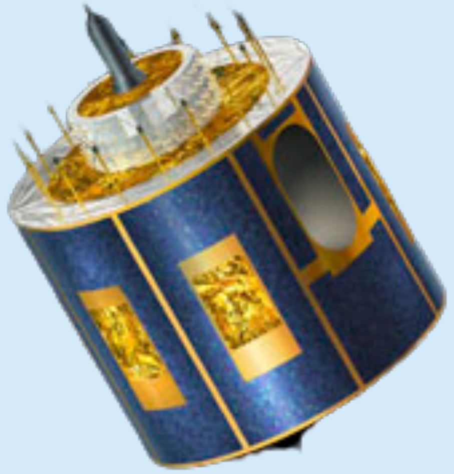
Using satellite-derived surface temperatures for atmospheric boundary-layer studies



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LST_cci User Workshop 2020, 25th June 2020

Brief description of the studies presented here

* **Statistical characterisation of the sea-breeze physical mechanisms through in-situ and satellite observations** *(IJOC, 2020)*.
The thermal difference (LST-SST) under SB conditions in the Palma basin (Balearic Islands) is analysed.

* **Generation of chilling hours maps using surface observations and satellite data** *(AR, 2020)*.
The areas with higher/lower CH in Mallorca are characterised, important for agricultural applications.

Data used

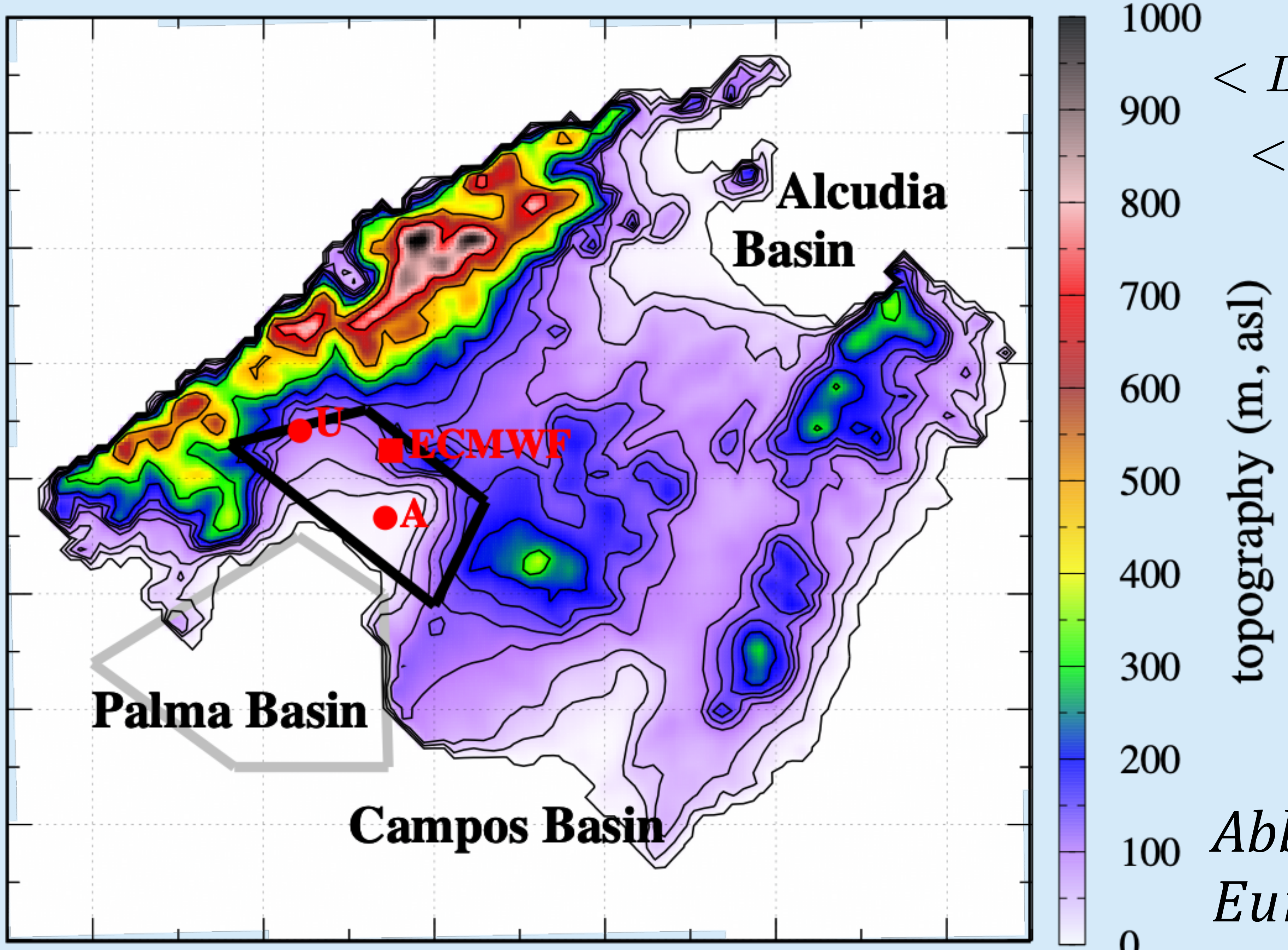
Source	Period	Resolution	Variable
MSG (LSA SAF and OSI SAF)	2009/17	4km x 4km (hourly)	LST/SST
AEMET	2009/17	hourly	T2m, wind10m
ECMWF	2009/17	Hourly, closest gridpoint	850hPa wind and T LST

EUMETSAT LSA SAF LAND SURFACE ANALYSIS

Agencia Estatal de Meteorología

EUMETSAT OSI SAF OCEAN AND SEA ICE

1. The Sea-Breeze in the Palma Basin



$< LST > \equiv$ Averaged Land Surface Temperature

$< SST > \equiv$ Averaged Sea Surface Temperature

$$\text{thermal difference} \equiv \Delta T = < LST > - < SST >$$

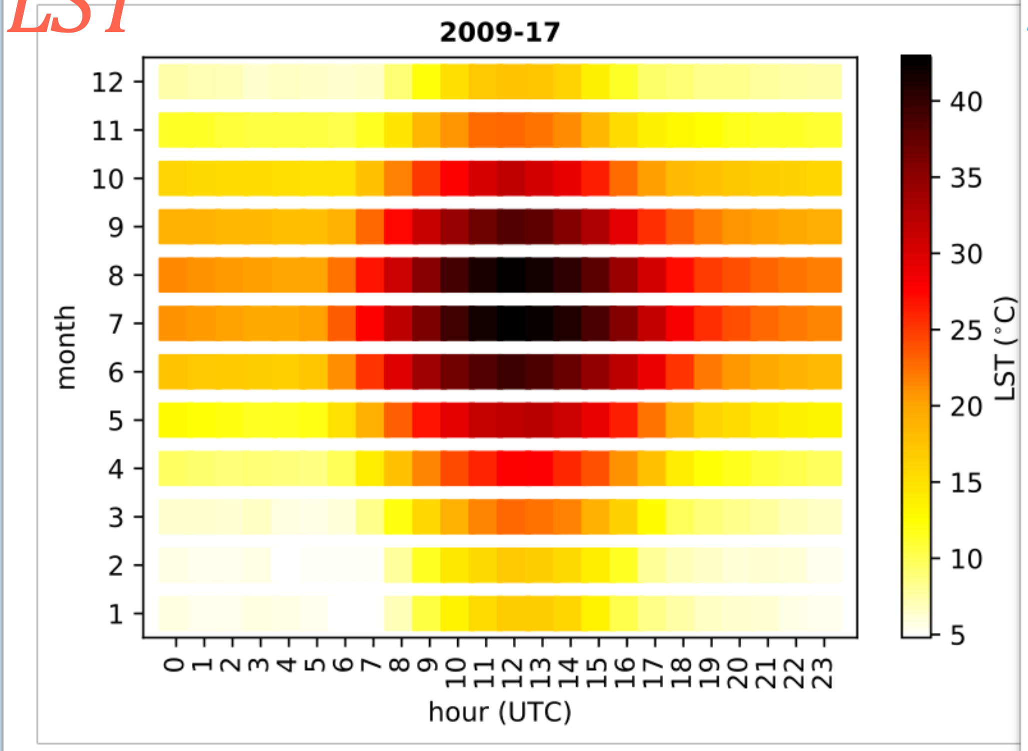
* We computed the thermal difference each hour.

Abbreviations: Airport (A), University (U), European Center for Medium-Range Weather Forecasts (ECMWF)

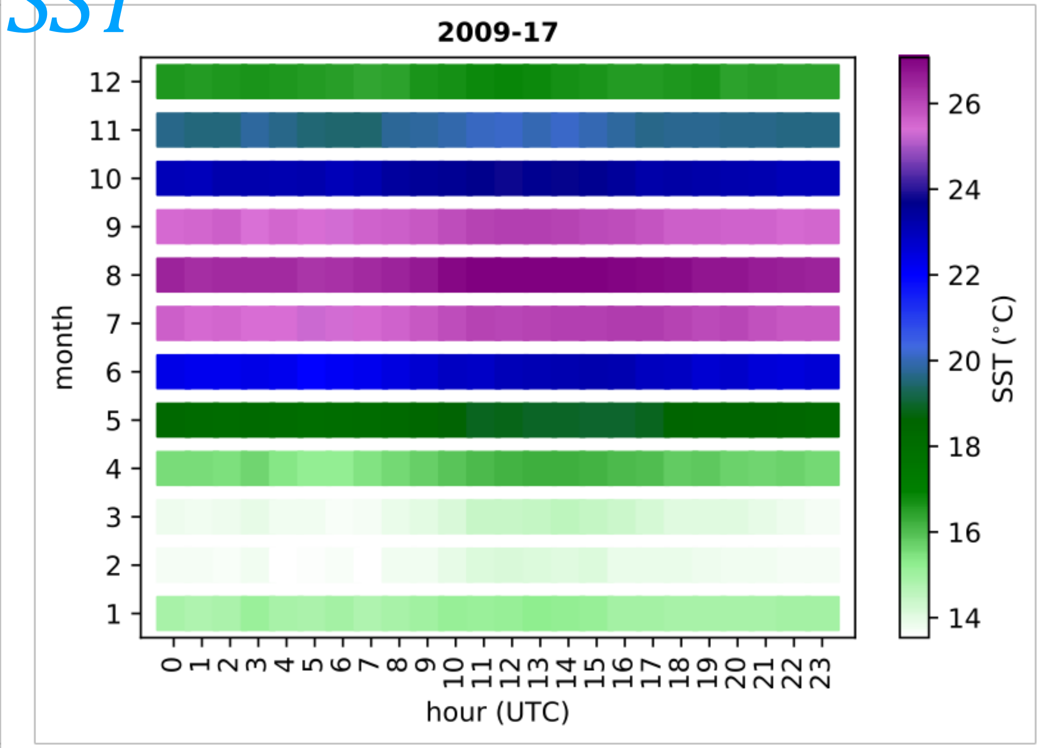
Land and Sea Surface Temperature

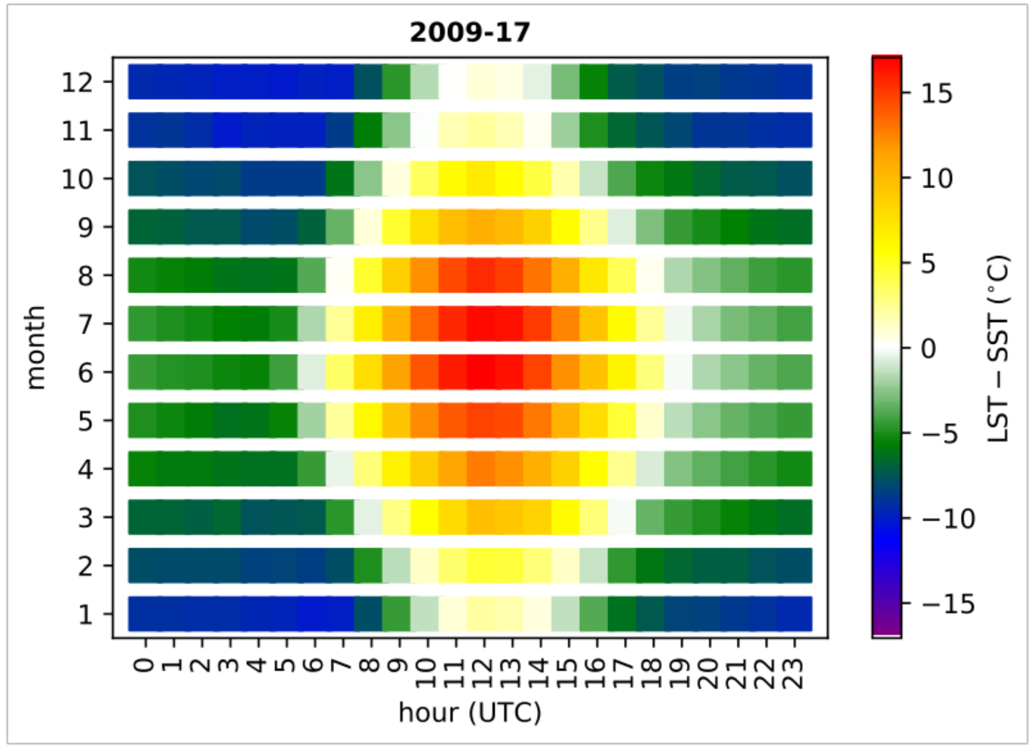
hourly averages of spatially-averaged temperatures per month

LST

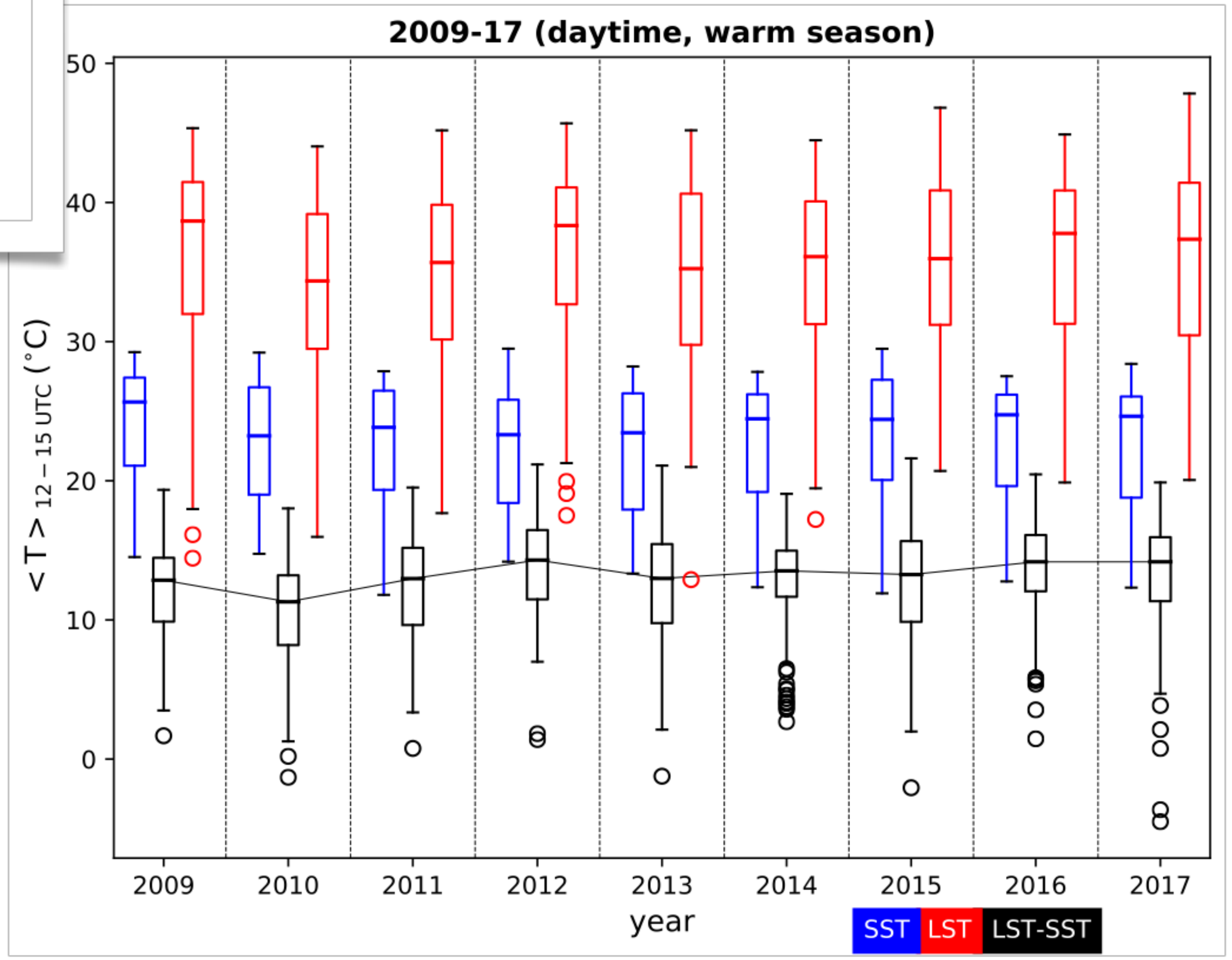


SST





box-plot of the averaged LST, SST and the corresponding difference



Sea-breeze method

* F1: Wind direction

$\checkmark\ 180^\circ \leq WD_A(12 \rightarrow 15\,\mathrm{UTC}) \leq 270^\circ$

* F2: Large-scale wind

$\checkmark\ 135^\circ \leq WD_U(12 \rightarrow 15\,\mathrm{UTC}) \leq 225^\circ$

$\checkmark < WS_A > \leq 8\ \mathrm{ms}^{-1}$

* F3: Wind reversal

$\checkmark\ MR_A\ \epsilon[06, 12\ UTC]$

$\checkmark MR_A - SR \geq 1h$

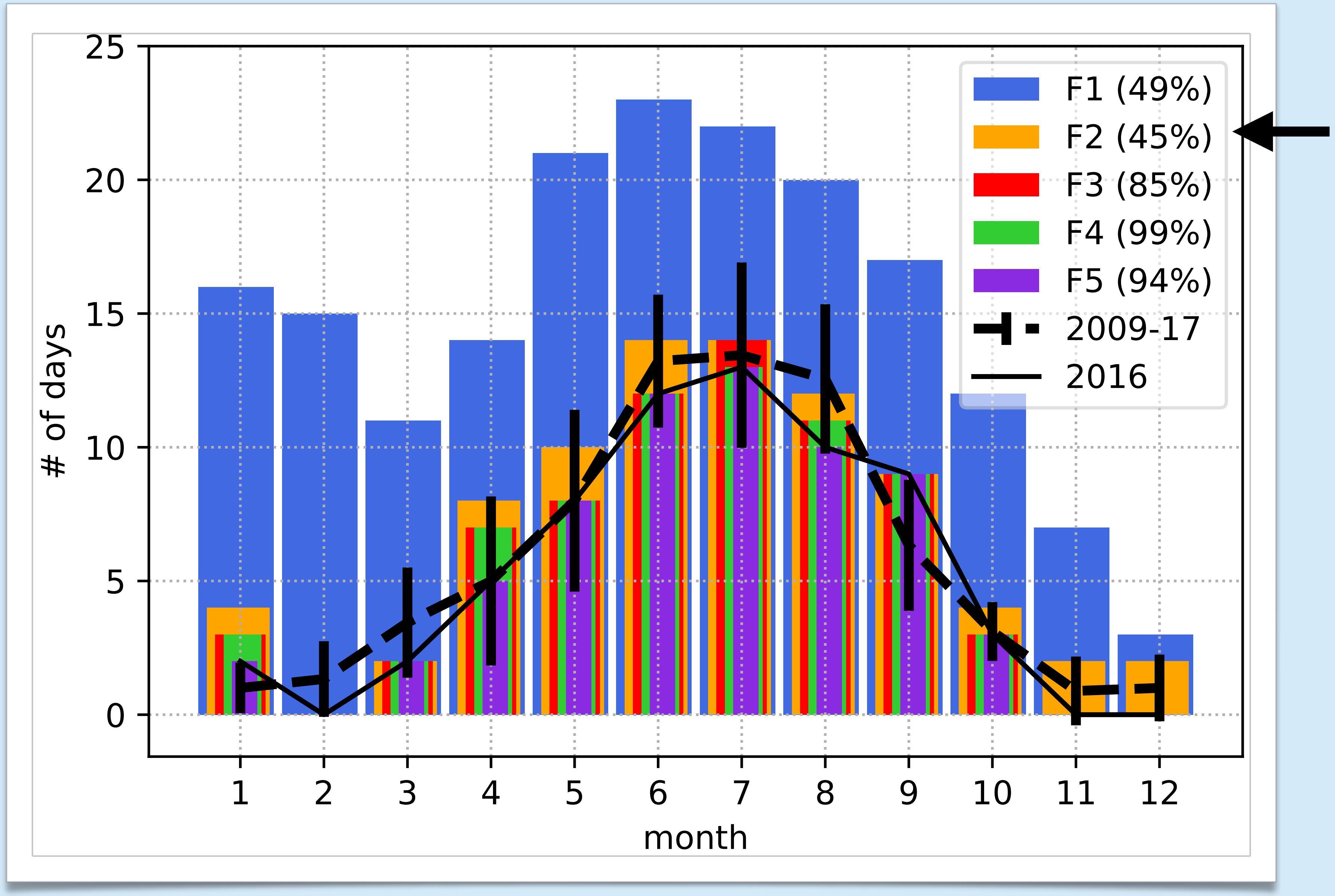
$\checkmark AR_A\ \epsilon[18, 00\ UTC]$

* F4: Wind speed increasing after veering

$\checkmark WS_A(MR_A + 2h) - WS_A(MR_A - 1h) > 0\ ms^{-1}$

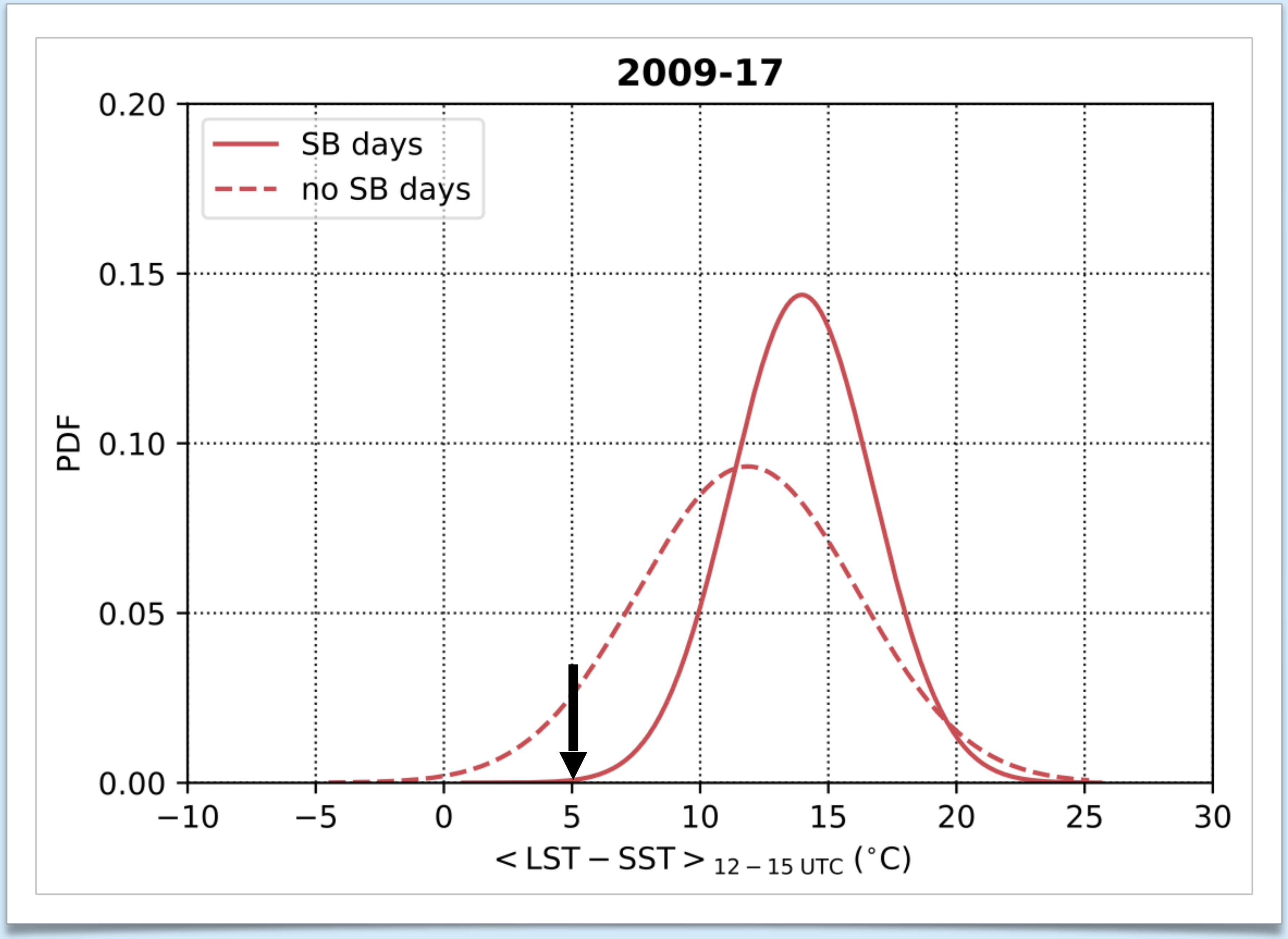
* F5: Precipitation

$\checkmark\ \mathrm{P}_{\mathrm{day}} = 0$



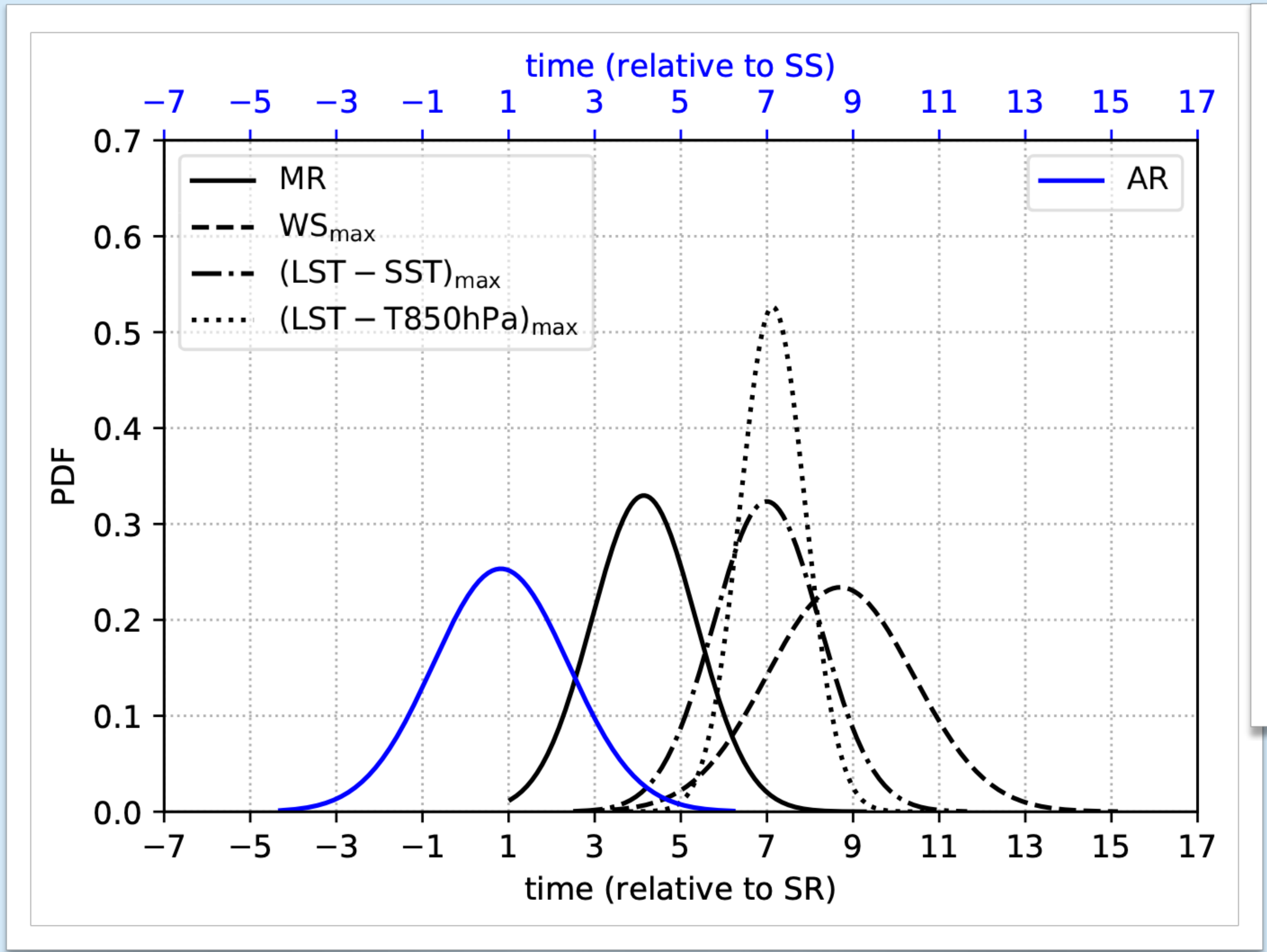
WD = Wind Direction
<X> = X avg 12-15 UTC
$X_{A/U}$ = X at airport/university
WS = Wind Speed
MR = Morning Reversal
SR = SunRise
AR = Afternoon Reversal

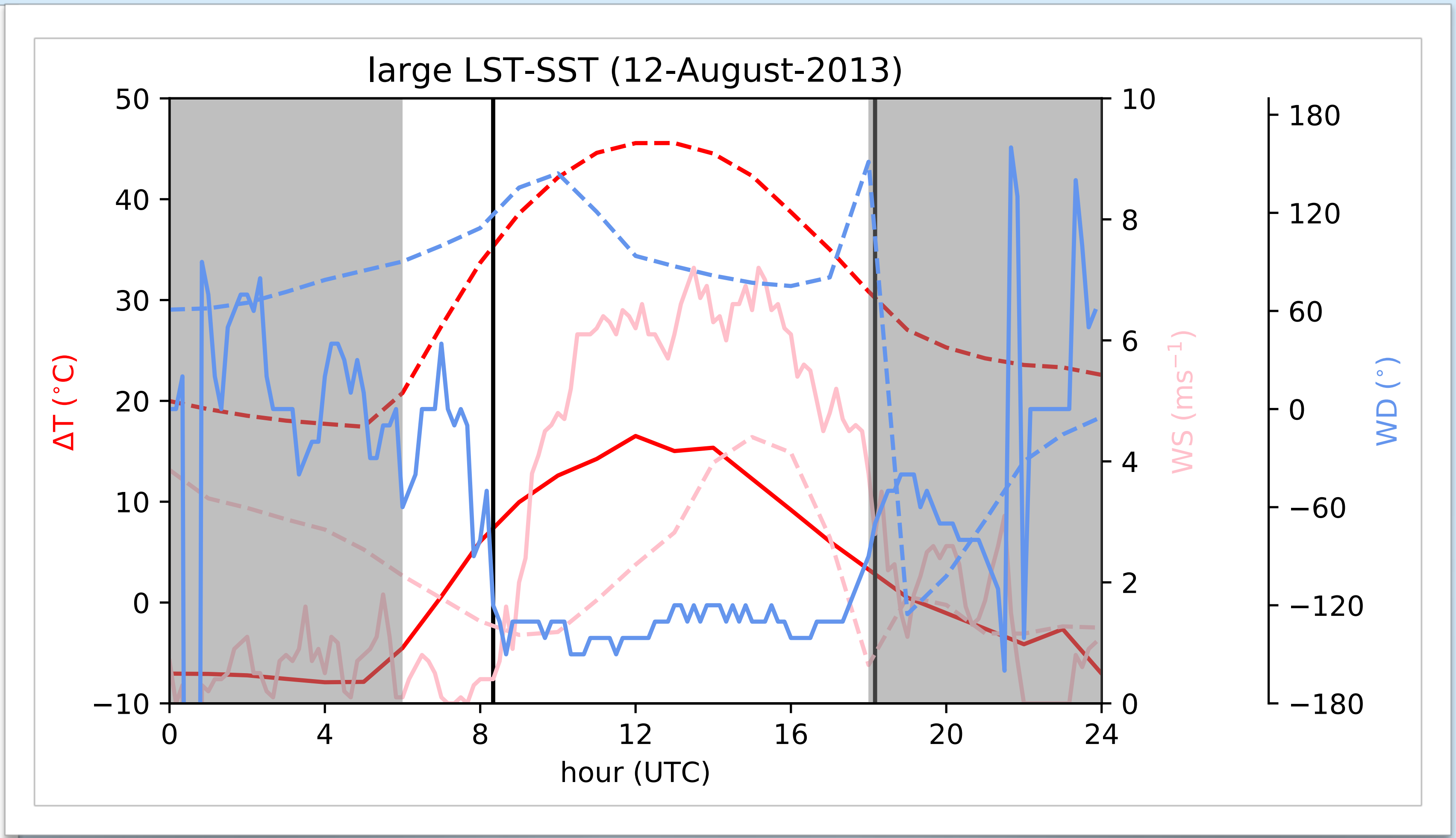
Thermal difference under SB conditions



$\Delta T > 5°C$ under Sea-breeze conditions

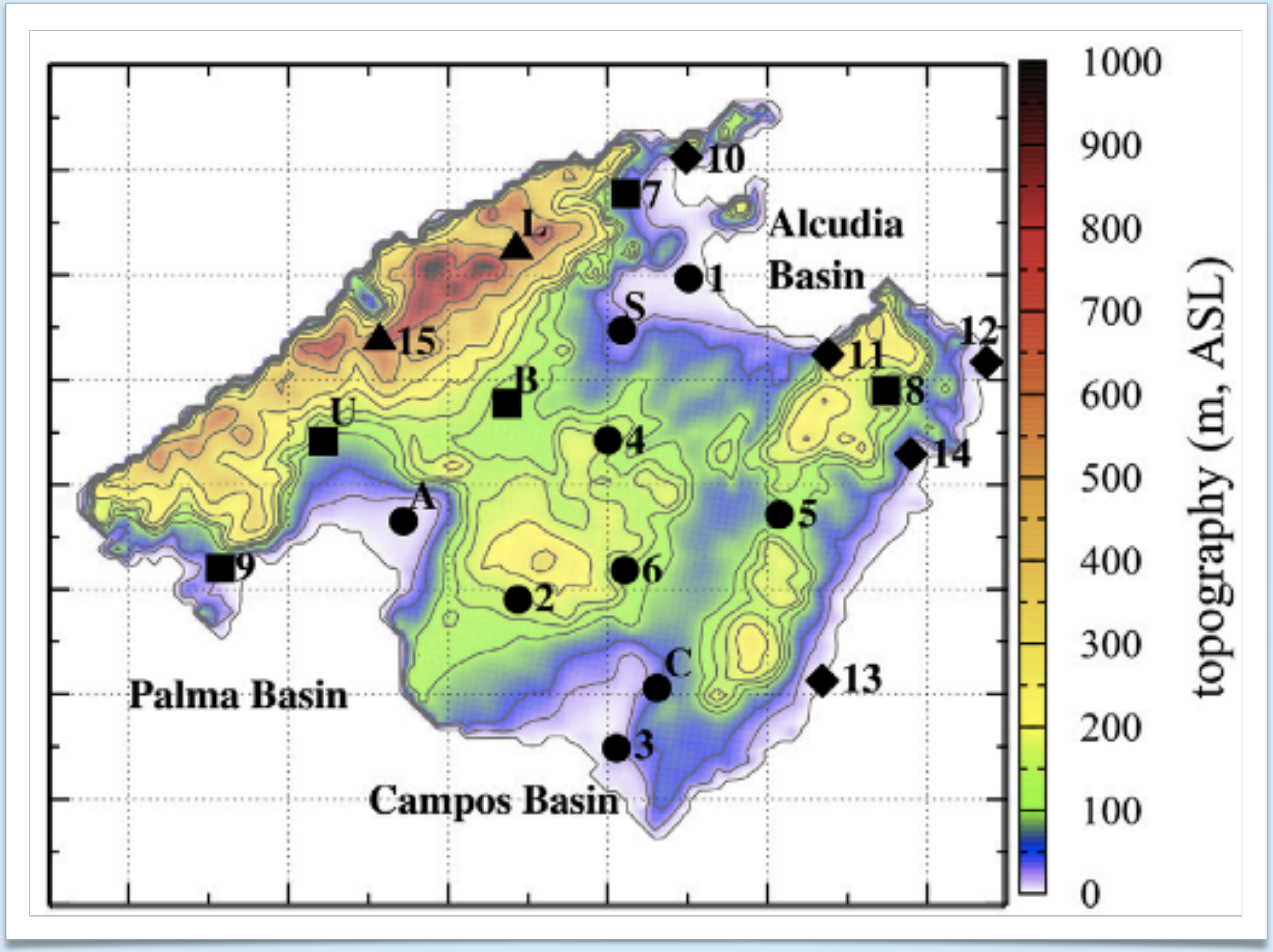
Physical Mechanisms under SB conditions





Abbreviations: SunRise (SR), SunSet (SS), Morning Reversal (MR), Afternoon Reversal (AR), Wind Speed (WS), Wind Direction (WD)

2. Chilling hours map



<u>*Methodology (2 ways):*</u>

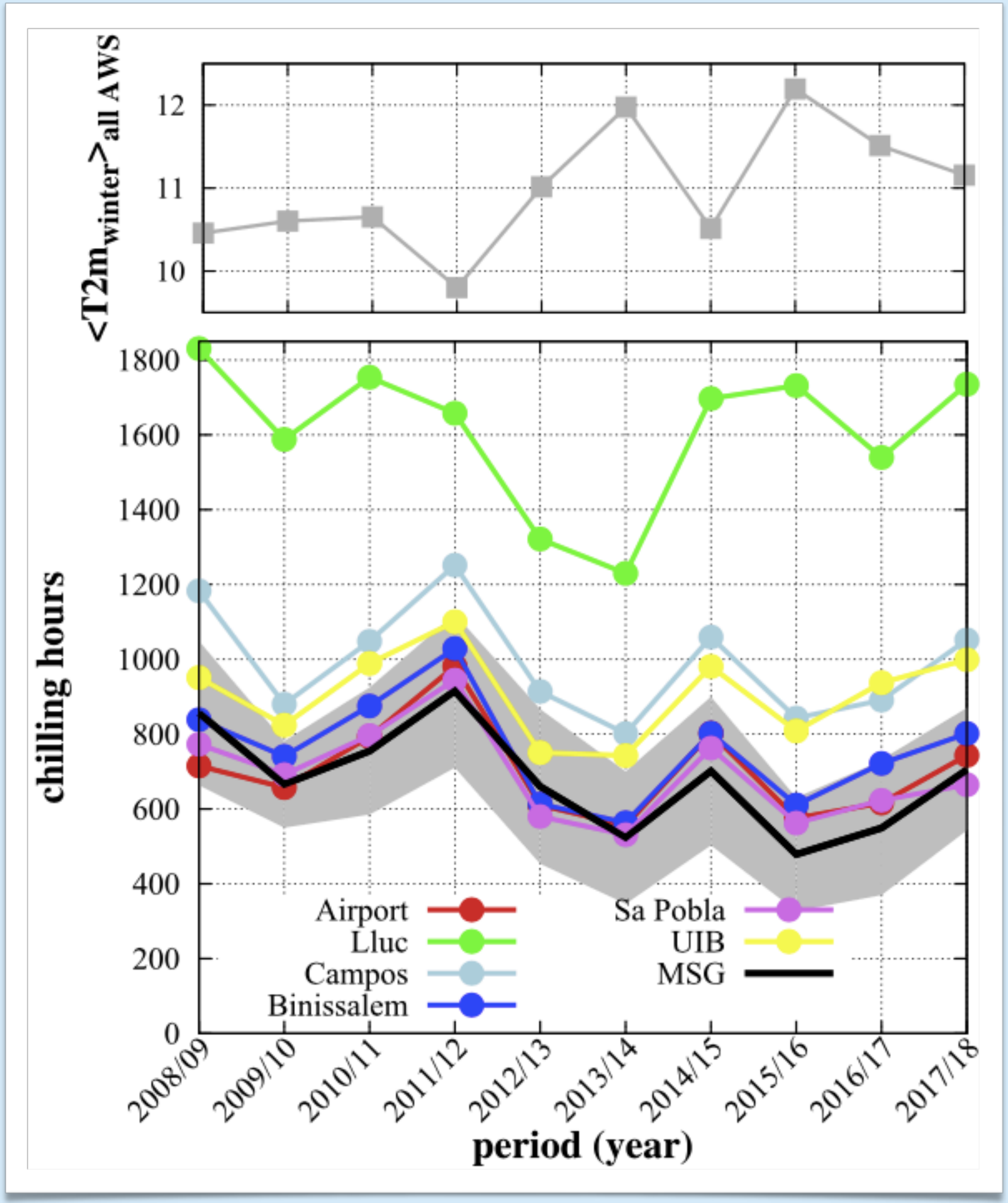
-> AWS: T2m < 7°C

-> MSG: LST -> T2m *(Simó et al., 2018)*

Symbology: plain (circles), coast (diamonds), foothills (squares) and mountains (triangles).

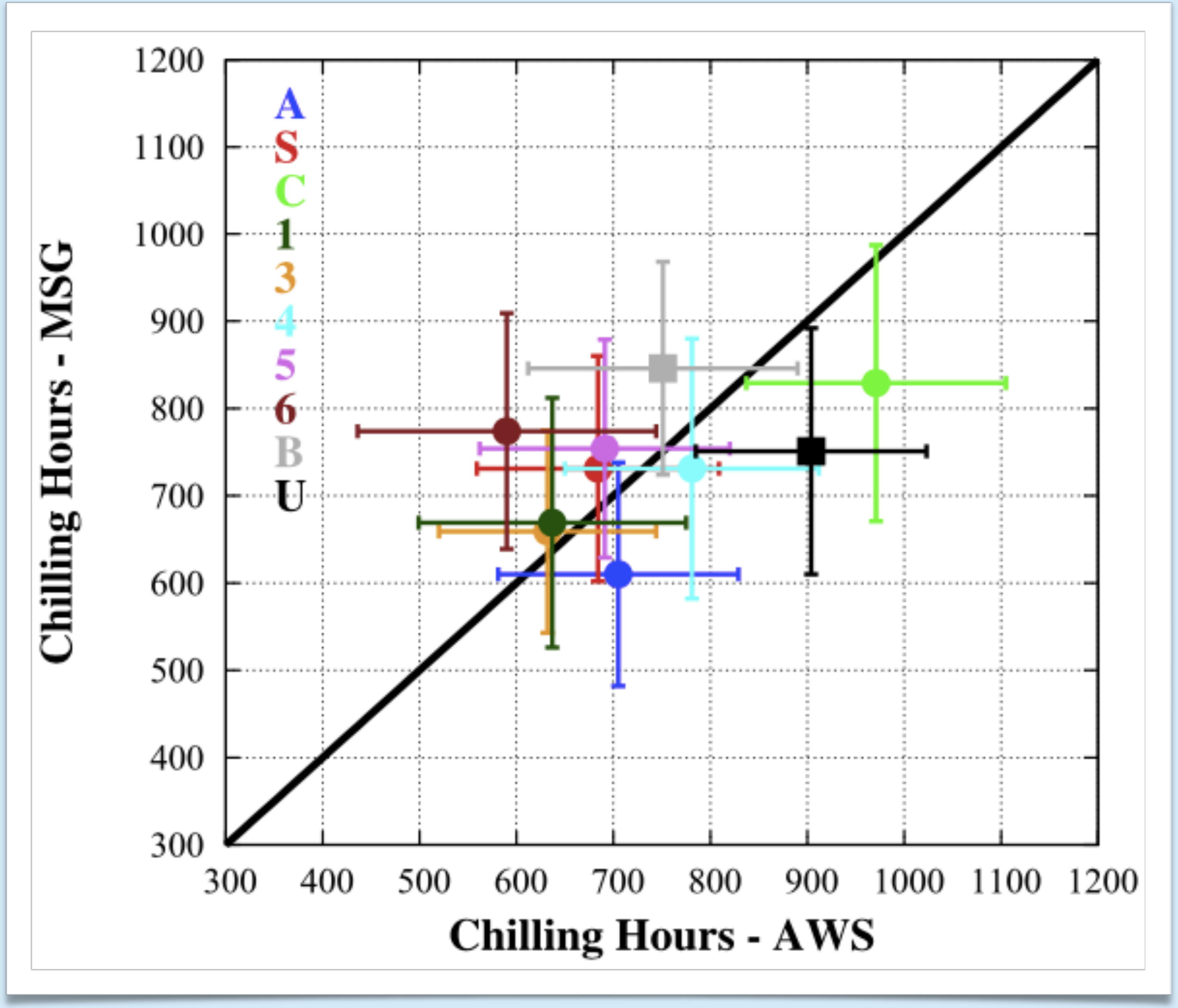
CH annual variability

* The inter-annual variability may exceed the 20% between the years, although the ranking from coldest to warmest is maintained during almost the entire period.
* We find a high correlation between the winter average of temperature (see top panel) and the CH accumulation, specially those years in which this average reach an extrema.



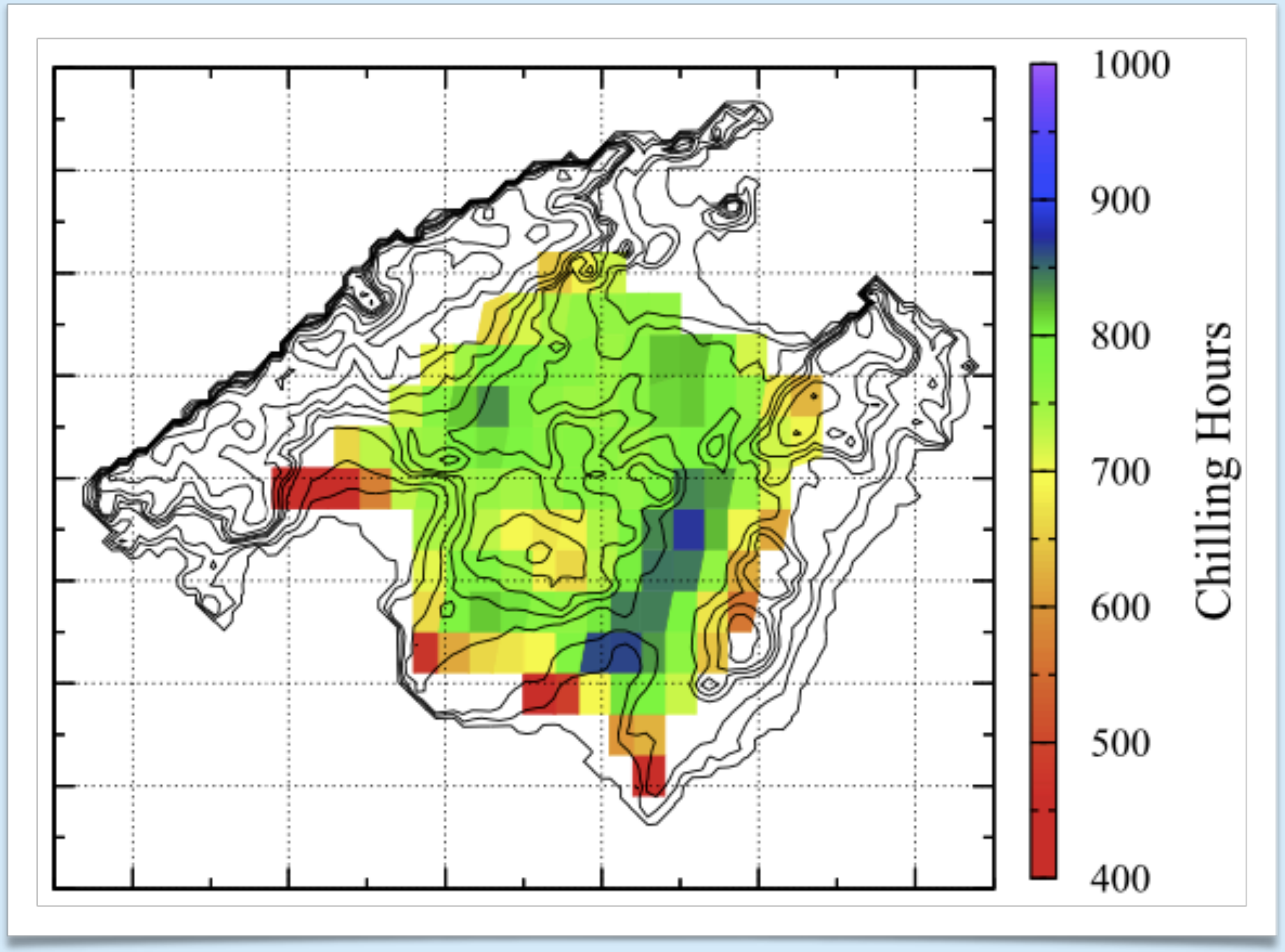
Comparison between the estimated CH (from MSG and AWS)

* The locations where differences are larger may be due to the special location of the AWS, not necessarily representative of the area covered by a MSG pixel probably related to the local features.

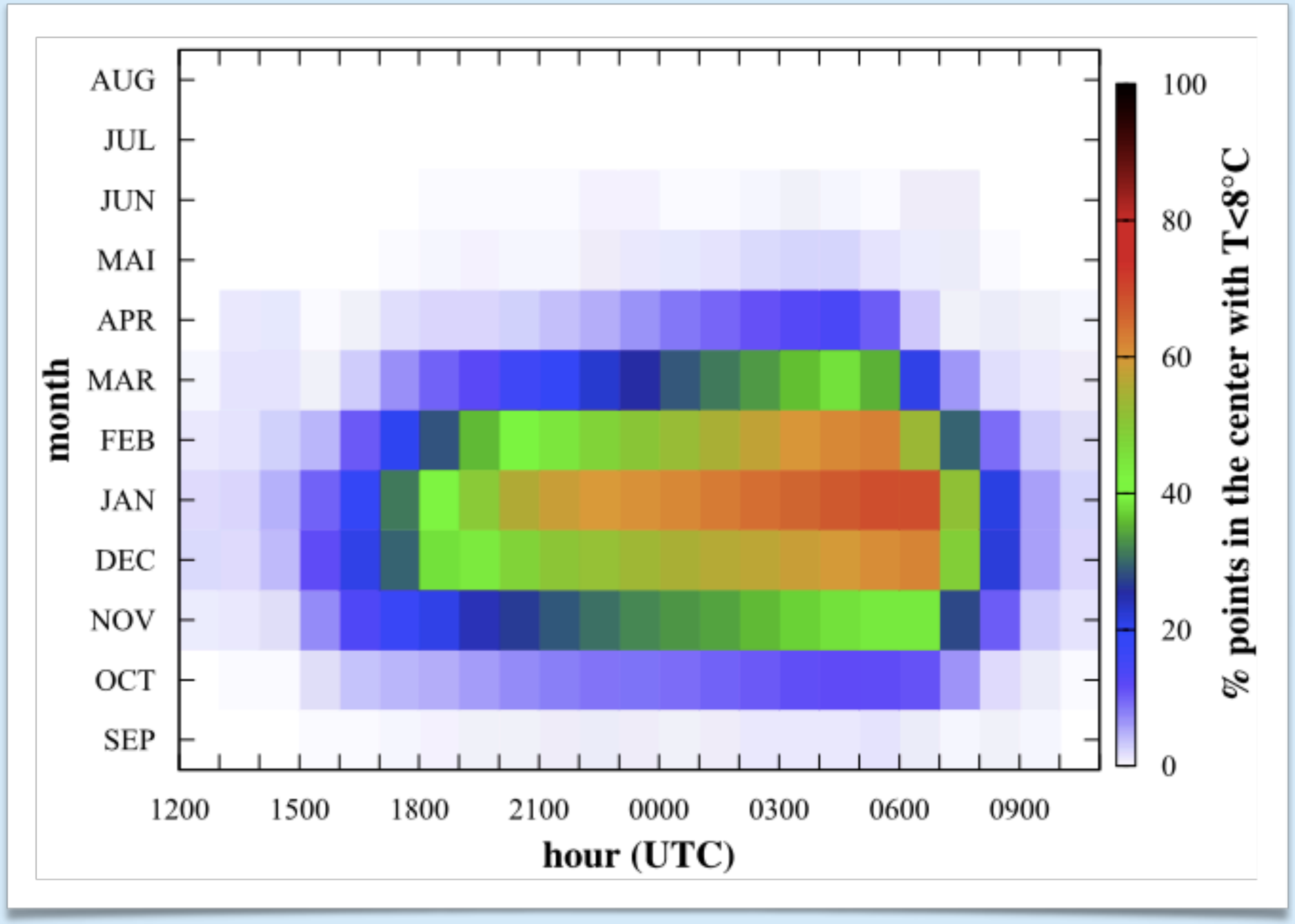


CH-map generation

Annual average of CH counting from MSG -LST fields.



Percentage of points (those of the left map) contributing to the amount of CH counting.



* The largest CH are placed in the bottom parts of the 3 main basins.
* CH tend to accumulate from Oct to May (specially in winter) and nighttime.

Conclusions

1. **The combined analysis of the AWS and satellite surface temperatures under SB conditions shows that the thermal gradient**:

-> is equal or larger than 5ºC

-> is important but other mechanisms are relevant: large-scale winds, soil moisture, locally-generated winds (upslope).

2. **A methodology is proposed to compute a CH map for agricultural applications**.

-> the coldest regions are placed in the bottom parts of the basin where cold pools are likely to form,

-> from the inspection of the CH maps from the years with available LST is it possible to determine its variability,

-> this methodology can be applied to other regions.

Acknowledgments

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