

# Total solar eclipse

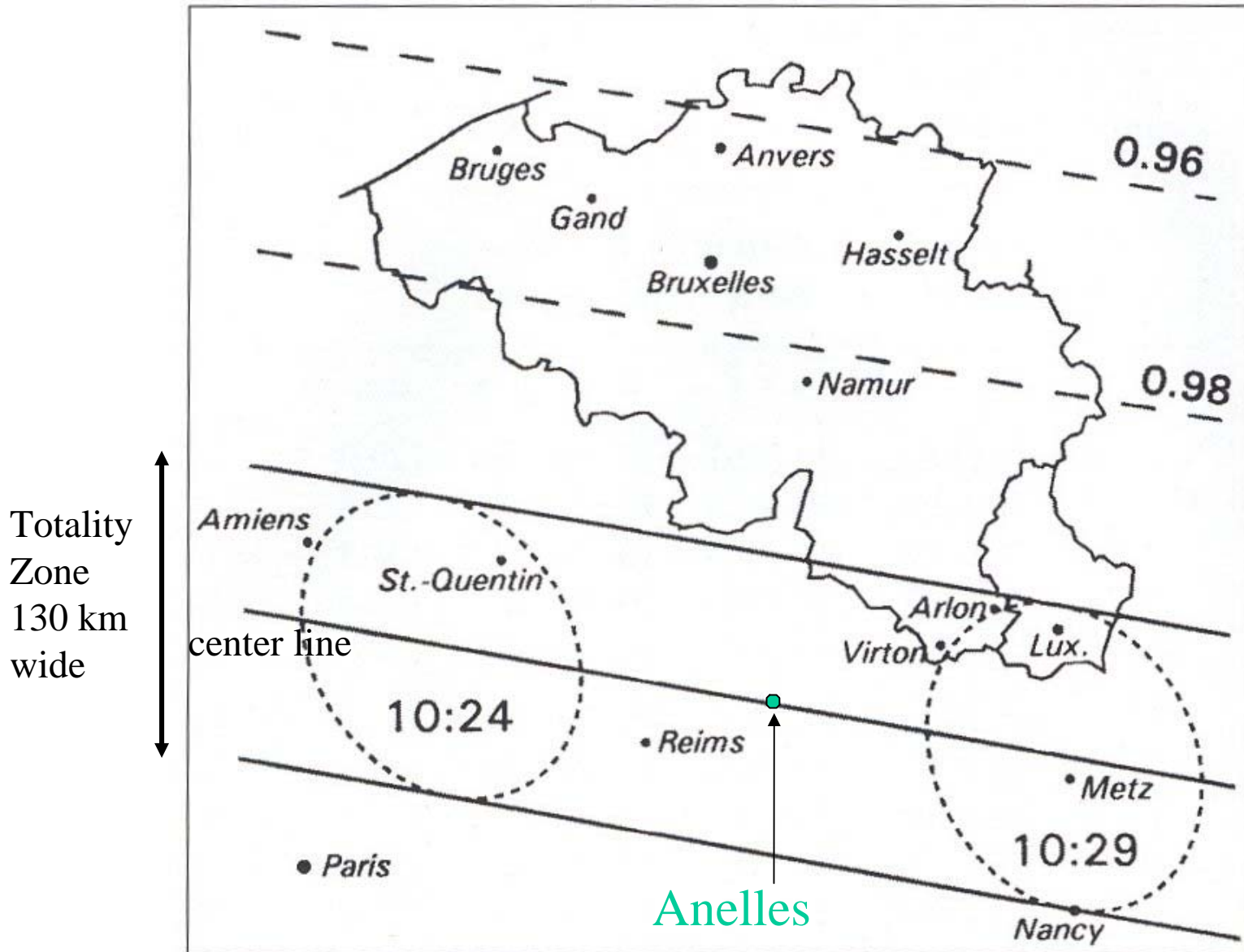
11 August 1999, Anelles, France



Surface layer turbulence measurements

Guy Schayes

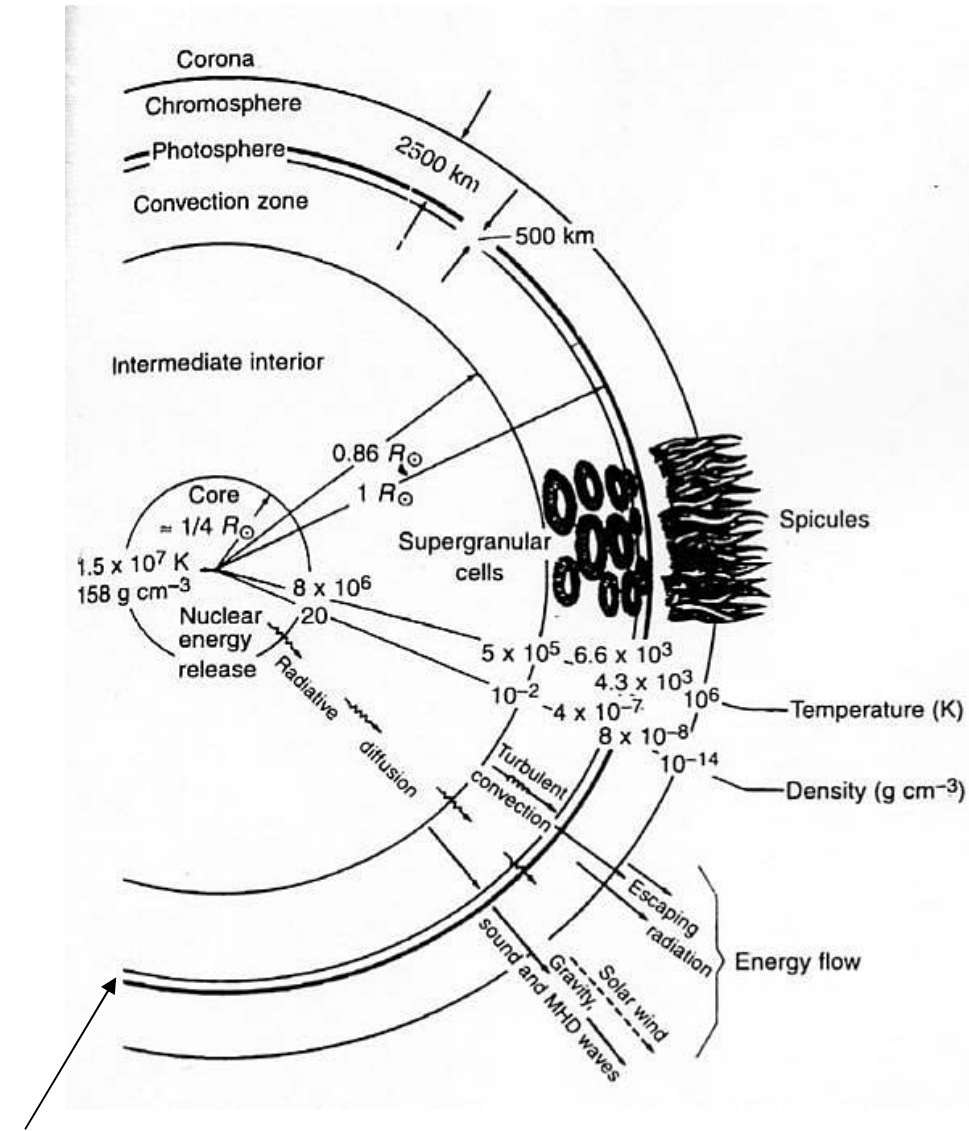
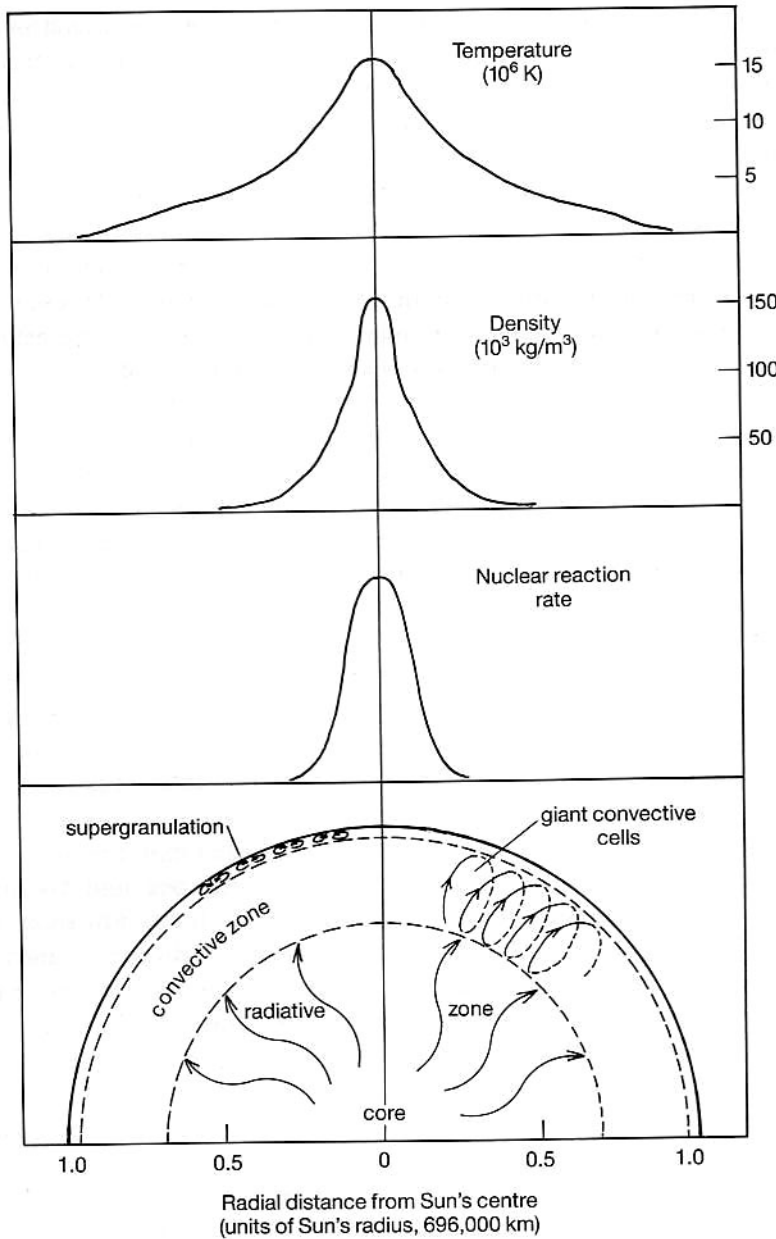
# Location of experiment



# Pictures of event



Gill propeller  
3D anemometer

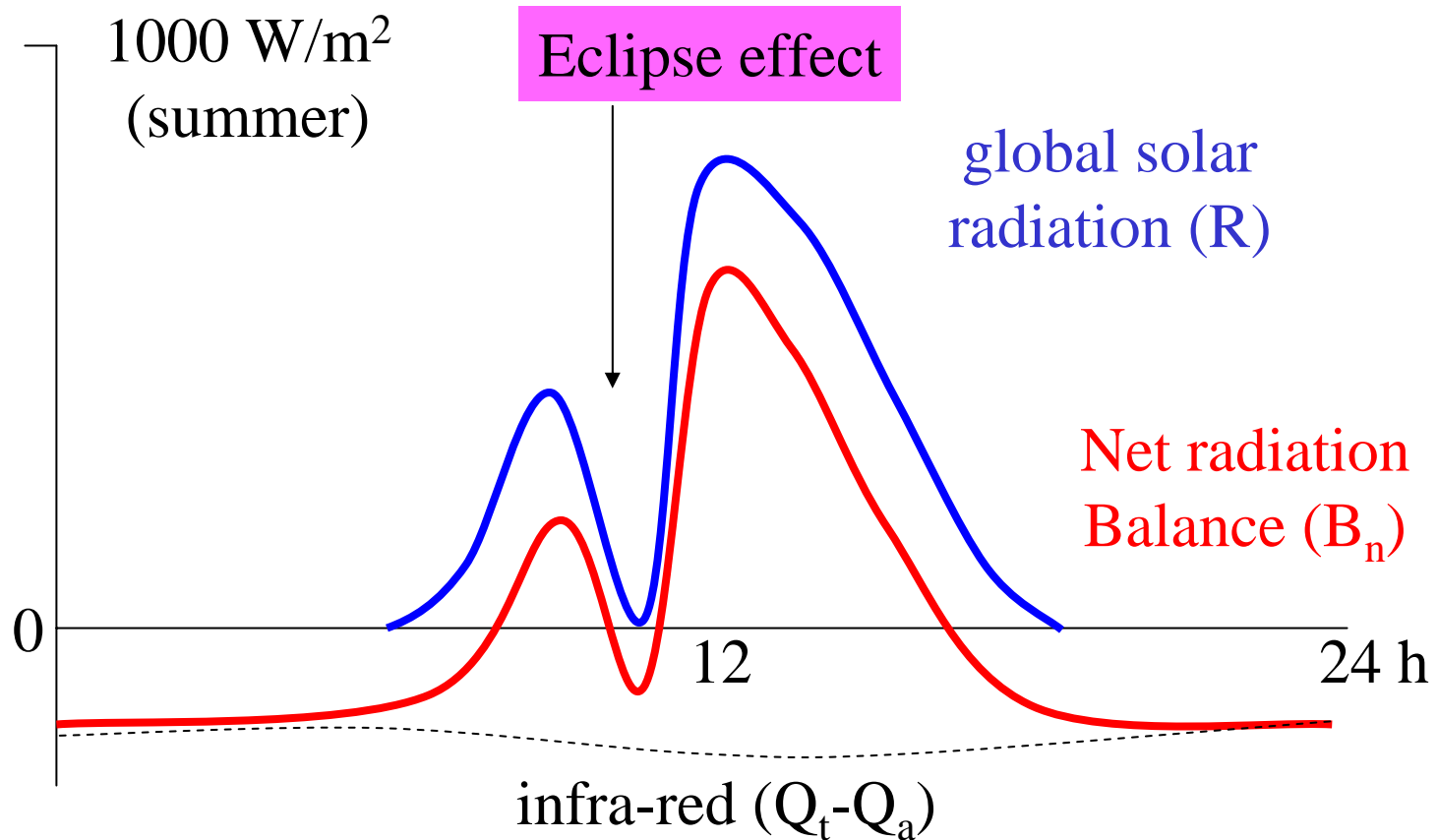


Photosphere: depth 350 km i.e.  $1/2000$  of  $R_{\odot}$   
 $T = 5780 \text{ K}$ , coldest zone of solar atmosphere

# Interest of atmospheric measurements during an eclipse

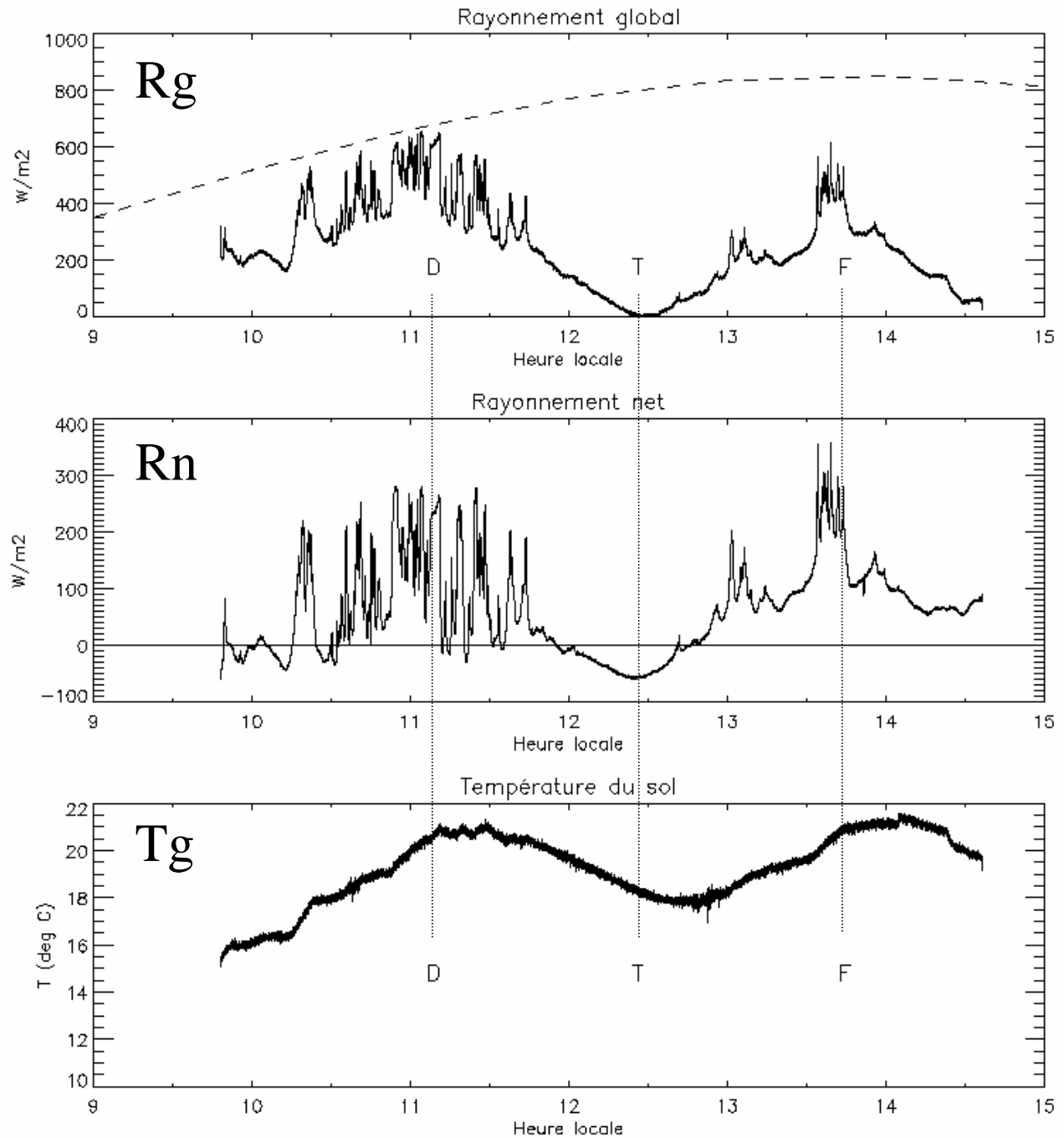
- Effect on radiation balance at first look similar to a passing big Cu
- This effect is much larger : the totality shadow is more than 100 km wide; the duration of the partial occultation is of the order of two hours
- → we are in presence of a mesoscale atmospheric feature with a predominant 1D structure
- As for the diurnal cycle, the SL is still in equilibrium with the phenomenon; the hole BL is not
- Possibility of finding an upper boundary for the time constant of the of atmospheric turbulence decay

# Diurnal variation of the radiation balance



# Radiation data

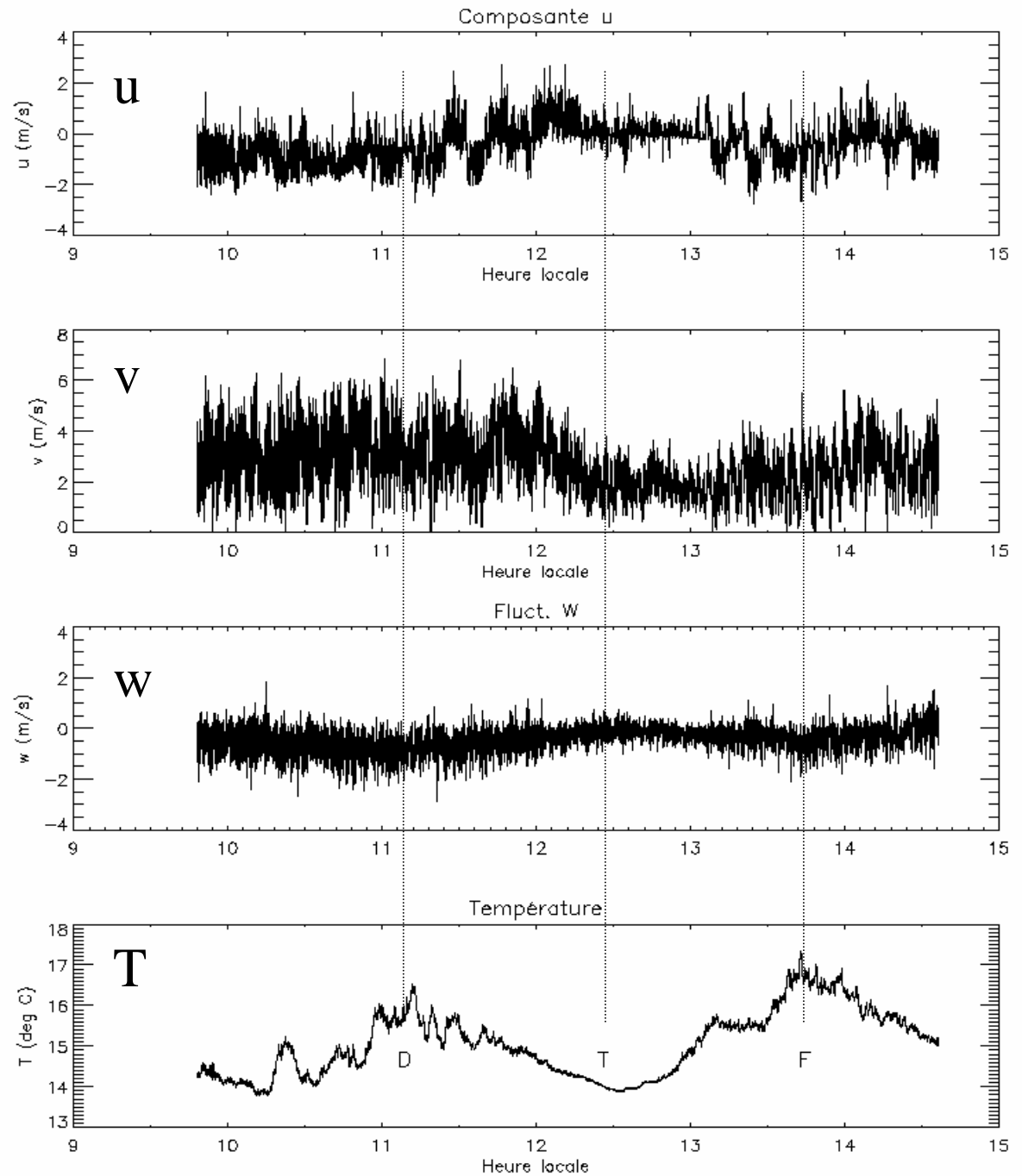
Totality duration :  
2 min 01s



# Raw turbulent data

$\Delta t = 1$  s

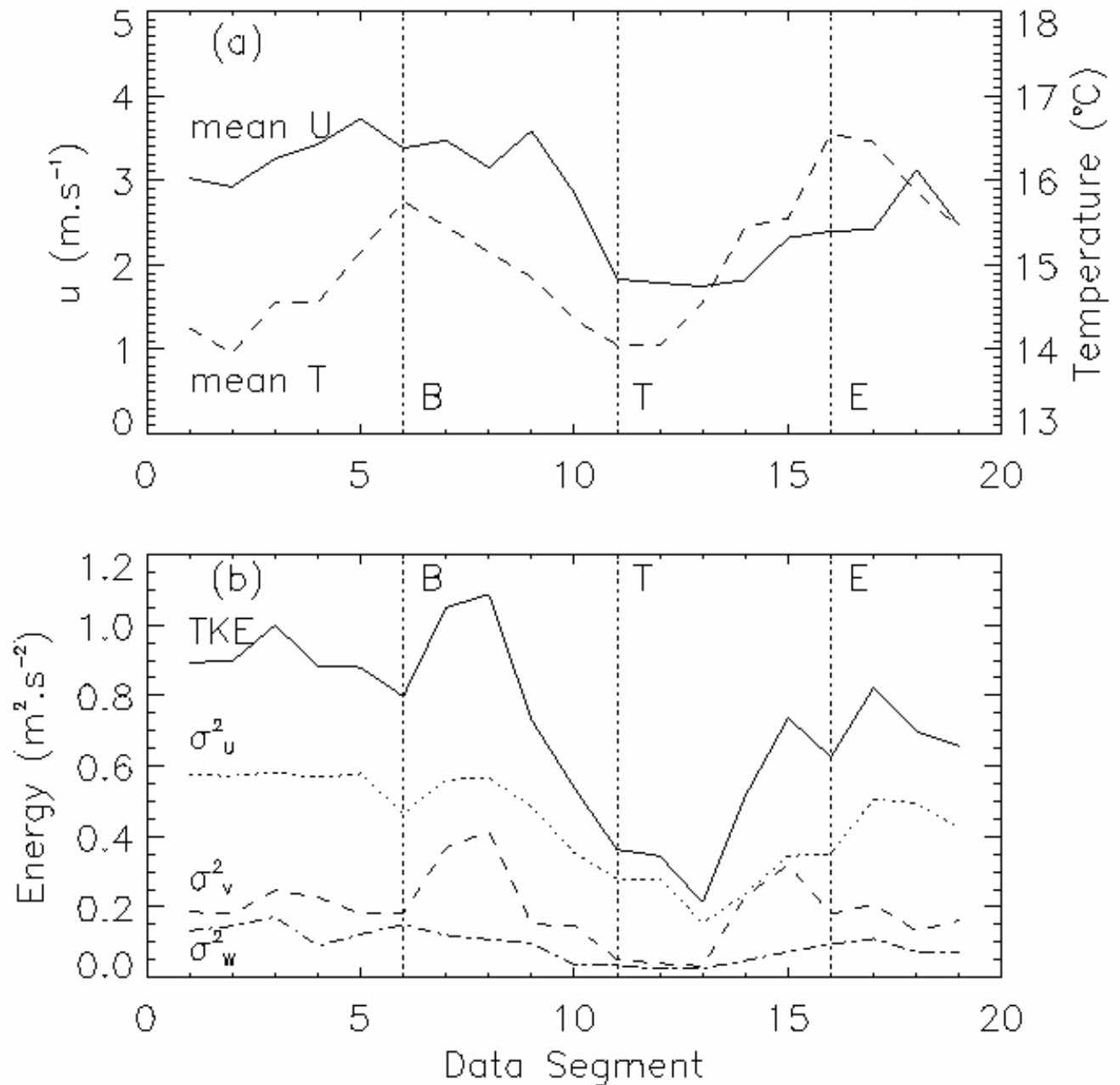
17 000 points





# Statistical results

Slices of  
15 min each  
(900 data pts)



Conditions at  
eclipse begin (6):

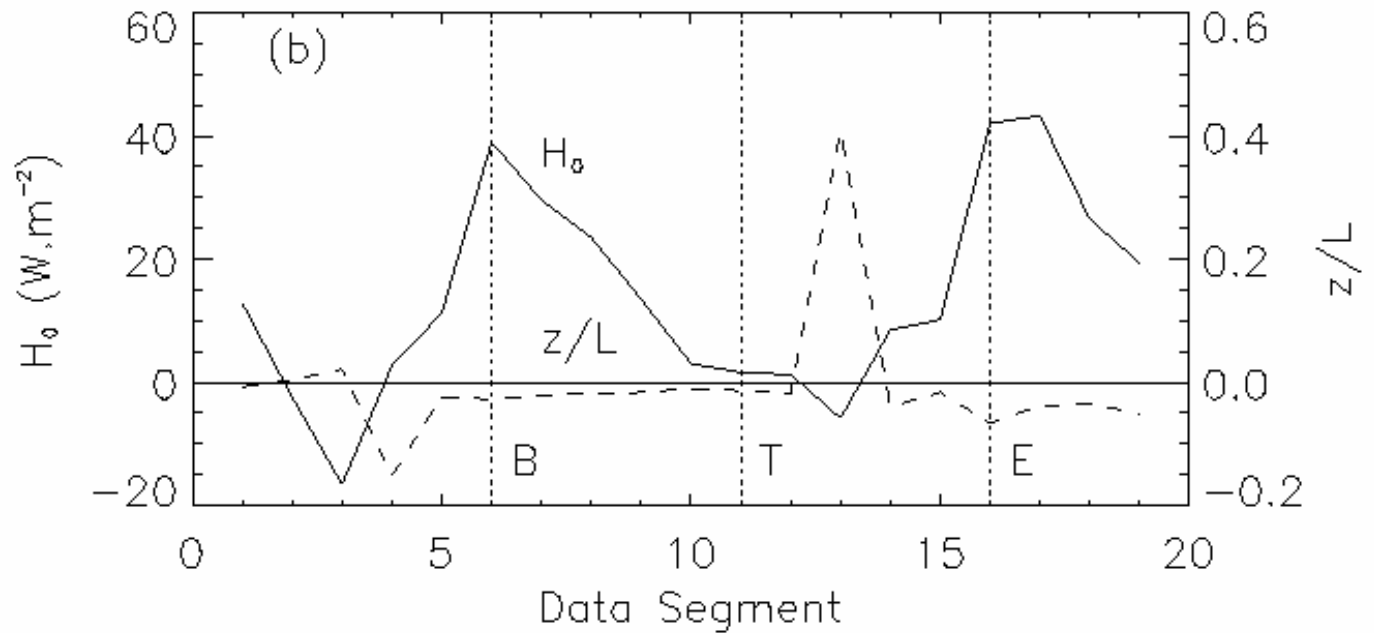
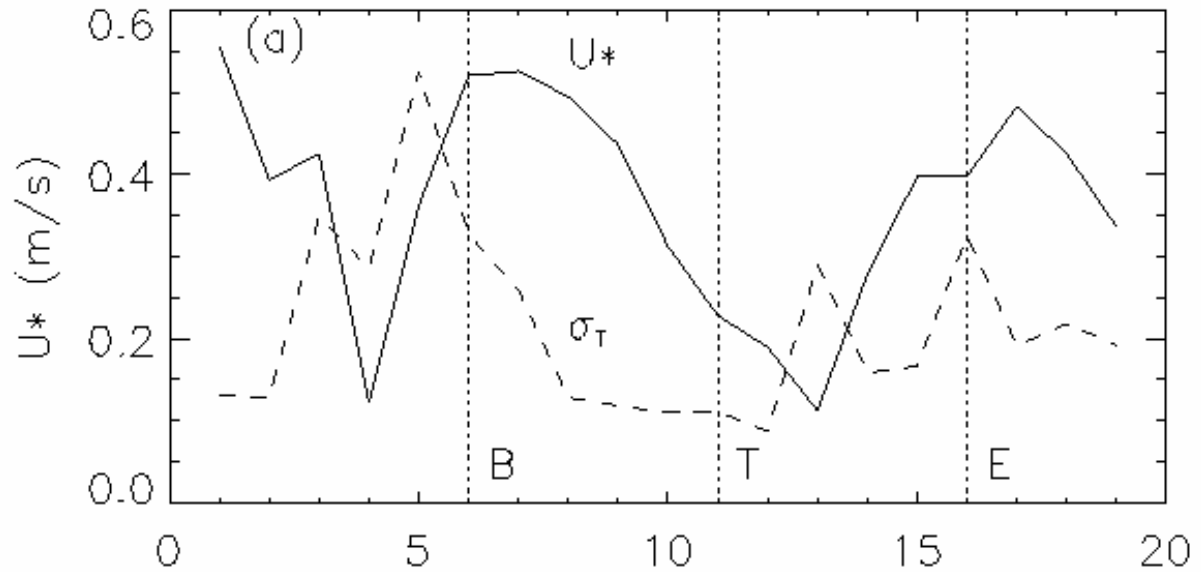
$$H_0 = 40 \text{ W m}^{-2}$$

$$h_i = 400 \text{ m (est.)}$$

$$w_* = 0.77 \text{ m s}^{-1}$$

$$u_* = 0.5 \text{ m s}^{-1}$$

$$t_* = 520 \text{ s}$$



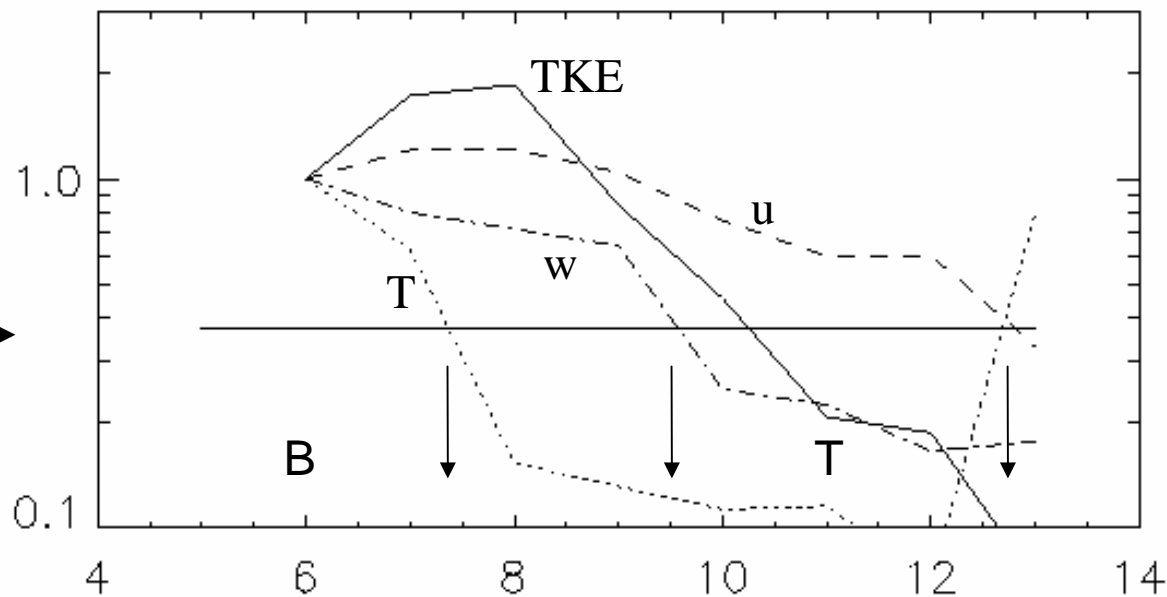
Longueur de M-O :

$$\odot = i \frac{\star \blacklozenge^3}{\psi \odot \&}$$

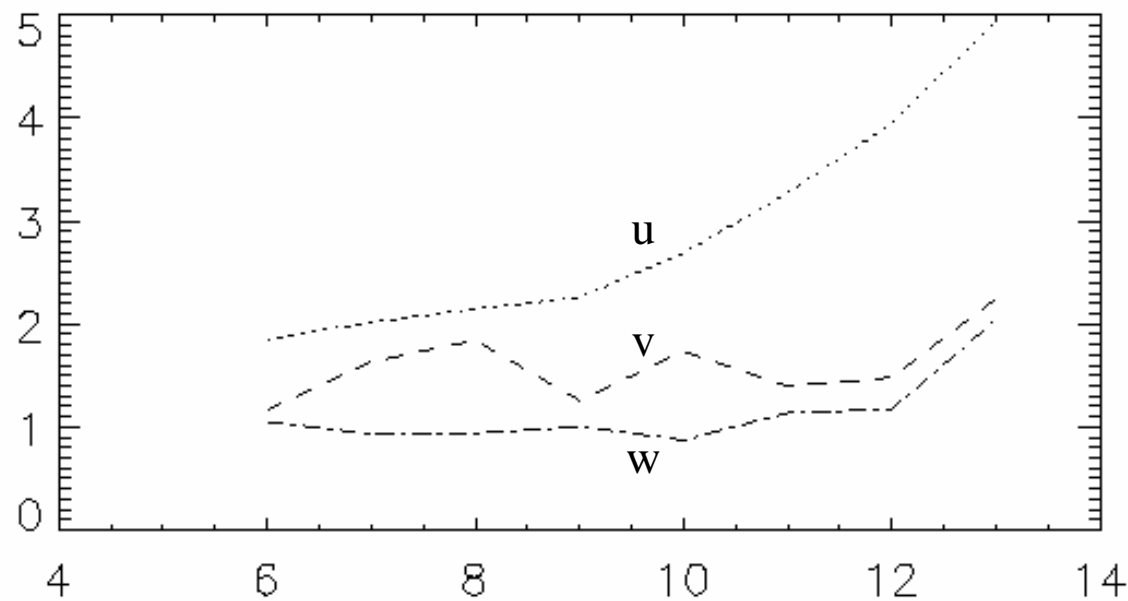
# Decay phase

Ratios :

$$\sigma^2 / \sigma^2(6) \longrightarrow$$



$$\sigma / u_* \longrightarrow$$



# Decay characteristics

Previous LES studies :

Nieuwstadt F., Brost R. (1986). The decay of convective turbulence

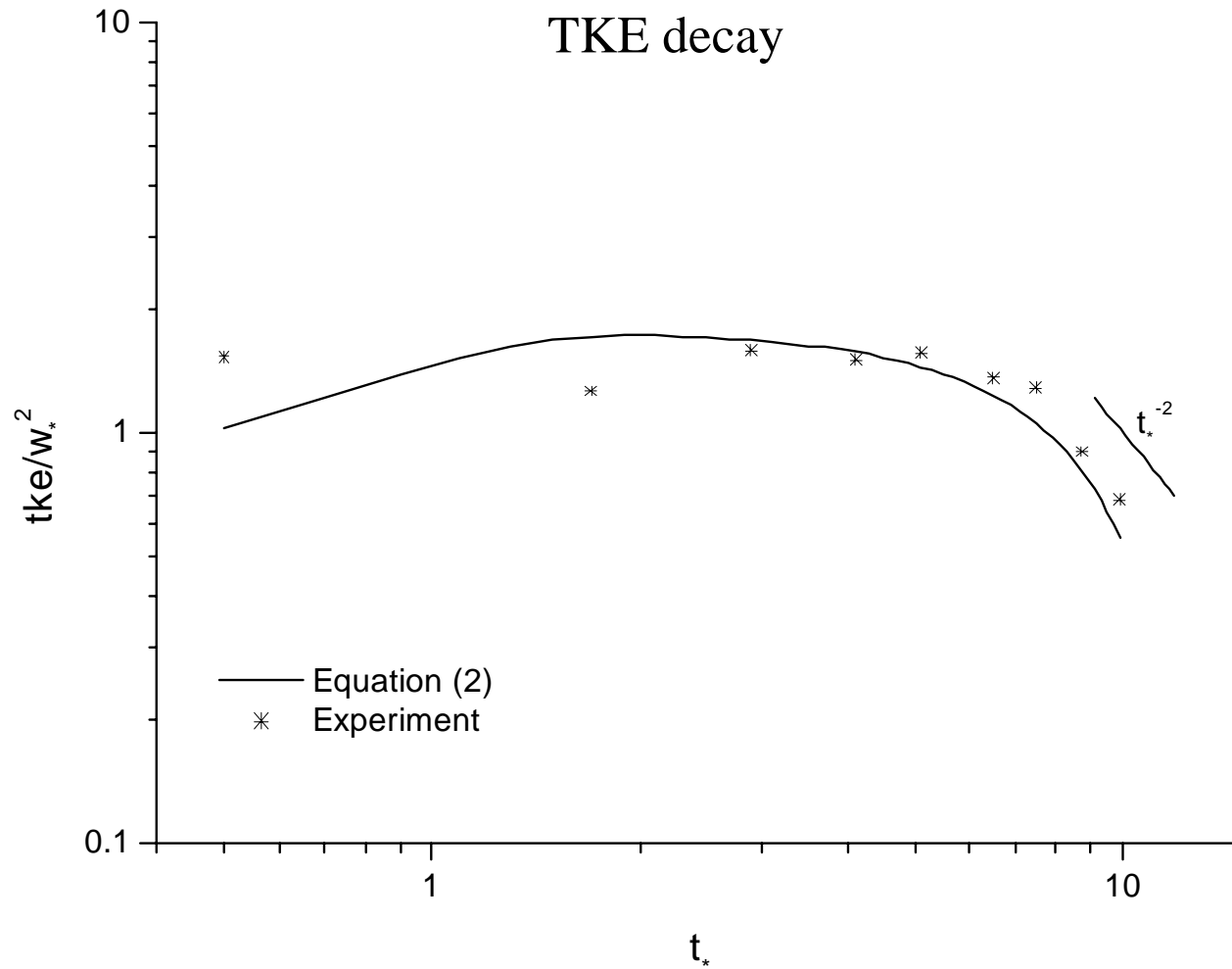
J. Atm. Sc. 43, 532-546

Sorbjan R. (1997). Decay of convective turbulence revisited.

BLM, 82, 501-515.

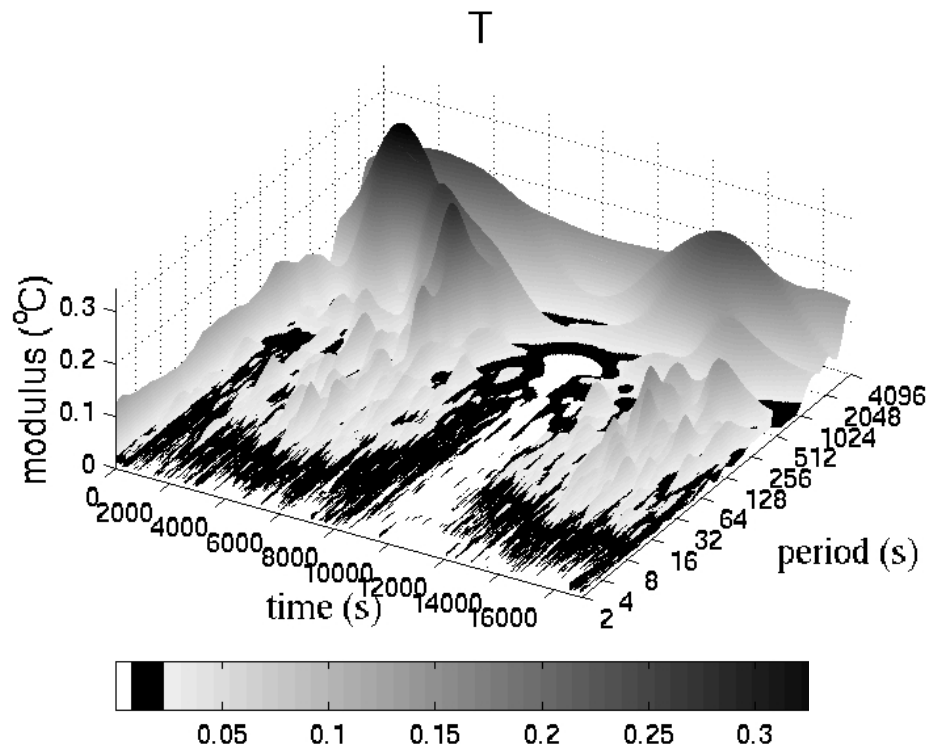
This experiment agrees on :

- Rapid and immediate decay of var T
  - var u stays constant for about  $2 t_*$  then decays slowly
  - var w decays more rapidly than var u
  - TKE decays with a -2 power law
- 
- Decay time ( $e^{-1}$ ) : less than 15 min for T, and 30 min for TKE.



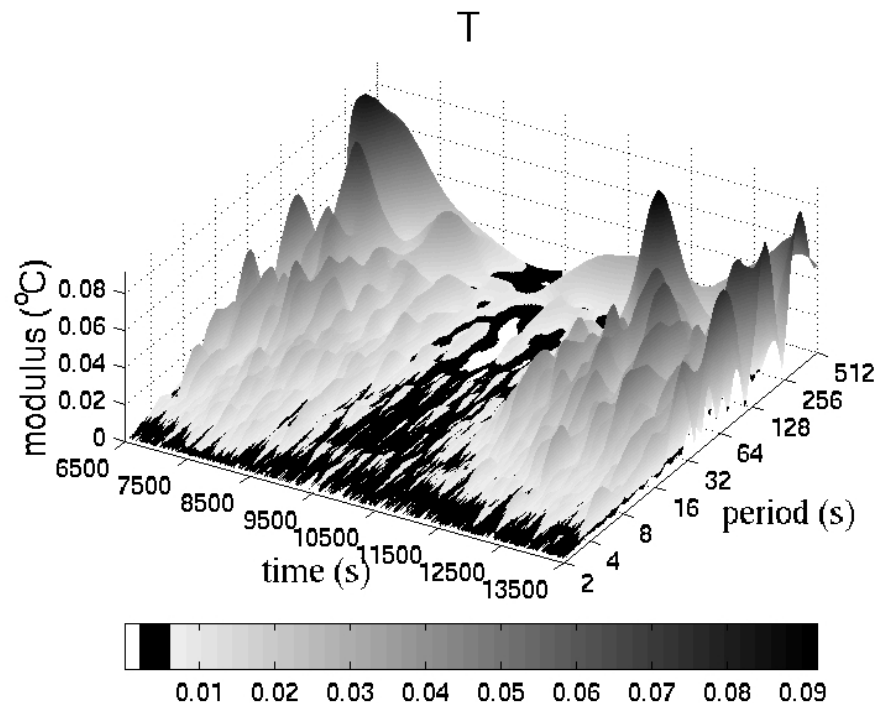
Comparison of data points with turbulence model  
Goulard et al. (2003), BLM 107, 143-155

→ Anfossi D., Schayes G. et Goulard, BLM, 2004

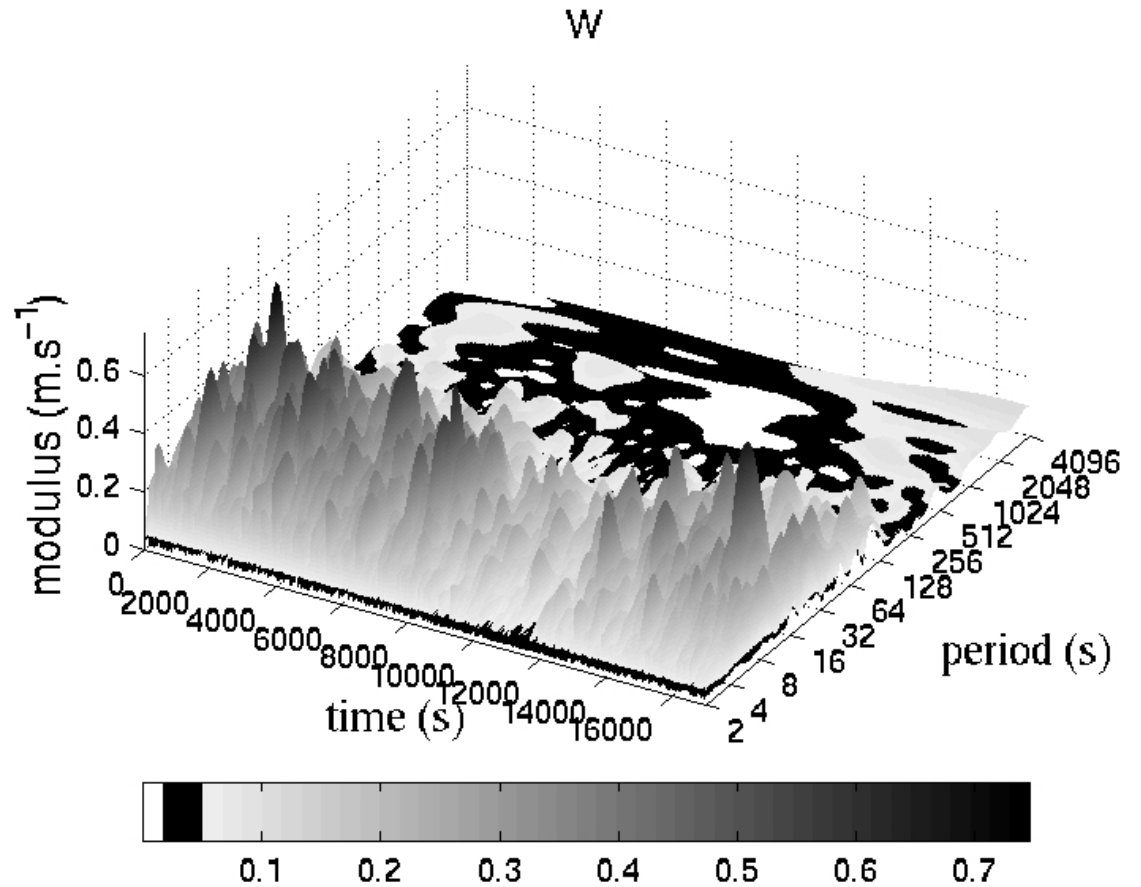


## Wavelet Transform of T

Zoom on  
central part



WT of w



# Conclusions

- The measurements succeeded in measuring the variations in the characteristics of the SL turbulence
- One of the (very) few measurements of this kind
- Model study to be improved ...
- Sky conditions were not optimal but :
- ⇒ Next occurrences :
  - Spain, on 3 October 2005 (annular)
  - Libya, Turkey, on 29 March 2006
  - Siberia, on 1 August 2008
  - ...