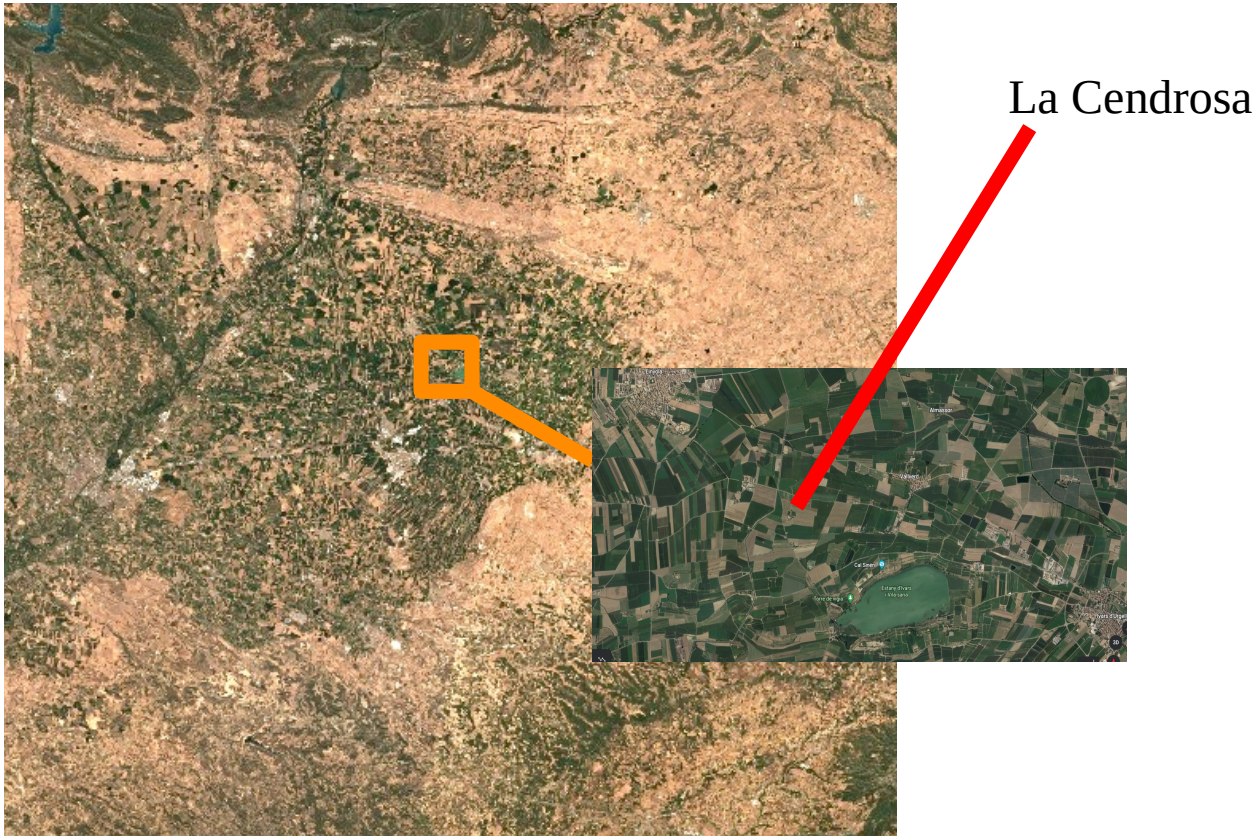
What turbulent processes in the lower atmosphere are observed over a irrigated surface during the LIAISE campaign?

G. Canut [1] , M. Lothon [2] , L.Joly [3] , A. Boone [1] , J. Couzinier [1] , J.C Etienne [1] , E. Moulin [1] and A. Roy [1]

[1]*CNRM, Météo-France UMR 3589 CNRS, Toulouse, France*
[2]*LAERO, Univ. of Toulouse, CNRS, UPS, Toulouse, France*
[3]*GSMA, Université de REIMS, CNRS, France*

Context, objectives

- La cendrosa, irrigated alpha field



Context, objectives

- La cendrosa, irrigated alpha field
- Long period deploiement (april → october 2021)
  - More observations during the SOP (15-28 july)
- Observations of the surface energy budget
- Observations of the vertical profile of the turbulence to :
  - Improve the knowledge of the low layer and of the vertical distribution of the humidity in the boundary layer
  - Evaluate models

Outlines

- Overview of data

  1- from 50 m tower

  2- from doppler lidar

  3- from tethered ballon

- Perspectives & conclusions

1- Data from 50m mast

Mean parameters :
0,2m 2m 10m 25m and 45m
Soil parameters :
3 levels : -5cm, -10cm, -30 cm
Wind at 10m
precipitation

Turbulent fluxes :
2 levels with sonic (Gill) and licor : 3 m and 50 m
1 levels with sonic : 25m

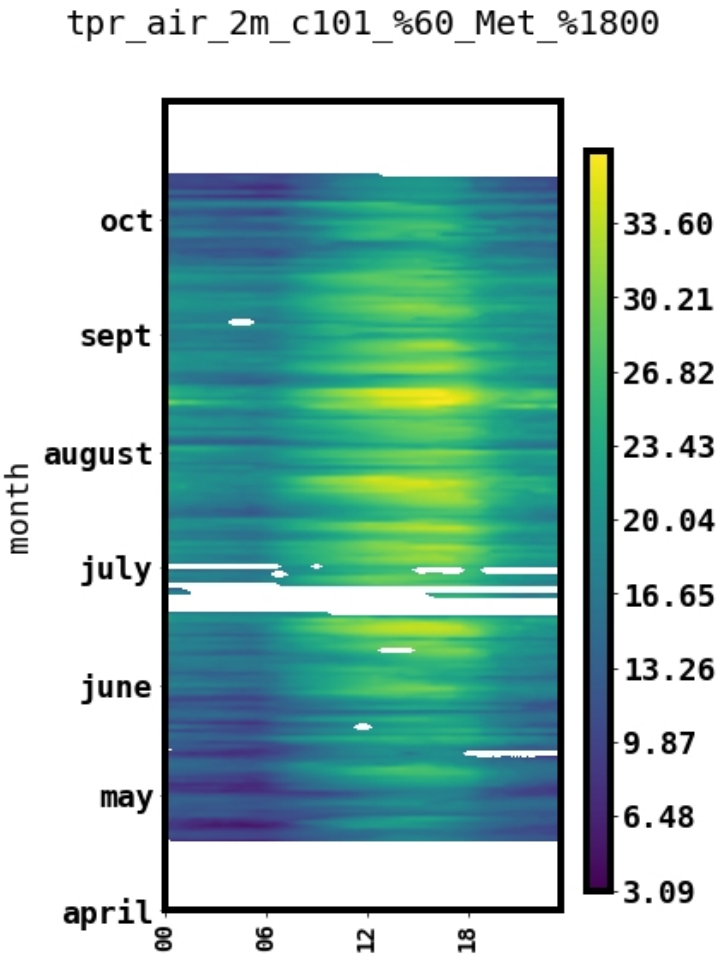
Radiatives fluxes (CNR4) :
1 levels at 1m

1 – Data from 50m mast

- **15 april to 12 october**
  Good availability during the long period electrical problem 18-25 june

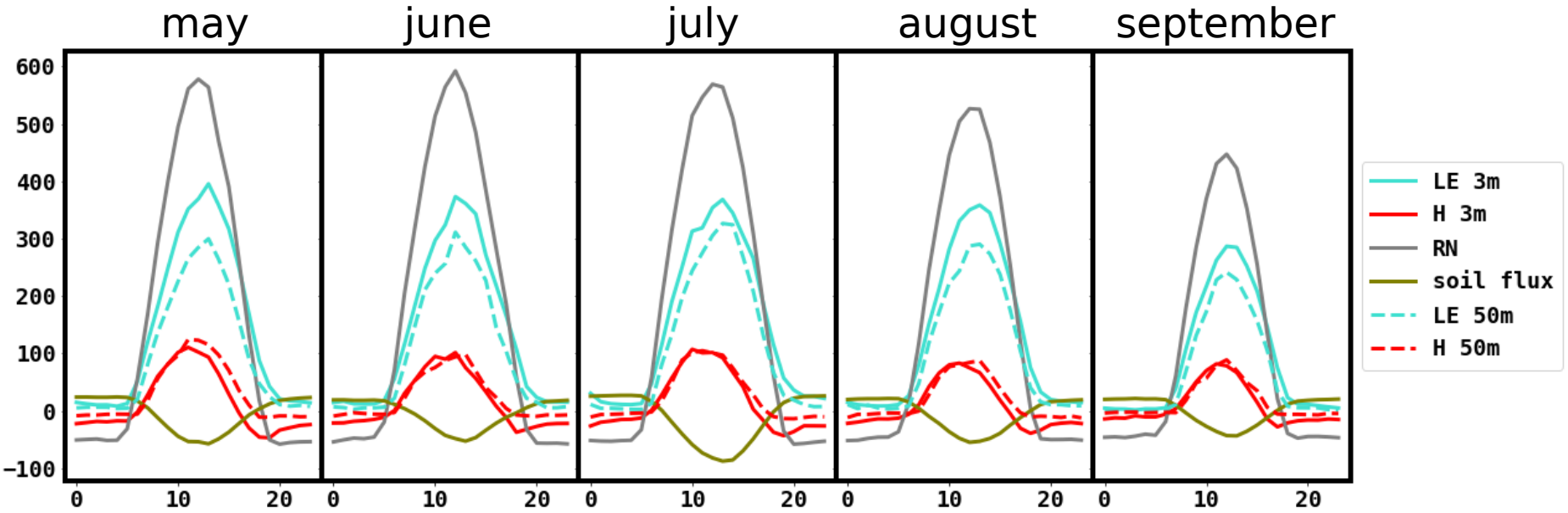
- **SOP period in july**
  continuous data

- **Heat fluxes processing**
  - despiking using a threshold on the variance
  - 2d rotation
  - detrending, use a low-pass filter
  - maximum covariance
  - spectral correction
  - flag quality (0,1,2 according to Mauder (2004))



1- Data from 50m mast

- **Mean diurnal cycle by month**

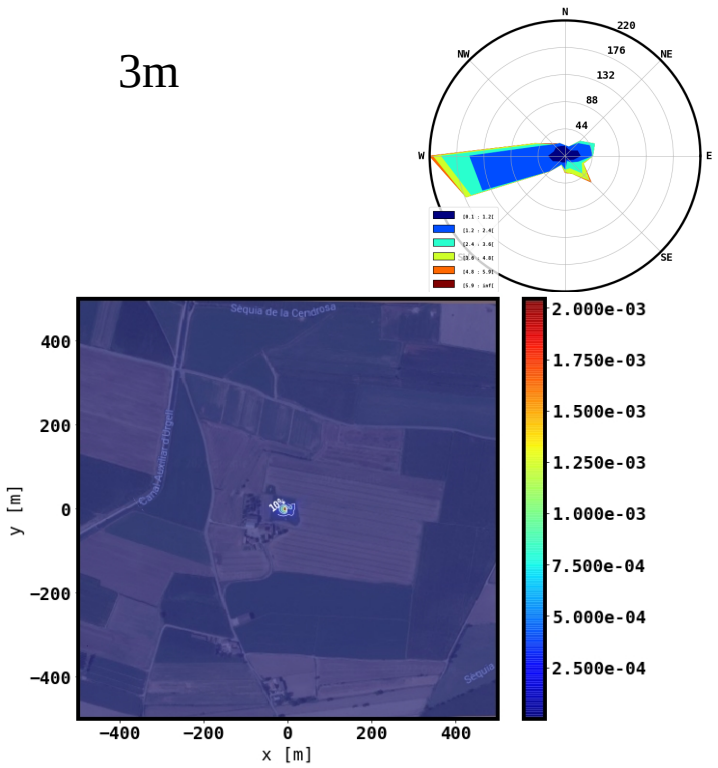


- Similar behaviour
  - same net radiation : may , june, july
  - small difference between 3 and 50m for H
  - larger difference for LE
  - in july, the difference 3m/50m for LE is smaller, values at 50m higher
  - soil fluxes, larger in july

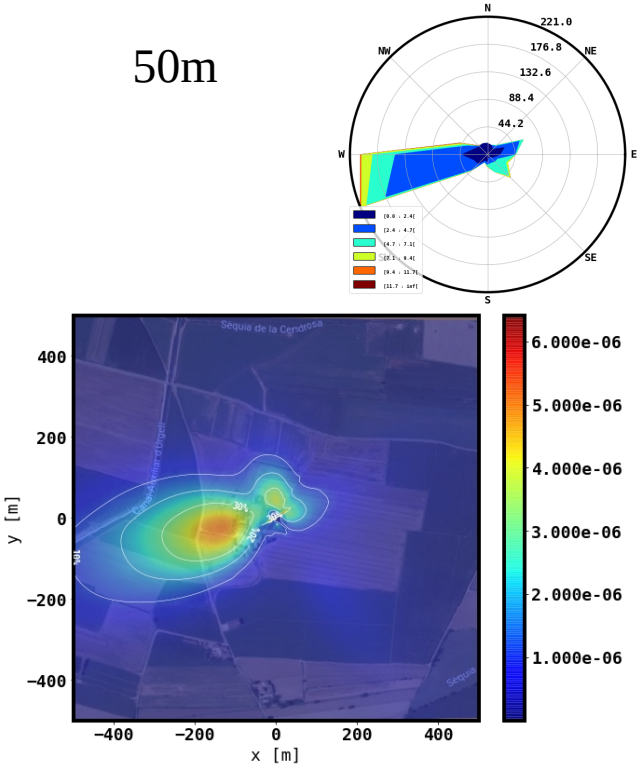
1- Data from 50m mast

- Footprint (Kljun 2014, 2D) (july when net radiation>20W/m2)

3m



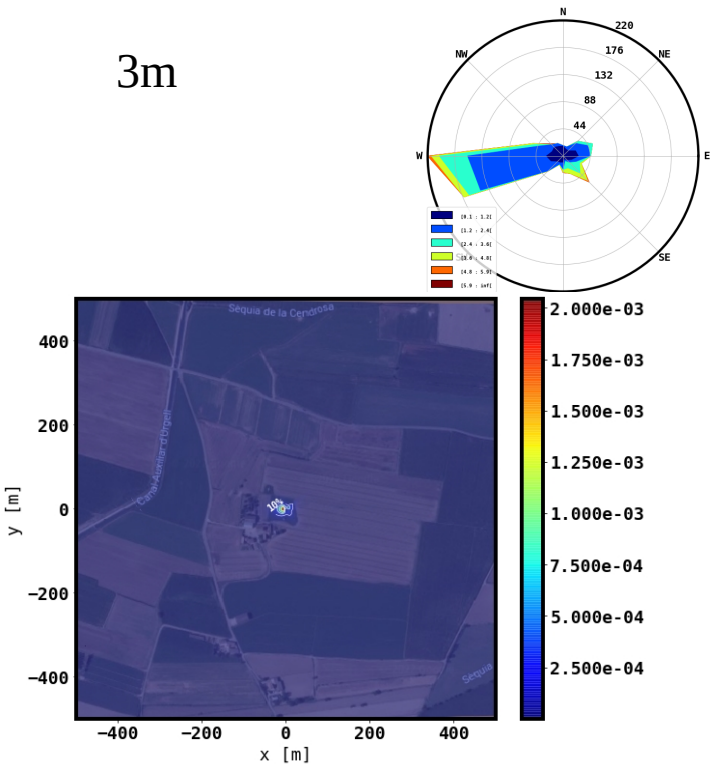
50m



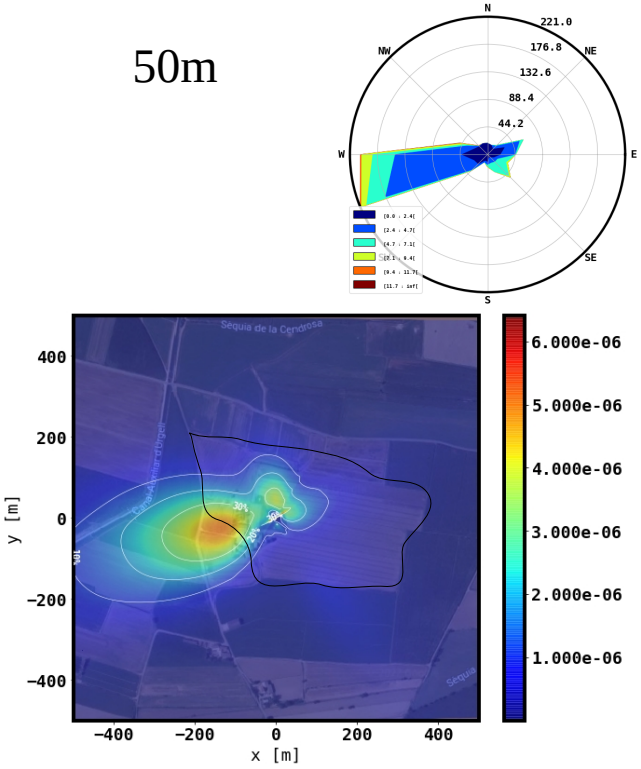
1- Data from 50m mast

- Footprint (Kljun 2014, 2D) (jully when net radiation>20W/m2)

3m



50m



Be careful , footprint at west of the alpha alpha field

2- Doppler lidar Windcube

Availibilty data : 8june-10 october

Leosphere (Vaisala company) Wincube7, 4 lasers
3 wind components : W, U, V
Temporal resolution : 1s and 10 minutes processing
Vertical resolution : 20 m
Alt min : 40m
Alt max : 240m

Research mode with data available every second → estimation of **variance and TKE**

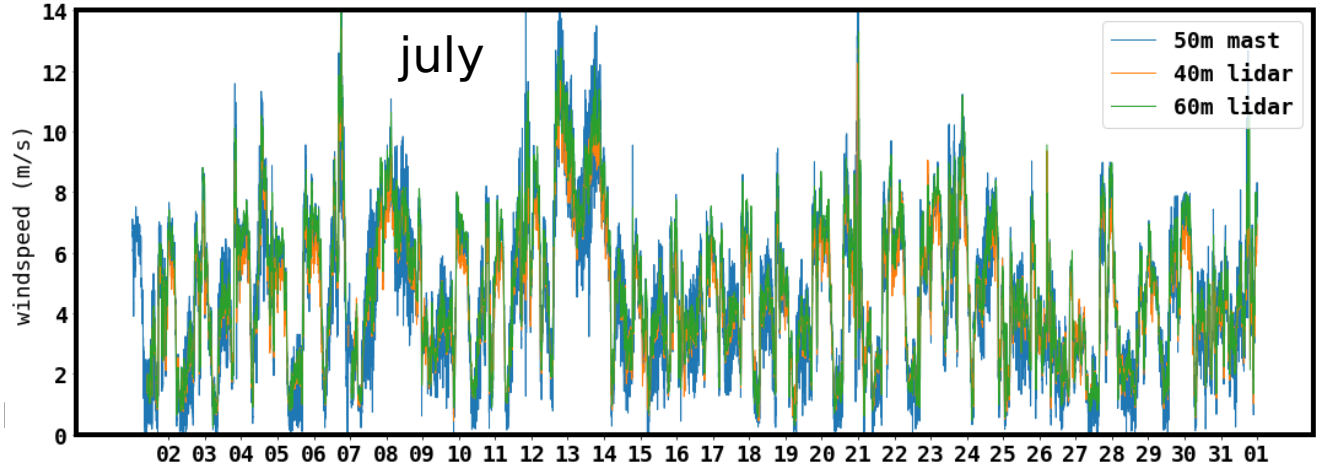
2- Doppler lidar Windcube

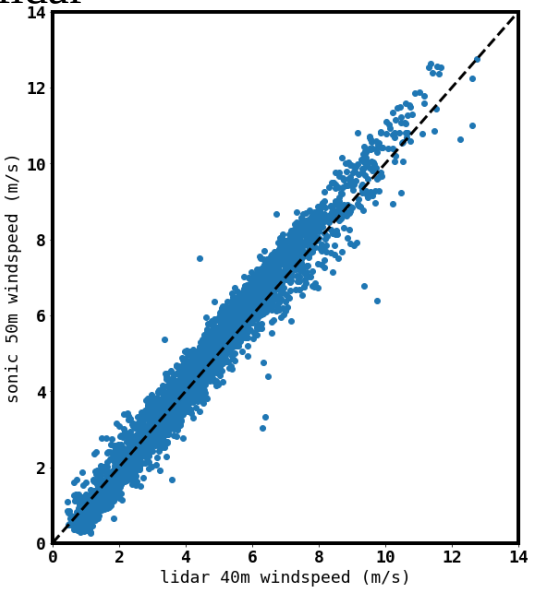
Availibilty data : 8june-10 octobre

Leosphere (Vaisala company) Wincube7, 4 lasers
3 wind components : W, U, V
Temporal resolution : 1s and 10 minutes processing
Vertical resolution : 20 m
Alt min : 40m
Alt max : 240m

Research mode with data available every second → estimation of **variance and TKE**

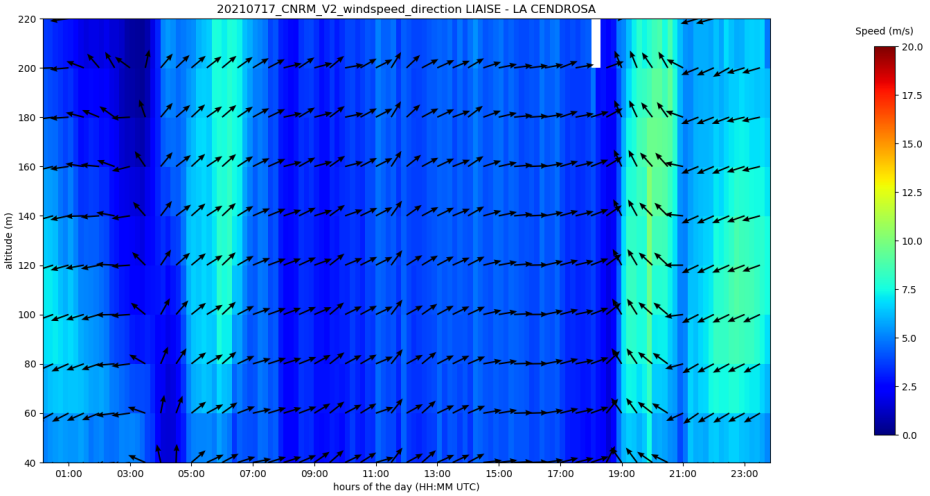
→ Mean data : good agreement between sonic anemometer and wind from lidar



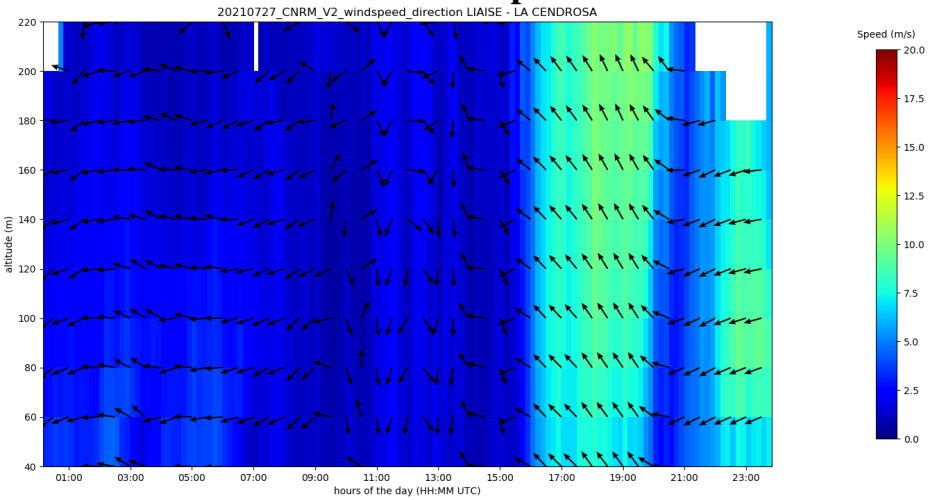


2- Doppler lidar Windcube

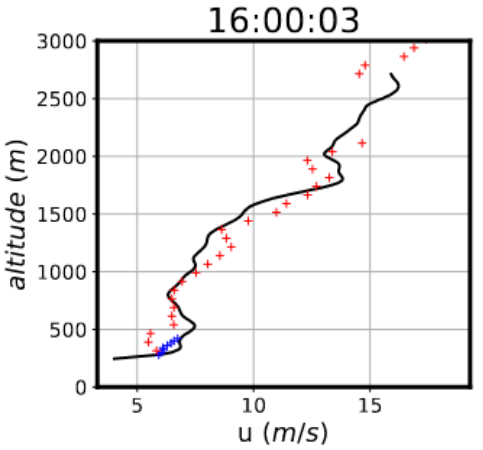
17/07/2021 10 minutes wind speed and direction



27/07/2021 10 minutes wind speed and direction



- A fine description of the low layer
- ideal for identifying wind shifts
- A complement to the UHF wind profiler



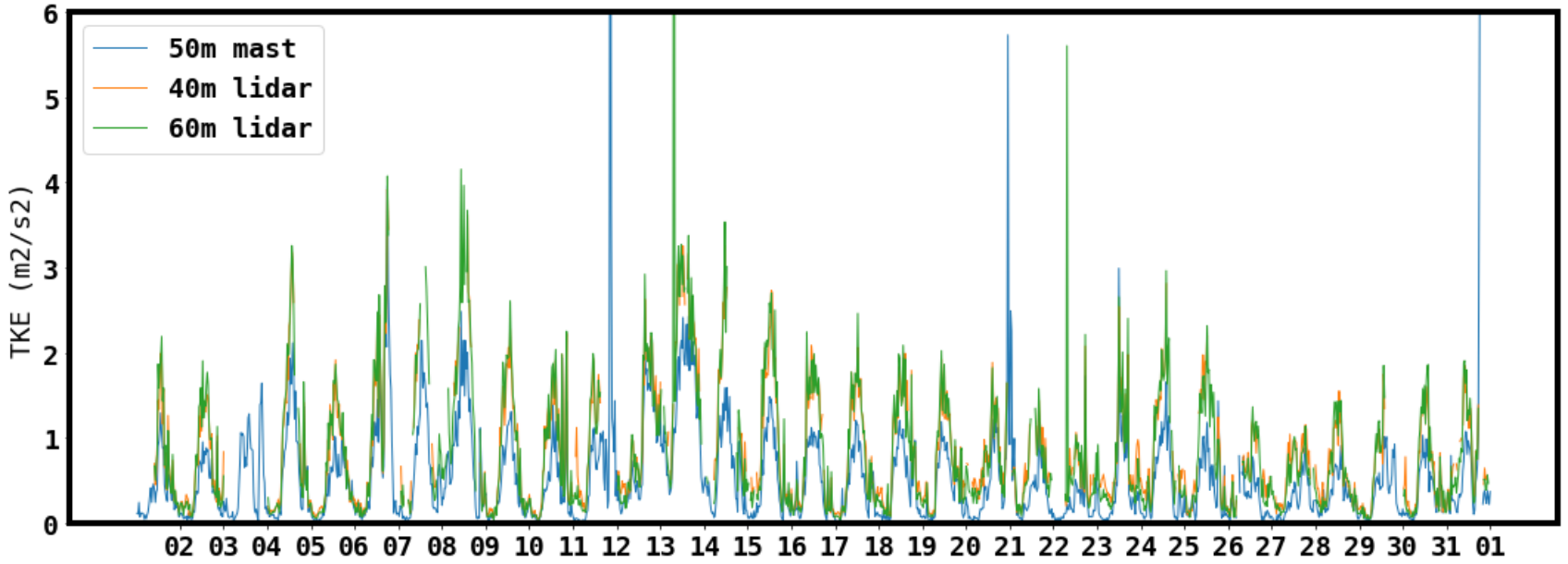
- RS
+Lidar
+UHF

2- Doppler lidar Windcube

Why to know TKE in the low layer?

- **It is one of the most important variables used to study turbulent boundary layers since it quantifies the intensity of turbulence which controls vertical mixing**
- Pronostic equation on various models (AROME or meso-NH models from Météo-France) for turbulence

TKE calculated every 30 minutes with 1s data for july



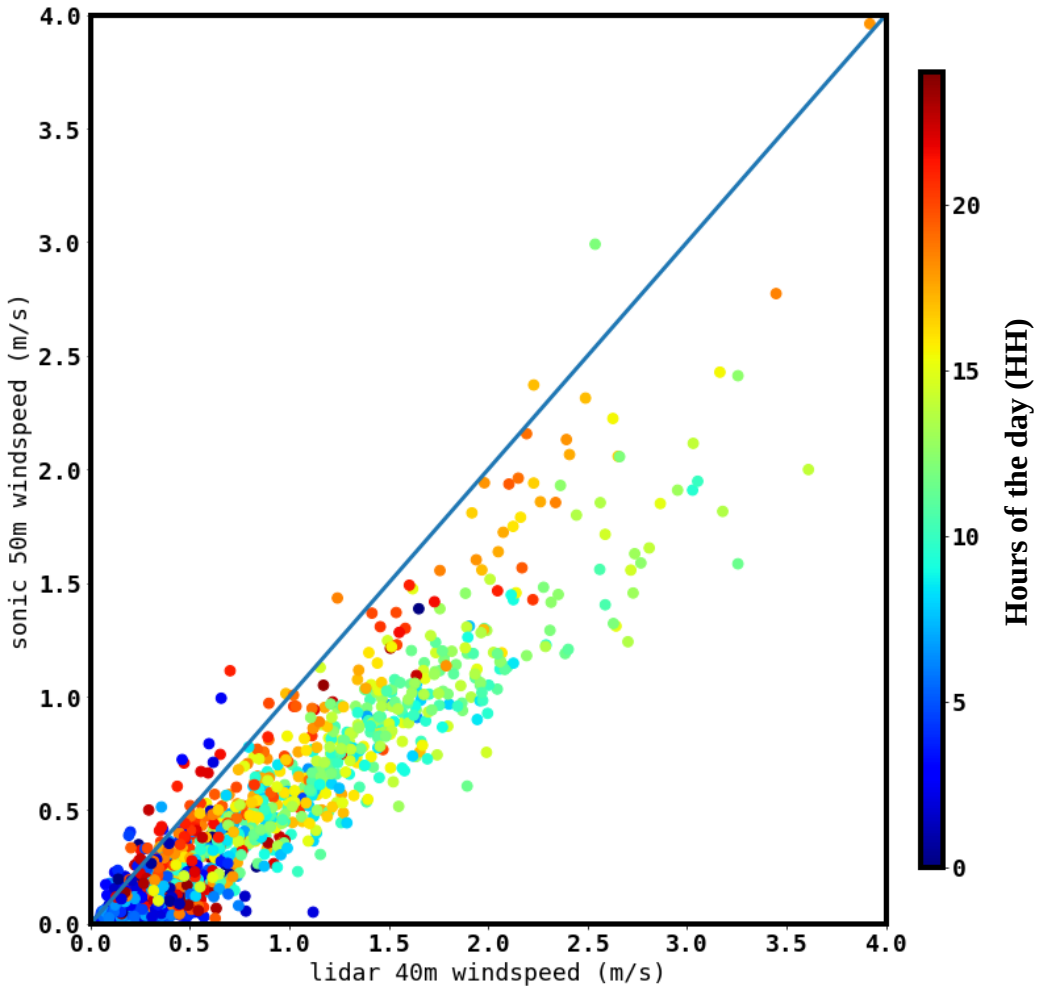
→ **Similar behaviour but differences in daytime amplitude**

2- Doppler lidar Windcube

Why to know TKE in the low layer?

- **It is one of the most important variables used to study turbulent boundary layers since it quantifies the intensity of turbulence which controls vertical mixing**
- Pronostic equation on various models (AROME or meso-NH models from Météo-France) for turbulence

TKE calculated every 30 minutes with 1s data for july



- underestimation by lidar
- needs to be further investigated

3- Tethered ballon

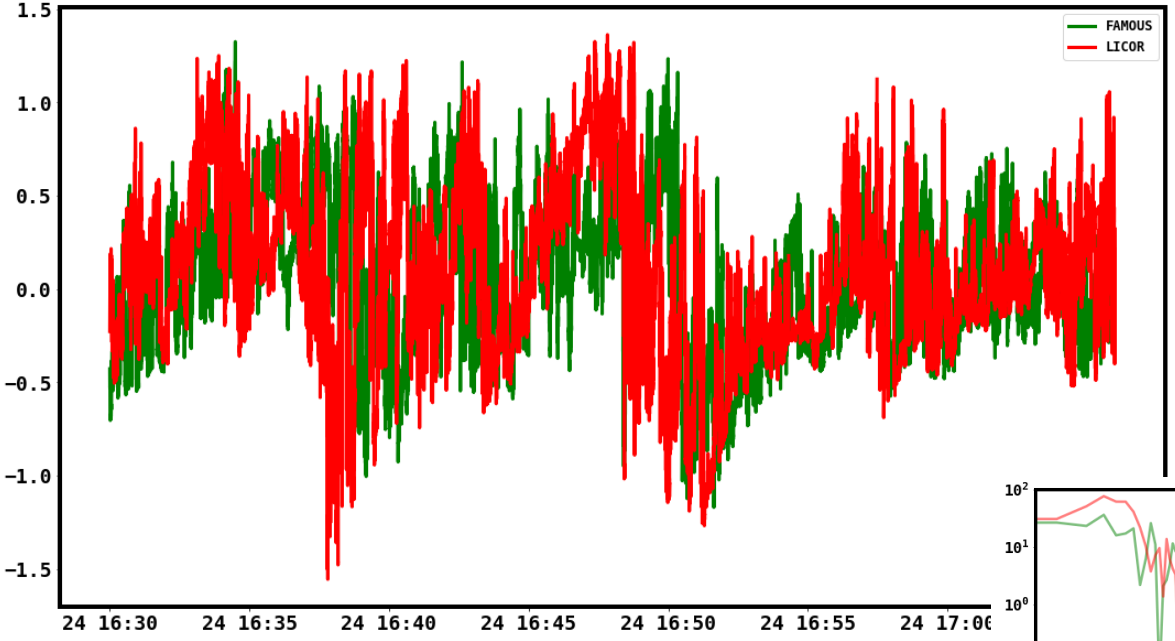
- To better understand what is happening as a turbulent exchange in the boundary layer, use of aircraft measurement and surface station.
- The tethered ballon fills the area between the two
- Since 2010, a turbulence probe with sonic and motion sensor
- Since 2020, sonic and motion sensor and FAMOUS (Fast humidity sensor in collaboration with GSMA of Reims (france))

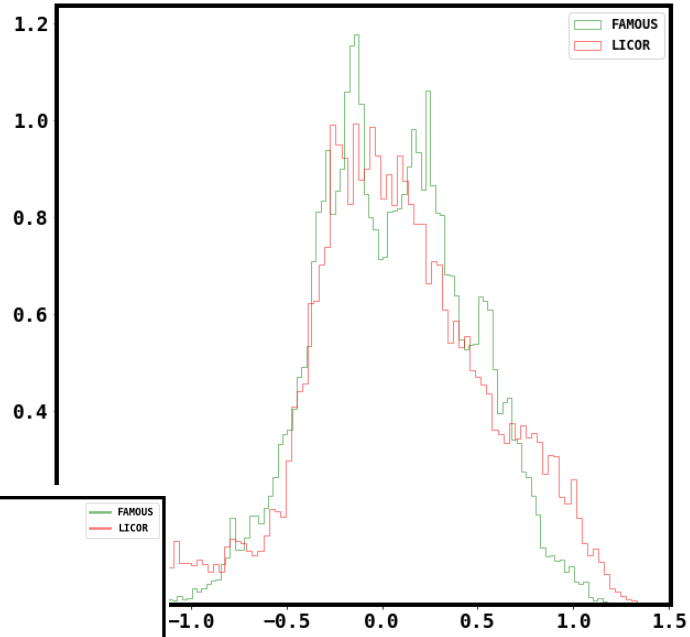
→ **Famous project, LIAISE first campaign**
A favorable context to measure humidity exchange

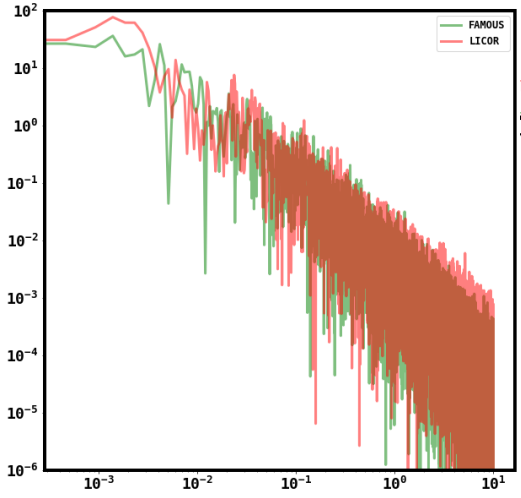
3- Tethered ballon

- Validation of humidity fluctuation at 20 hertz

  Famous vs licor 7500 @50m



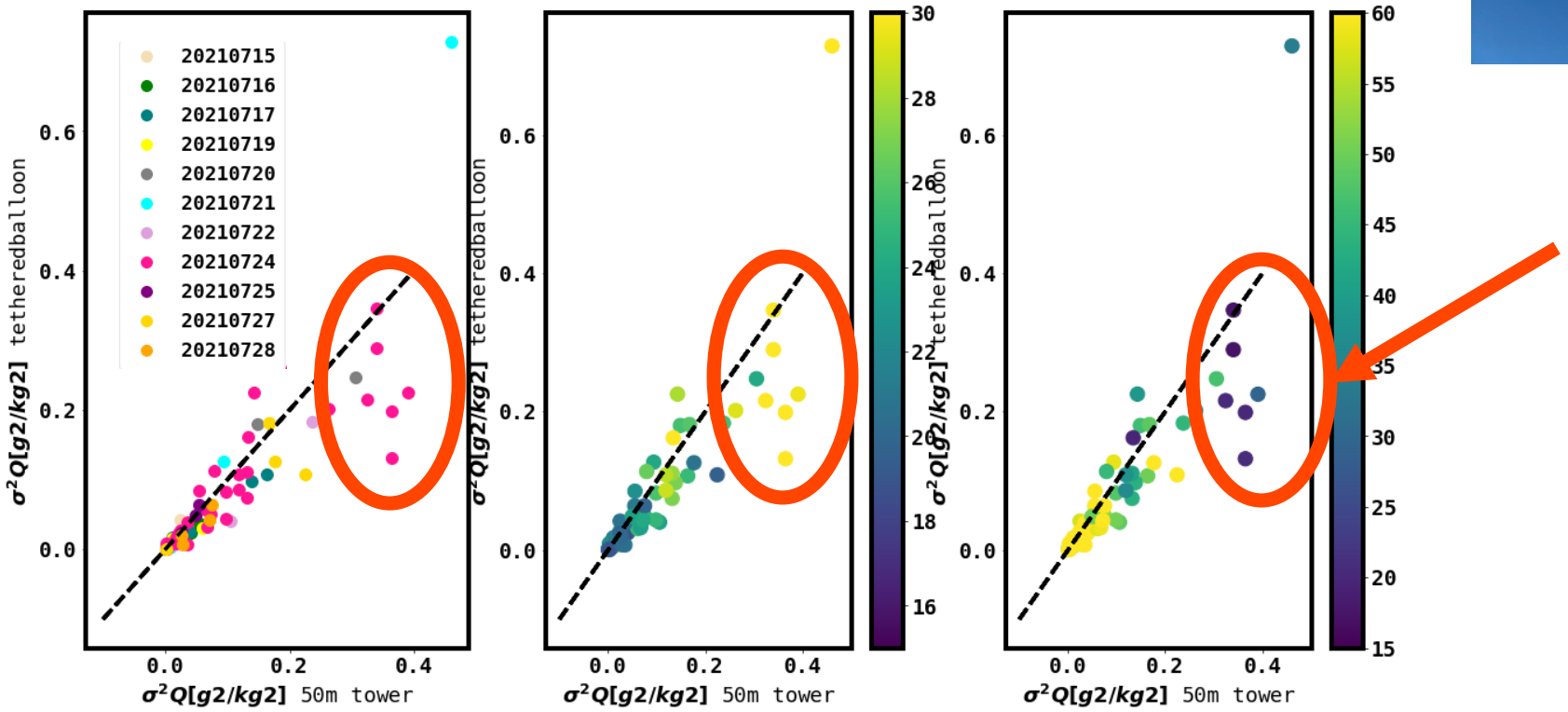




3- Tethered ballon

- Validation of humidity variance

  Famous vs licor 7500 @50m

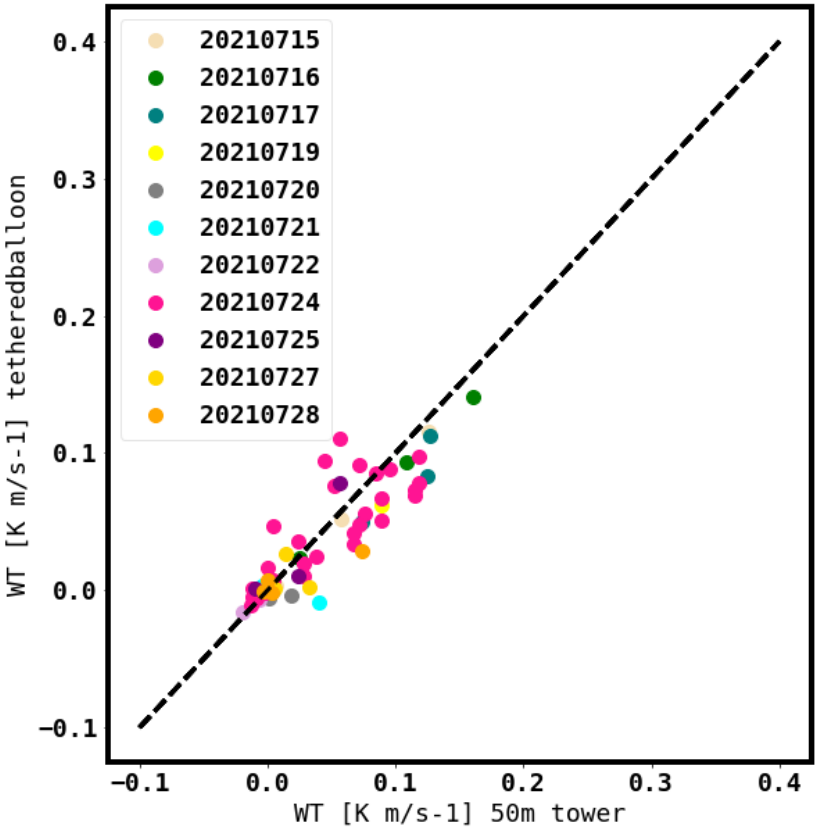


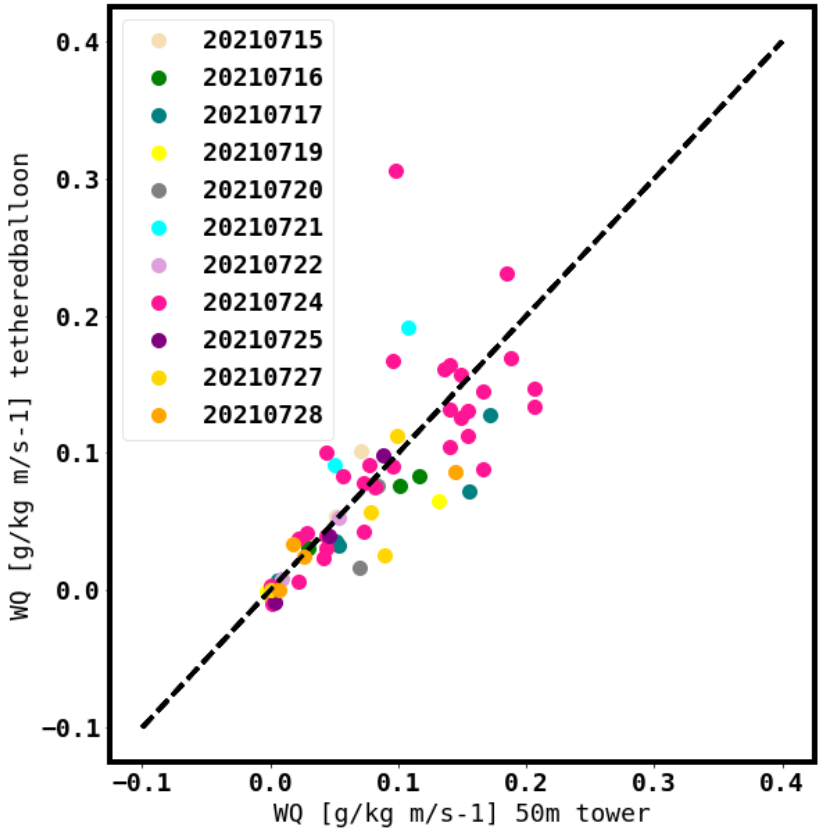
Greater difference on the hottest and driest day (24/07)

3-Tethered ballon

- Validation of heat fluxes

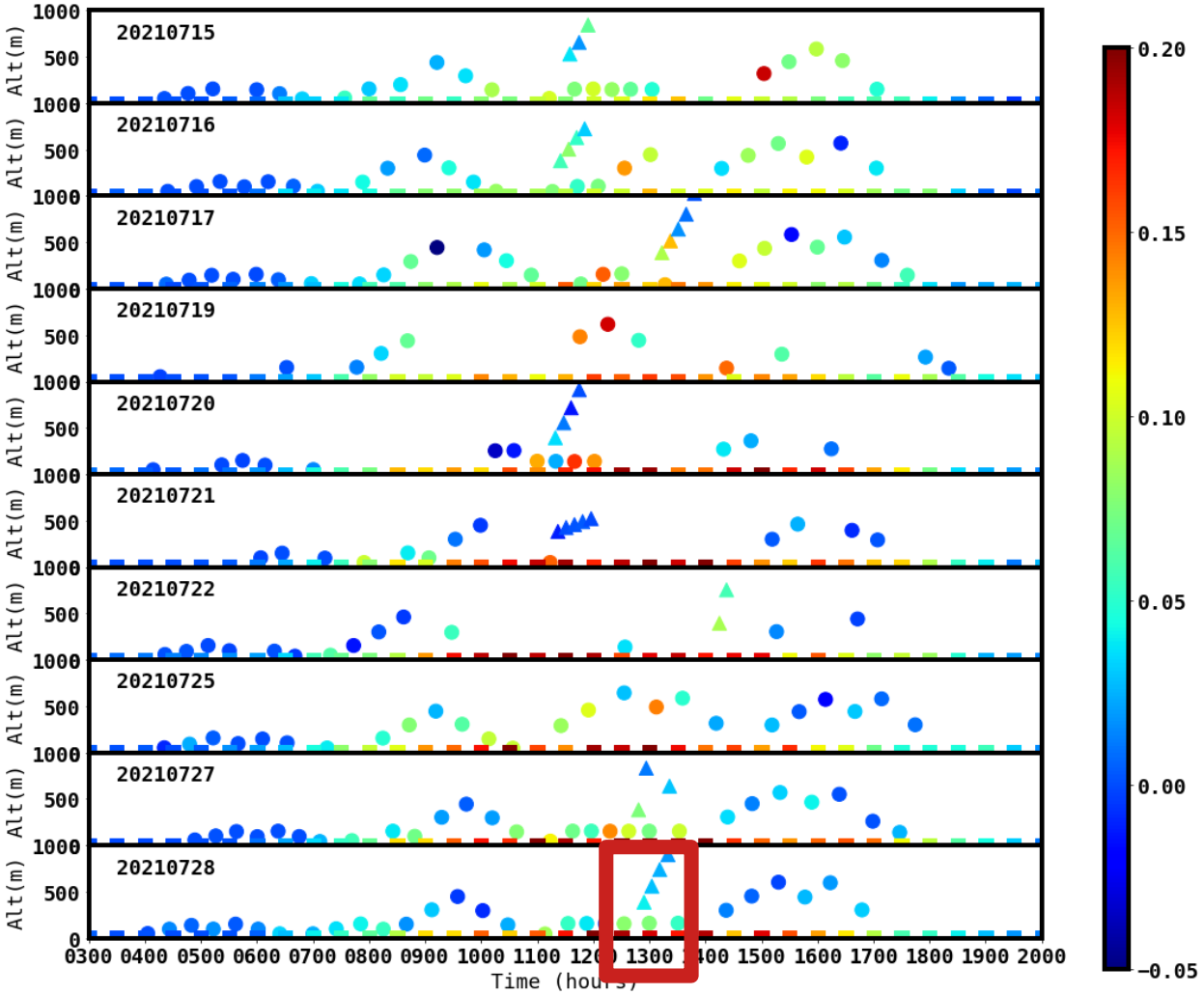
  Famous vs licor 7500 @50m





3- Tethered ballon

- Overview of the variance of humidity at differents levels



Avion (licor)

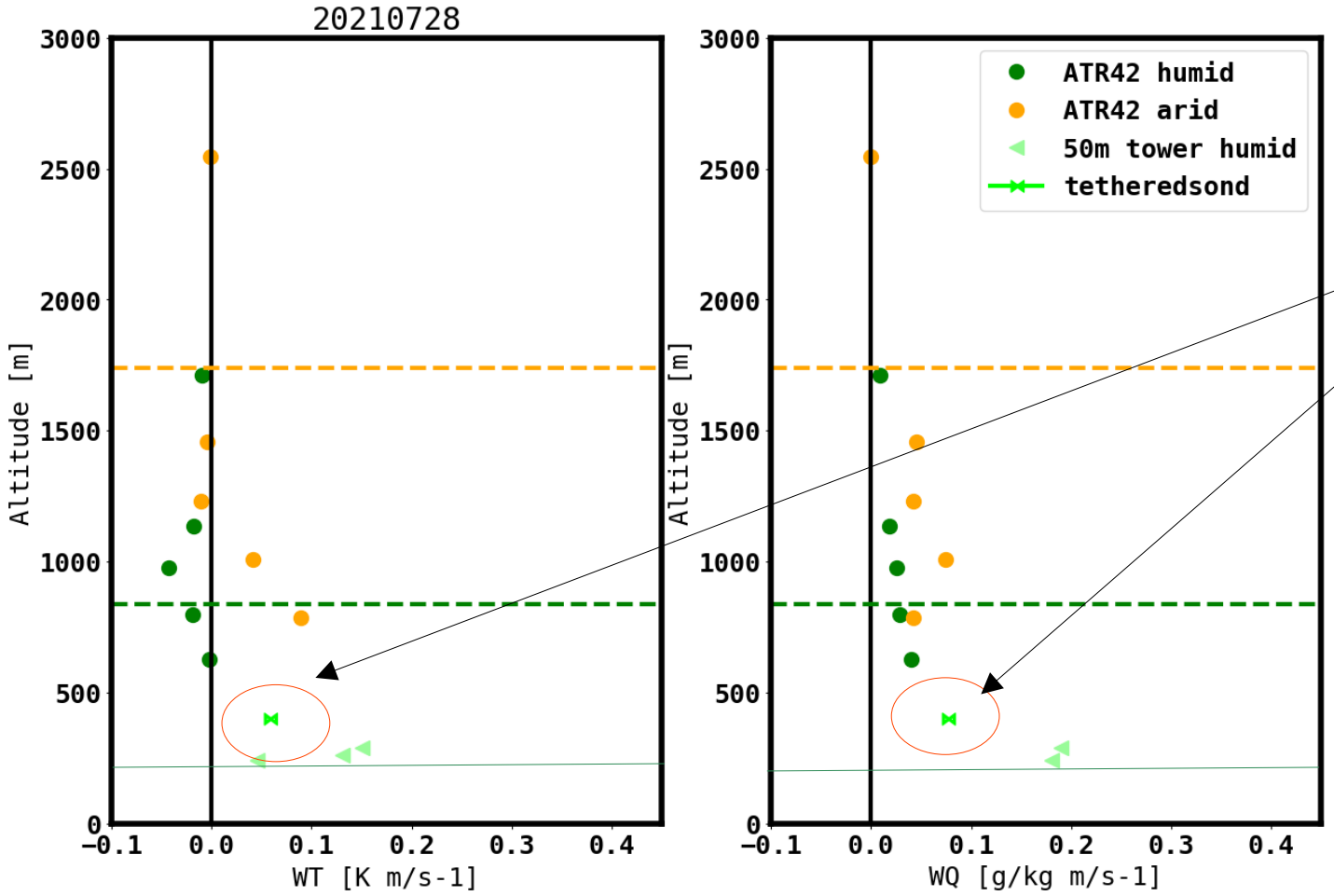
Ballon (Famous)

Mat de 50m (licor)

10 days with 8 with aircraft

3- Tethered ballon

- Overview of the heat fluxes at differents levels



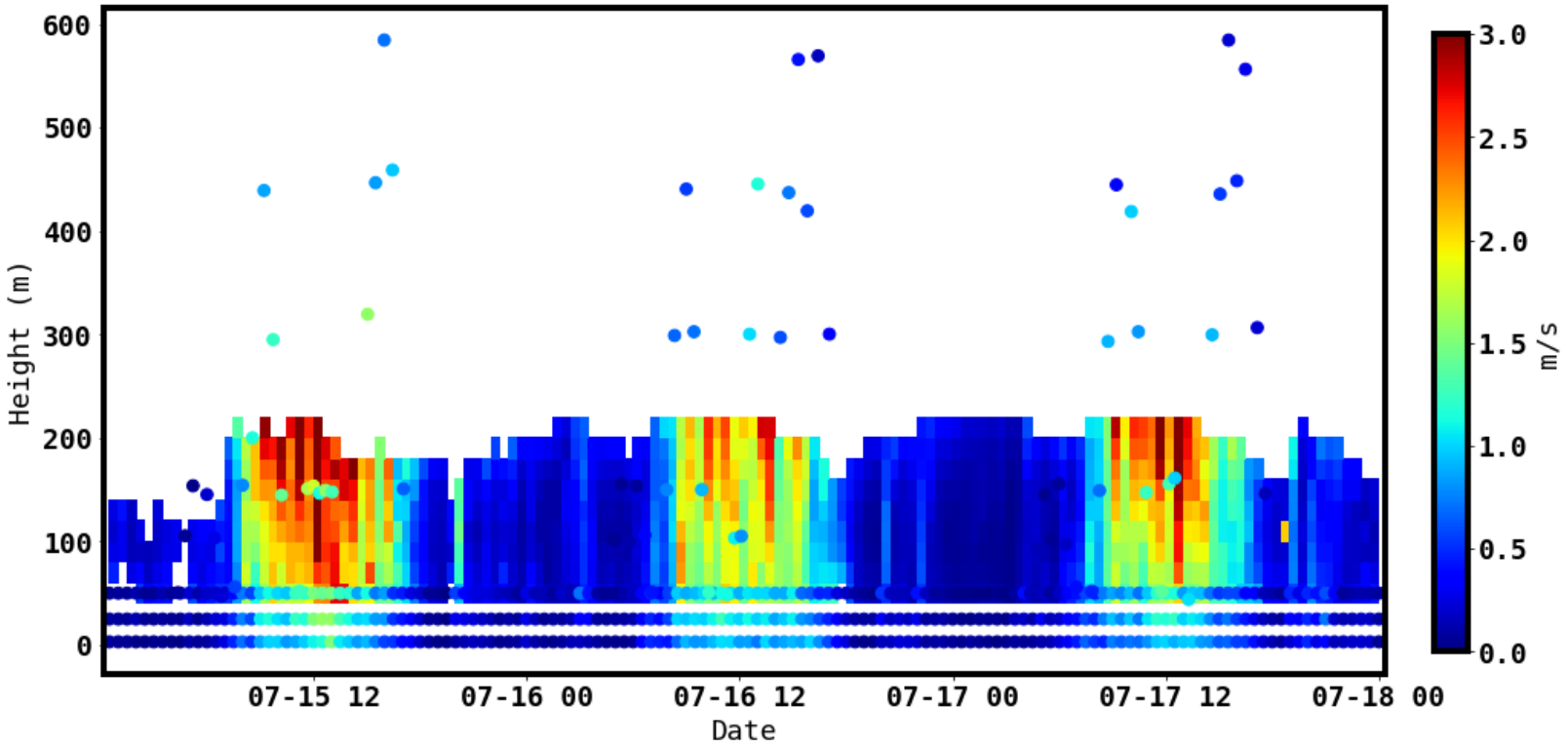
Tethered ballon

10 days with 8 with aircraft

→ rapid decrease of fluxes and variance (not show)

Perspectives & Conclusions

- Need to continue work on lidar tke



Perspectives & Conclusions

- Need to continue work on lidar tke
- good quality data from the humidity sensor under the tethered ballon → deposit of the dataset very soon on Aeris website
- LIAISE field campaign : a good dataset to improve the knowledge of the vertical profile of the turbulence in a irrigated surface
- Dataset similar at els plans (mast and aircraft) to identify
  - difference behaviour,
  - instrumental synergy: wind profiler, SEB station, RS, Aircraft
  - horizontal circulation & Internal boundary layer (more details by Marie Lothon)