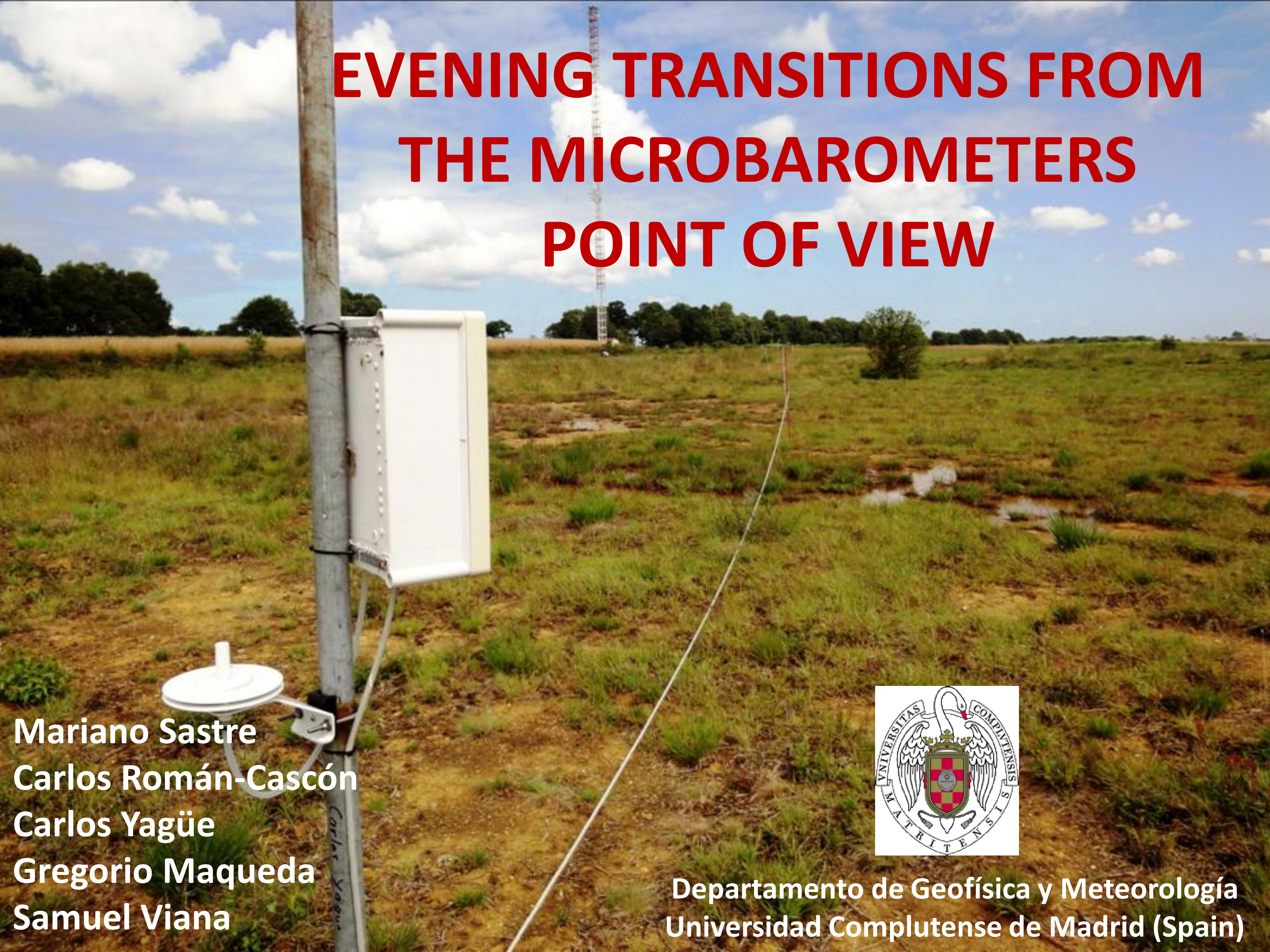

EVENING TRANSITIONS FROM THE MICROBAROMETERS POINT OF VIEW

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CONTENTS

INTRODUCTION

Super-site1

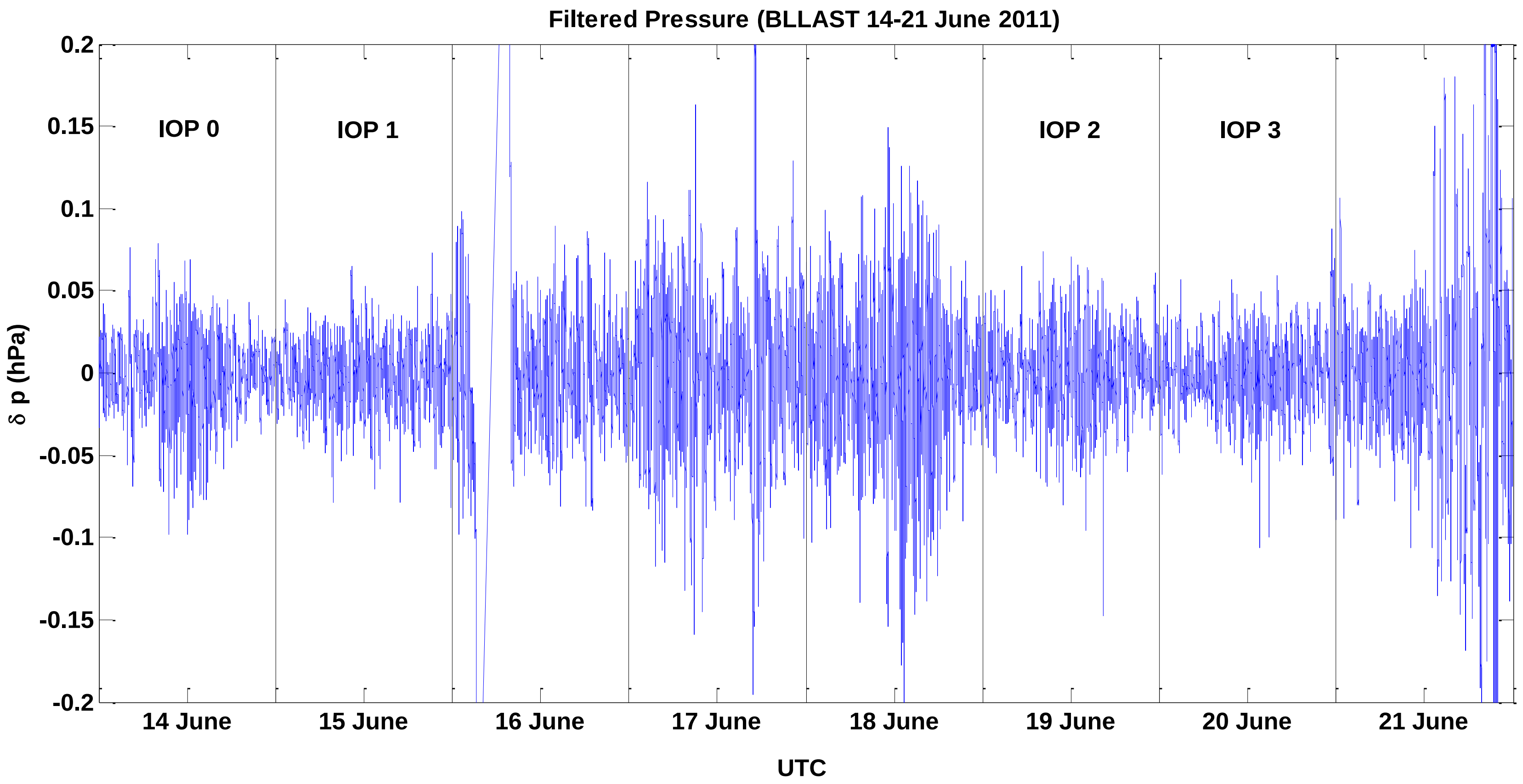
- Triangular array of 150m approx.
- Height: 1m a.g.l.

- Sampling rate: 2 Hz
- Resolution: 0.002 hPa

Objective: study small scale static pressure fluctuations.

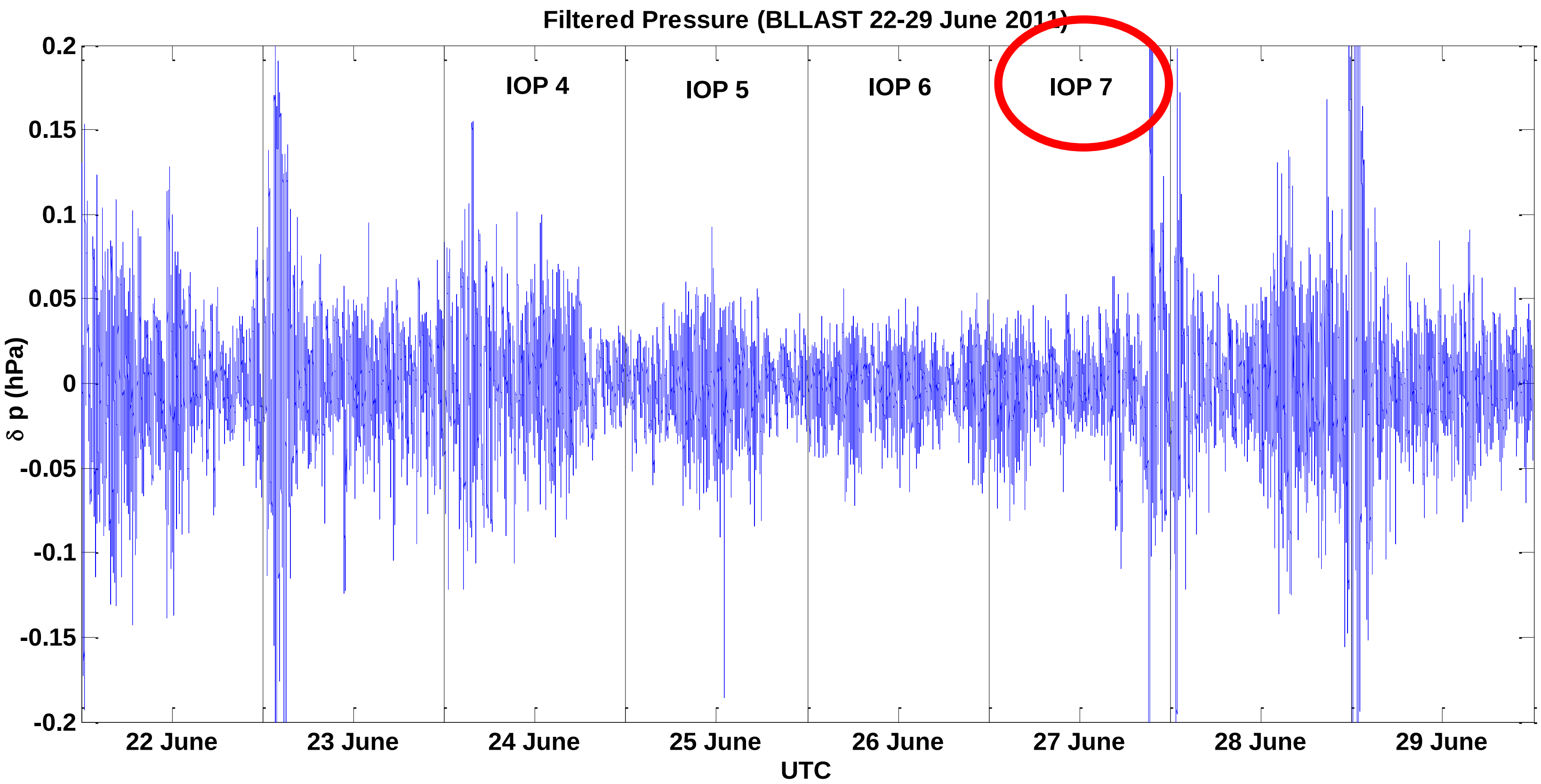
BLLAST campaign and IOP days

First week



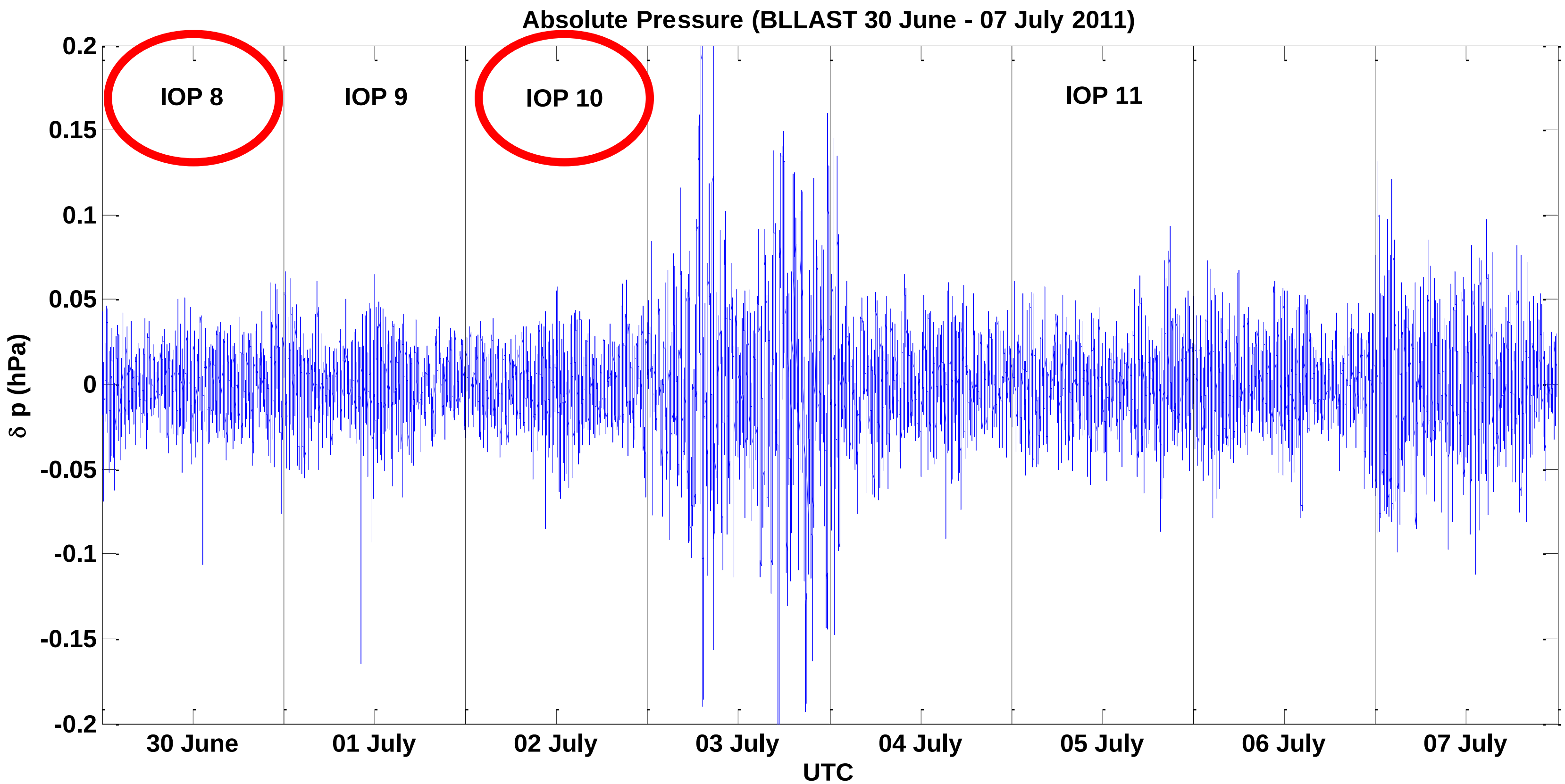
BLLAST campaign and IOP days

Second week

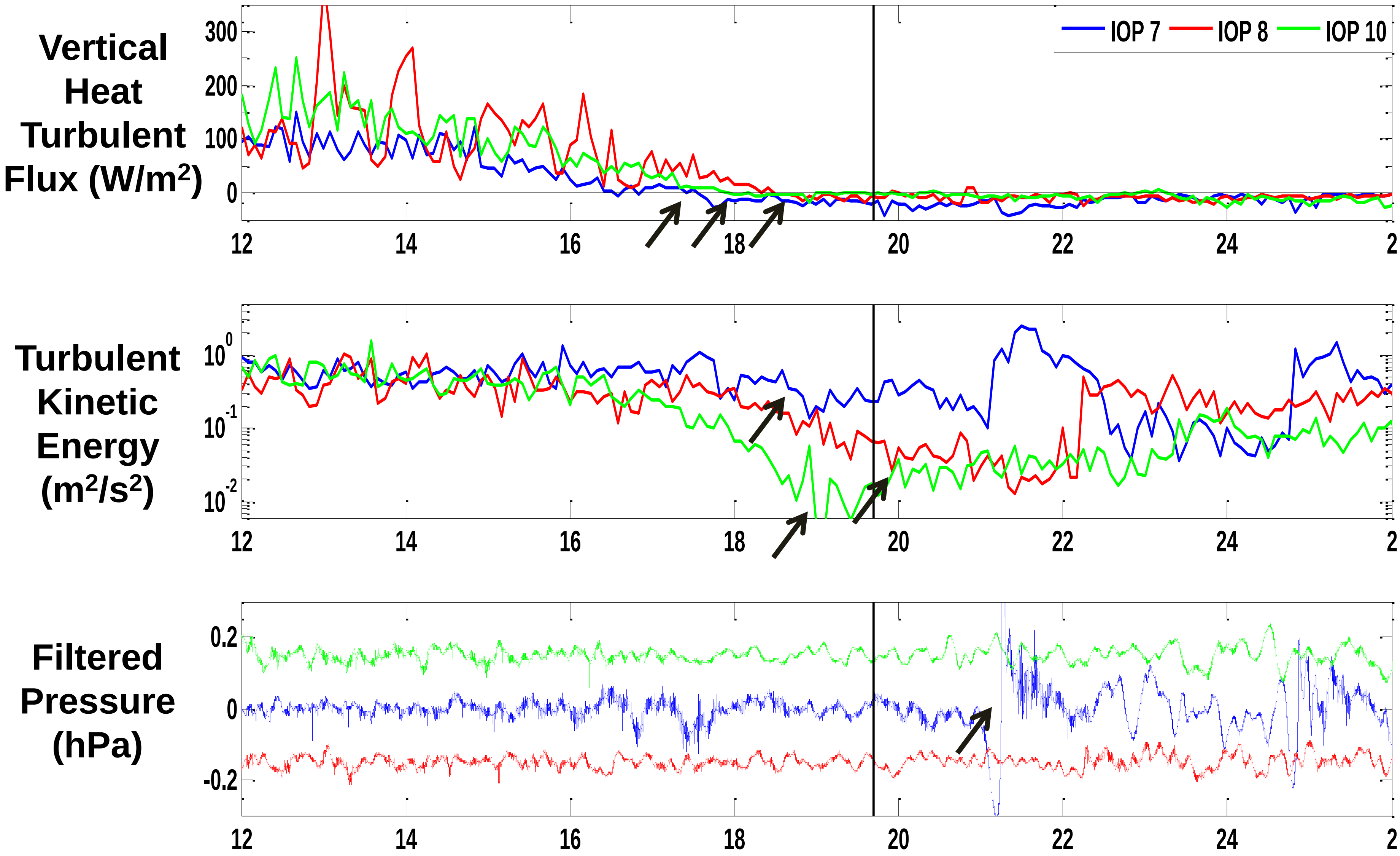


BLLAST campaign and IOP days

Third week

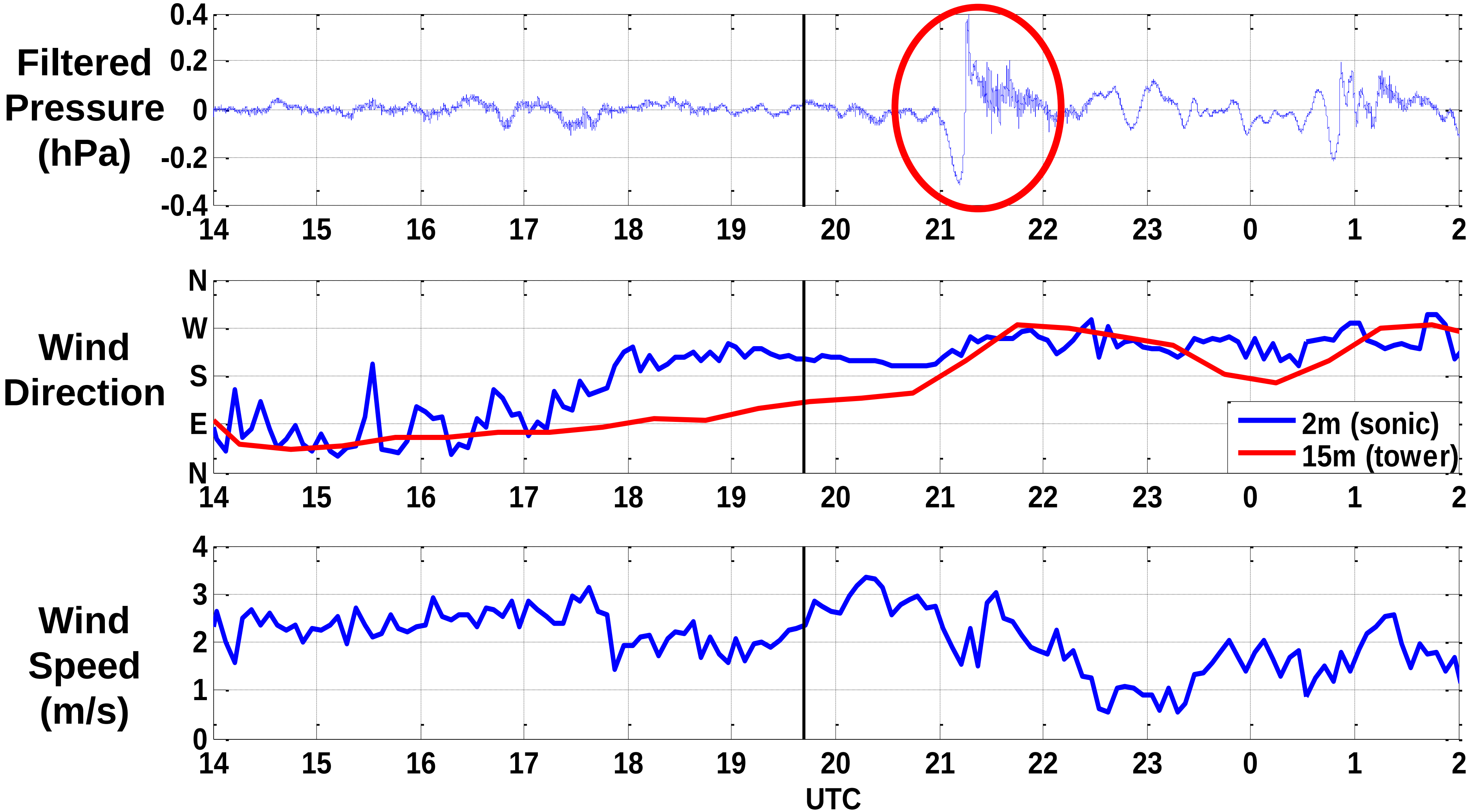


Studied IOP days



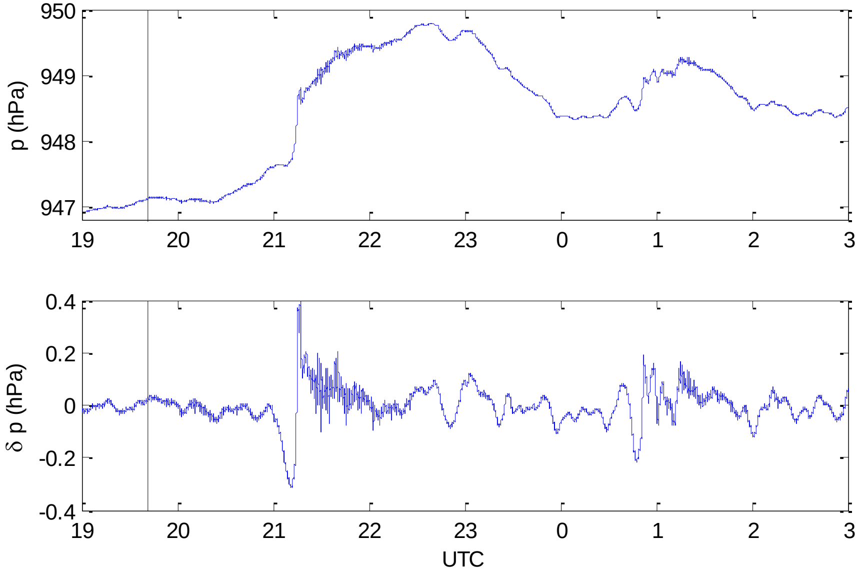
IOP 7 – 27 June

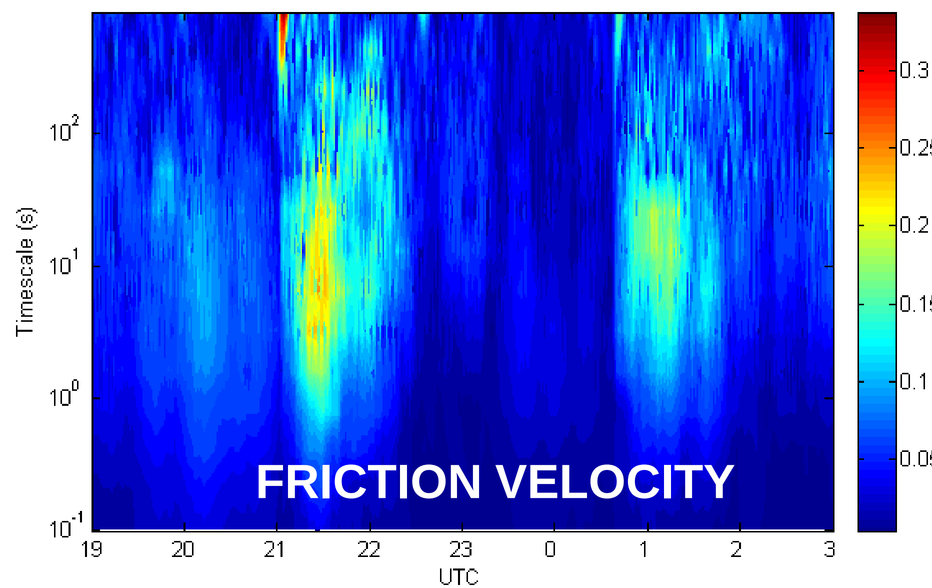
(14:00 – 02:00 UTC)

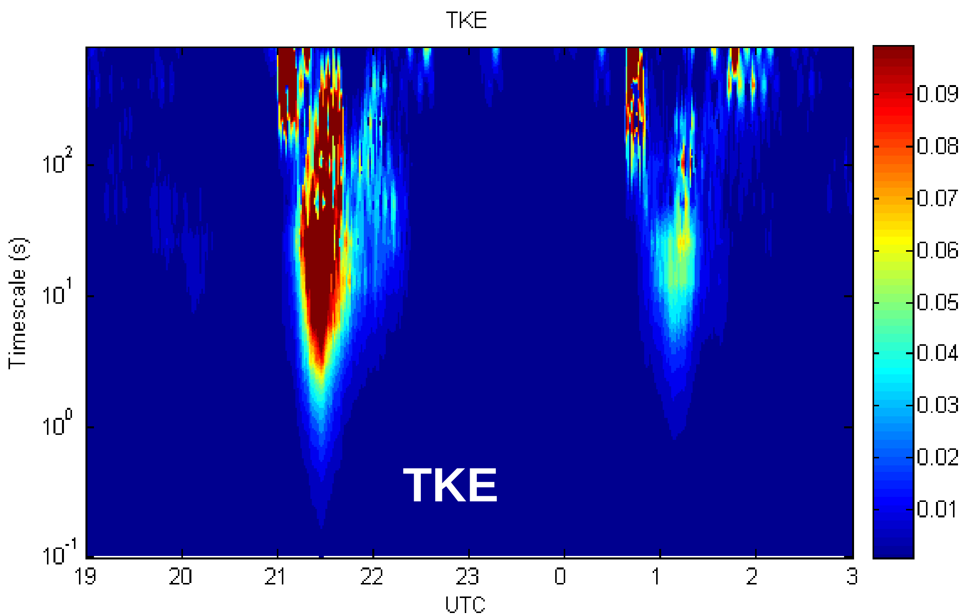


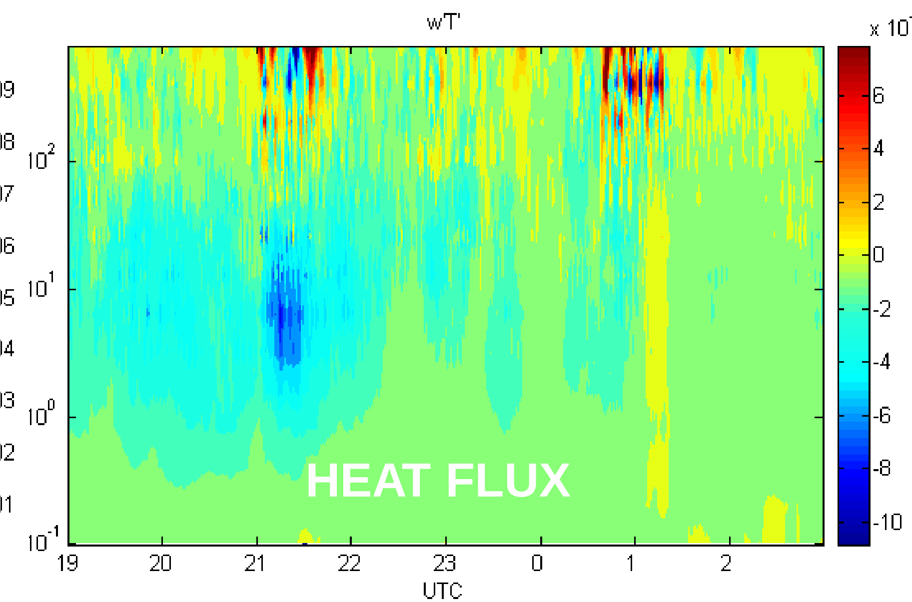
IOP 7 – 27 June

(Multiresolution Flux Decomposition)



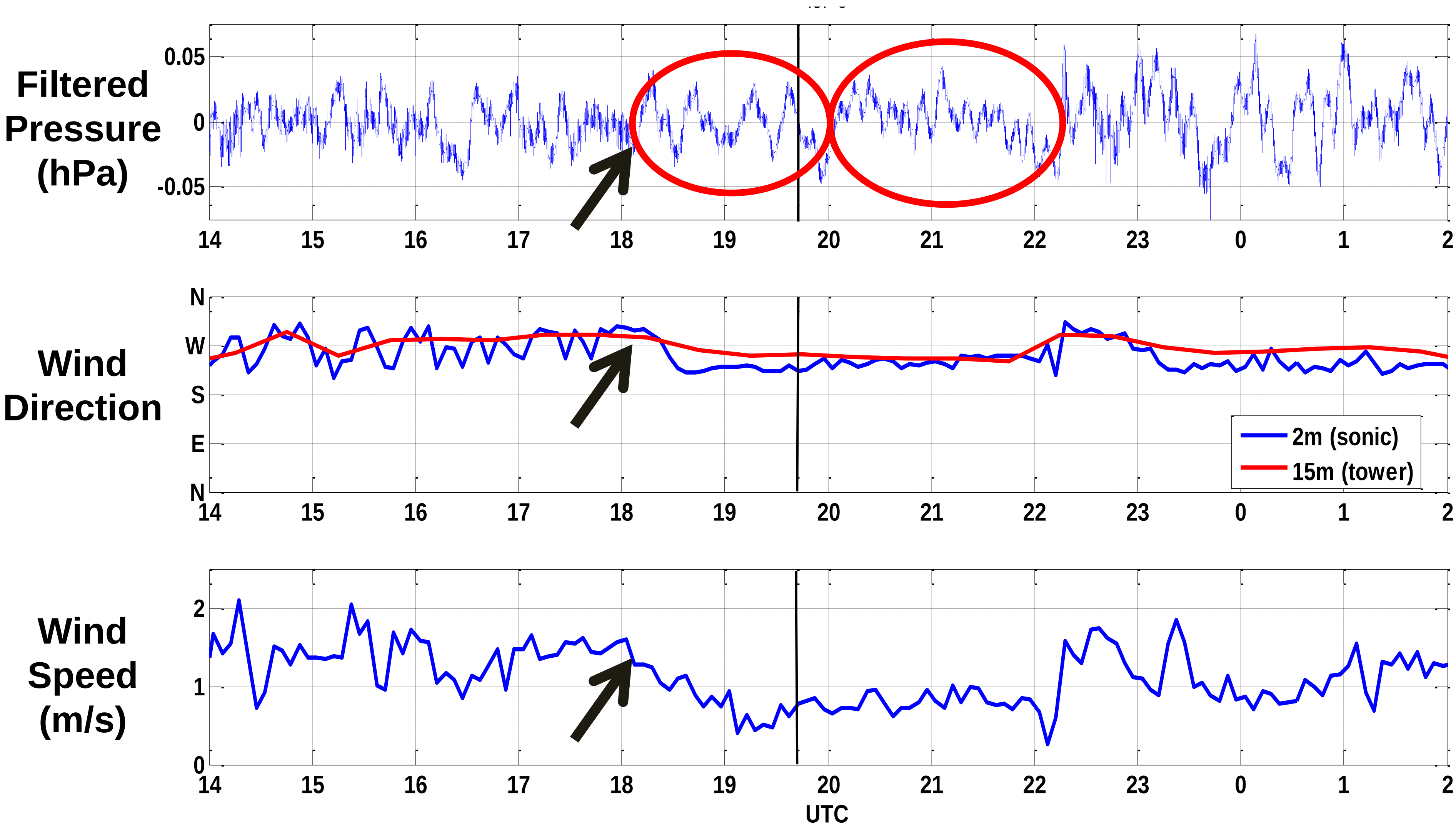






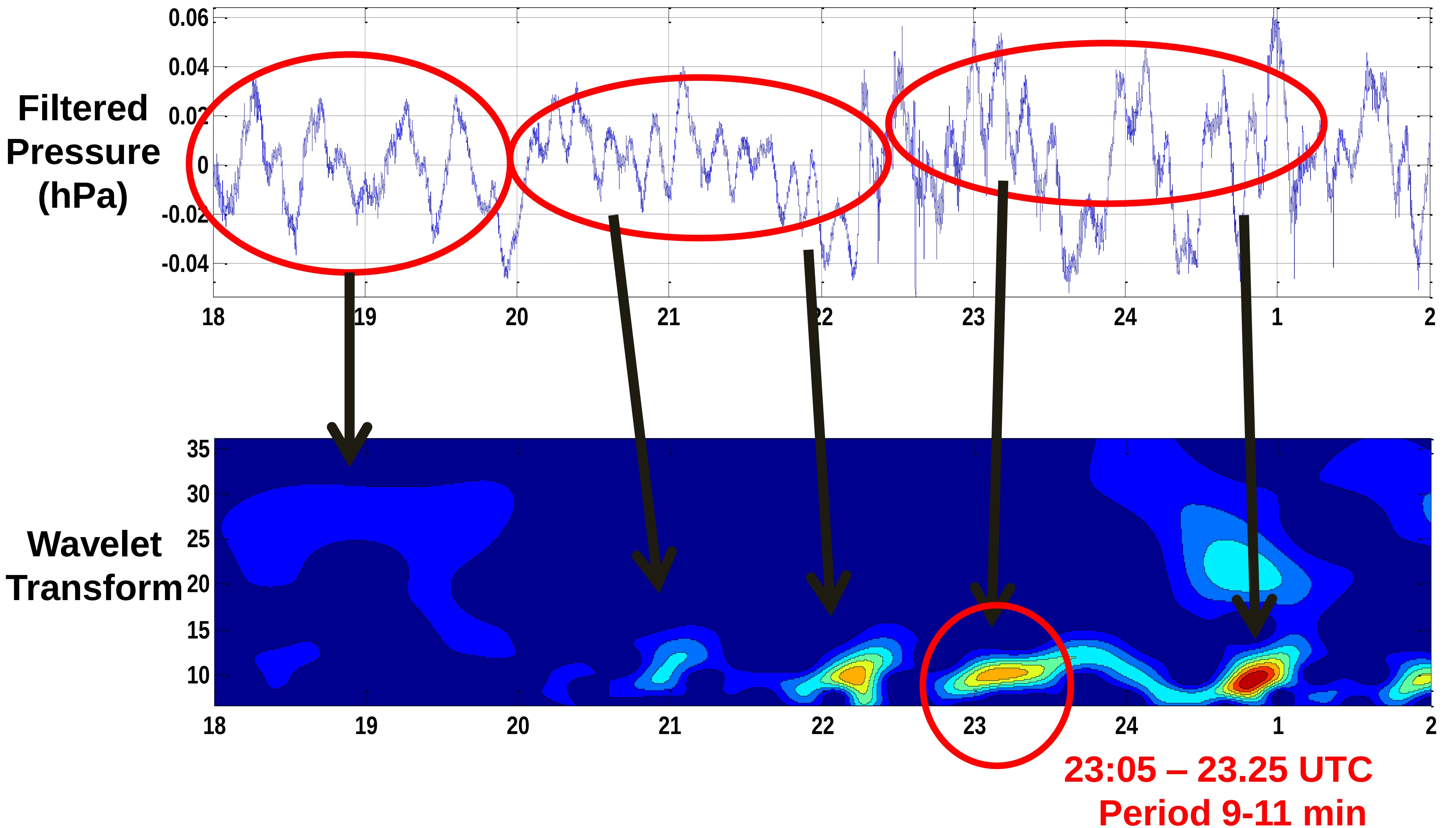
IOP 8 – 30 June

(14:00 – 02:00 UTC)



IOP 8 – 30 June

(Wavelet analysis)

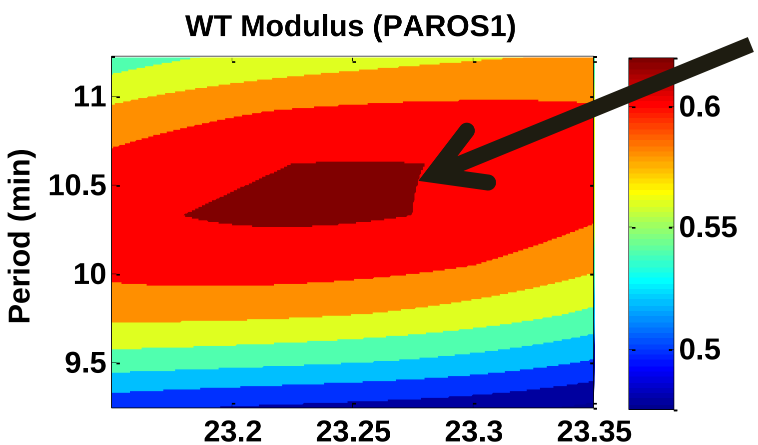


IOP 8 – 30 June

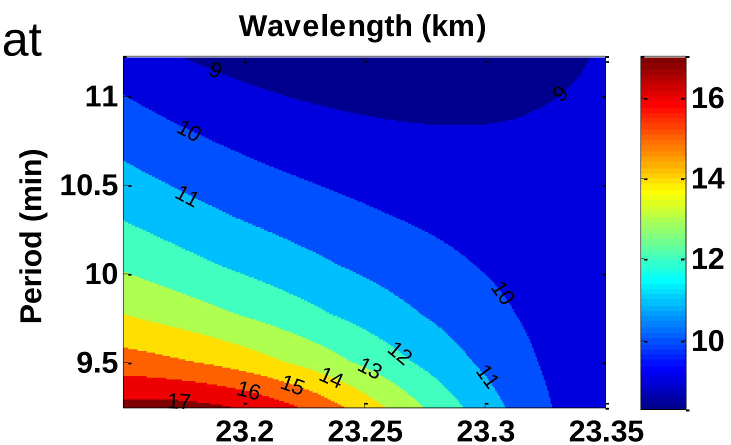
(Wave parameters (23:00))

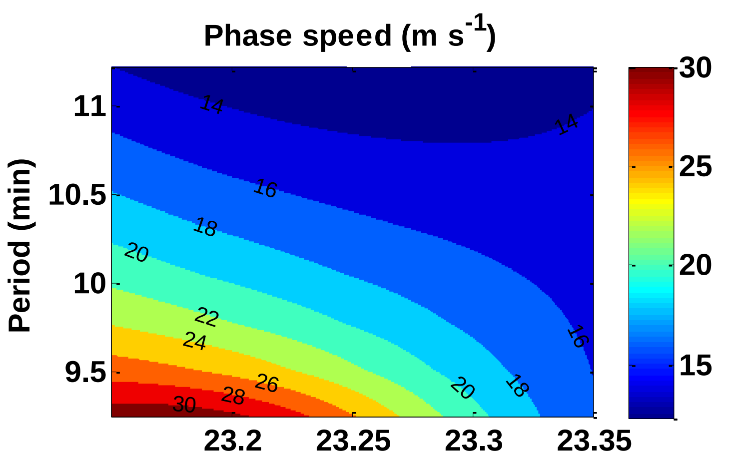
- 23:05 – 23:20 UTC
- Period 9-11 min

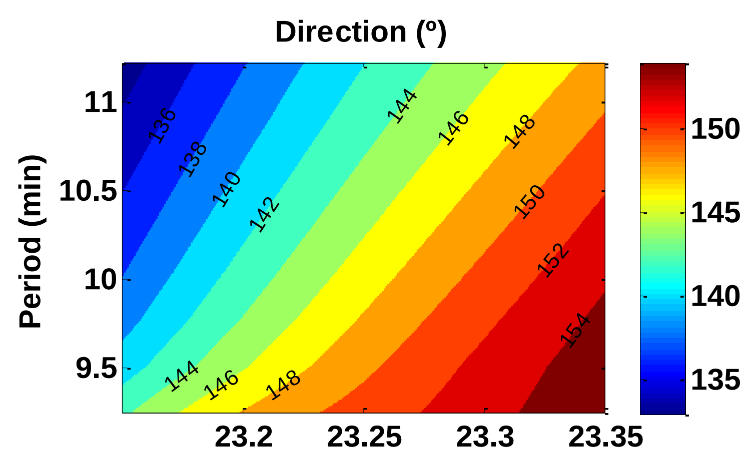
- Wavelength → 10 km
- Phase velocity →16-18 m/s
- Direction of propagation →145º (wave coming from NW approx)



(Centered at 23:15 and 10.5min period)



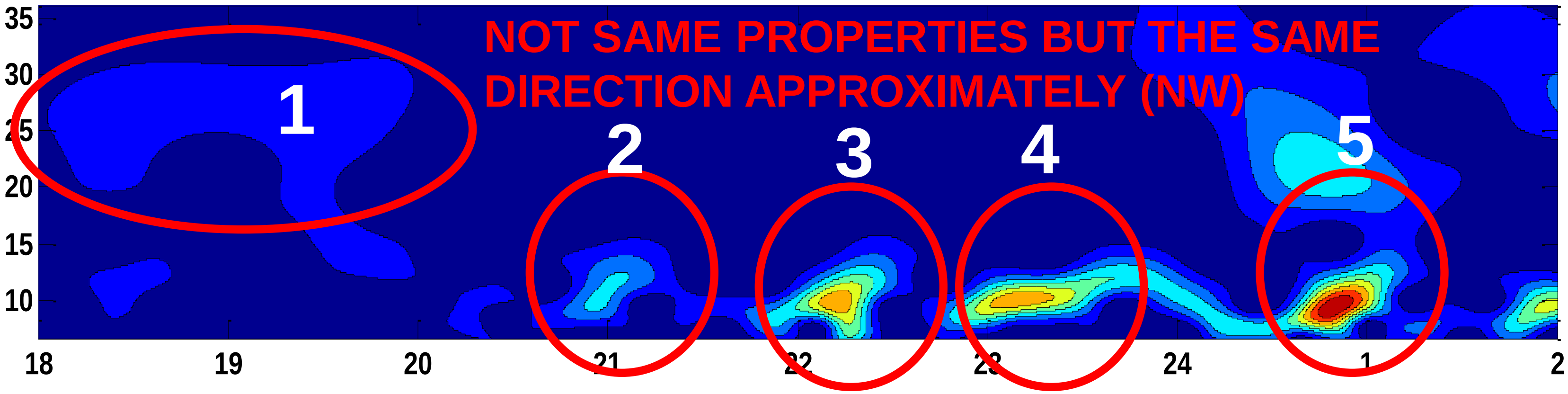




IOP 8 – 30 June

(All waves parameters)

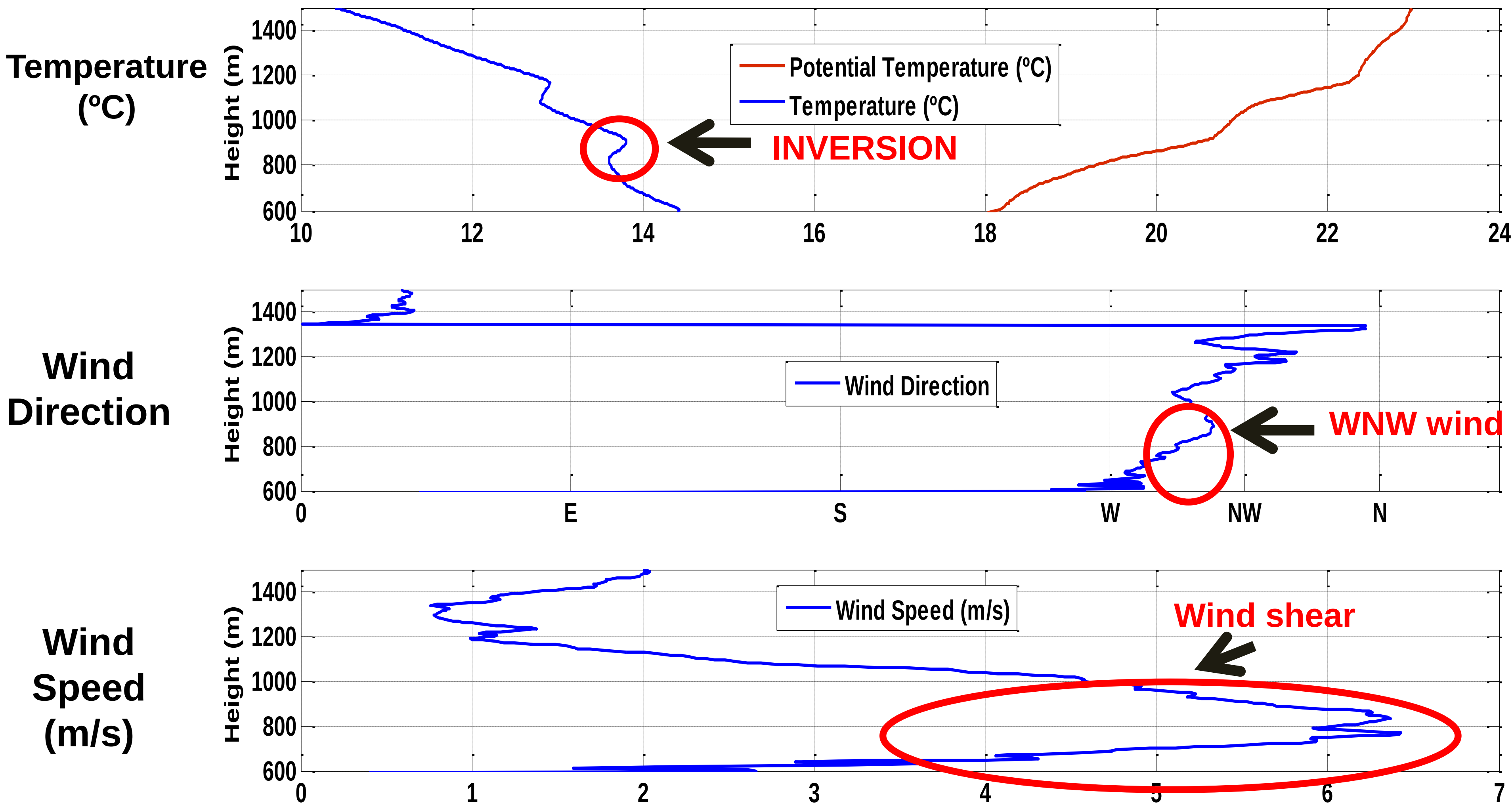
Wavelet Transform



	Time	Period	Wavelength	Phase speed	Direction (from)
1	18:15 – 19:30	27-29 min	14-20 km	8 - 13 m/s	340º-010º
2	20:55 - 21:20 UTC	10-14 min	17 - 22 km	15-20 m/s	310º - 330º
3	22:05 - 22:25 UTC	8 -12 min	5 - 5.5 km	8 - 10 m/s	335º - 340º
4	23:05 - 23:25 UTC	8 - 12 min	10- 14 km	12- 20 m/s	320º - 330º
5	00:35 - 01:00 UTC	8- 12 min	5- 8 km	10 - 14 m/s	280º - 330º

IOP 8 – 30 June

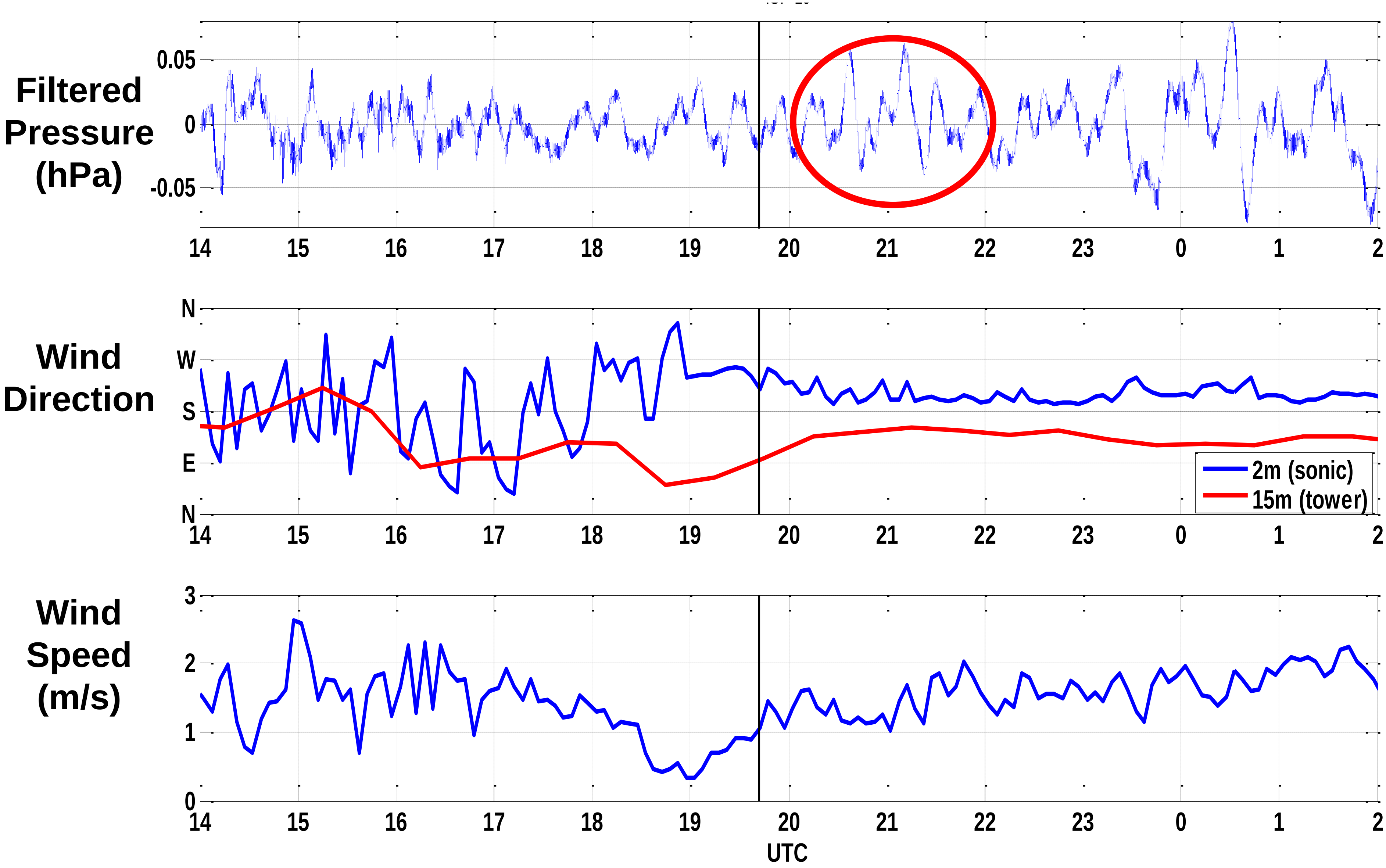
(23.00 UTC MODEM Radiosounding)



POSSIBLE WAVE SOURCE – KELVIN HELMHOLTZ INSTABILITY AT 800m

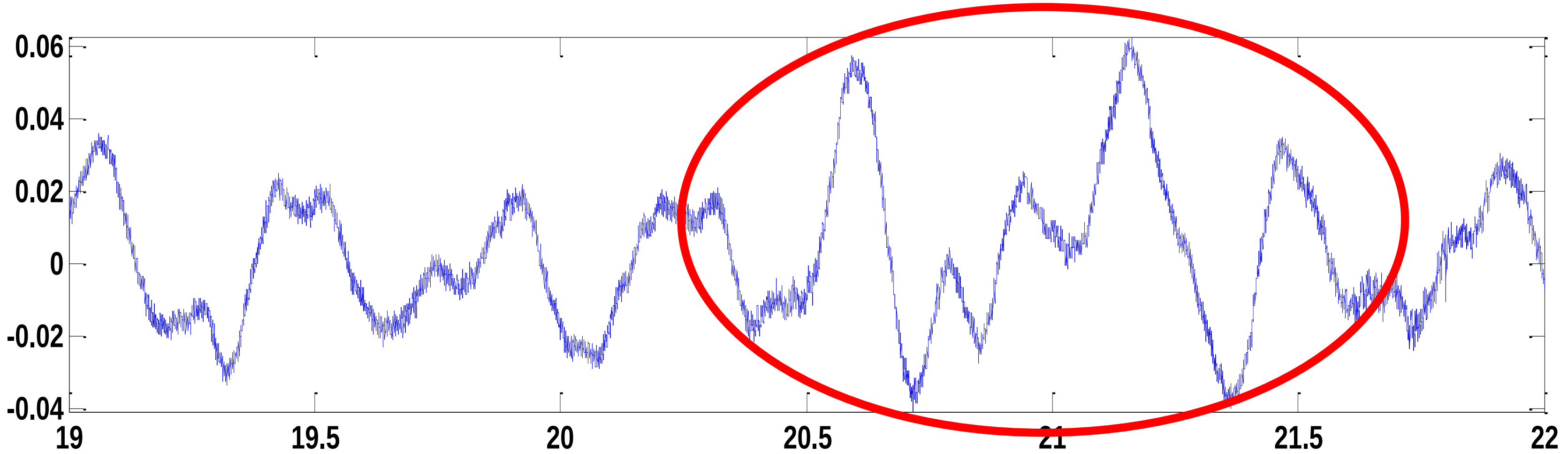
IOP 10 – 2 July

(14:00 – 02:00 UTC)

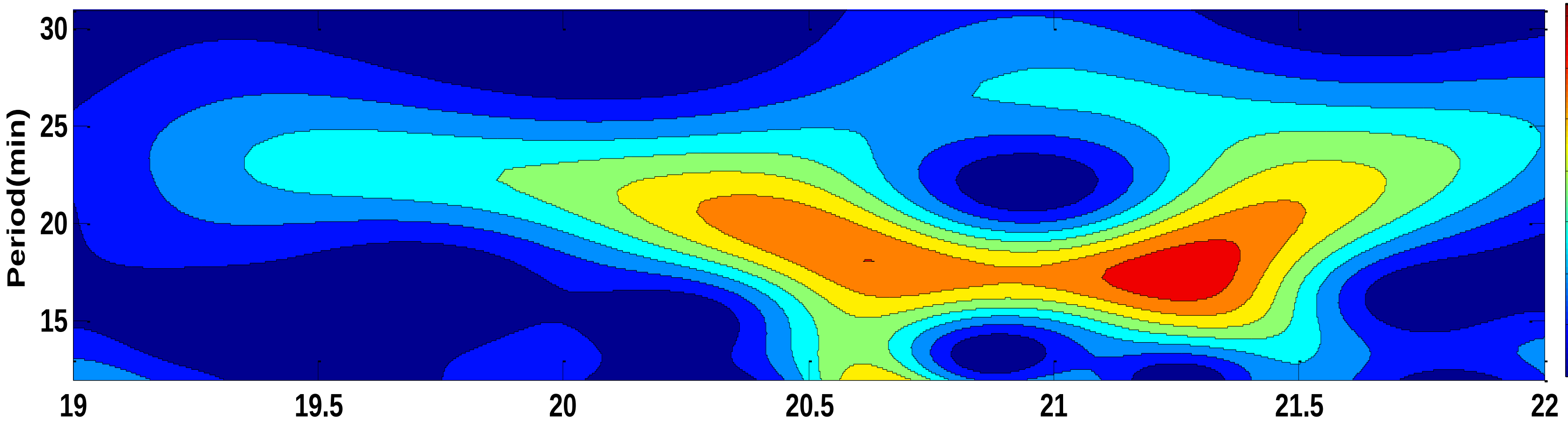


IOP 10 – 2 July
(Wavelet analysis)

Filtered Pressure (hPa)



Wavelet Transform

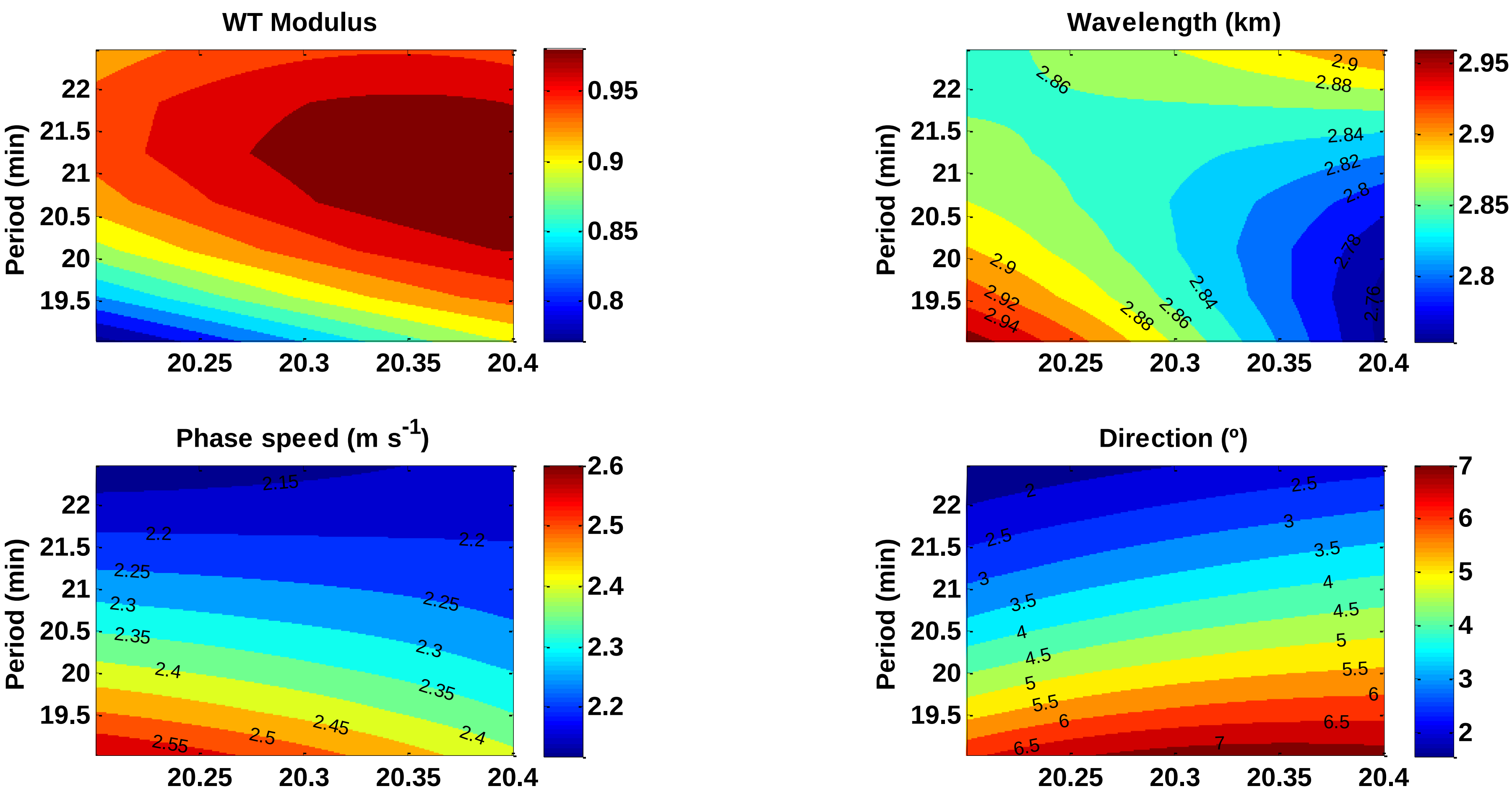


IOP 10 – 2 July

(Wave parameters)

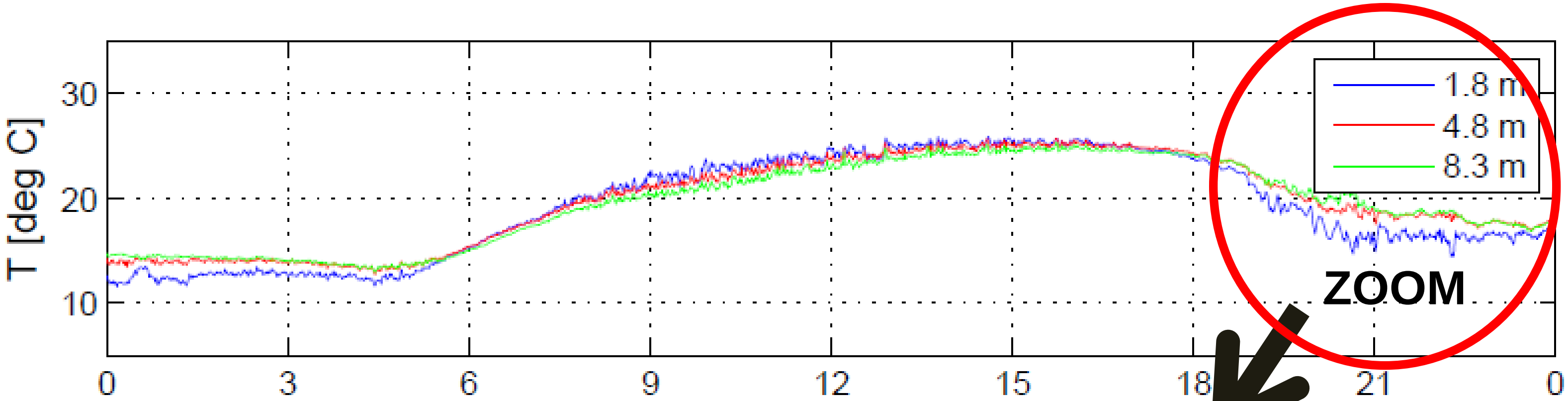
- 20:15 – 20:25 UTC
- Period 21 min

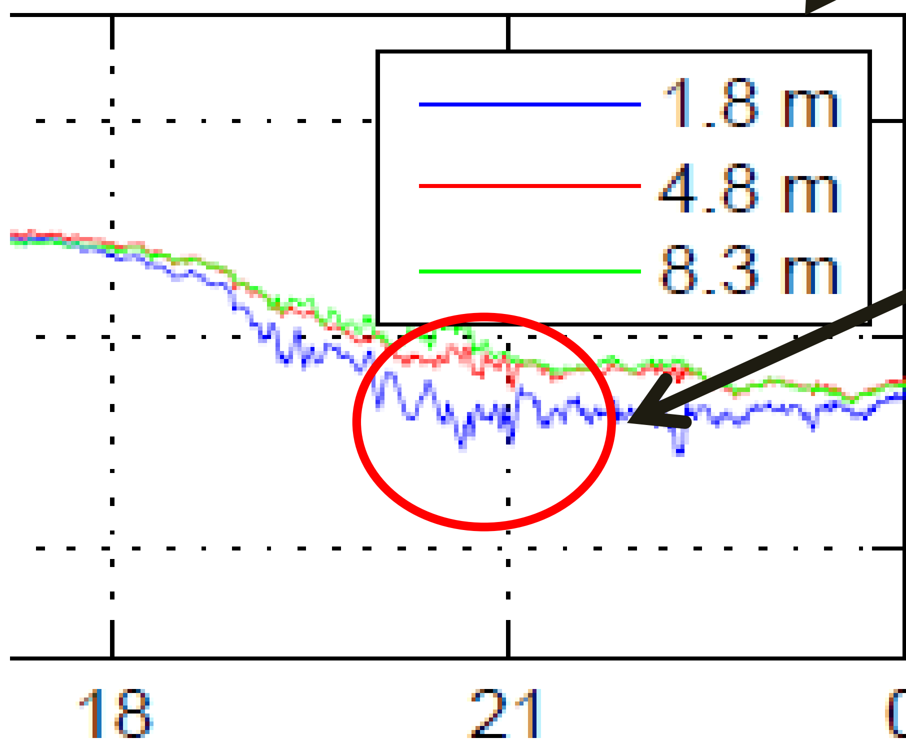
- Wavelength → 2.8 km
- Phase velocity →2.3 m/s
- Direction of propagation →4º (wave coming from S approx.)



IOP 10 – 2 July

Temperature at flux site





1.5ºC temperature fluctuations during wave event at 1.8m

No temperature fluctuations at 4.8m and 8.3m !!!

SUMMARY AND CONCLUSIONS

- Microbarometers are a good tool to find and characterize especial events along the evening transitions to NBL.

- Filtered pressure records show differences between:
  - a) daytime and nighttime
  - b) stormy, cloudy and sunny (typically IOP) days.

- Differences within IOPs are remarkable too (sensitive to small changes in wind speed and direction).

- Wavy behavior during transitions: origin of coherent structures?

- Calculations of wave parameters using data from the triangular microbarometers array.

FUTURE WORK

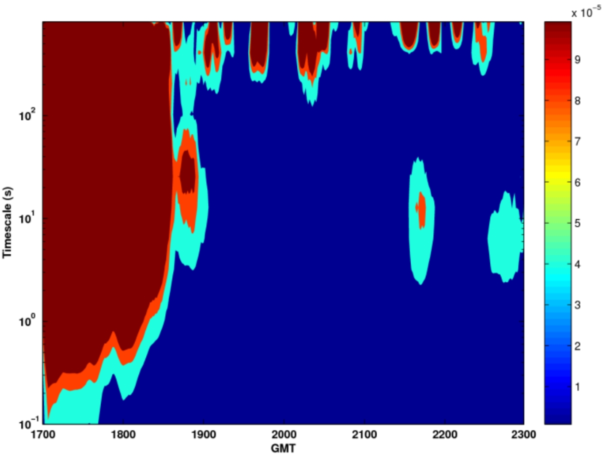
- ❖ To find out the possible source of the different waves detected during BLLAST campaign.
- ❖ To see if the fluctuations detected in the pressure records are also detected in different parameters as temperature, wind, humidity...
- ❖ To separate different types of transitions (intensity, wind direction, level of turbulence, sensible heat decrease) and to try to relate different types of transitions with different kind of waves.
- ❖ To study the relation between turbulence and coherent structures (waves) during the transition and during the development of the NBL.
- ❖ Further study of the katabatic flows as a possible source of waves.
- ❖ To analyze the different scale contributions from MRFD analysis.
- ❖ Study pressure fluctuations during stormy events.

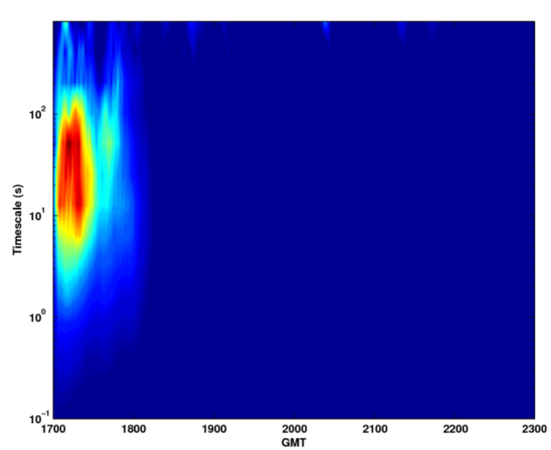
THANK YOU !!

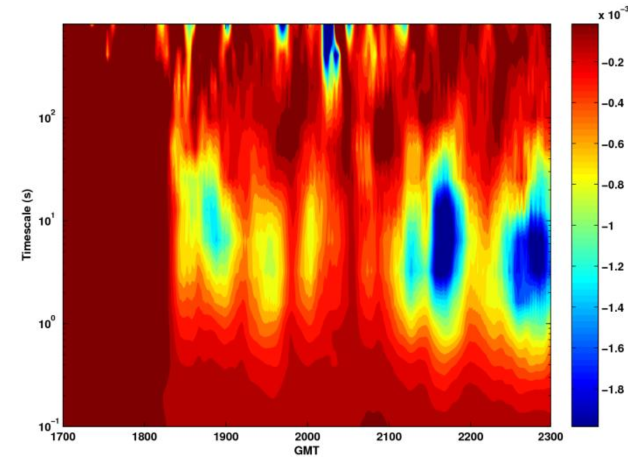
MRFD analysis

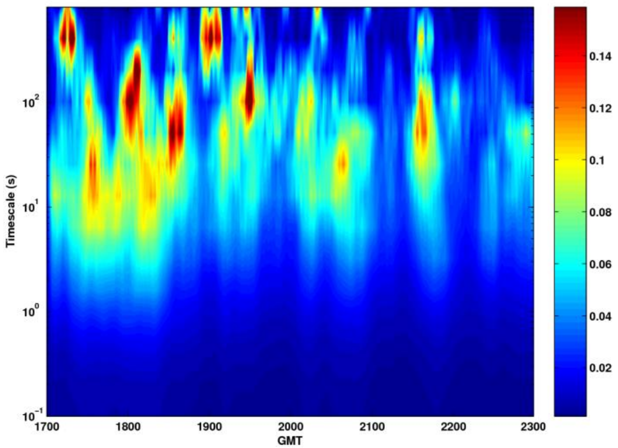
CIBA study (SPAIN): two different transitions

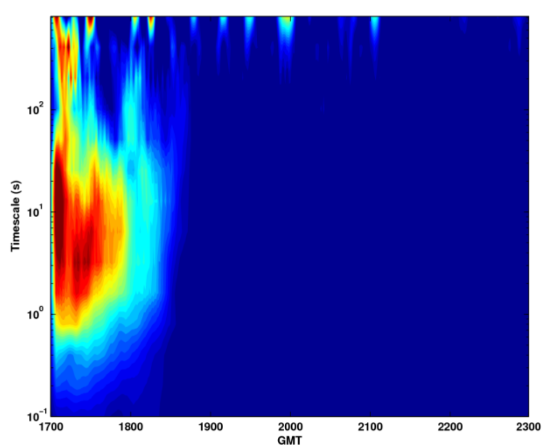
TKE | SENSIBLE HEAT FLUX | SENSIBLE HEAT FLUX

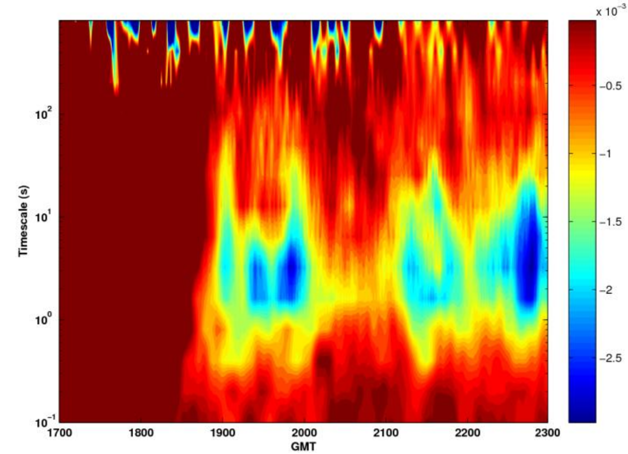










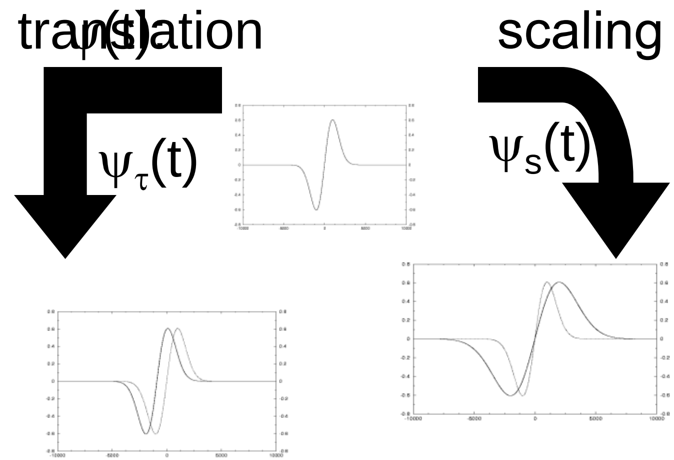


Methodology: *wavelet transform (WT)*

$$F(s,\tau) = \int f(t)\psi^{*}_{s,\tau}(t)dt$$

$$\psi_{s,\tau}(t) = \frac{1}{\sqrt{s}}\psi\left(\frac{t-\tau}{s}\right)$$

Morlet mother wavelet



- Similar to a Fourier transform, but it decomposes a signal *locally*.
- Other functions (i.e. Morlet, Mexican, etc) instead of sins and cosines are used for the convolution.

Wavelet Energy and energy density:

$$E = \int_{-\infty}^{\infty} \left|f(t)\right|^2 dt = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \underbrace{\frac{\left|F(s,\tau)\right|^2}{C_\psi s^2}} ds\,d\tau$$

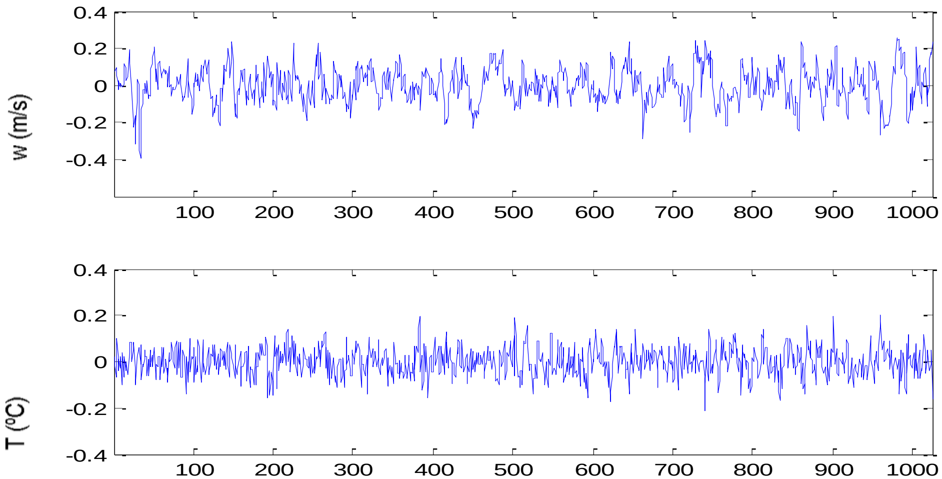
$$e_{s\tau} = \frac{\left|F(s,\tau)\right|^2}{C_\psi s^2}$$

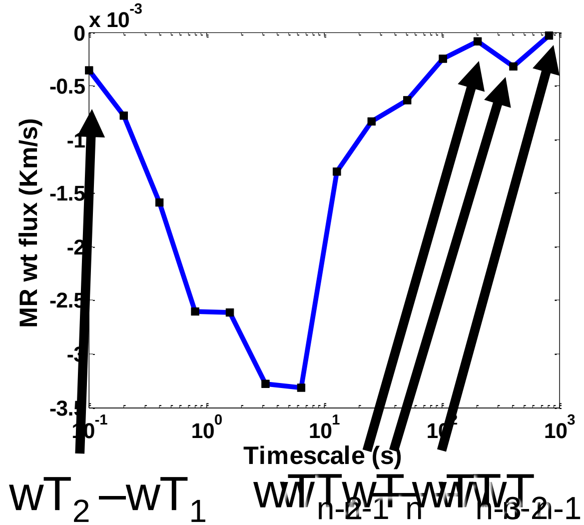
Wavelet energy density (per unit scale and time).

- Additional wavelet methods were used to evaluate vertical heat fluxes from sonic data (Cuxart et al., 2002) and to derive wave parameters from pressure records from the surface array (Terradellas et al., 2001).

Methodology: *Multi-resolution decomposition (MR)*

➢ MR is an orthogonal decomposition used here for computing turbulent fluxes (Howell and Mahrt, 1997). Two series of 2^n points are recursively filtered by substracting moving averages of decreasing length (2^{n-1}, 2^{n-2},....2). Covariances are evaluated for each cycle.





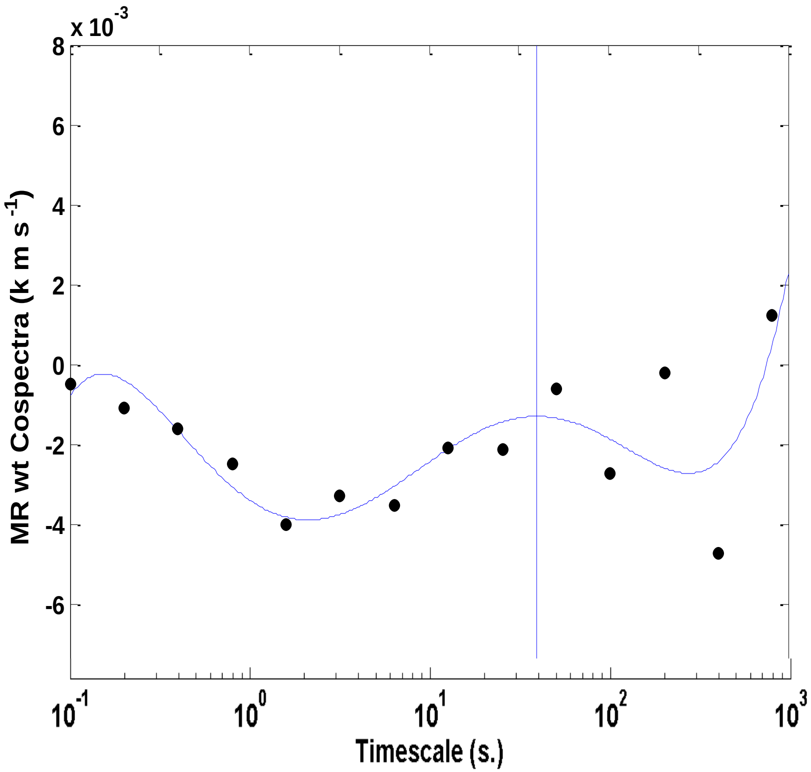
wT_n, wT_{n-1}, wT_{n-2}, $wT_{n-3...}$

➢ Resulting MR coefficients (Diferences between consecutive covariances) represent the contribution to the total flux from structures of different timescales.

➢ We used 2^{14} points sub-series(≈14min), overlapping to get MR every 5 minutes.

➢For every sonic anemometer, a planar-fit (long-term) rotation scheme was used to define the vertical axis (z) and calculate the vertical wind component (w). For every 2^{14}-points time series, y&z axis are rotated again to define along-wind and cross-wind components (u,v).

<u>Methodology:</u> Determination of gap's timescale.



➢ Every MR heat cospectra is fitted to a 5th-order polynomial.

➢The timescale of the spectral gap is estimated according to a criteria based on the first occurrence of a zero crossing, an inflexion point or a maximum after the turbulent peak of maximum downward heat flux. (Voronovich and Kiely, 2007). Some visual inspection must be made.

➢ Cumulative MR coefficients are directly related to "average Reynolds fluxes" of different averaging lenghts along the series.