

# Effects of Sea Breeze on San Diego Climate

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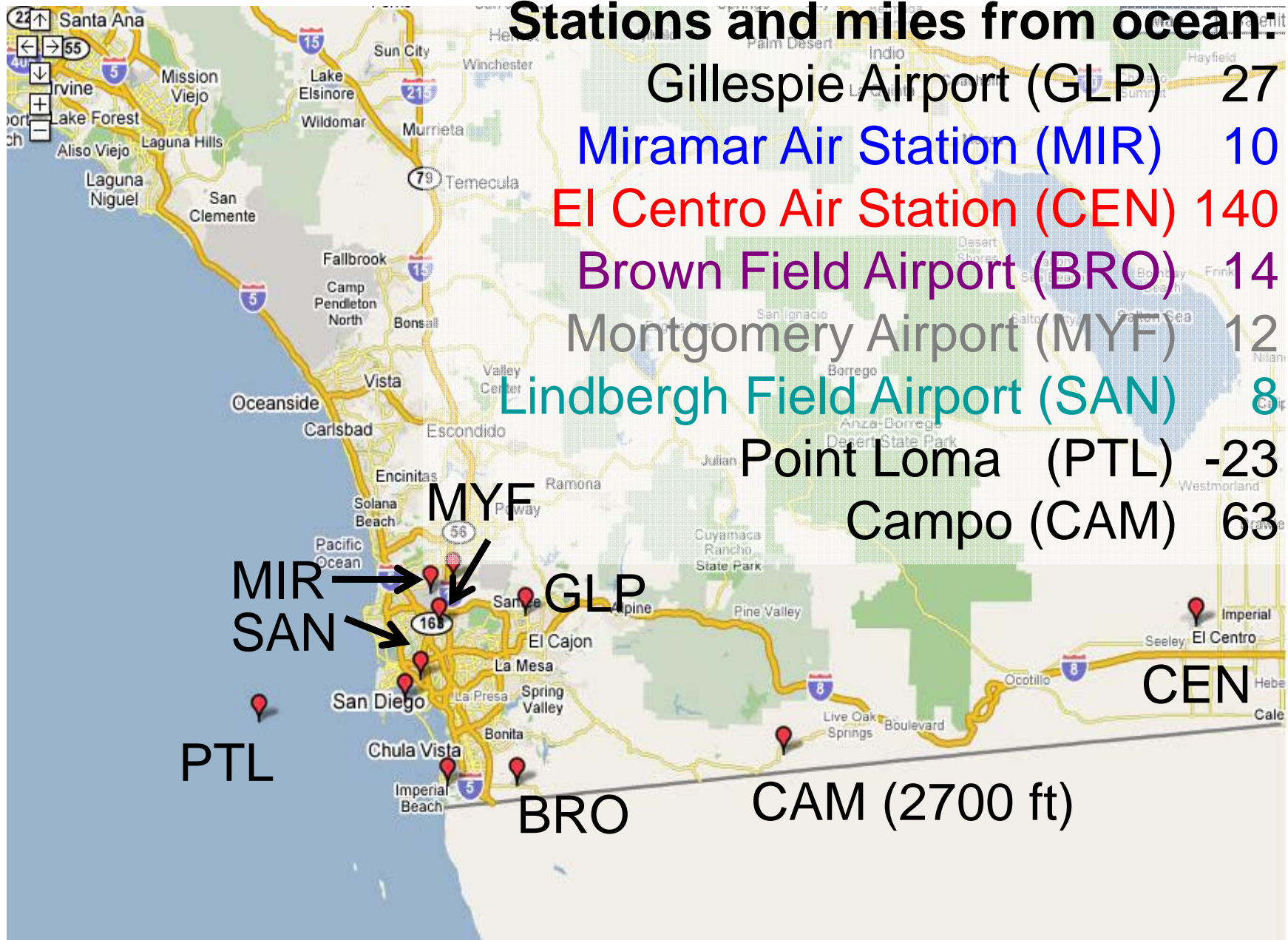
MAE - UCSD

# Agenda

- Data Description
- Definition of Variables Along with Sea Breeze
- Annual, Diurnal, and Monthly-Hourly Plots
- Conclusion

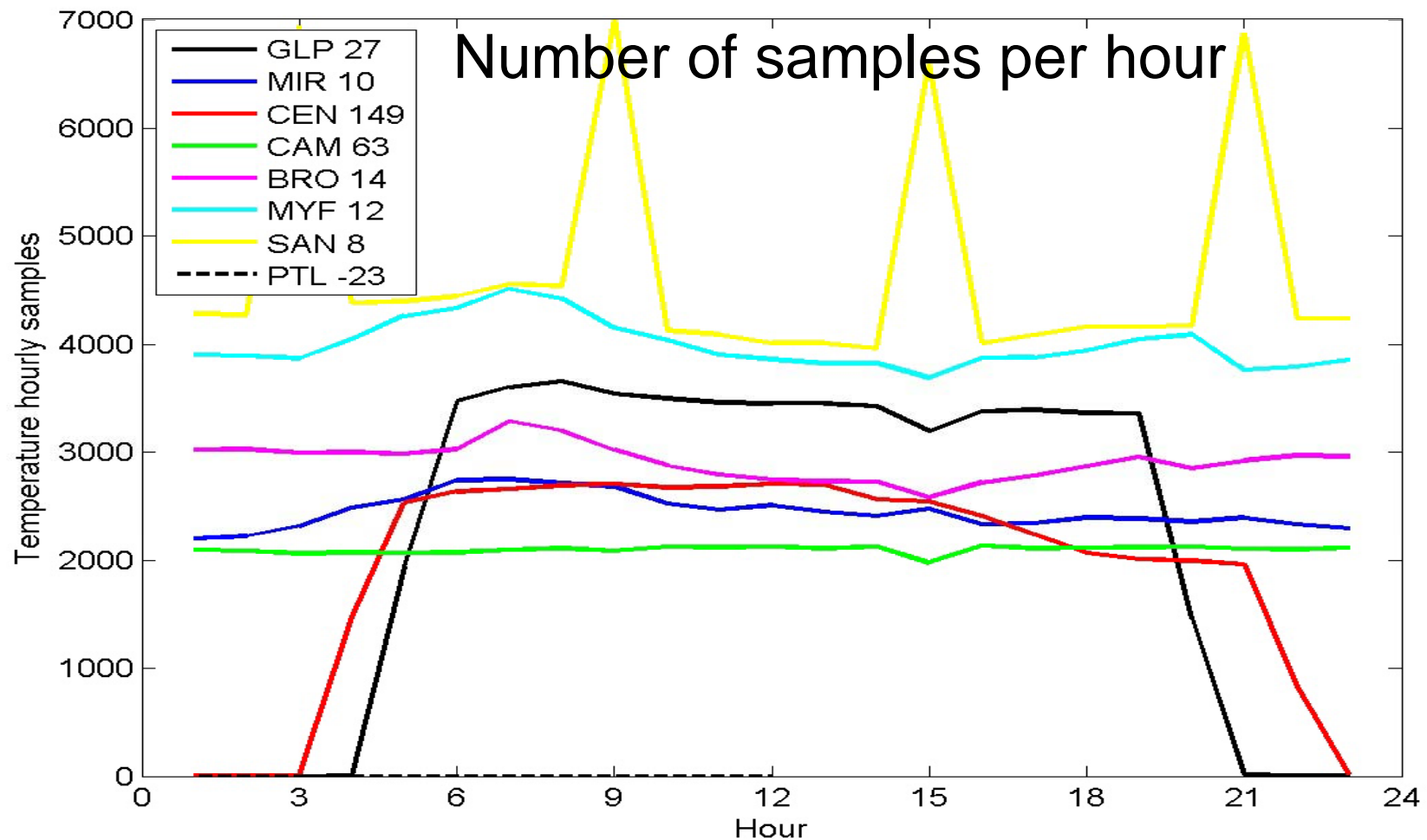


# Map of the Analyzed Stations



# Data set

- 10 years of data between 1997-2007
- Collection frequency: hourly 24/7; GLP and CEN do not collect data at night (see below)



# Variables

- Air Temperature
- Dew Point Temperature
- Wind Speed (2 min average)
- Wind Direction (2 min average in 10s of degrees)
- Air Pressure
- Cloudiness (as in clear, scattered, broken, overcast). At automated stations only clouds below 12,000 ft may be recorded

Table 9-3. Reportable Contractions for Sky Cover

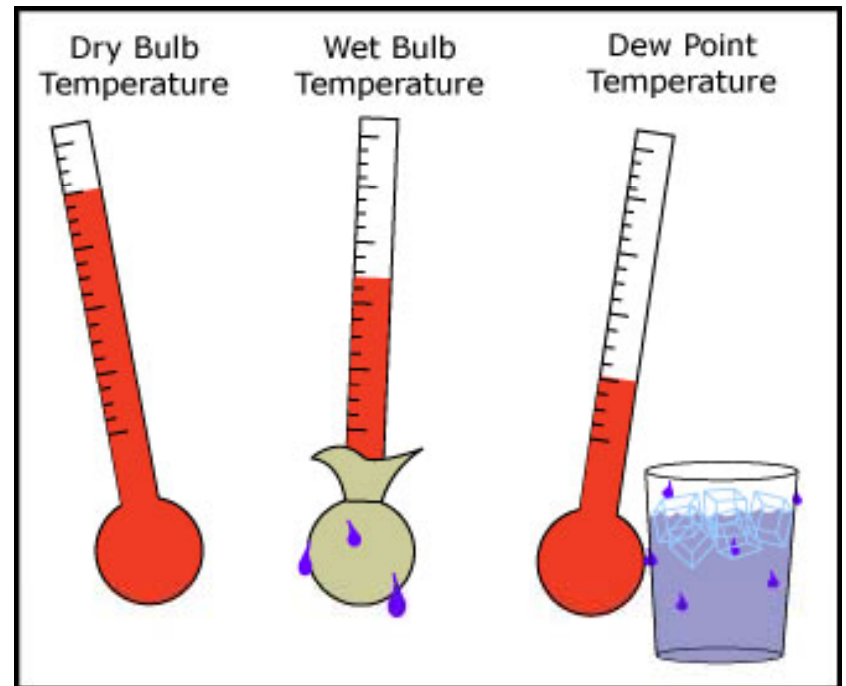
Reportable Contraction	Meaning	Summation Amount of Layer
VV	Vertical Visibility	8/8
SKC or CLR <sup>1</sup>	Clear	0
FEW <sup>2</sup>	Few	1/8 - 2/8
SCT	Scattered	3/8 - 4/8
BKN	Broken	5/8 - 7/8
OVC	Overcast	8/8

1. The abbreviation CLR shall be used at automated stations when no layers at or below 12,000 feet are reported; the abbreviation SKC shall be used at manual stations when no layers are reported.

2. Any layer amount less than 1/8 is reported as FEW.

# What is Dew Point Temperature?

- The dew point of a given parcel of air is the temperature to which the parcel must be cooled, at constant barometric pressure for water vapor to condense into water



# What is Sea Breeze?

The “ Sea Breeze” which flows inland at the coastline on sunny days is caused by the temperature difference between the hot land and the cool sea. This difference increases during the day and produces a pressure difference at low levels in the atmosphere, which causes the low-level sea-breeze to blow.



# Annual Plots

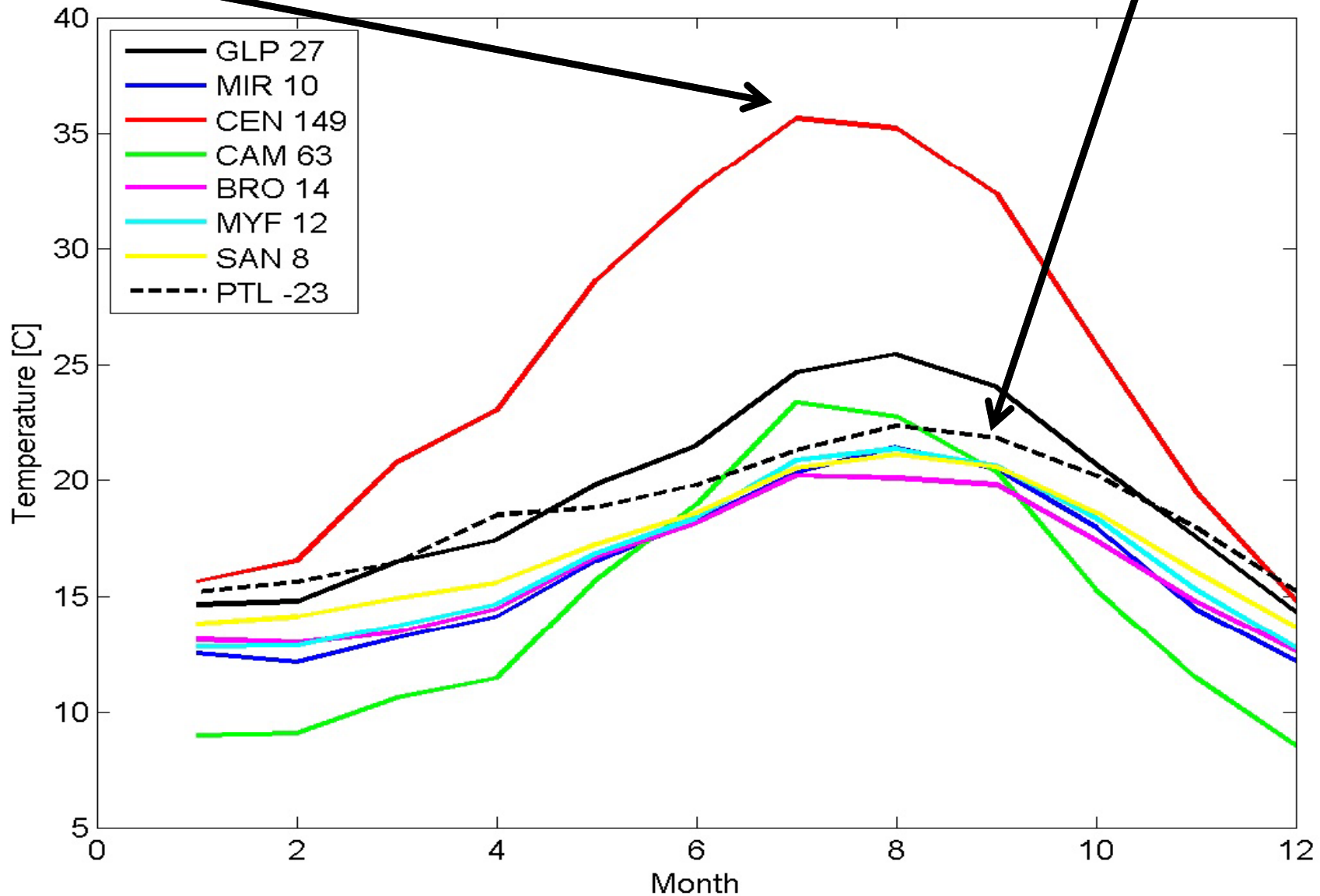
- Temperature
- Dew Point Temperature
- Wind Direction
- Cloudiness



# Annual Cycle of Temperature

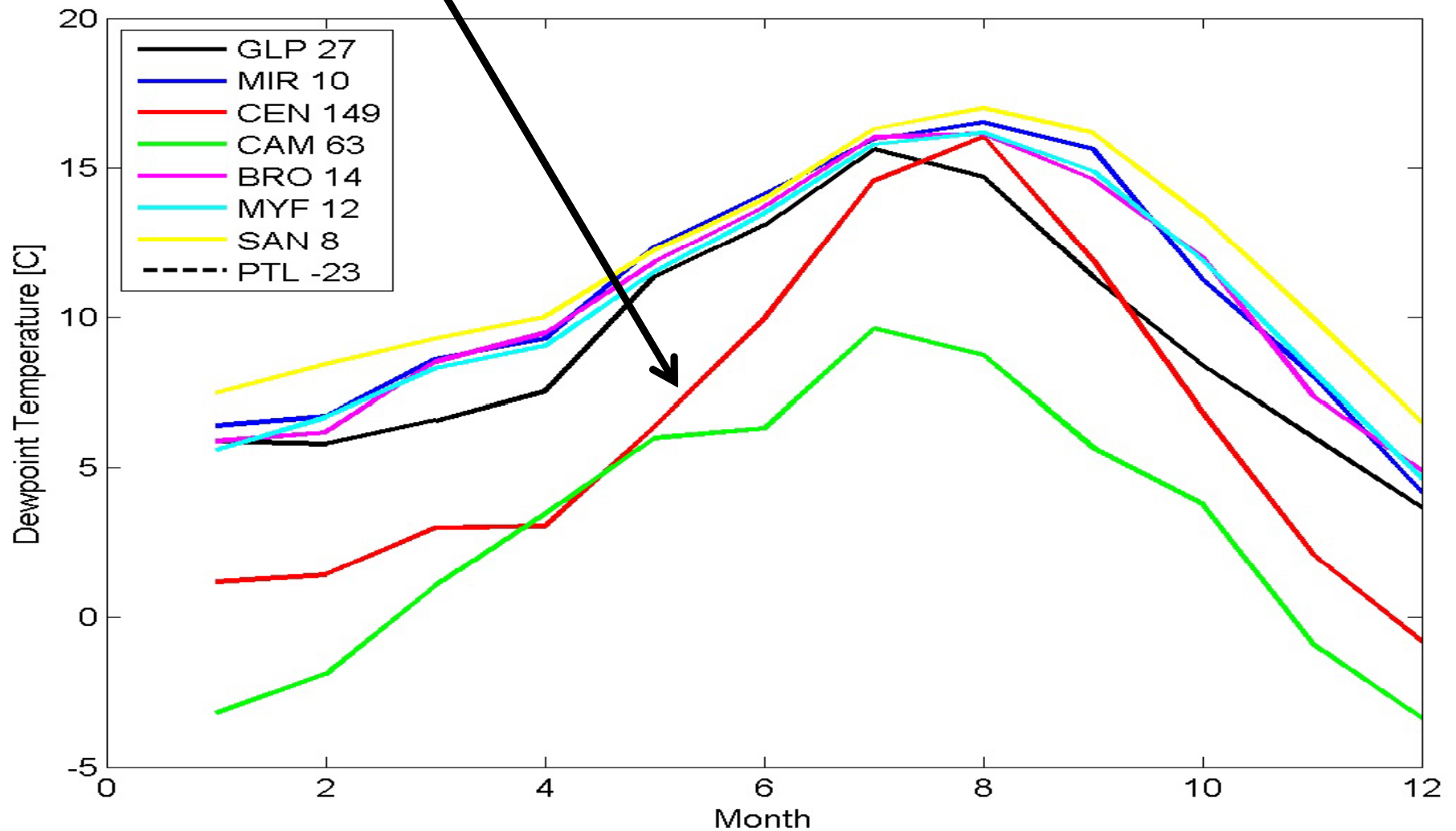
SAN, BRO, MYF, MIR very similar

El Centro: hottest and most variable temperature. Point Loma: Oceanic



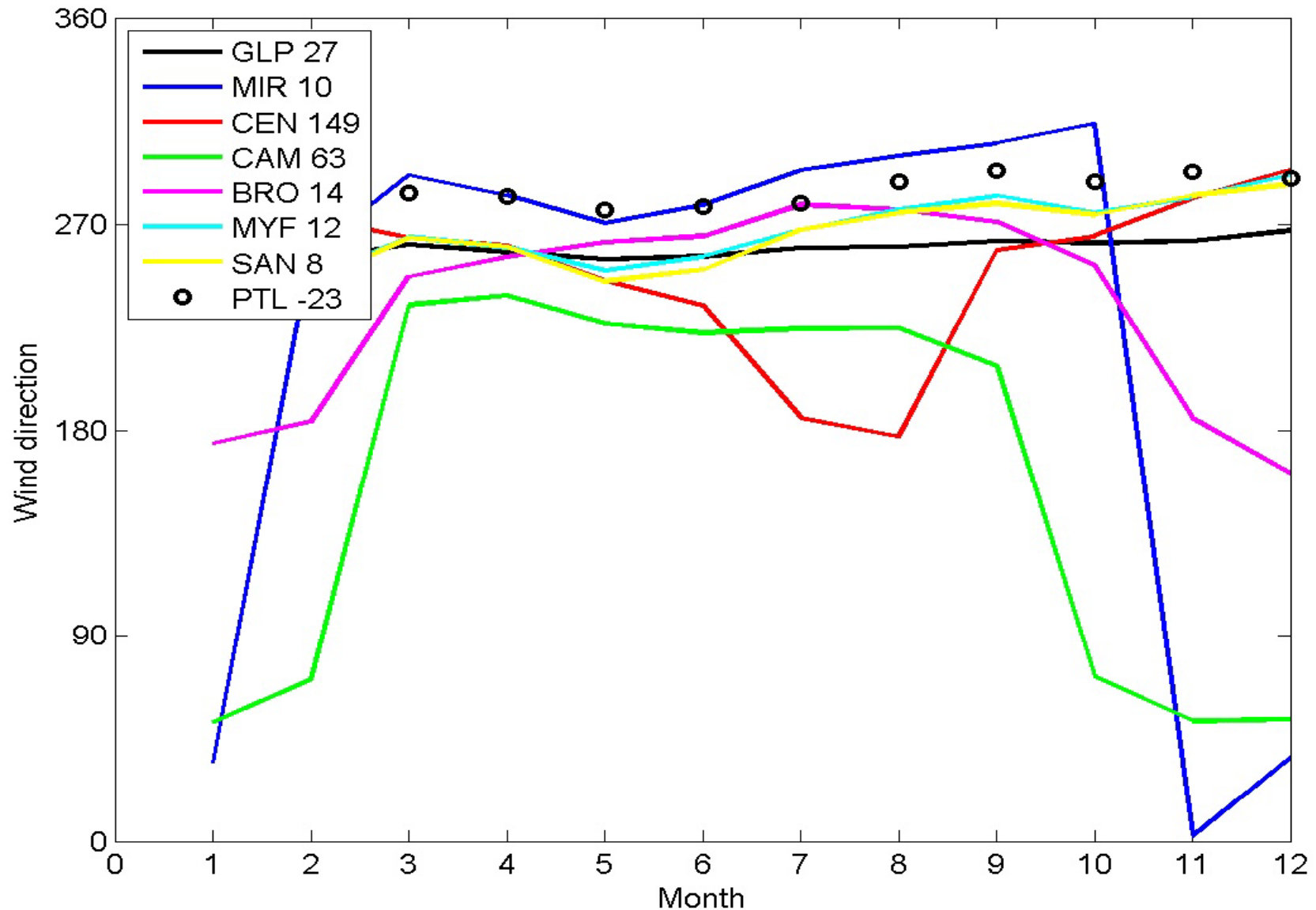
# Annual Cycle of on Dew Point Temperature

- EL Centro is dryer in winter, but similar dewpoint temperature in summer (irrigation and evaporation?)



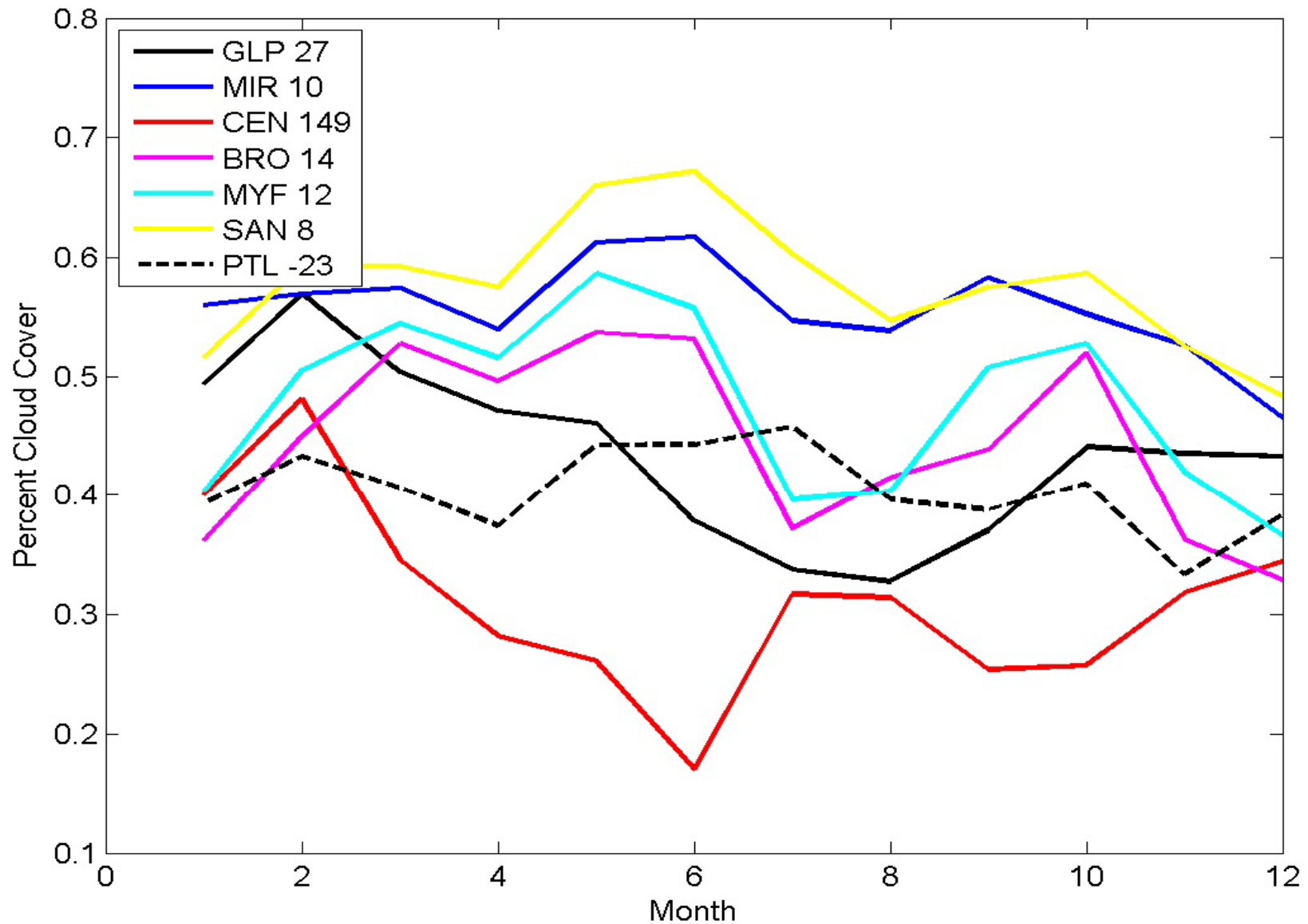
# Annual Cycle of Wind Direction

On average westerly winds all year. Changes in wind direction during winter for CAM, BRO, MIR



# Annual Cycle of Cloudiness

Minima of cloudiness in July and Nov-Jan for coastal stations

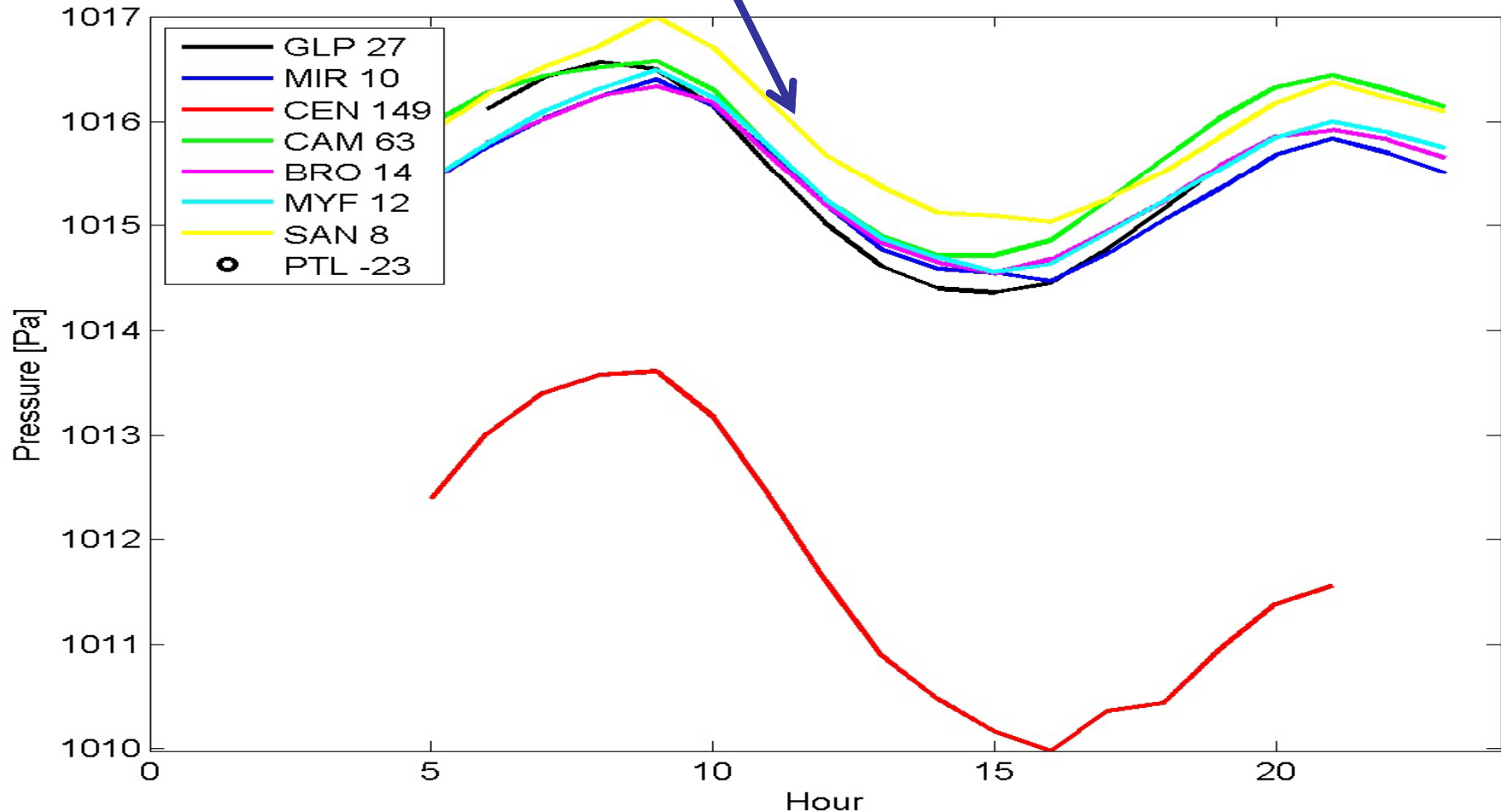


# Hourly Plots

- Pressure
- Temperature
- Dew Point Temperature
- Wind Direction
- Wind speed
- Cloudiness

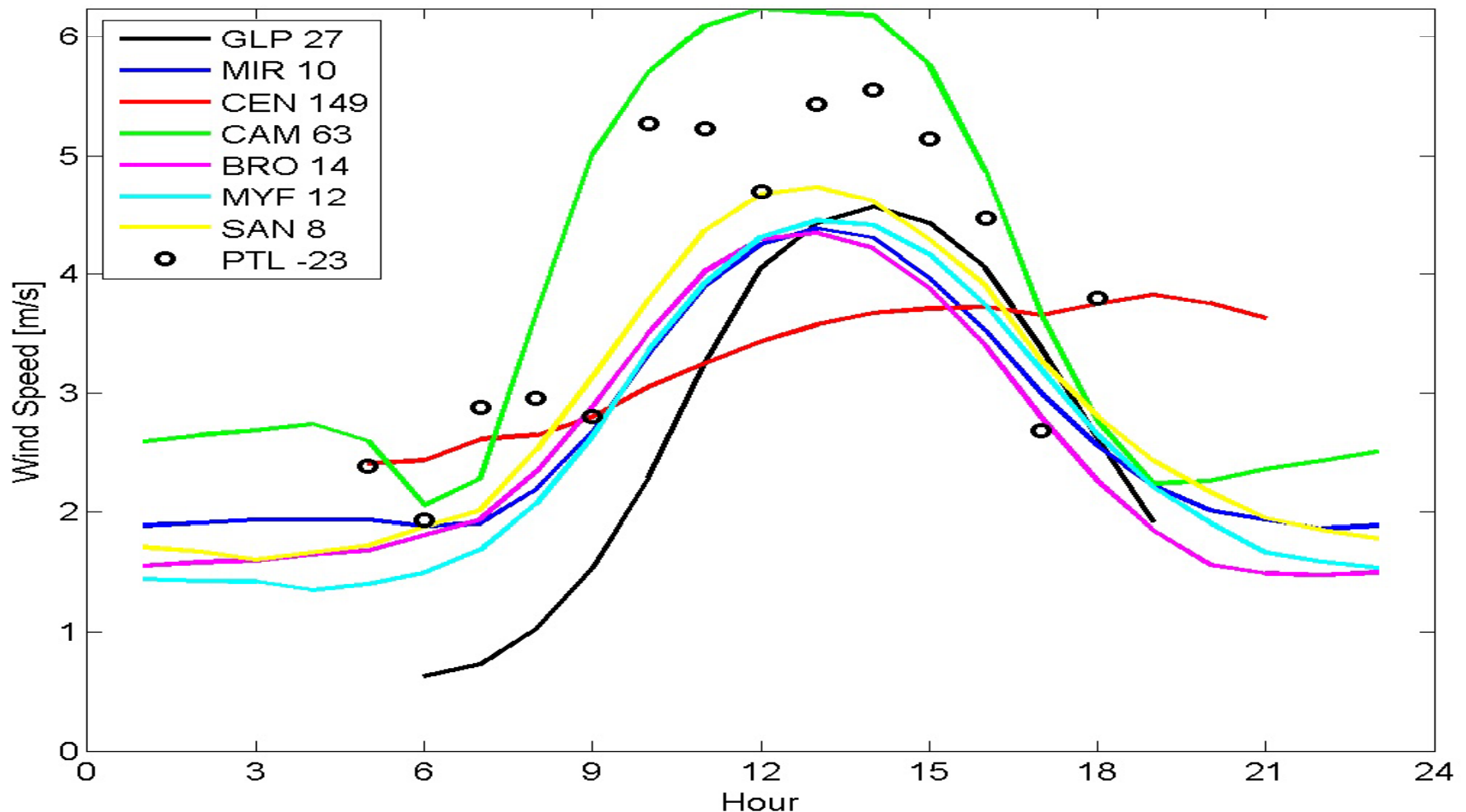
# Diurnal Cycle of Pressure

- Pressure is consistent for the coastal stations
- Pressure is one of the main causes for the sea breeze. Decreasing pressure on land initiates the sea breeze



# Diurnal Cycle of Wind Speed

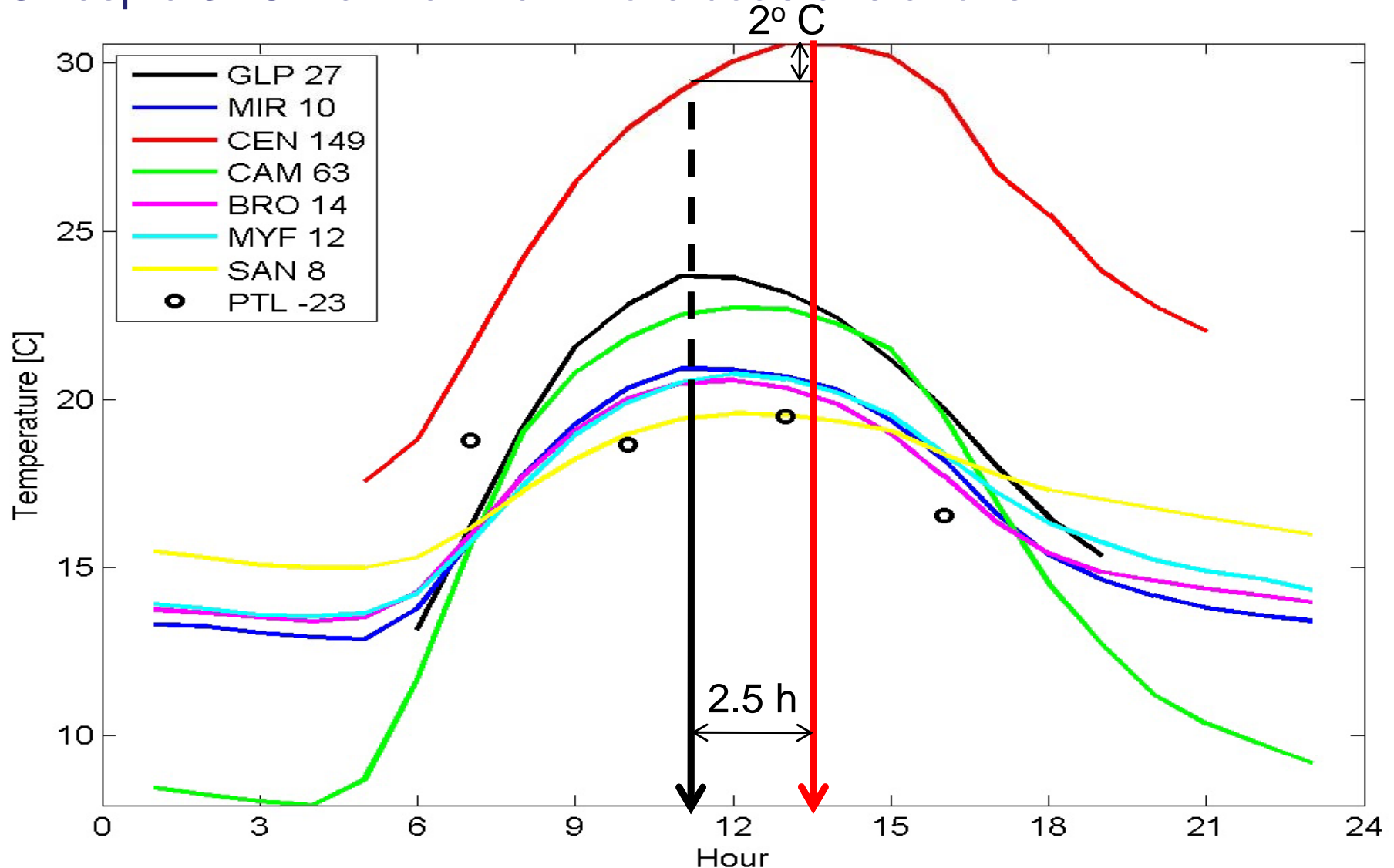
- All the other stations are almost identical
- El Centro (no sea breeze), and Campo (exposed mountain) are the only stations that are different



# Diurnal cycle of Temperature

El Centro reaches maximum temperature much LATER than coastline stations → quantify sea breeze effect

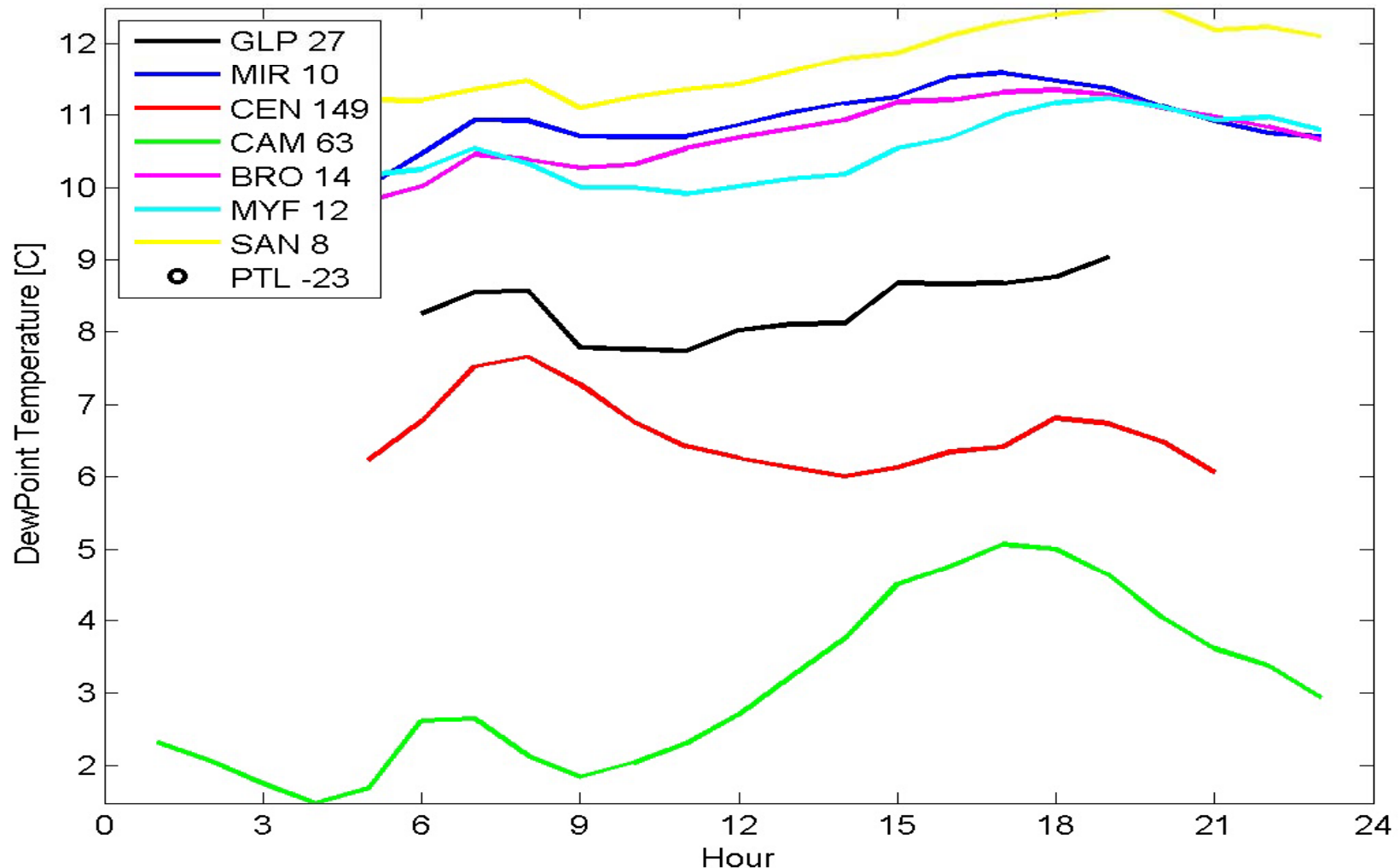
Gillespie 3° C warmer than more coastal stations





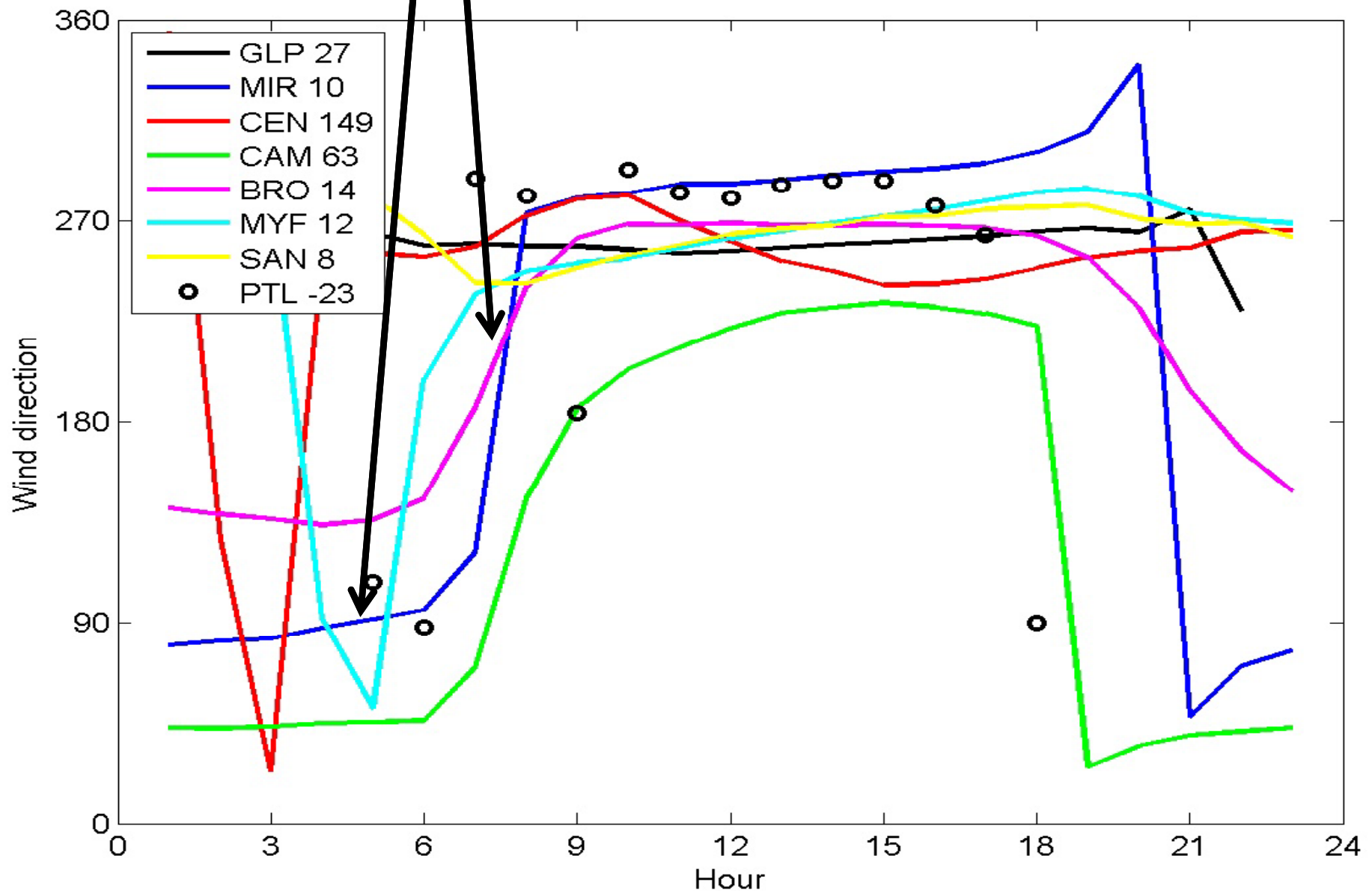
# Diurnal Cycle of Dew point Temperature

- Air from ocean is expected to carry more water vapor and have a higher dew point temperature
- Without sea breeze the curve would be flat



# Diurnal Cycle of Wind Direction

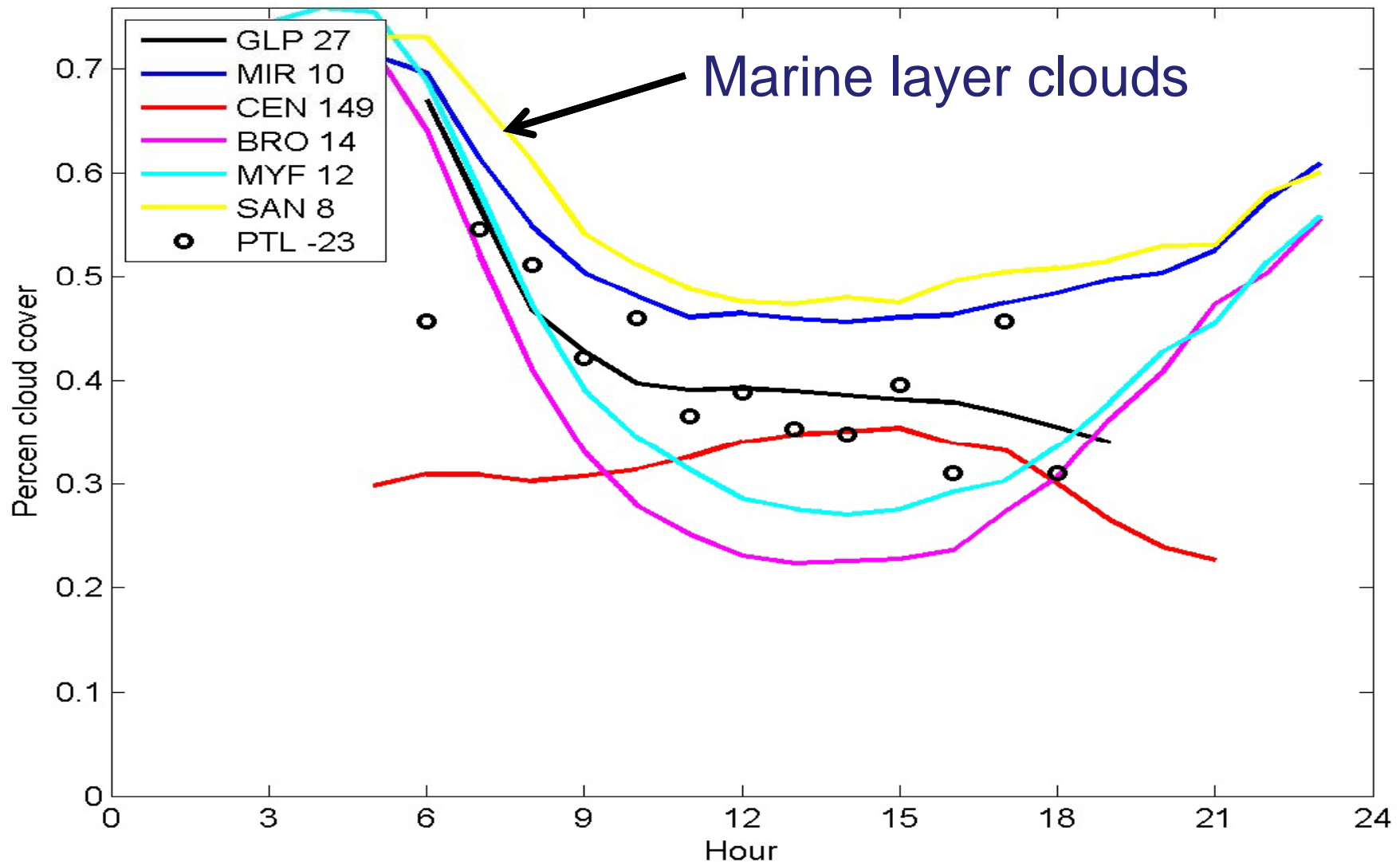
- The wind goes from west to east during the day, but reverses at night at different times for each station



# Diurnal cycle of Cloudiness

For the costal stations there is a direct relationship between the cloudiness and the solar panel power output

Larger uncertainty in this variable then other variables

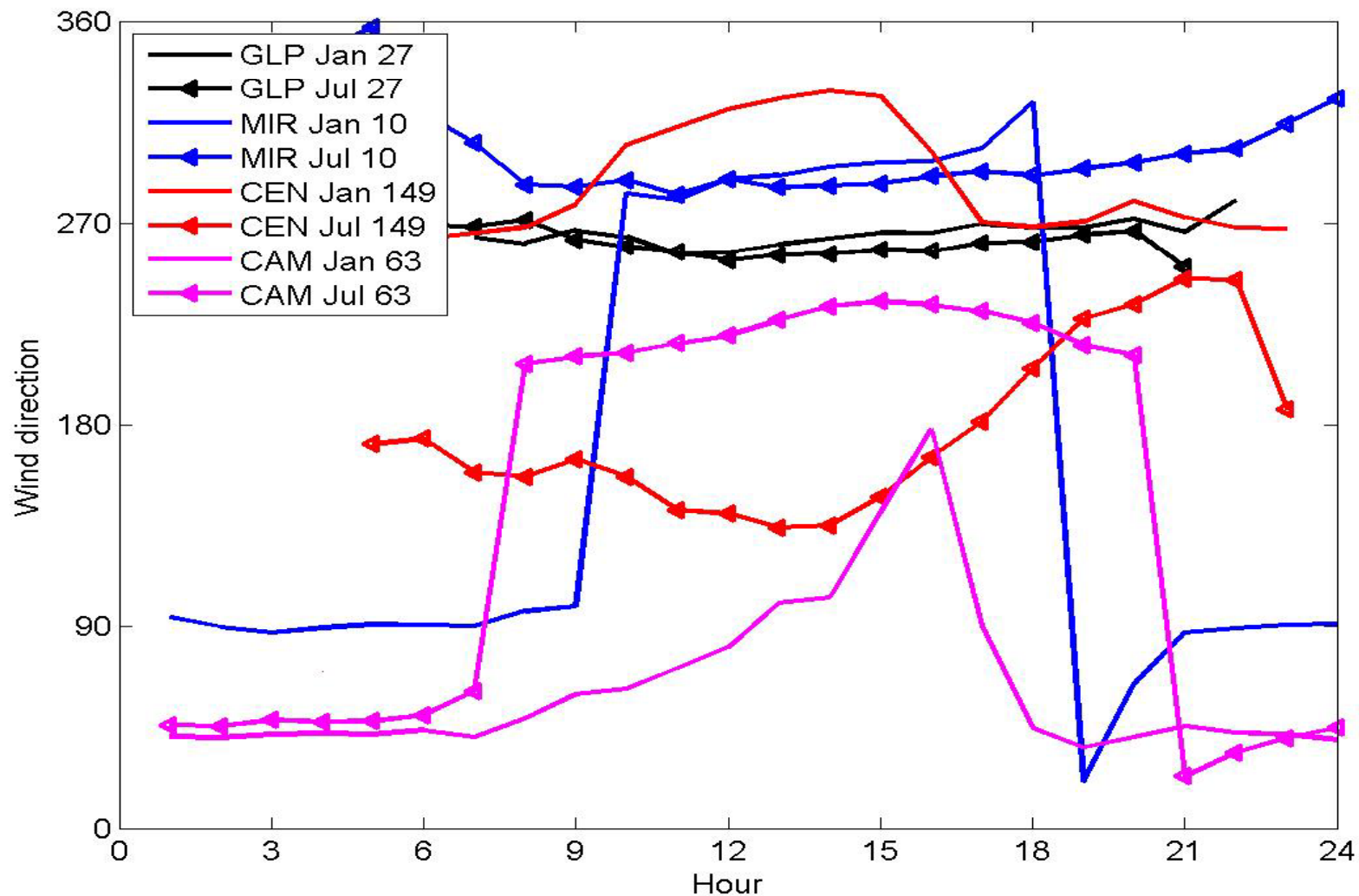


# Monthly-hourly Plots

- Wind Direction
- Temperature
- Dew Point Temperature
- Wind Speed

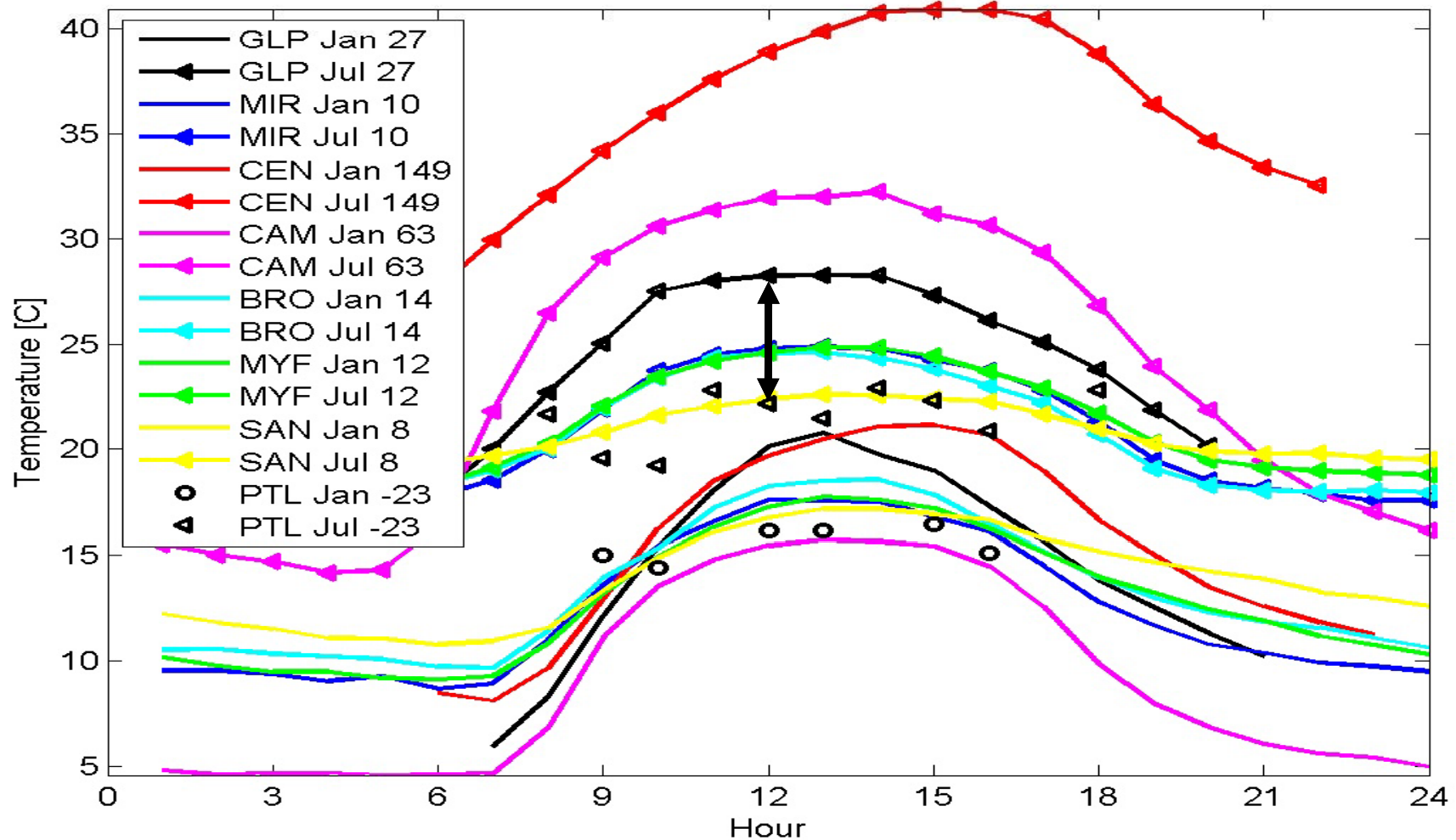
# Wind Direction

- In summer the wind direction stays constant in the coastal stations
- In winter time there is a strong change in wind direction in the morning and in the evening, i.e. the land breeze exists.



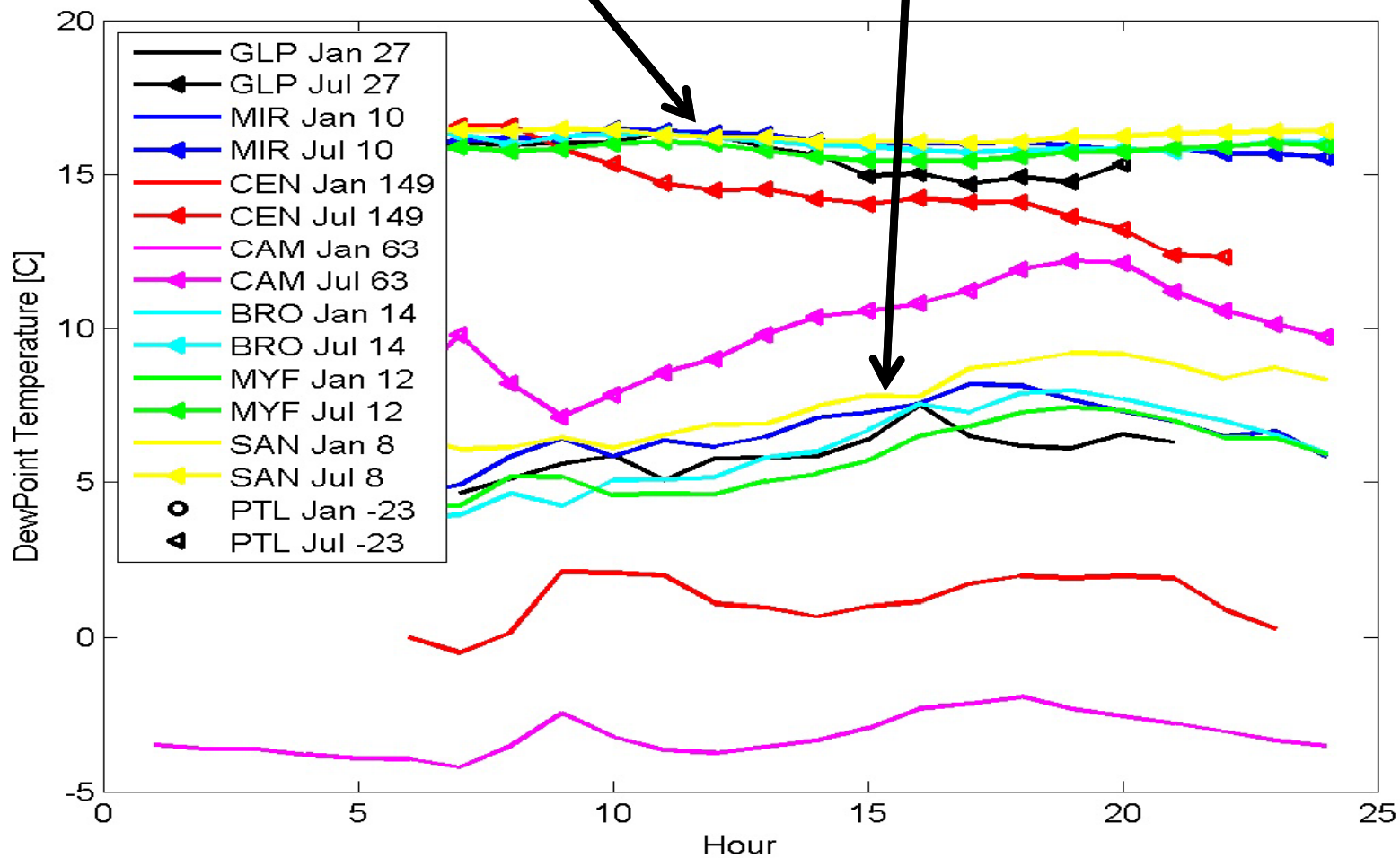
# Temperature

- Highest temperatures in July. July day starts earlier, days are longer and the peak is wider
- Large temperature variation SAN – MIR – GLP in summer



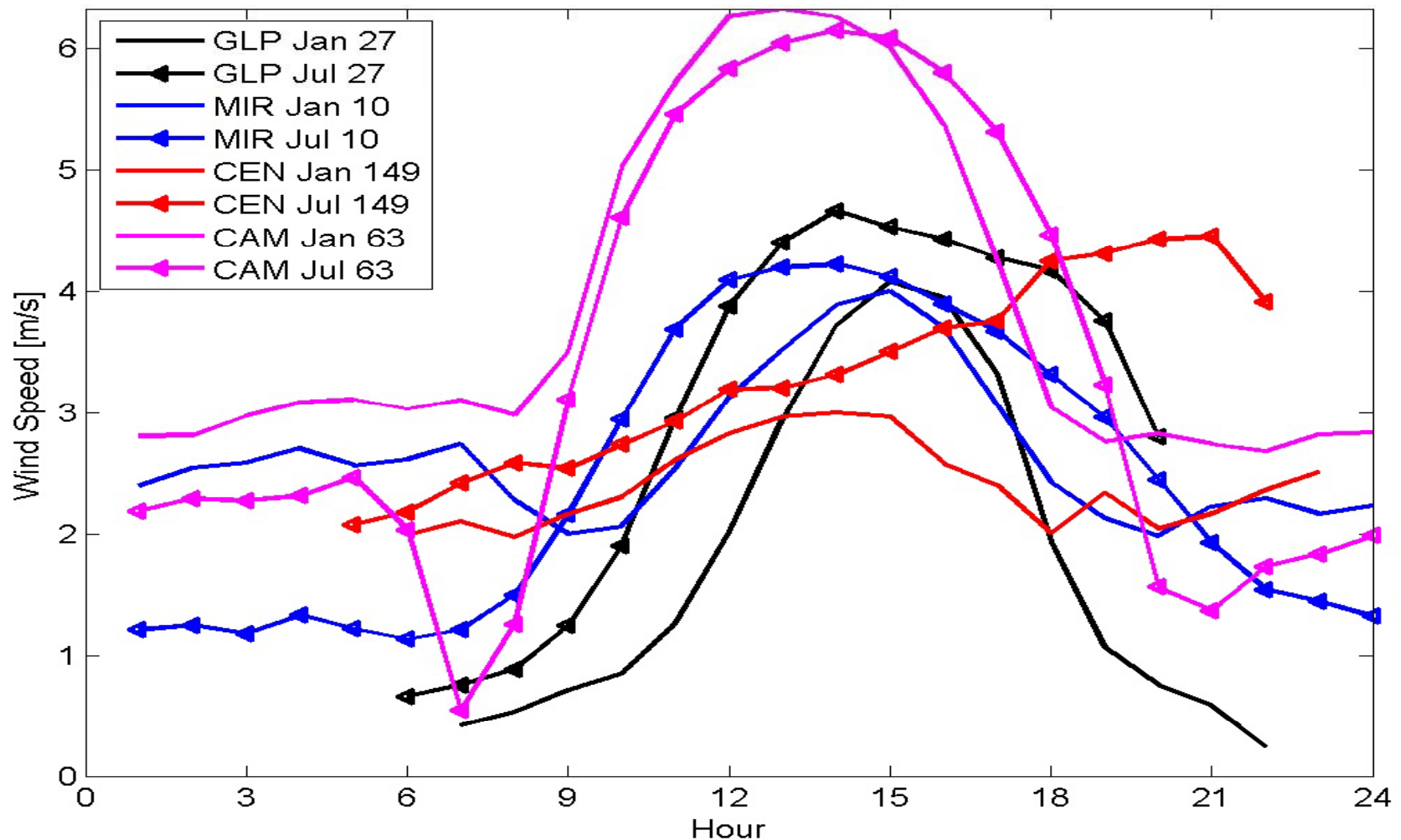
# Dew Point Temperature

- January: Dew Point increases during the day
- July: dew point is flat (unexpected)



# Wind Speed

- Wind speed magnitude in summer and winter is the same. → sea breeze equally strong in January and July?





# Summary Diurnal Cycle

- Sea breeze affects the diurnal cycle of meteorological variables:
  - Change in wind direction at night only at a few stations
  - Earlier and lower peak in temperature
  - Wind speed peak at 1pm. Smaller during night.
  - Pressure drops in the morning



# Summary Differences Winter-Summer

- Sea breeze affects the diurnal cycle of meteorological variables:
  - Change in wind direction during the night only in winter
  - Increase in dewpoint temperature only in winter
  - Larger coast-inland temperature gradient in summer



# Conclusions

- Sea breeze has an enormous effect on the wind direction, wind speed and especially temperature
- Coastal stations are a lot cooler in the summer
- Smart building design and energy management could potentially save a lot on energy



# Question?



**It's QUESTION TIME!!**