Observed mesoscale patterns in the irrigated Eastern Ebro basin

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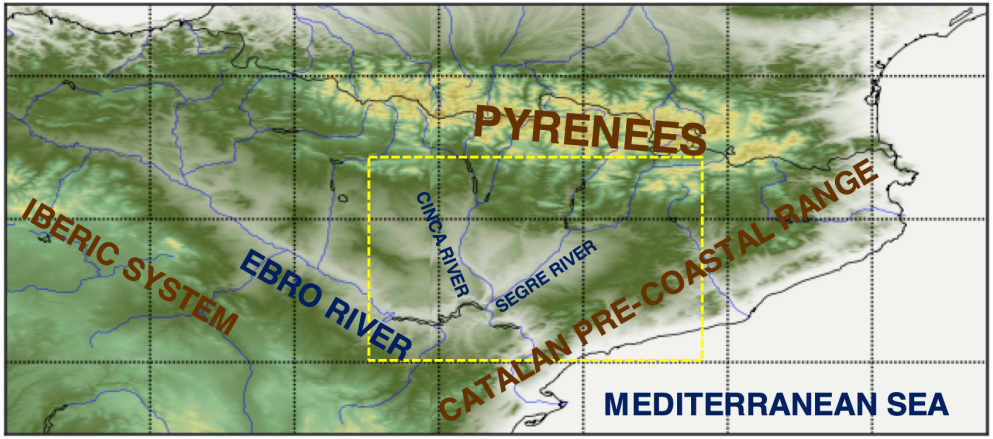
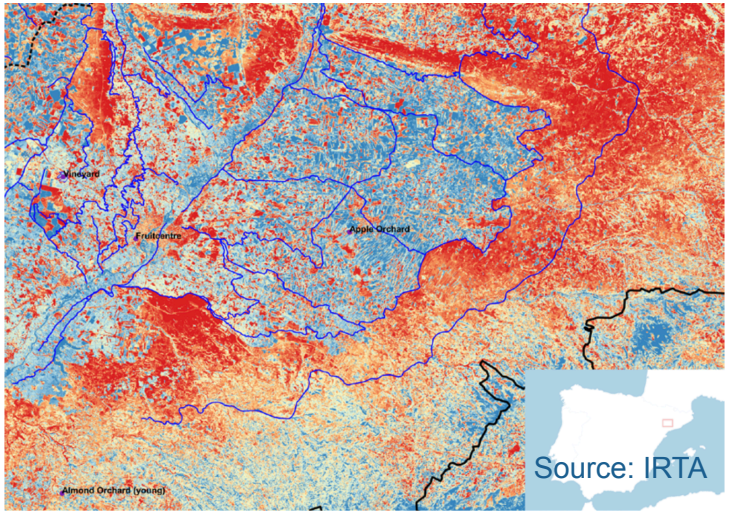
8th MetMed conference, online, 25-27 May 2021

LIAISE: contrasting irrigated and rainfed areas





Blue: irrigated
Red: rainfed

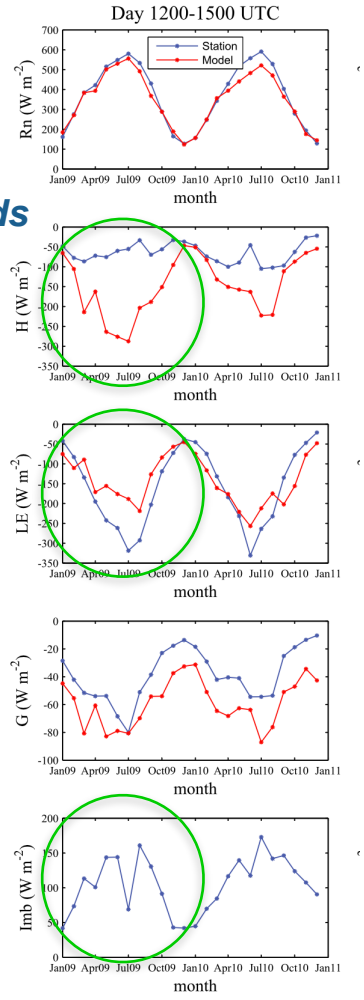
Raimat:
drip irrigated vineyards

Bowen ratio in ECMWF inverted:

model: H>LE
obs: LE>H

a large surface energy budget imbalance

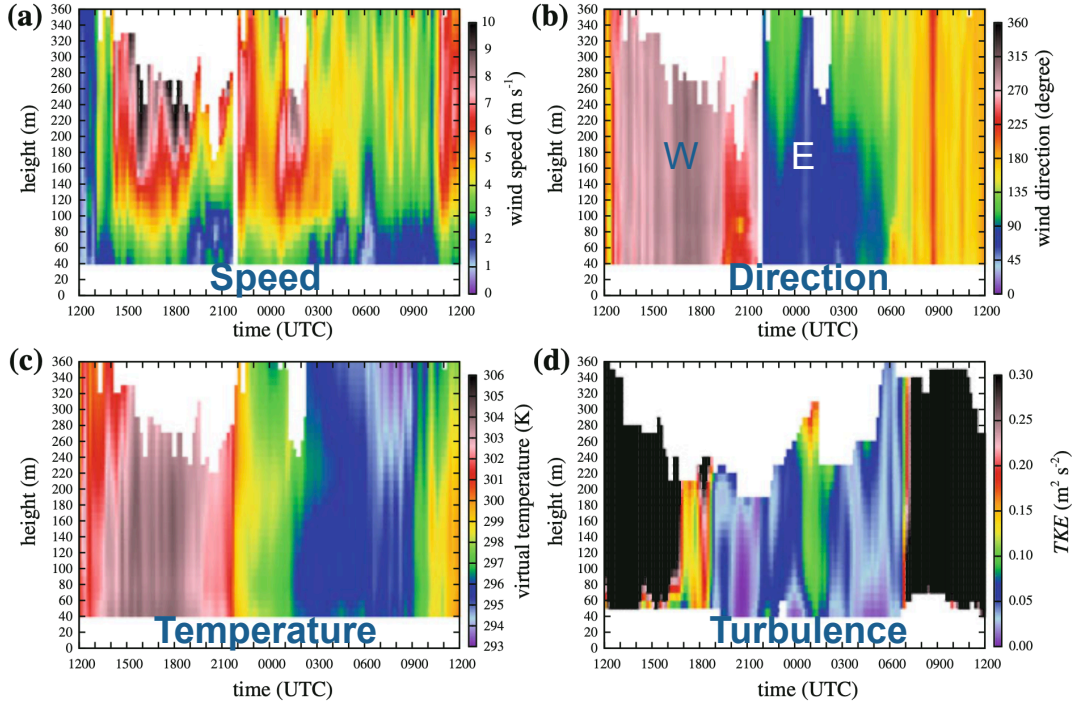
Consequences in modeled mesoscale circulations?



Cuxart et al, 2015, JGR

Documented mesoscale thermally induced circulations

WindRASS profiles 5-6 July 2009



MODIS LST 5 July 2009

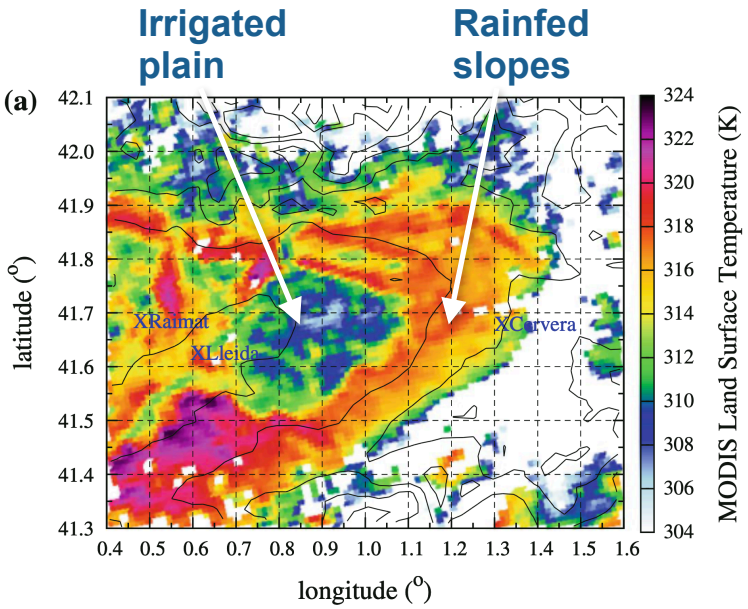
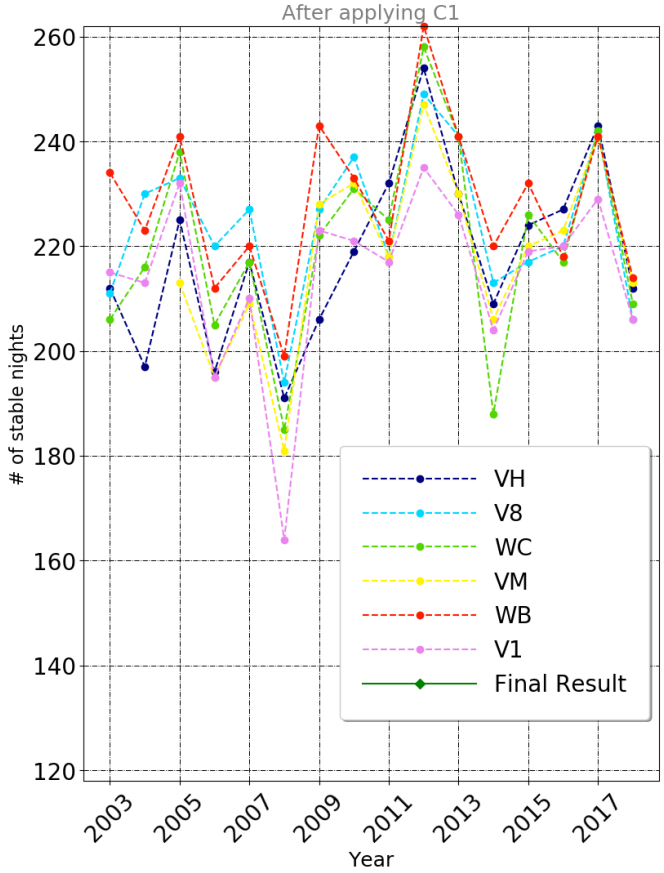
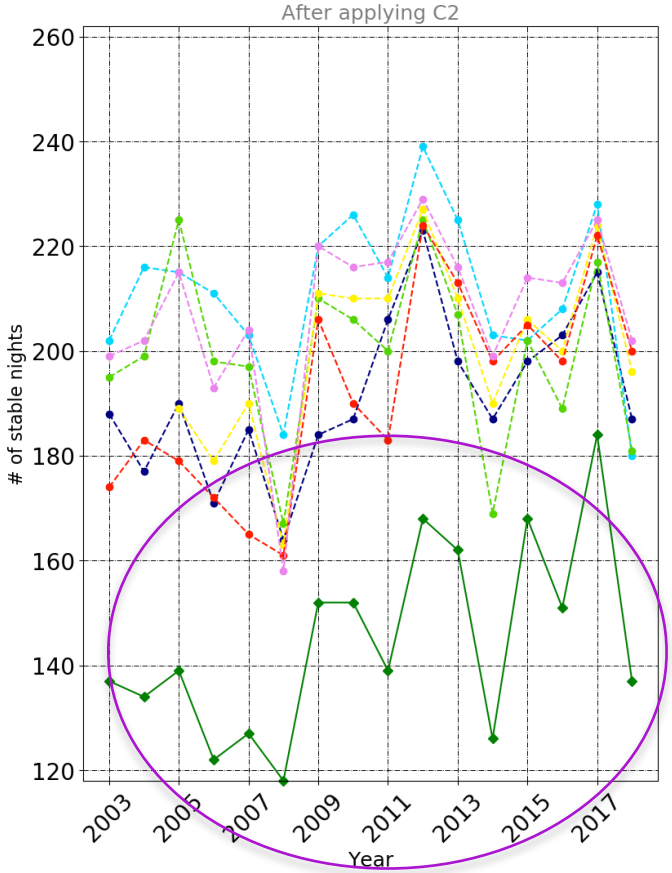


Fig. 9 Temporal evolution of the WindRASS profiles of **a** wind speed, **b** wind direction, **c** virtual temperature, **d** estimation of the TKE for the night 5–6 July 2009, with local circulations

Cuxart et al, 2012, BLM

Selected days when regional mesoscale circulations prevail



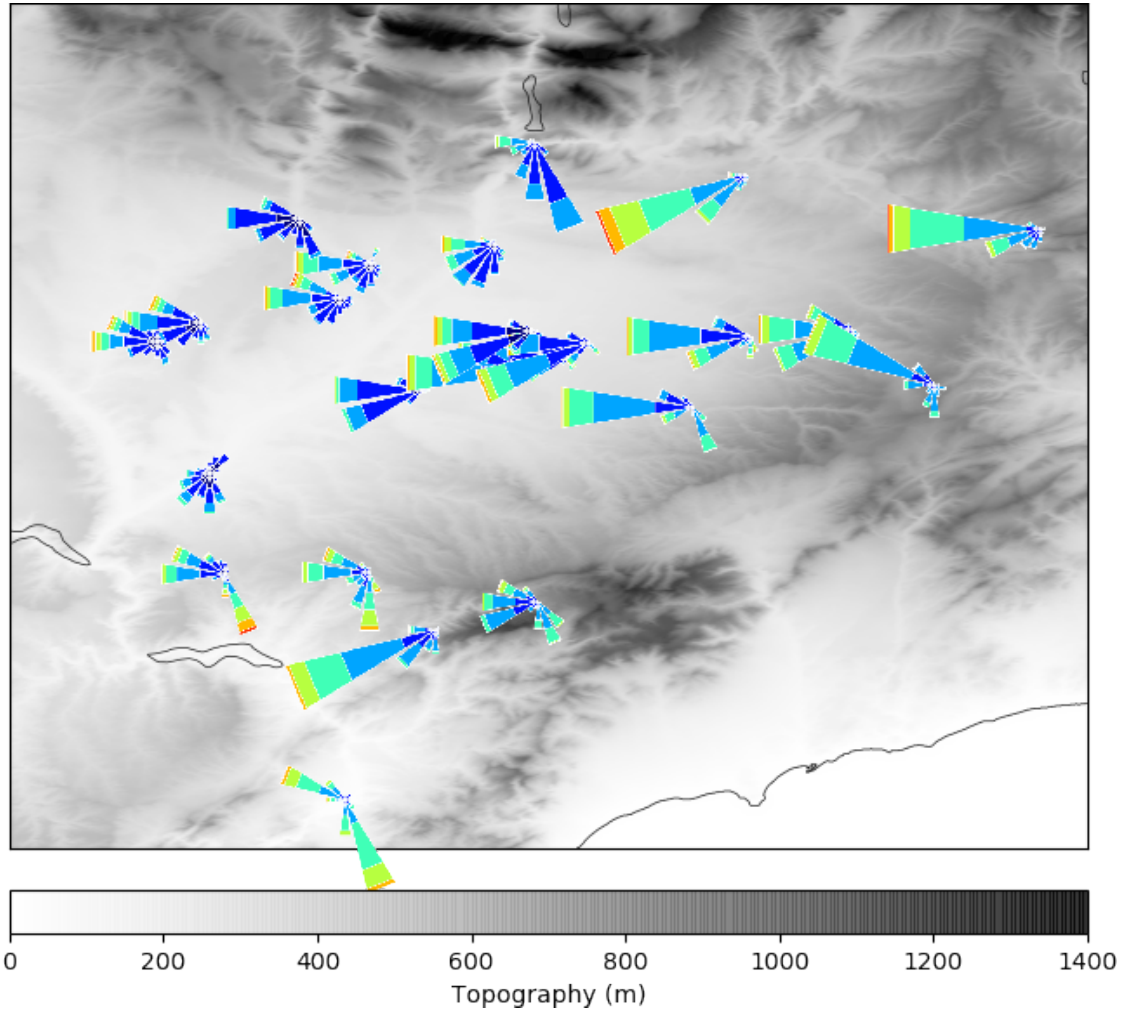


Conditions for filtering:
1. Diurnal clear skies
2. Weak nocturnal winds
3. Simultaneity at 6 stations

The number of stable nights is around 40%, with a significant increase in the last decade. A similar study made in 2007 provided 37% stable nights.

Martinez et al, 2007, Tethys

Grau et al, 2021, JAMC (submitted)

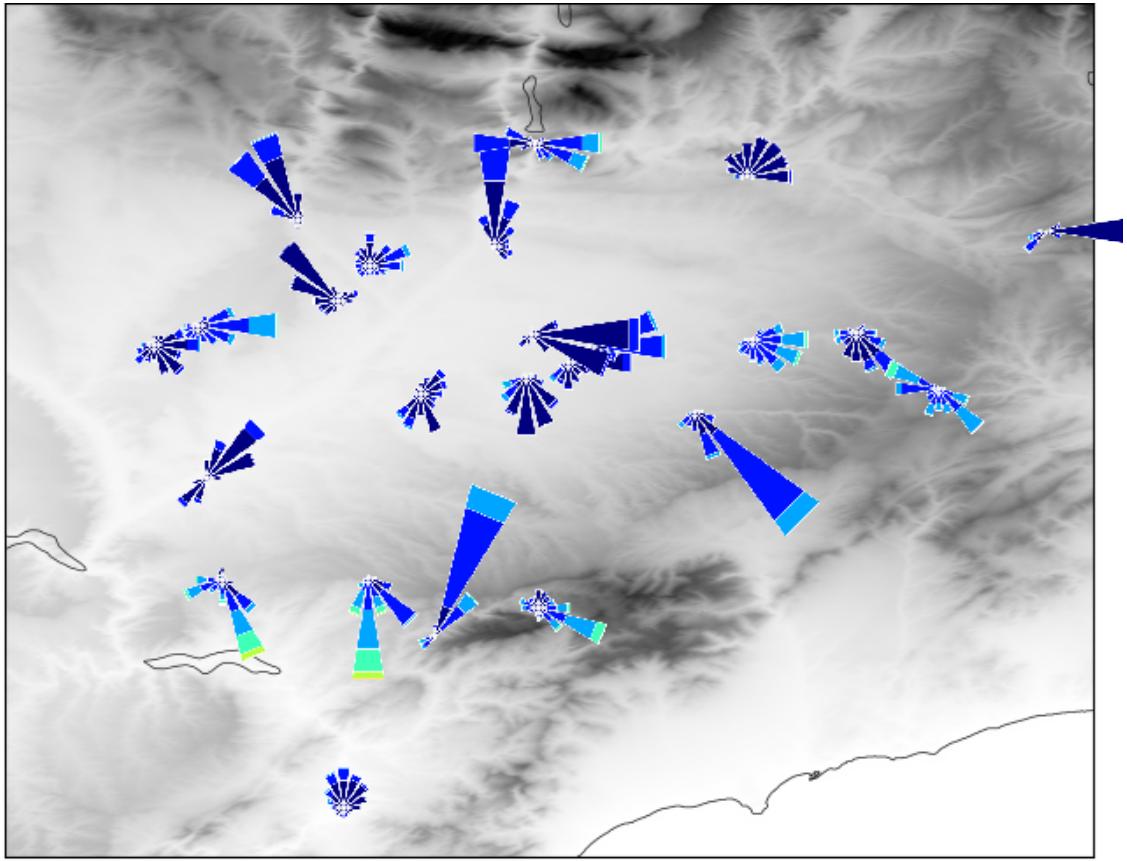


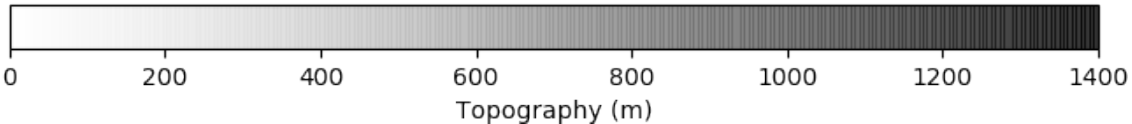
Wind roses in high-pressure conditions at noon in July

Wind blows from the west corresponding to the diurnal upvalley circulations

There are upvalley southerly flows through narrow passes in the pre-Pyrenean ranges

At the lowest parts of the basin, far away from the slopes, near-surface winds are variable.





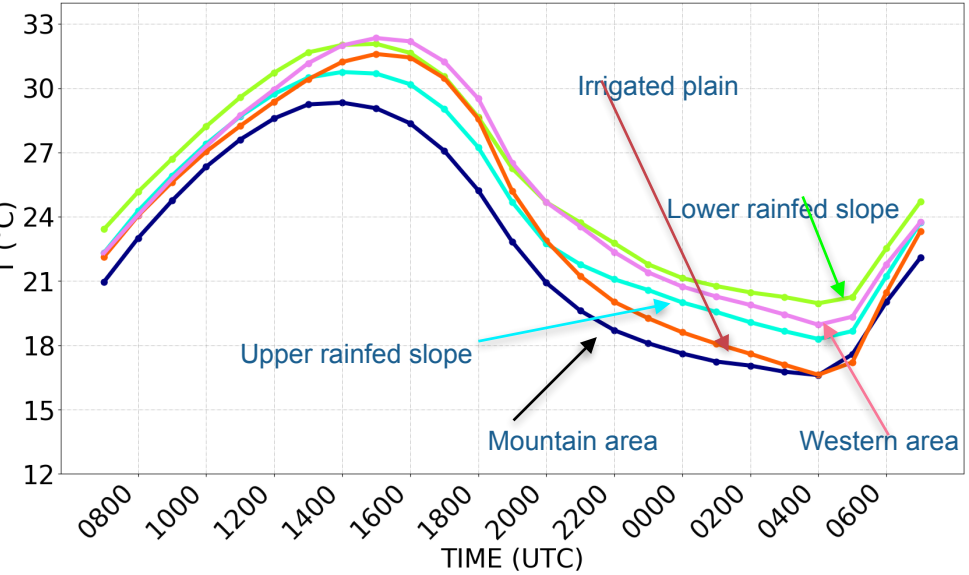
Wind roses in high-pressure conditions at midnight in July

Wind blows from the east corresponding to the nocturnal downvalley circulations

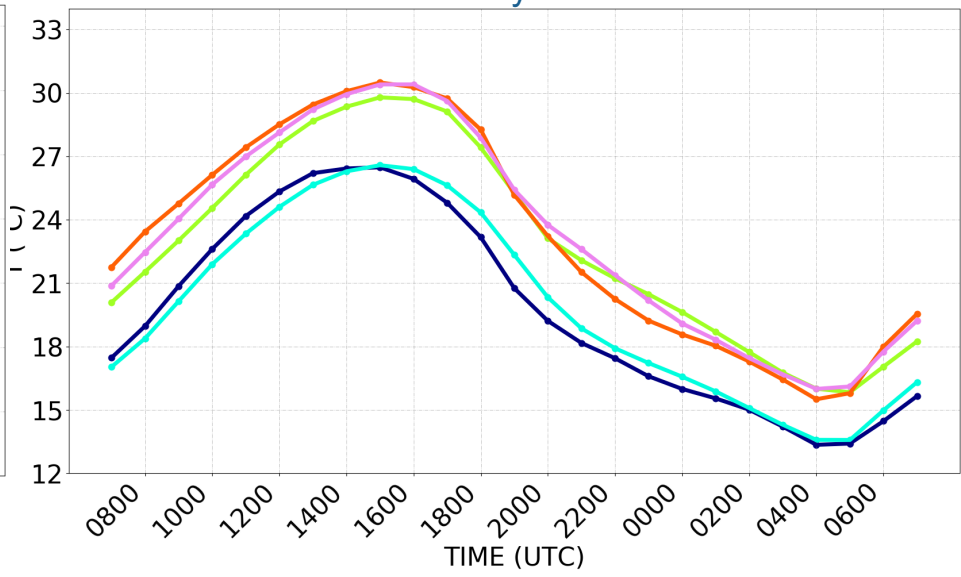
There are downvalley northern flows through narrow passes in the pre-Pyrenean ranges and along river valleys

At the lowest parts of the basin, winds follow the topography and a cold air pool forms, air flowing along the narrow gorges connecting the Ebro river to the Mediterranean Sea.

Local winds

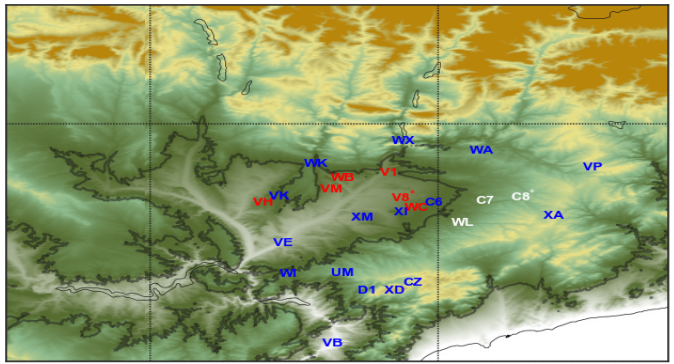


Westerly winds



*the irrigated plain presents the largest temperature drop, creating a cold air pool area.

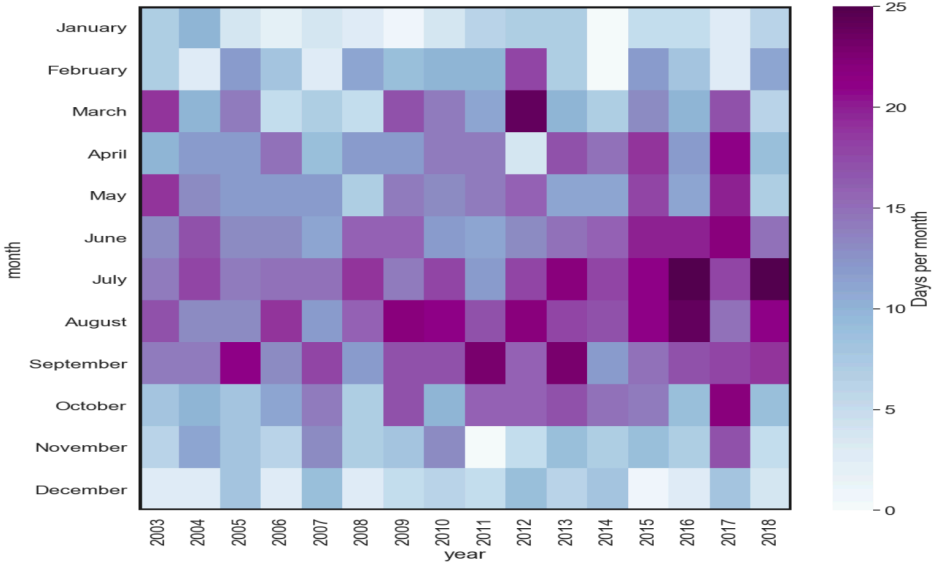
*the lower rainfed slope has the smallest T drop, linked to turbulent mixing of the katabatic flow.



In general nocturnal westerly flows, all stations cool at a similar rate regardless of their position in the basin

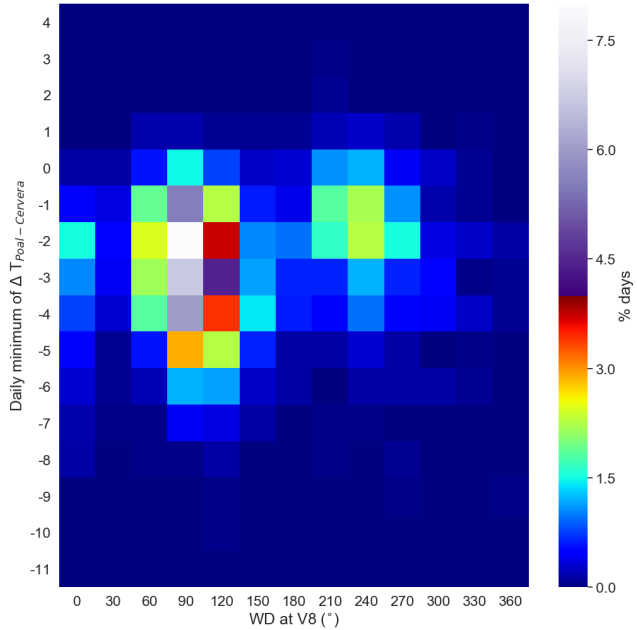
Nocturnal features

Clear stable nights prevail in summer
In winter, fog is the main feature

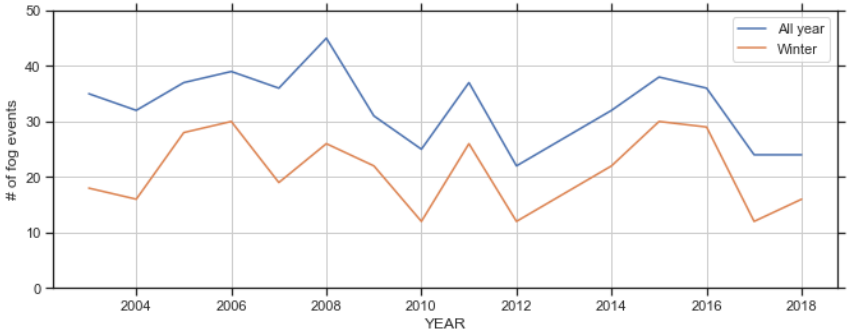


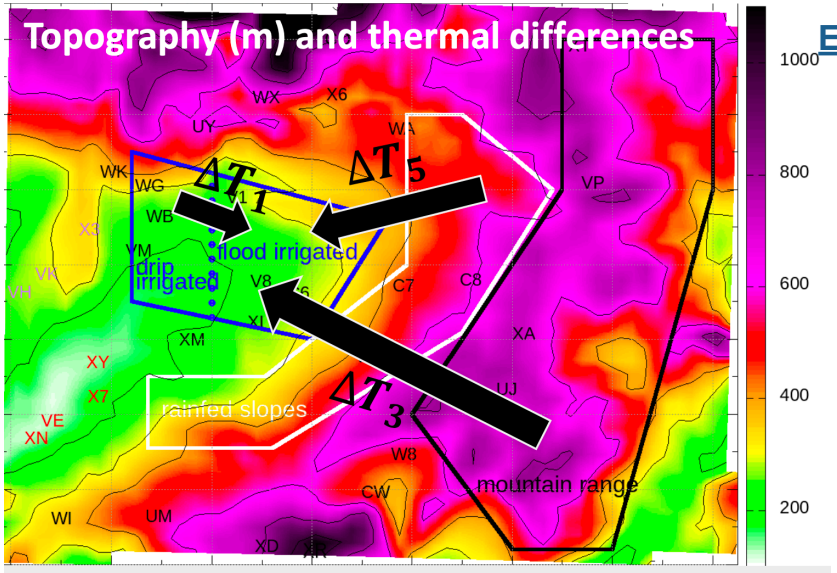
Number of stable nights per month and year

Strength of the cold air pool (upper slope-plain) and wind direction at the plain: E dominates

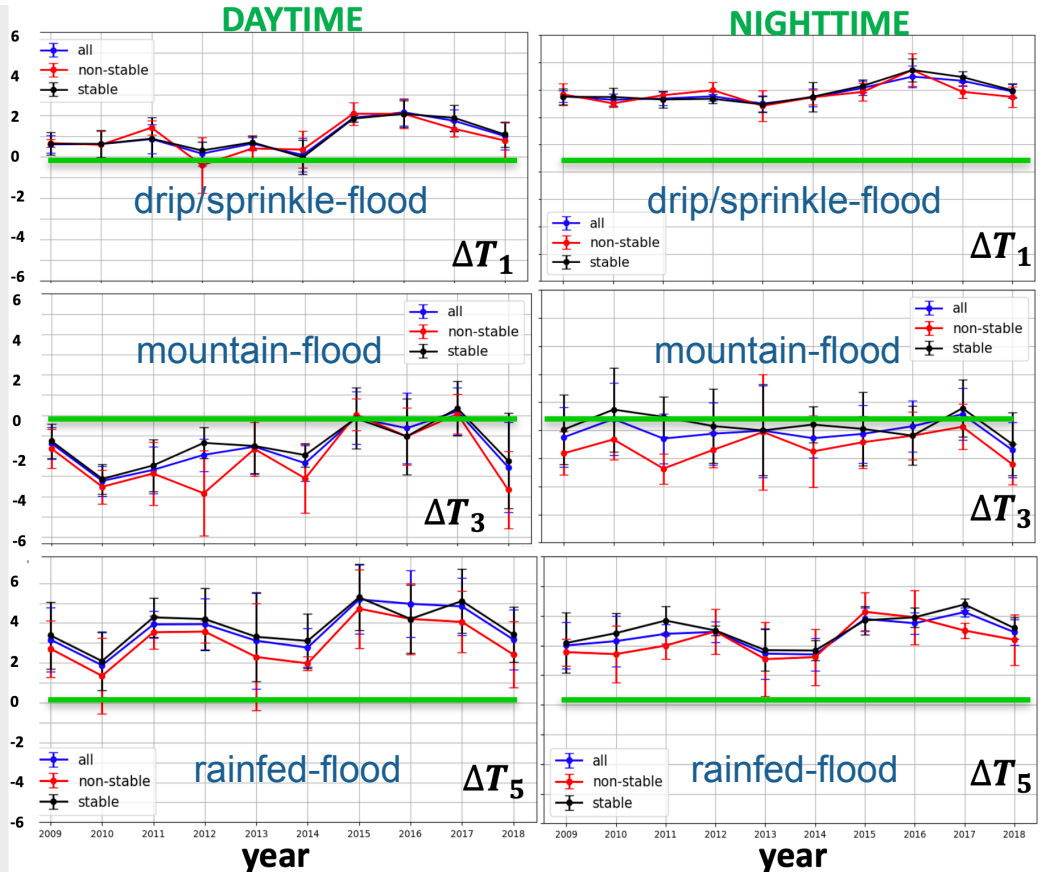


Yearly and winter number of nights with fog per year

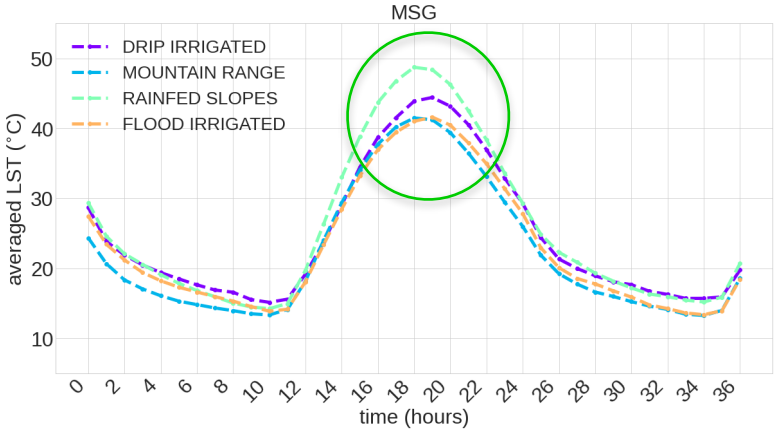




Exploring the thermal gradients (LST) using satellite information



Yearly values (period 2009-2018)

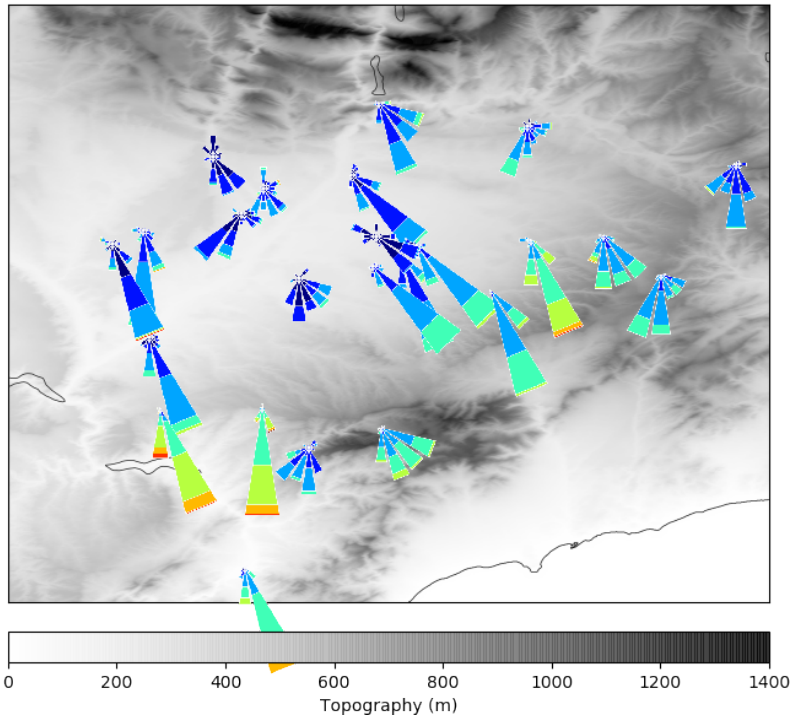


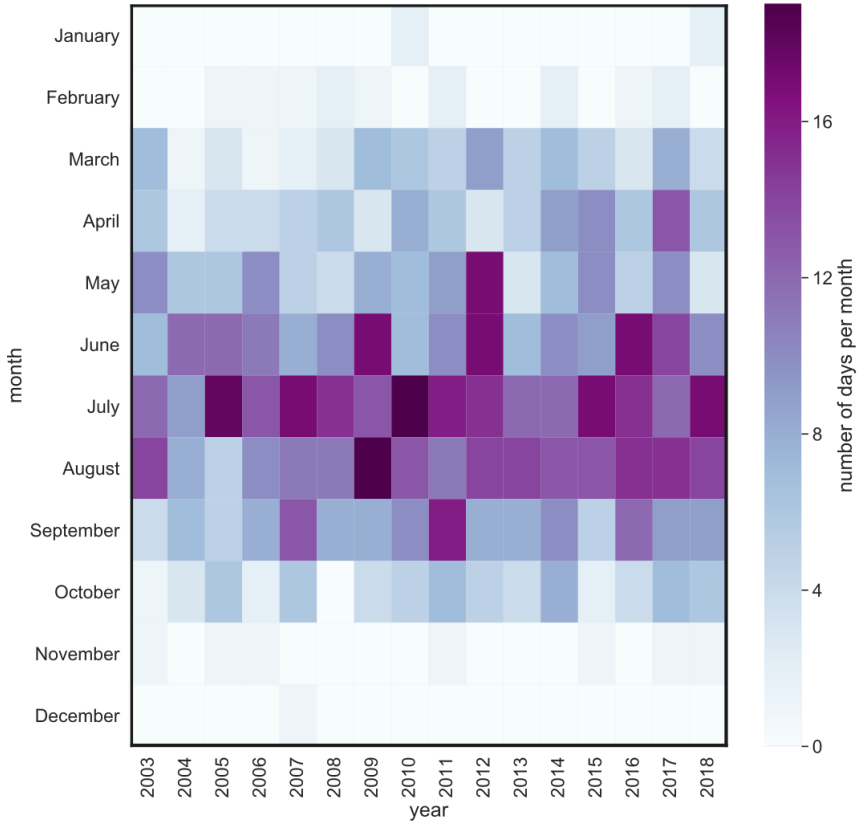
3-day event (July 2016, mesoscale model intercomparison)

In Summer: arrival of the Sea Breeze in the late afternoon surmounting the pre-coastal Catalan range.

Selection criteria:
1. diurnal clear skies
2. wind blowing from SB direction at 3 nearby stations
3. wind veering after 1200 UTC

The SB arrival (between 15 to 18 UTC in the SE-NW direction) is marked by an increase in specific humidity.





SB events take place between June and September, with maximum frequency in July and August,

Concluding remarks

1. ***Local circulations are dominated by the topography***:
- Upvalley in the daytime (W)
- Downvalley and downhill in the nighttime (E)
- Nocturnal cold air pooling in the lower valley

2. ***Surface thermal heterogeneities are well marked, with an important role of irrigation***, during stable nights:
-the low plain and the mountain tops are is the coldest areas. colder at the plain in stable nights
-the slopes are well ventilated and have lower temperature drops
-the flood-irrigated area is also colder than the drip/sprinkler irrigated area
while during the day the flood-irrigated area is the coldest of all

3. Mesoscale seasonal features are, ***in the summer the sea breeze*** arrives surmounting the Catalan pre-coastal range between 15 and 18 UTC (17 to 20 summer official local time), with a noticeable drop of temperature and increase of specific humidity

In winter, ***fog*** dominates under high-pressure conditions, and can be persistent during several days.