The Cerdanya Cold Pool Experiment 2015 (CCP15)

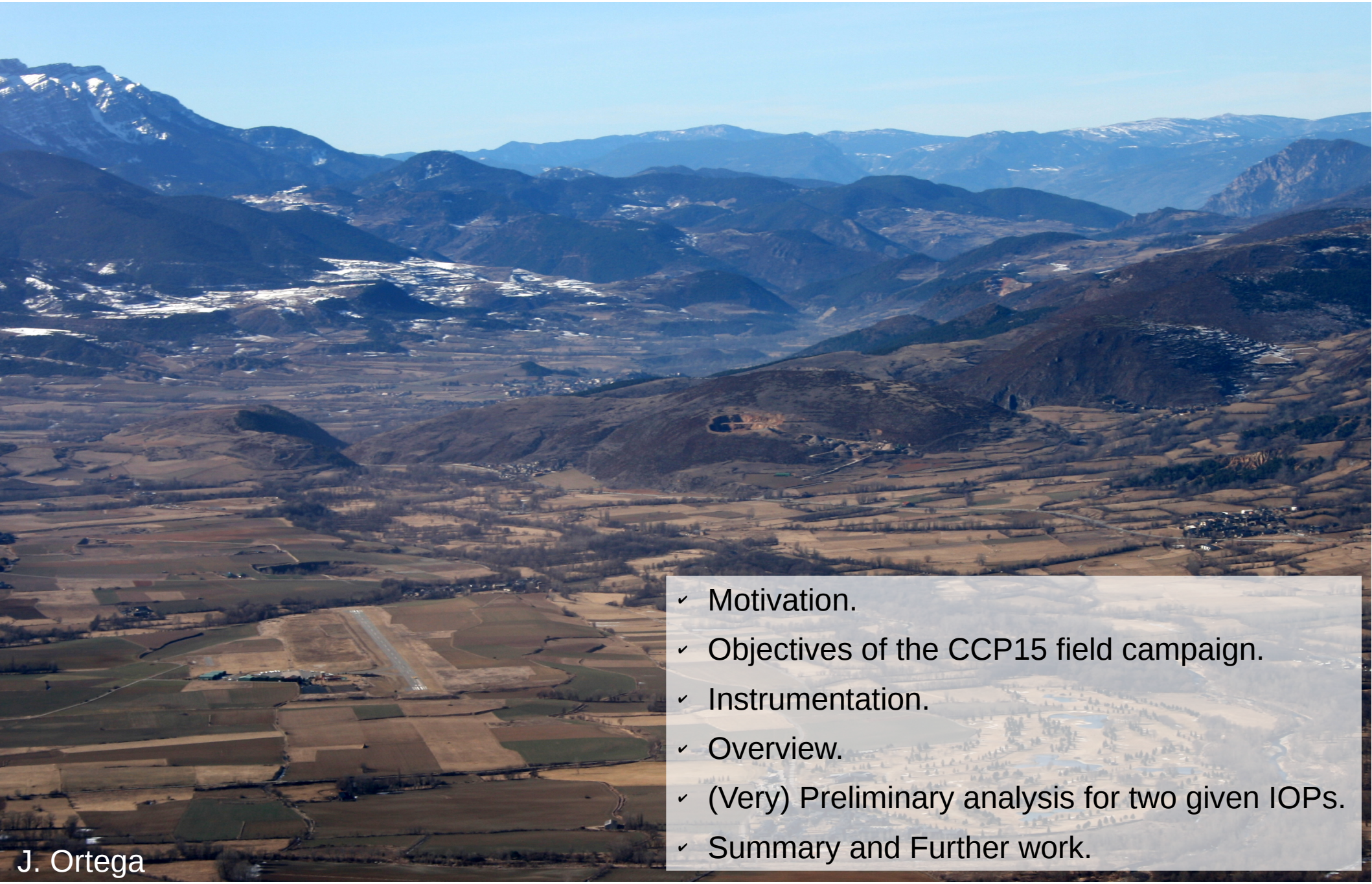
A study on the valley wind system and cold air pooling within the largest Pyrenean valley

Daniel Martínez-Villagrasa (1*), Gemma Simó (1), Laura Conangla (2), Davide Tabarelli (3), Josep Ramon Miró (4), Álvaro López (1), Burkhard Wrenger (5), Maria Antònia Jiménez (1), Rodrigo Picos (1), Dino Zardi (3), and Joan Cuxart (1)

(1) University of the Balearic Islands, Physics, Palma de Mallorca, Spain,
(2) Polytechnic University of Catalonia, Applied Physics, Manresa, Spain,
(3) Universitá degli studi do Trento, Ingegneria Civile e Ambientale, Trento, Italy,
(4) Meteorological Service of Catalonia, Barcelona, Spain ,
(5) University of Applied Sciences, Hochschule Ostwestfalen-Lippe, Germany

(*) dani.martinez@uib.cat

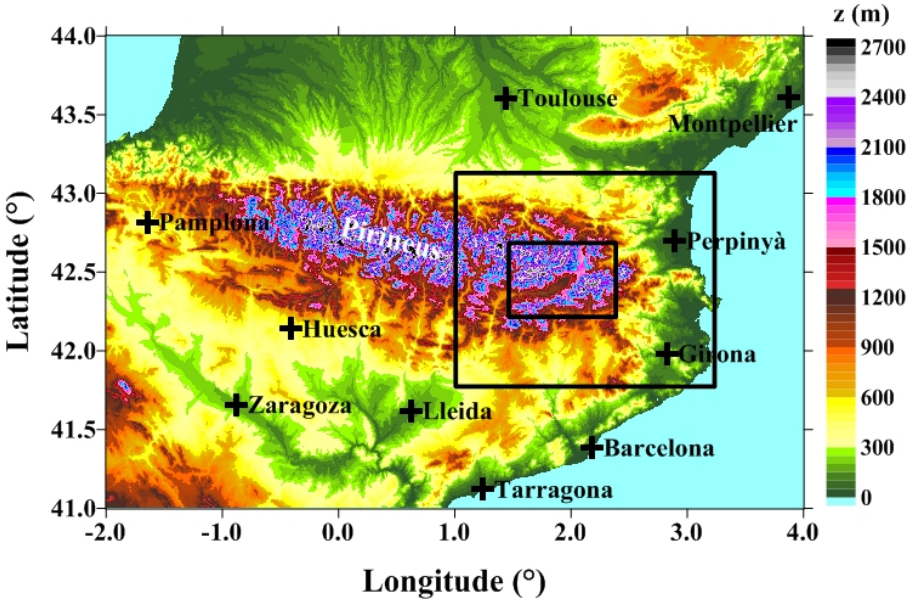
Outline



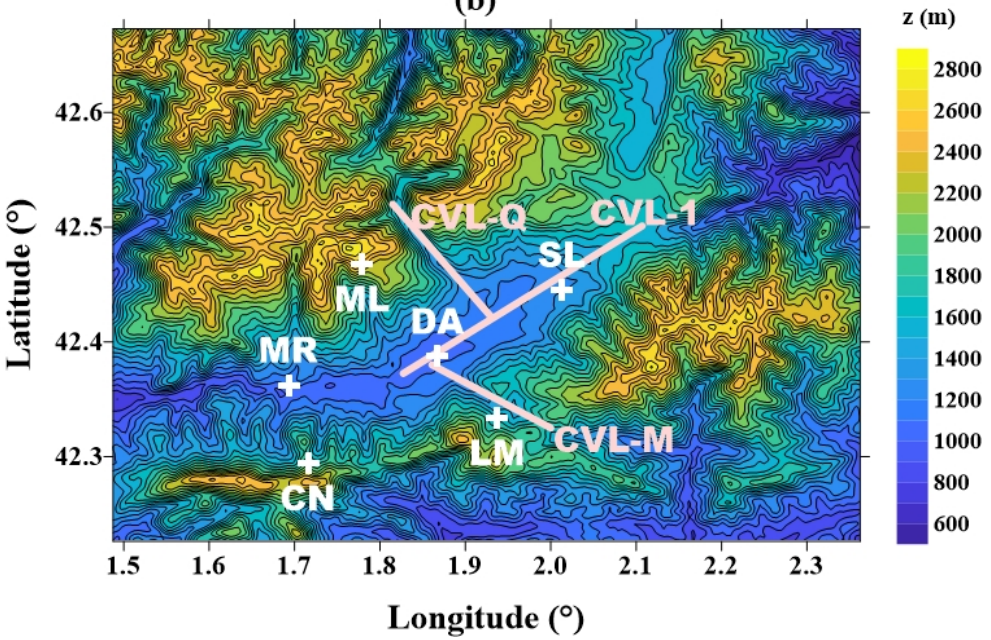
- Motivation.
- Objectives of the CCP15 field campaign.
- Instrumentation.
- Overview.
- (Very) Preliminary analysis for two given IOPs.
- Summary and Further work.

J. Ortega

Motivation



(b)



Period: 01/09/2010 — 31/08/2014

CAP definition: T_{DA}-T_{SL} ≤ - 3 K.

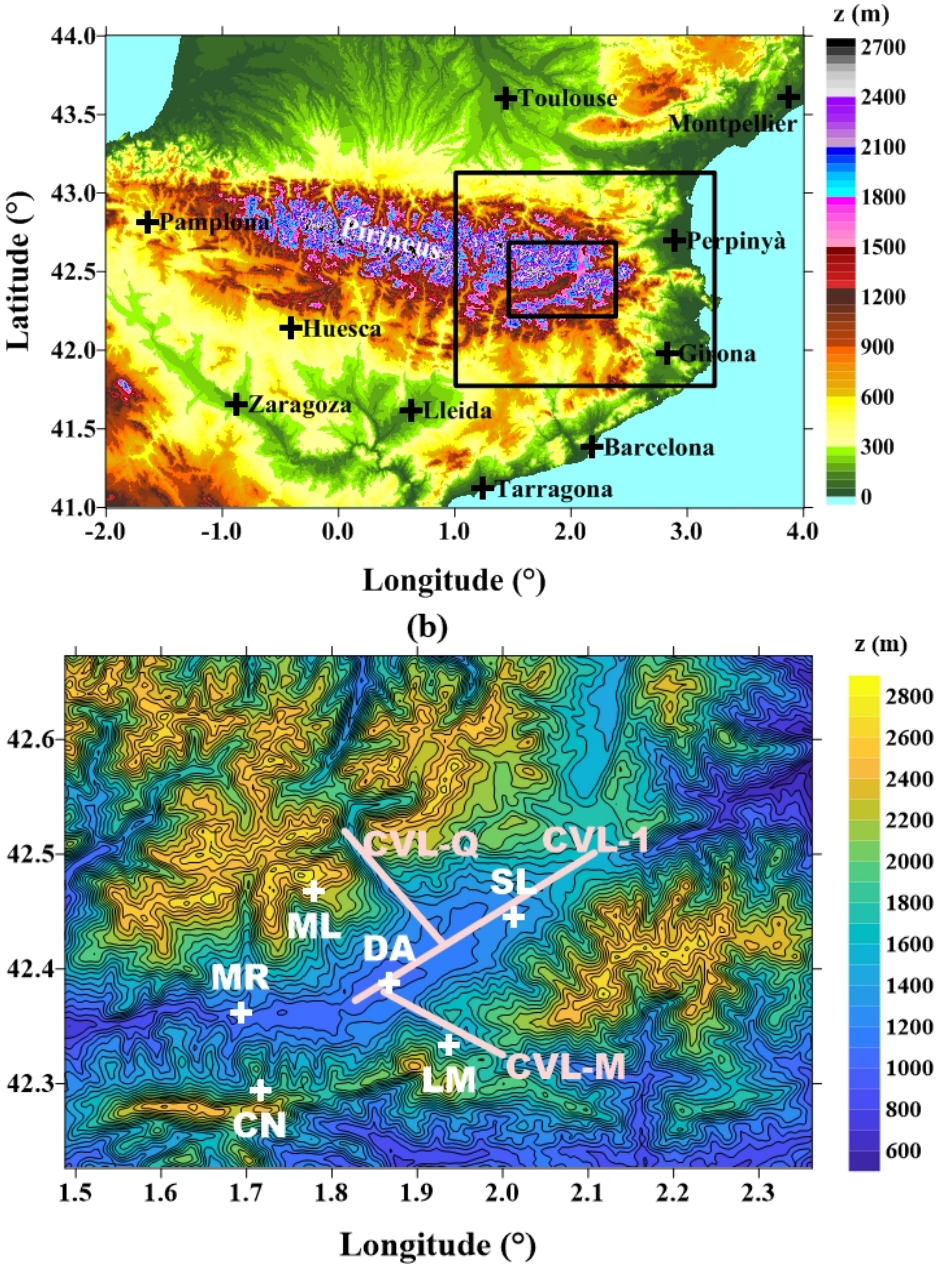
Table II. Percentage of days with cold-air pool, mean strength (S) and mean duration (D) per month, in the period from 1/9/2010 to 31/8/2014, for the temperature difference criteria between Das and Santa Llocaia (T_{DA} - T_{SL}) ≤ - 3.0 °C.
Standard deviation values are in parentheses.

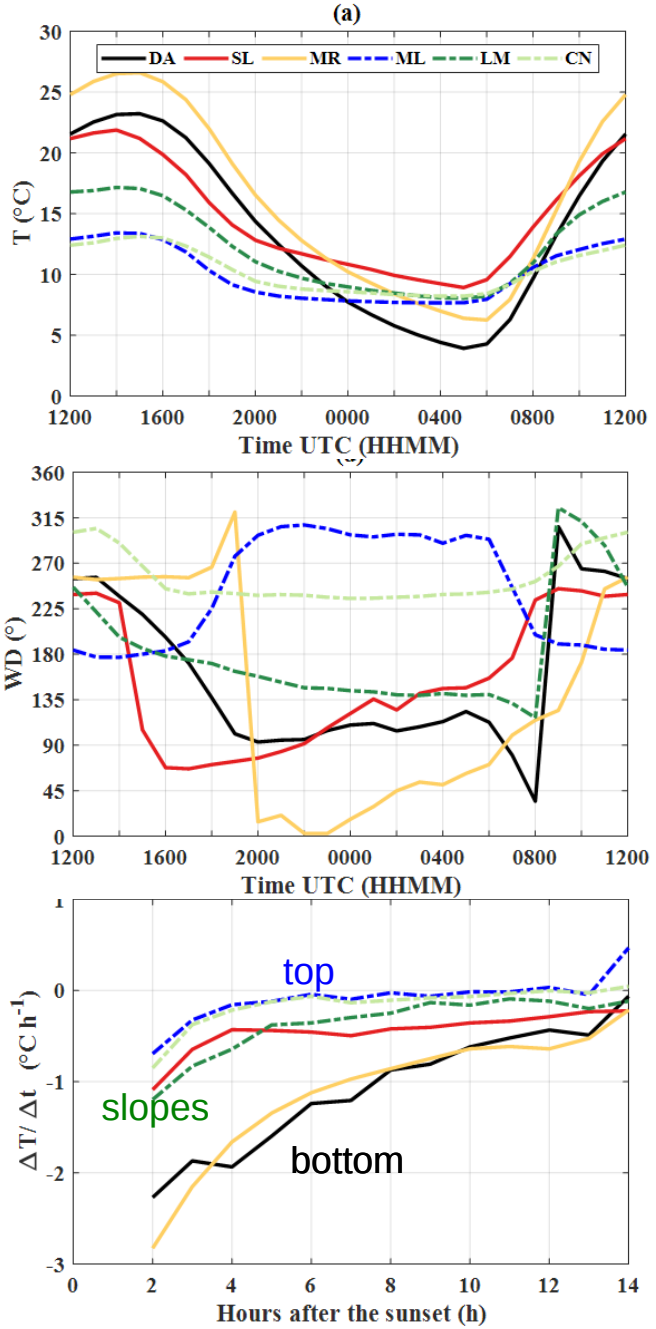
	T_{DA} - T_{SL} ≤ -3.0 °C				
	% days	S (°C)		D (h)	
Jan.	70.2	-7.4	(2.4)	12.6	(5.1)
Feb.	50.0	-6.7	(2.1)	9.7	(4.3)
Mar.	52.4	-6.1	(1.6)	8.2	(3.1)
Apr.	45.0	-5.8	(1.2)	6.5	(2.7)
May	54.0	-5.4	(1.2)	5.2	(1.9)
Jun.	45.0	-5.5	(1.2)	6.6	(2.1)
Jul.	50.8	-5.3	(1.3)	5.8	(2.3)
Aug.	61.3	-5.7	(1.3)	7.1	(2.8)
Sep	70.8	-6.0	(1.4)	7.8	(2.9)
Oct	65.3	-6.3	(2.0)	9.5	(3.8)
Nov.	55.0	-6.2	(1.9)	10.3	(4.3)
Dec.	80.6	-7.1	(2.1)	13.9	(5.4)

- 59% of the nights with daily CAPs.
- 70% with T_{DA}-T_{SL} ≤ - 5 K and 5% ≤ - 10 K
- Daily CAPs persist more than 5 h.

Conangla et al. (2018): Cold-air pool evolution in a wide Pyrenean valley. *Int. J. Clim.*

Motivation



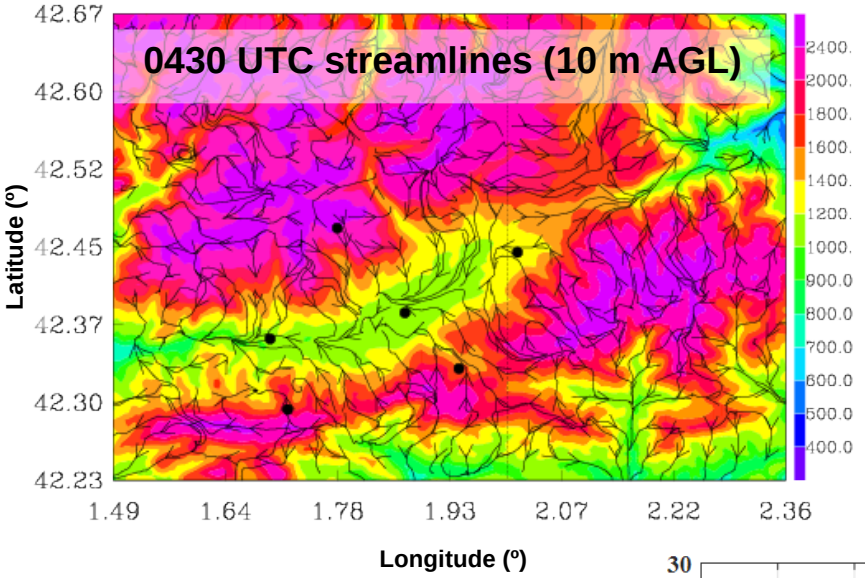


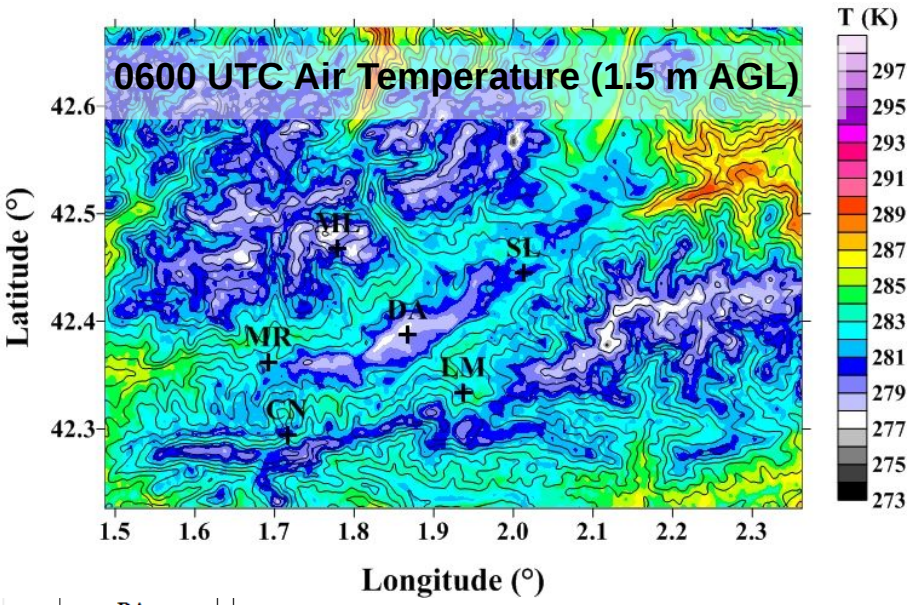
Conangla et al. (2018): Cold-air pool evolution in a wide Pyrenean valley. *Int. J. Clim.*

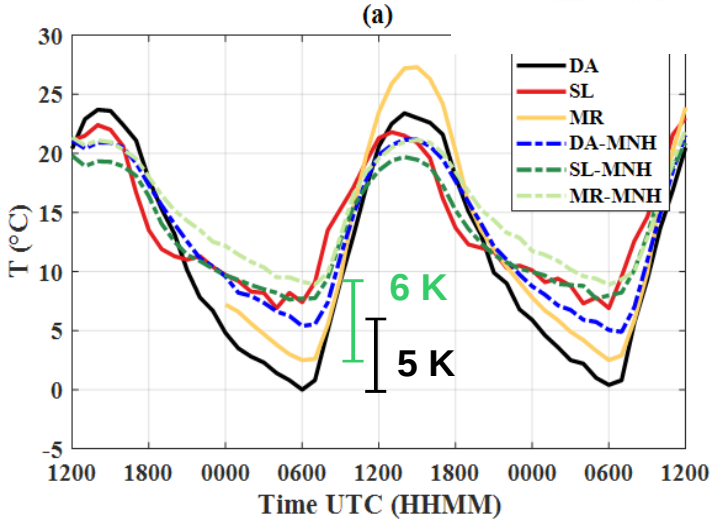
Motivation

A 48-h long case study **(12 UTC 30/09/2011 – 12 UTC 02/10/2011)**:
Meso-NH model (Lafore at al., 1998) with **two nested domains.**

- Horizontal resolution: 2 km and 400 m.
- Stretched vertical resolution: **3 m close to the ground** and 8 m at 500 m height.
- Initial and lateral boundary conditions: ECMWF analysis every 6 h. One way nesting for domain 2.



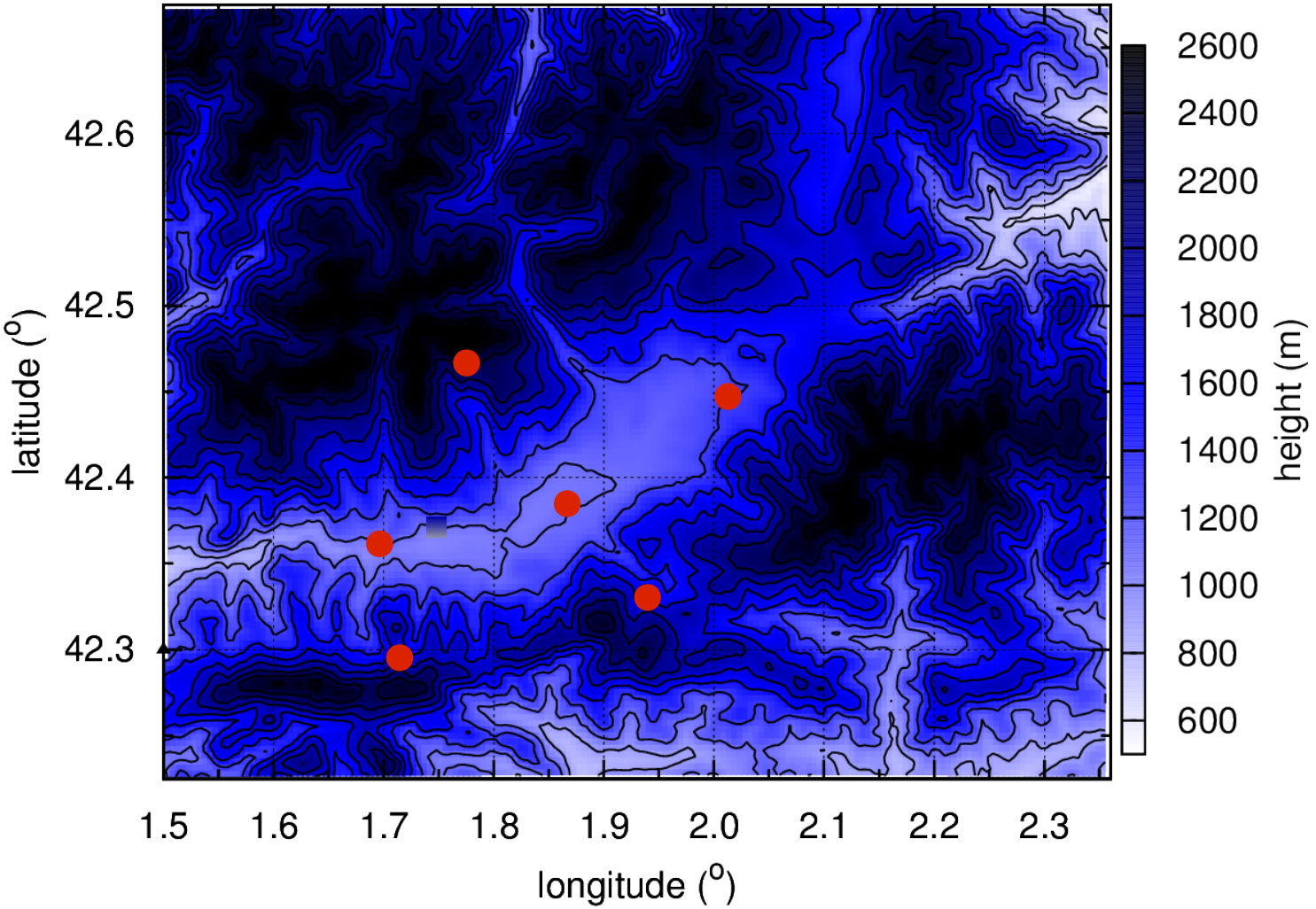




Conangla et al. (2018): Cold-air pool evolution in a wide Pyrenean valley. *Int. J. Clim.*

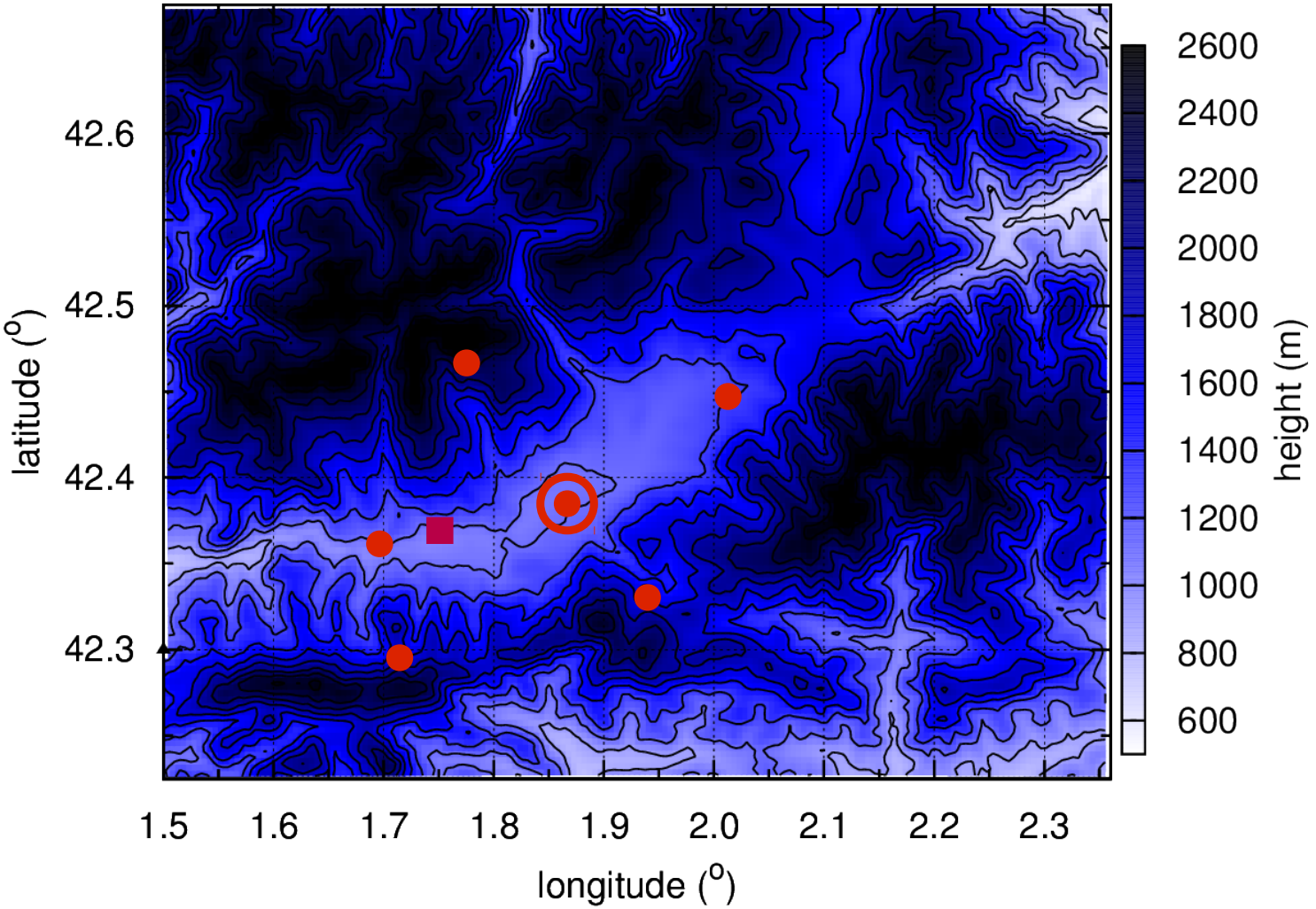
Objectives

- Study the structure and evolution of the cold-air pool (CAP) at the bottom part of the Cerdanya valley under fair weather conditions. Together with...
  - Valley wind circulations (slope and valley flows).
  - Evolution of the surface energy budget (SEB) at the centre of the valley.
  - Fine structure of the thermal inversion within the first meters above ground.

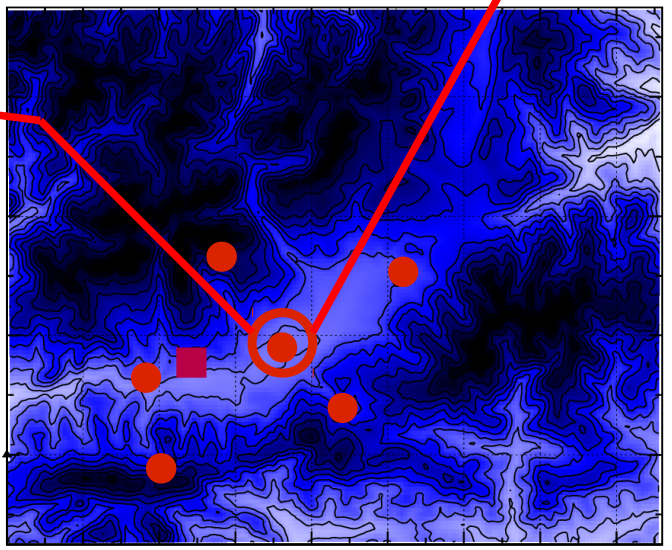


Objectives

- Study the structure and evolution of the cold-air pool (CAP) at the bottom part of the Cerdanya valley under fair weather conditions. Together with...
  - Valley wind circulations (slope and valley flows).
  - Evolution of the surface energy budget (SEB) at the centre of the valley.
  - Fine structure of the thermal inversion within the first meters above ground.



Instrumentation

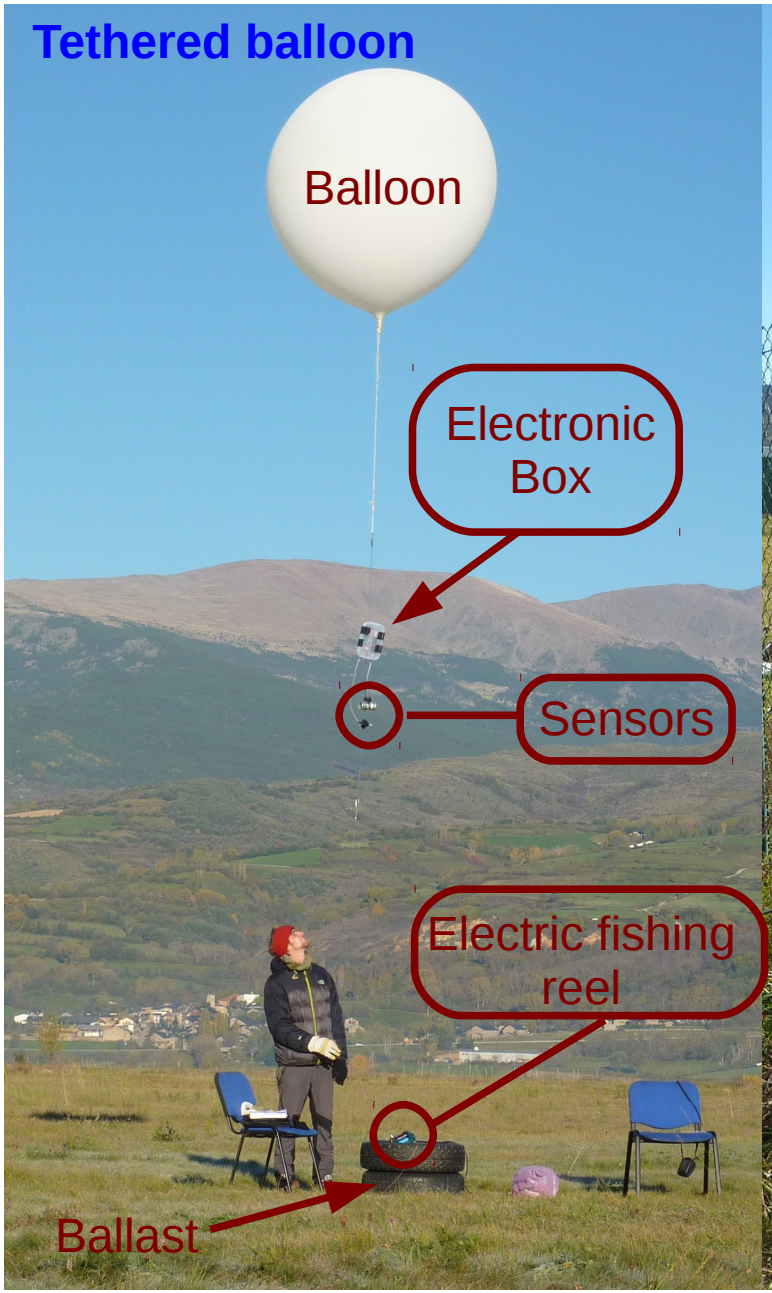


WindRASS and **SEB** operated by the **Catalan Met Service** were installed near their operational station at the Das Aerodrome.

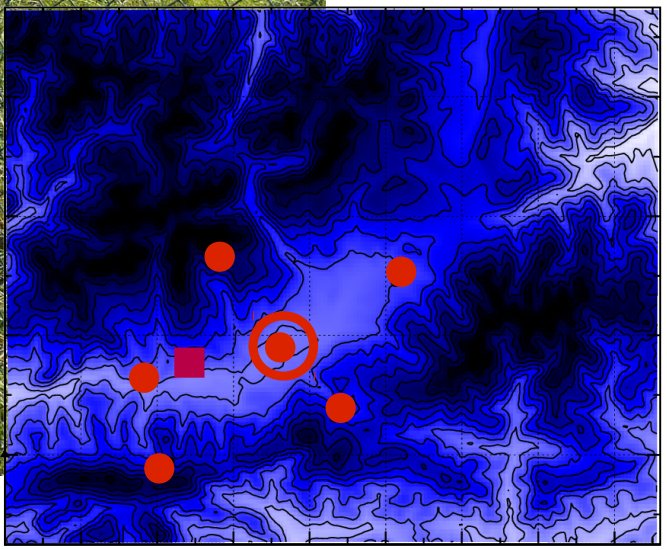
Period: Oct 2015 – April 2018 (~2+ yr data).

Instrumentation

Tethered balloon



2-m column of thermistors

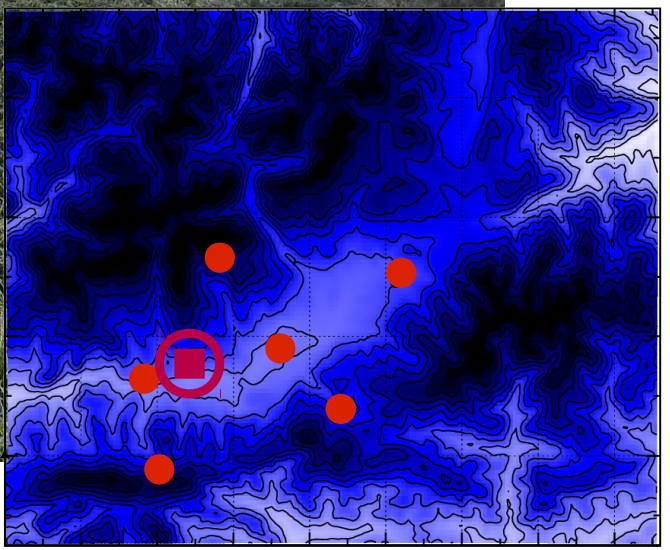


Belen Martí (yesterday)

Additional weather station

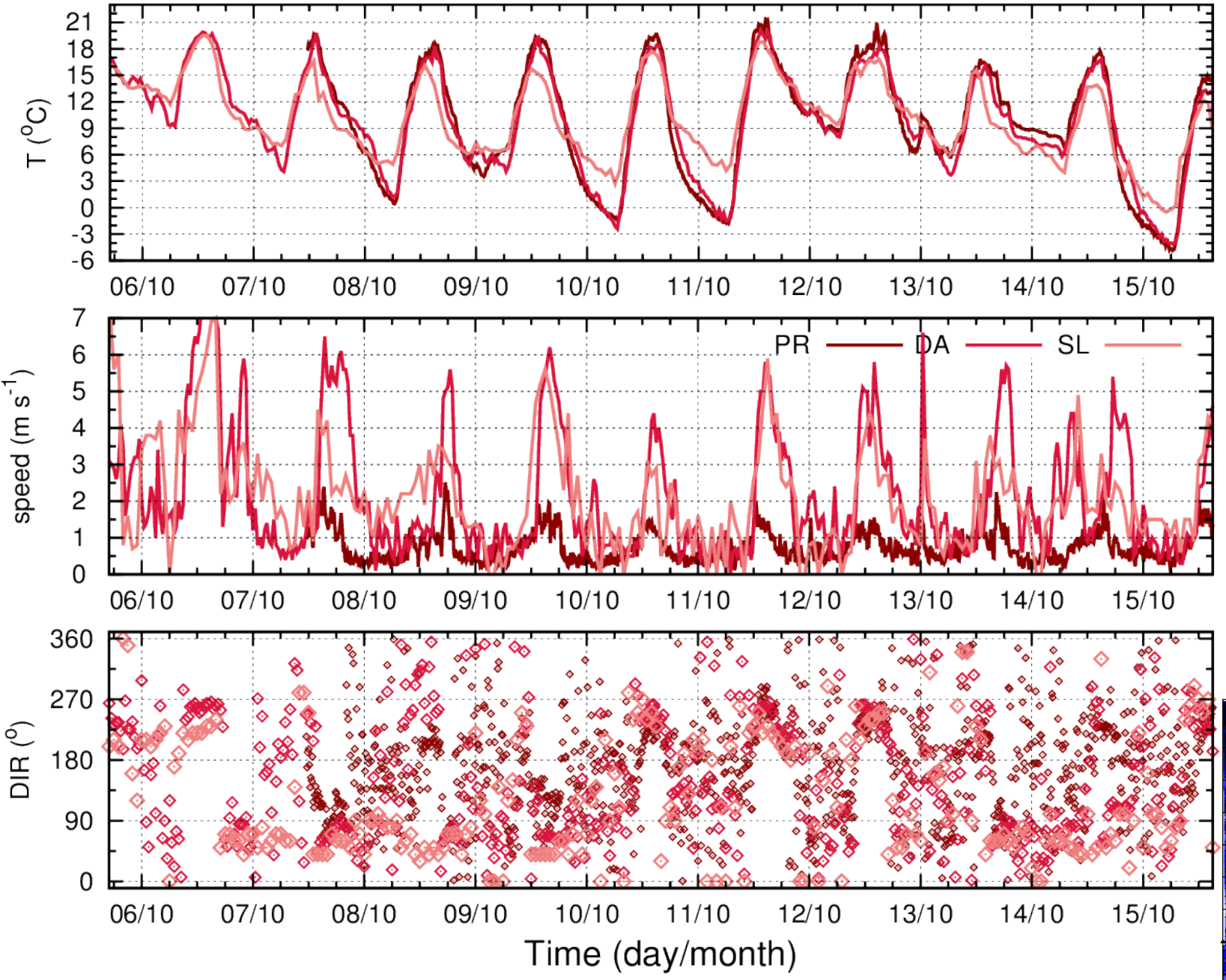
Wind (3 m)

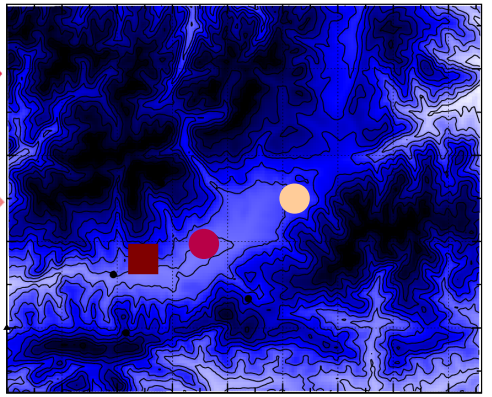
T + RH (2 m)



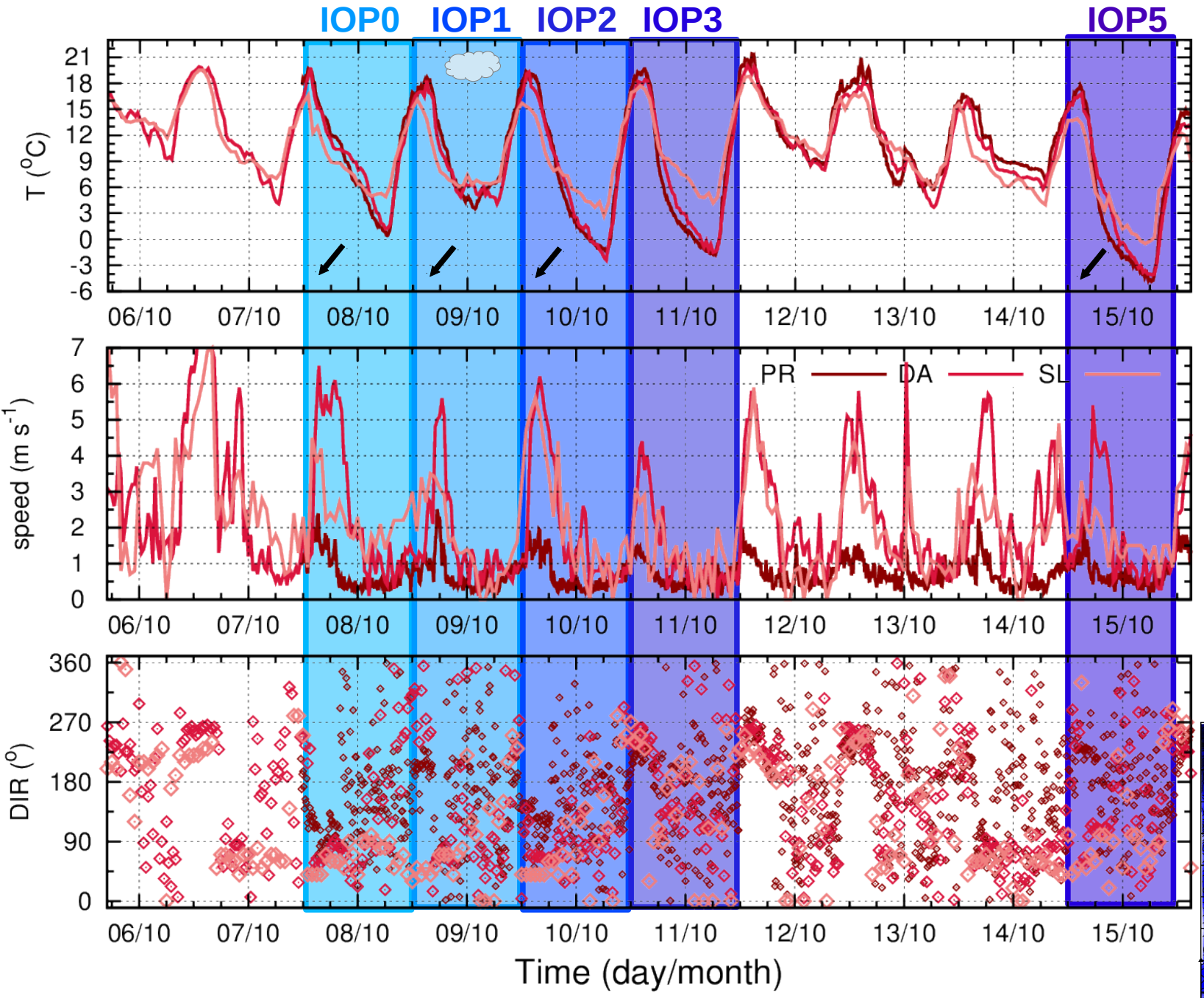
CCP15 field campaign: Overview

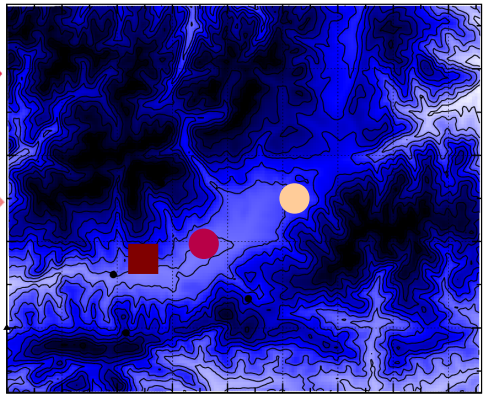
Period: 6 – 15 Oct 2015 (10 days).



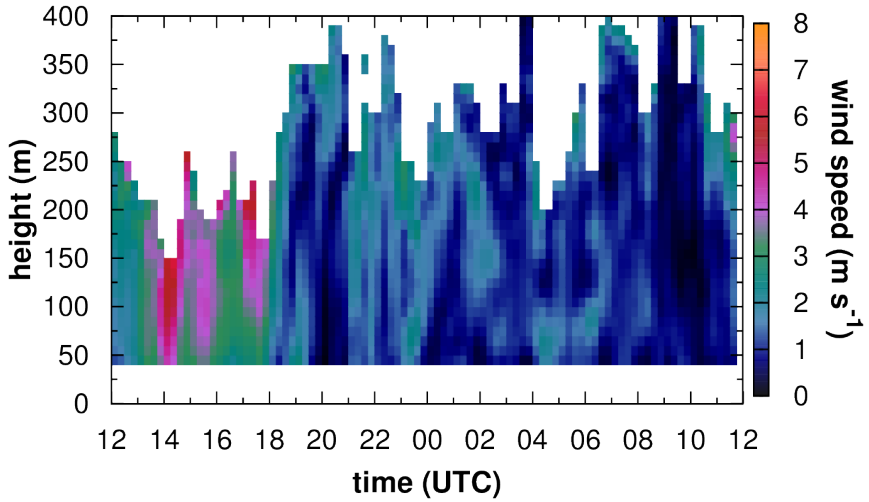


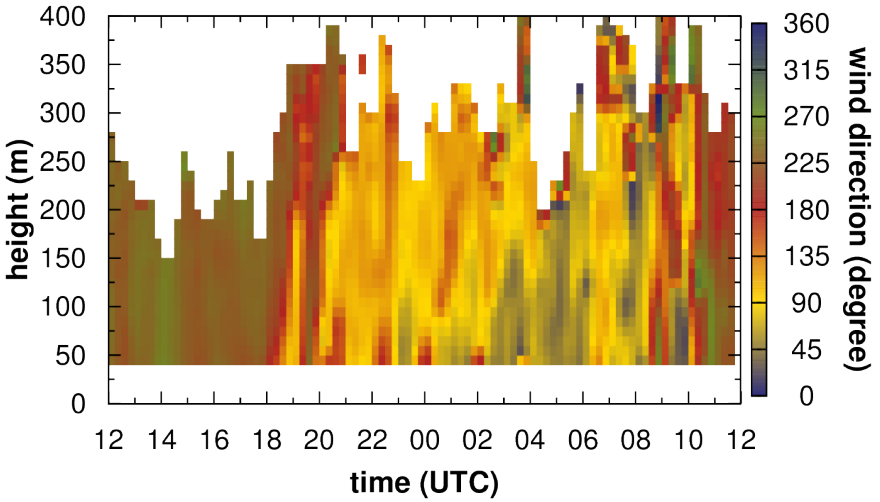
CCP15 field campaign: Overview

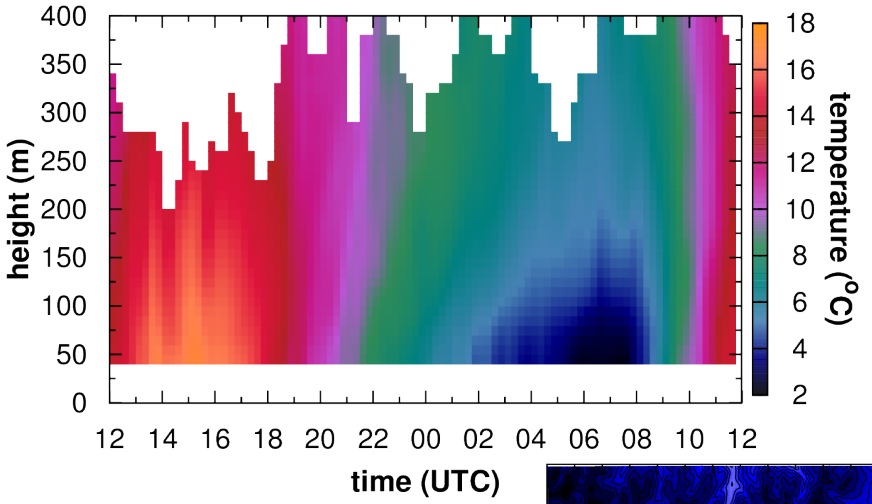


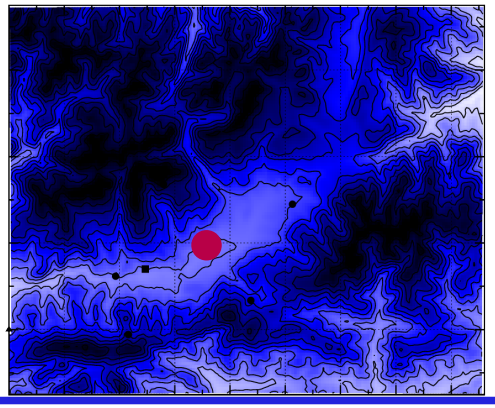


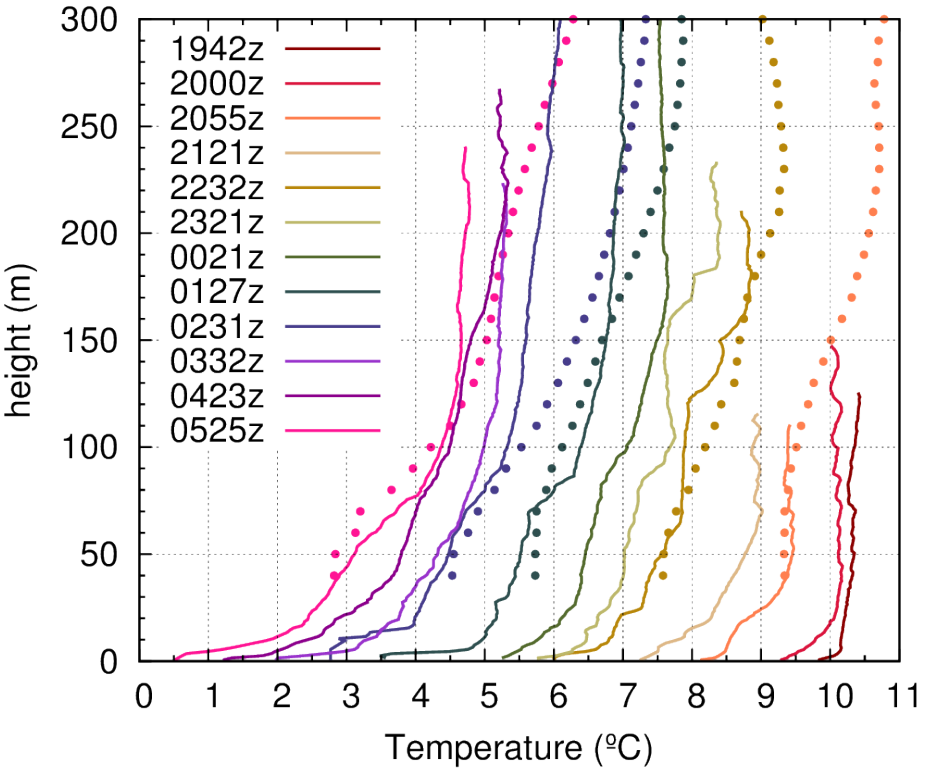
CCP15 field campaign: IOP3



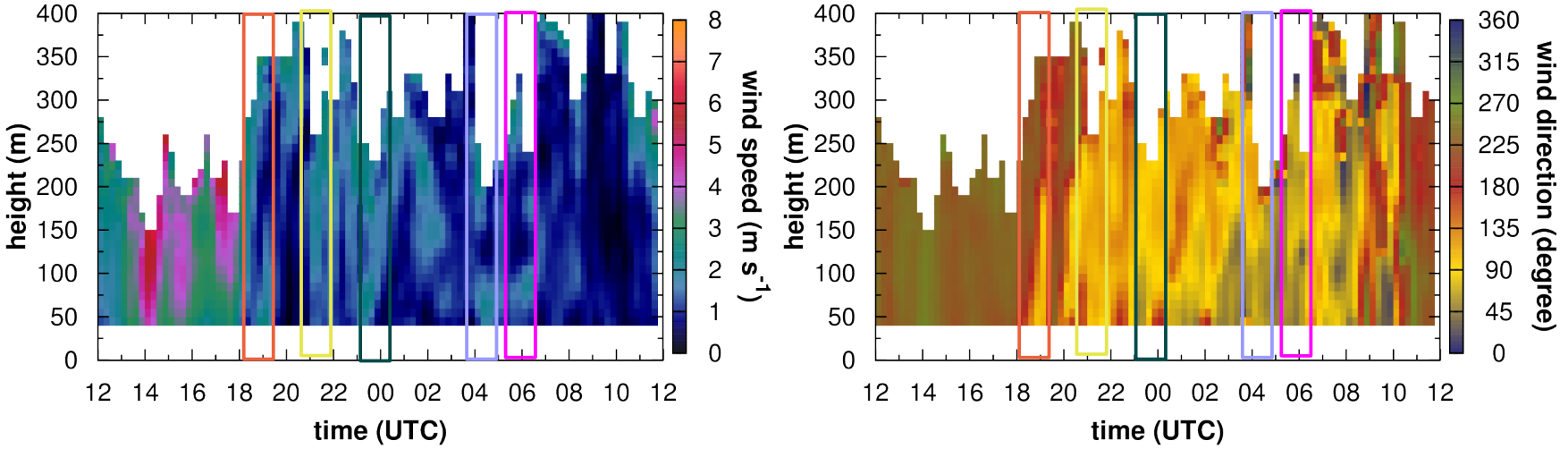


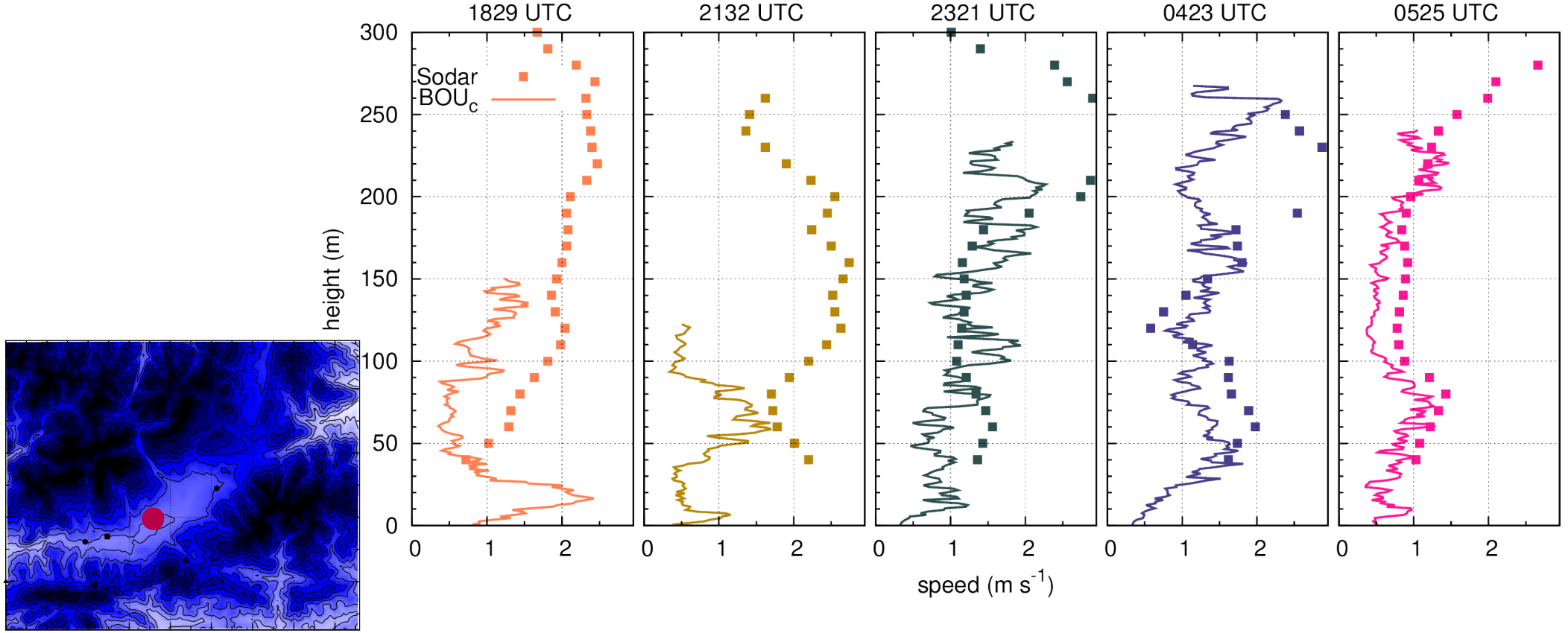




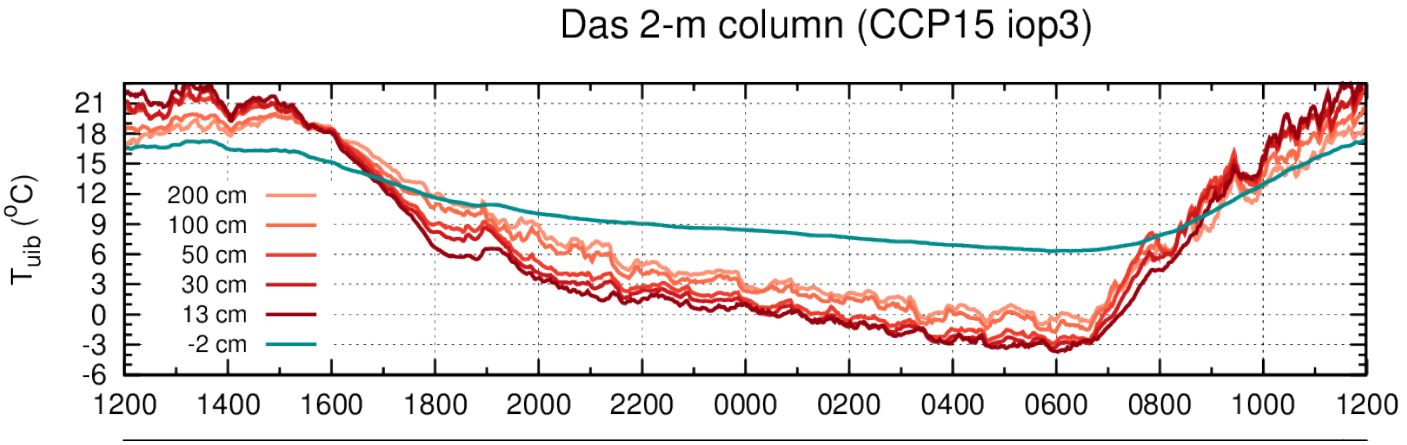


CCP15 field campaign: IOP3

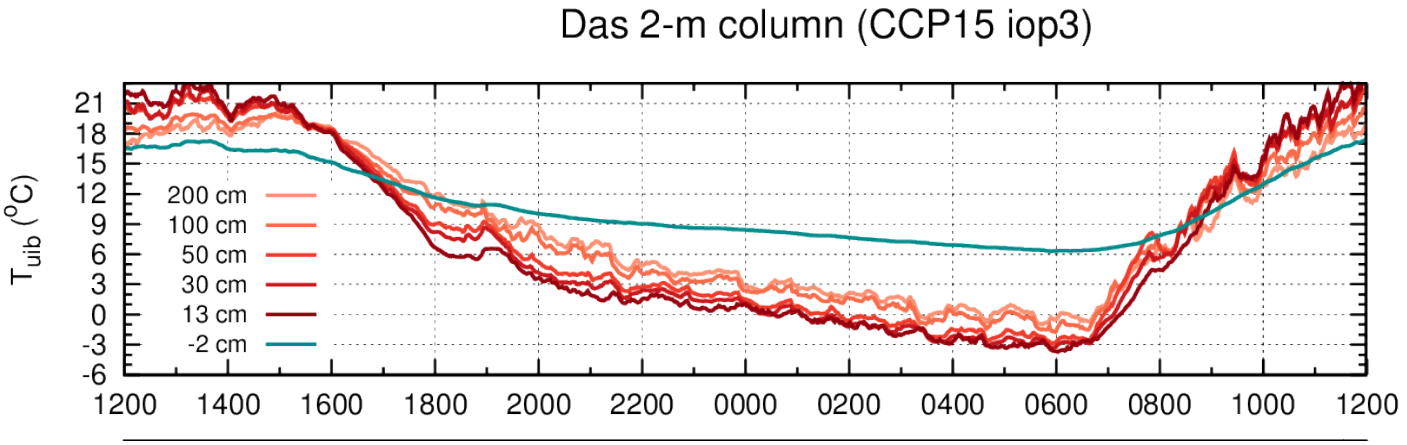


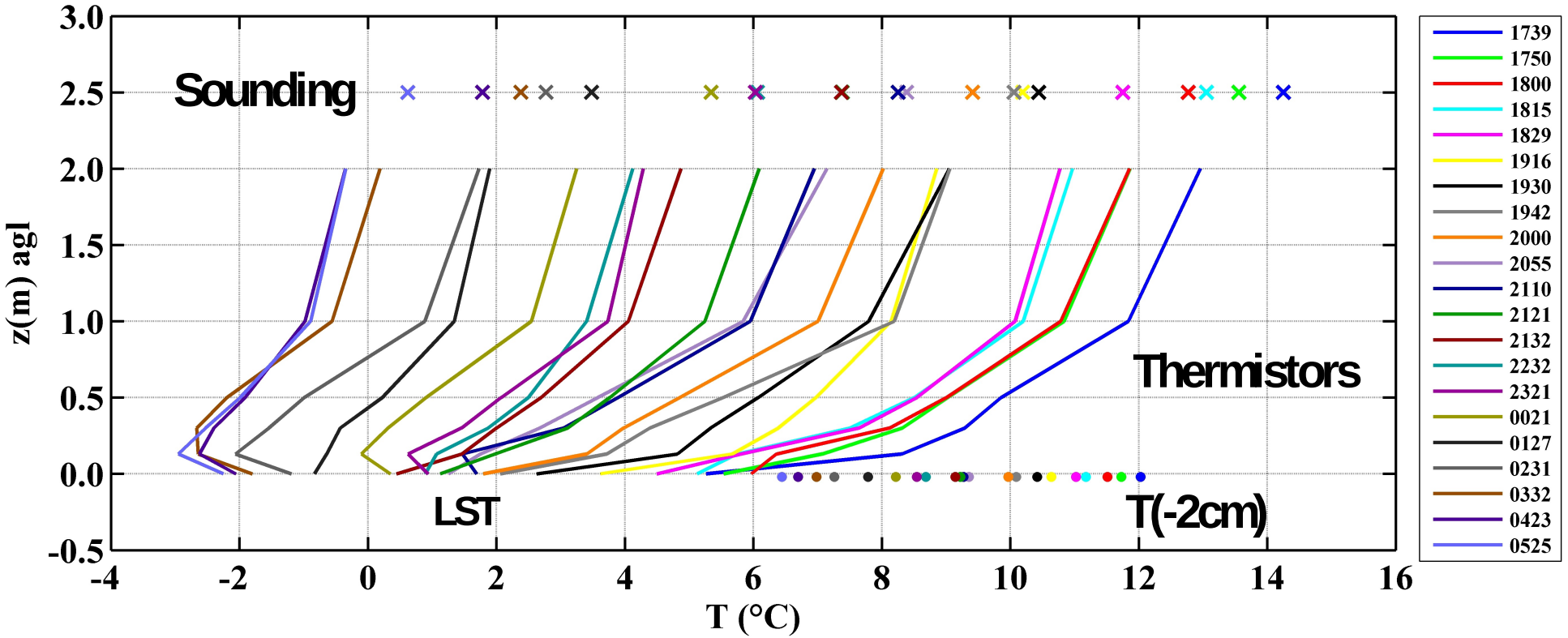


CCP15 field campaign: IOP3

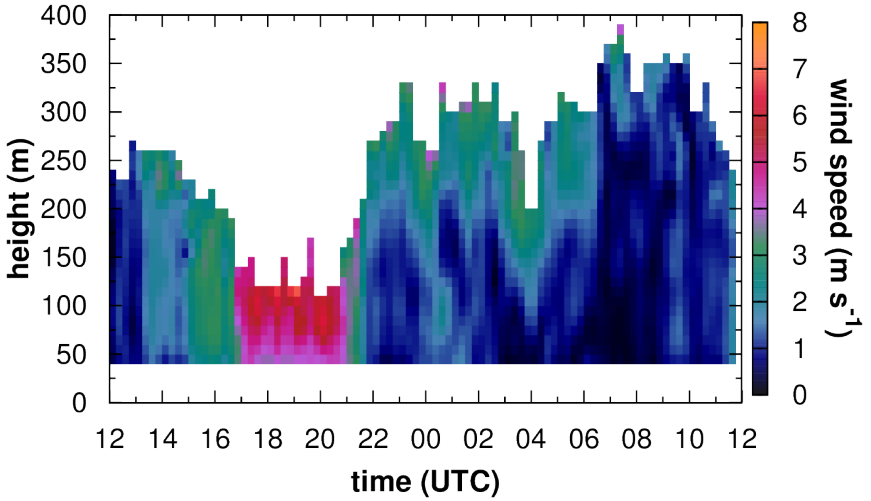


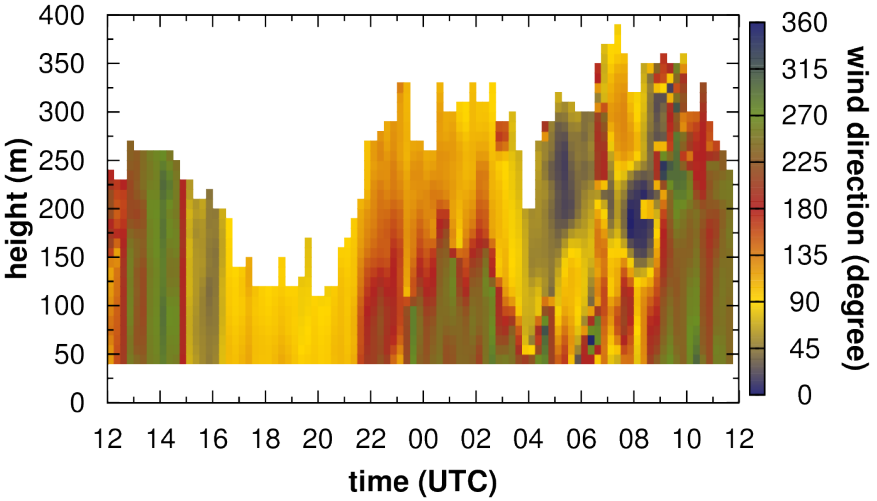
CCP15 field campaign: IOP3

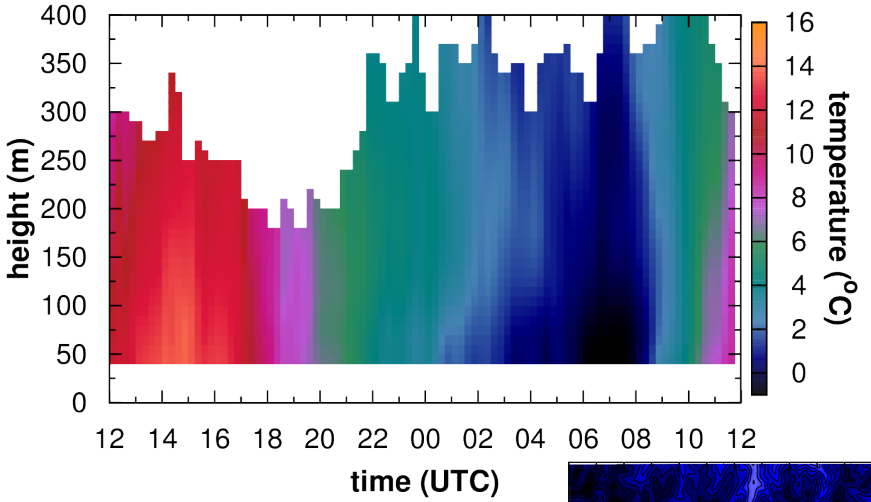


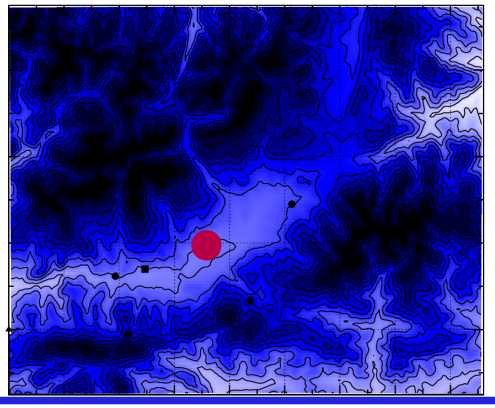


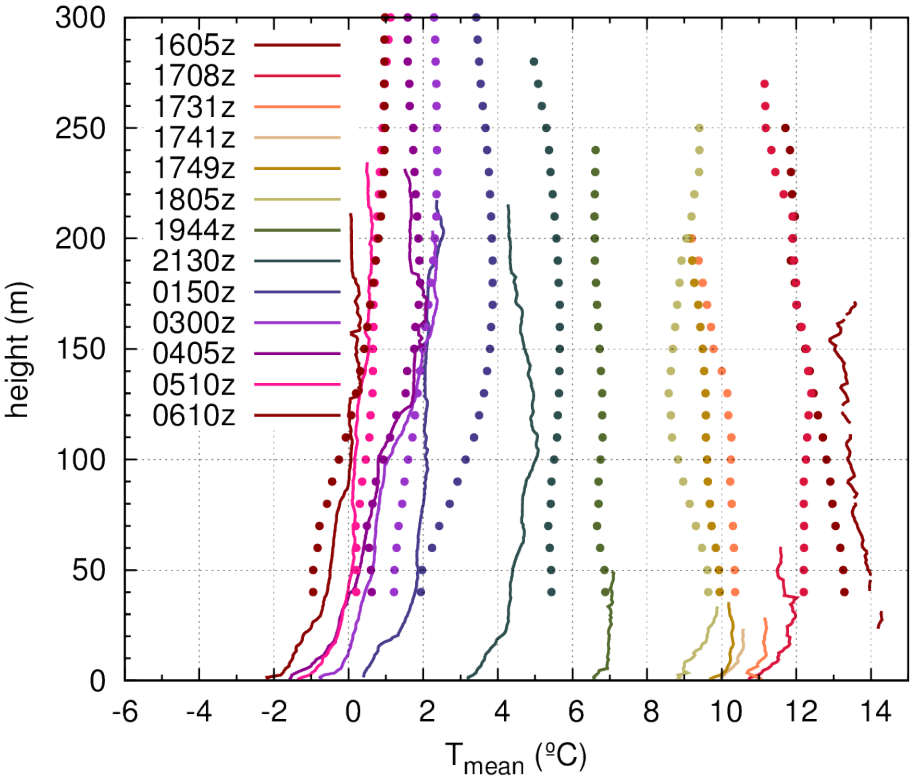
CCP15 field campaign: IOP5



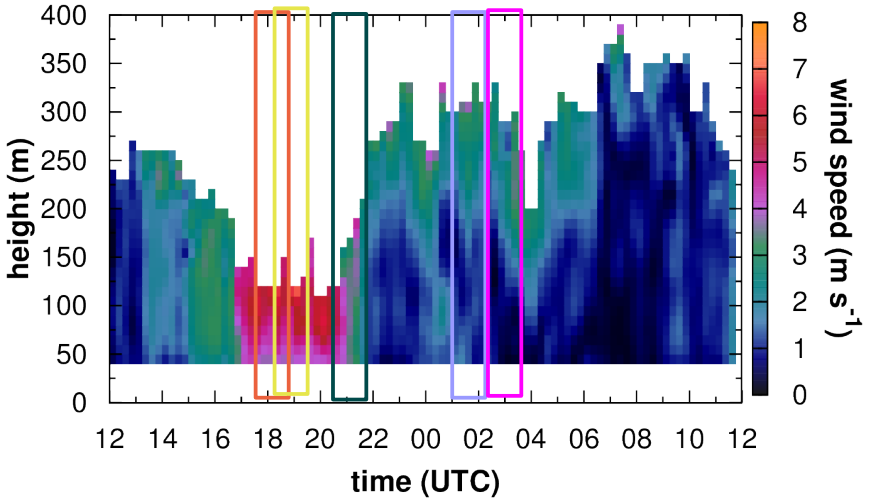


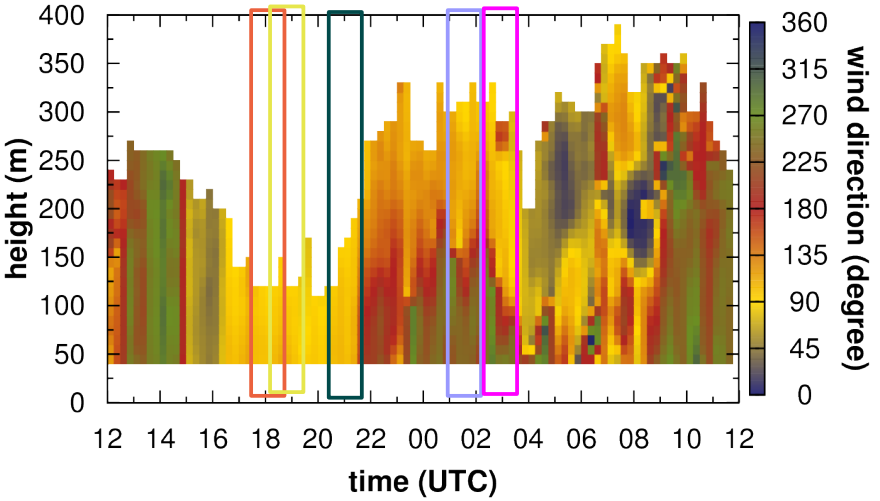


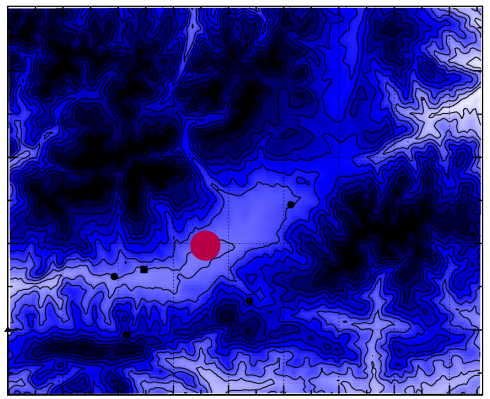


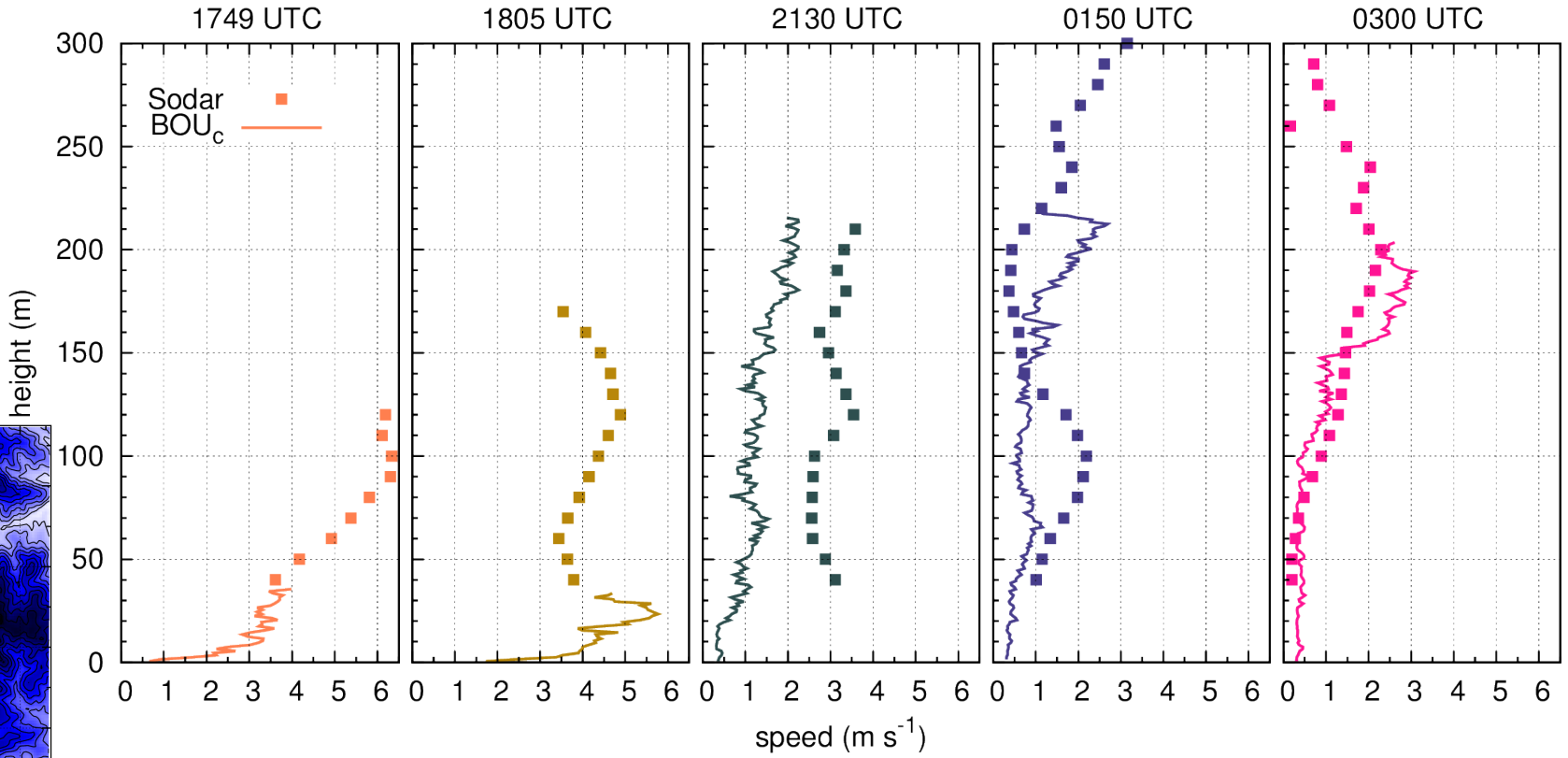


CCP15 field campaign: IOP5

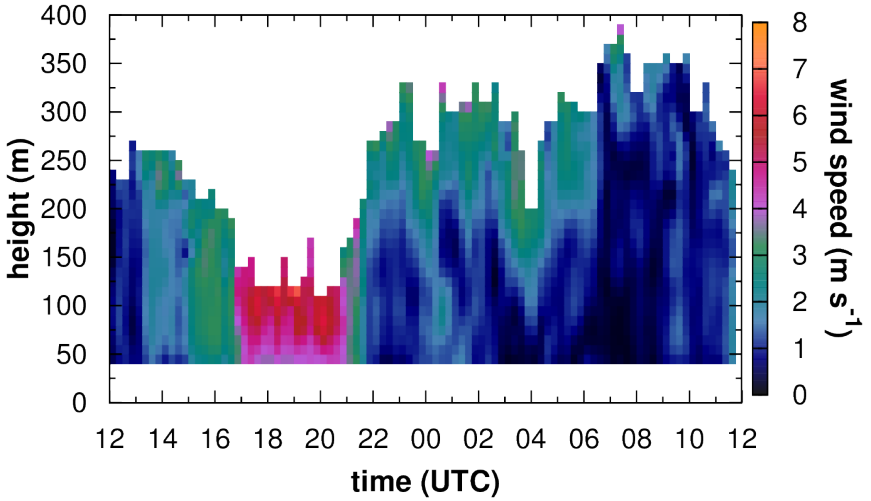


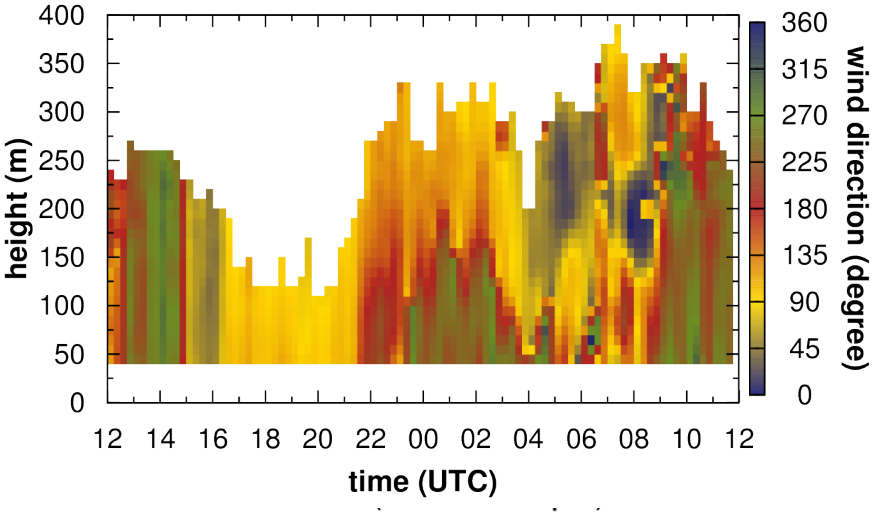


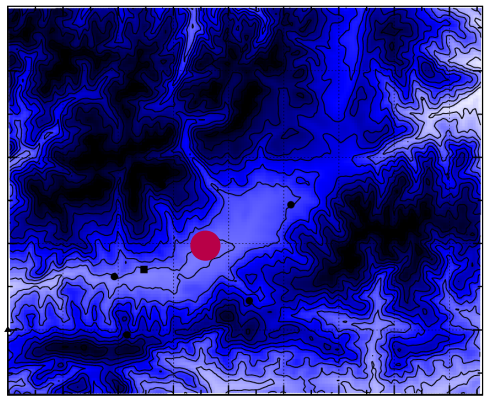


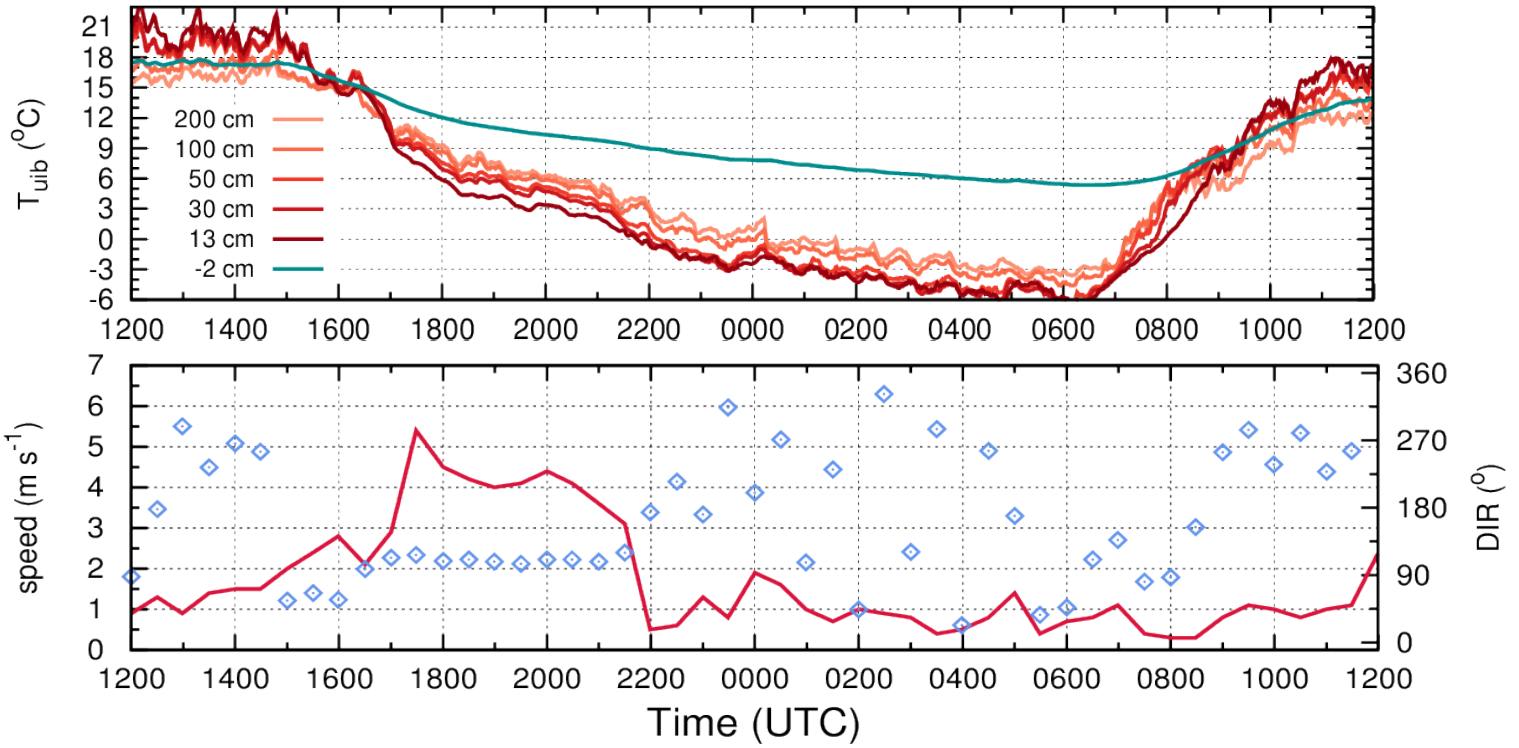


CCP15 field campaign: IOP5

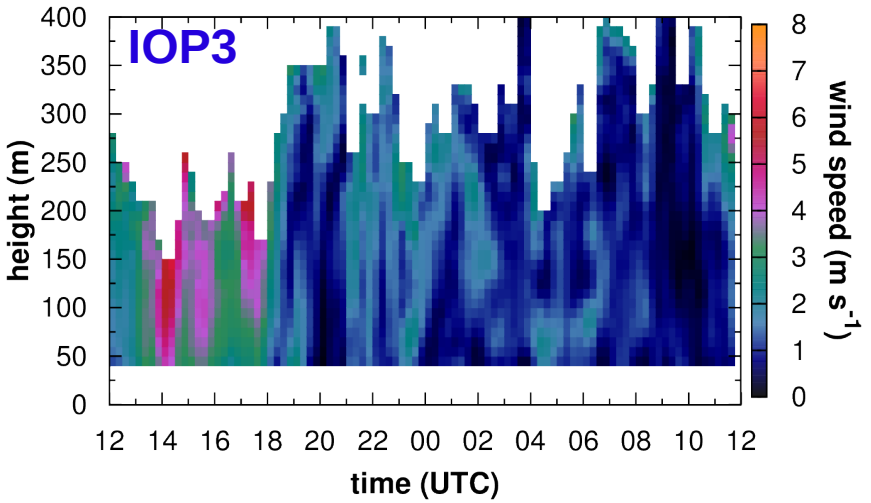


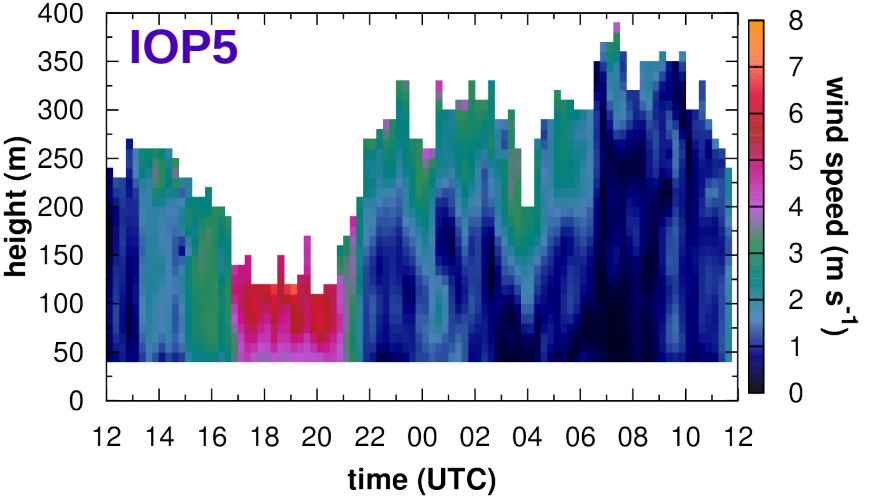


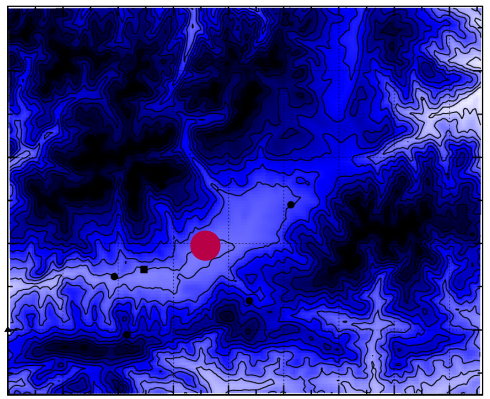


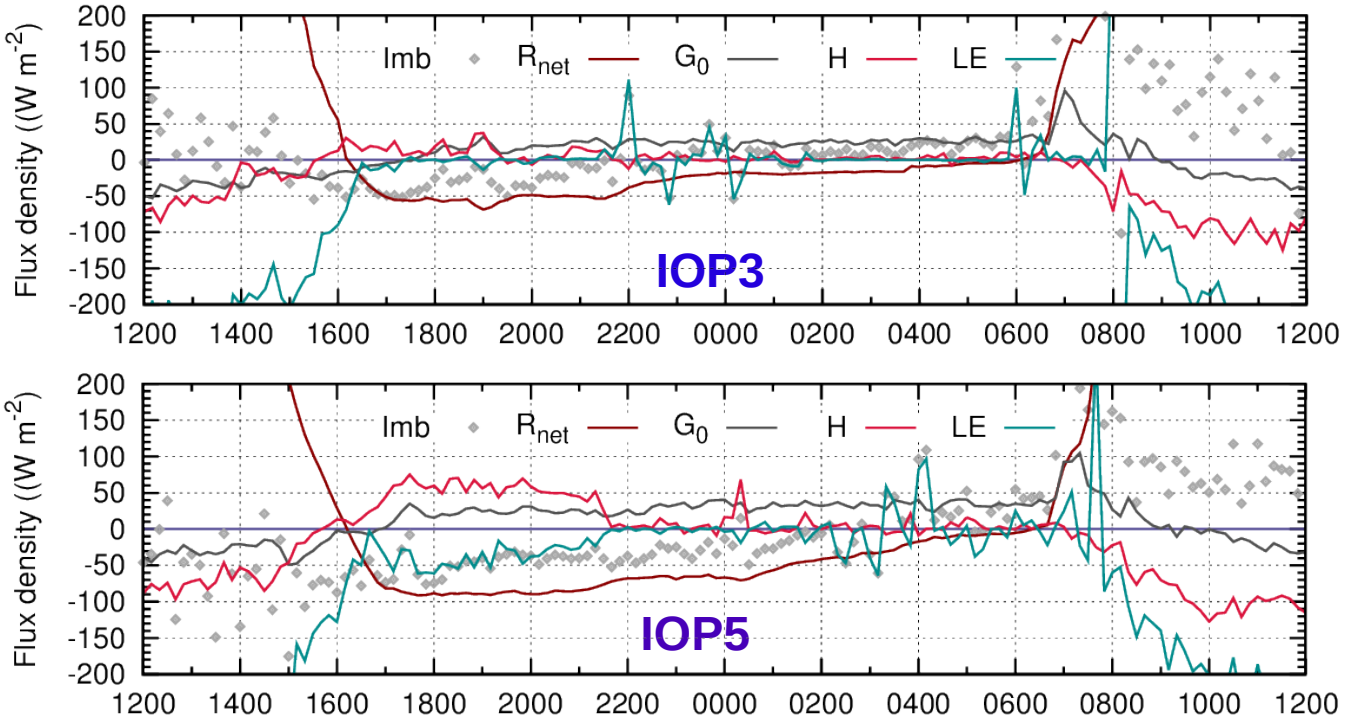


CCP15 field campaign: SEB









Summary

- **Aim:** study the structure and evolution of the CAP at the bottom part of the Cerdanya valley under fair weather conditions.
- A boundary-layer **temperature and wind profiler** and a **Surface Energy Budget** station were installed near the operational AWS at the Das Aerodrome. Both devices have been running for more than 2 years (Oct 2015 – Apr 2018).
- **CCP15 field campaign (6-15 Oct 2015):**
  - A 2-m column of **thermistors** to analyse the **surface thermal inversion**.
  - An additional surface weather station installed at a **secondary sub-basin** of the Cerdanya valley located few kilometres downstream to evaluate the **spatial thermal differences** at the surface.
  - **5 IOPs** were identified: variety of cases that allow to study the cold-air pool formation and development of local winds **under quiescent conditions**, under the presence of a significant **background wind channelized** along the main valley axis **or with increasing cloud cover**.
    - Differences in development of ***T* inversion**.
    - **SEB** terms (+ Imbalance).

Further (on going) work

- **High-resolution mesoscale simulations** performed for each IOP.
  - Validation against observations.
  - Assessment in the **physical mechanisms** responsible for **intensive cooling** within the valley and...
  - … in the description of the **valley wind system** and influence of the larger scale wind patterns.
- Put the findings from **CCP15** in context with the **4-year statistical study** and...
- … with the **CCP17** field campaign (**winter**).

Acknowledgements:

- Data provided by three meteorological services (**Meteocat**, **AEMET**, **Meteofrance**).
- Thanks to the **staff** from the **Das Aerodrome** (they were really helpful).
- Grants of the Spanish Government **CGL2015-65627-C3-1-R** (that includes Regional Funds **FEDER**) and **PCIN-2014-016-C07-01** (within the framework of **ERA NET PLUS NEWA**).

Govern de les Illes Balears

MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Further (on going) work

- **High-resolution mesoscale simulations** performed for each IOP.
  - Validation against observations.
  - Assessment in the **physical mechanisms** responsible for **intensive cooling** within the valley and...
  - … in the description of the **valley wind system** and influence of the larger scale wind patterns.
- Put the findings from **CCP15** in context with the **4-year statistical study** and...
- … with the **CCP17** field campaign (**winter**).

Thank you!

Acknowledgements:

- Data provided by three meteorological services (**Meteocat**, **AEMET**, **Meteofrance**).
- Thanks to the **staff** from the **Das Aerodrome** (they were really helpful).
- Grants of the Spanish Government **CGL2015-65627-C3-1-R** (that includes Regional Funds **FEDER**) and **PCIN-2014-016-C07-01** (within the framework of **ERA NET PLUS NEWA**).

Govern de les Illes Balears

MINISTERIO
DE ECONOMÍA
Y COMPETITIVIDAD