

# Single column modeling of the diurnal cycle based on CASES99 data

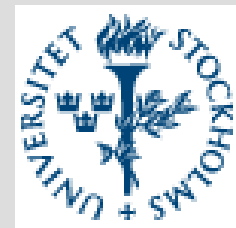
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## GABLS second intercomparison project



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Stockholm University  
SWEDEN**



Atmospheric boundary layer parameterizations are based on observational data for idealized conditions (horizontal homogeneity, stationary etc)

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They are supposed to work in the real world

How can we test them in the best way?

- 1) Real data
- 2) Idealized
- 3) Idealized based on data

## **Motivation for the design of the experiment**

- Attract many groups – especially the operational weather forecast centers and global climate centers
- Close enough to observations
- Not introducing too many processes
- Not introducing too many implementation errors



## GABLS 2<sup>nd</sup> experiment

- Idealized simulation based on observations
- CASES-99
- Kansas US (37.6N, -96.7E)
- Flat terrain with  $z_0=0.03\text{m}$
- Constant geostrophic wind  $u_g=3 \text{ ms}^{-1}$ ,  $v_g=-9 \text{ ms}^{-1}$
- Prescribed surface temperature
- Latent heat flux 2.5% of the potential value
- Simulation time 60 hours with start at 16LT October 22

# Participating models

>20 SCM results  
(colors)

 COAMPS-3D

 WUR-obs

 NCAR-obs

 LM-obs

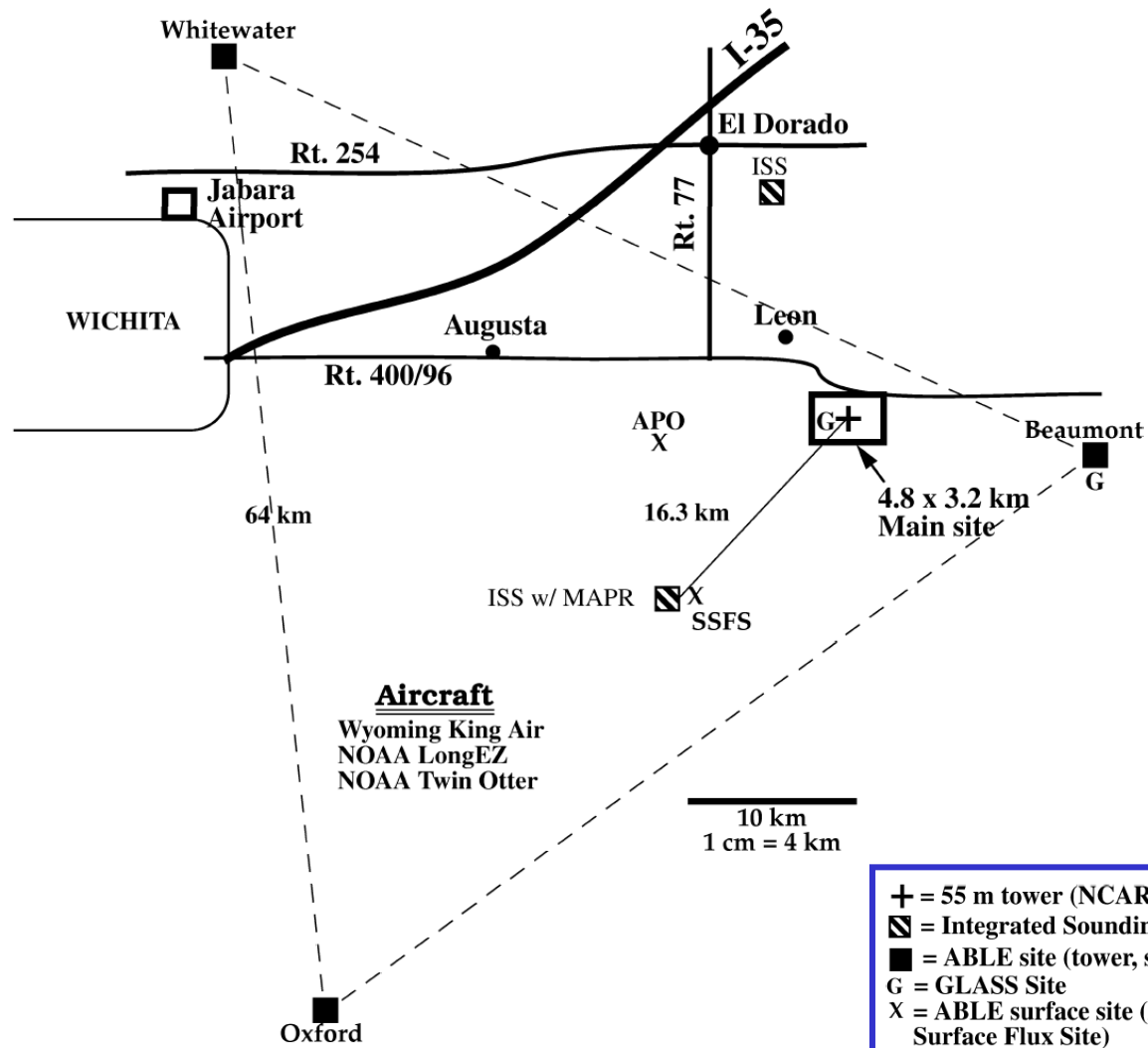
50% 1<sup>st</sup> order  
50% TKE schemes

ca 10 Operational  
One GCM

3D-dimensional simulation

# Cooperative Atmosphere-Surface Exchange Study 1999

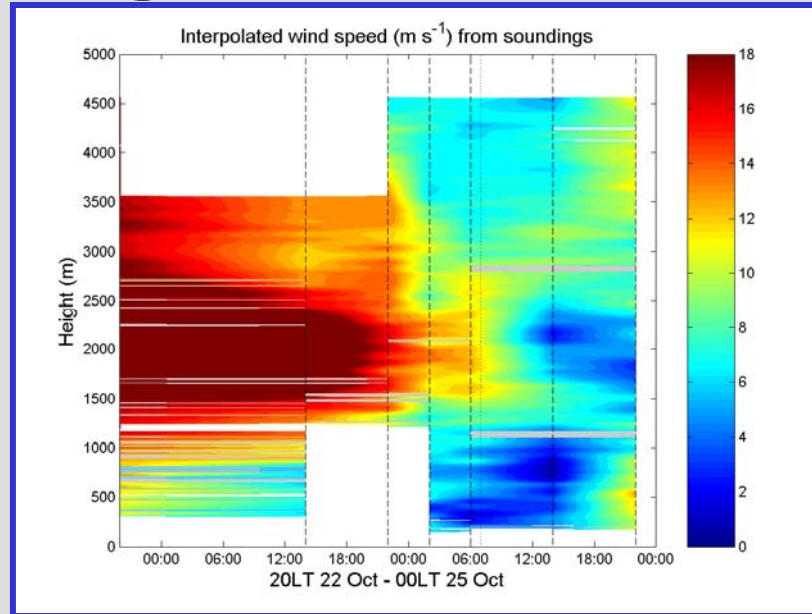
**Figure 1** Plan view of CASES-99



+ = 55 m tower (NCAR ATD) w/ GLASS (220 sondes)  
 □ = Integrated Sounding System (NCAR ATD - 32 sondes each)  
 ■ = ABLÉ site (tower, sodar, 915 MHz wind profiler: Beaumont)  
 G = GLASS Site  
 X = ABLÉ surface site (APO - ABLÉ Project Office, SSFS - Smileyberg Surface Flux Site)

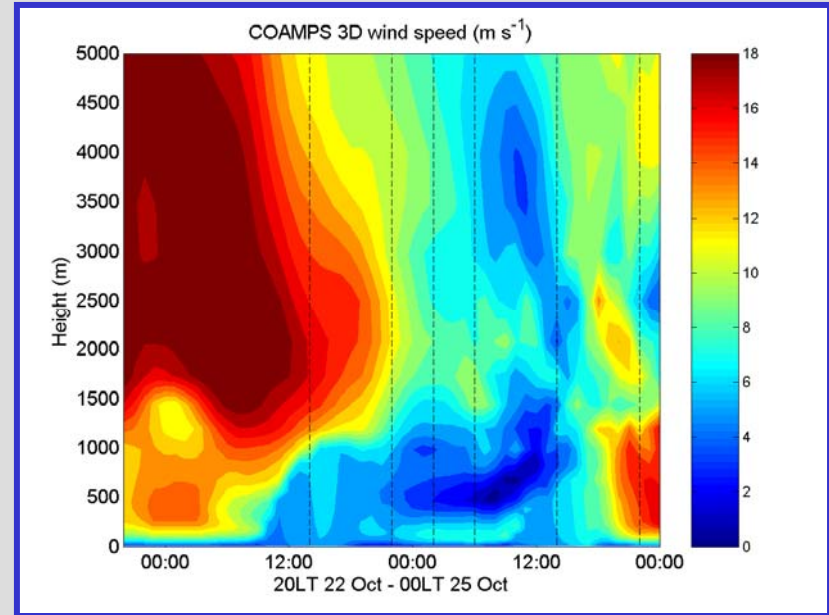
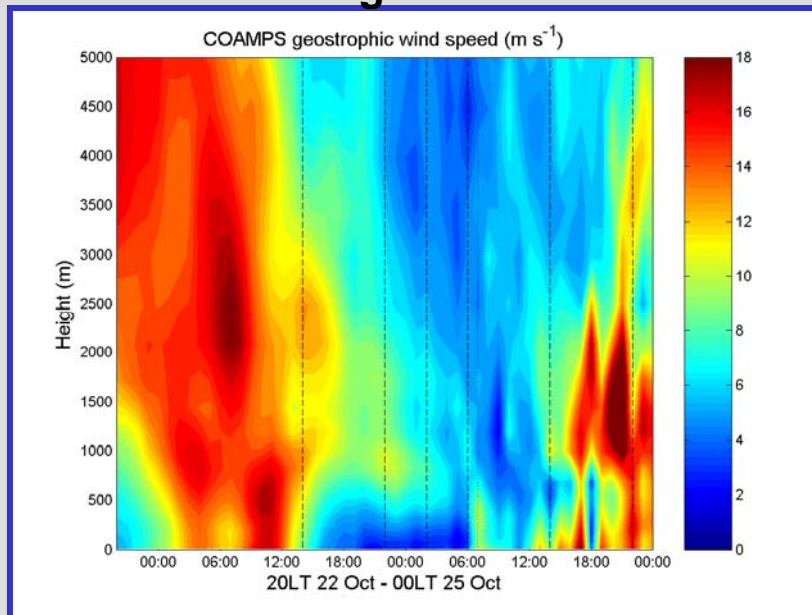
# Background conditions

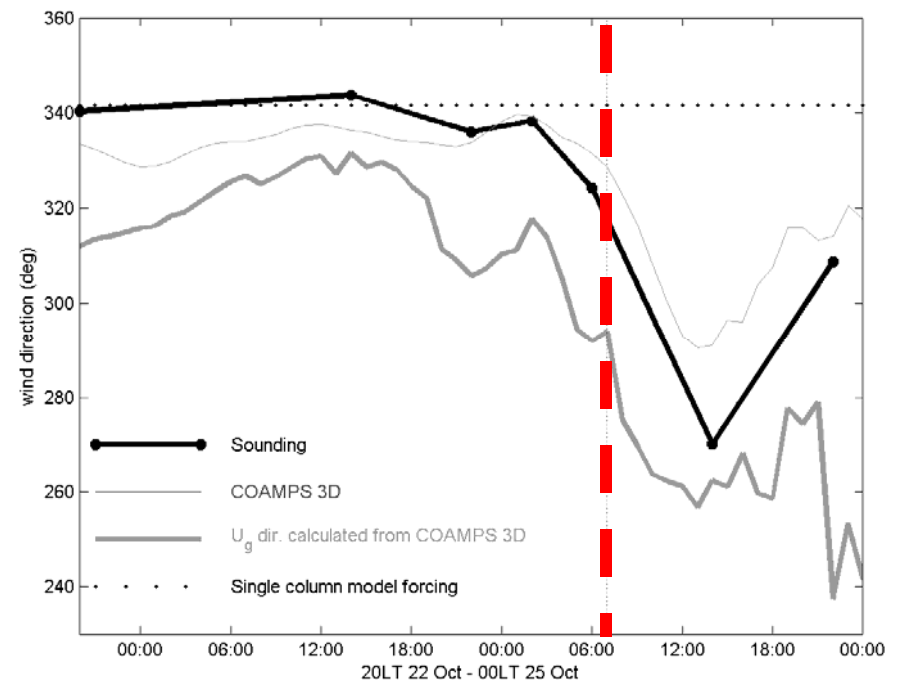
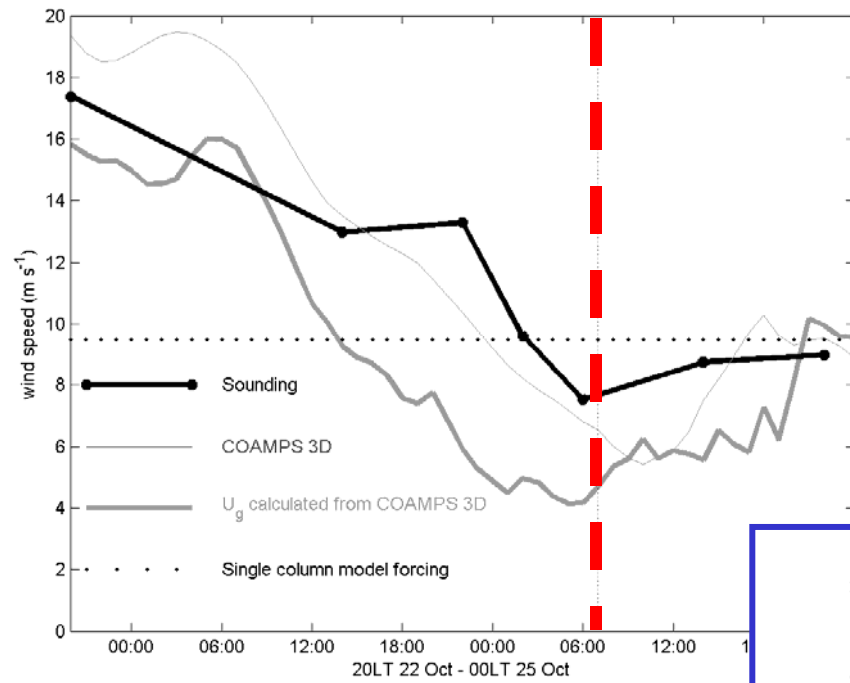
Observations



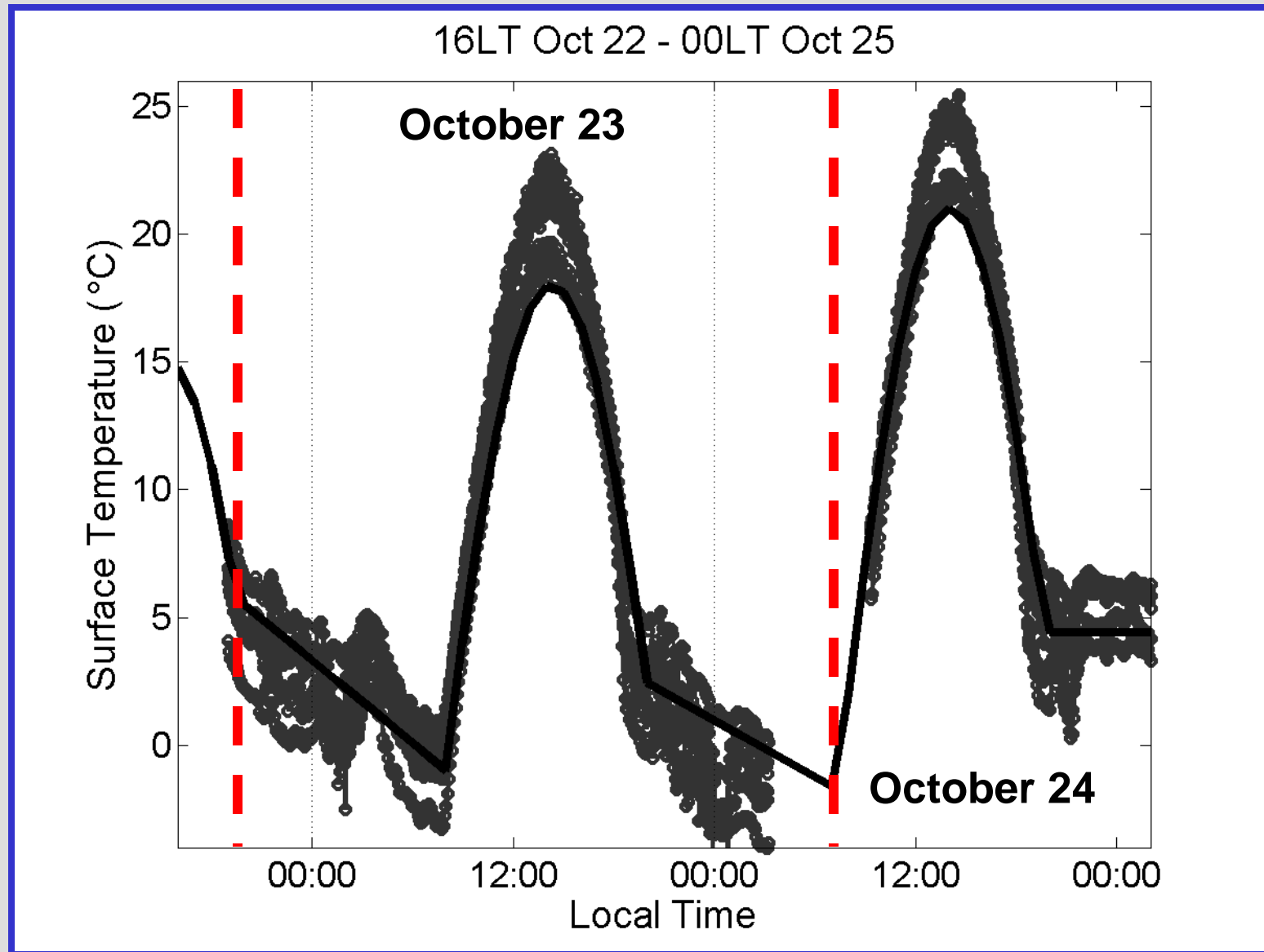
COAMPS  $U_g$

COAMPS 3D

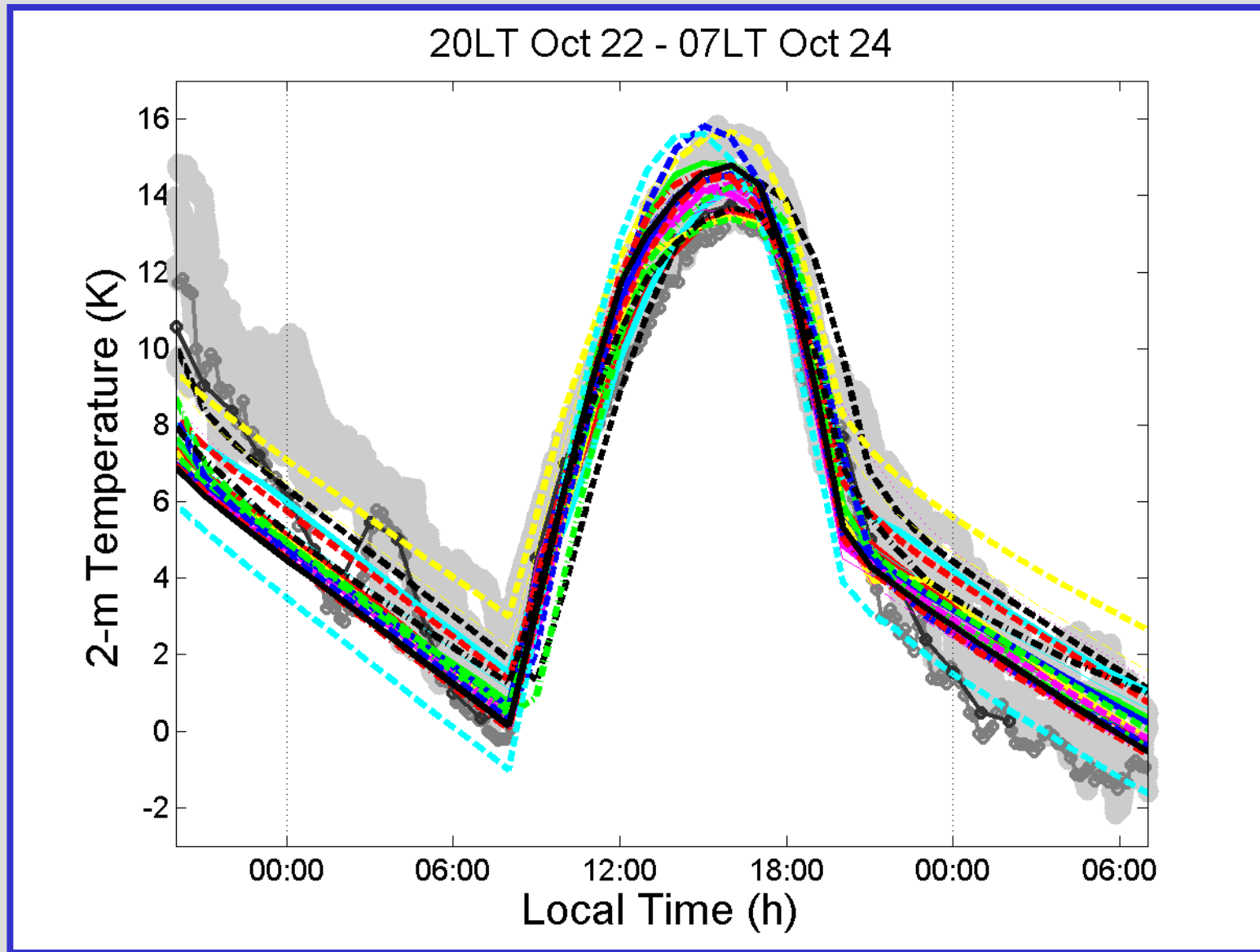




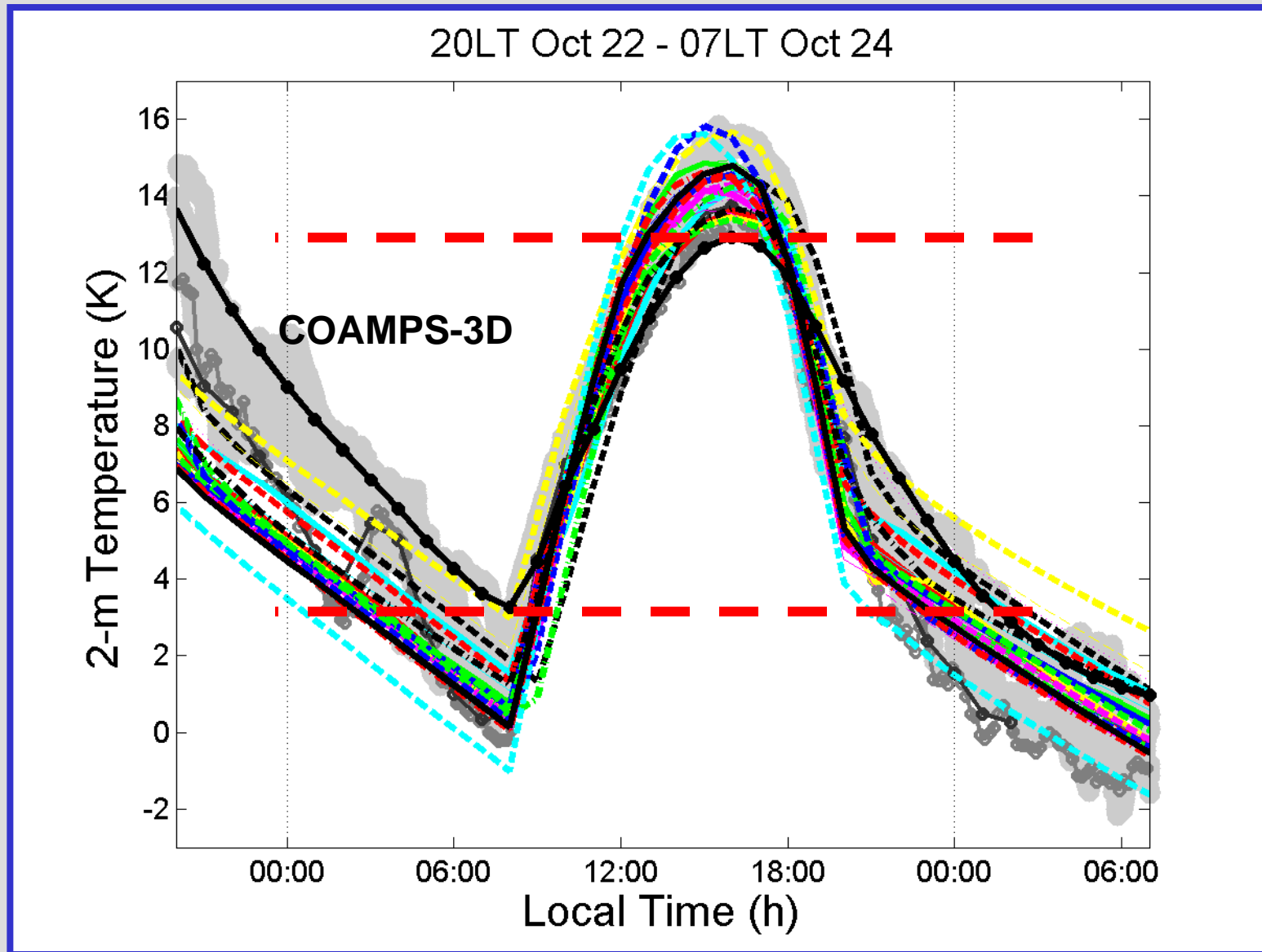
# Prescribed surface temperature



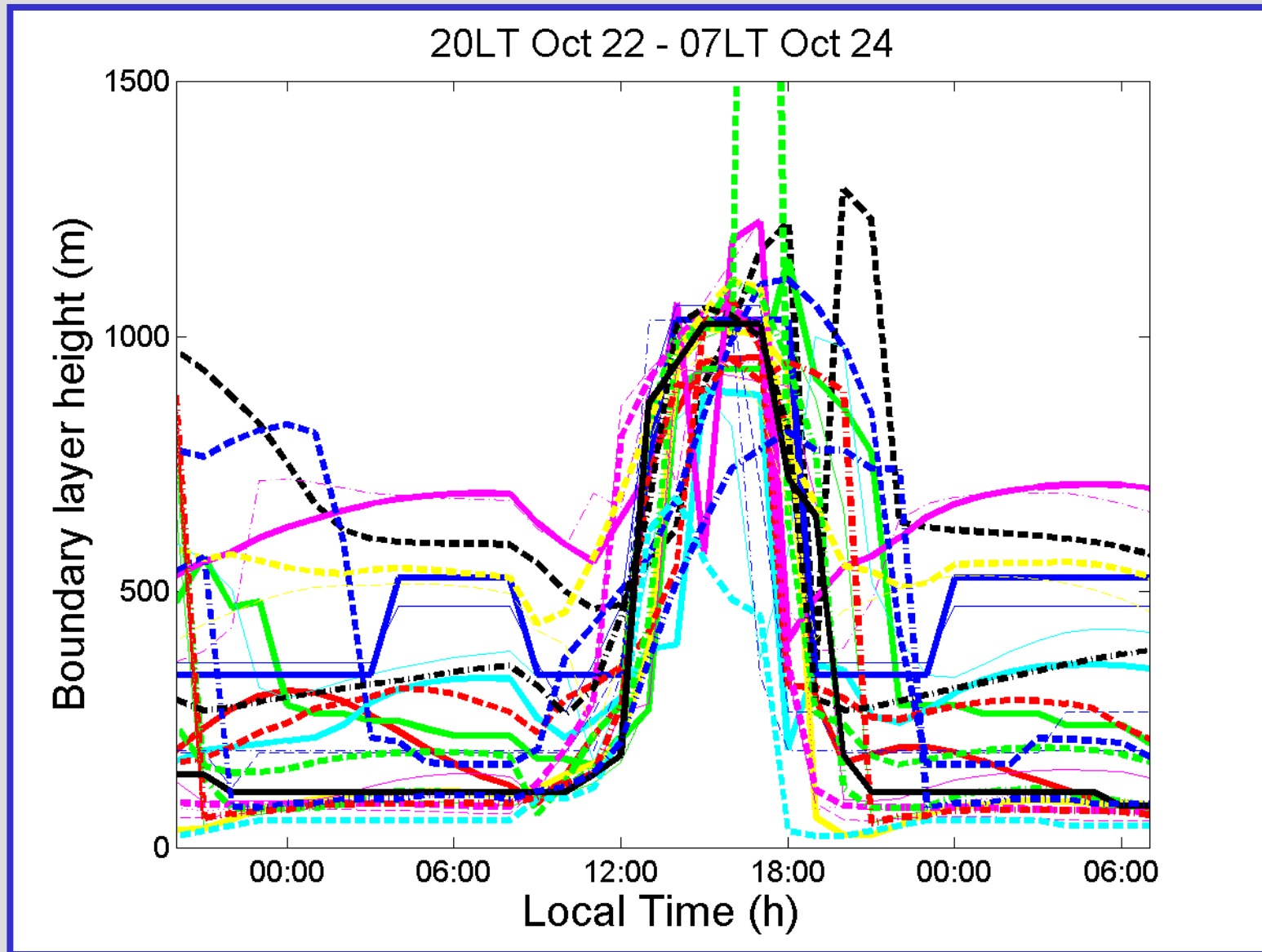
# Surface air temperature



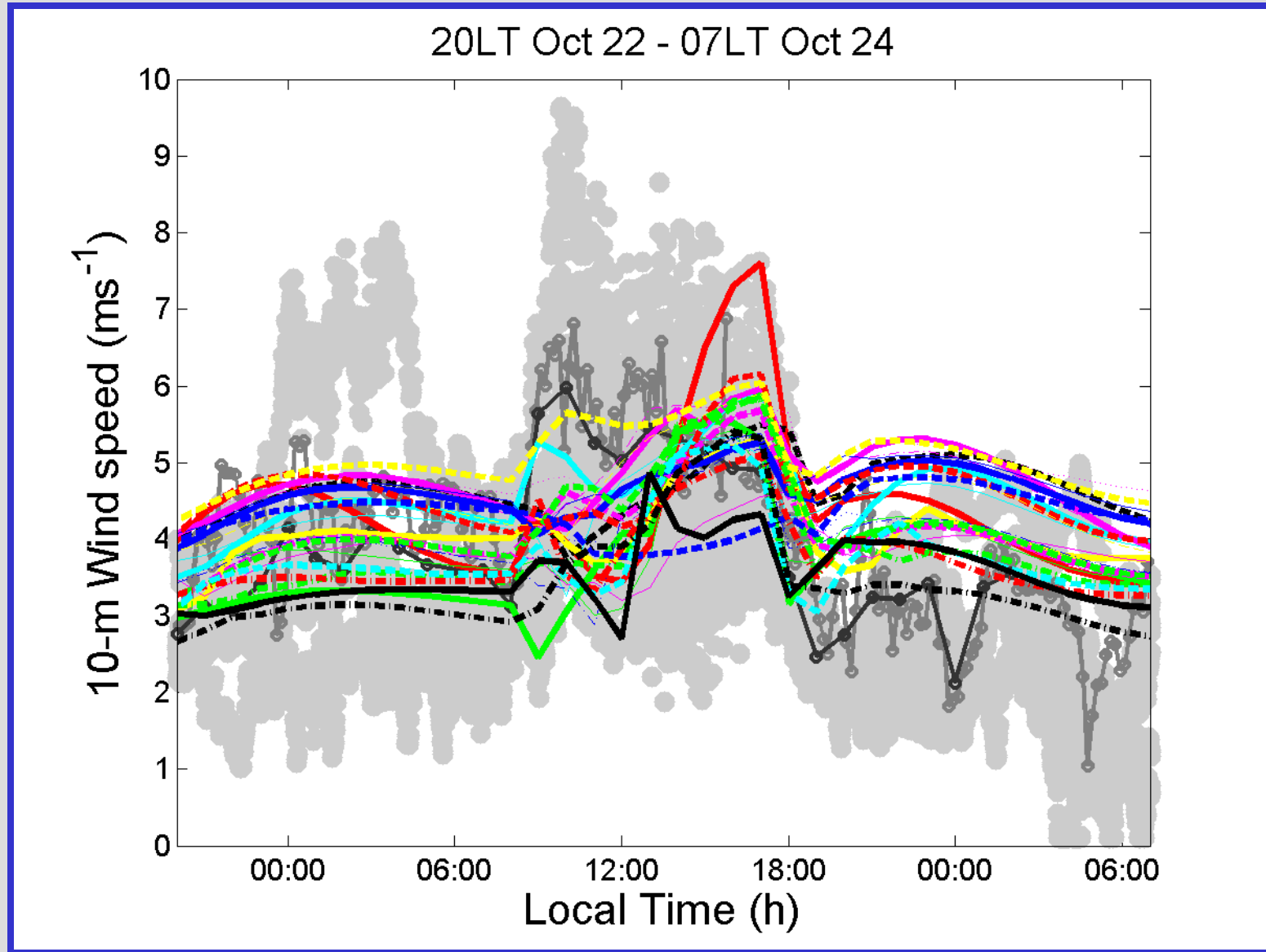
# Surface air temperature



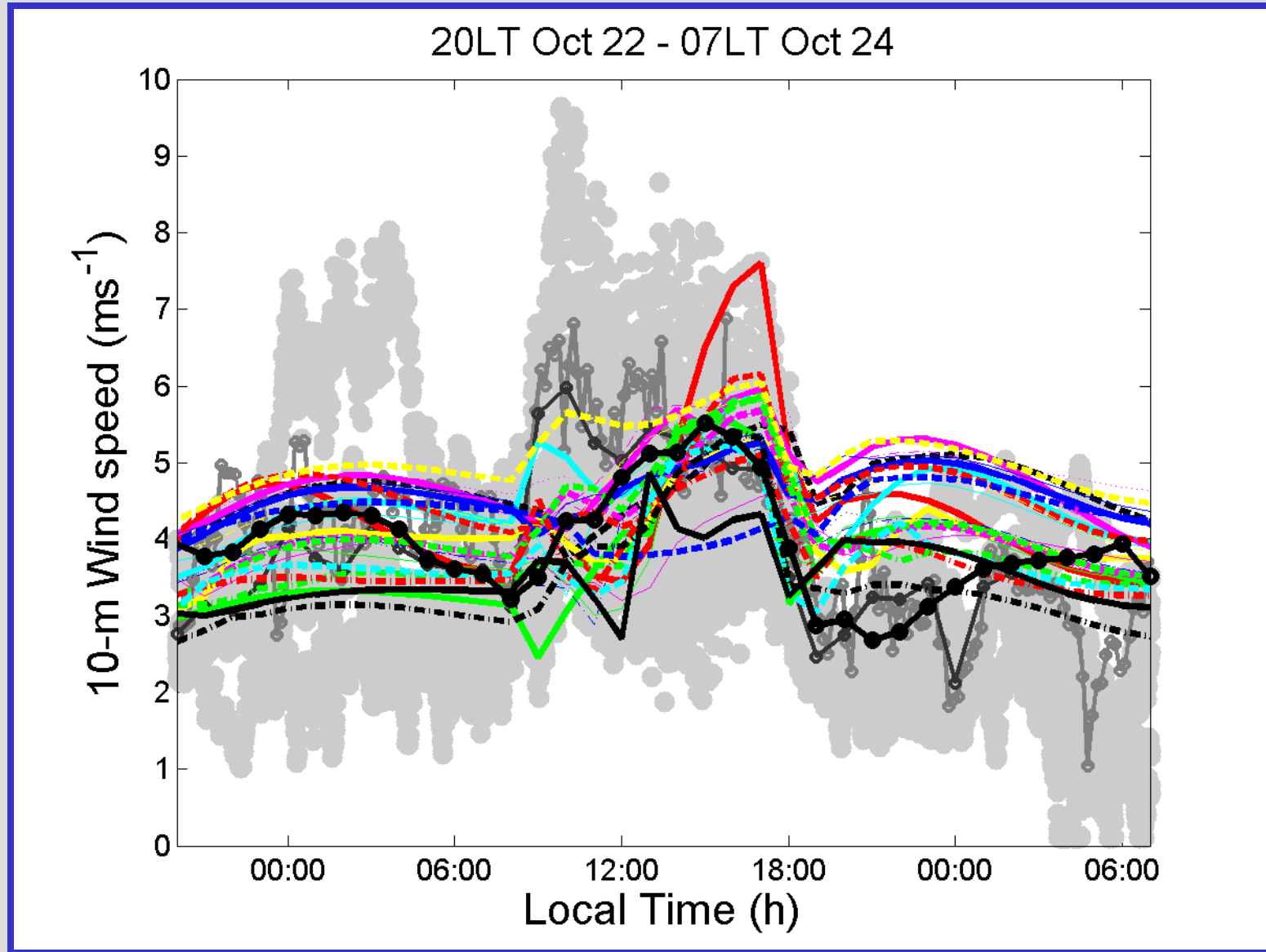
# Boundary-layer height



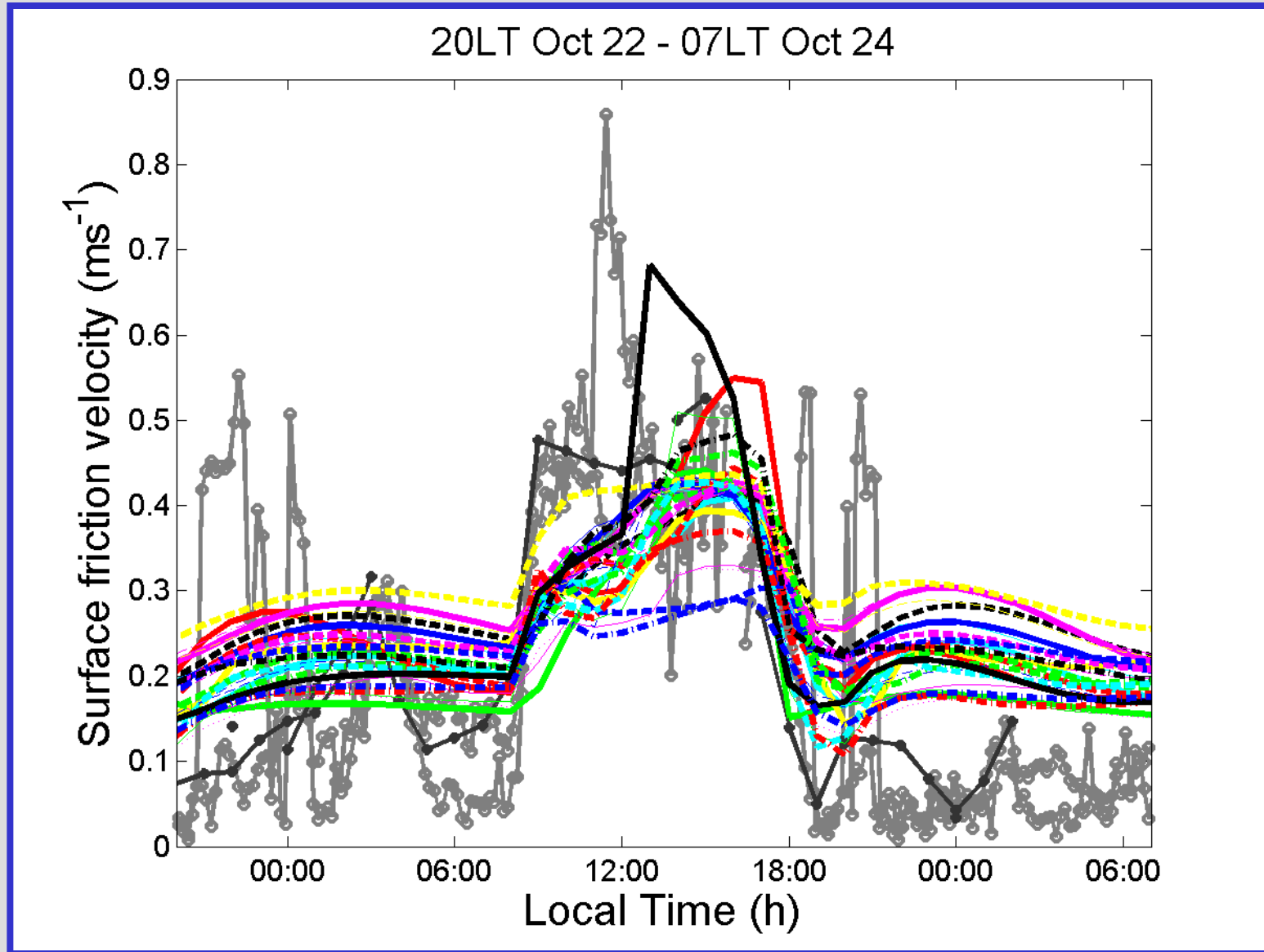
# Wind speed



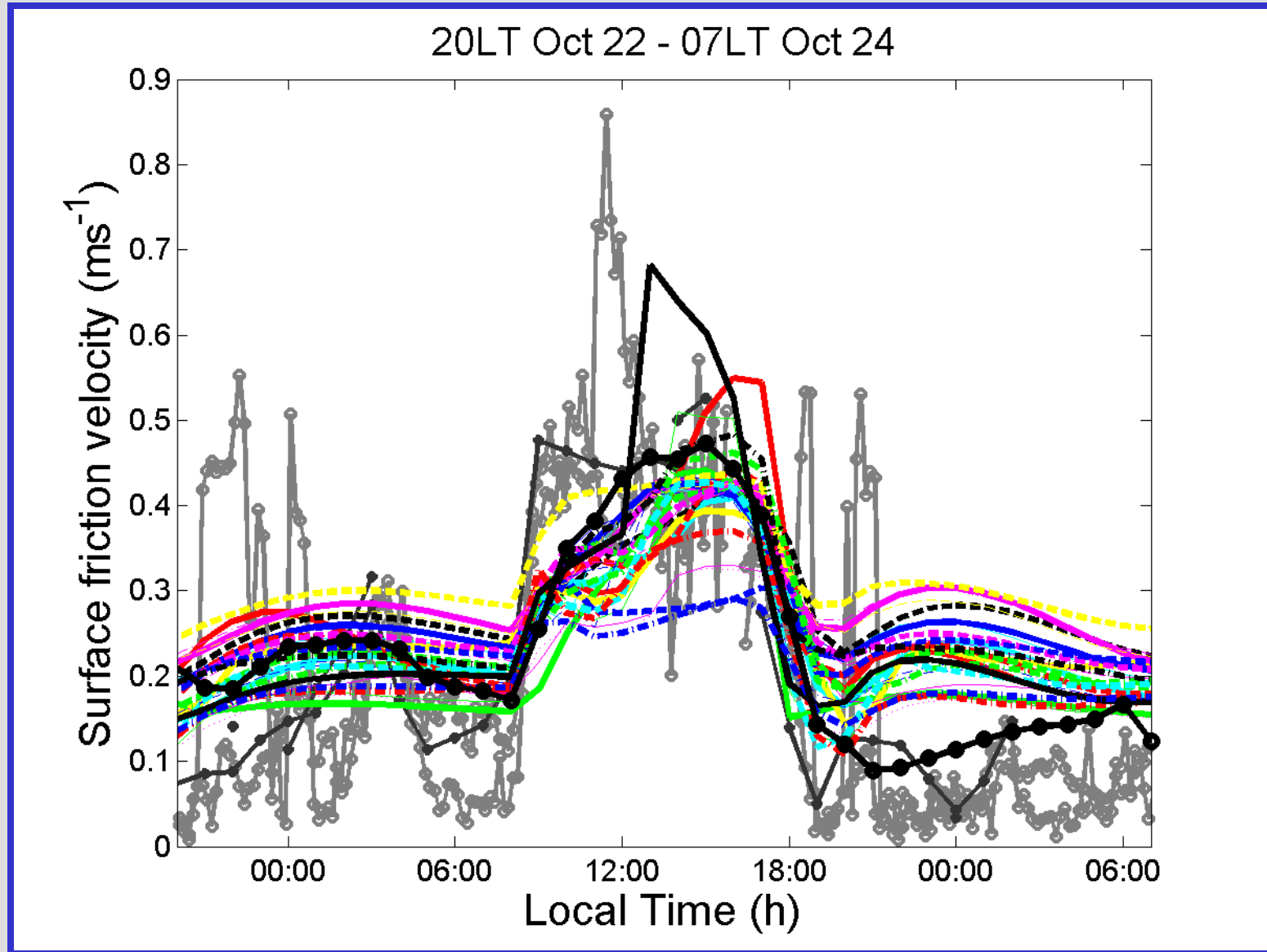
# Wind speed



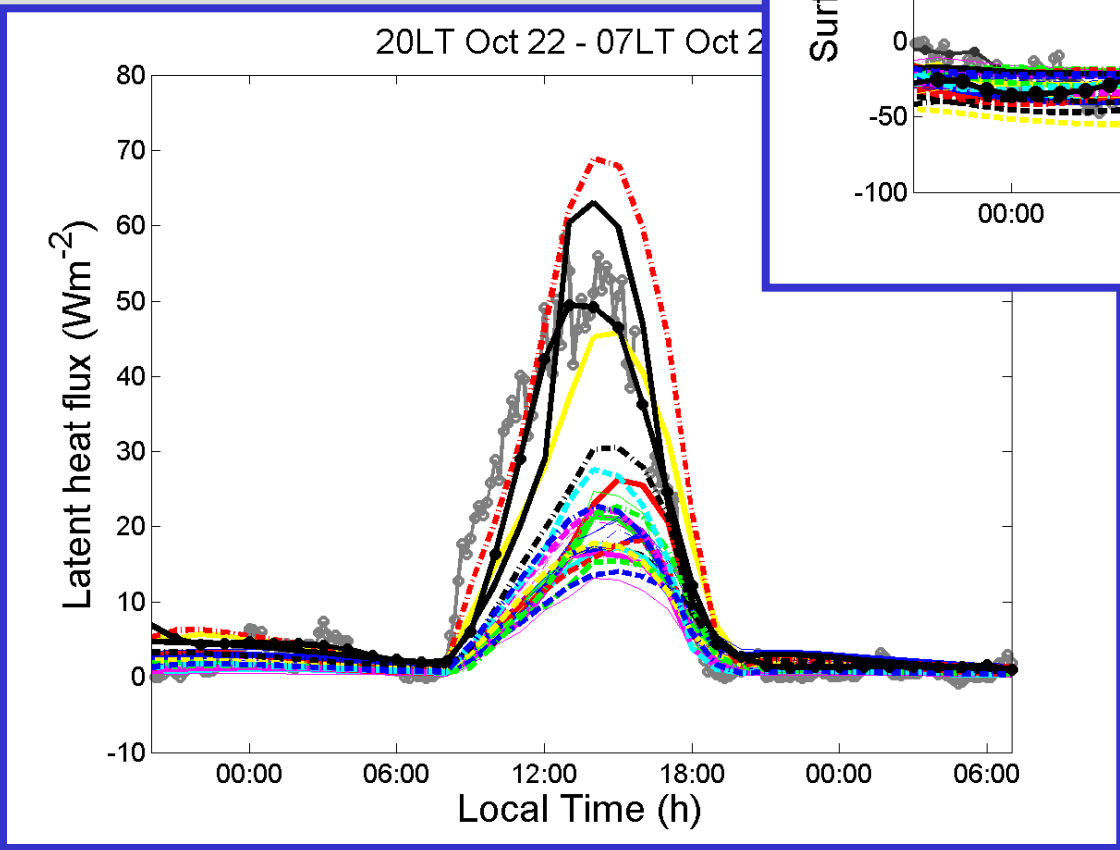
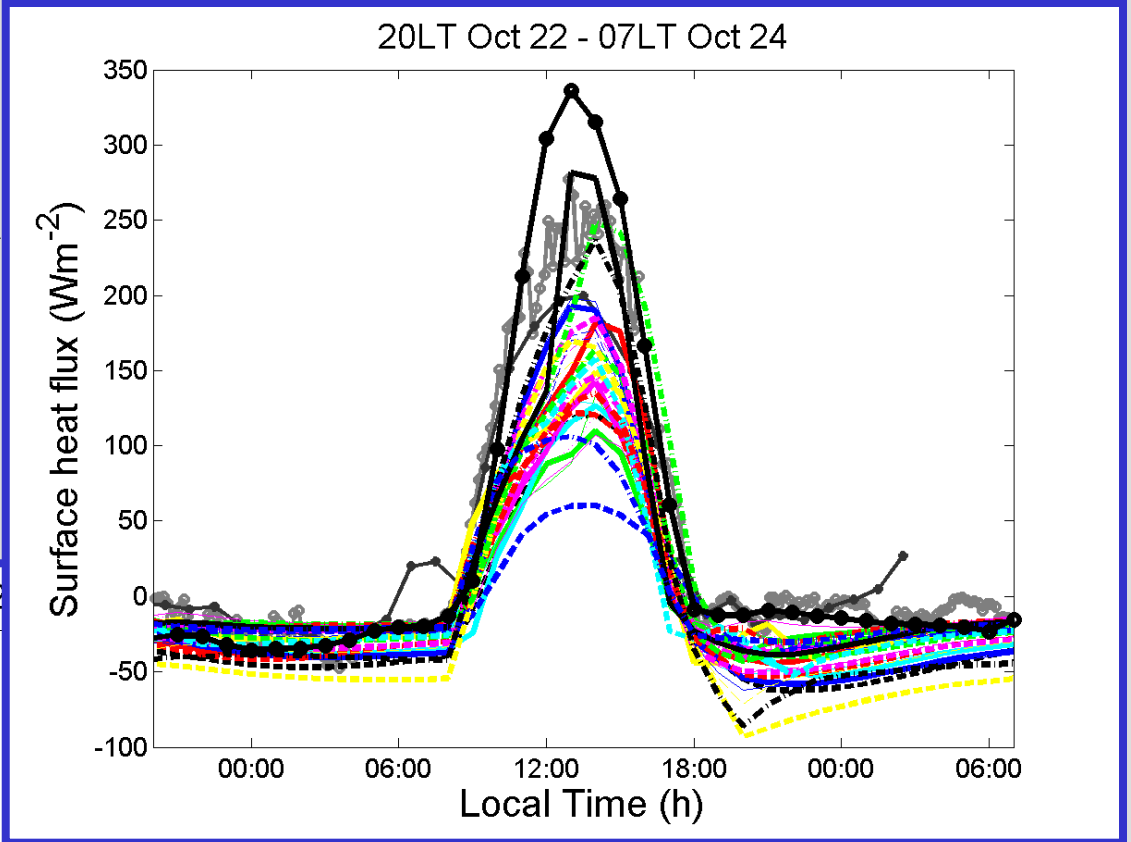
# Friction velocity



# Friction velocity

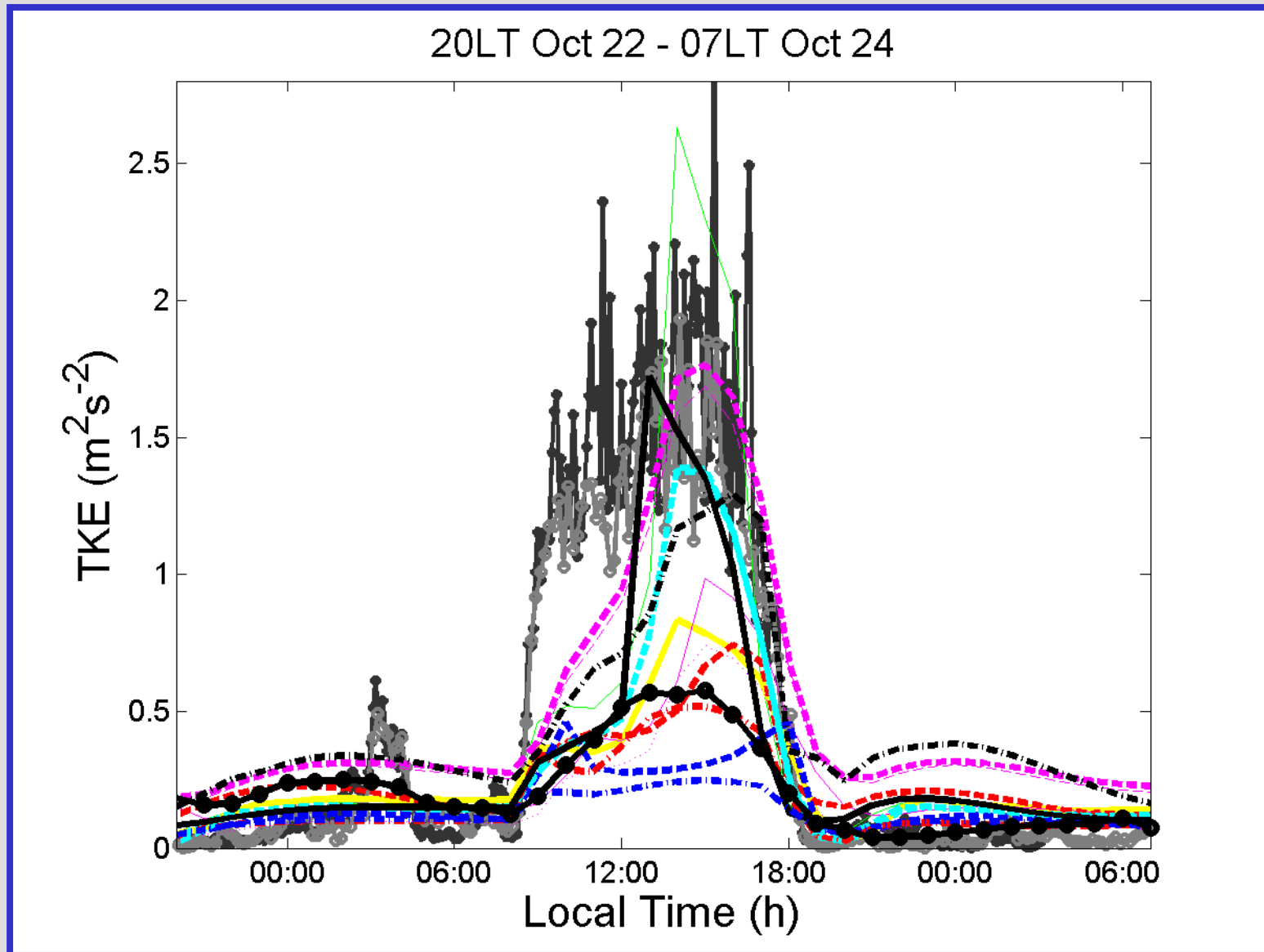


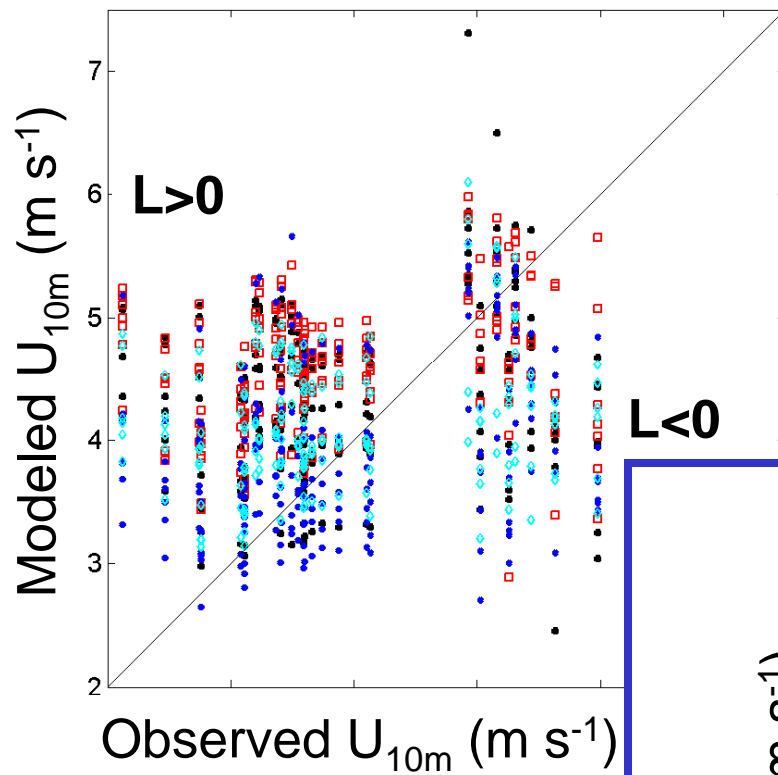
# Sensible heat flux



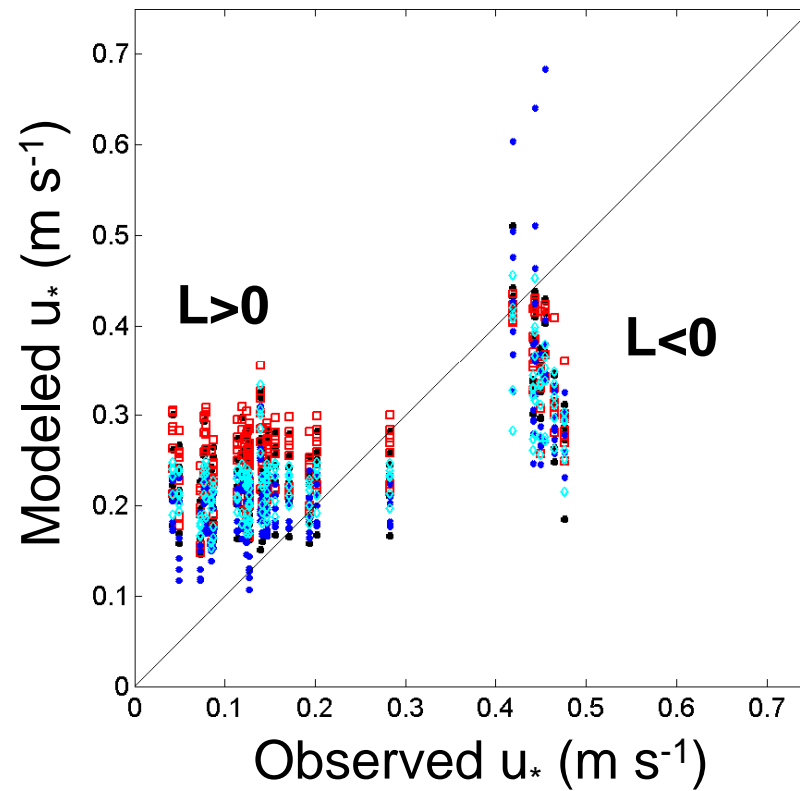
# Latent heat flux

# Turbulent kinetic energy

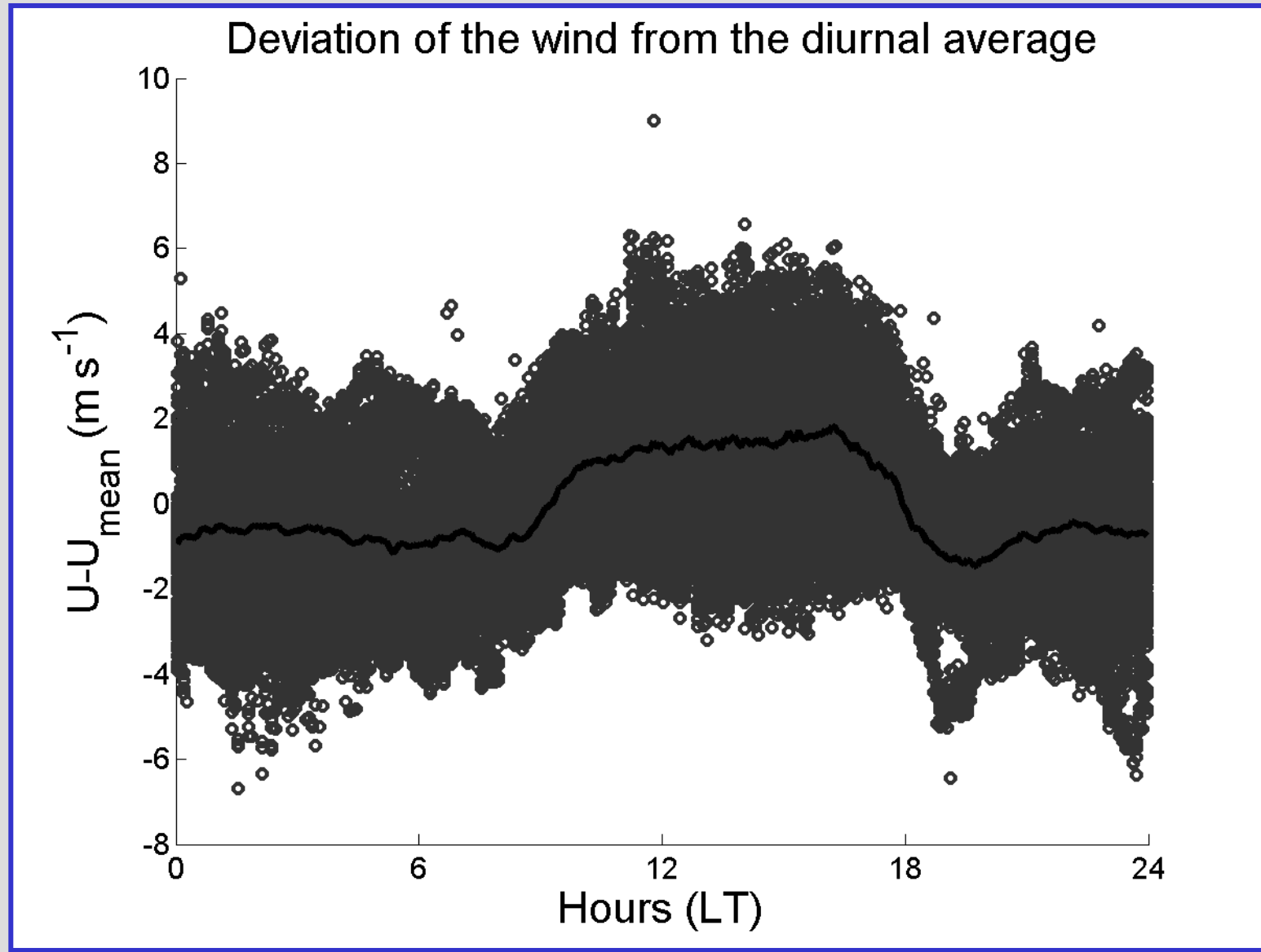




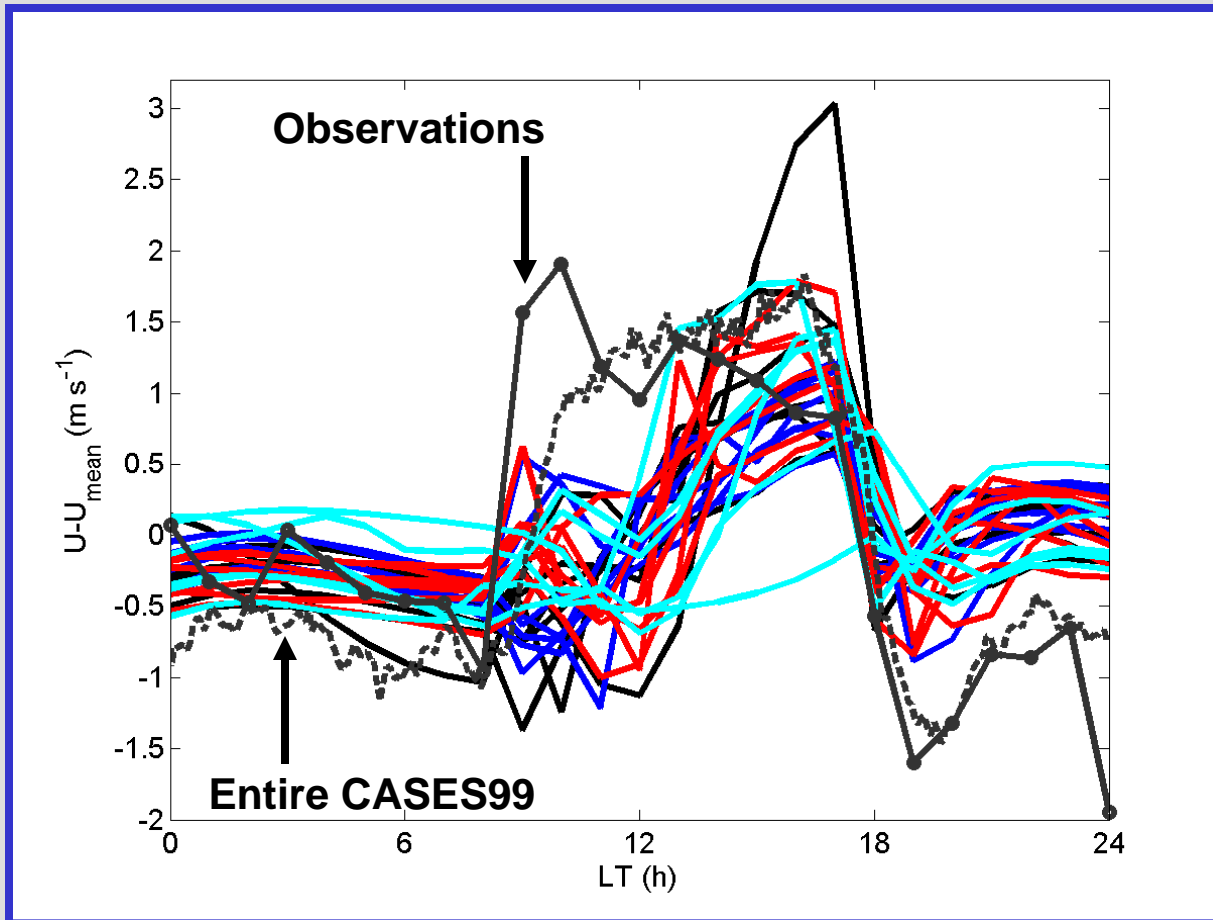
1<sup>st</sup> order closure  $z_1 < 5m$   
1<sup>st</sup> order closure  $z_1 > 5m$   
TKE closure  $z_1 < 5m$   
TKE closure  $z_1 > 5m$



# Data from entire CASES99



# Modeled diurnal wind variation October 23



1<sup>st</sup> order closure  $z_1 < 5\text{m}$

1<sup>st</sup> order closure  $z_1 > 5\text{m}$

TKE closure  $z_1 < 5\text{m}$

TKE closure  $z_1 > 5\text{m}$

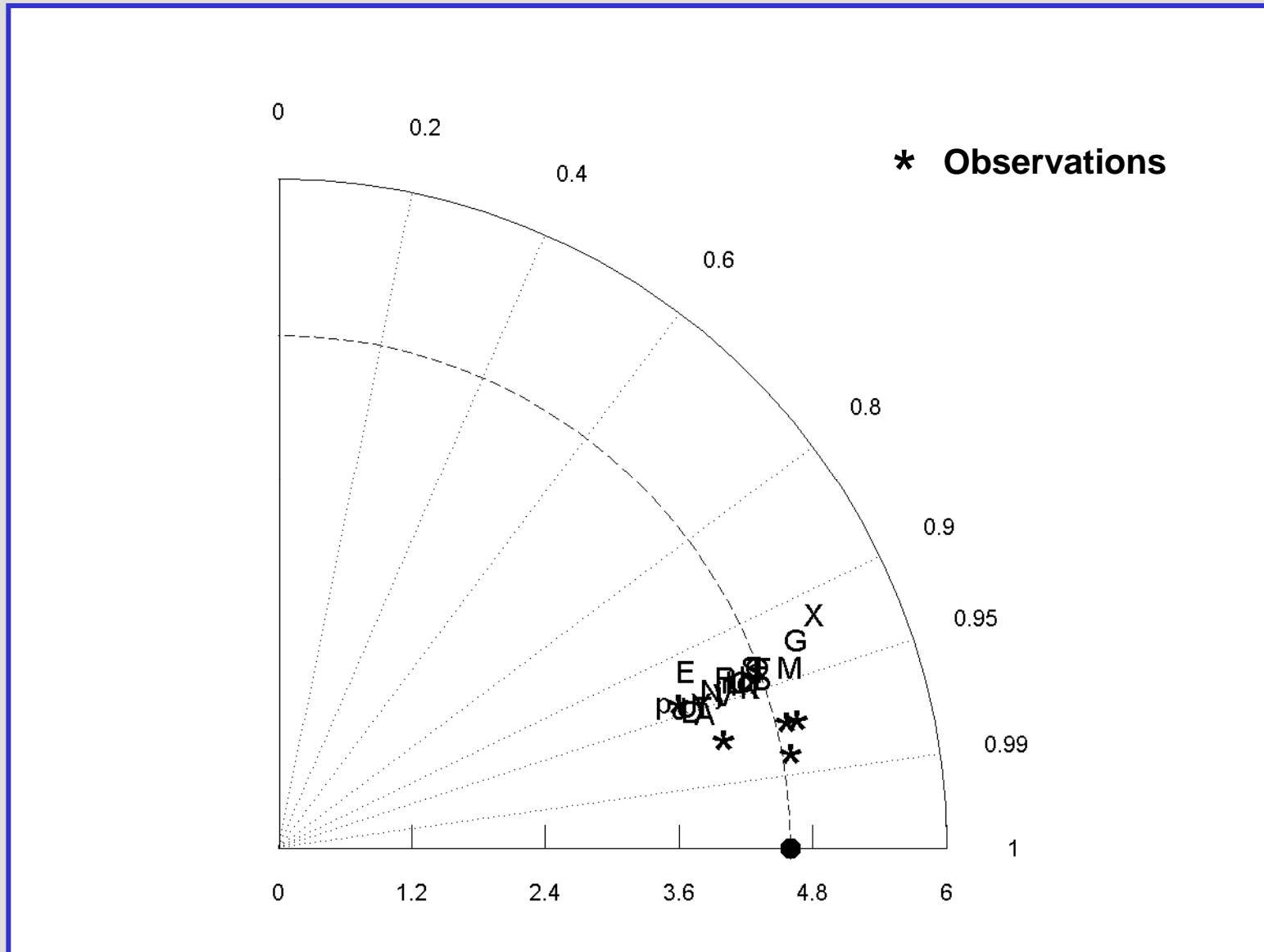
Observed mean  
wind speed:

4.1 ms<sup>-1</sup>

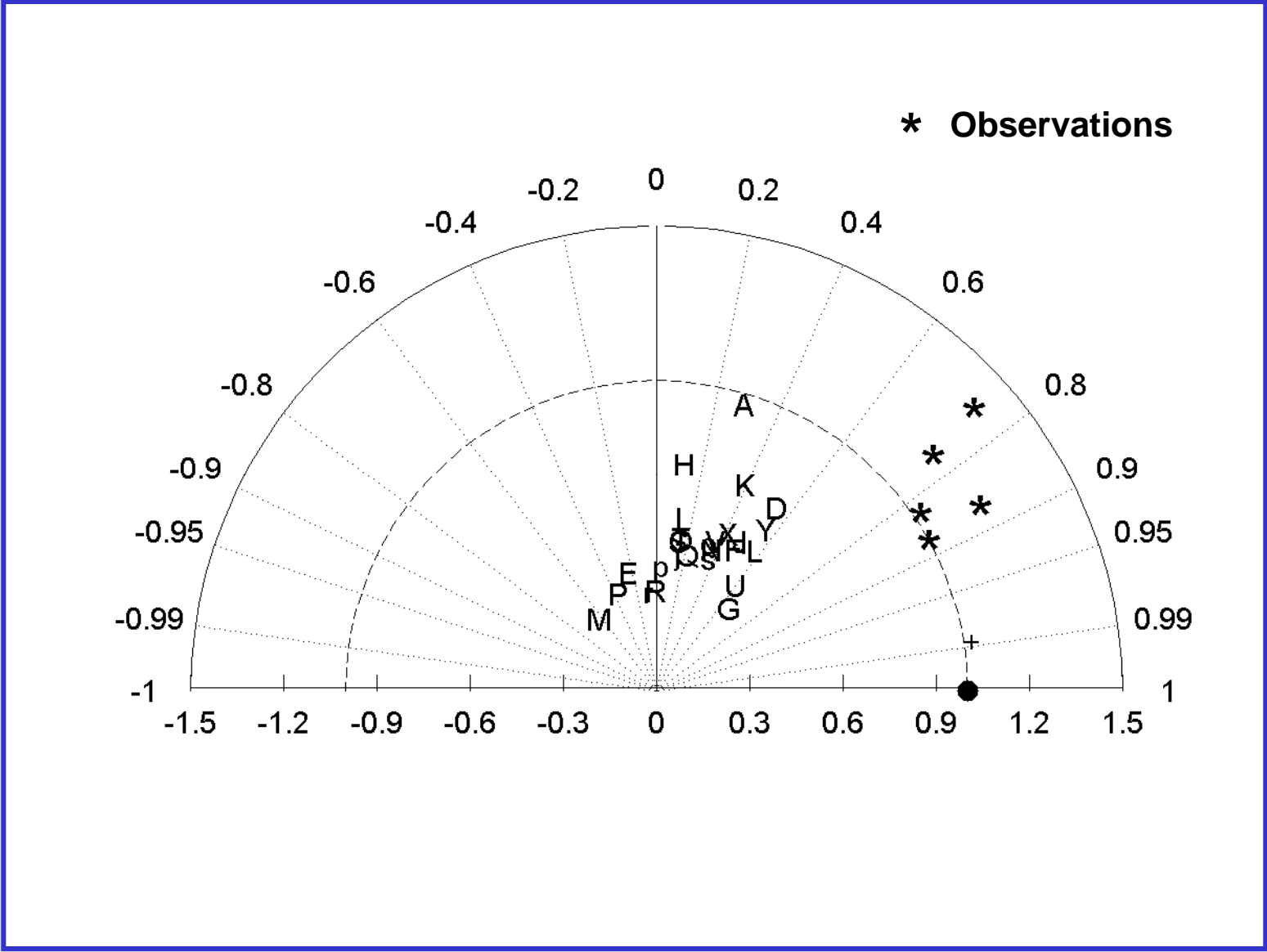
Modeled mean  
wind speed:

3.6 – 5.2 ms<sup>-1</sup>

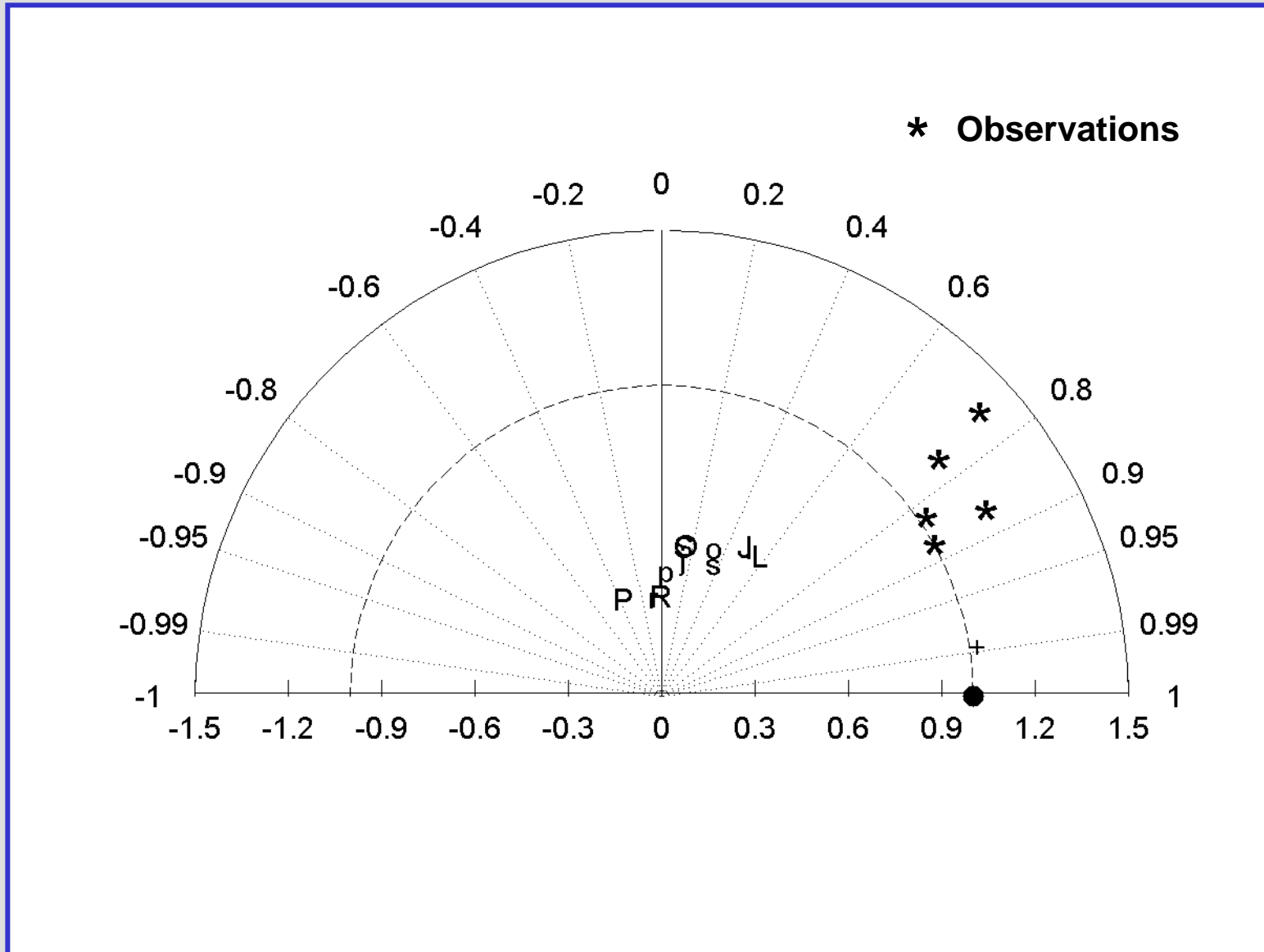
# Taylor diagram for 2-m temperature



# Taylor diagram for 10-m wind speed

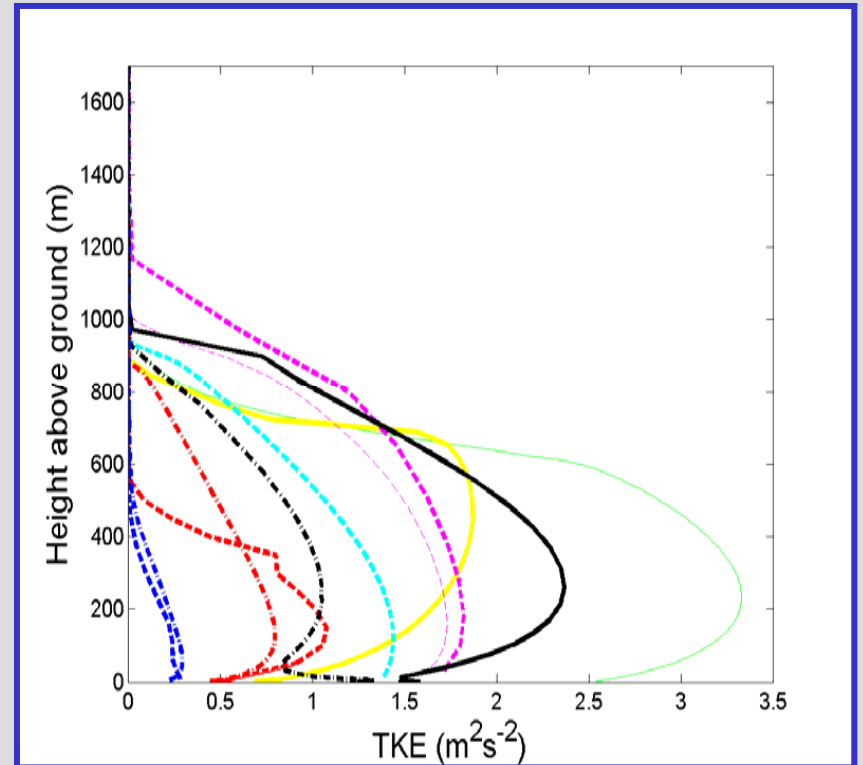
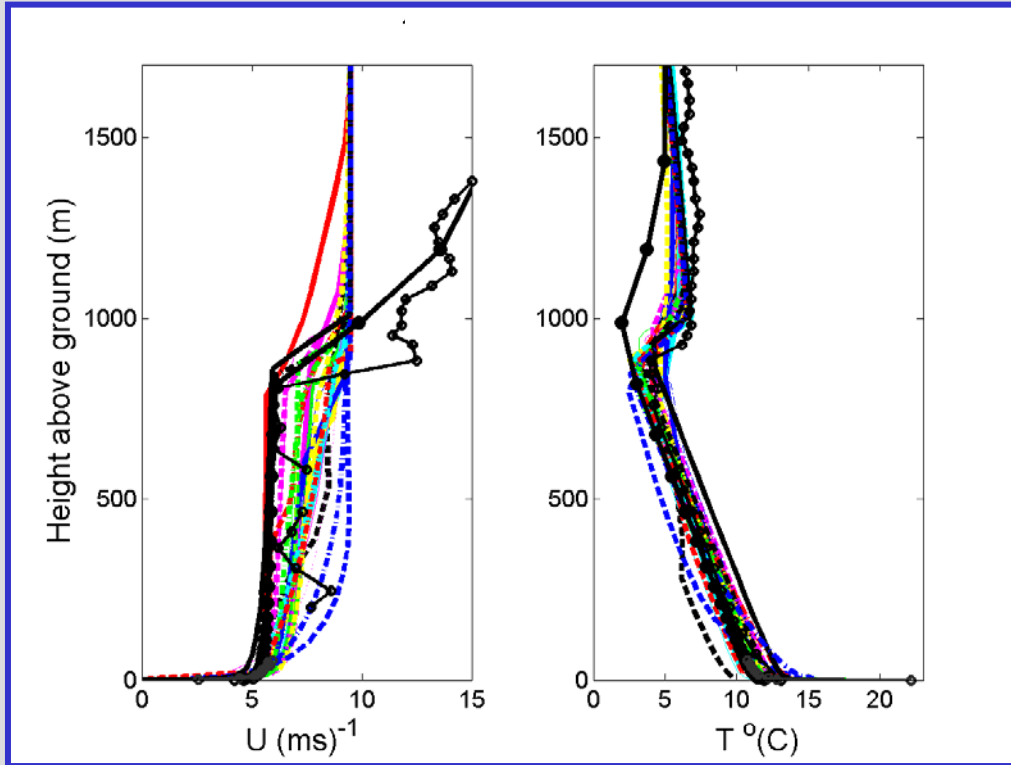


# Impact of vertical resolution

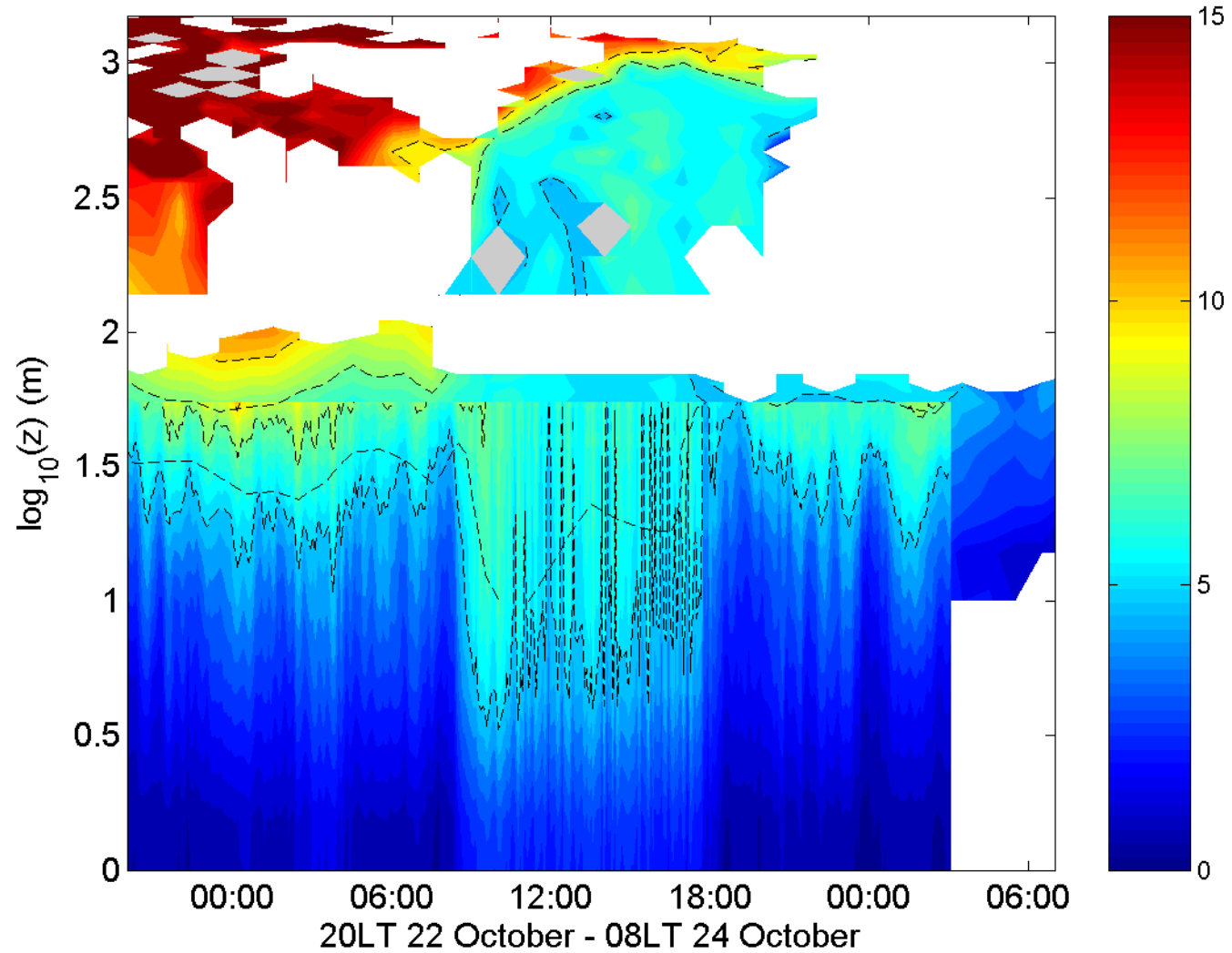


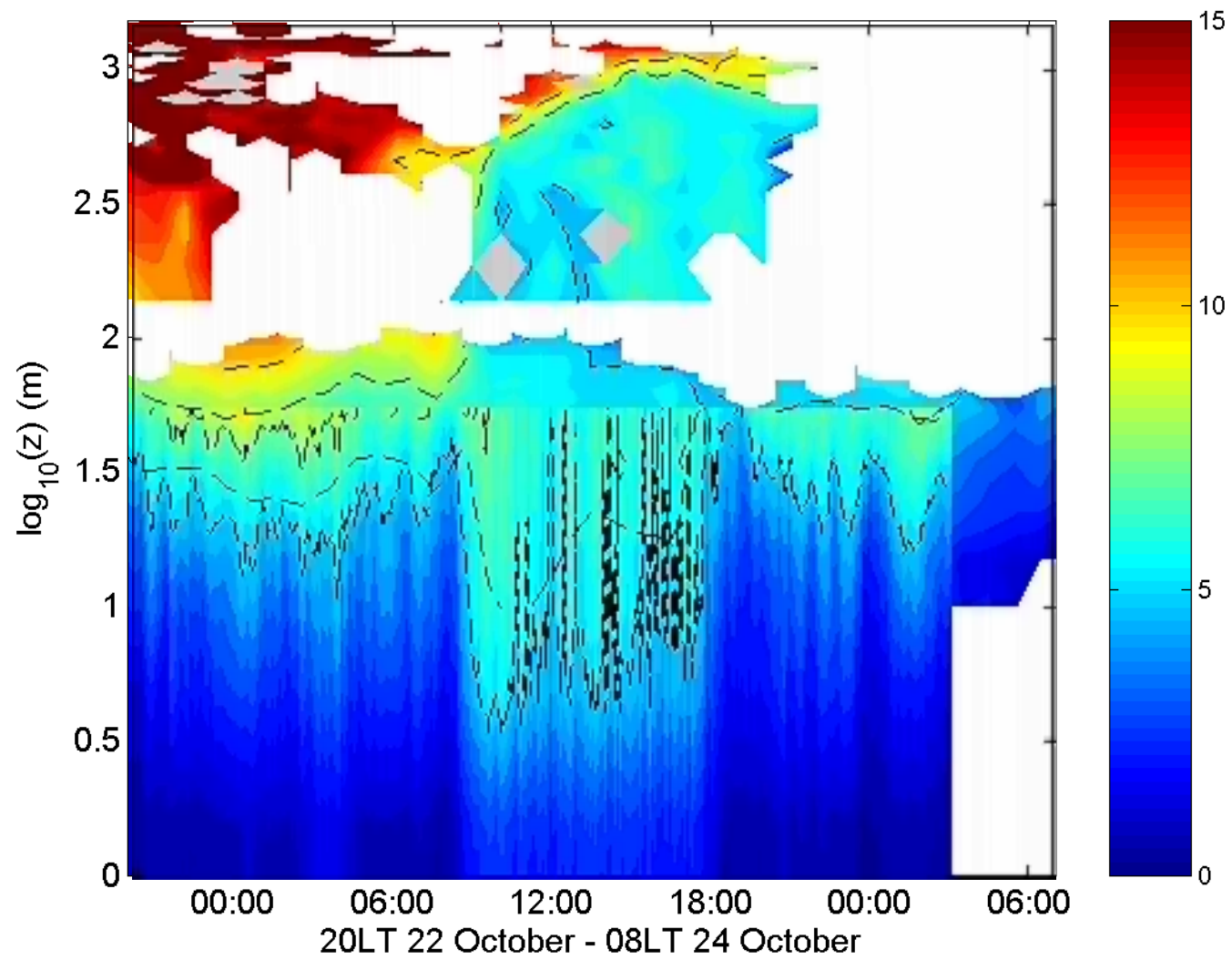
# Vertical structure

14 LT October 23

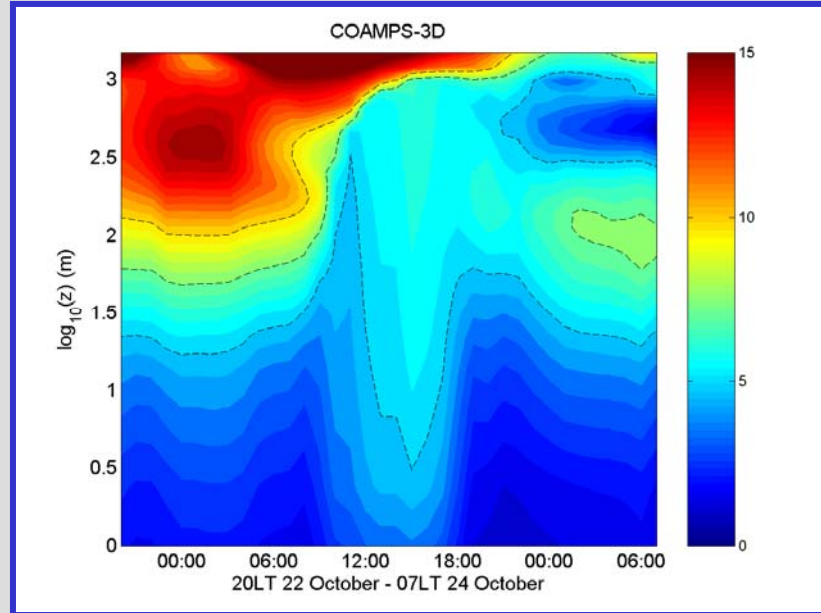
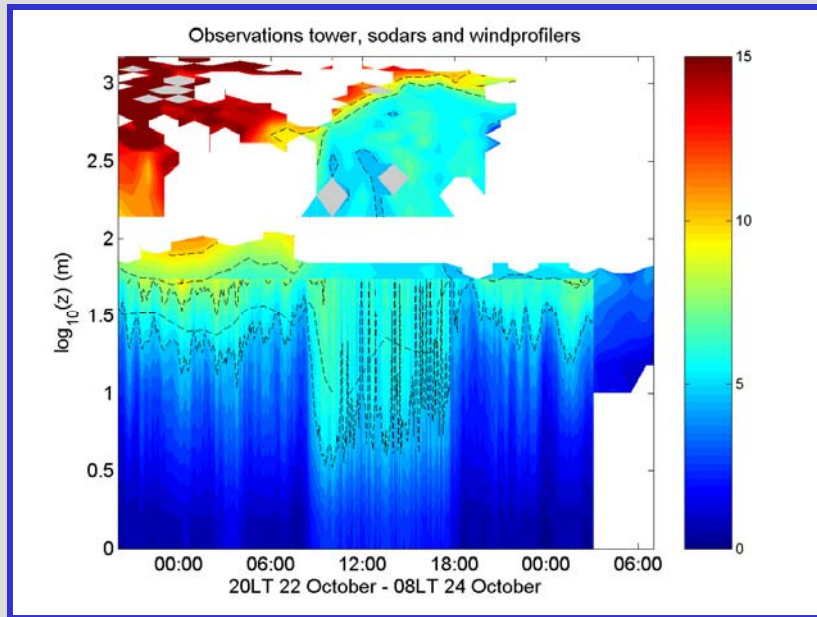


Observations tower, sodars and windprofilers

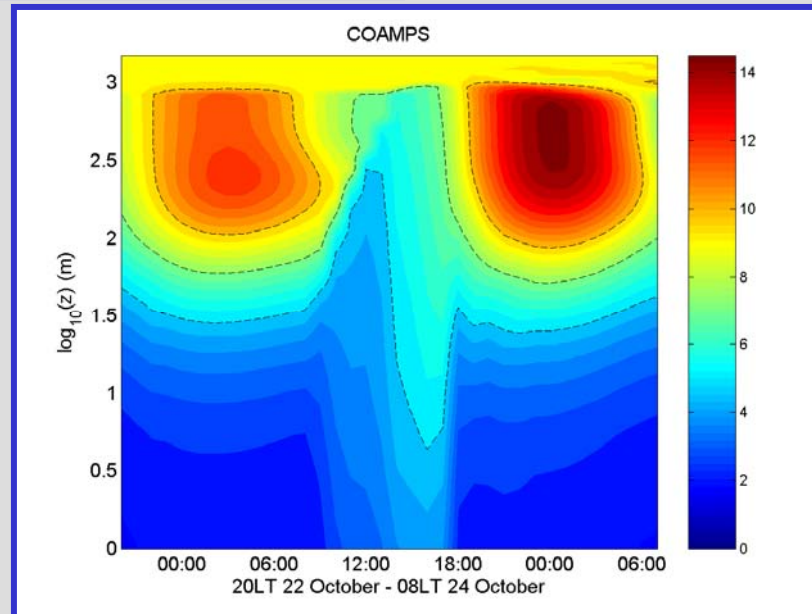




# Low-level wind in COAMPS



3D



SCM

# **MORE ONGOING WORK**

## **LES**

- Surface forcing – T or flux
- Pressure forcing – constant or variable

## **Regional modeling**

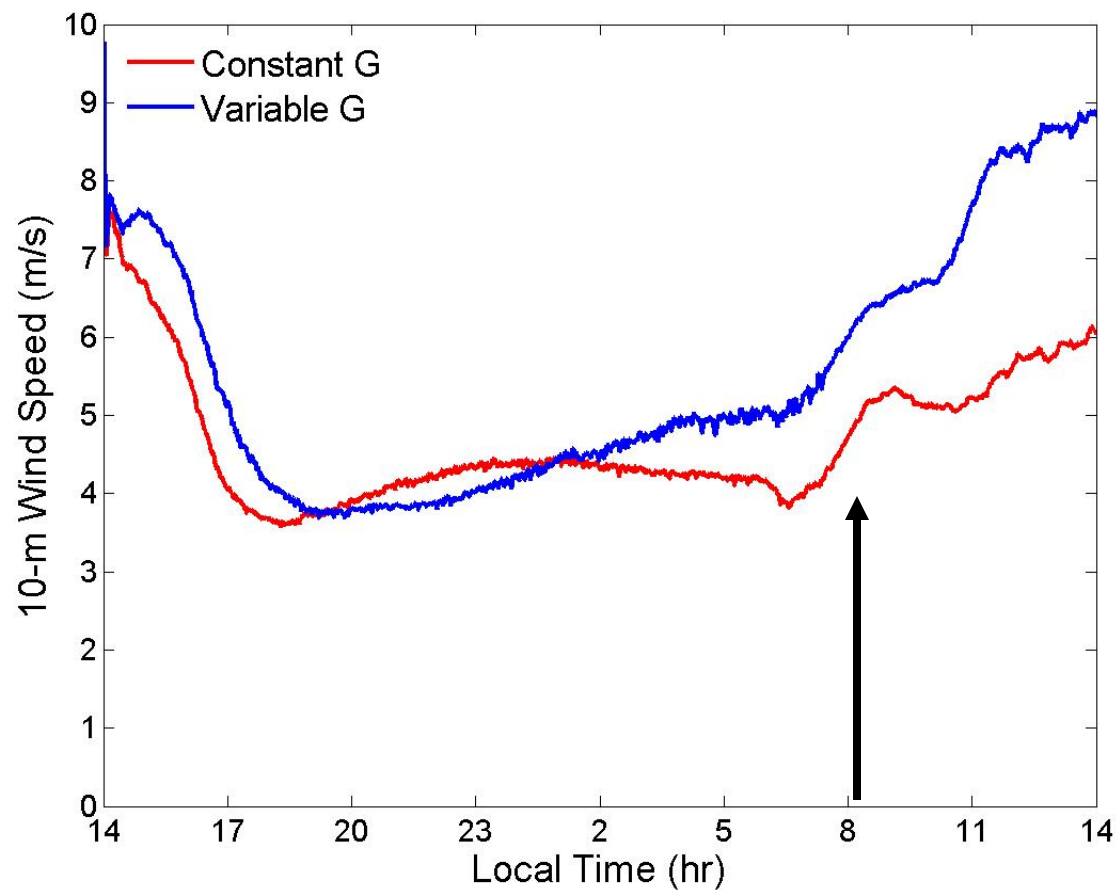
- COAMPS
- MM5
- HIRLAM

## **1-D models**

- More experiments

# MORE ONGOING WORK

## LES results



Courtesy Sukanta Basu

# MORE ONGOING WORK

## LES

- Surface forcing – T or flux
- Pressure forcing – constant or variable

## Regional modeling

- COAMPS
- MM5
- HIRLAM

## 1-D models

- More experiments



## CONCLUDING REMARKS

Diurnal cycle is not well predicted by current models even though the surface temperature is given

It takes too long time for the convective PBL to develop

Simulated vertical wind structure very variable – what is right?

No systematic variation with model closure