

Modelling BVOC emissions from Holm oak considering integrated impacts of leaf microclimate and drought

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Introduction

Measurements

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Isoprenoid emission response to drought

Days from water-logging	Moisture content (%)	Isoprene emission rate ($\mu\text{g C dm}^{-2} \text{ h}^{-1}$)	Net photo-synthetic rate ($\text{mg CO}_2 \text{ dm}^{-2} \text{ h}^{-1}$)	Transpiration rate ($\text{mg H}_2\text{O dm}^{-2} \text{ h}^{-1}$)	Leaf conductance (cm s^{-1})
1	76	14.0	4.80	398	0.093
2	53	13.9	3.97	373	0.079
3	36	14.9	1.22	224	0.024
4	26	14.0	0.09	131	0.008
5	24	7.0	-0.26	97	0.005
	SD 5.37	SGD 1.53	SD 1.54	SGD 1.31	SGD 2.24

Tingey et al. 1981 (*Quercus virginiana*)

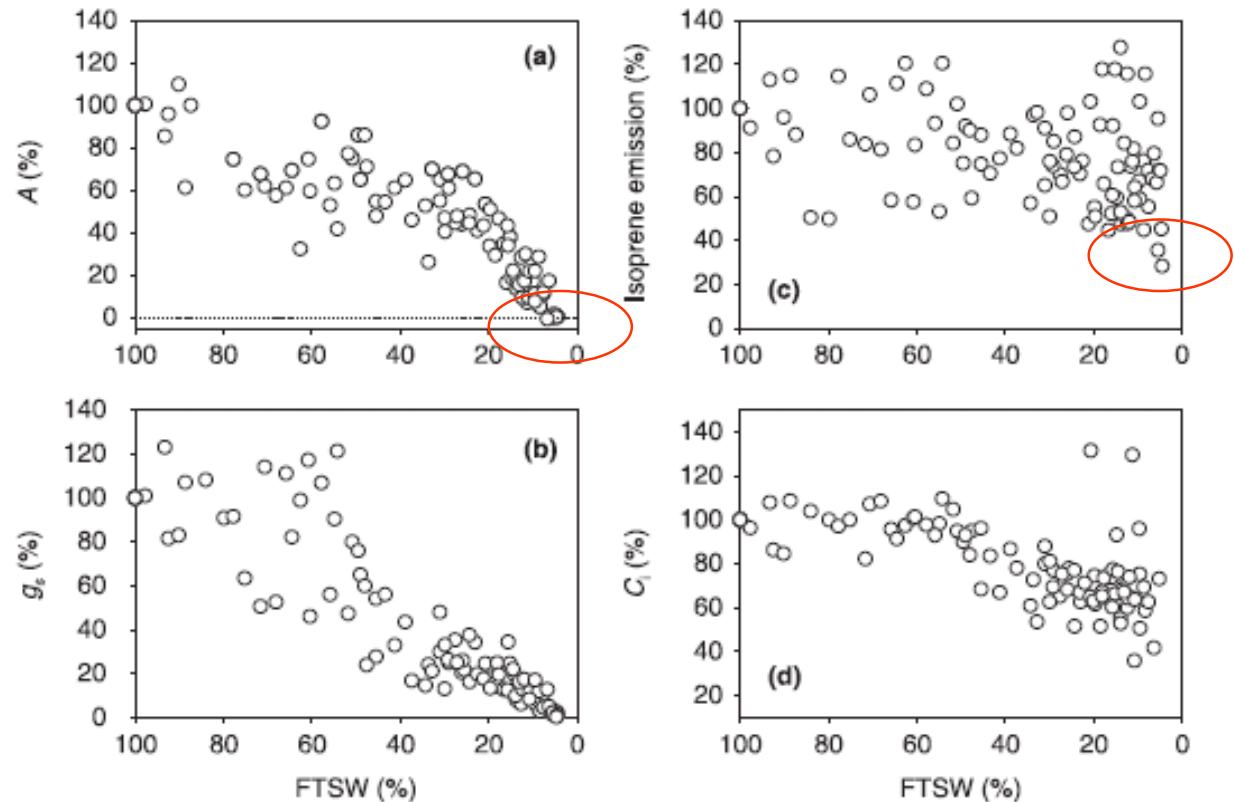
Isoprenoid emission response to drought

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Brilli et al. 2007 (*Populus alba*)

Holm Oak site at Puechabon

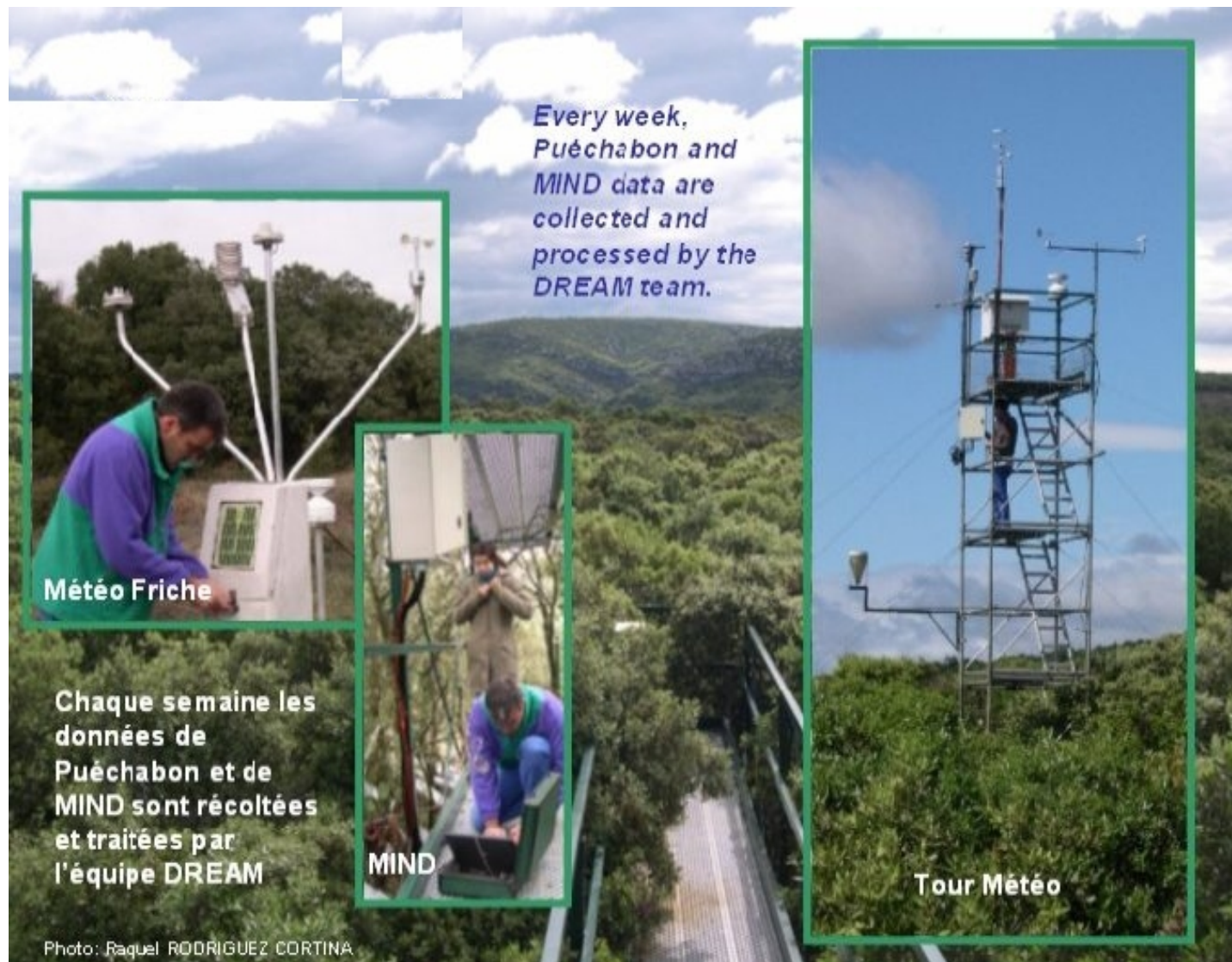
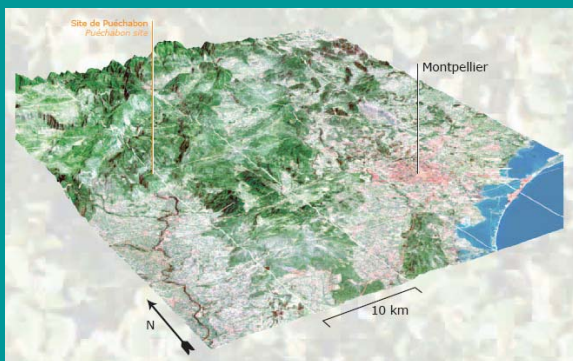
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- The site

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Holm Oak site at Puechabon

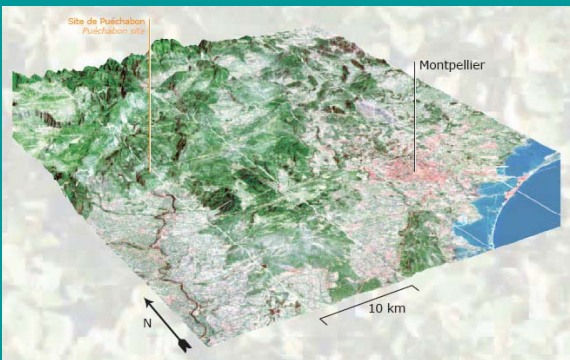


+



app. 30% less water input

+ irrigated field plants



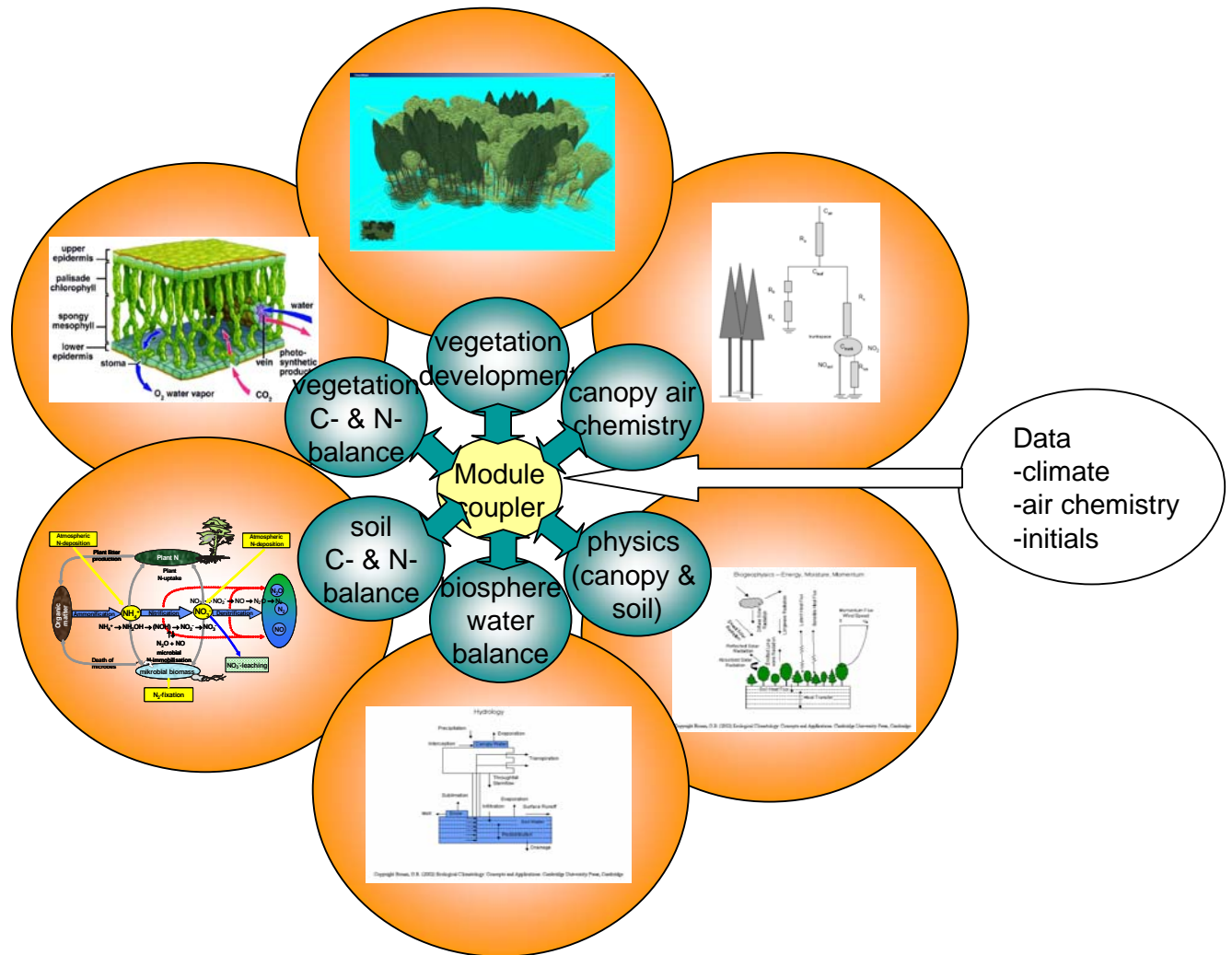
The Modelling Framework MoBiLE

Introduction

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- Modelling
framework

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Introduction

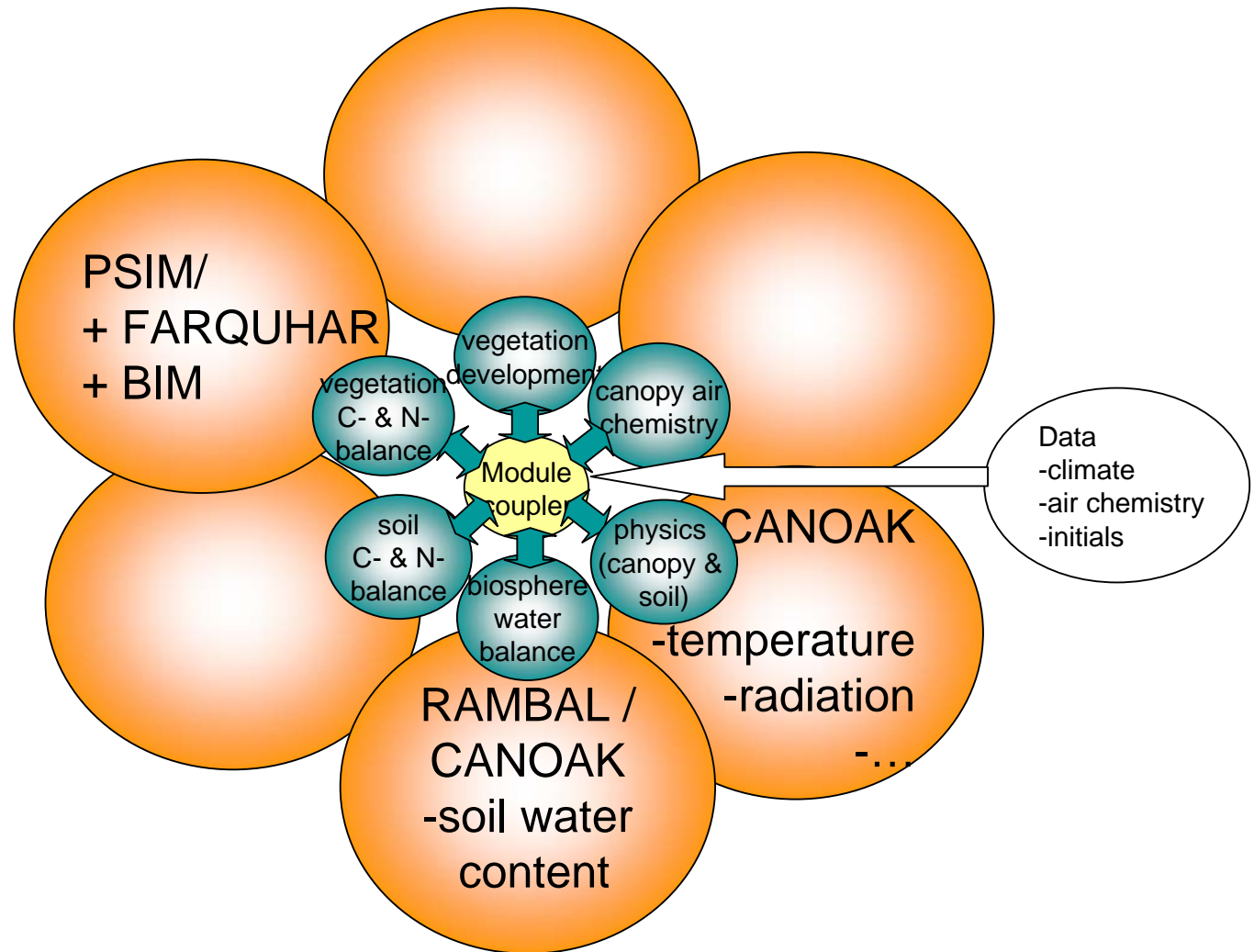
Measurements

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- Model combination

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Applied Models



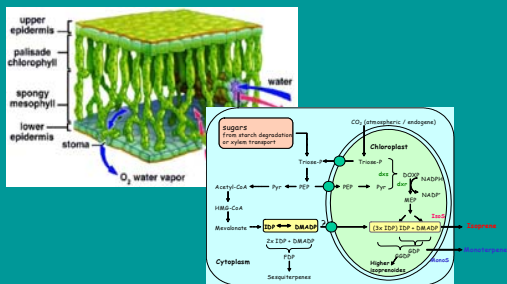
The PSIM-BIM model

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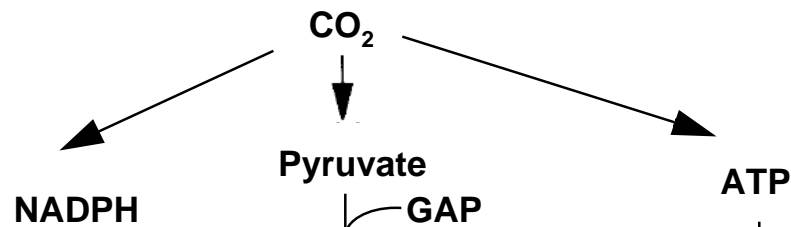
Modelling
- Model description

Conclusions



Grote 2007

Photosynthesis sub-model (Farquahr)



Biochemical Isoprenoid Model (BIM)

D-1-deoxyxylulose-5-phosphate

Methyl erythritol cyclodiphosphate

Isopentenyl pyrophosphate

Dimethylallyl pyrophosphate

Geranyl pyrophosphate

Farnesyl-pyrophosphate

Isoprene synthase

Isoprene

Monoterpene synthase

Monoterpenes

Phenology sub-model (SIM)

Foliage development stage

Age class distribution

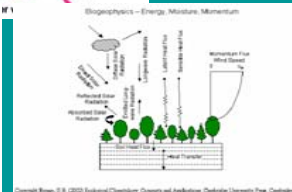
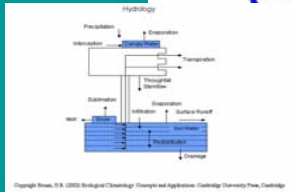
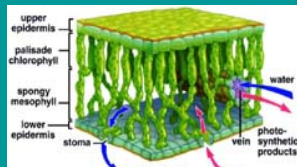
Enzyme activity state

Introduction

Measurements

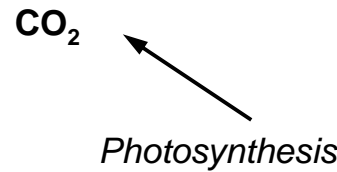
Modelling
- Model description

Conclusions



Drought impact

Photosynthesis sub-model (Farquhar) + Phenology sub-model (PSIM)



Foliage amount and distribution

Soil water content

Evaporation
Transpiration,
Percolation
Runoff

Canopy temperature
and radiation

Soil temperature
Potential evaporation

Water Balance Model
(Rambal, CANOAK)

Canopy model
(empirical, CANOAK)

Introduction

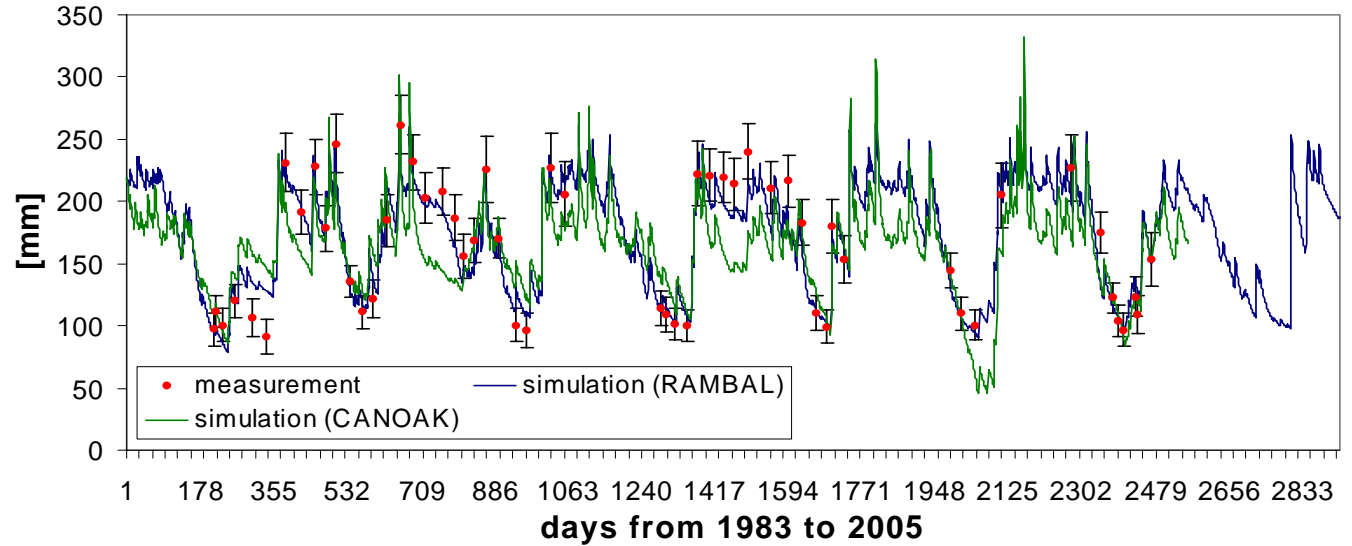
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- Evaluation

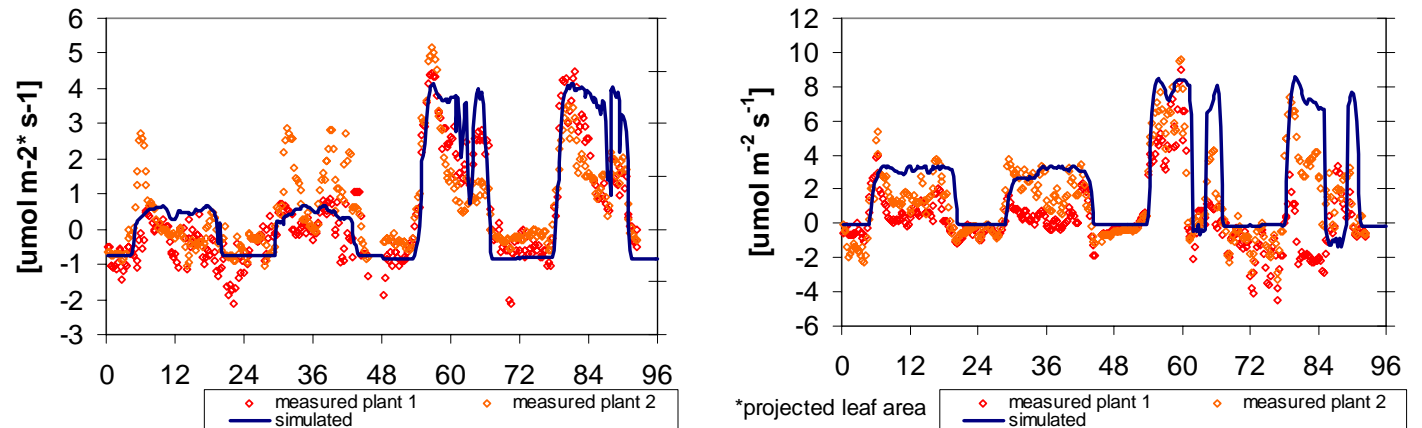
Conclusions

Grote et al. 2006

Puechabon 1983-2004: Water Balance



Greenhouse 2002 / 2003: Photosynthesis



Introduction

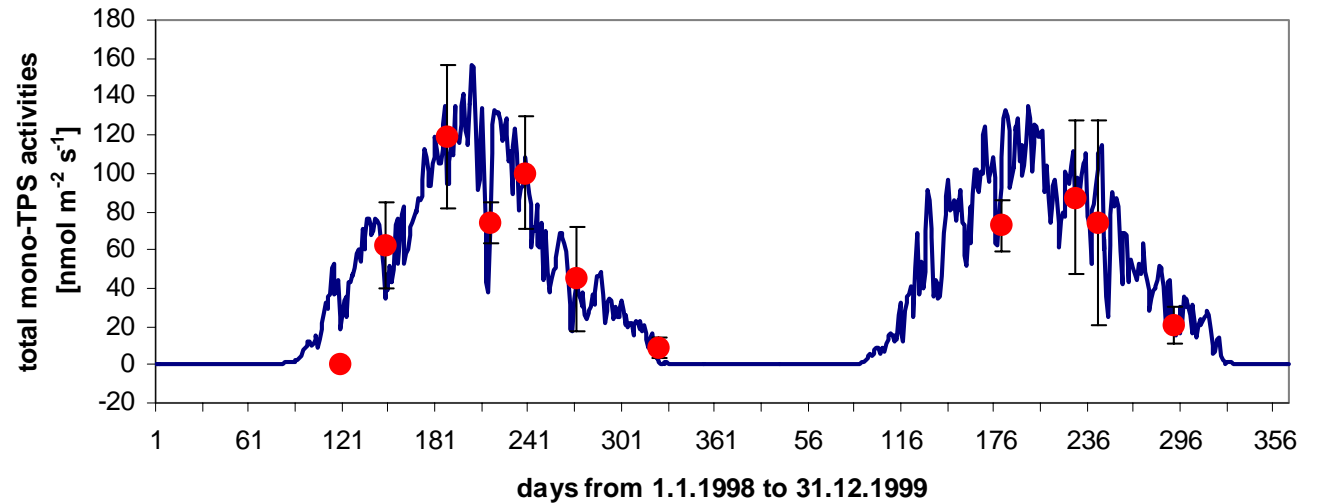
Measurements

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- Evaluation

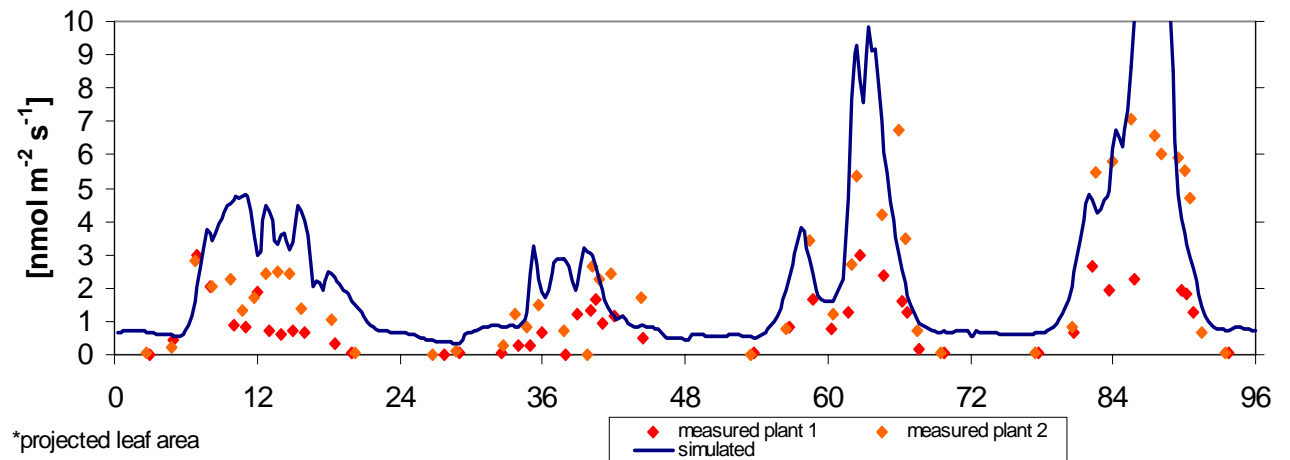
Conclusions

Grote et al. 2006

Puechabon 1998 / 1999: Enzyme activity



Greenhouse 2003: Monoterpene Emission



Introduction

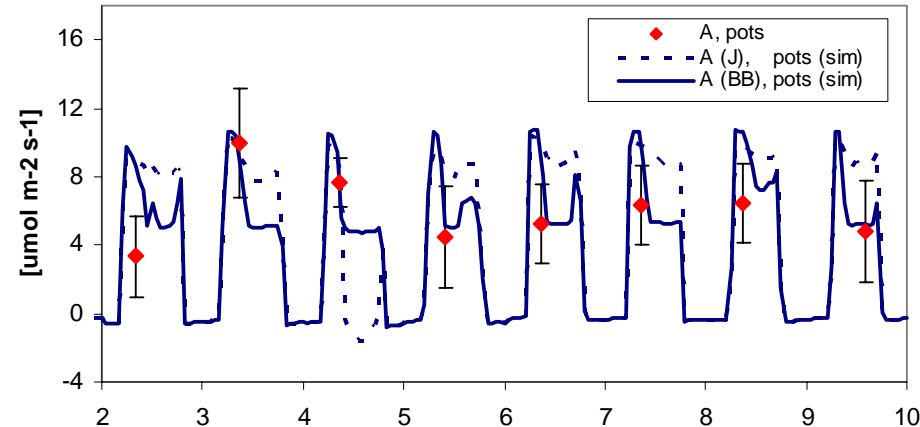
Measurements

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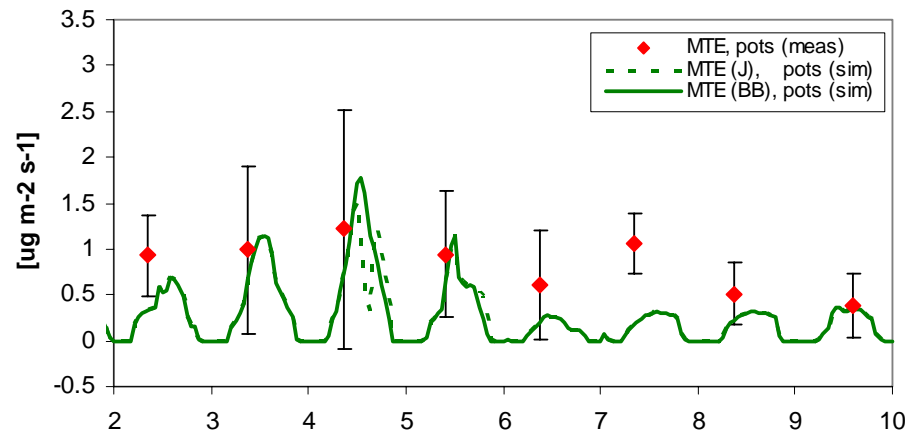
- Evaluation
(2 photosynthesis
models)

Conclusions

Montpellier 2006: Photosynthesis (well watered)



Montpellier 2006: Monoterpene Emission (well watered)



End of May → Early October

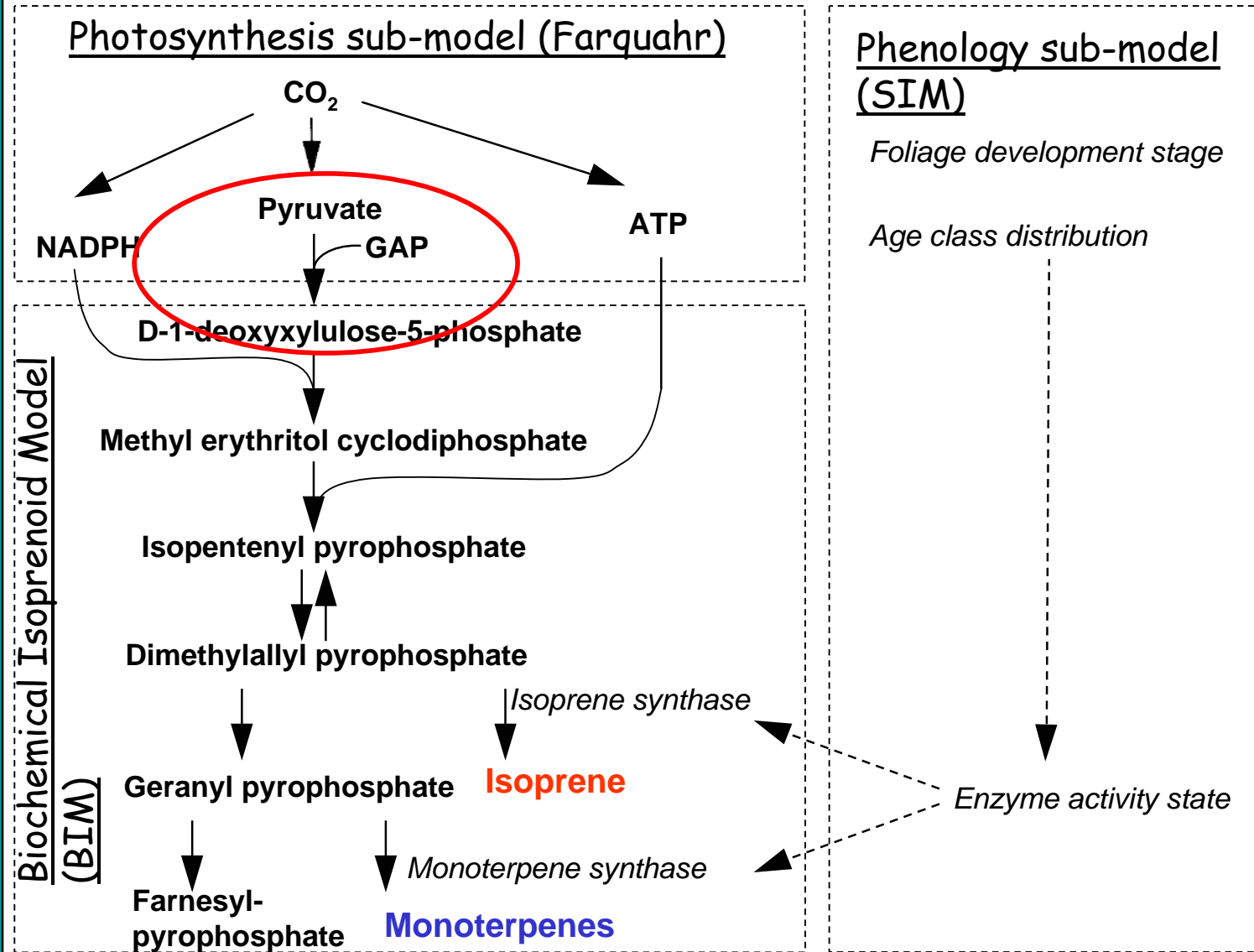
The PSIM-BIM model

Introduction

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- Reminder

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Introduction

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- Simulation

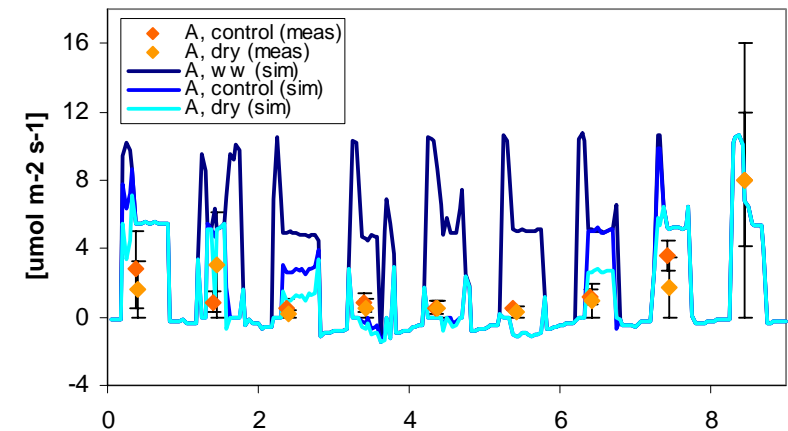
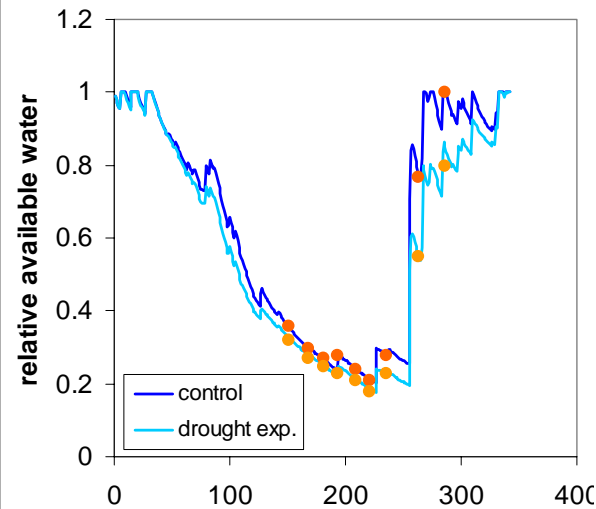
Conclusions



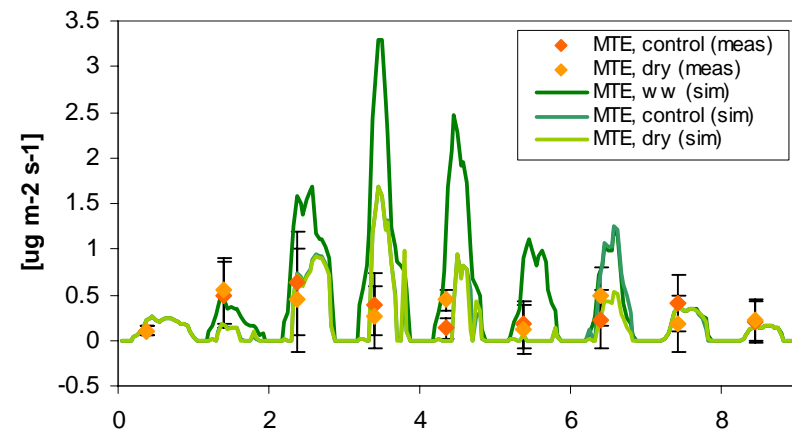
Drought Response

Puechabon 2006:

Photosynthesis



Monoterpene Emission



End of May → Early October

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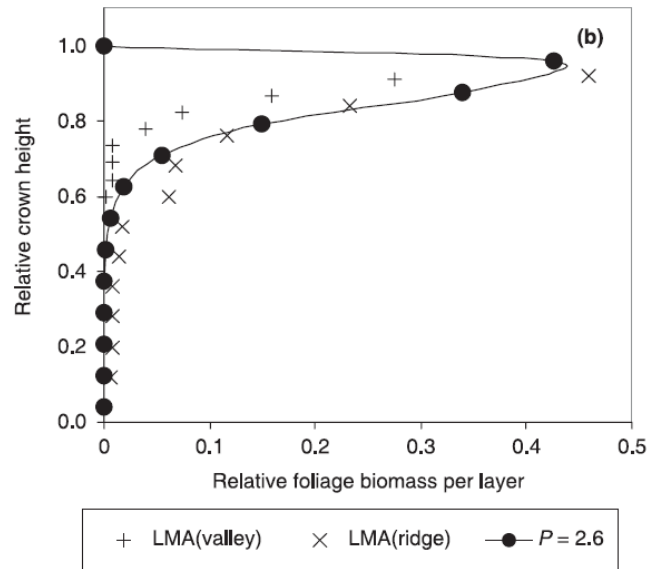
- Upscaling
(canopy
properties)

Conclusions

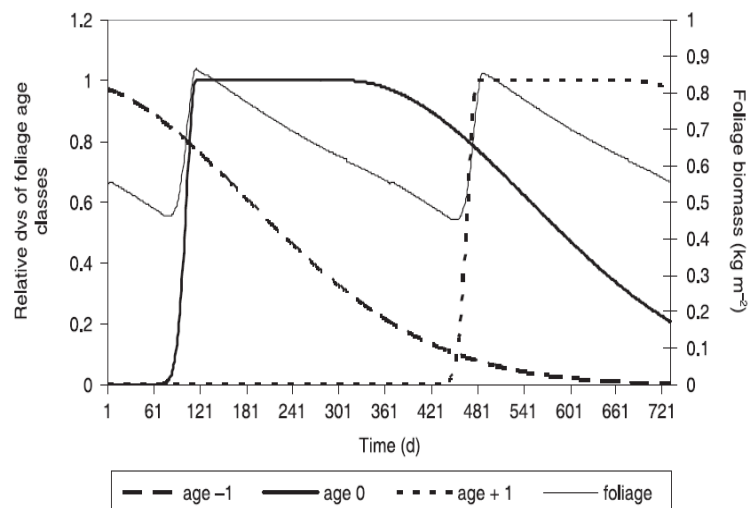


Grote 2007

Upscaling



- Vertical leaf distribution
- Canopy microclimate
- Seasonal change of LAI
- Seasonal leaf age class distribution
- Enzyme activity dynamics



Introduction

Measurements

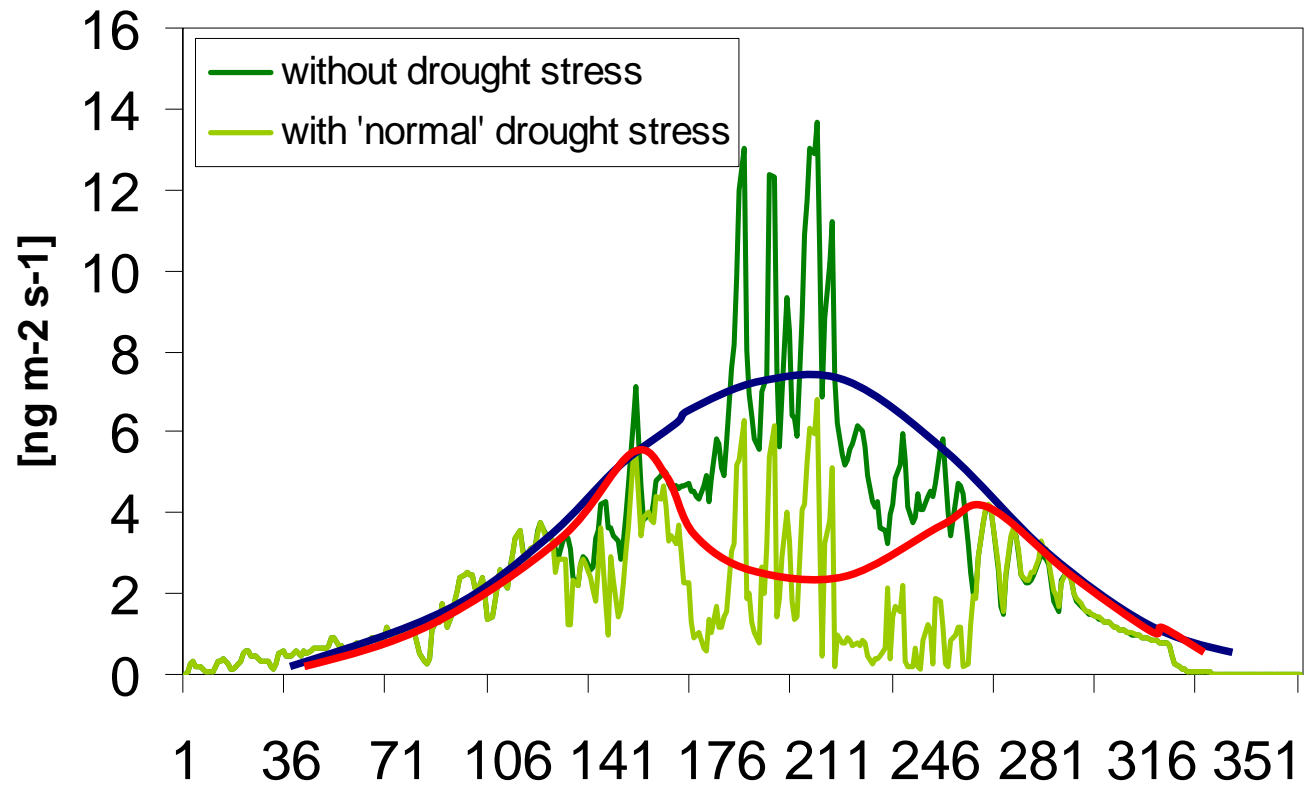
Modelling
- Upscaling

Conclusions



Upscaling

Simulated daily monoterpene emission for a Holm oak stand in Puechabon for the year 2006



Introduction

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Some points to remember:

1. Emission is insensitive to soil drought until photosynthesis is practically zero
2. Substrate limitation might explain most of the decreased emission rates under drought
3. The overall drought related decrease in Holm oak monoterpene emission for the year 2006 has been estimated to be app. 44%

Thank You for your attention!

