Are the models able to reproduce the soil-atmosphere processes observed during LIAISE?

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1st mesoscale modelling intercomparison, *what have we learned*?

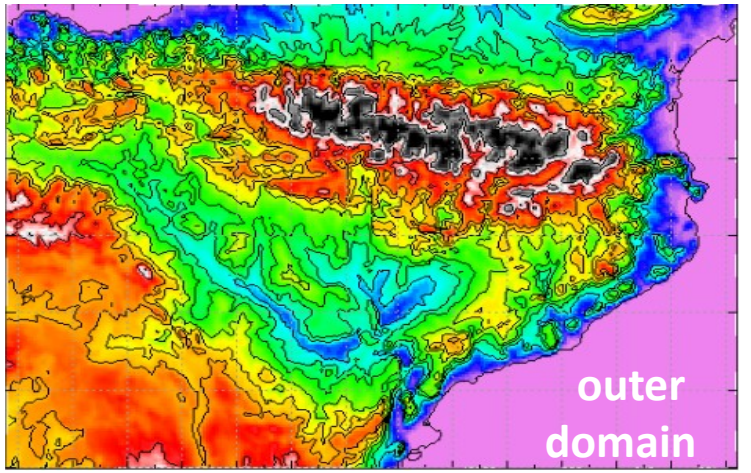
Jiménez et al. (2025) QJRMS

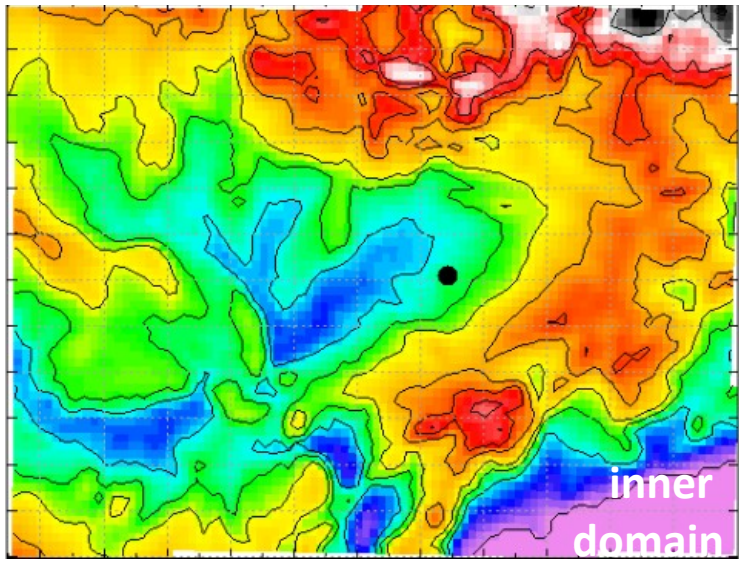
The 1st mesoscale intercomparison case (Jiménez et al. 2025)

Models
MesoNH (MNH)
Unified Model (UM)
WRF

16-18 July 2016

* clear skies, A conditions
* locally/basin/mesoscale generated winds (interact)





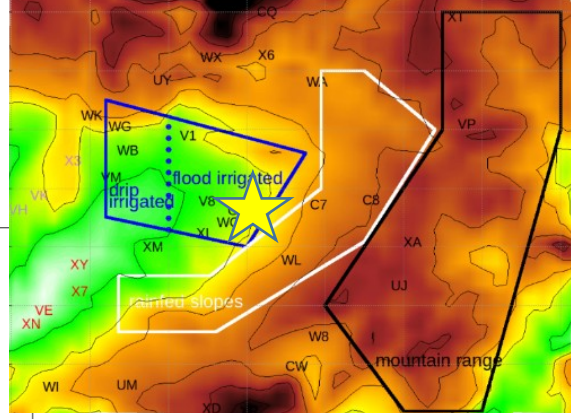
Model setup

- **36h run**

  (from 16 July at 1800 UTC to 18 July at 0600 UTC)
- **2 nested domains** (1-way): 2km x 2km and 400m x 400m resolution (540 x 450 gridpoints)
- **Vertical resolution**

  (2m and stretched above, 85 levels)
- **Initial/Lateral BC**: ECMWF
- **Differences**: Turbulence, Radiation (5min), Surface scheme

Model validation (rainfed slopes, mountain)-> OK!
Difficulties in irrigated regions...



MNH
UM
WRF

10m – wind direction (º)

10m – wind speed (m/s)

2m – temperature (ºC)

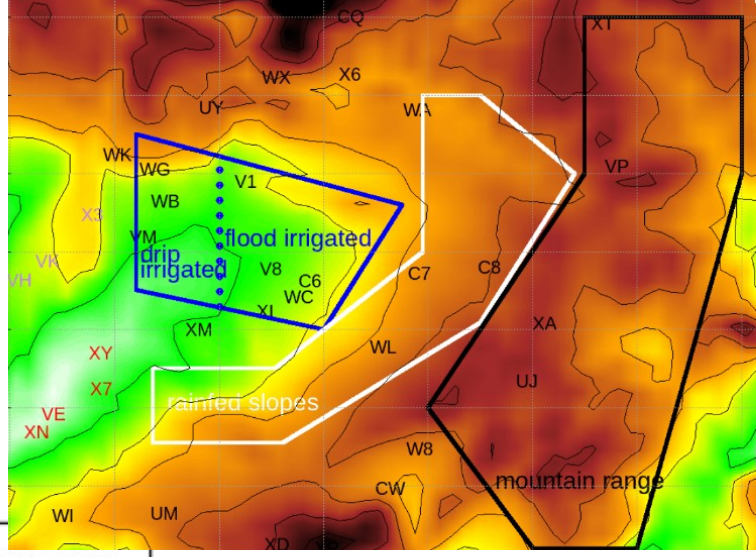
2m – specific humidity (g/kg)

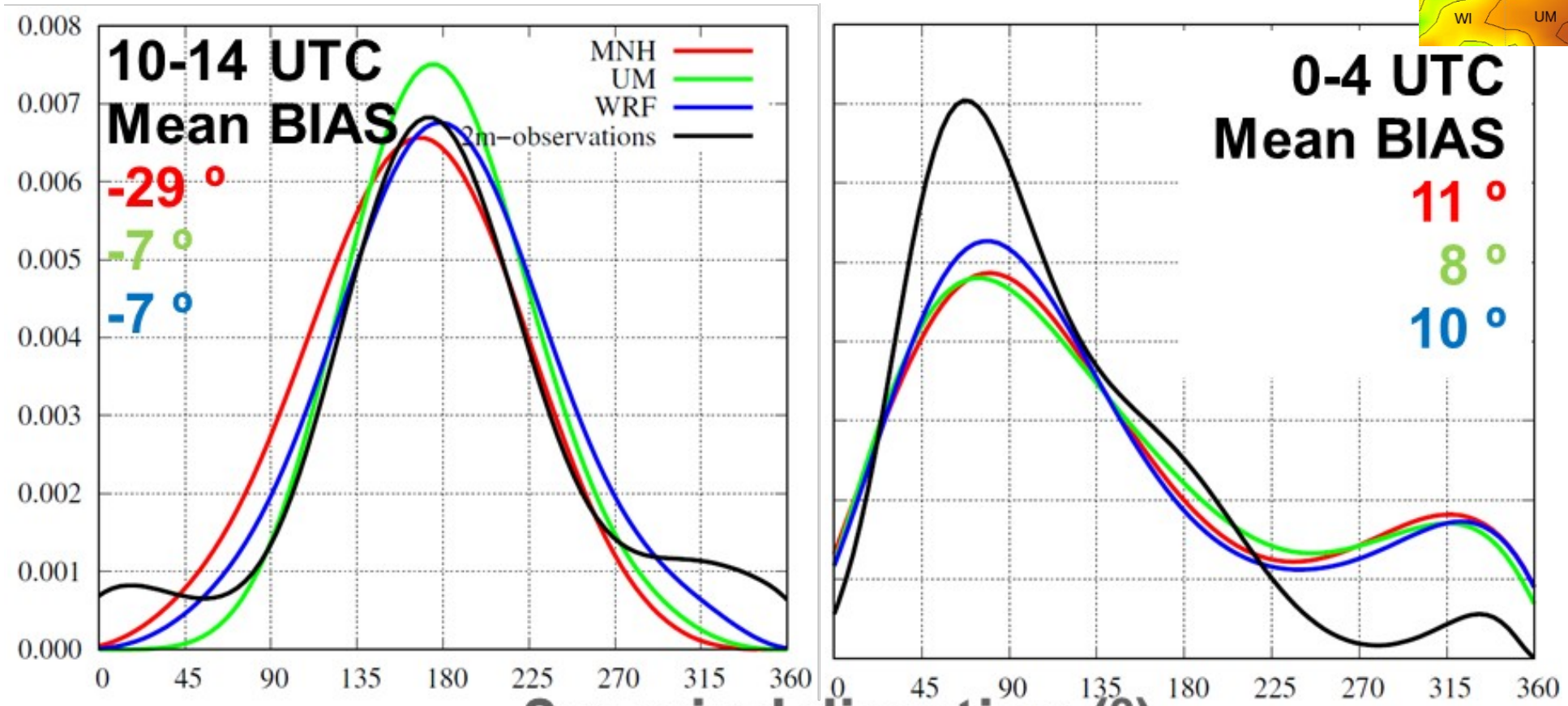
time (UTC)

time (UTC)

1st model gridpoint – 2m observations

Organization of the flow at lower levels-> OK!





2m-wind direction (°)

MesoNH

UM

WRF

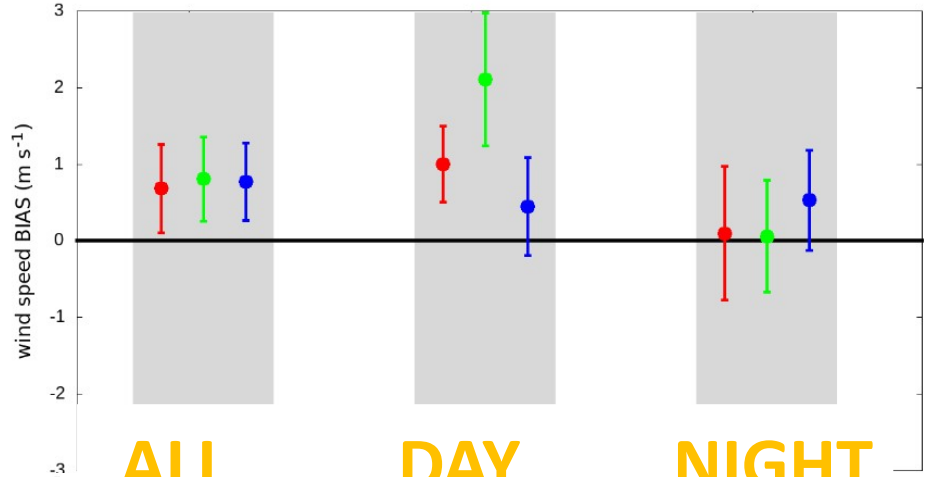
Mean BIAS

MesoNH

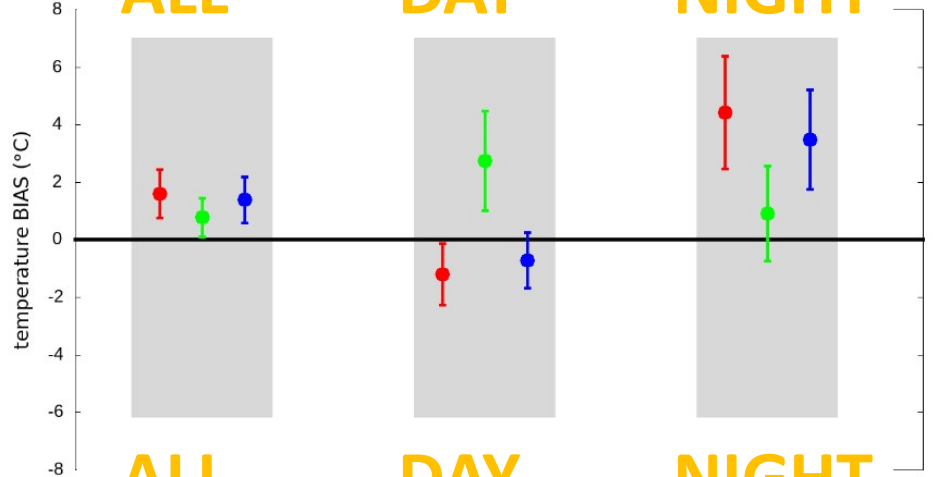
UM

WRF

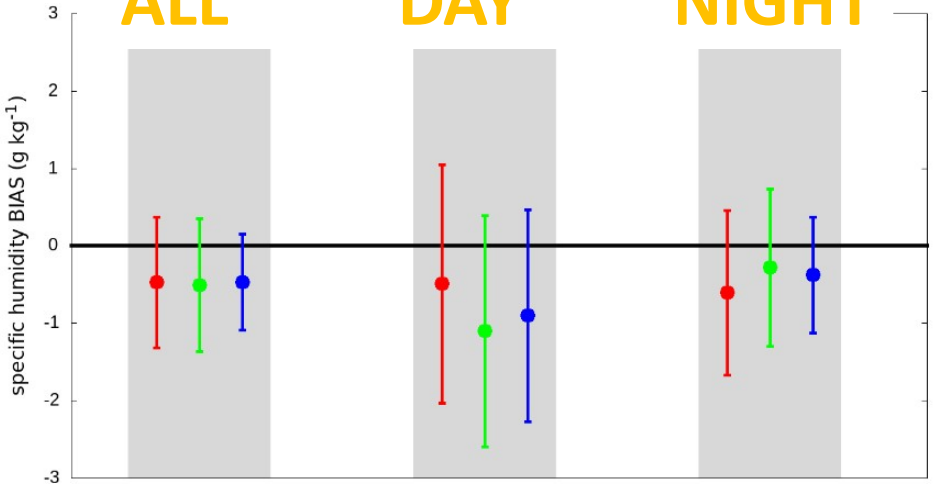
IRRIGATION!!!!



Wind speed (m/s)

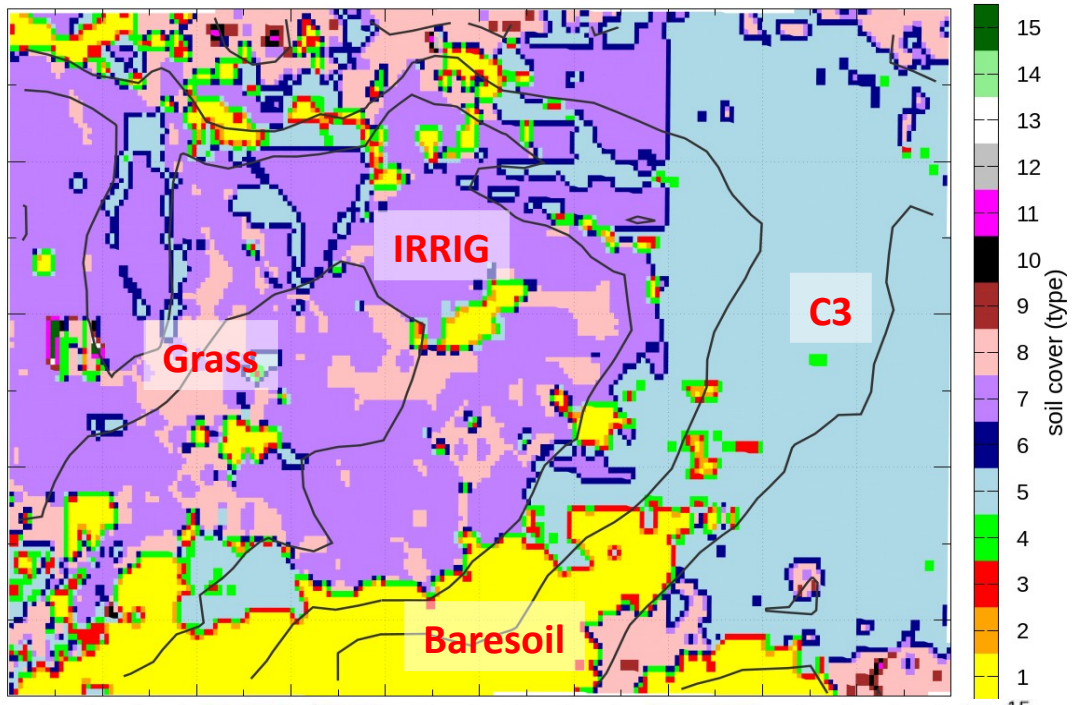


Temperature (ºC)

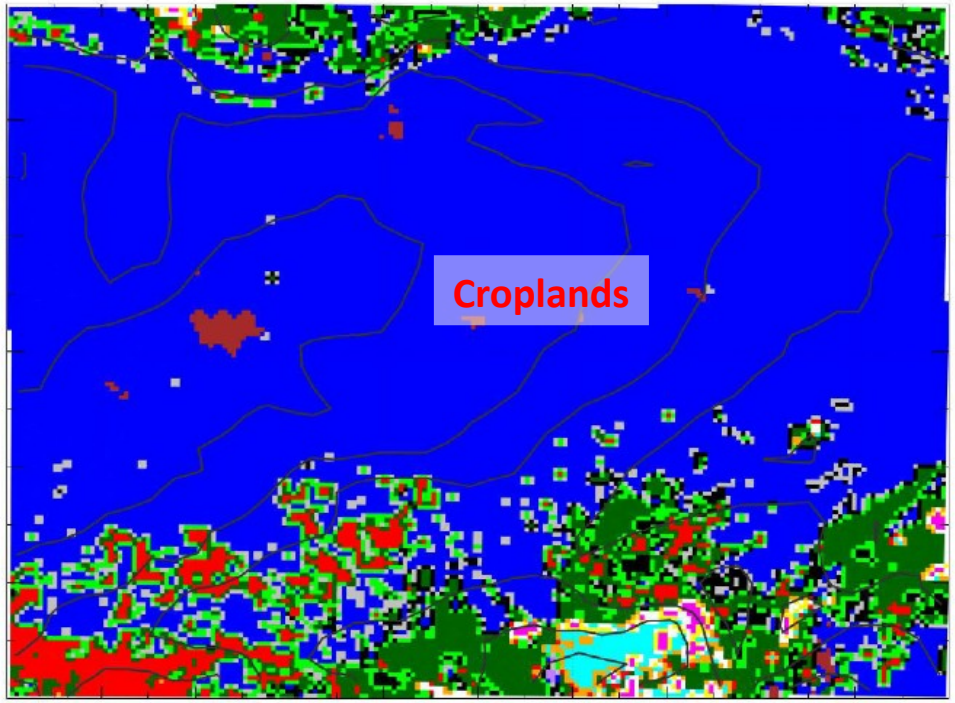


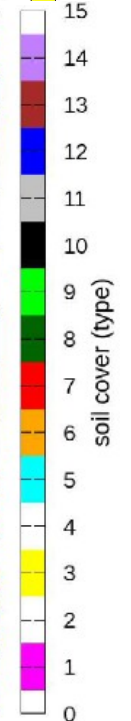
Specific humidity (g/kg)

MesoNH

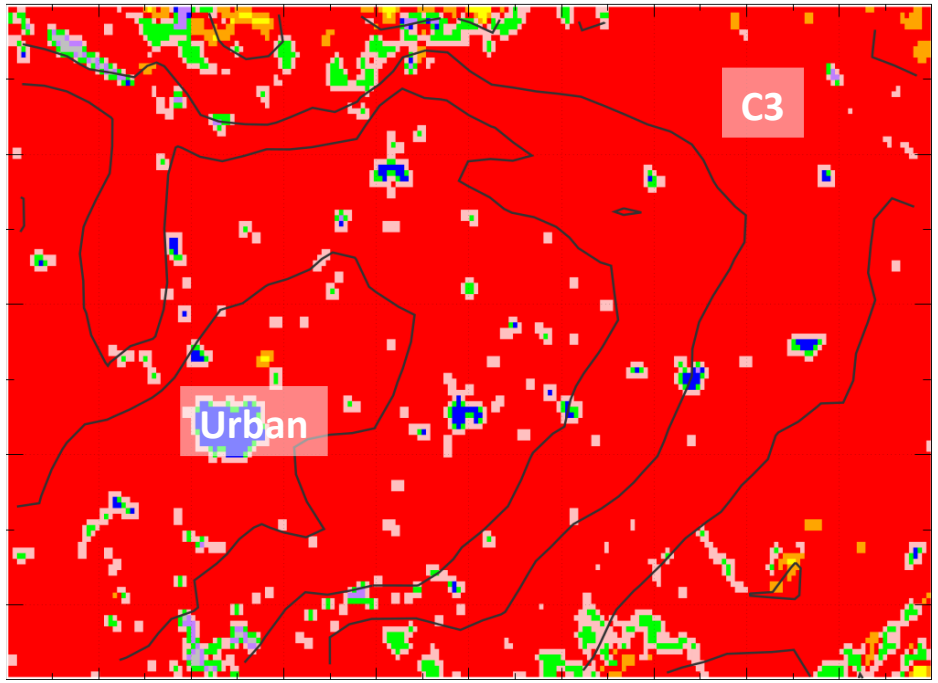


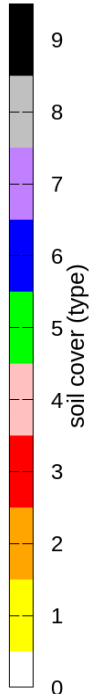
WRF



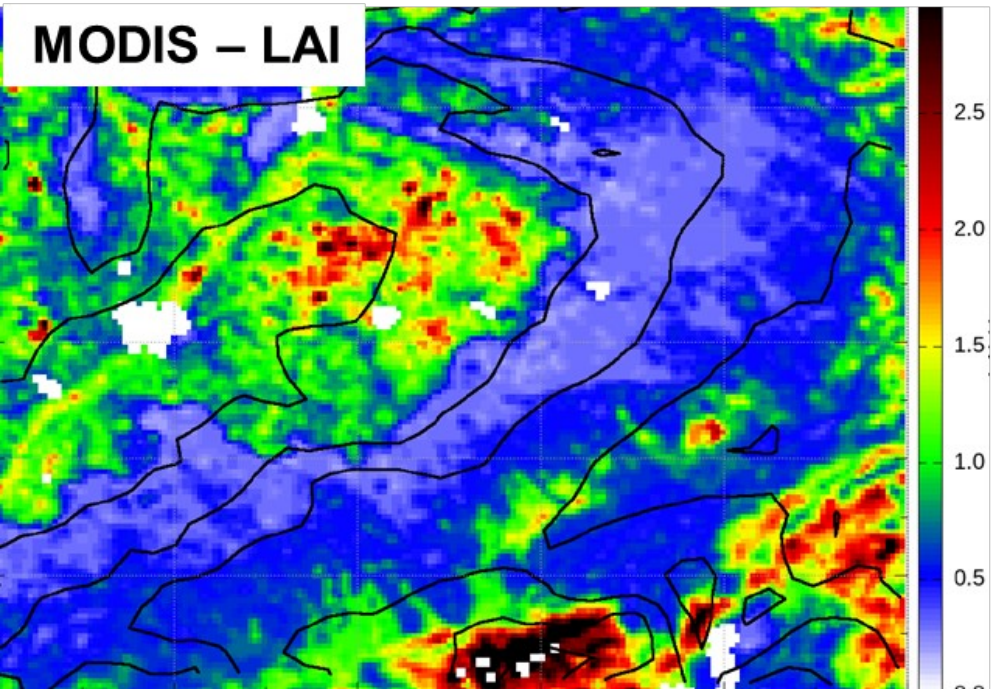


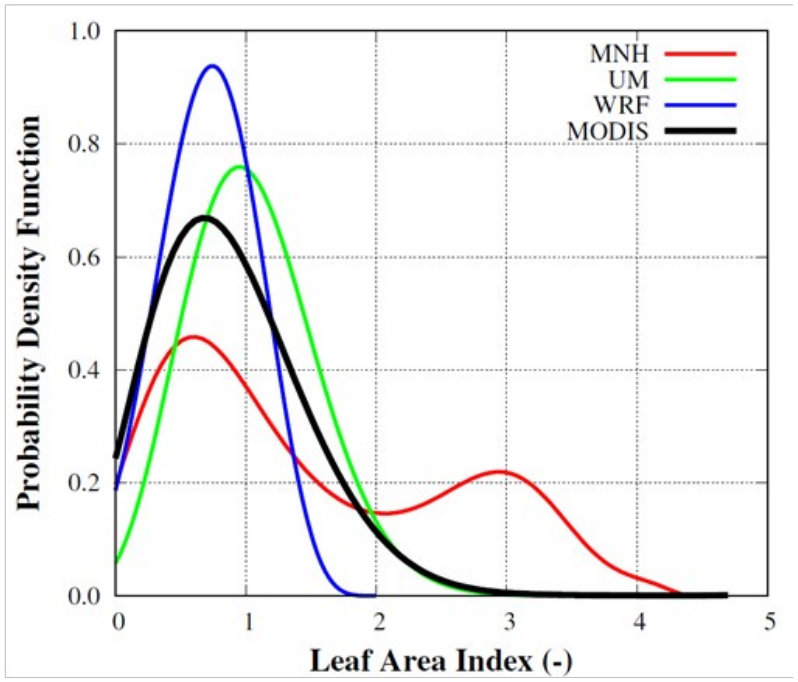
UM



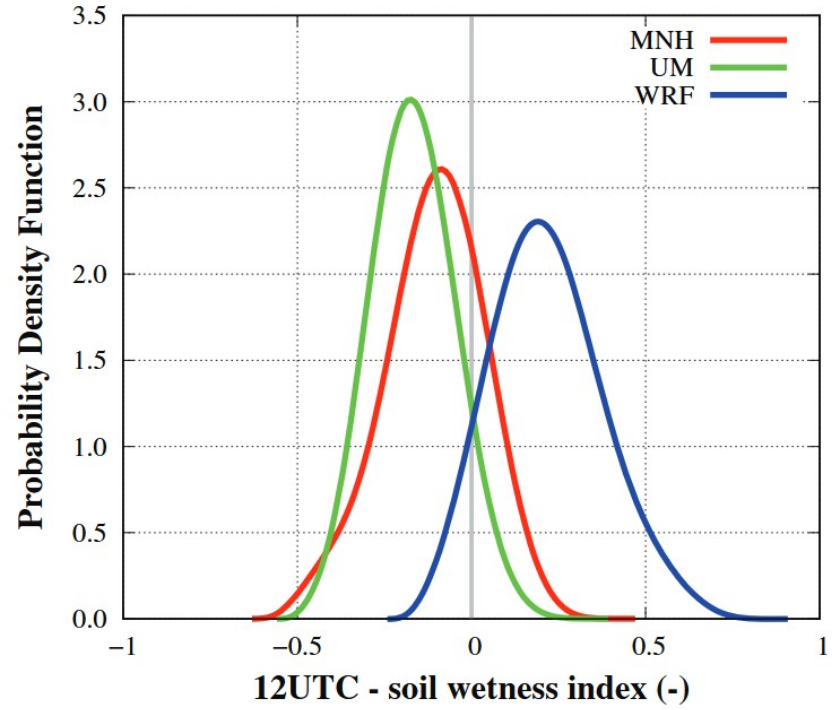


Large variability of the soil cover





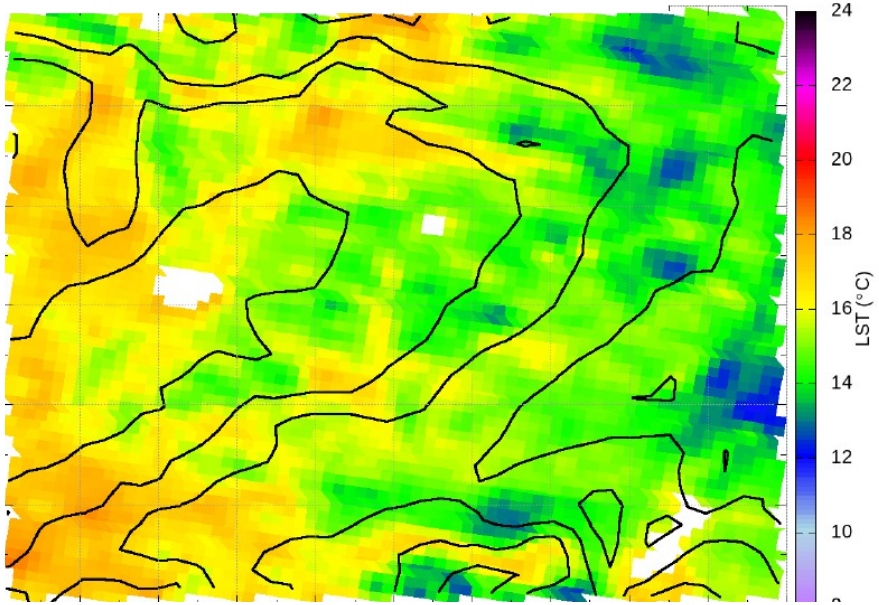
Variability of the surface characteristics

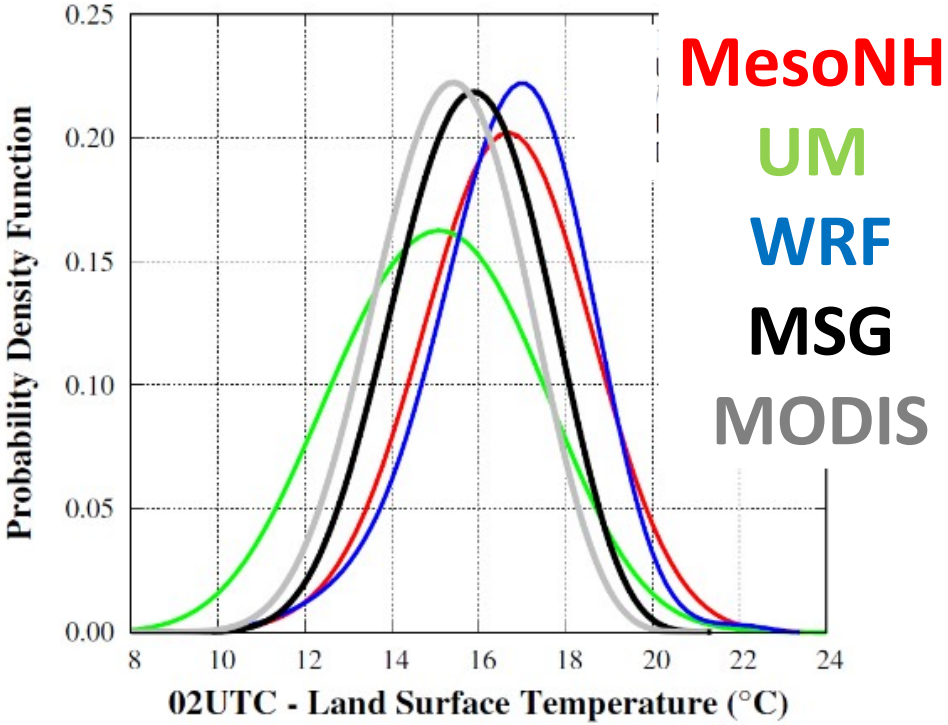


- ✓ **Models present differences in the Surface parameters (LAI, z_0, fveg, albedo, ...)**
- ✓ **Dry conditions prevail in all the models**

$$SWI = \frac{Wc - Wc_{\text{wilt}}}{Wc_{\text{fc}} - Wc_{\text{wilt}}}$$

LST MODIS – 02 UTC





MesoNH

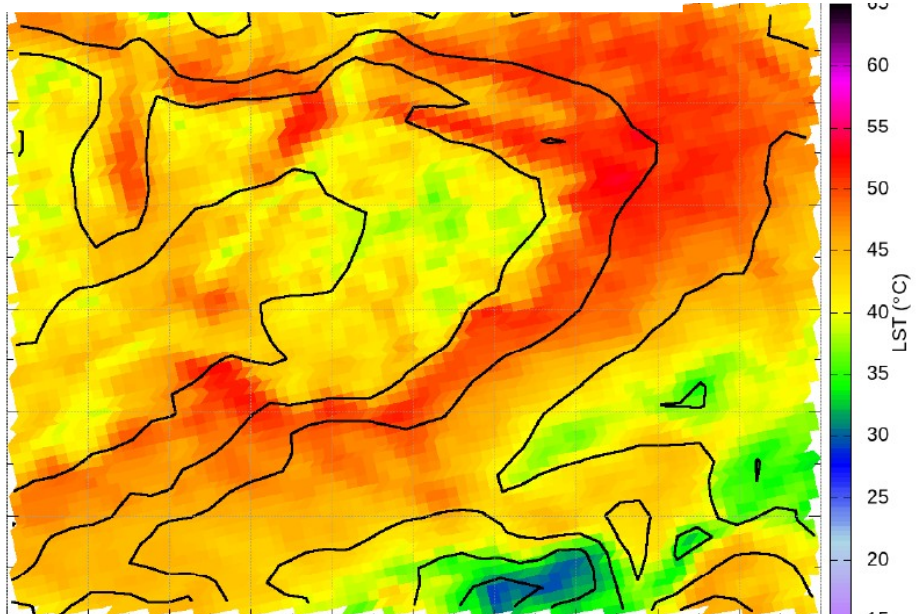
UM

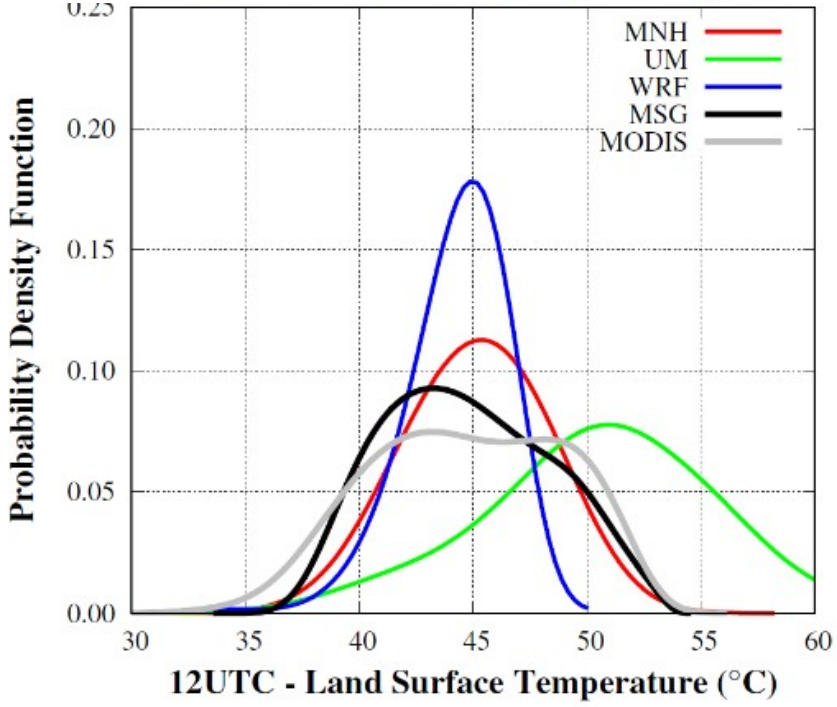
WRF

MSG

MODIS

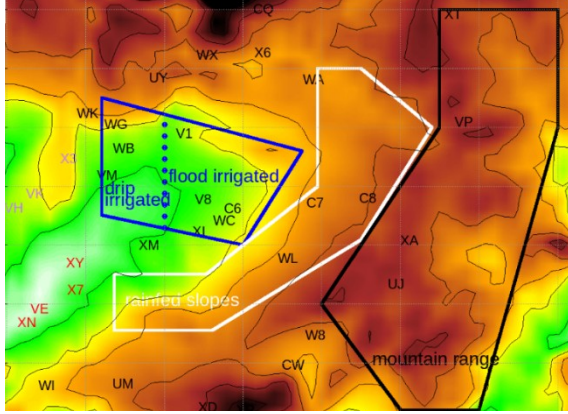
LST MODIS – 12 UTC





SEB terms (W/m2)
averaged over diferent regions at 1200 UTC

Meso-NH	RN	H	LE	G
Dry	592 ± 21	314 ± 68	95 ± 29	183 ± 72
Mountain	613 ± 29	345 ± 73	115 ± 42	158 ± 57
Drip	581 ± 94	328 ± 93	128 ± 42	125 ± 88
Flood	569 ± 115	329 ± 102	123 ± 43	118 ± 88
UM	**RN**	**H**	**LE**	**G**
Dry	566 ± 34	466 ± 69	19 ± 23	79 ± 21
Mountain	644 ± 30	546 ± 63	29 ± 25	66 ± 16
Drip	568 ± 23	461 ± 65	16 ± 22	80 ± 19
Flood	565 ± 24	464 ± 66	12 ± 17	76 ± 16
WRF	**RN**	**H**	**LE**	**G**
Dry	576 ± 13	370 ± 33	45 ± 22	160 ± 17
Mountain	609 ± 29	432 ± 49	35 ± 22	142 ± 24
Drip	570 ± 12	379 ± 28	38 ± 16	154 ± 15
Flood	569 ± 13	378 ± 29	37 ± 14	154 ± 16



Validation????

WHAT HAVE WE LEARNED?

- ✓ Models are able to **reproduce the organization of the flow at lower levels**
- ✓ There is a large variability in the **soil cover of the models** (impact on LST, LAI, SEB terms, ...)
- ✓ Differences between model/observed moisture can be related to the **absence of irrigation in the models**
- ✓ **Data from the LIAISE experimental field campaign** will be crucial to further evaluate the representation of the surface processes in the models

More results in ***Jiménez et al. (2025) QJRMS***

Limitations of the 1st mesoscale intercomparison

- ✓ **No observations to validate: LIAISE campaign**
  - ✓ the surface processes (SEB, soil moisture, …)
  - ✓ the vertical structure
- ✓ None of the models/tests reproduce the **humidity** at lower levels
  - ✓ **irrigation: how/when/…?**
- ✓ Large differences in **soil characteristics** (LAI, roughness length, …)

Think about a 2nd intercomparison case??

Think about a 2nd intercomparison case? – OBJECTIVES

- ✓ Check if models are able to reproduce **the land-atmosphere interactions in a complex terrain region** (topography and irrigated/rainfed regions)

- ✓ **Evaluate the effect of including the irrigation in models** and the importance of having a realistic surface characteristics

- ✓ **Recommendations** to operational models to obtain the most realistic results in such a complex terrain region

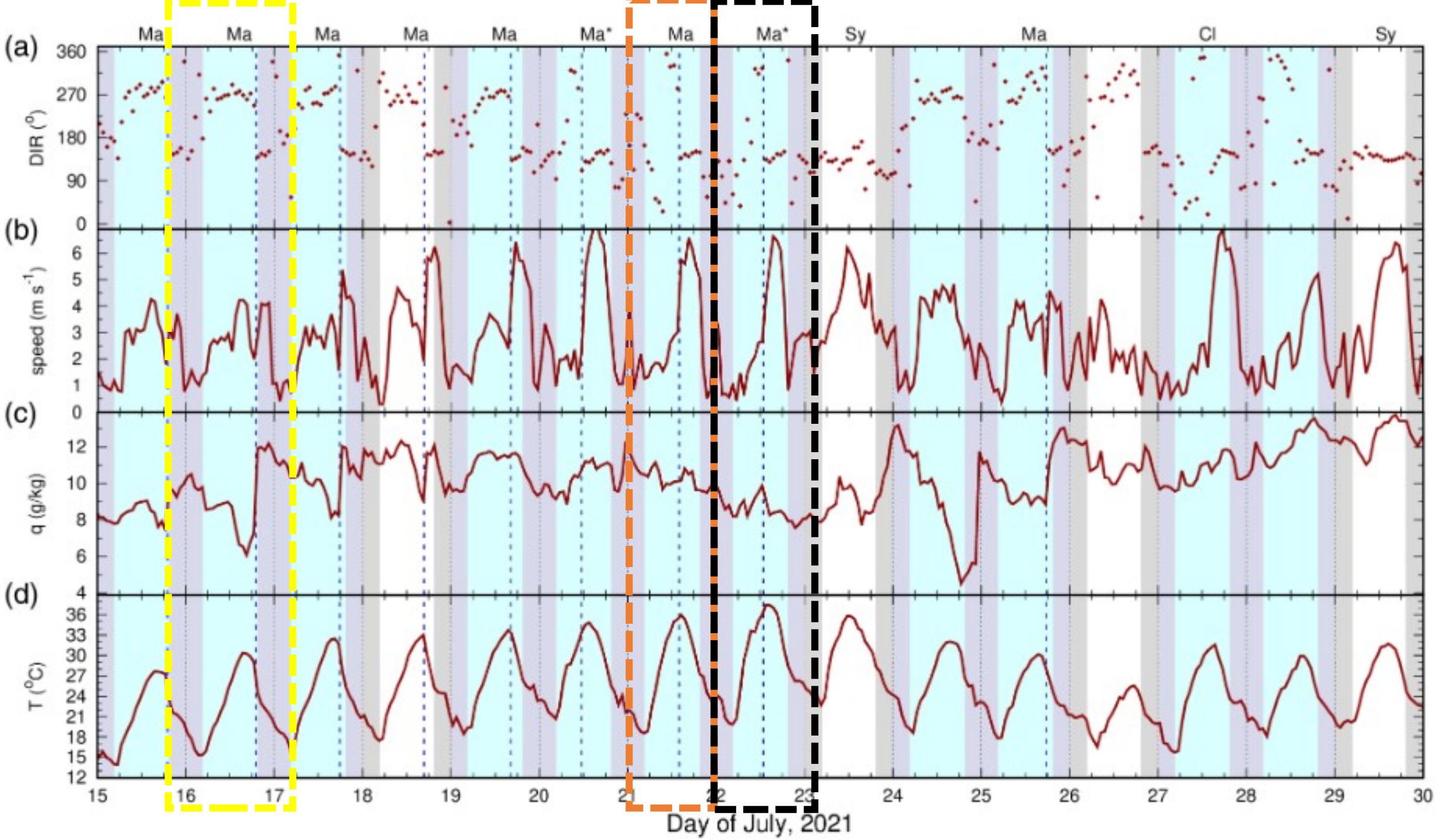
Think about a 2nd intercomparison case? – METHODOLOGY

- ✓ **Mesoscale simulations**
  - ✓ Case representative of the climatology of the site (***Marinada***)
  - ✓ Include the **irrigation** effect
  - ✓ **2km resolution** (enough to reproduce the organization of the flow)
  - ✓ Impose similar/equal **surface characteristics**
  - ✓ **Control and modified simulations** to evaluate the improvements

- ✓ **Validate model outputs using**
  - ✓ **LIAISE observations** (SOP)
  - ✓ **Others** (SMC network, satellite-derived fields, …)

Case study based on previous works (Lunel et al. 2024a and Lunel et al. 2024b)

- ✓ **16 July 2021** : typical summer day with *Marinada*
- ✓ **21 July 2021**: **Marianada** with thermal low
- ✓ **22 July 2021**: irrigation+ Marinada breezes


(a)
(b)
(c)
(d)
Ma
Ma
Ma
Ma
Ma
Ma*
Ma
Ma*
Sy
Ma
Cl
Sy
DIR (°)
speed (m s-1)
q (g/kg)
T (°C)
Day of July, 2021

22 July 2021

Model setup

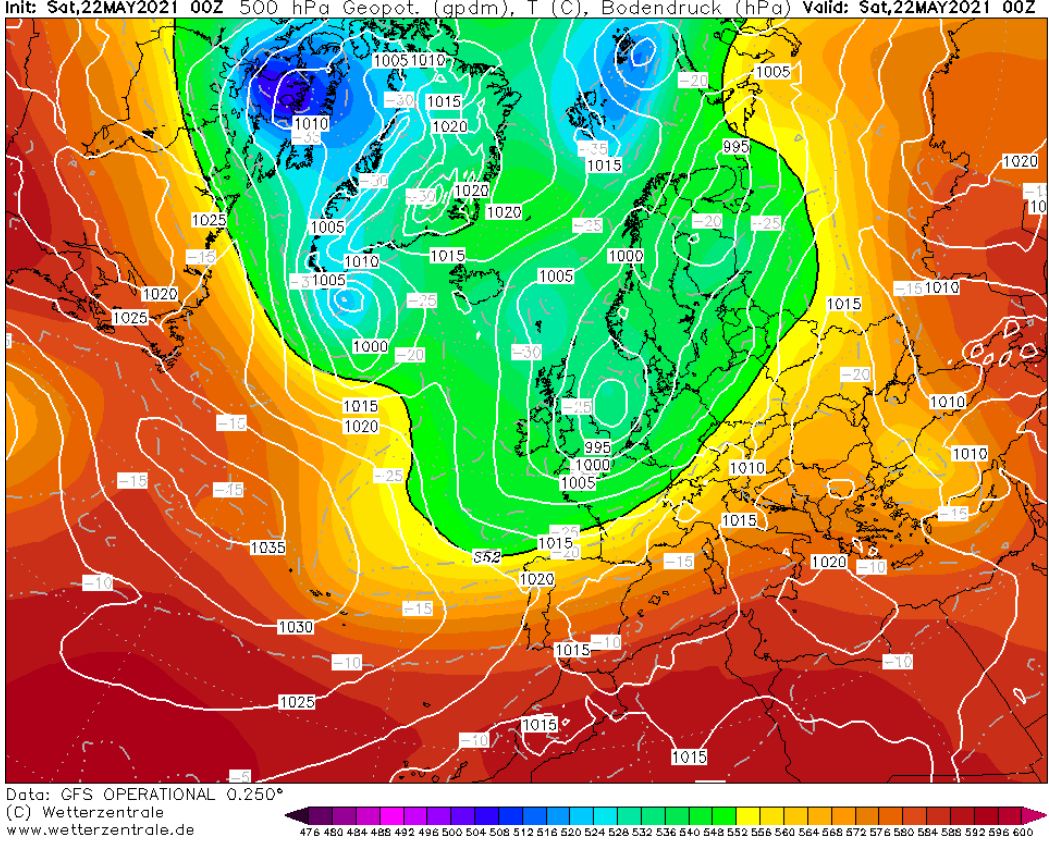
- **36h run**

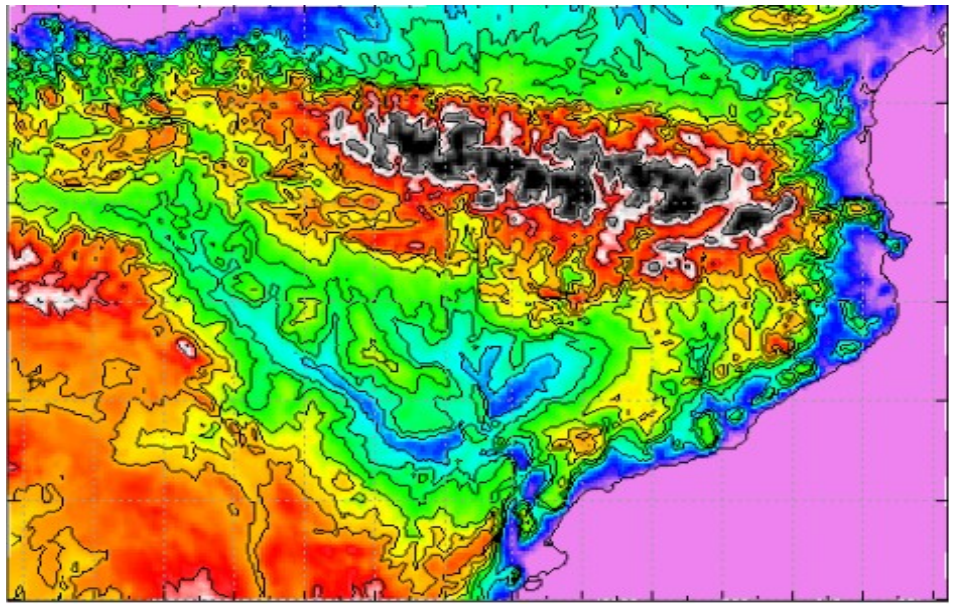
(from 21 July at 1800 UTC to 23 July at 0600 UTC)

- **1 domain:** 2km x 2km
- **Vertical resolution**

(2m and stretched above, 85 levels)

- **Initial/Lateral BC**: ECMWF
- **Control and irrigated** (SM at field capacity-> spinup? Similar land-surface map CCI) runs





Lunel et al (2024a)

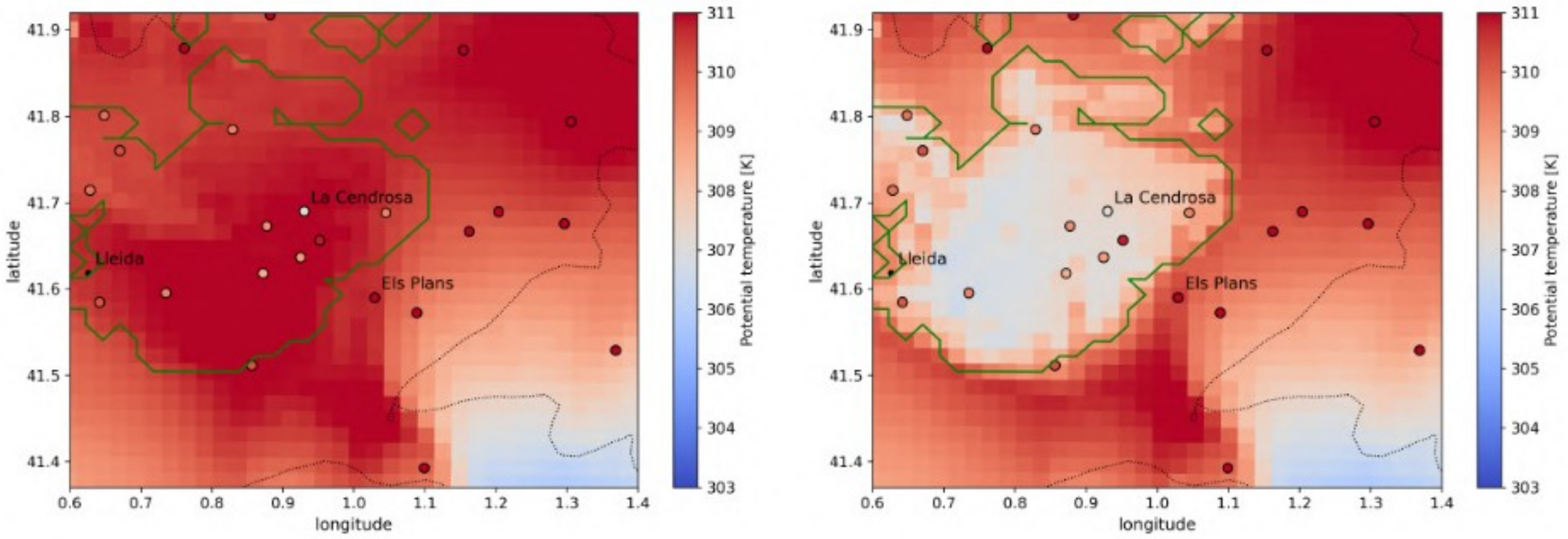
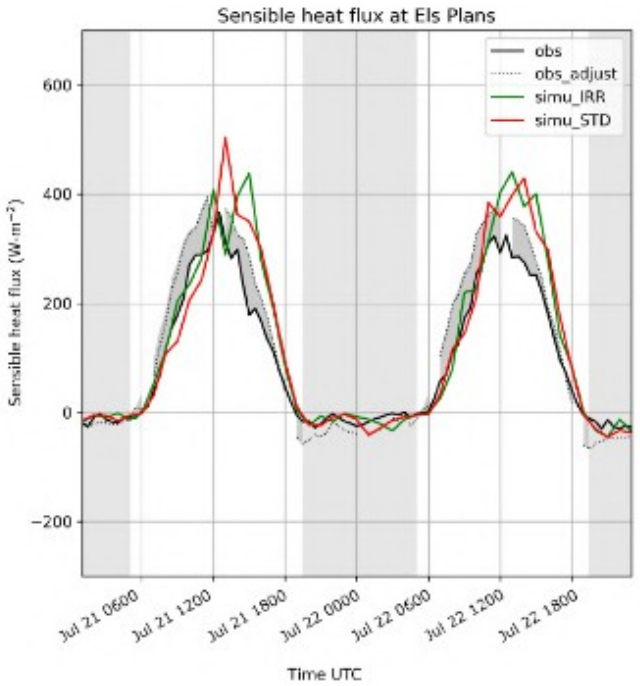


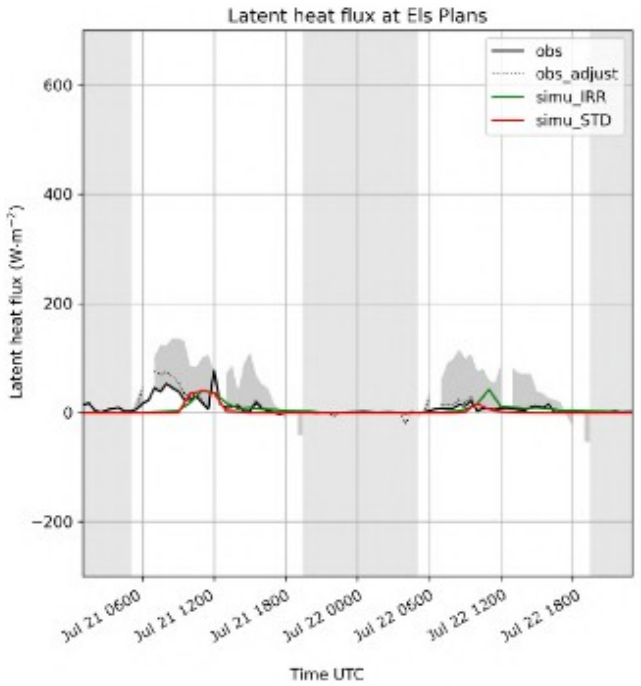
Figure 5.12: Maps of 2-m potential temperature on the Urgell region on 22 July 2021 at 12:00 UTC. The left and right panels correspond to the model without and with irrigation respectively, also referred to as STD and IRR in the article above. The colors inside the circles are observations obtained from the SMC AWS network.

Lunel et al (2024a)

Els Plans



(a)



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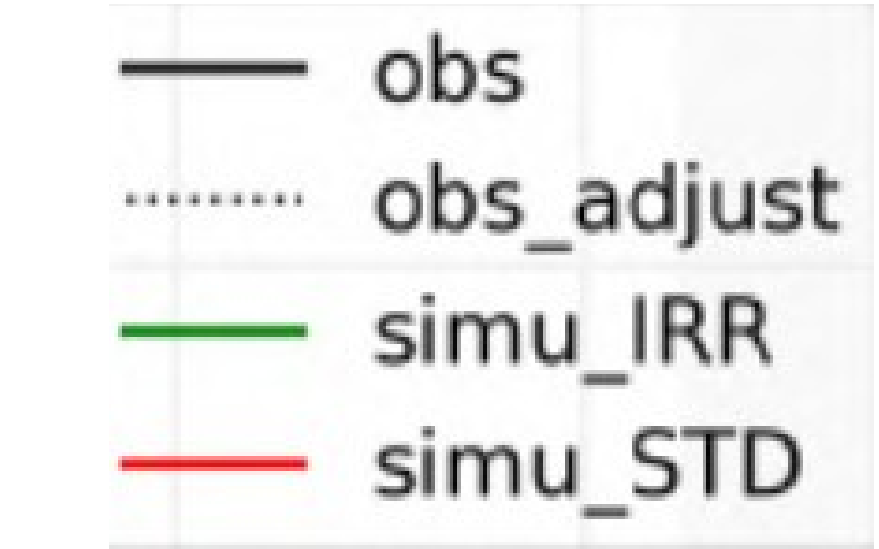
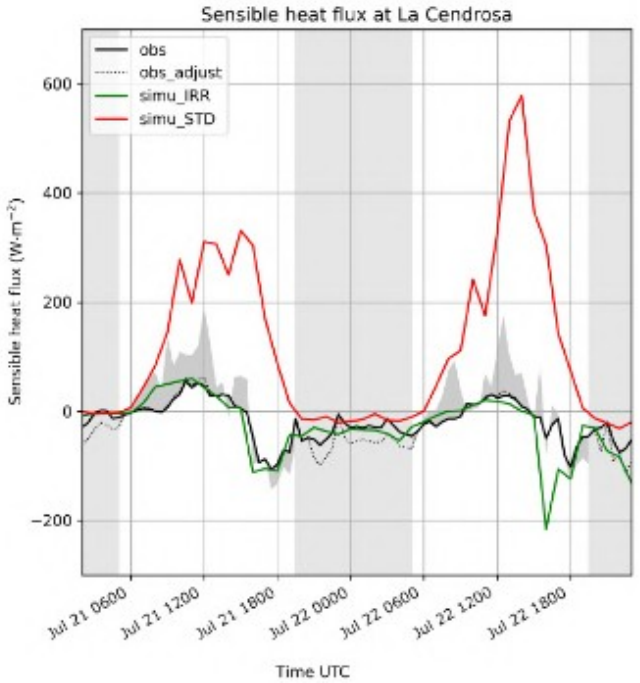
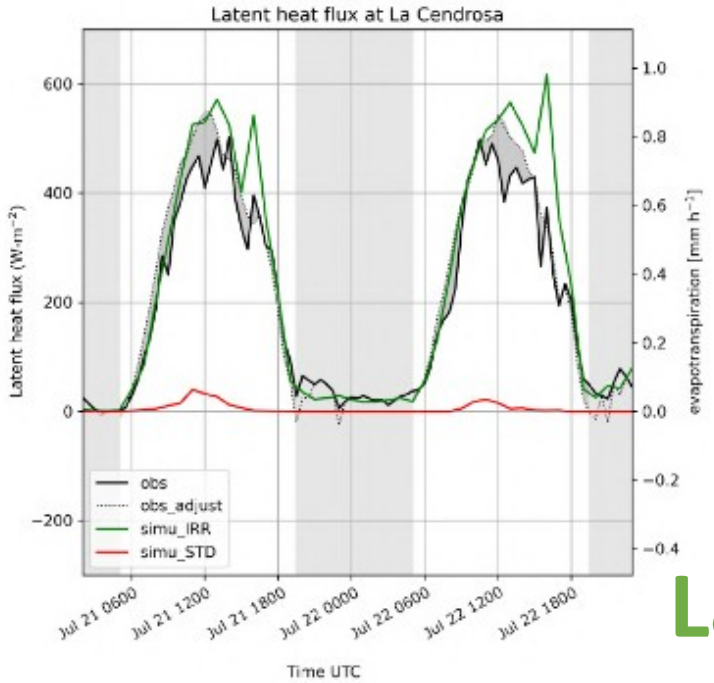
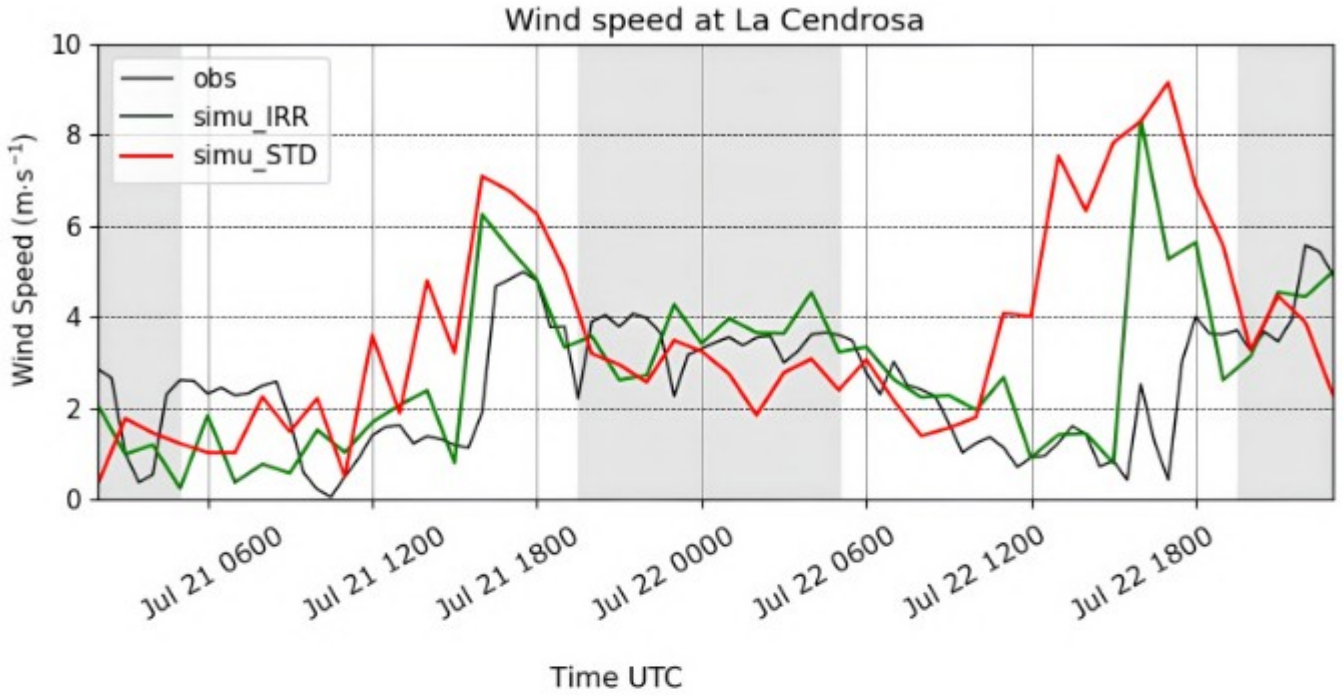


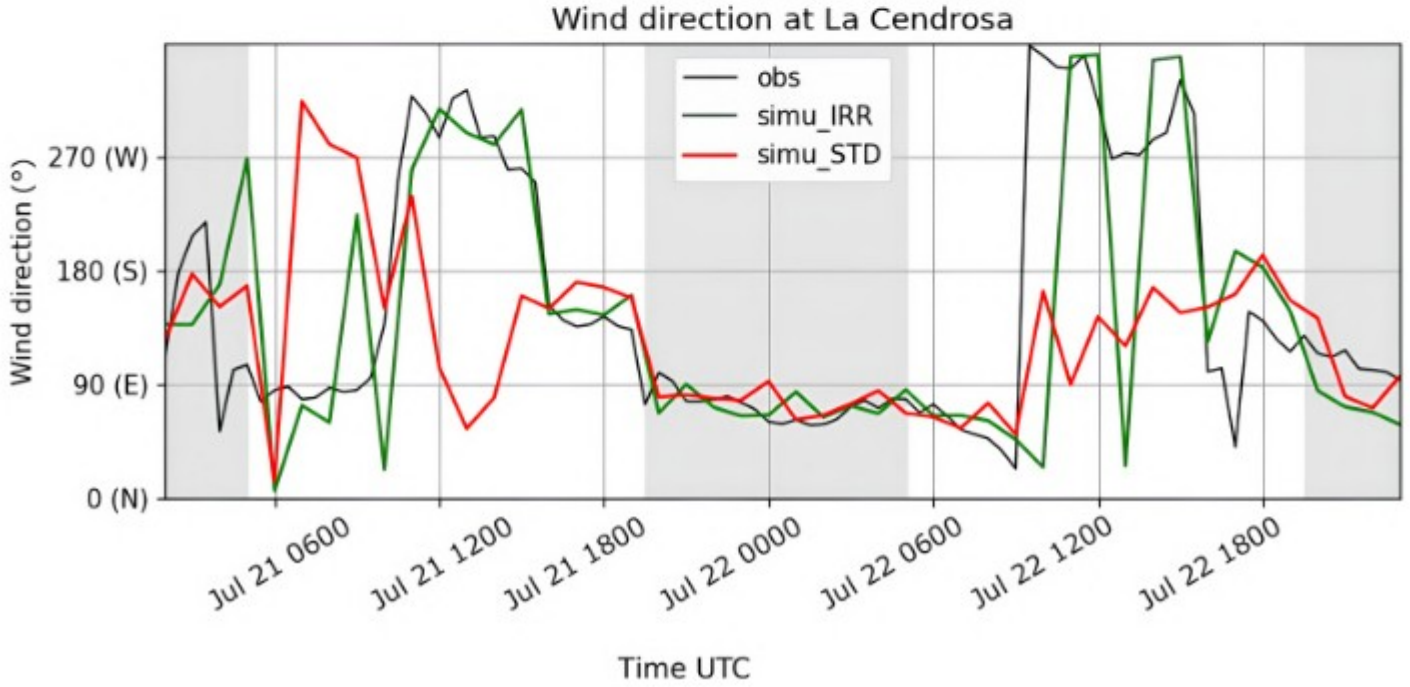




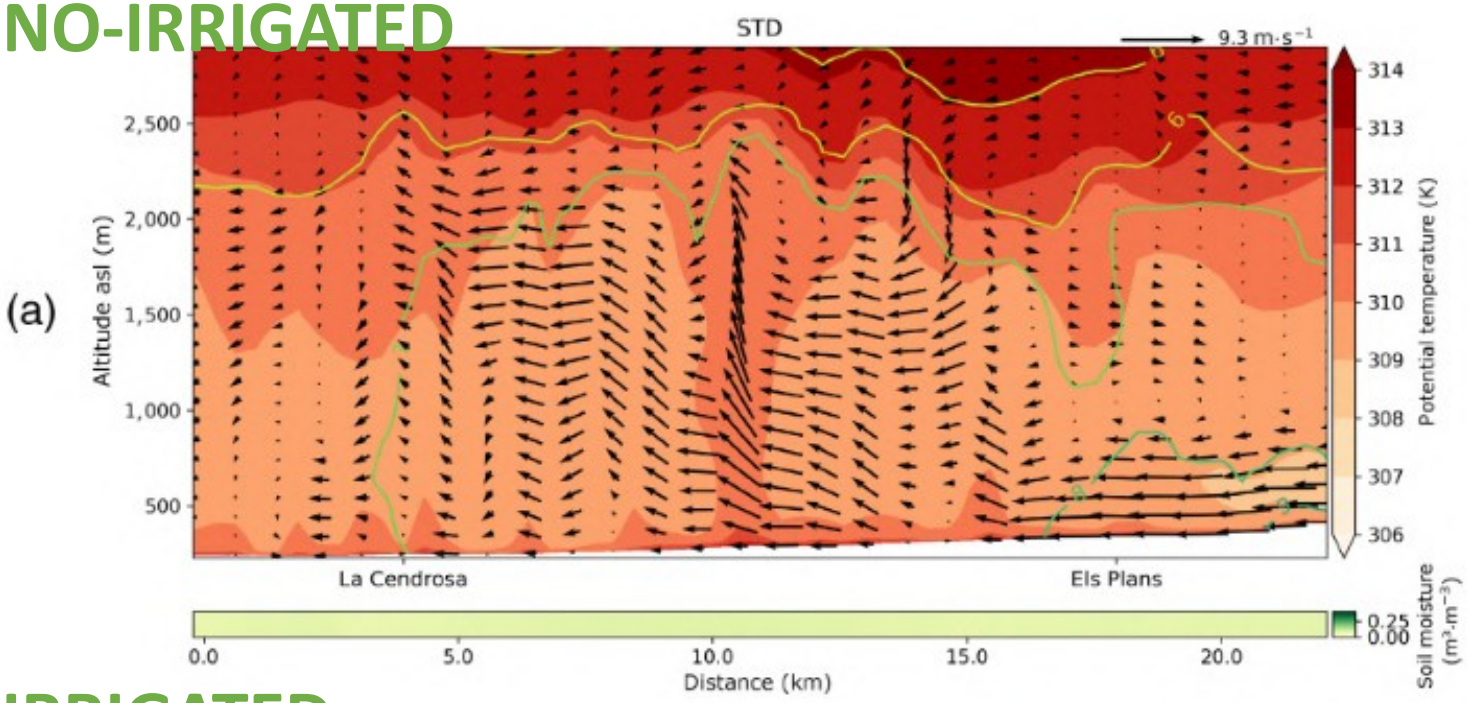
La Cendrosa

Lunel et al (2024a)

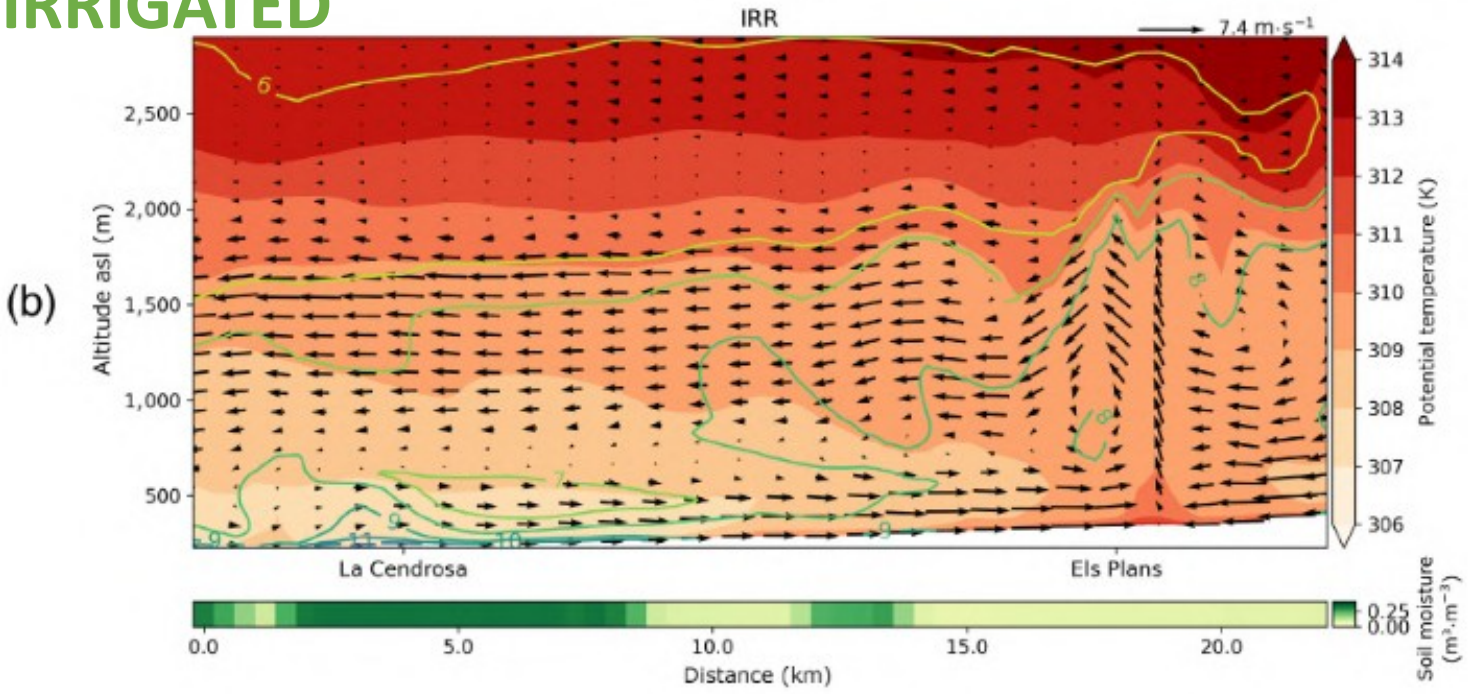




NO-IRRIGATED



IRRIGATED



Lunel et al (2024a)

22nd July 2021
at 1200 UTC

Think about a 2nd intercomparison case? – PARTICIPANTS

- ✓ **MesoNH**
- ✓ **WRF**
- ✓ **UM**
- ✓ **…**
- ✓ **Other NWP models (IFS?,…)**

Model versions/parameterizations

Models able to run with irrigation!

Think about a 2nd intercomparison case? – SCHEDULE

1. **Compare the initial surface fields for 22nd July 2021**: ***September 2025***

2. **Search for common surface features**

LAI, roughness length, albedo, land cover, irrigation map, soil texture (clay/sand fractions): ***September 2025***

3. Define of the case (**model setup, outputs**)

4. **Preliminary results** for control and irrigated simulations

5. **Revision** of the runs

6. **Sensitivity tests** (irrigation, surface features, resolution, ...)

7. **Final results**

QUESTIONS

Think about a 2nd intercomparison case?