

Sensitivity of WRF model simulations to high-resolution static fields: Leaf Area Index and Vegetation Fraction

Iciar Guerrero^{(1),(2)}, Jordi Mercader⁽¹⁾

(1) Servei Meteorològic de Catalunya, Berlín 38-46, 4a planta, 08029 Barcelona, Spain

(2) Facultat de Física, Universitat de Barcelona, Diagonal 645, 08028 Barcelona, Spain



Servei Meteorològic
de Catalunya

CONTENTS

1. Motivation

2. Model Set-up

3. Sensitivity test: 4th July 2022

4. LIAISE PROJECT: new LAI data

5. Results

6. Conclusions

7. Further work

1. Motivation

- Study the impact of setting an extreme and constant value of **Leaf Area Index (LAI)** and **Vegetation Fraction (VEGFRA)**, with the aim of determining if the model responds to the change.
- Using **high-resolution and near-real-time data** of LAI and VEGFRA in the operational configuration of the Meteorological Service of Catalonia (SMC) and assess their impact on the forecast.

Leaf Area Index: is defined as half the total area of green elements of the canopy per unit horizontal ground area.

Vegetation fraction: it corresponds to the fraction of ground covered by green vegetation

CONTENTS

1. Motivation

2. Model Set-up

3. Sensitivity test: 4th July 2022

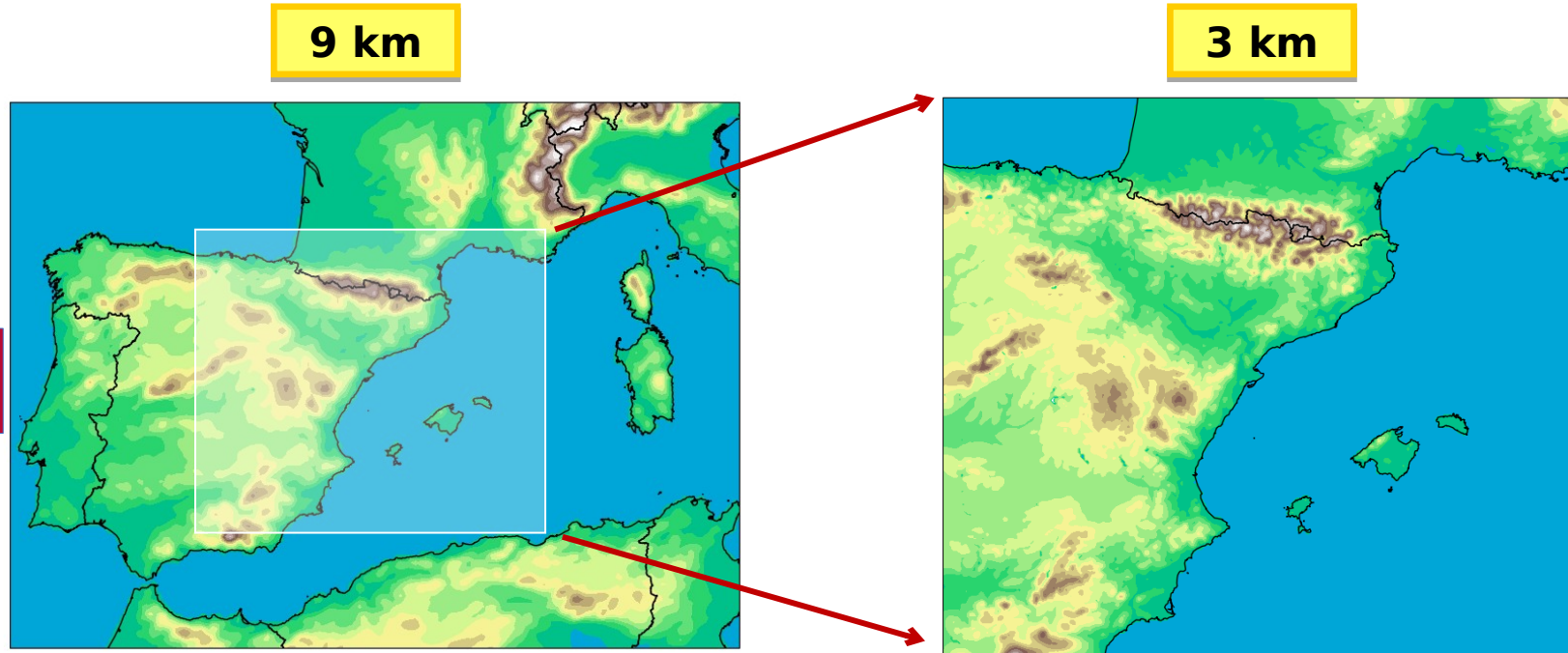
4. LIAISE PROJECT: new LAI data

5. Results

6. Conclusions

7. Further work

2. Model Set-up



17 simulations

Analysed period:
15th - 31st July

No spin-up time

WRF-ARW
v4.3

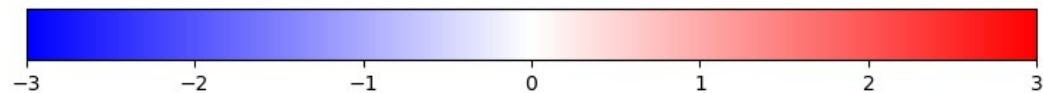
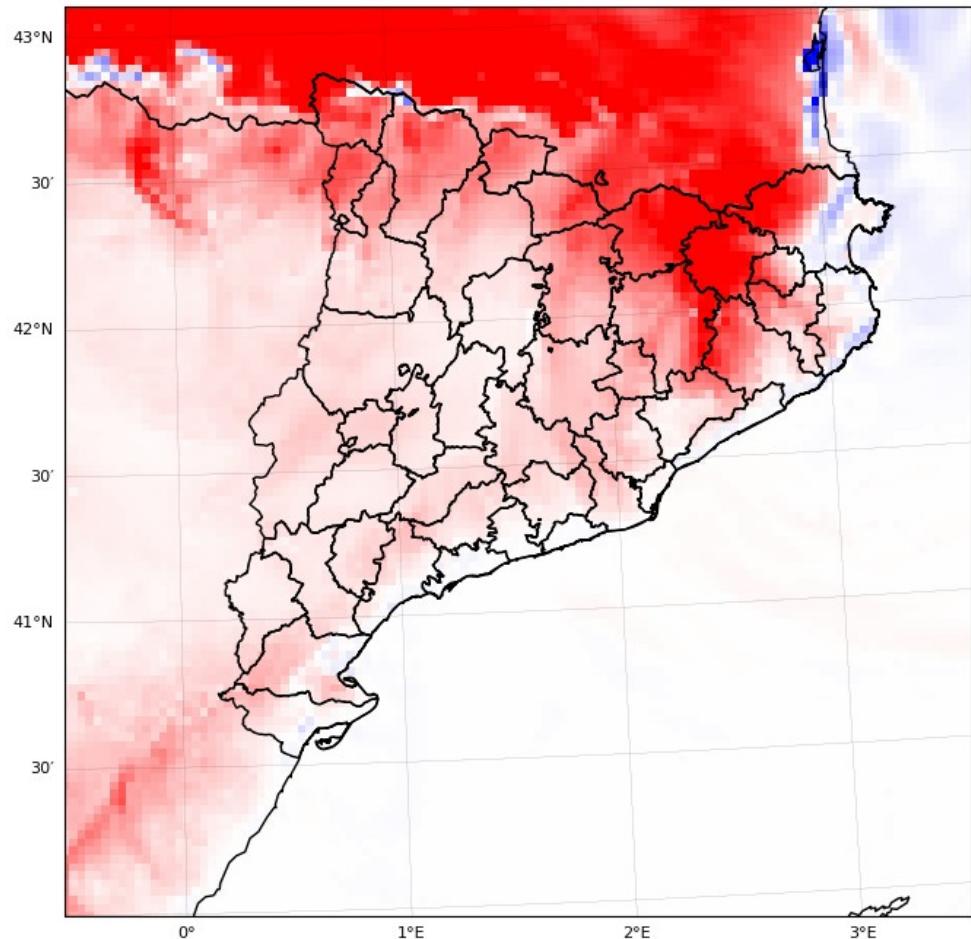
GRID	XxYxZ	Length	BC	PBL	MICRO	CONV	LW	SW	SOIL	FDDA	NEST
9 km	200x150x31	72 h	1 h	YSU	WSM5	Kain-Fritsch	RRTM	Dudhia	Noah LSM	YES	
3 km	301x262x31	72 h	1 h	YSU	WSM5	Kain-Fritsch	RRTM	Dudhia	Noah LSM	NO	1-way

CONTENTS

1. Motivation
2. Model Set-up
- 3. Sensitivity test: 4th July 2022**
4. LIAISE PROJECT: new LAI data
5. Results
6. Conclusions
7. Further work

3. Sensitivity test: July 4th 2022

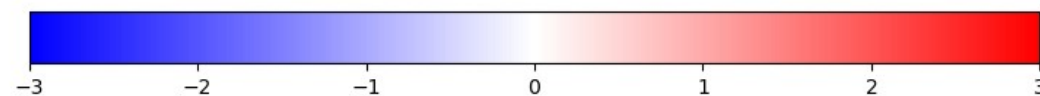
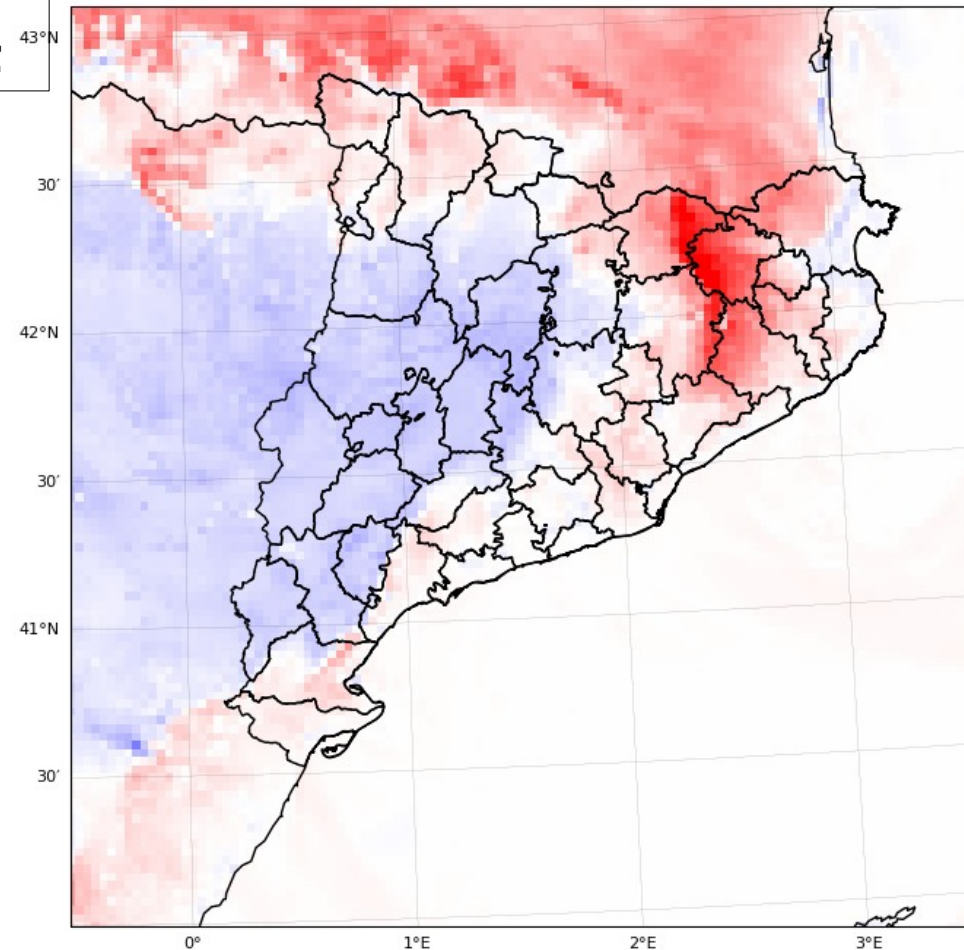
Temperature bias at 2 m - 04/07/2022 12:00



LAI = 0.0

**Bias:
EXP - default**

Temperature bias at 2 m - 04/07/2022 12:00

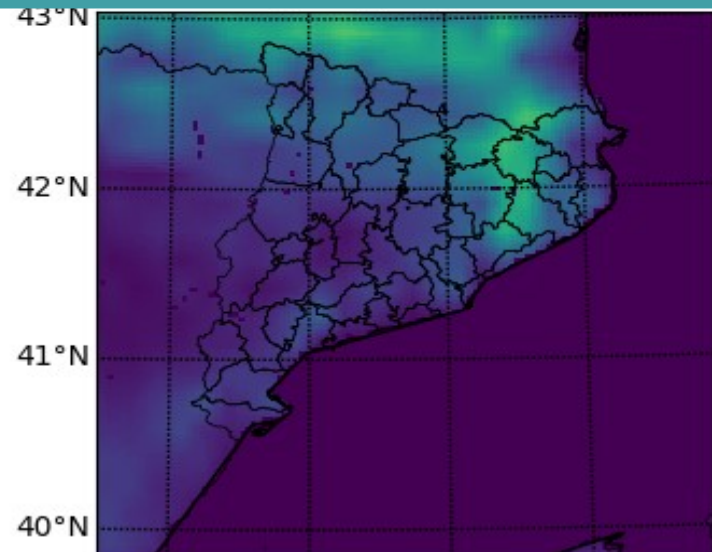


VEGFRA = 0.0

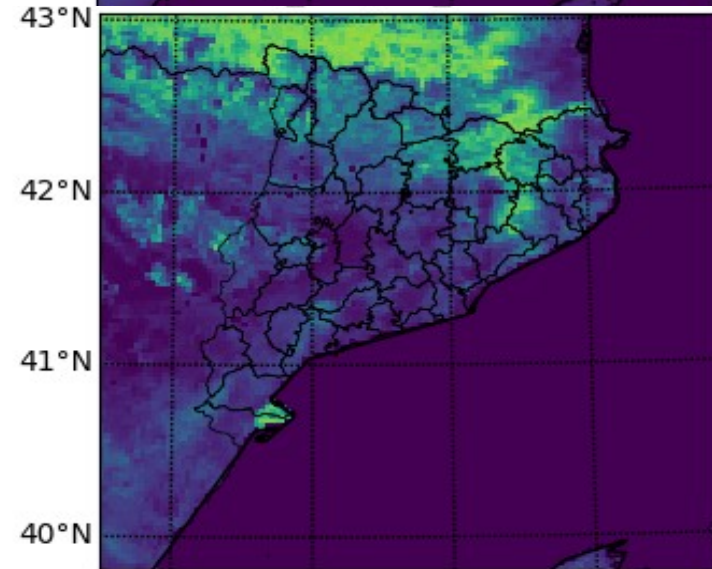
CONTENTS

1. Motivation
2. Model Set-up
3. Sensitivity test: 4th July 2022
- 4. LIAISE PROJECT: new LAI data**
5. Results
6. Conclusions
7. Further work

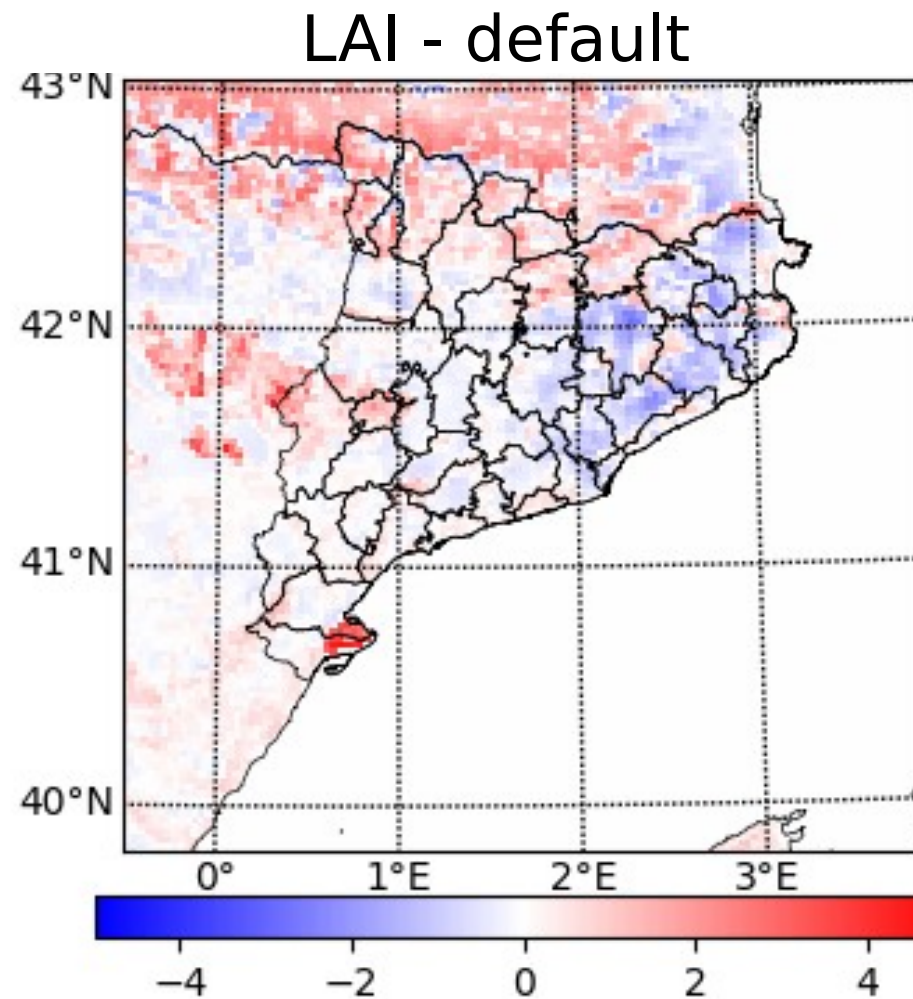
4. LIAISE PROJECT: new LAI data



Default
Resolution:
10 min
(~ **18 km**)



LAI
Resolution:
300 m
20-31 July
2021



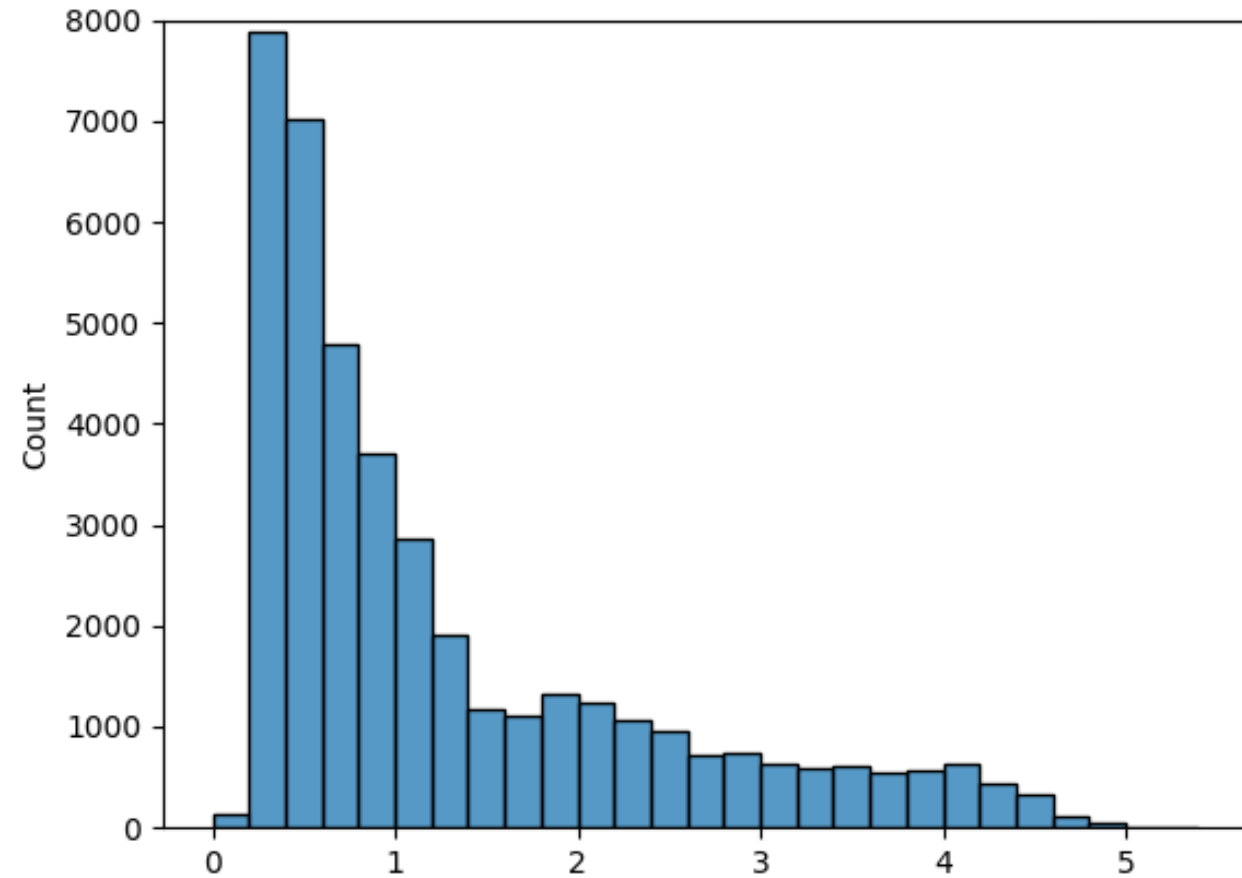
Copernicus
Global Land
Service
(CGLS)



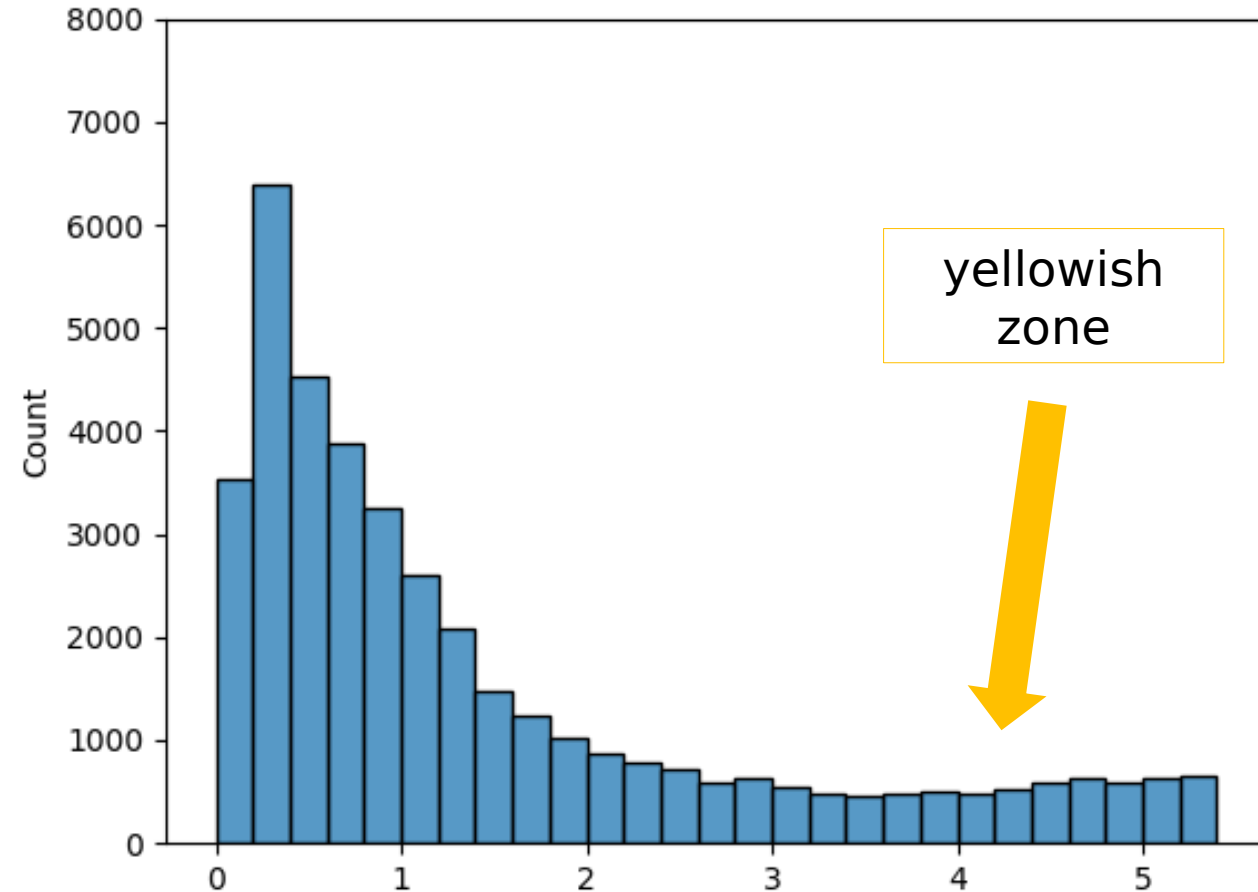
High-resolution
Near-real-time

4. LIAISE PROJECT: new LAI data

default

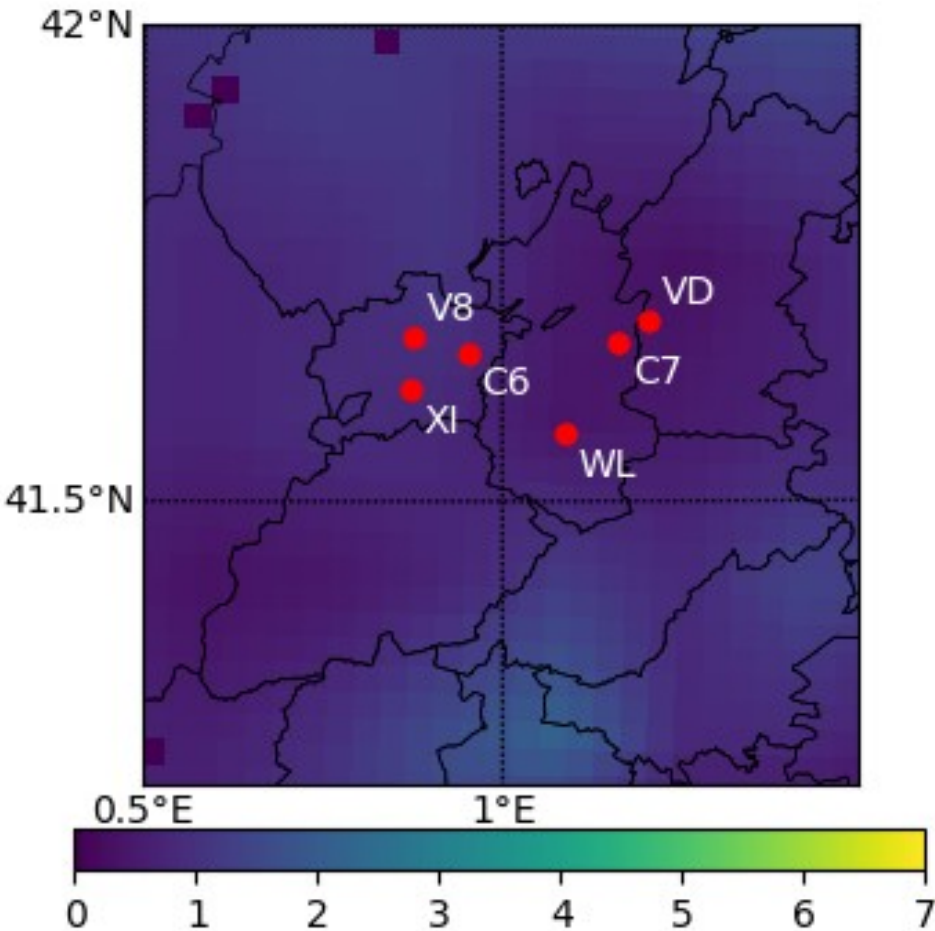


LAI



4. LIAISE PROJECT: new LAI data

default



IRRIGATED:

XI: Mollerussa

V8: EL Poal

**C6: Castellnou
de Seana**

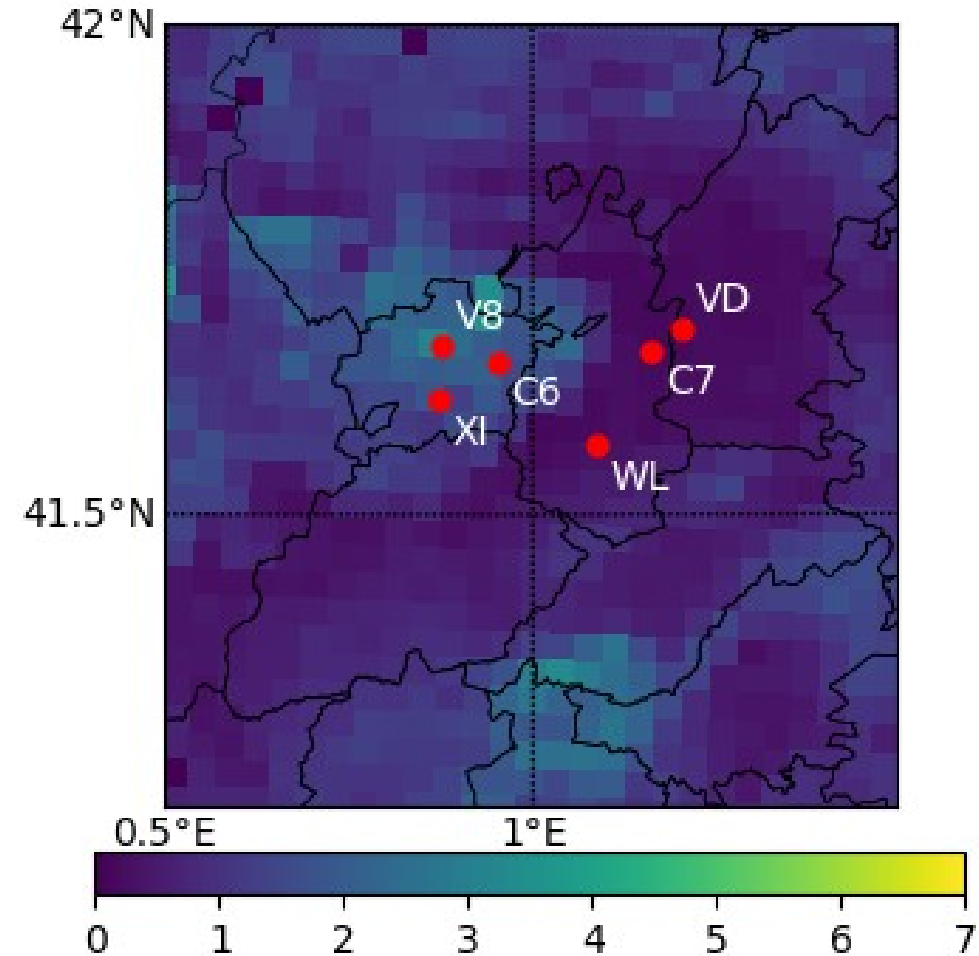
NON-IRRIGATED:

WL: Sant Martí de
Riucorb

VD: El Canós

C7: Tàrrega

LAI

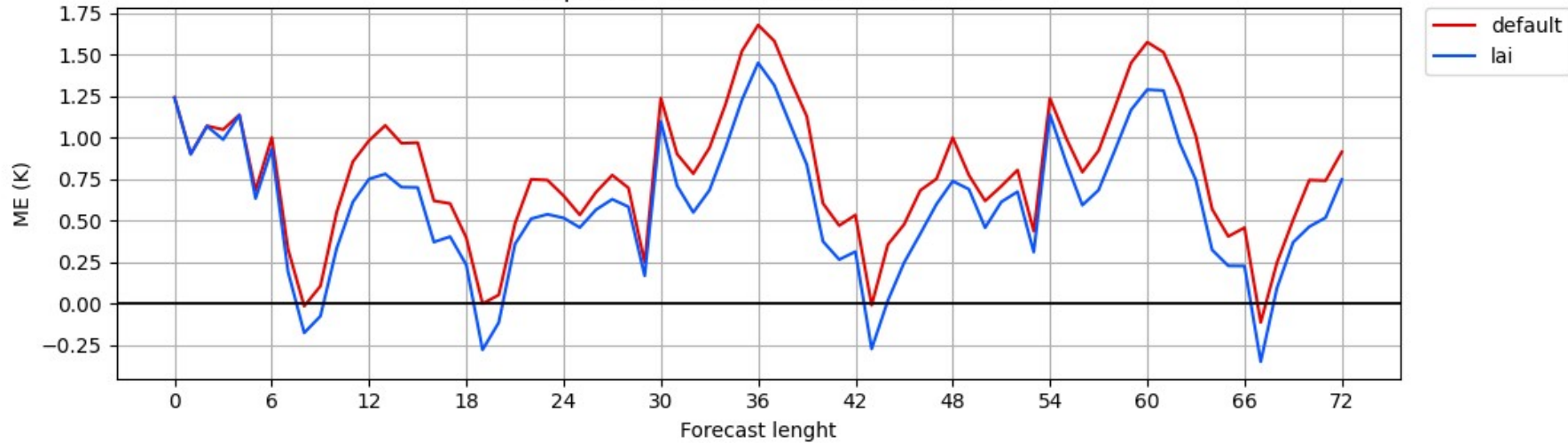


CONTENTS

1. Motivation
2. Model Set-up
3. Sensitivity test: 4th July 2022
4. LIAISE PROJECT: new LAI data
- 5. Results**
6. Conclusions
7. Further work

5. RESULTS: Temperature

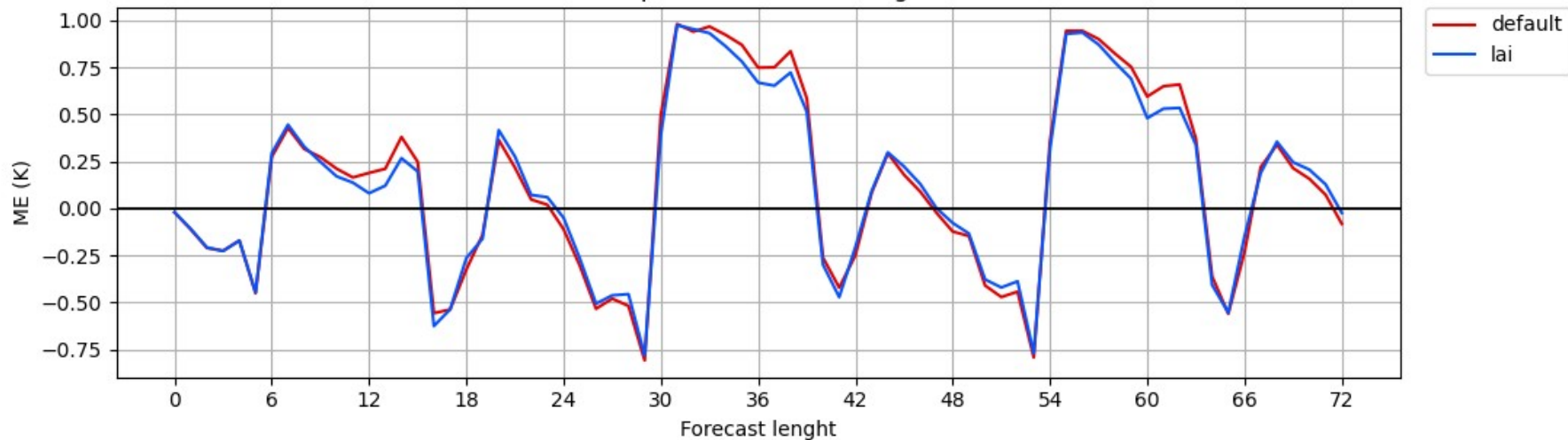
Temperature for C6 Castellnou de Seana



Default: 0.84 -> LAI: 2.1

- **Overestimation** of temperature
- LAI experiment **cools**: up to 0.25 K

Temperature for C7 Tàrrega

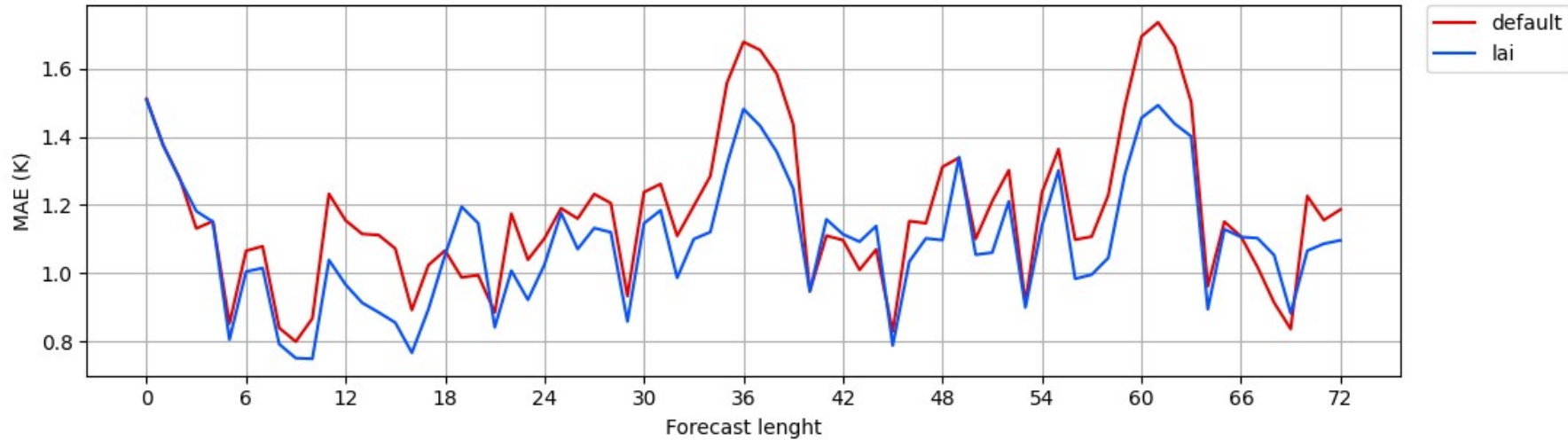


Default: 0.41 -> LAI: 0.16

- Not much difference between two simulations
- LAI experiment cools the temperature at noon

5. RESULTS: Temperature

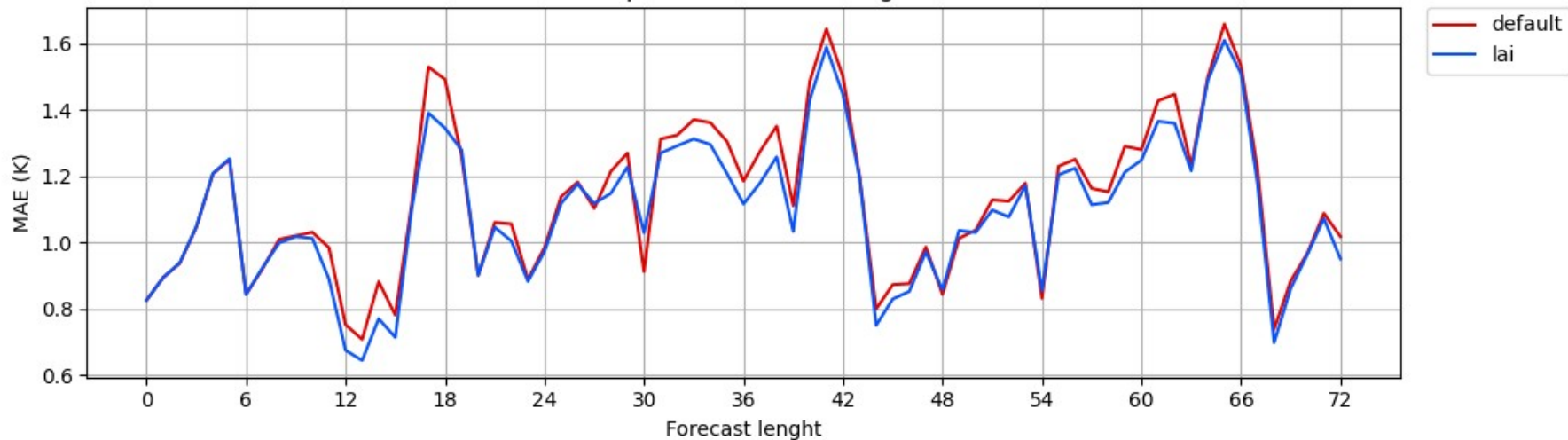
Temperature for C6 Castellnou de Seana



Default: 0.84 -> LAI: 2.1

- Reduction of error

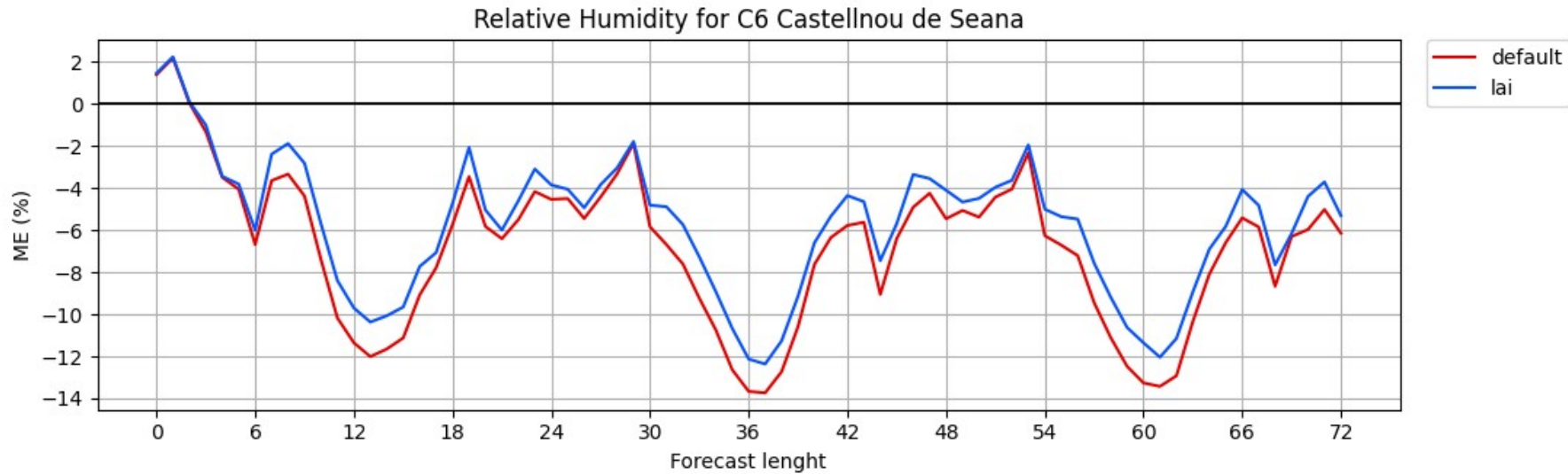
Temperature for C7 Tàrrega



Default: 0.41 -> LAI: 0.16

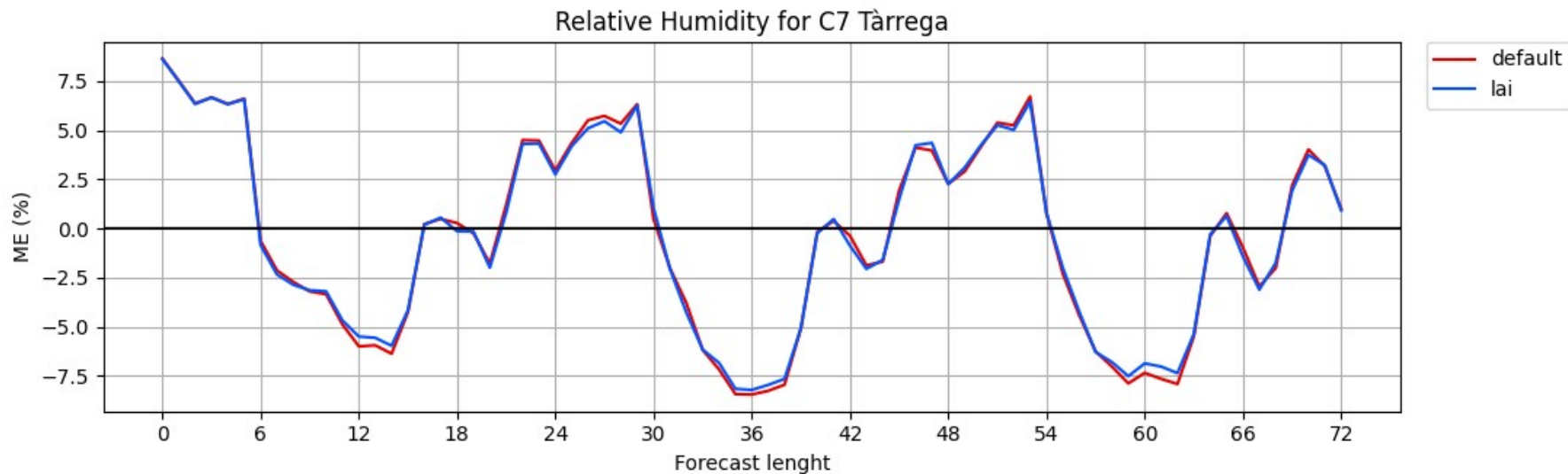
- Not much difference between two simulations
- Reduction of error at noon

5. RESULTS: Relative Humidity



Default: 0.84 -> LAI: 2.1

- **Underestimation** of humidity
- LAI experiment **wetter**

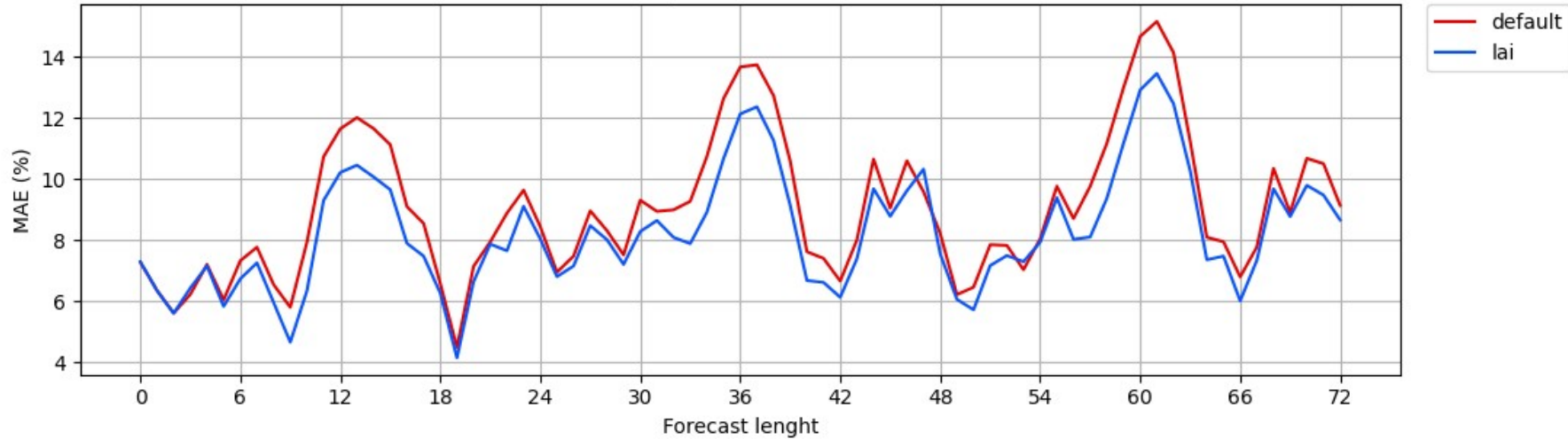


Default: 0.41 -> LAI: 0.16

- Not much difference between two simulations
- Reduction of error at noon

5. RESULTS: Relative Humidity

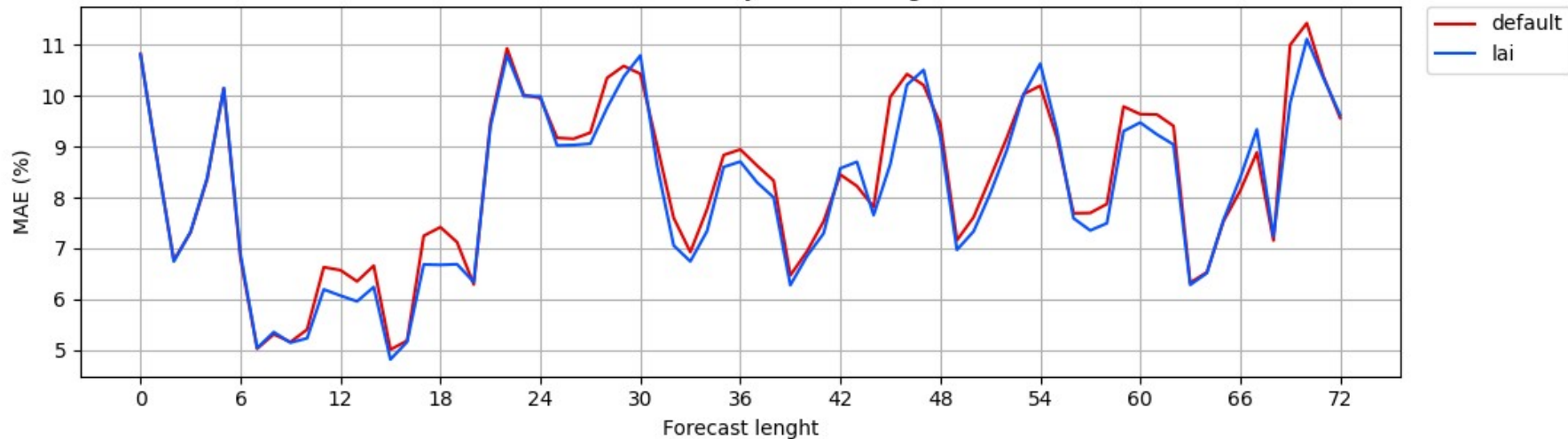
Relative Humidity for C6 Castellnou de Seana



Default: 0.84 -> LAI: 2.1

- General reduction of error

Relative Humidity for C7 Tàrrega

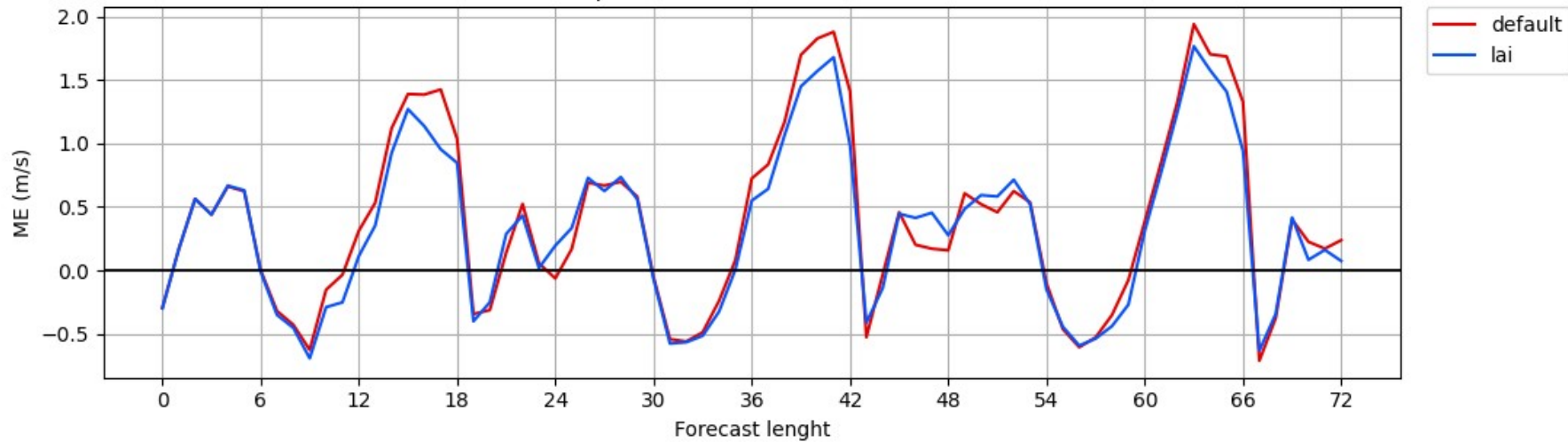


Default: 0.41 -> LAI: 0.16

- Not much difference between two simulations
- Reduction of error at noon

5. RESULTS: Wind Speed

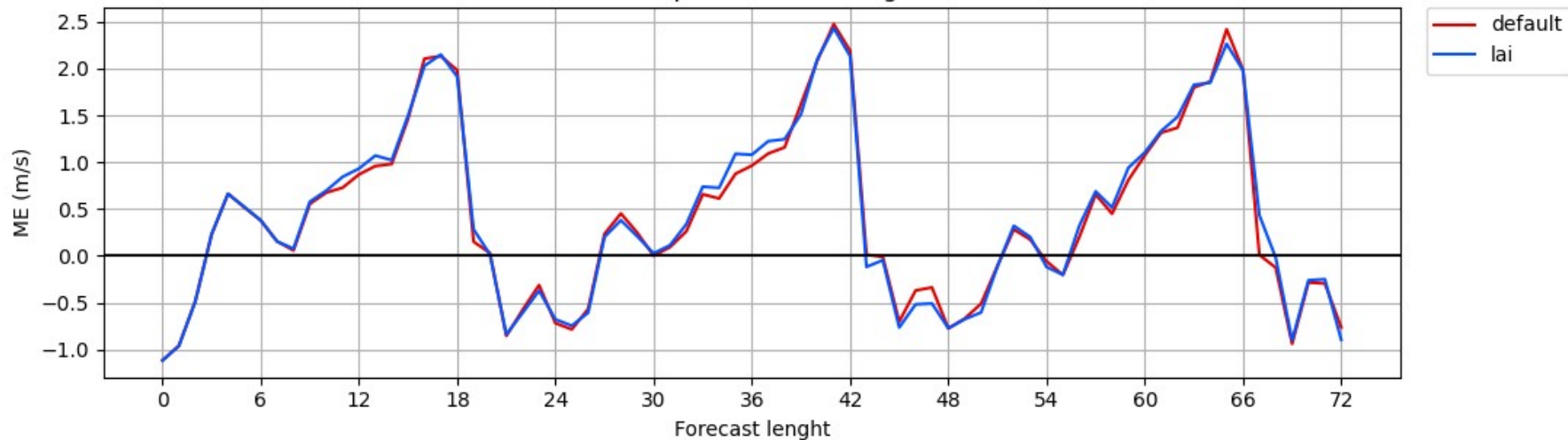
Wind Speed for C6 Castellnou de Seana



Default: 0.84 -> LAI: 2.1

- **Reduction** of mean error at certain time intervals

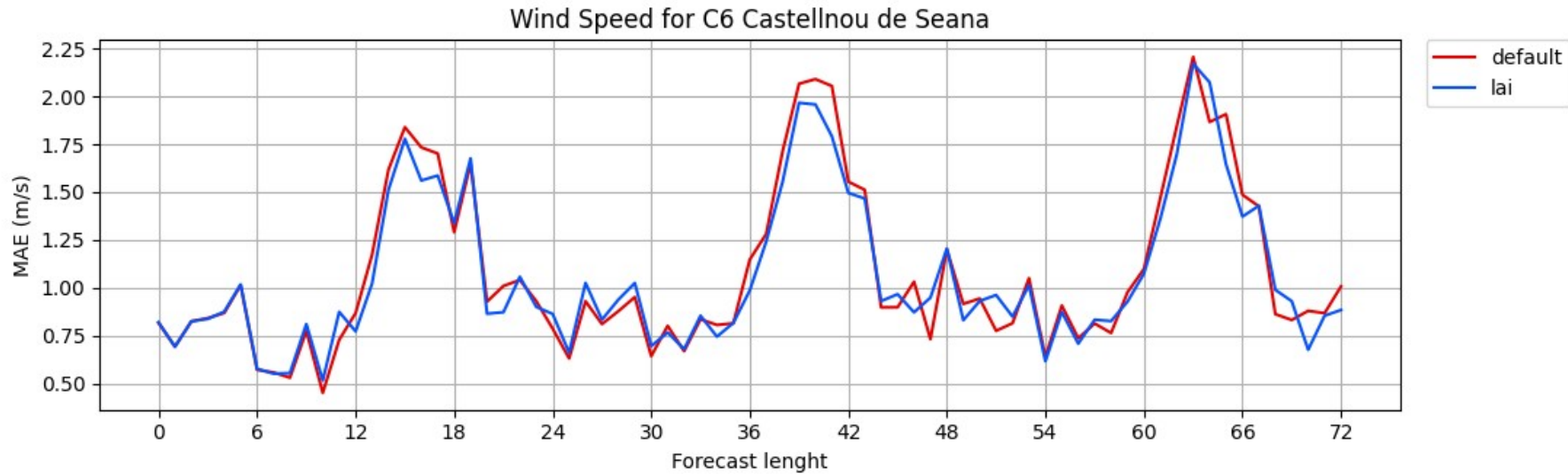
Wind Speed for C7 Tàrrega



Default: 0.41 -> LAI: 0.16

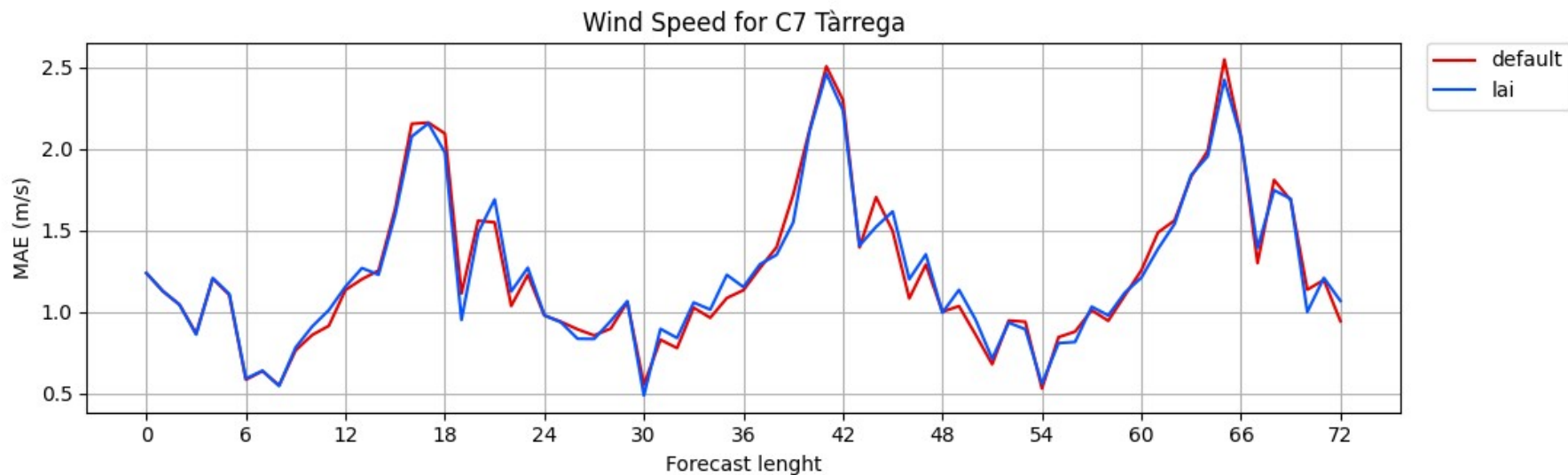
- Not much difference between two simulations
- Increase of error at noon

5. RESULTS: Wind Speed



Default: 0.84 -> LAI: 2.1

- **Reduction** of mean absolute error

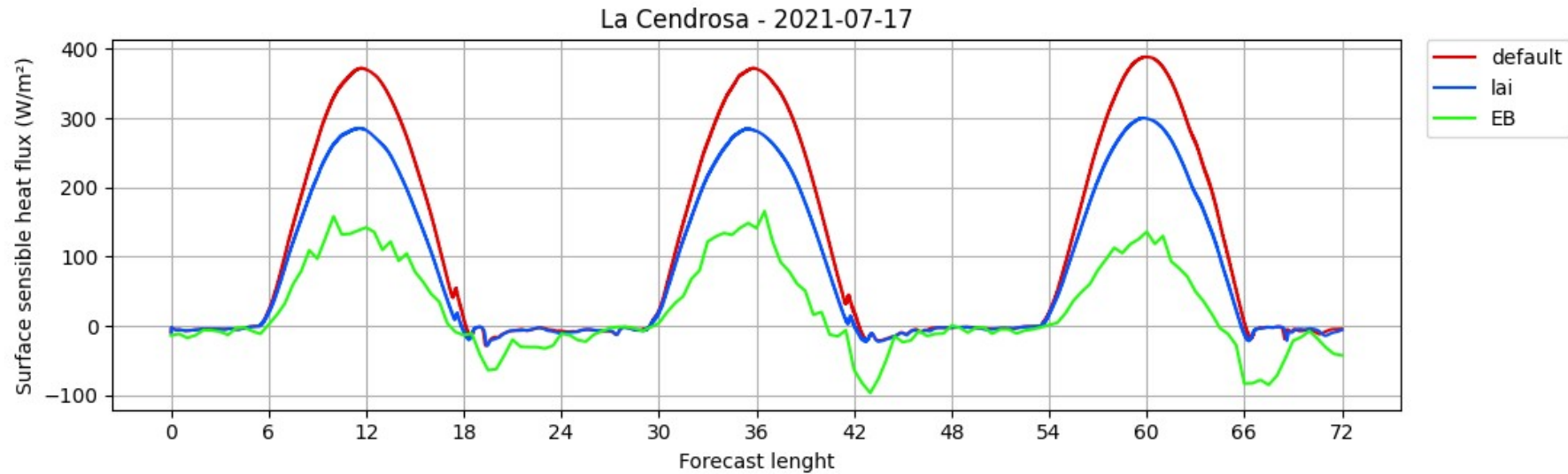


Default: 0.41 -> LAI: 0.16

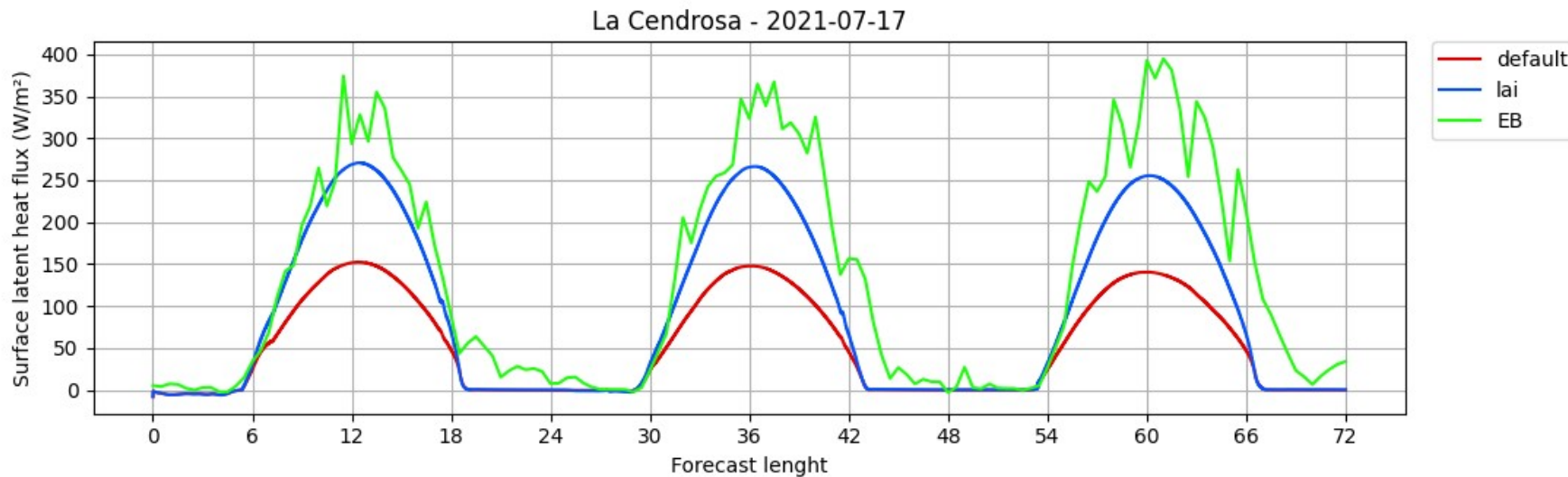
- Not much difference between two simulations

5. RESULTS: July 17th 2021

Default: 0.94 -> LAI: 3.01



- **Reduction** of sensible heat flux for LAI EXP
- No simulation captures the observed sensible flux



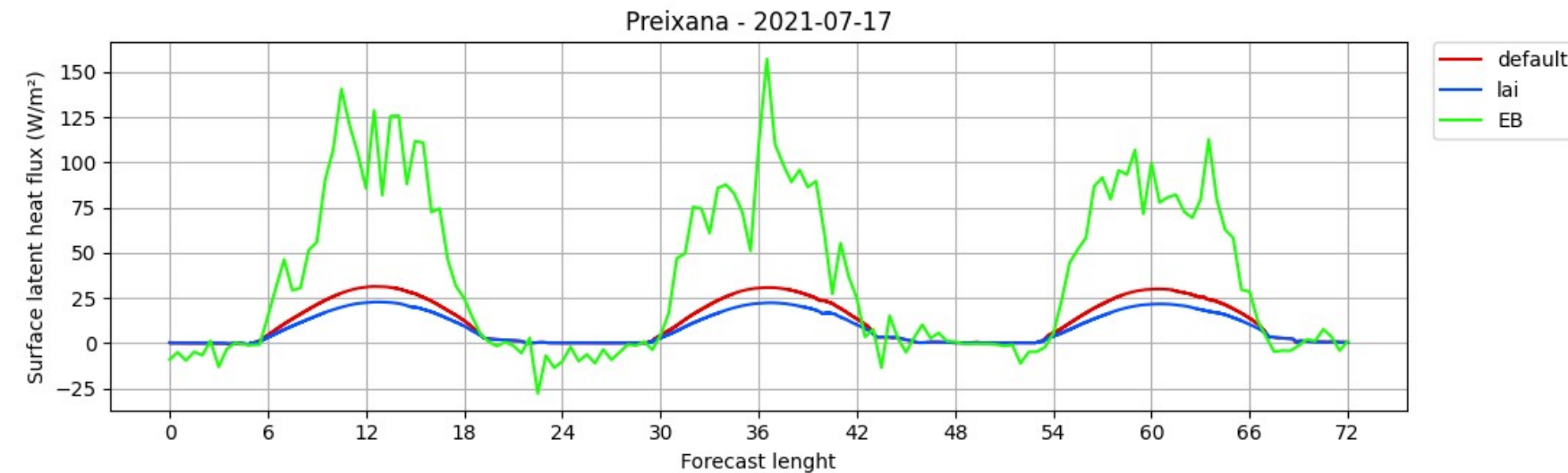
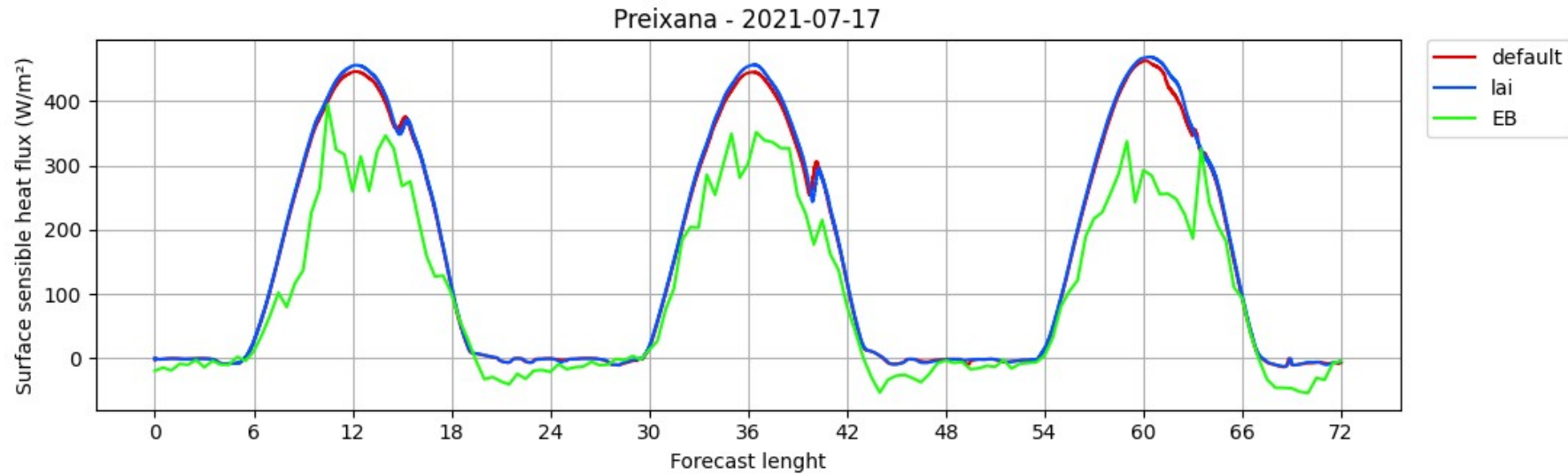
- **Increase** of latent heat flux for LAI EXP
- LAI EXP approaches to observed latent flux

5. RESULTS: July 17th 2021

Default: 0.40 -> LAI: 0.19

- **Increase** of sensible heat flux for LAI EXP
- No simulation captures the observed sensible flux

- **Reduction** of latent heat for LAI EXP
- No simulation captures the observed sensible flux



CONTENTS

1. Motivation
2. Model Set-up
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4. LIAISE PROJECT: new LAI data
5. Results
- 6. Conclusions**
7. Further work

6. CONCLUSIONS

- The Copernicus Global Land Service LAI data has more **heterogeneity** and **higher values** than the default dataset
- Specially at IRRIGATED areas: **overestimation** of temperature and **negative BIAS** of RH
- The differences between the default and LAI experiments are higher in the IRRIGATED areas than in the NON-IRRIGATED ones. In IRRIGATED areas, the LAI EXP lowers the error
- WRF doesn't capture well the energy balance at the surface. However, LAI EXP helps to obtain surface fluxes closer to observed ones at La Cendrosa (Default: 0.94 -> LAI: 3.01)
- **More realistic LAI values -> WRF output closer to obs -> less error**

CONTENTS

1. Motivation
2. Model Set-up
3. Sensitivity test: 4th July 2022
4. LIAISE PROJECT: new LAI data
5. Results
6. Conclusions
- 7. Further work**

7. FURTHER WORK

- Study the impact of using **more realistic Vegetation Fraction data**
- In-depth study of the **energy balance at the surface**
- Use **alternative parametrisations of radiation and surface processes** in the WRF model

THANK YOU

Iciar Guerrero: iciarguerrero@gencat.cat

Acknowledgements: Josep Ram3n Mir3, Enric Casellas, Merc3 Barnolas, Wageningen University & Research (WUR), Copernicus Global Land Service (CGLS)



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