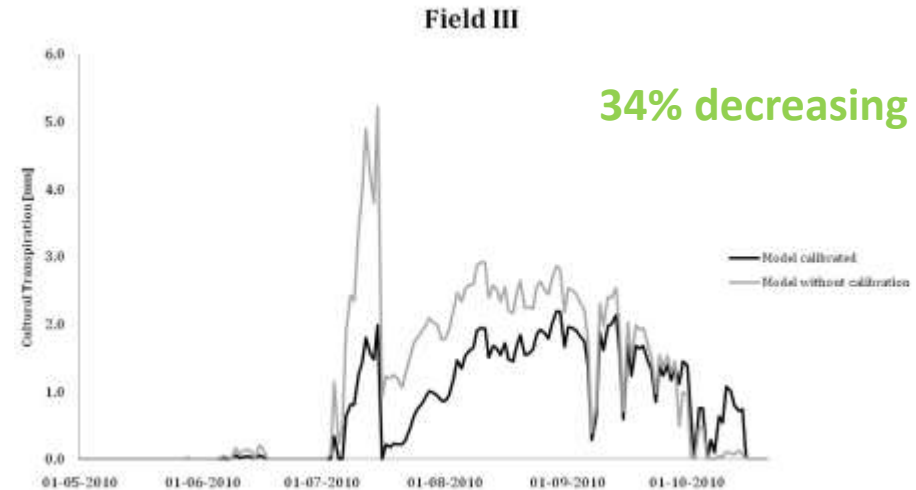
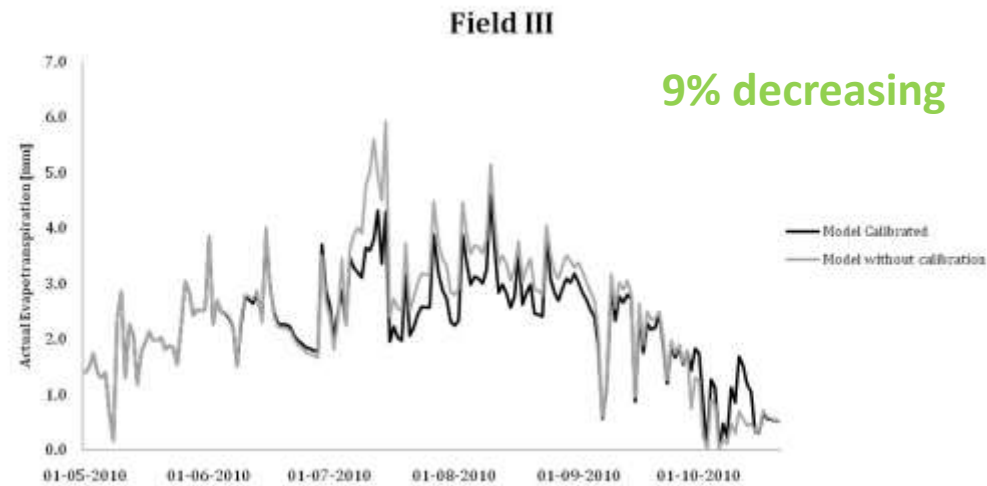Field measurements
hu=2200
hu=2400
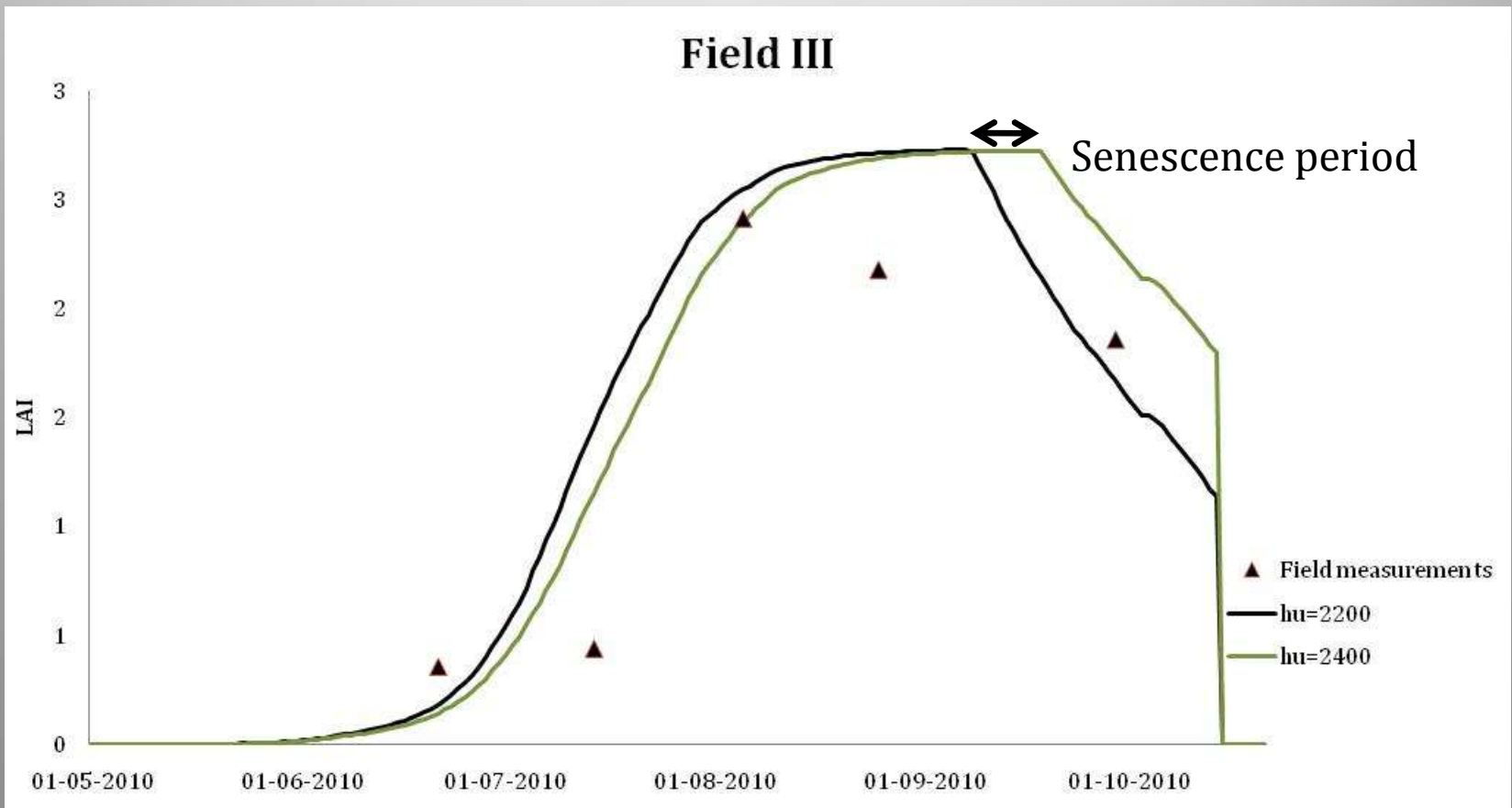
Impact on biomass results with LAI calibration

Field III

Biomass decrease

Impact on evapotranspiration results with LAI calibration

Impact on evapotranspiration results with LAI calibration

9% decreasing

34% decreasing

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Conclusion

Conclusion

- The LAI calibration in SWAT has a positive impact on LAI results and biomass production (with a maximum values decrease of 14 %)

- The evapotranspiration results in general had not significant impact, with a decrease on average of about 9 %

- Estimated values of leaf area index can be successful determined using software tools like *Hemisfer* software, using hemispherical photographs.

- The model calibration process with two parameters changed resulting in highly realistic results, that influence many others important crop results.

Future work

Future work

USE SAME CALIBRATION FOR OTHER WATERSHEDS

Enxoé river basin

- Same calibration used in this work to simulate more realistic LAI values

- Impact on sediments/erosion

Serra da Estrela (Alva river basin)

- LAI values comparison with SWAT model results and NDVI results

THANK YOU!!

Hemispherical photographs

- The sun should not appear on the photographs.

There are several possibilities to achieve this goal:

- Take the photographs before sunrise or after sunset (but this limits the time available);

- Take the photographs when the sky is overcast (the more homogenous, the better).

Hemisfer software calibration

Parameters changed:

- Radius (1295.5 reduced to 920),

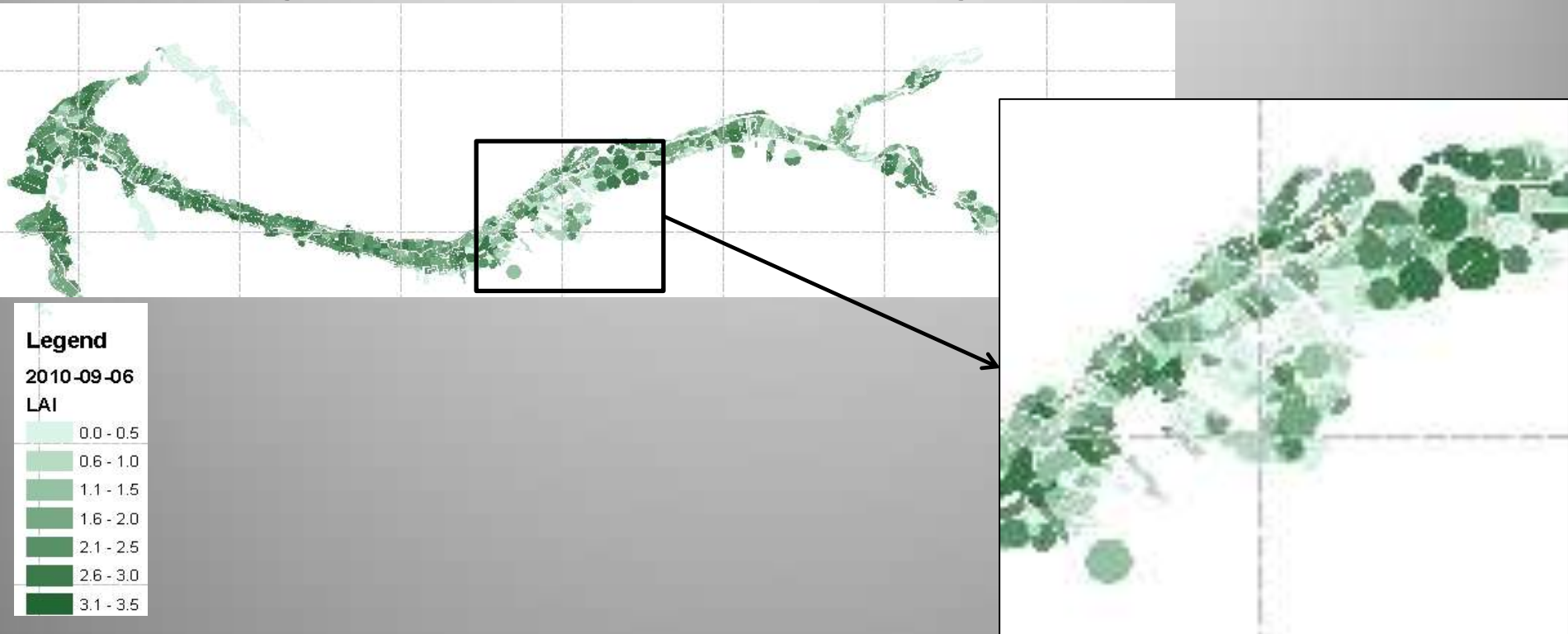- Center y (1295.5 to the value 1325)

- North (0 to 180)

QUESTION

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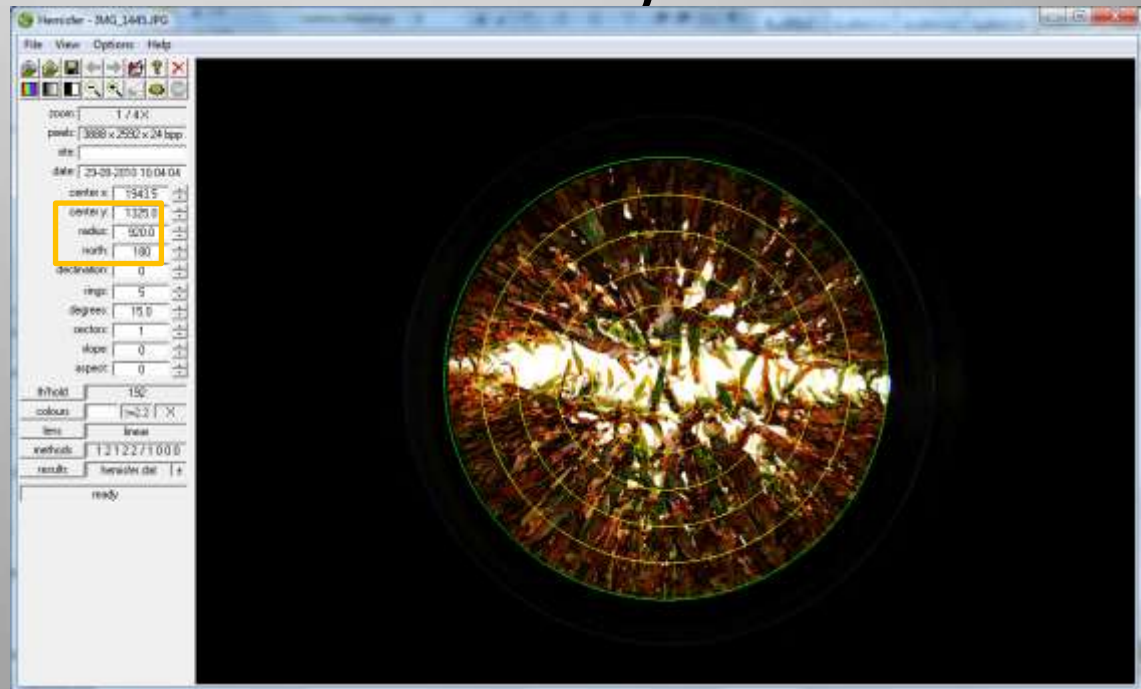
Question

- Considering that corn crops species in Sorraia Valley are different for many plots

Legend
2010-09-06
LAI

	0.0 - 0.5
	0.6 - 1.0
	1.1 - 1.5
	1.6 - 2.0
	2.1 - 2.5
	2.6 - 3.0
	3.1 - 3.5

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How calibrate LAI in SWAT model for each plot?

Parameters that determine LAI curve are general, and only total heat units can differ in each plot (that correspond to each HRU)