BLLAST workshop 2015, Barcelona

# A comparison between atmospheric boundary layer evening transitions at two experimental sites


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2nd February 2015

# Outline

1.- Motivation

2.- Sites, data and methodology

3.- Results

- Observations
- WRF experiment

4.- Summary and conclusions

# Motivation

- Two experimental sites comparison: learn about similarities and differences

- Numerical study: test model response to variations

# Experimental sites

# Experimental sites

CIBA
(Spain)

•840 m asl

•Plateau away from mountains

•Quite homogeneous terrain

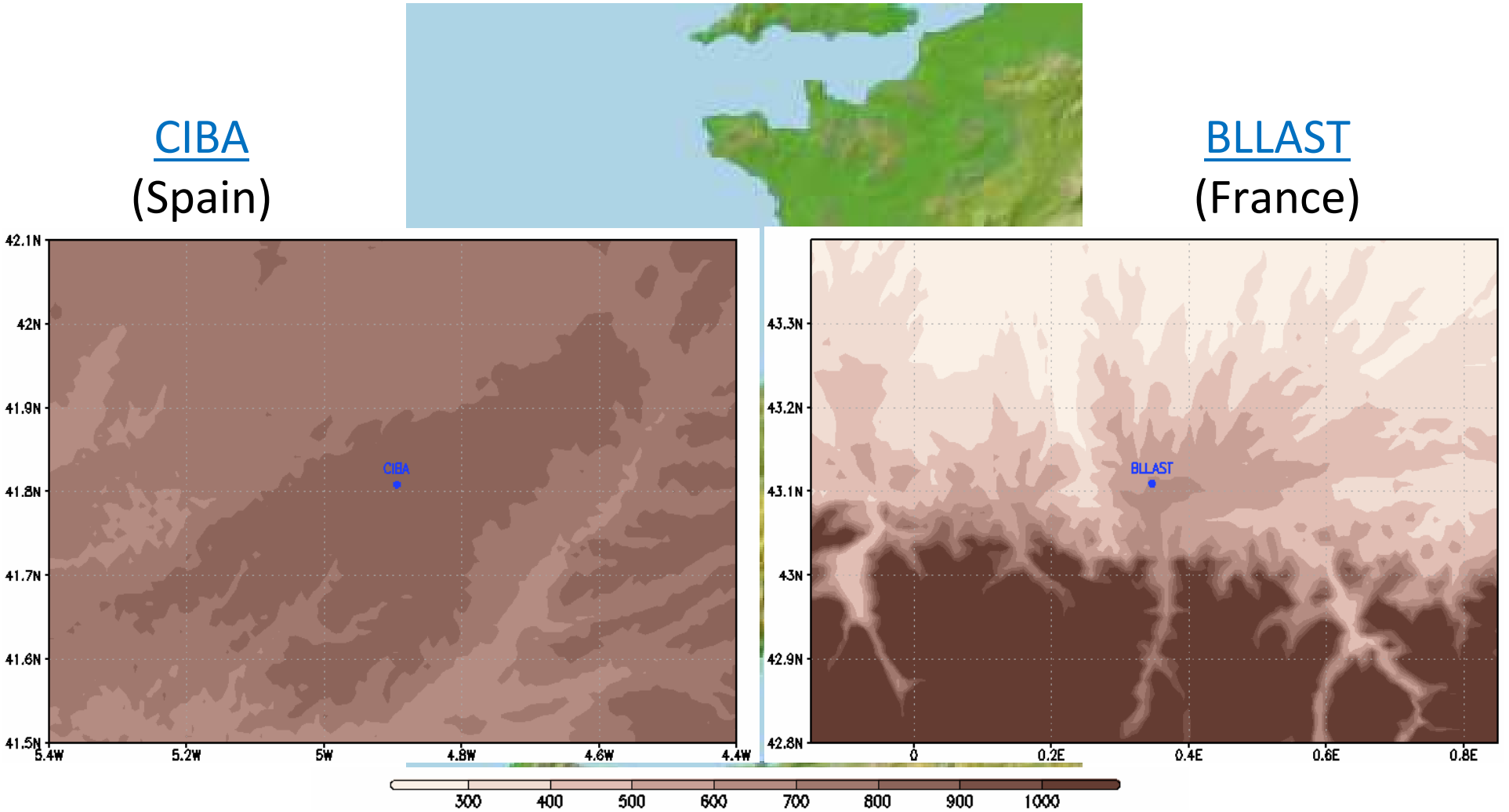

BLLAST
(France)

•600 m asl

•Plateau near mountain foothills

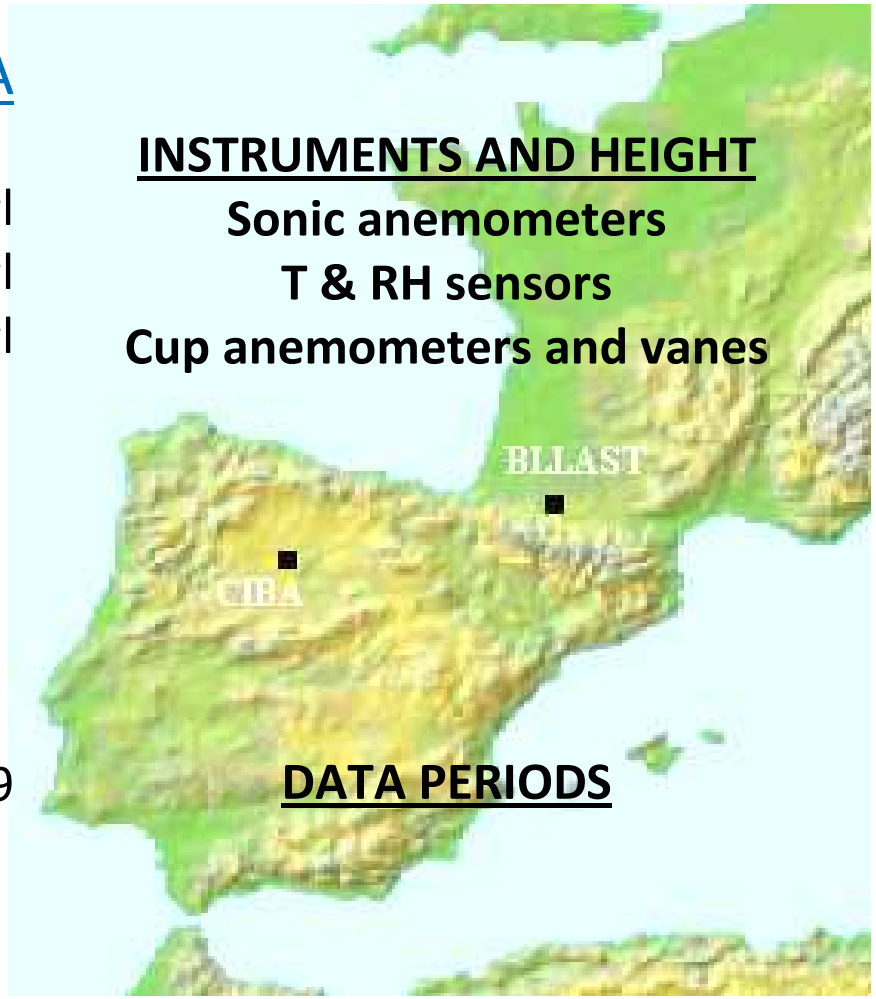
•Heterogeneous terrain

# Experimental sites



# Data and instruments

| CIBA | | BLLAST |
|---|---|---|
| | **INSTRUMENTS AND HEIGHT** | |
| 10 m agl | **Sonic anemometers** | 2.4 m agl |
| 1.5 & 10 m agl | **T & RH sensors** | 2 & 15 m agl |
| 10 m agl | **Cup anemometers and vanes** | 15 m agl |
| July-August 2009 | **DATA PERIODS** | June-July 2011 |



# Methodology

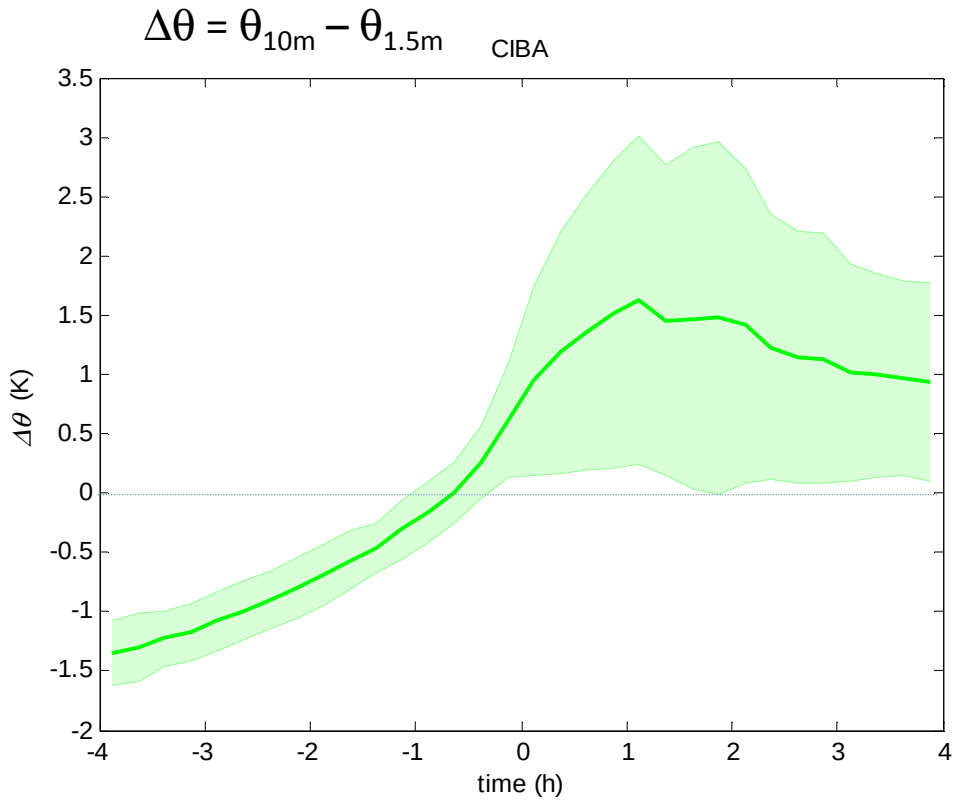
- Transitions with “fair weather” conditions
- Timing normalization: sunset => t=0
- Time intervals considered: t=[-4, 4] h
- Simulations: WRF model

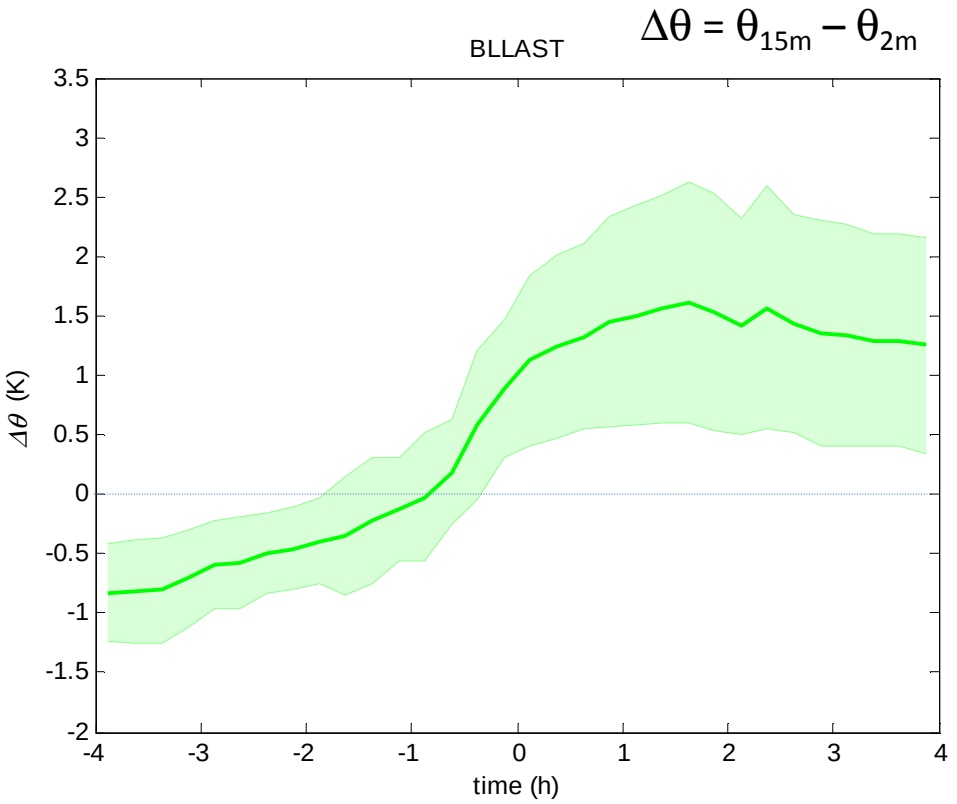
# Observations: average values

CIBA

BLLAST

$\Delta\theta$ (K)

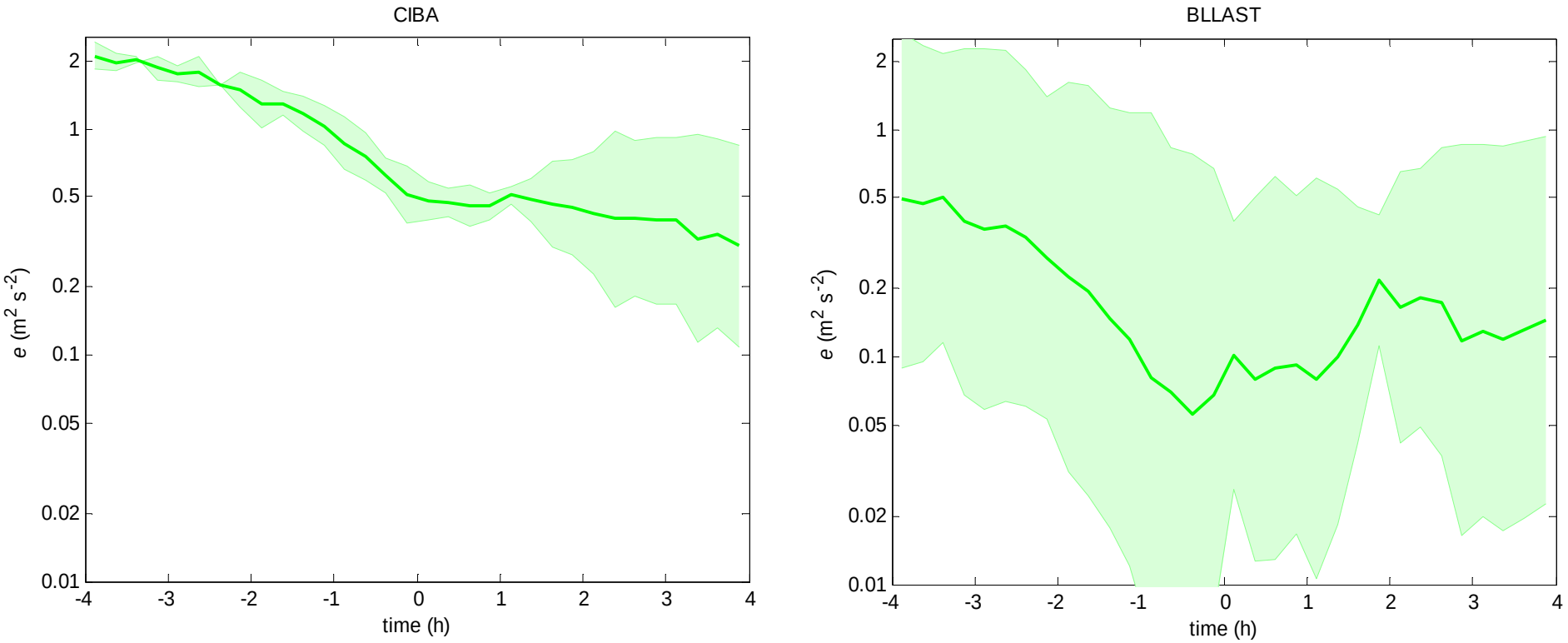


# Observations: average values

CIBA BLLAST

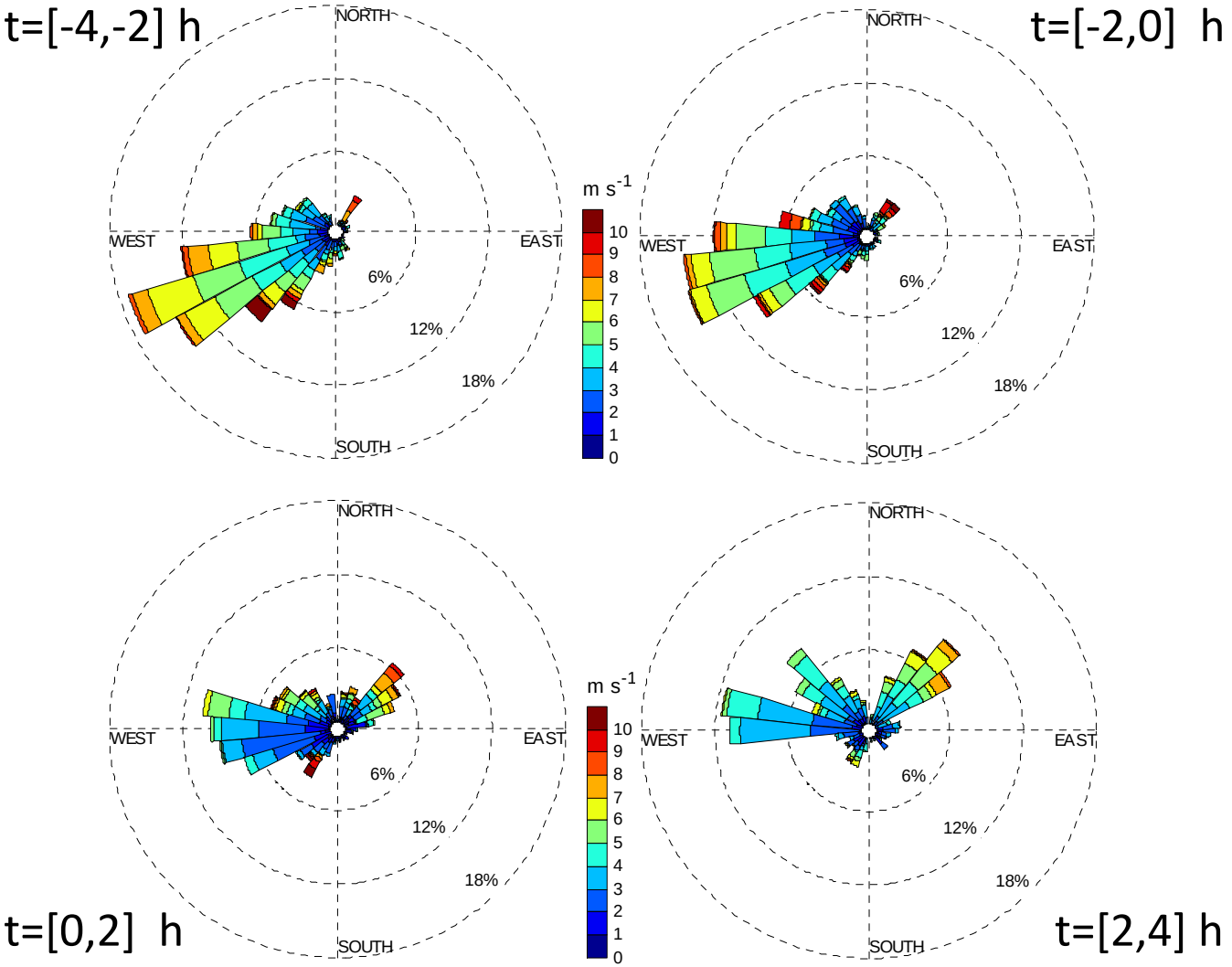
**TKE ($m^2 s^{-2}$)**



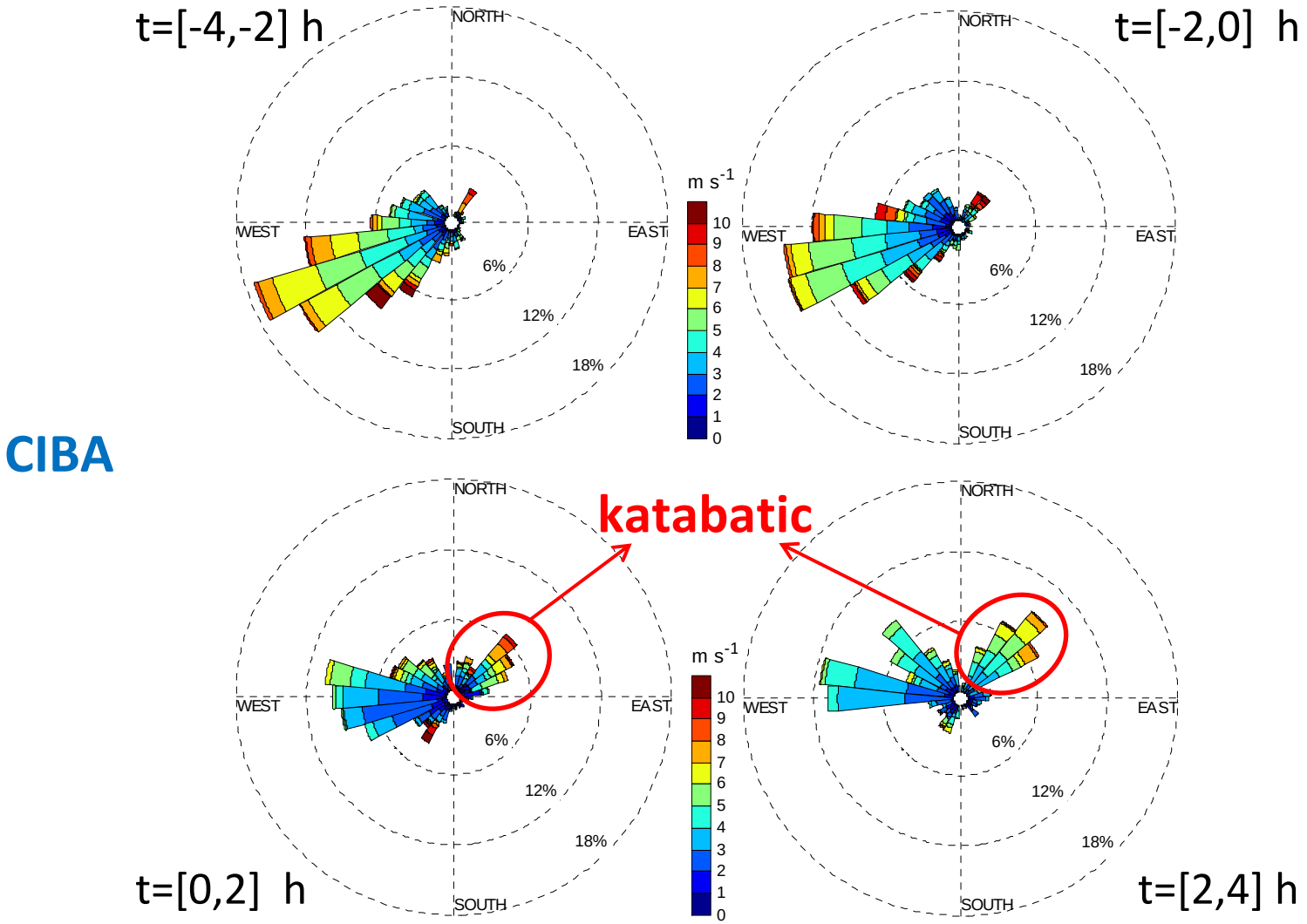

$$\mathrm{TKE} = \frac{1}{2}\left(\overline{u'^2} + \overline{v'^2} + \overline{w'^2}\right)$$

# Observations: wind distributions

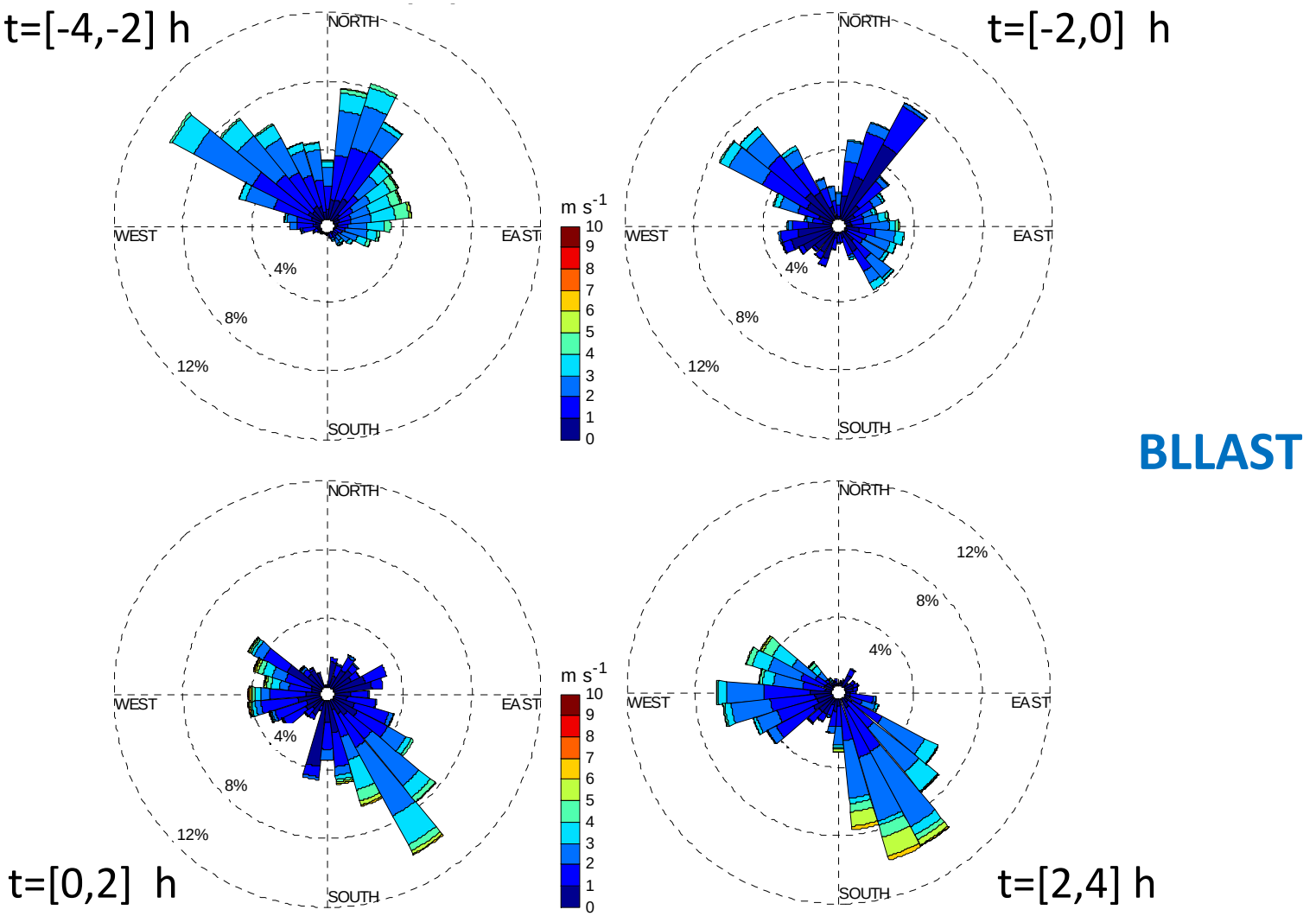
**CIBA**



# Observations: wind distributions

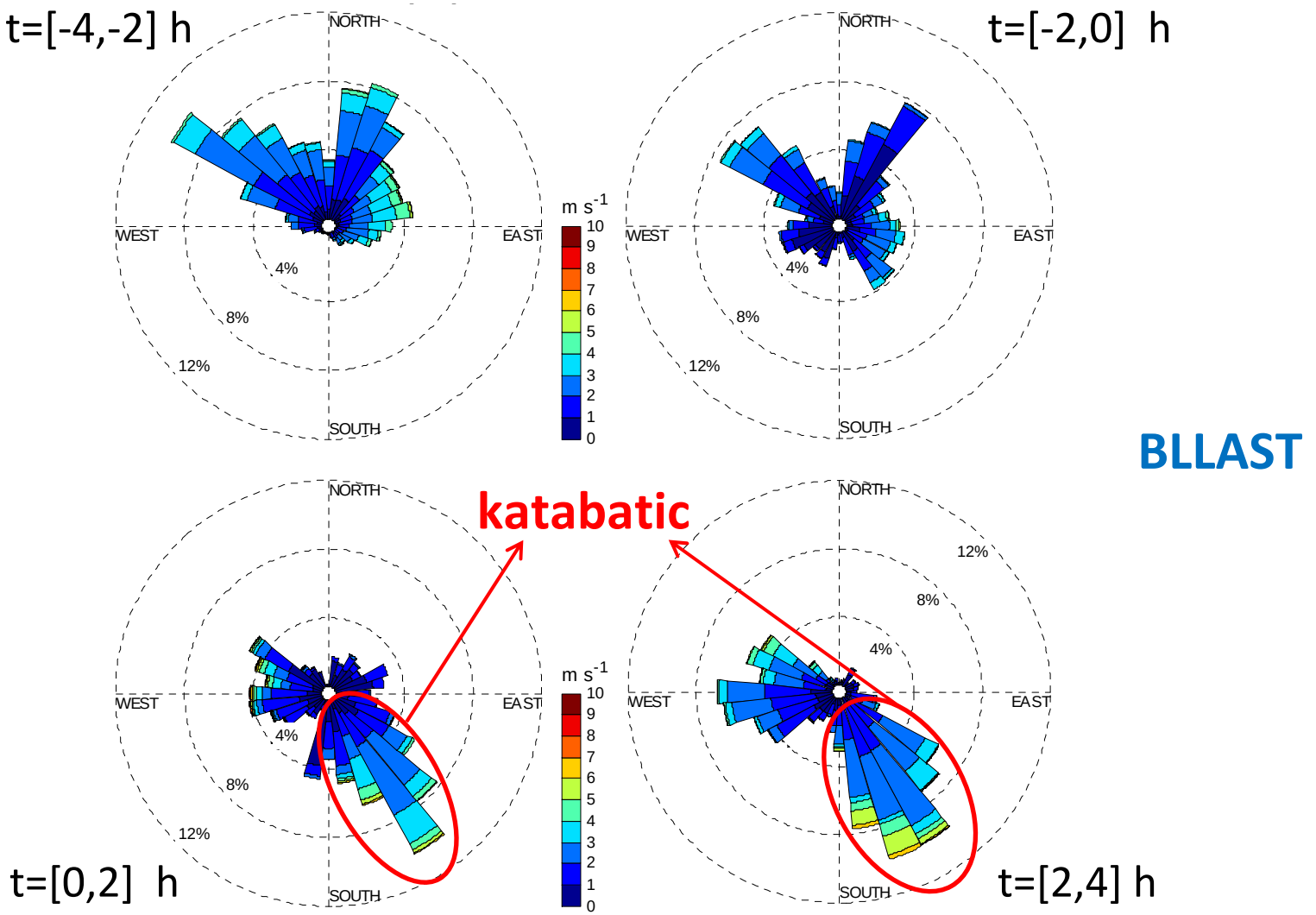


# Observations: wind distributions




**BLLAST**

# Observations: wind distributions



# WRF experiment

## Settings overview

| | |
|---|---|
| MODEL | WRF-ARW version 3.5 |
| INITIAL AND BOUNDARY CONDITIONS | NCEP FNL data<br>1° resolution;<br>every 6 h |
| HORIZONTAL RESOLUTION | 3 nested domains<br>Grids of: 9 km, 3 km, 1 km |
| VERTICAL RESOLUTION | 50 eta vertical levels<br>(8 between ground and 100 m) |
| TIME STEP | 3.3 s |
| SPIN UP | 24 h |
| PBL | YSU |
| LSM | NOAH |

# WRF experiment

## Settings overview

| | |
|---|---|
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| **INITIAL AND BOUNDARY CONDITIONS** | **NCEP FNL data 1° resolution; every 6 h** |
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| **VERTICAL RESOLUTION** | **50 eta vertical levels (8 between ground and 100 m)** |
| **TIME STEP** | **3.3 s** |
| **SPIN UP** | **24 h** |
| **PBL** | **YSU** |
| **LSM** | **NOAH** |

| | CIBA | BLLAST |
|---|---|---|
| Soil moisture: | ~ 0.17 $m^3\ m^{-3}$ | ~ 0.30 $m^3\ m^{-3}$ |

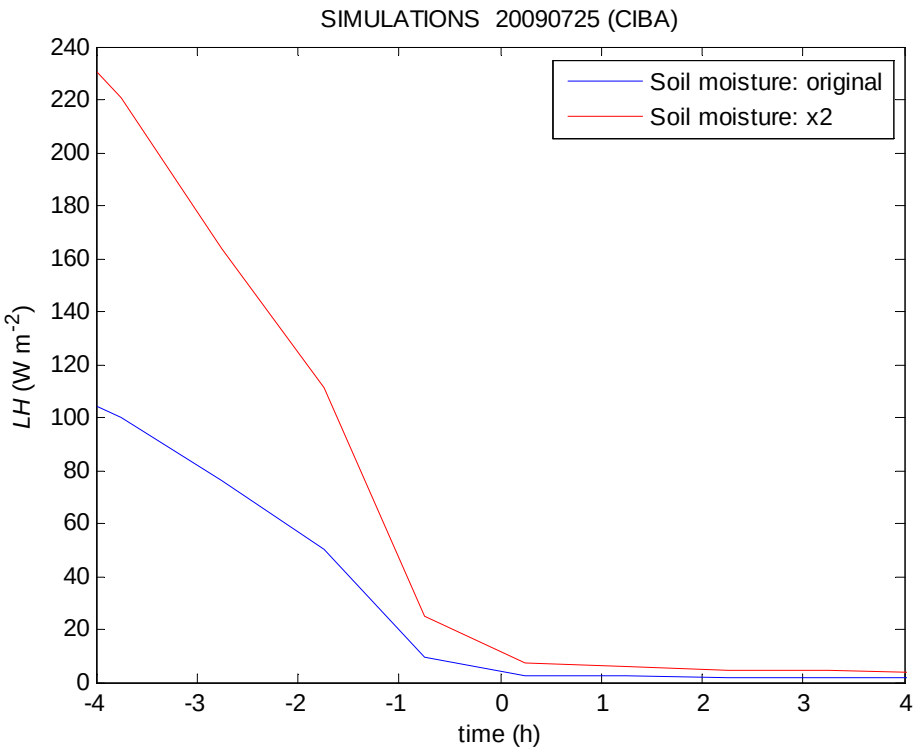
**Modify SOIL MOISTURE**

| | CIBA | BLLAST |
|---|---|---|
| Simulation 1 | SMOIS: Standard | SMOIS: Standard |
| Simulation 2 | SMOIS: Standard **x2** | SMOIS: Standard **x0.5** |

# WRF experiment

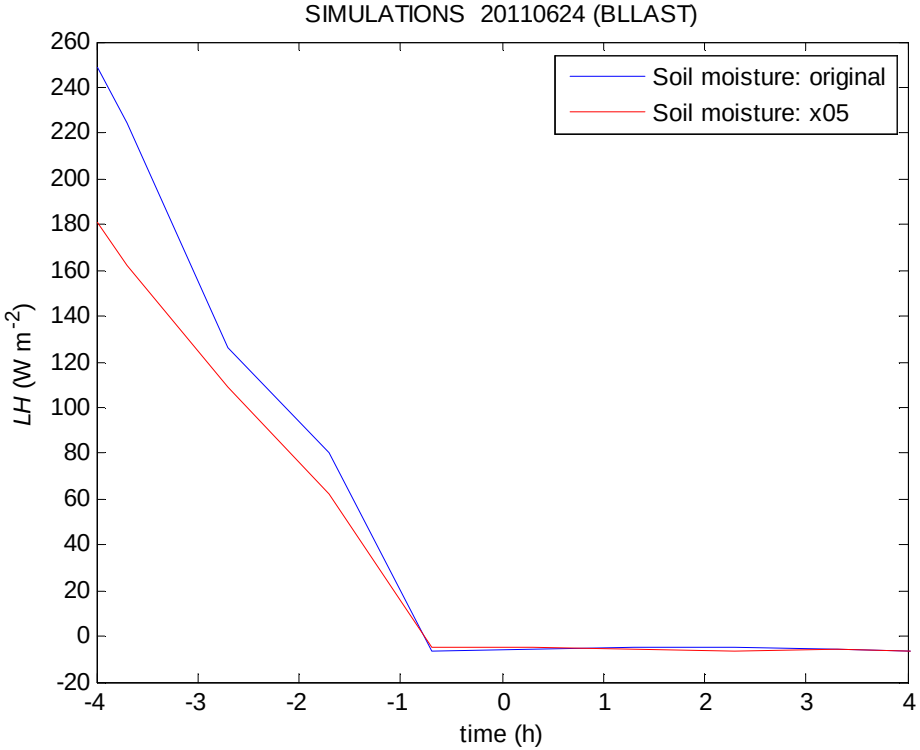
## LATENT HEAT FLUX

CIBA




SMOIS STANDARD
SMOIS x2

BLLAST

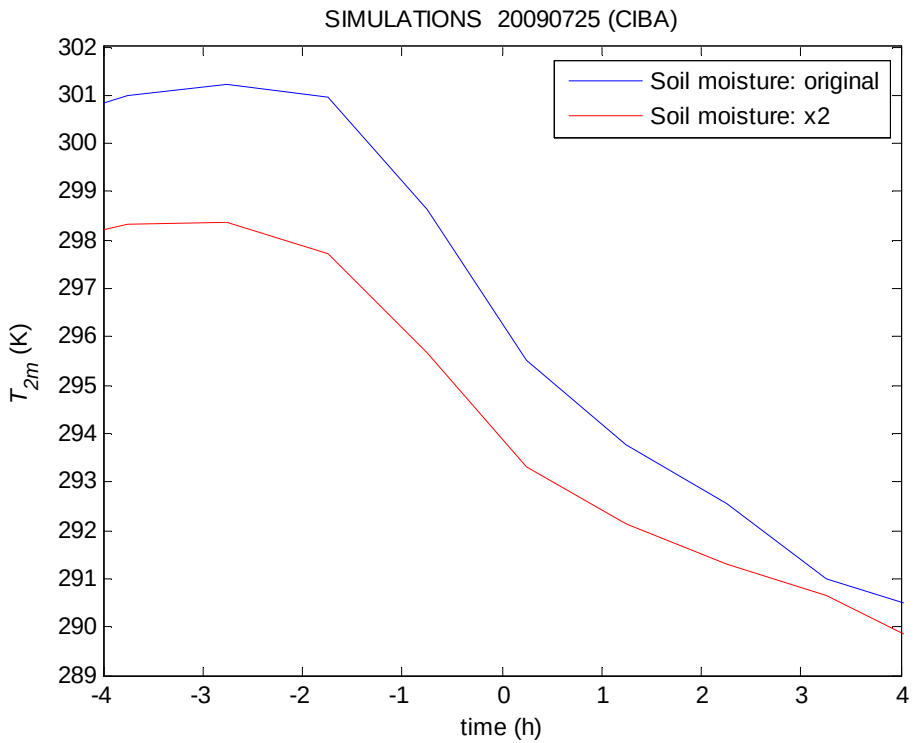



SMOIS STANDARD
SMOIS x0.5

# WRF experiment

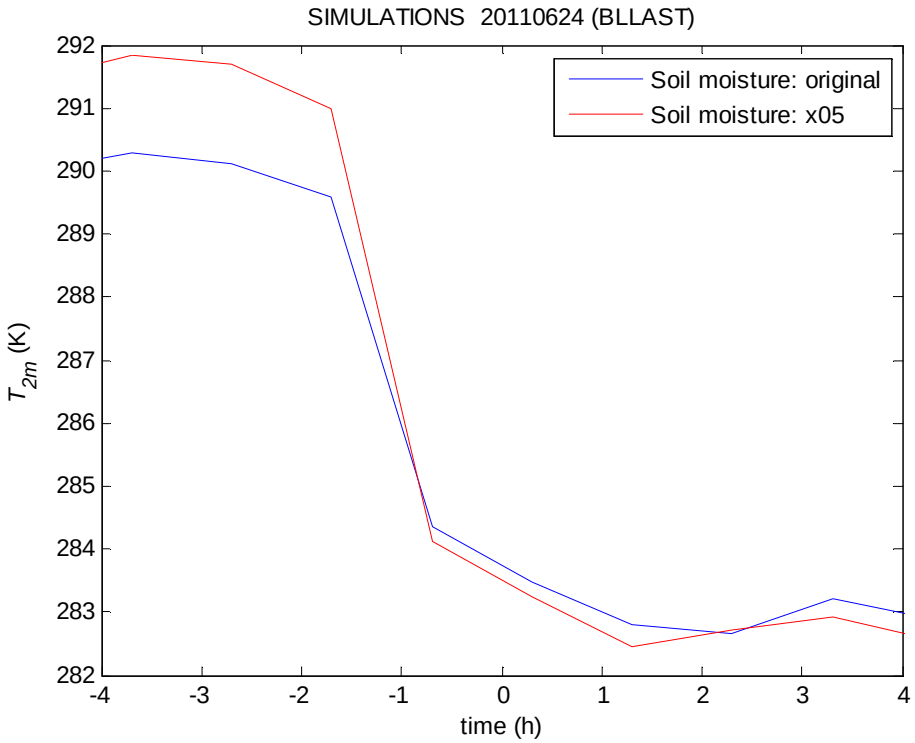
## 2m-TEMPERATURE

CIBA




SMOIS STANDARD
SMOIS x2

BLLAST



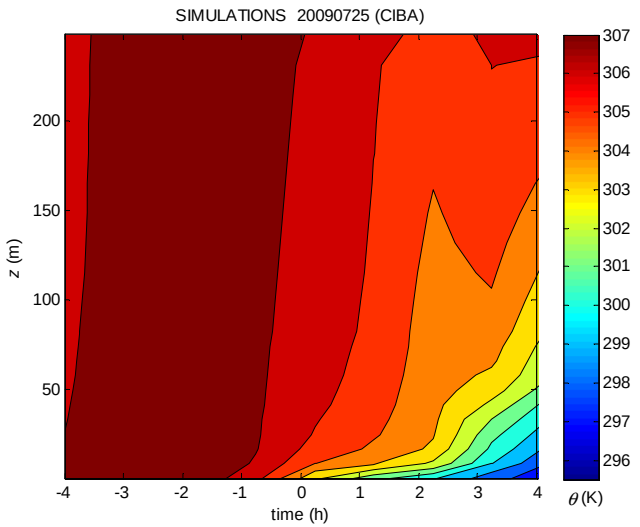

SMOIS STANDARD
SMOIS x0.5

# WRF experiment

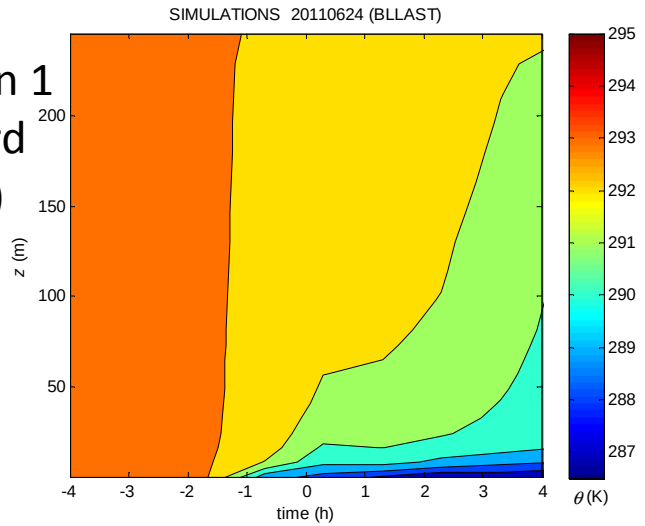
CIBA

θ (K) profile

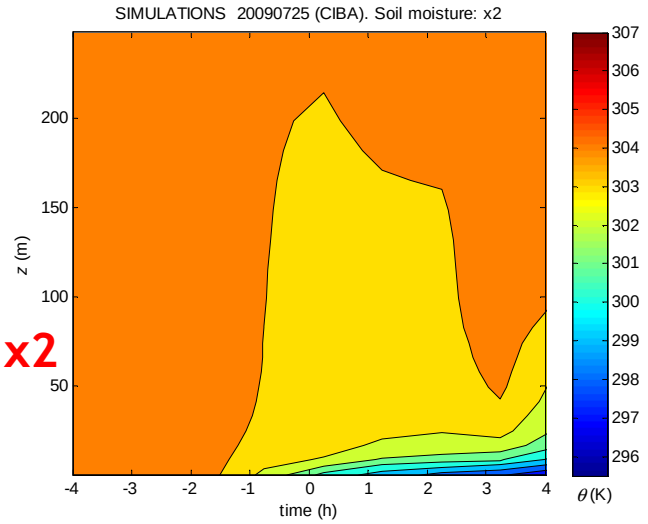
BLLAST



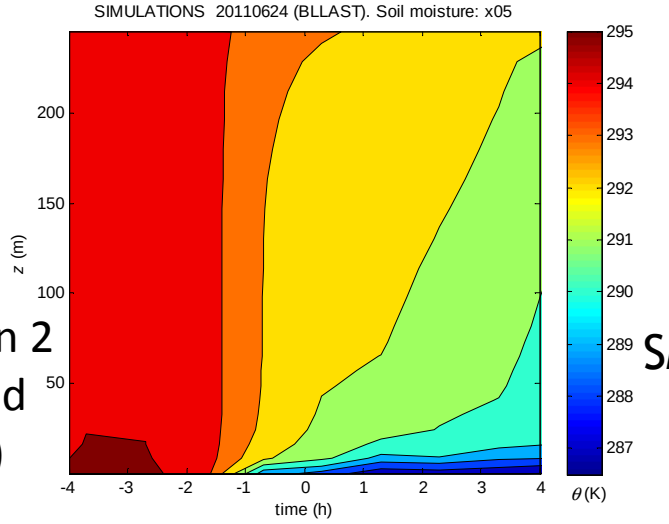

Simulation 1 (standard SMOIS)




SMOIS **x2**




Simulation 2 (modified SMOIS)

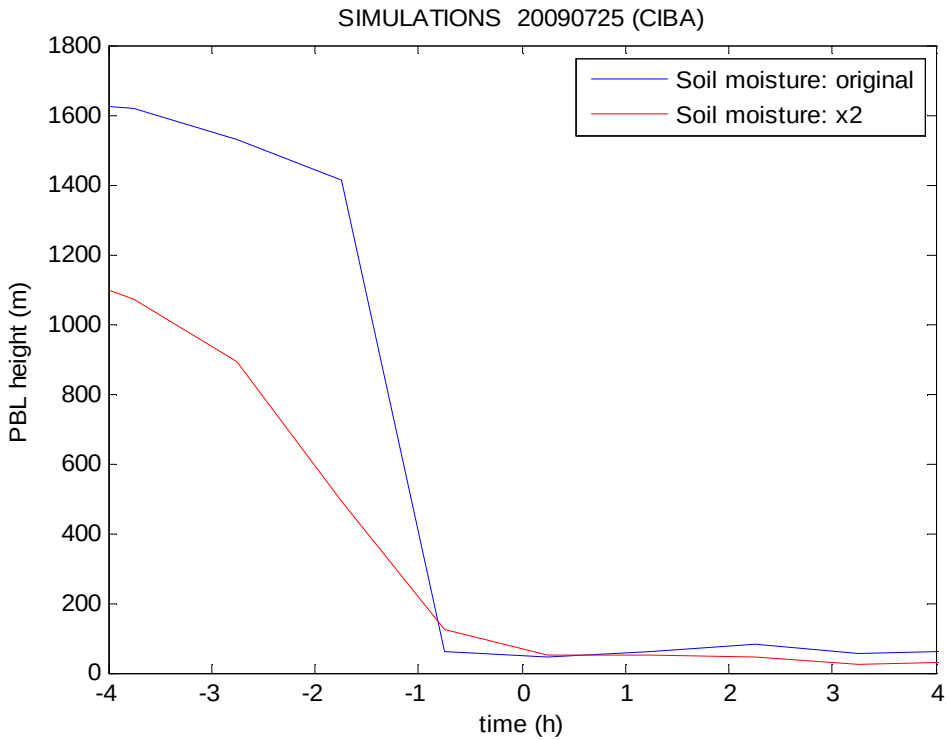



SMOIS **x0.5**

# WRF experiment

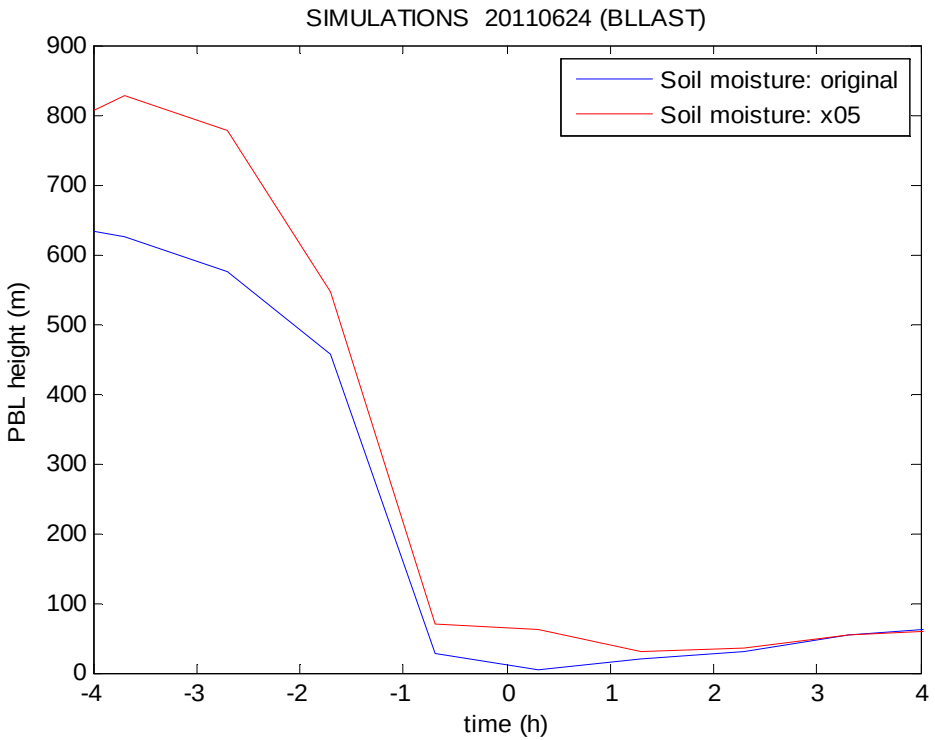
## PBL HEIGHT

CIBA




SMOIS STANDARD
SMOIS x2

BLLAST

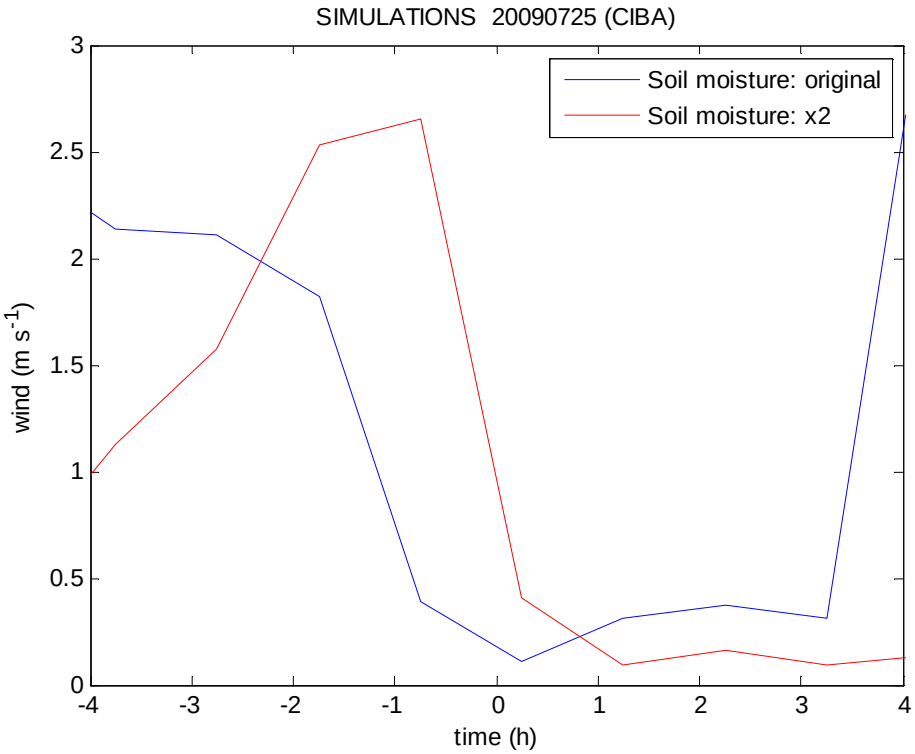



SMOIS STANDARD
SMOIS x0.5

# WRF experiment

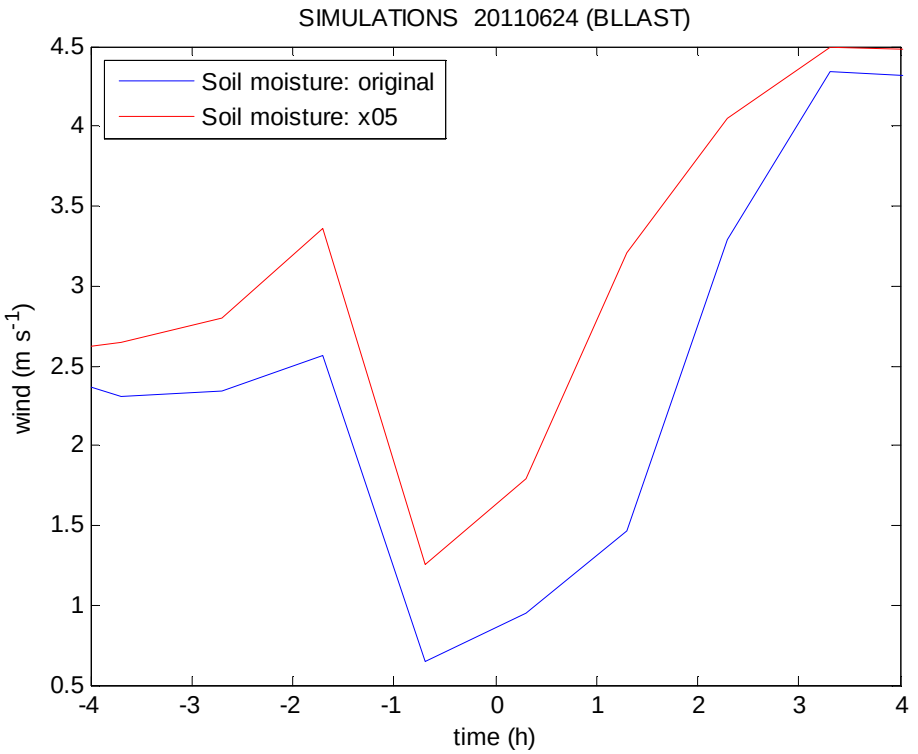
## WIND

CIBA




SMOIS STANDARD
SMOIS x2

BLLAST




SMOIS STANDARD
SMOIS x0.5

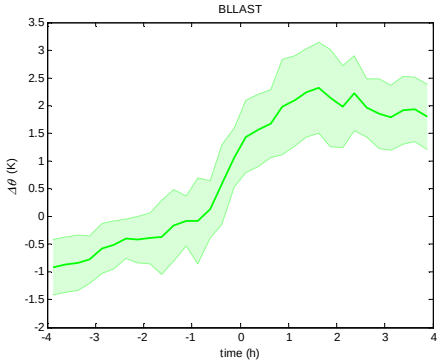
# Summary and conclusions

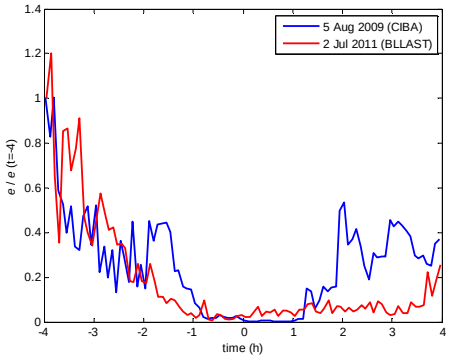
- Main similarities → global qualitative observed evolution
- Main differences
  - -extreme values
  - -time lags
  - -turbulence decay
  - -katabatic occurrence
- Role of moisture → decisive for radiative surface cooling
- Simulations: importance of modifying humidity
  → effects greater & lasting longer at driest site

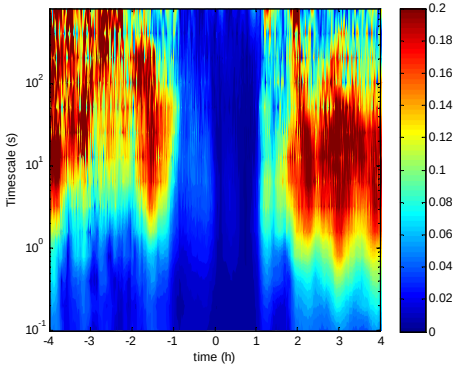
# More…

- Sastre, M., Yagüe, C., Román-Cascón, C., Maqueda, G.: Atmospheric boundary layer evening transitions: a comparison between two different experimental sites, Bound. Lay. Meteorol. (under review).

- Averages for only the katabatic cases
- Case study
  - * Variables related to their value at t=-4 h
  - * Multi-Resolution Flux Decomposition



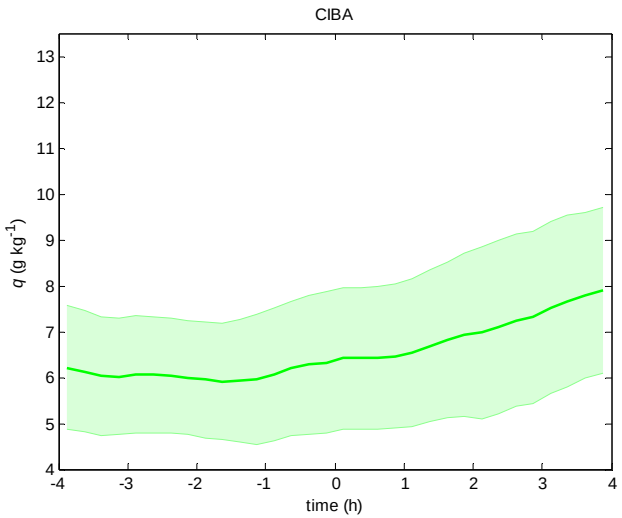



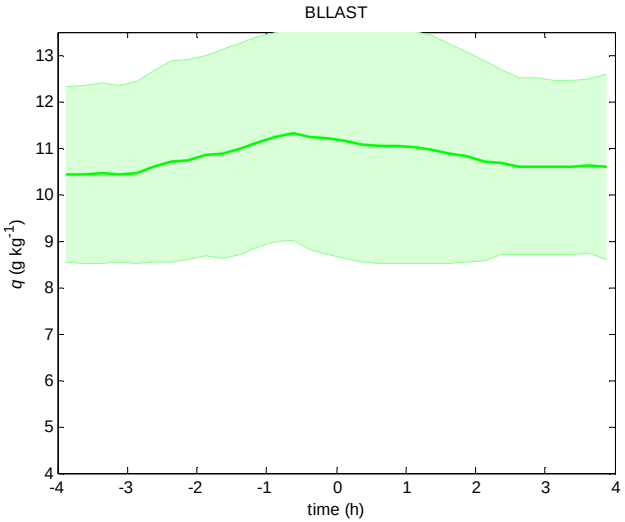
# Observations: average values

## CIBA

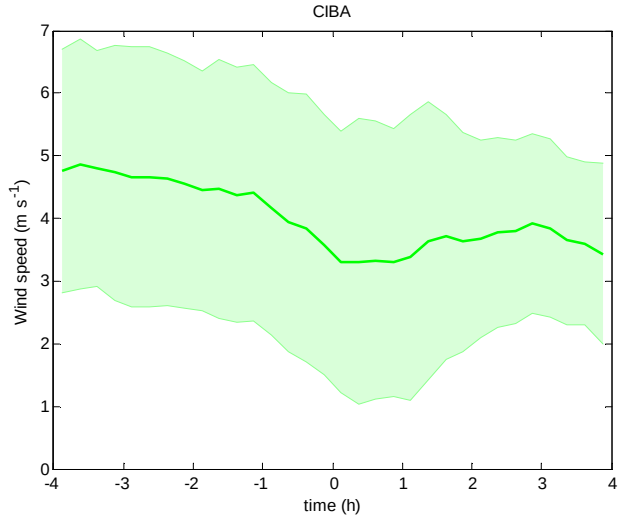
## BLLAST

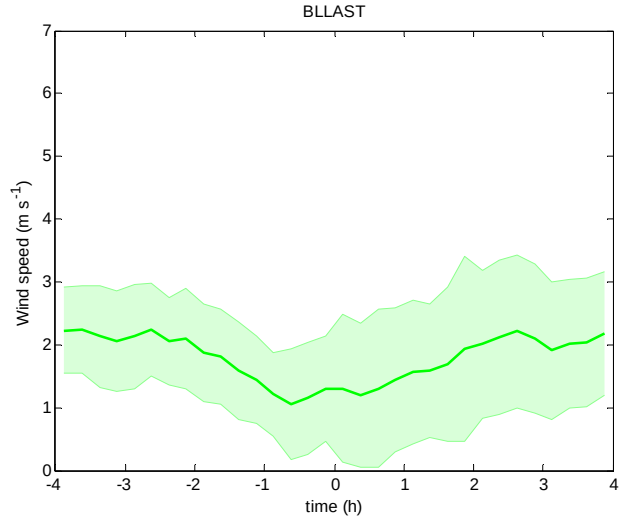
**q**




**wind**

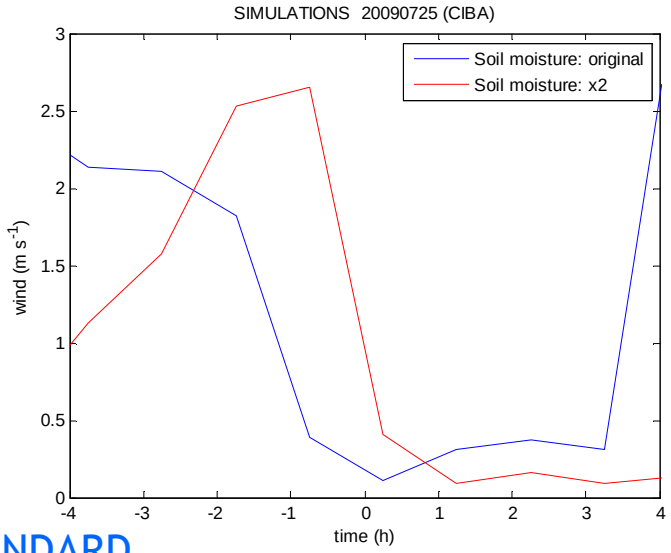


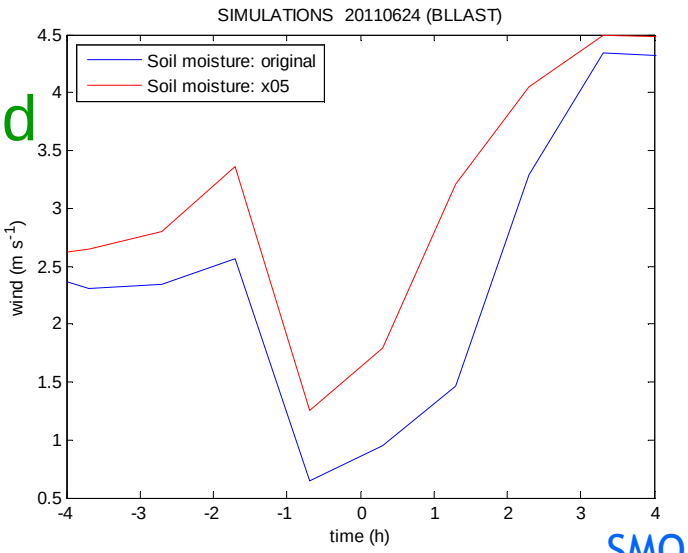
# WRF experiment

CIBA

BLLAST




wind

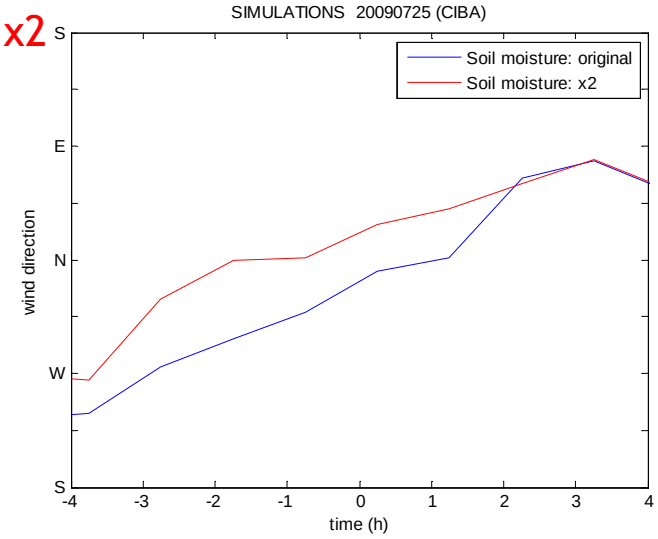



SMOIS STANDARD

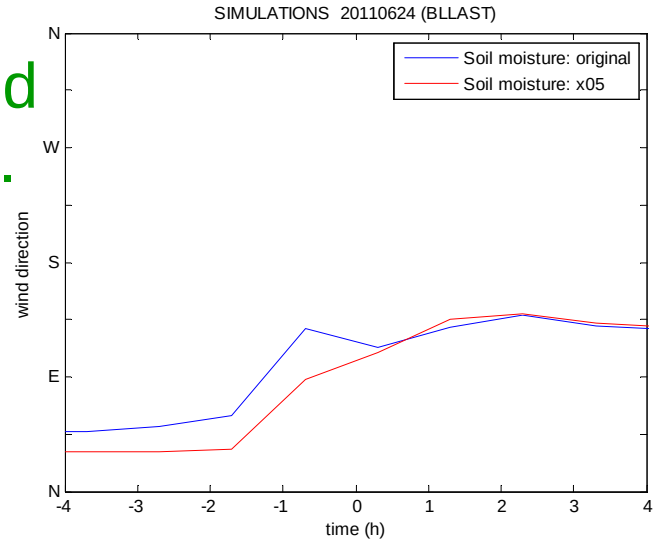
SMOIS x2

SMOIS STANDARD

SMOIS x0.5



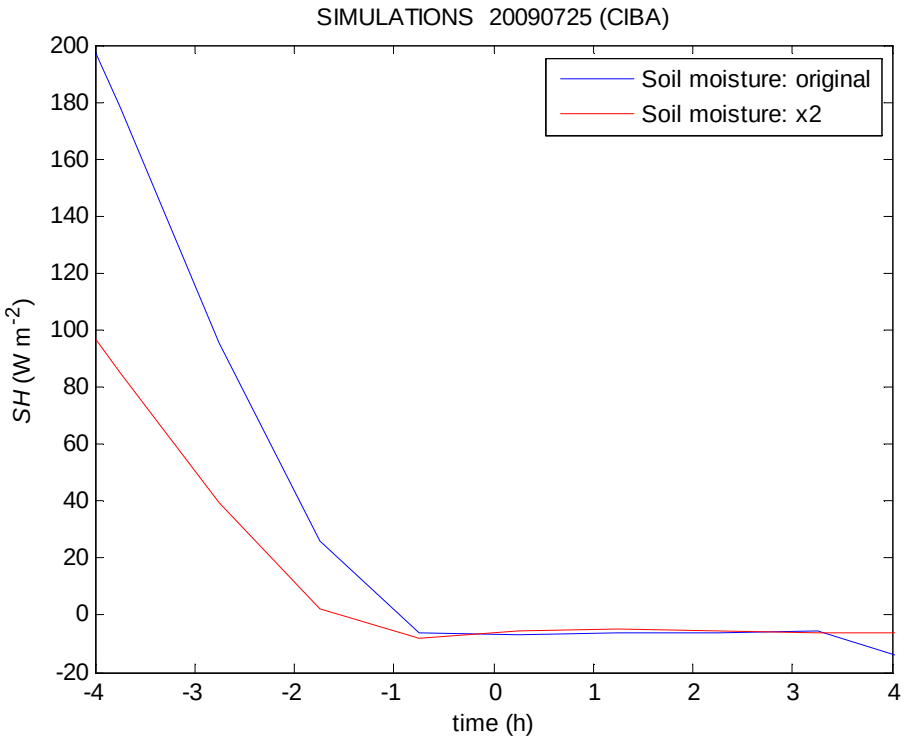

wind dir.



# WRF experiment

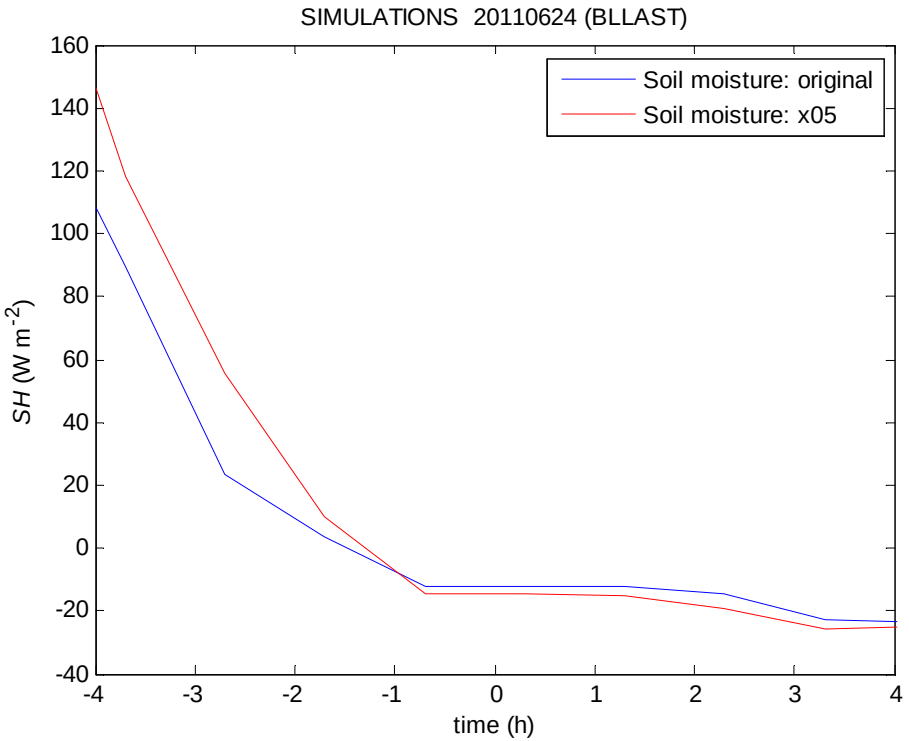
## SENSIBLE HEAT FLUX

CIBA




SMOIS STANDARD
SMOIS x2

BLLAST




SMOIS STANDARD
SMOIS x0.5

# Crossover: mean time

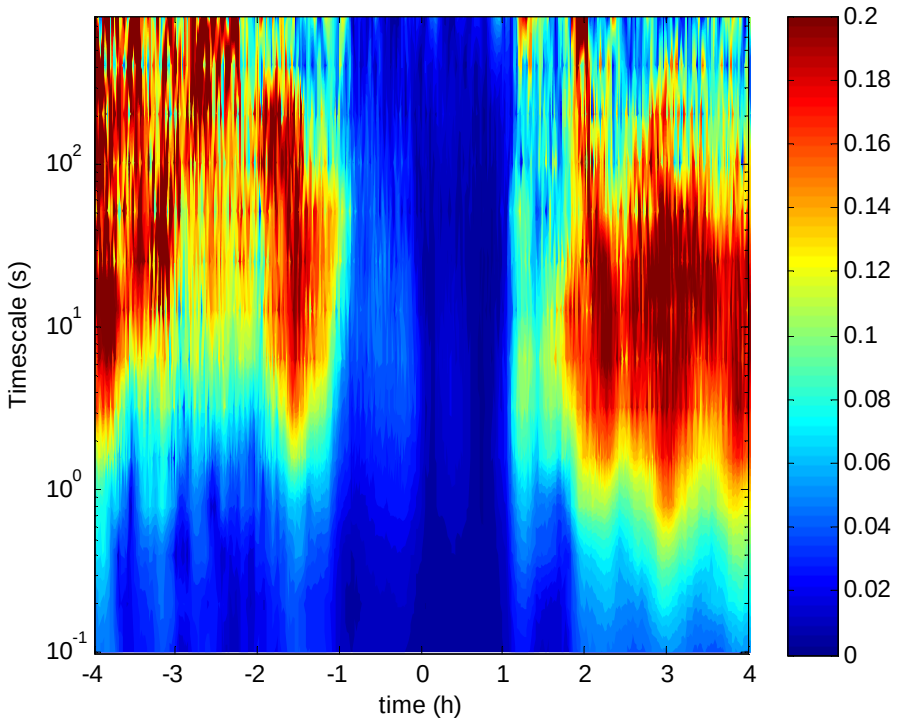
| | Mean time | |
|---|---|---|
| | [$H = 0$] | [$\Delta\theta = 0$] |
| CIBA | -47 min | -43 min |
| BLLAST | -1 h 36 min | -1 h 17 min |

sunset => t=0

# Case study: MRFD ($u_*$)

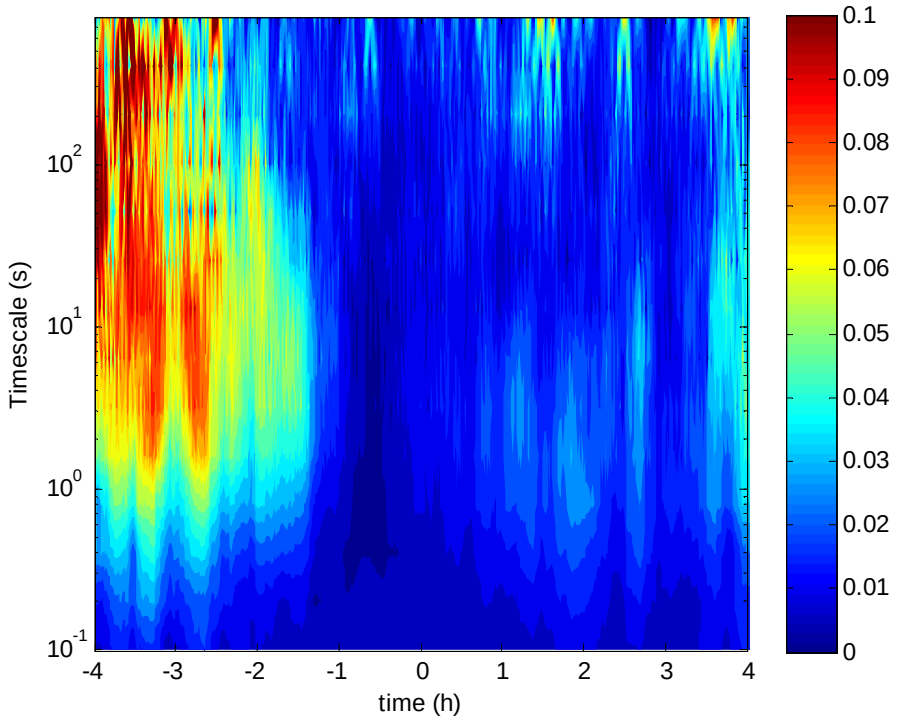
## CIBA

5th August 2009




## BLLAST

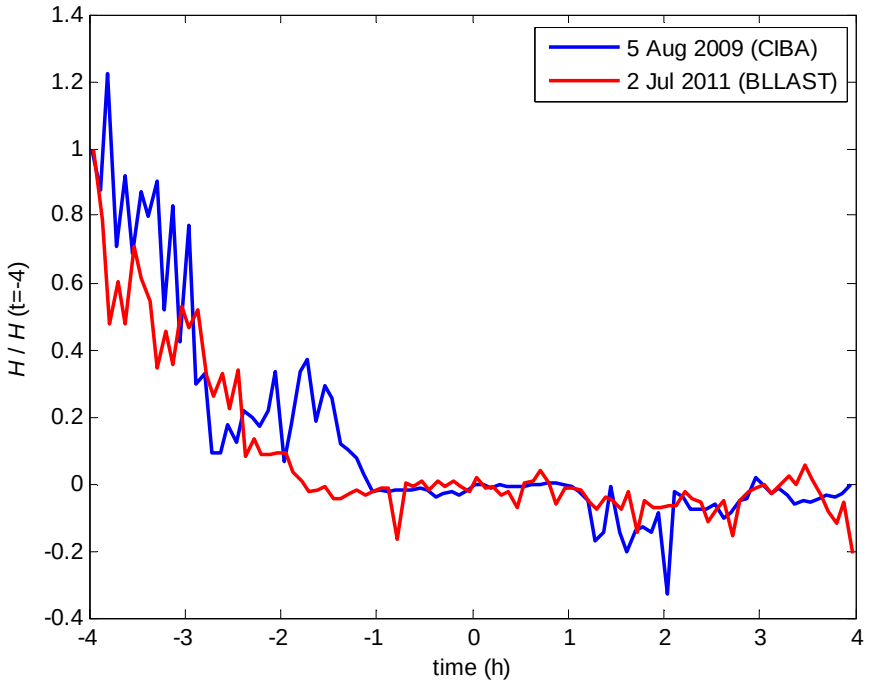
2nd July 2011



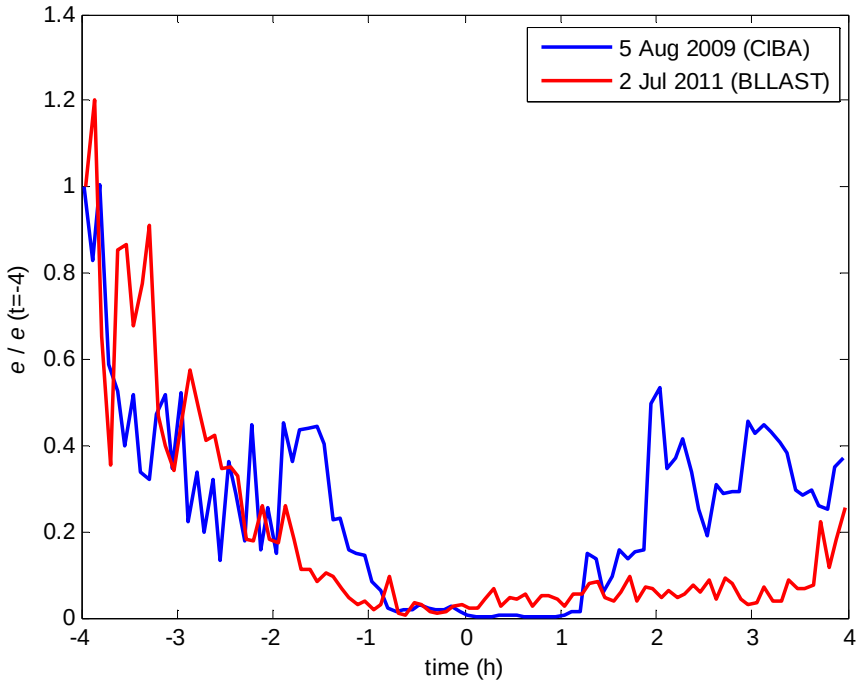

$$u_* = \left[ (\overline{u'w'})^2 + (\overline{v'w'})^2 \right]^{1/4}$$

# Case study

**H** (relative to t=-4h)




**TKE** (relative to t=-4h)

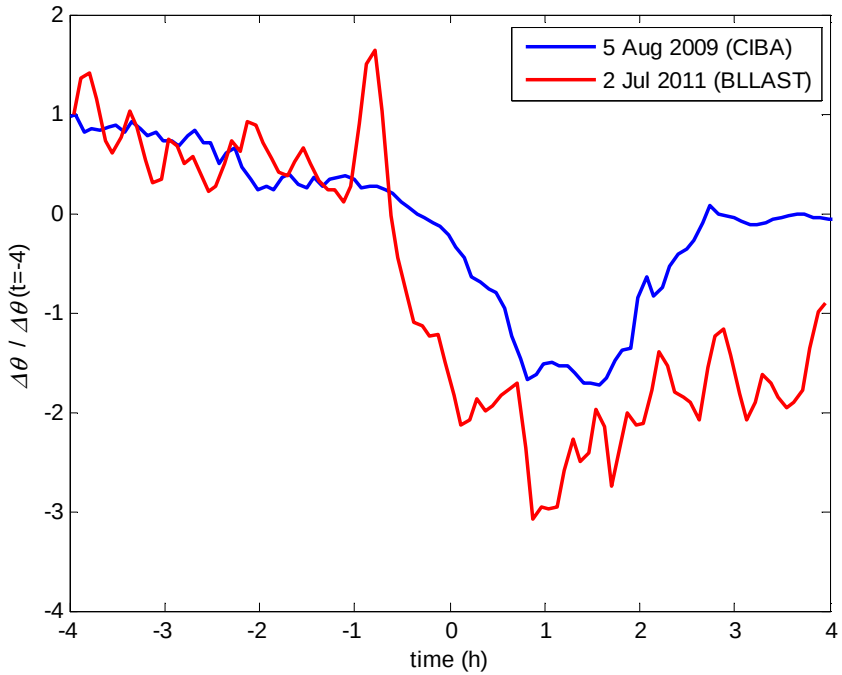



CIBA (5 August 2009)

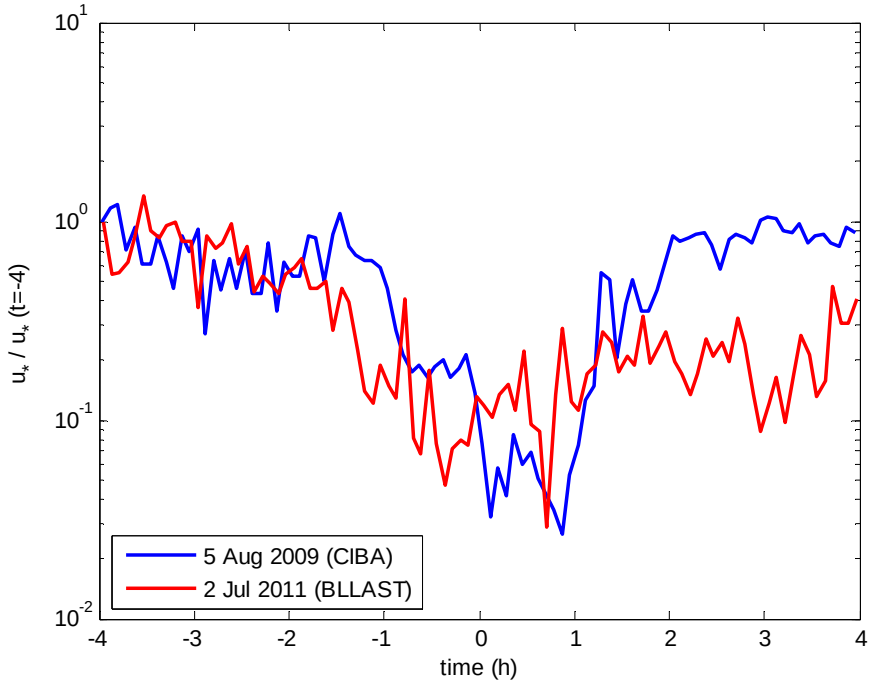
BLLAST (2 July 2011)

# Case study

$\Delta\theta$ (relative to t=-4h)




$u_*$ (relative to t=-4h)



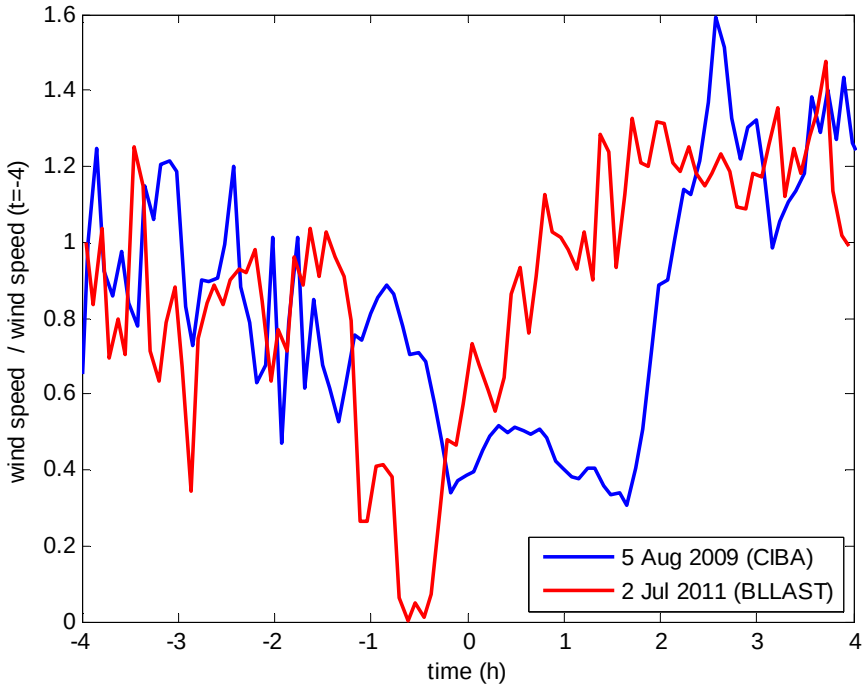

CIBA (5 August 2009)

BLLAST (2 July 2011)

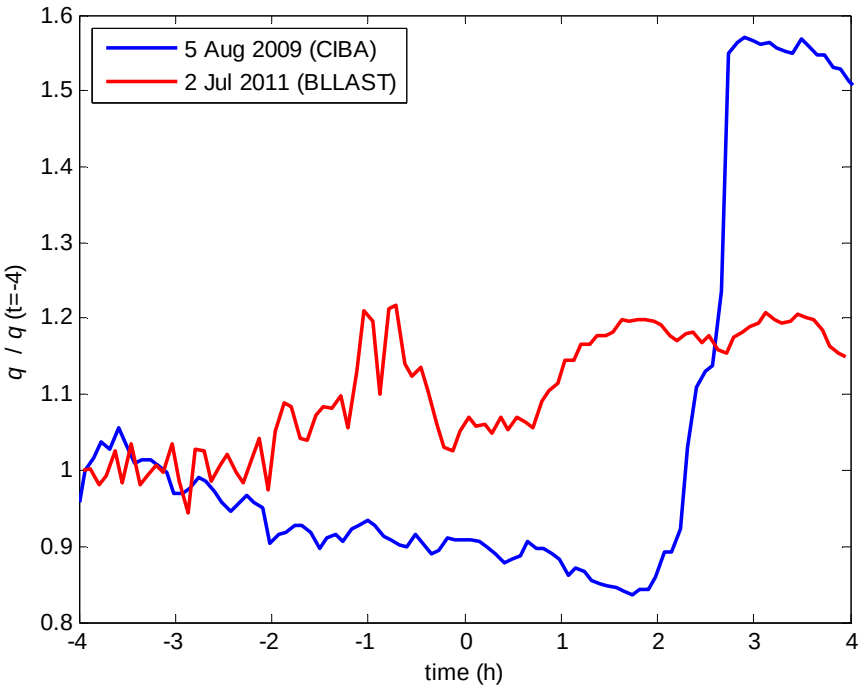
$$u_* = \left[(\overline{u'w'})^2 + (\overline{v'w'})^2\right]^{1/4}$$

# Case study

**wind** (relative to t=-4h)




**q** (relative to t=-4h)




CIBA (5 August 2009)

BLLAST (2 July 2011)