Dynamic agrivoltaics:

relevance of panel steering policies to sustain production against climatic hazards

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Who are we ?

Charlotte JOUVE
Agroparistech
Marketing and b-2-b manager – SUN'AGRI

Perrine JUILLION
PhD in agronomy
R&D Engineer – SUN'AGRI

Summary

1. Concept of our agrivoltaic solution
2. From R&D to optimized solution
3. Results and discussions

01

Concept

Our agrivoltaic solution

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Answer to the farmer's needs in terms of

Excessive radiation

Hydric stress

Climate hazards

€ 9b : yearly cost of drought damages on agriculture in Europe

It will increase with climate change

+2 °C in France by 2050

>> 90% increase of climatic costs in France over 2014-2039 compared to 1988-2013

>> With the increase in extreme weather events farmers are in search of solutions

Drought of June, 28th of 2019

Frost of April, 8th of 2021

Dispositif Sun'Agri sur vignes à Tresserre, août 2022

Concrete impacts of agrivoltaic solution in - Piolenc, veraison 2022-

With agrivoltaic system	Without
	
	

2

From R&D to optimized solution

The challenge of algortihms development

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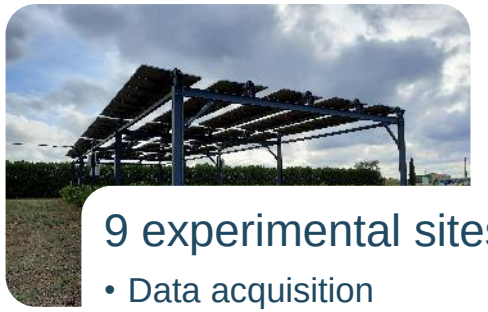
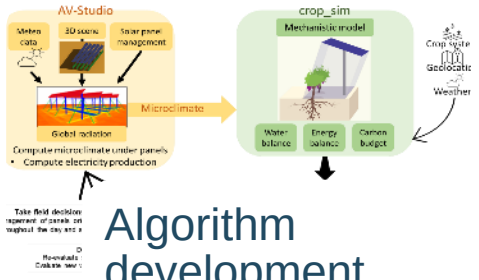
13 years of collaborative R&D

2009-2013	2013-2017	2017-2023	> 2019
SUN'AGRI 1 Proof of concept	SUN'AGRI 2 Products and softwares development	SUN'AGRI 3 Demonstration phase	COMMERCIAL DEVELOPMENT
1st FIXED SITE	1st DYNAMIC SITES	9 EXP. SITES 11 COMMERCIAL SITES	FRANCE / INTERNATIONAL



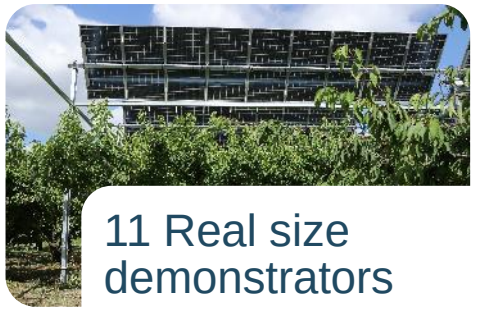
9 experimental sites

- Data acquisition
- Crop validation



Algorithm development

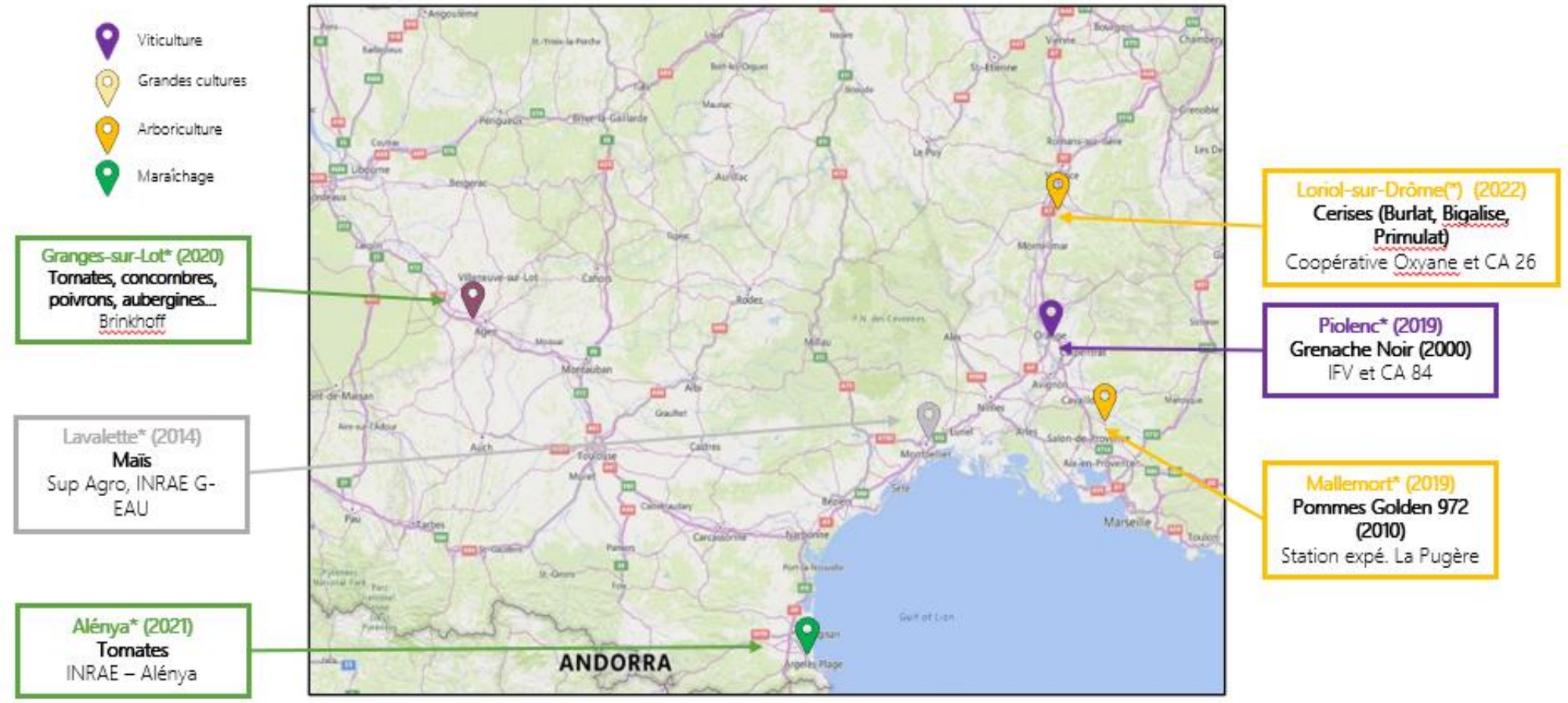
- Agronomic models based on water balance/energy balance/carbon budget



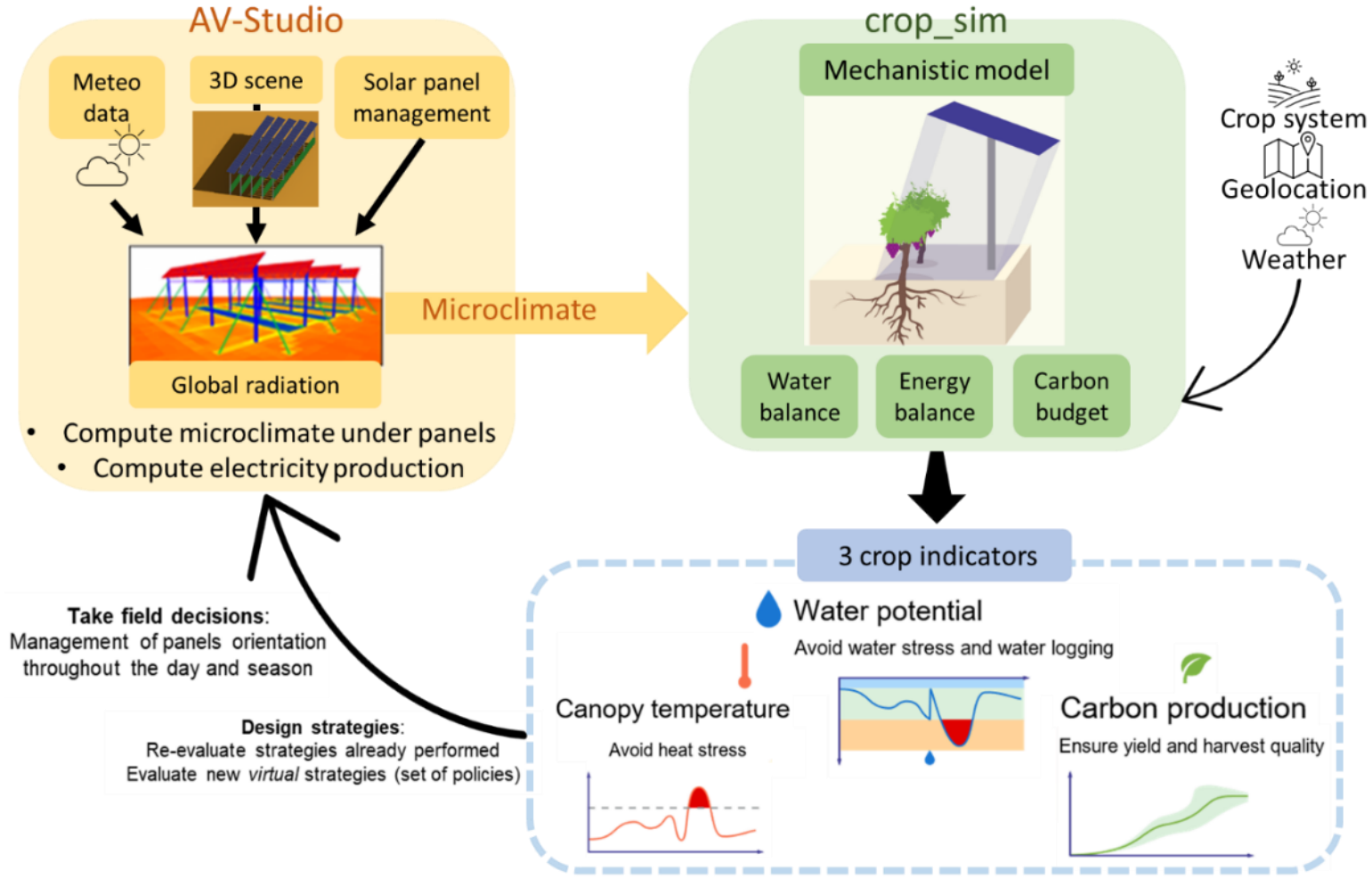
11 Real size demonstrators

- Real-life management based on the software, the farmer's goals and microclimatic sensors

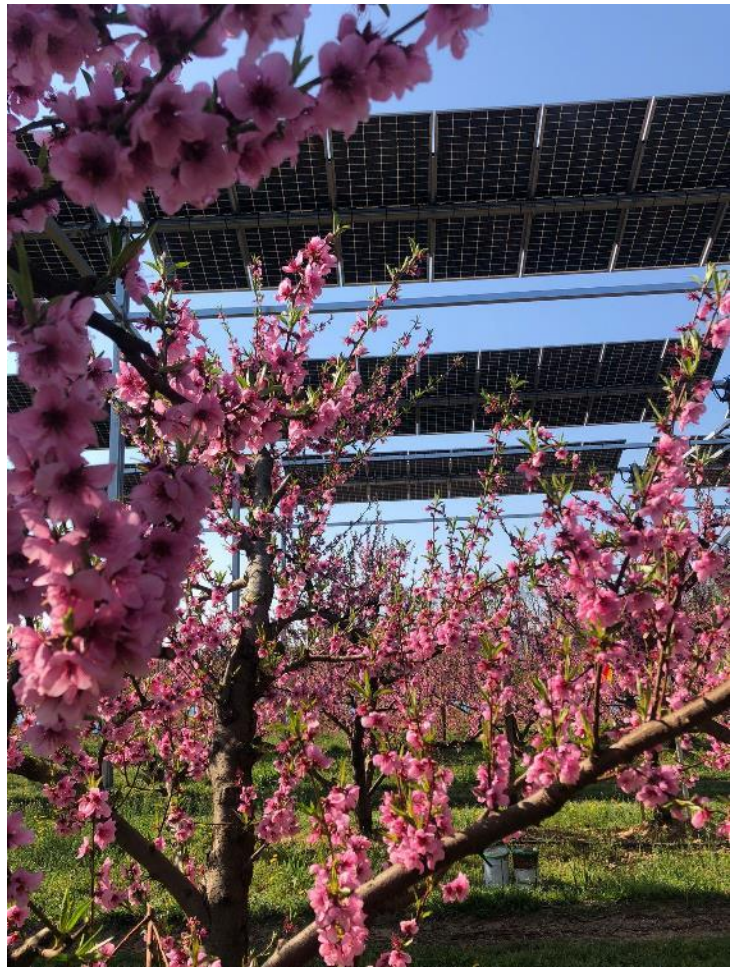
9 experimental sites …



… to develop algorithms…



… to be used on real size demonstrators



3

Results and discussion

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Dynamic agrivoltaic system over mature apple trees

STATION D'EXPERIMENTATION Arboricole
PROVENCE ALPES COTE D'AZUR
"LA PUGÈRE"

Mallemort
(France: 43°44'24.0"N; 5°07'30.0"E)

- Installation : February 2019
- Crop : 'Golden Delicious' apple orchard
- 730 m² under dynamic solar panels next to a control plot of 1480 m² without solar panels.
- 'Solar Tracking' strategy to maximize shading (mean interception: 40 %) : have a better understanding of the advantages and disadvantages of exposing apple trees to shade and to test the limit of this technology in term of response of the plant.

Dynamic agrivoltaic system over mature vineyards

- Installation : March 2019
- Crop : ‘Grenache Noir’ vineyard
- 600 m² under dynamic solar panels next to a control plot of 340 m² without solar panels.
- Different shading strategies tested : develop and test a vine growth model integrating the impact of the microclimate under an agrivoltaic system

Dynamic agrivoltaic systems: an effective protection against the impacts of climate change

Reduction of climatic demands : better water status and reduction of total irrigation over the season up to 30% in apple trees

Year	Minimal water potential over the season (MPa)		Total irrigation over the season (mm)	
	Control trees	Trees under dynamic solar panels	Control trees	Trees under dynamic solar panels
2019	-1.3	-1 (+ 23%)	1150	800 (- 30%)
2020	-1.4	-1.2 (+ 14%)	750	710 (- 5%)
2021	-1.2	-0.8 (+ 33%)	1380	890 (- 36 %)

Dynamic agrivoltaic systems: an effective protection against the impacts of climate change

Decrease in **leaf and fruit sunburns** in grapevine (veraison 2022) and apple trees (August 2022)

SHADE

CONTROL

SHADE

CONTROL

Dynamic agrivoltaic systems: adverse effects of a poorly panel steering policies

Decrease in **fruit quality at harvest** after 3 years of maximum shading (solar tracking)

Skin colour

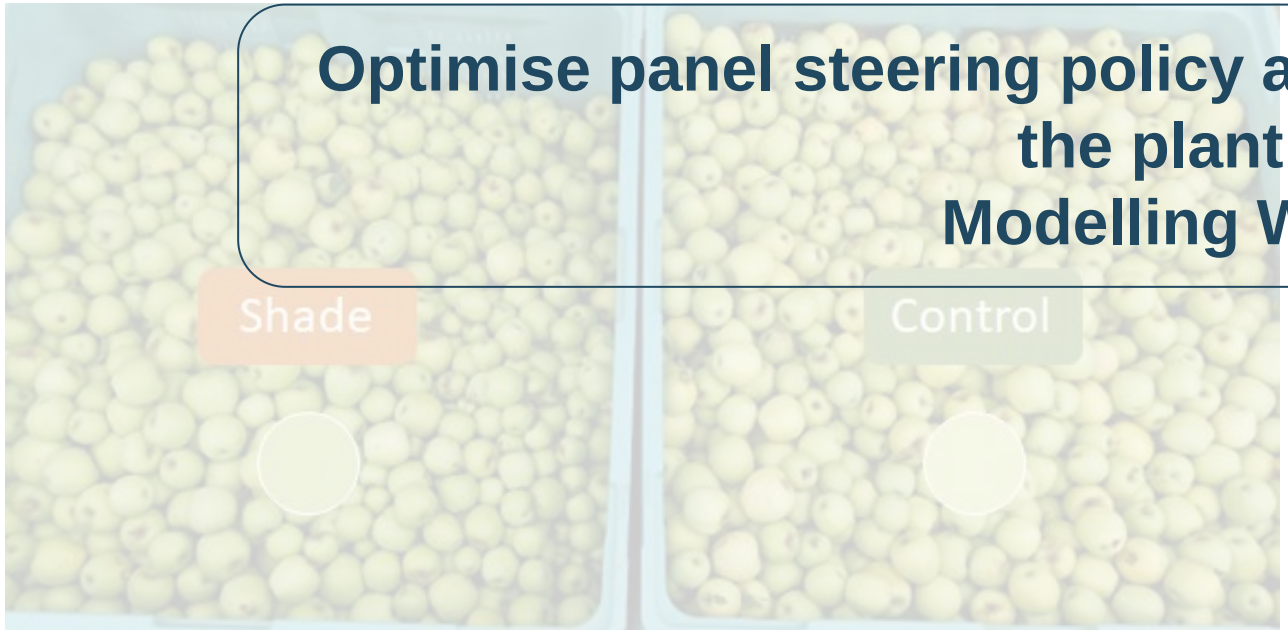
°Brix

		Refractometrix index (°Brix)	
Year	Plot	Mean	sd
2019	Control	10.9	1.1
	Under AVD	9.8	0.7
2020	Control	12.4	0.6
	Under AVD	9.5	0.7
2021	Control	12.5	1.5
	Under AVD	10.3	1

Dynamic agrivoltaic systems: adverse effects of a poorly panel steering policies

Decrease in **fruit quality at harvest** after 3 years of maximum shading (solar tracking)

Skin colour



°Brix

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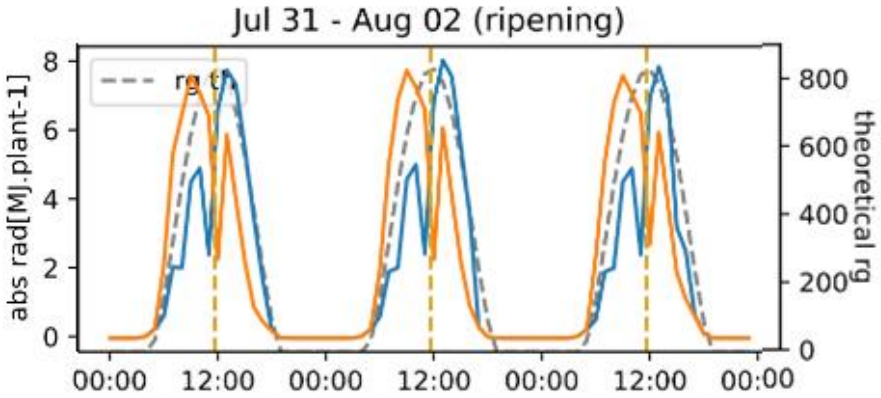
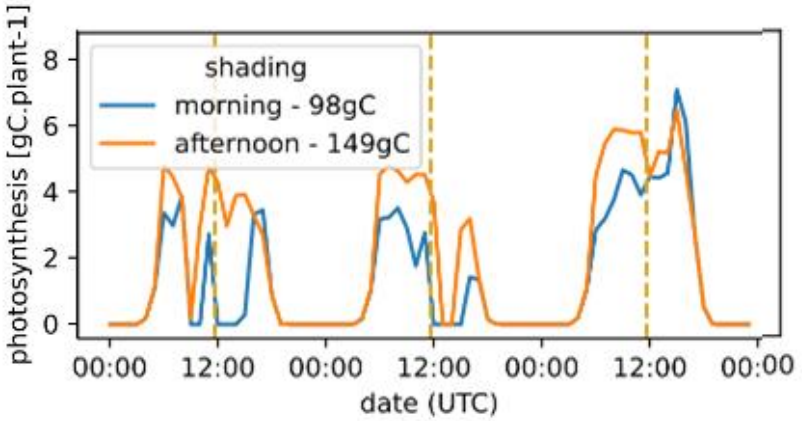
Optimise panel steering policy according to the needs of the plant : Modelling Work

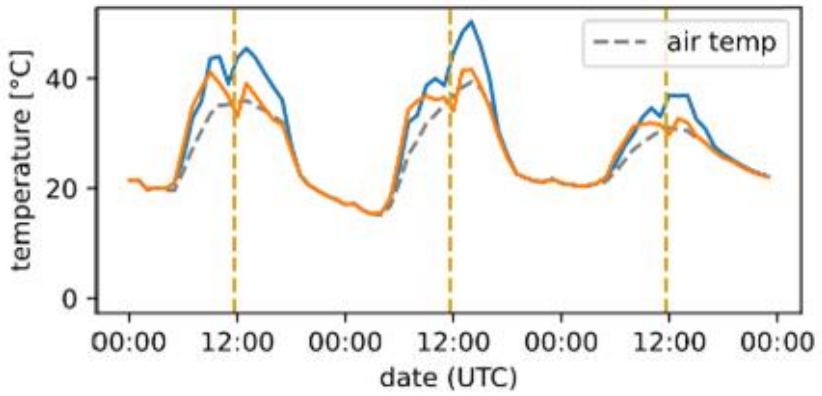
Crop modelling: an assistance in the panel steering policies

Experimentation in apple trees: only one shading strategy tested with solar tracking
Crop modelling: Used to compare two **other panel steering policies**: ‘morning’ (tracking only in the morning during all the season) and ‘afternoon’ (tracking only in the afternoon during all the season)





Interaction between light interception, photosynthesis and temperature



Crop model allow to determine best panel steering policy

3 years on maximal shading on experimental site of La Pugère …

… to determine best panel steering policy ..

… and be abble to apply our software on real orchard planted in 2022

Llupia, near to Perpignan, 2022

QUESTIONS & ANSWERS