The Diel Cycle of Modeled and Measured Latent Heat Flux in a Colorado Subalpine Forest: Measurements vs CLM

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Community Land Model (CLM) Tutorial

16 Septemeber 2016

Niwot Ridge AmeriFlux Tower (US-NR1)

(photo credit: Bill Bowman)

Talk Outline/Details

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- Influence of Precipitation on Warm-Season Fluxes

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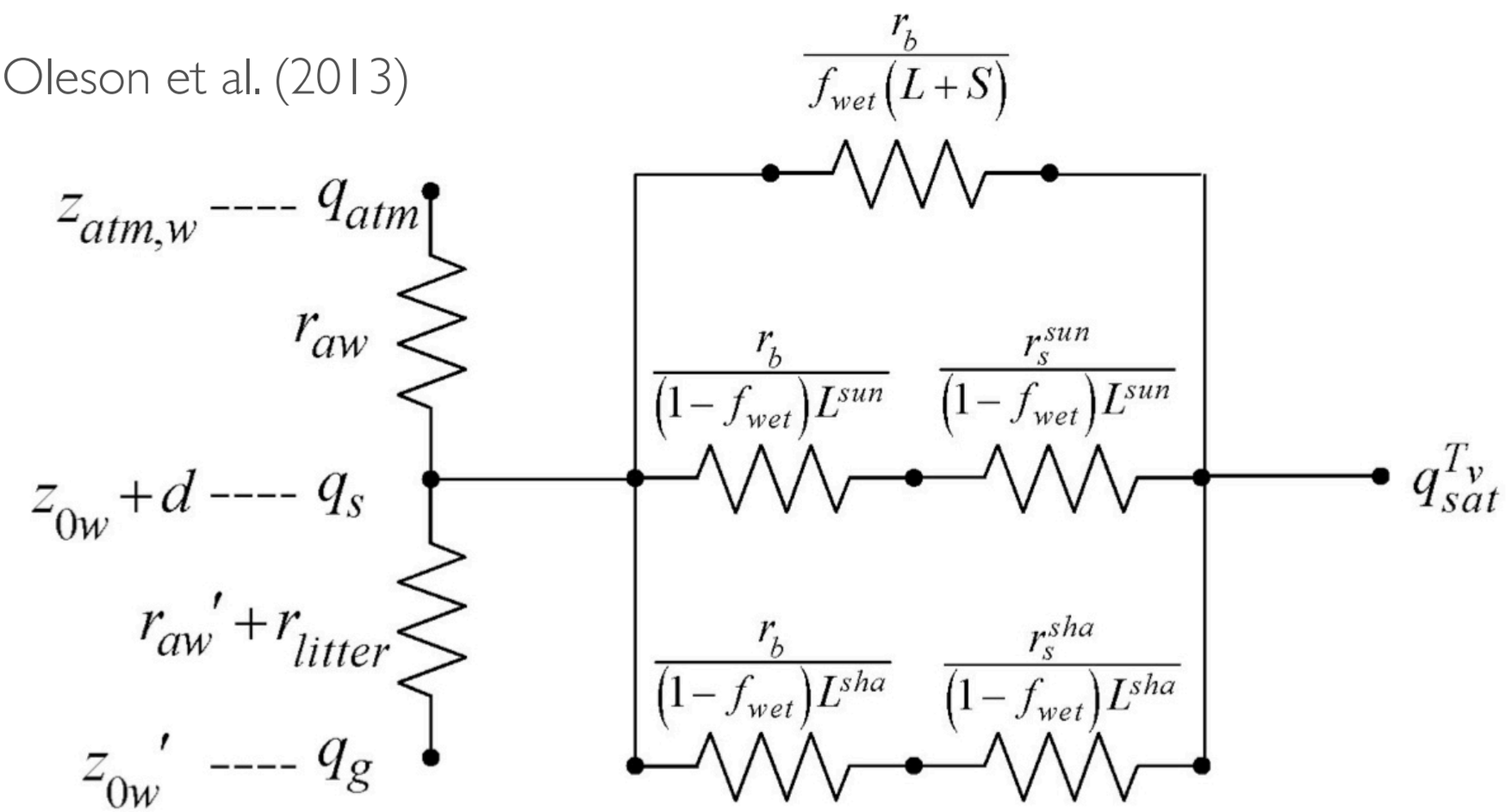
  ➡ In CLM, fluxes calculated using M-O Similarity Theory + additional resistance and turb trans coefficient to represent the subcanopy transport

CLM Water Vapor Transport

Oleson et al. (2013)



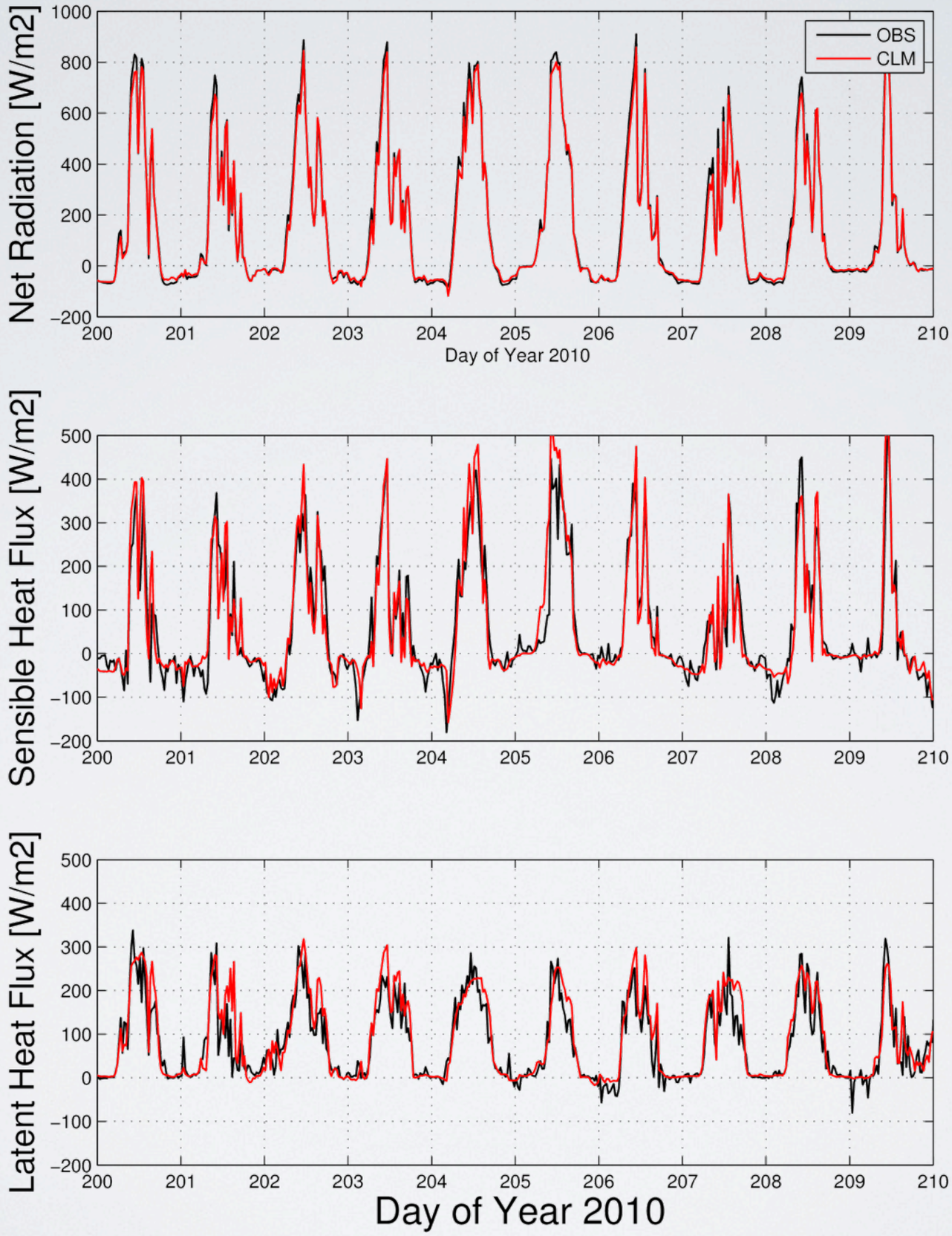
The aerodynamic resistances to heat (moisture) transfer between the ground at height z_{0h}' (z_{0w}') and the canopy air at height $z_{0h}+d$ ($z_{0w}+d$) are

$$r_{ah}' = r_{aw}' = \frac{1}{C_s U_{av}} \tag{5.113}$$

where

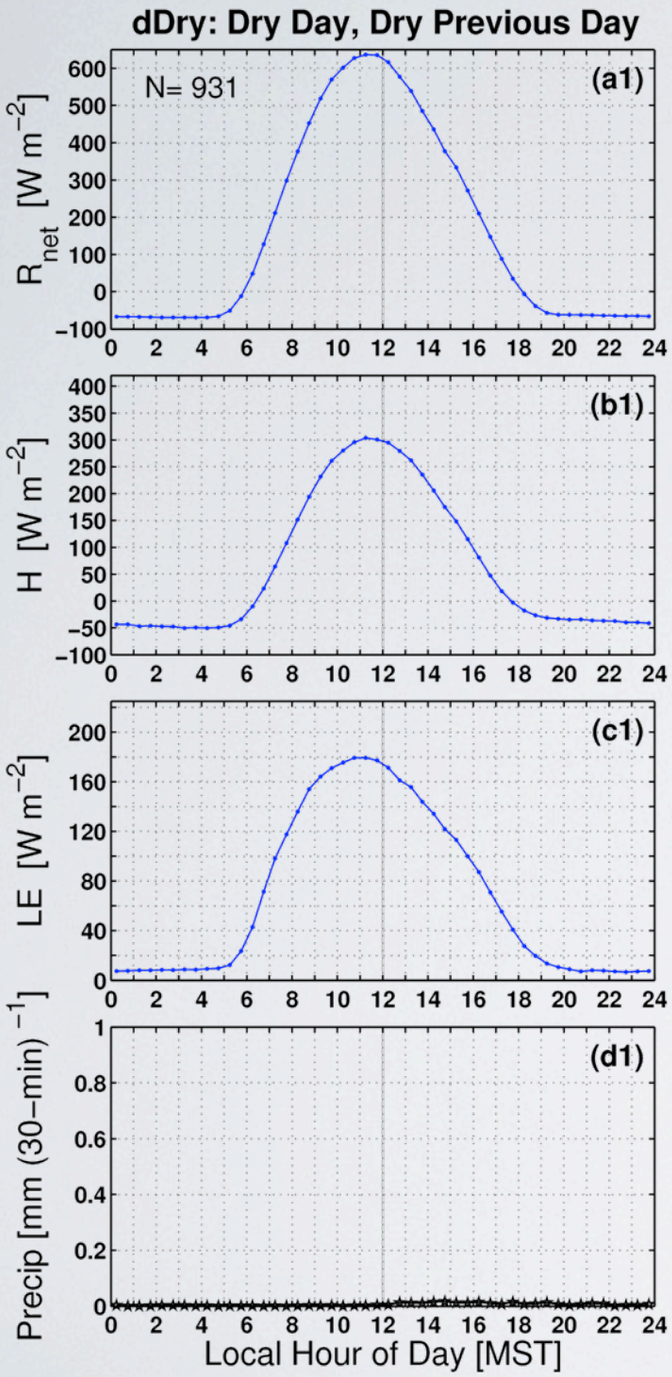
$$U_{av} = V_a \sqrt{\frac{1}{r_{am} V_a}} = u_* \tag{5.114}$$

CLM vs OBS Time Series Comparison



Warm-Season Precipitation, Conditional Sampling

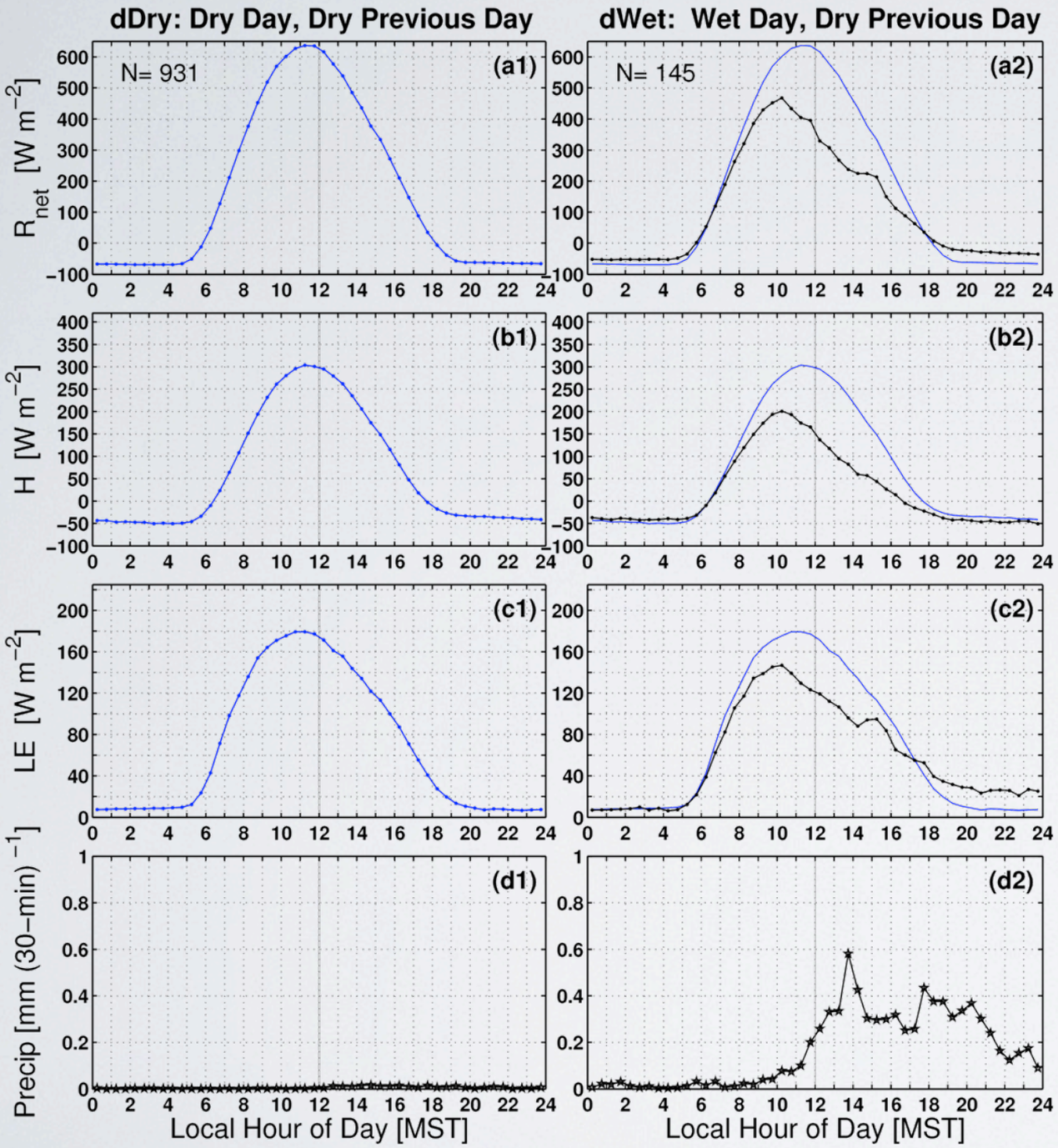
dDry



0:00 Noon 24:00

Warm-Season Precipitation, Conditional Sampling

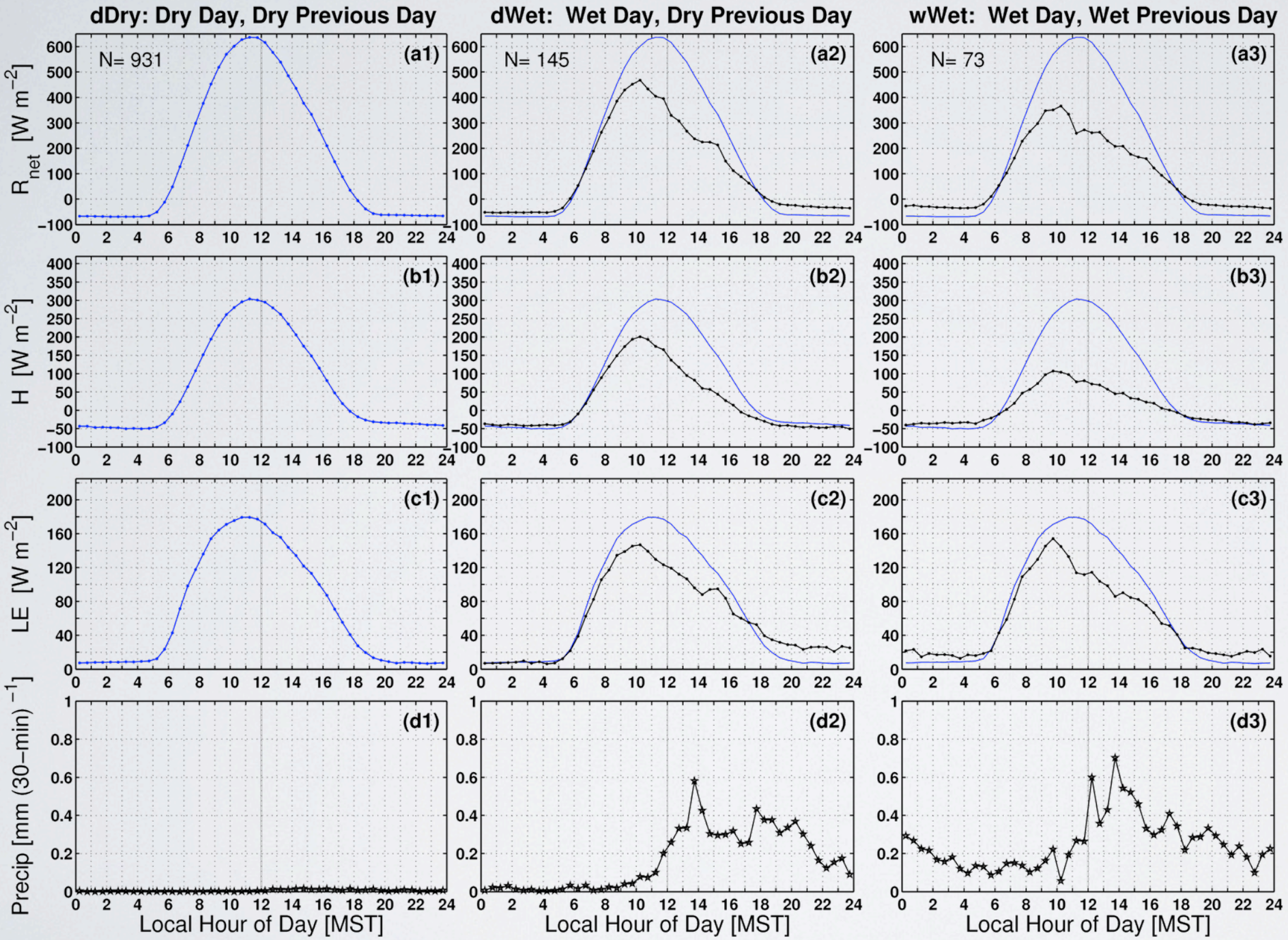
dDry **dWet**



0:00 **Noon** **24:00**

Warm-Season Precipitation, Conditional Sampling

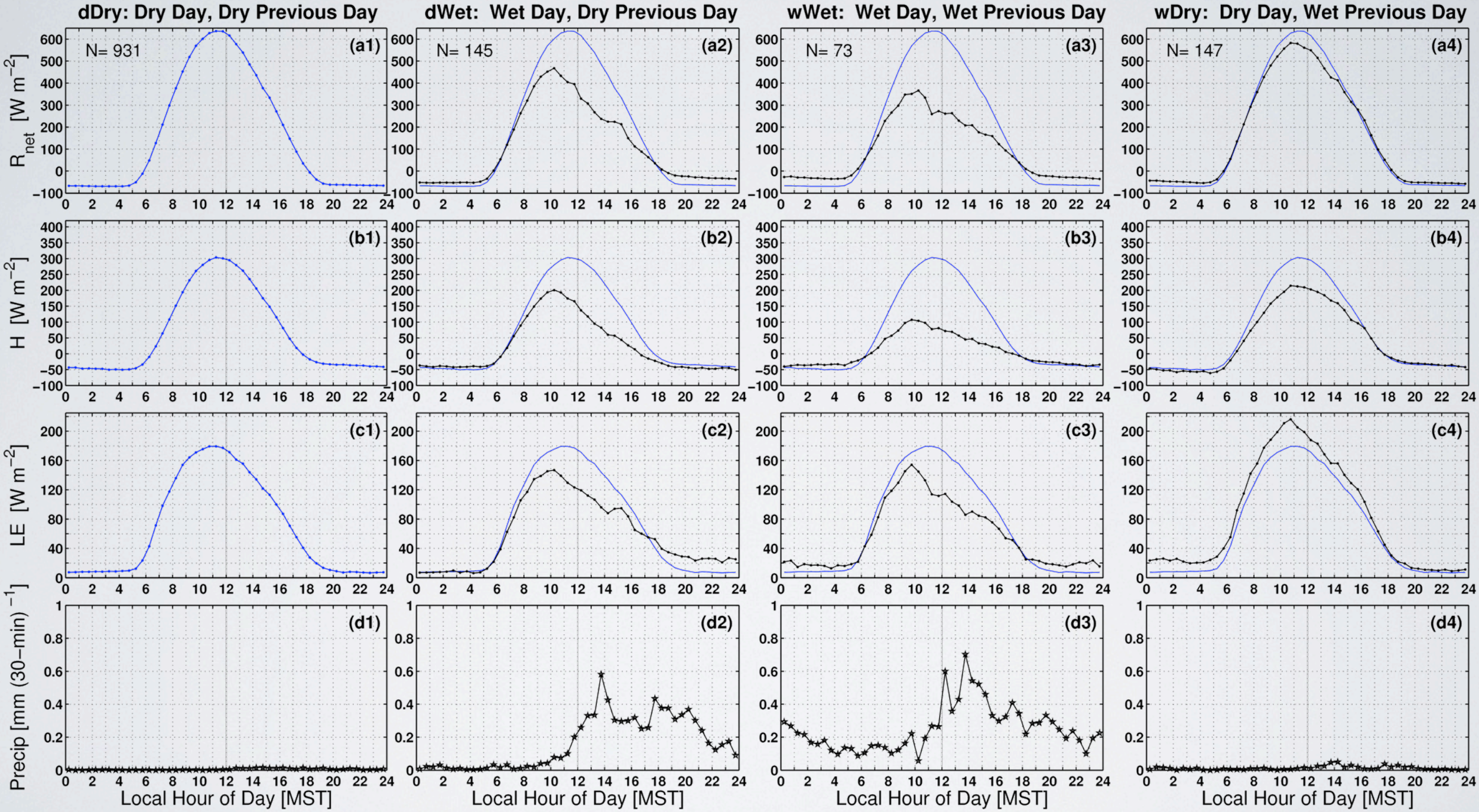
dDry **dWet** **wWet**



0:00 **Noon** **24:00**

Warm-Season Precipitation, Conditional Sampling

dDry **dWet** **wWet** **wDry**



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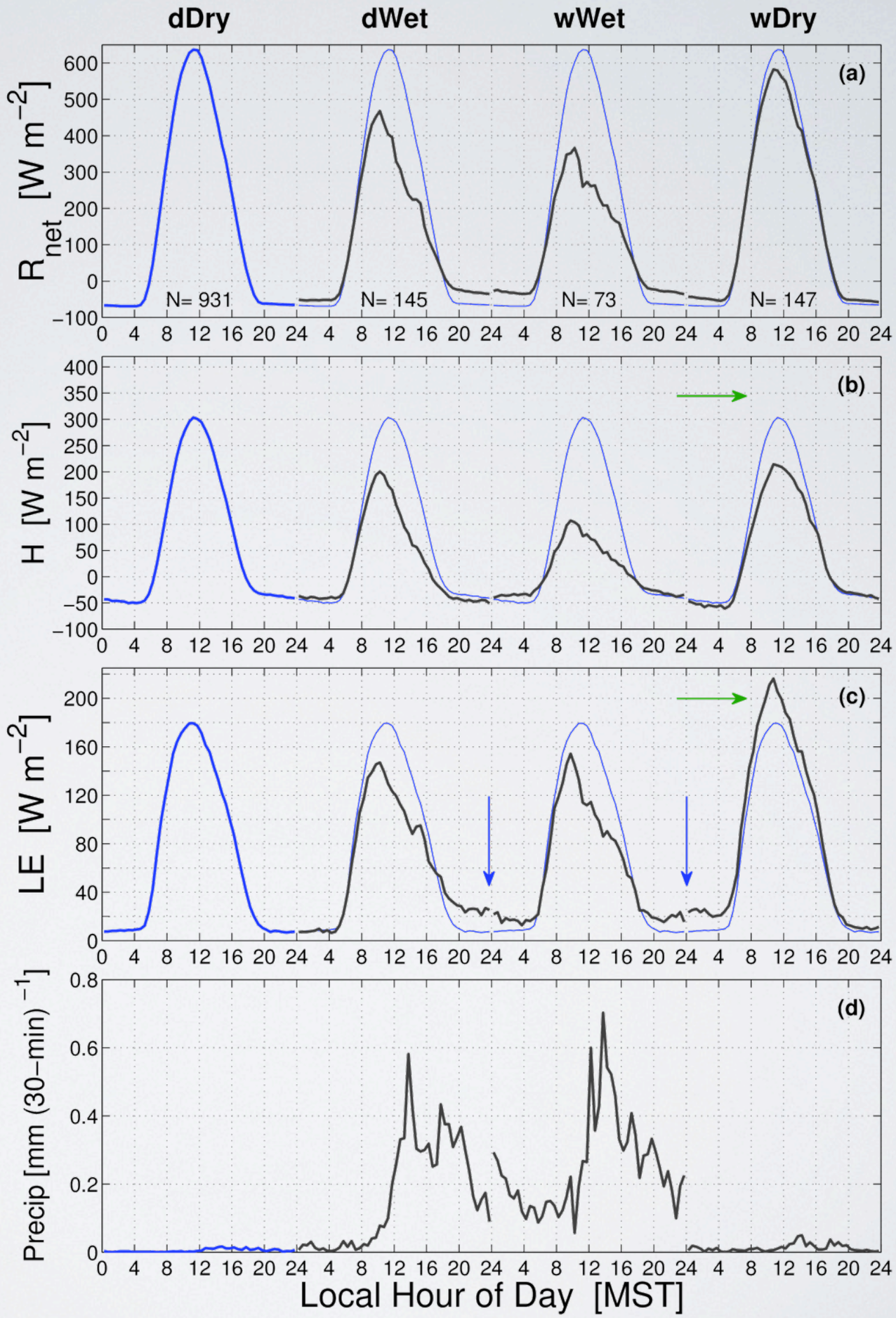
Observations Summary

Burns, et al. (2015)



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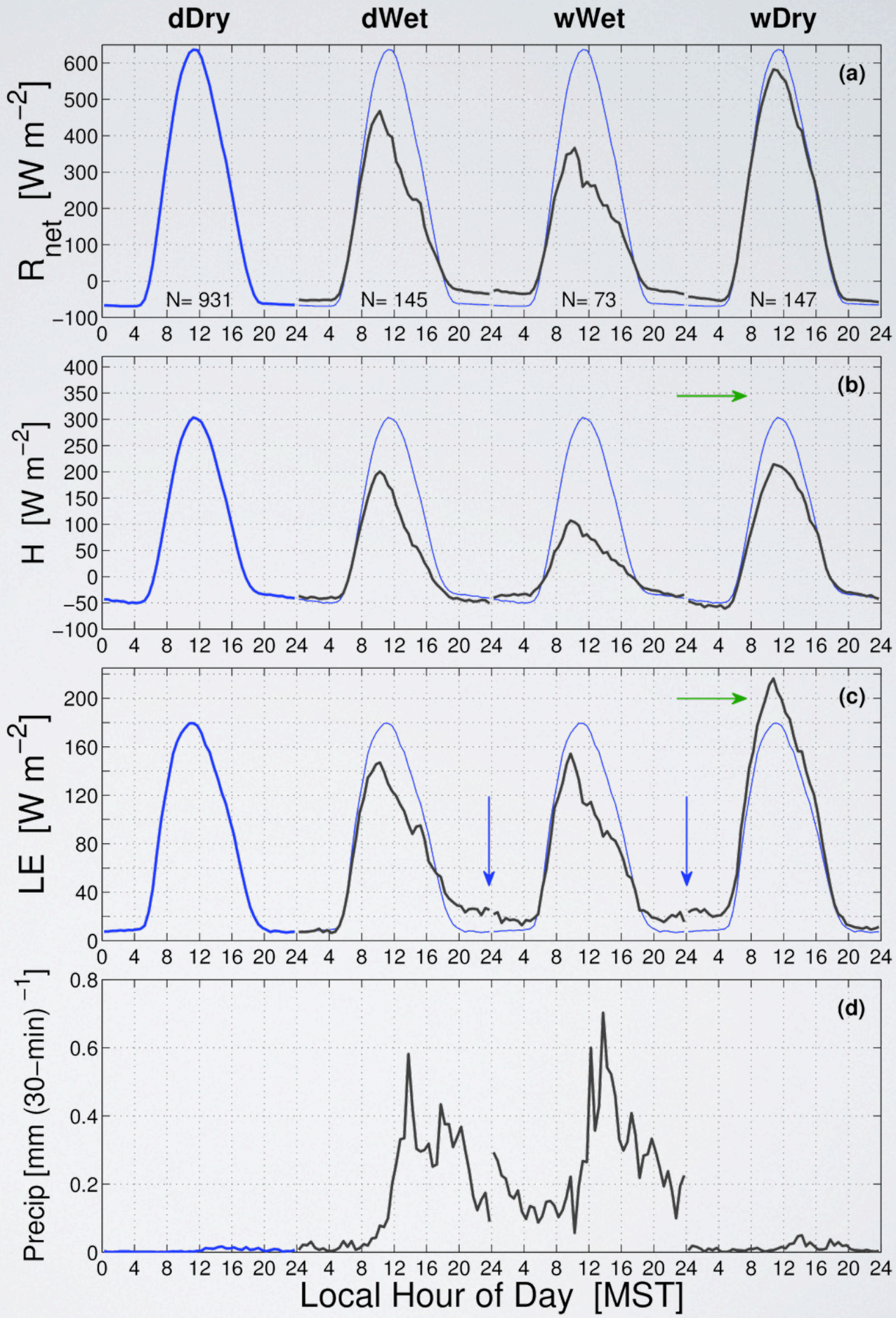
*** Increase in nocturnal LE during wet periods**



Observations Summary

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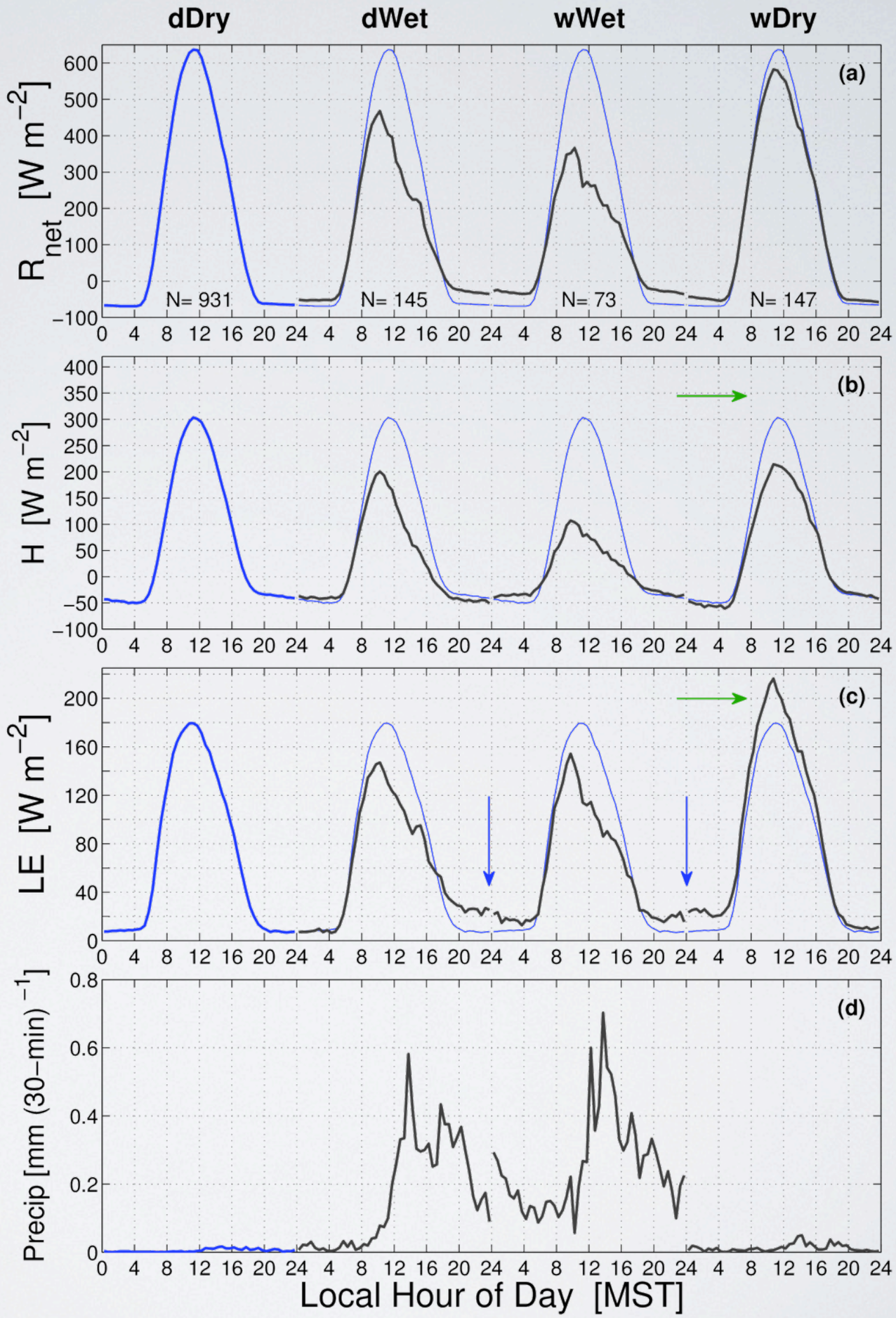
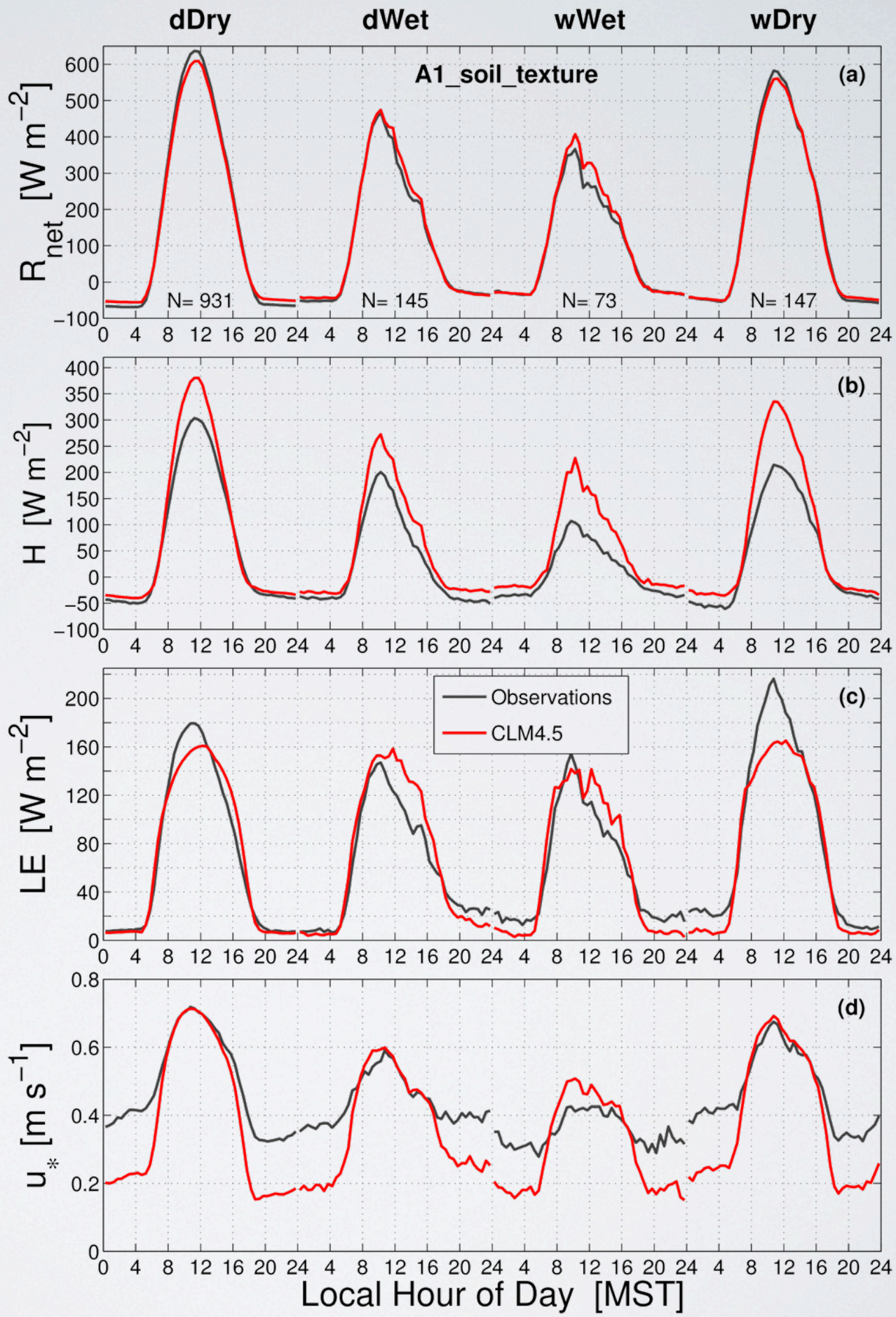
*** Increase in nocturnal LE during wet periods**

*** Increase in mid-day LE during wDry days**

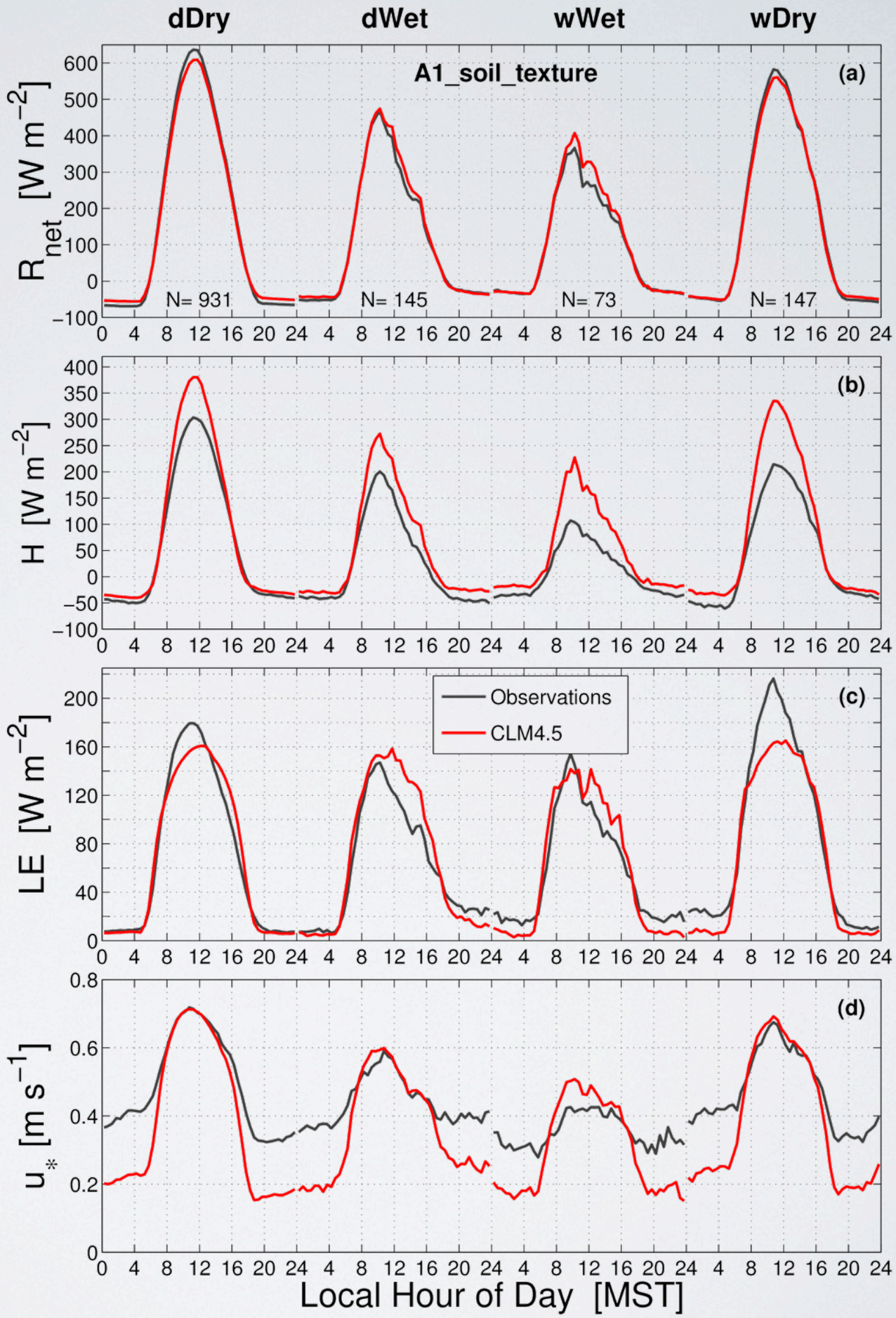


Observations versus CLM



Observations versus CLM

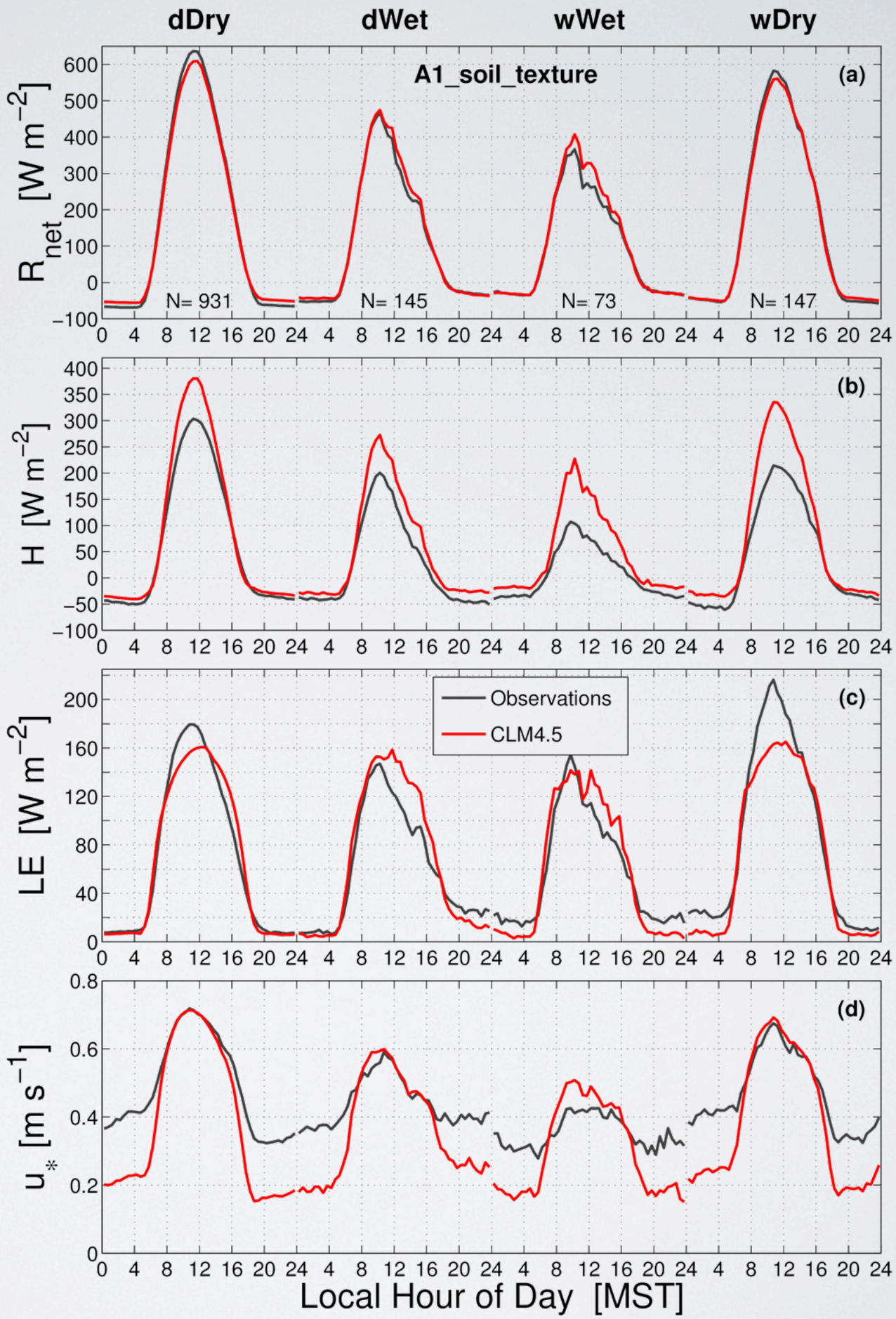
*** CLM LE at night too low (in wet conditions)**



Observations versus CLM

*** CLM LE at night too low (in wet conditions)**

*** No increase in CLM LE on wDry days**

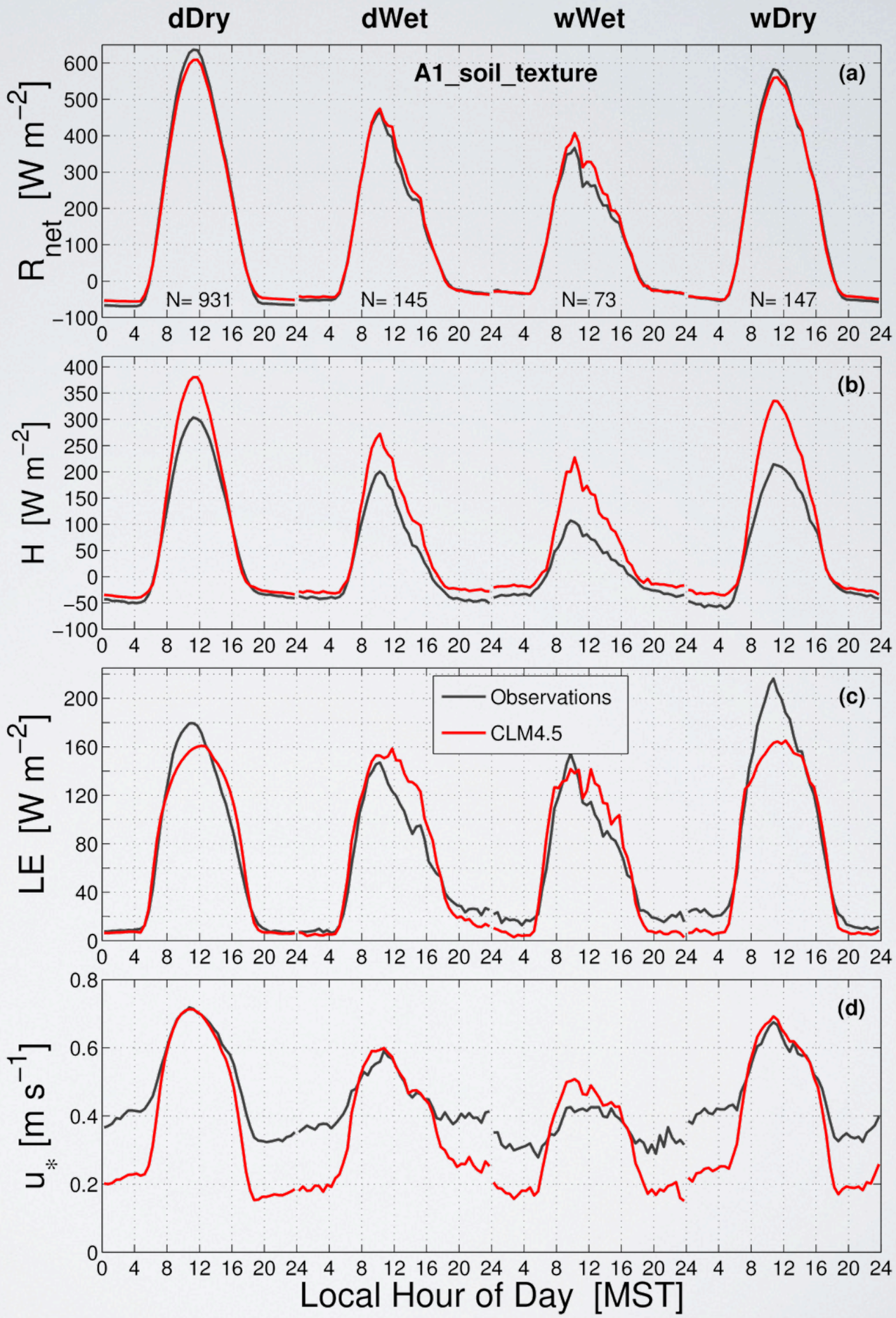


Observations versus CLM

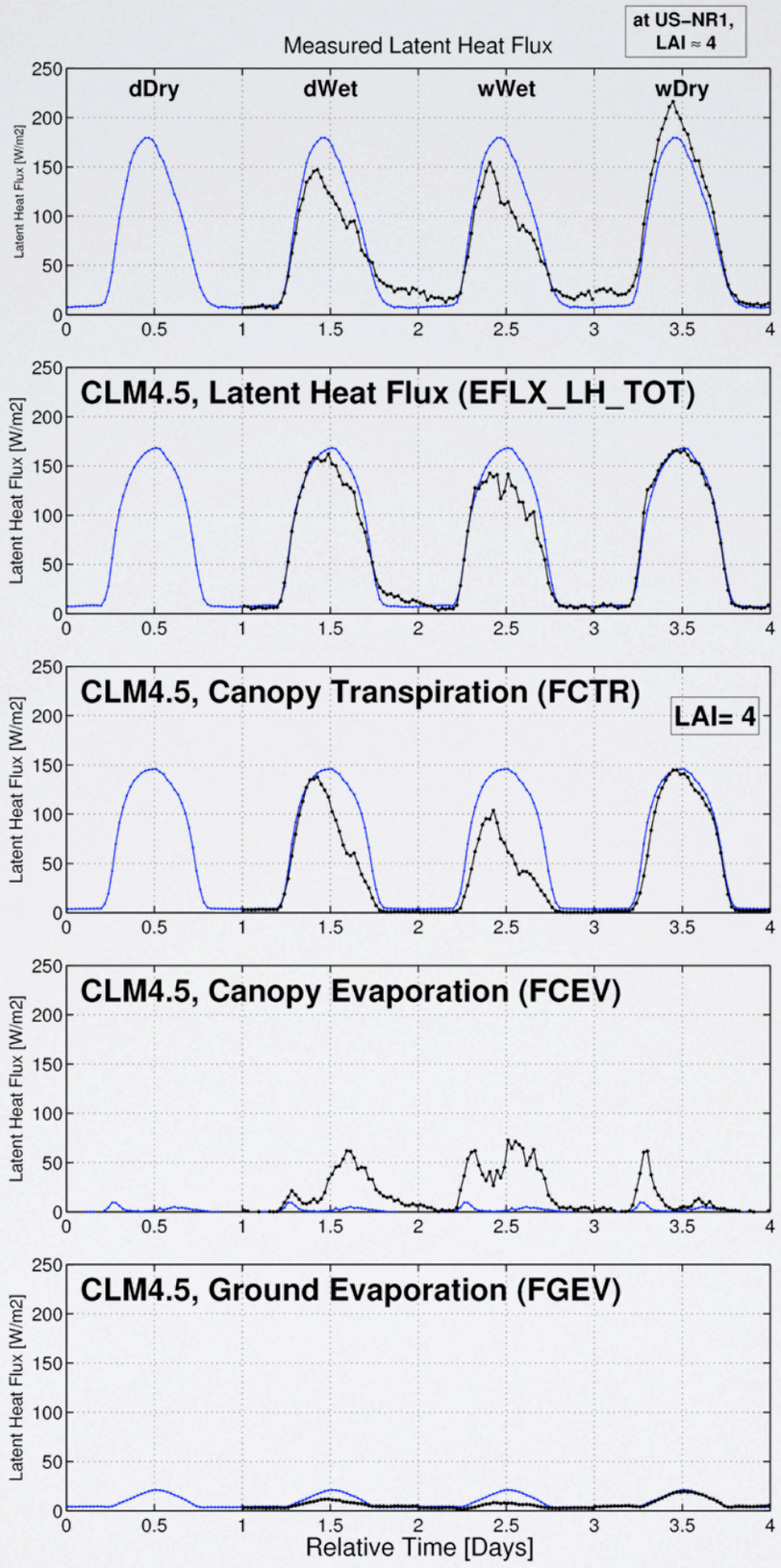
*** CLM LE at night too low (in wet conditions)**

*** No increase in CLM LE on wDry days**

*** ustar at night is too low (e.g., Bonan, Patton)**

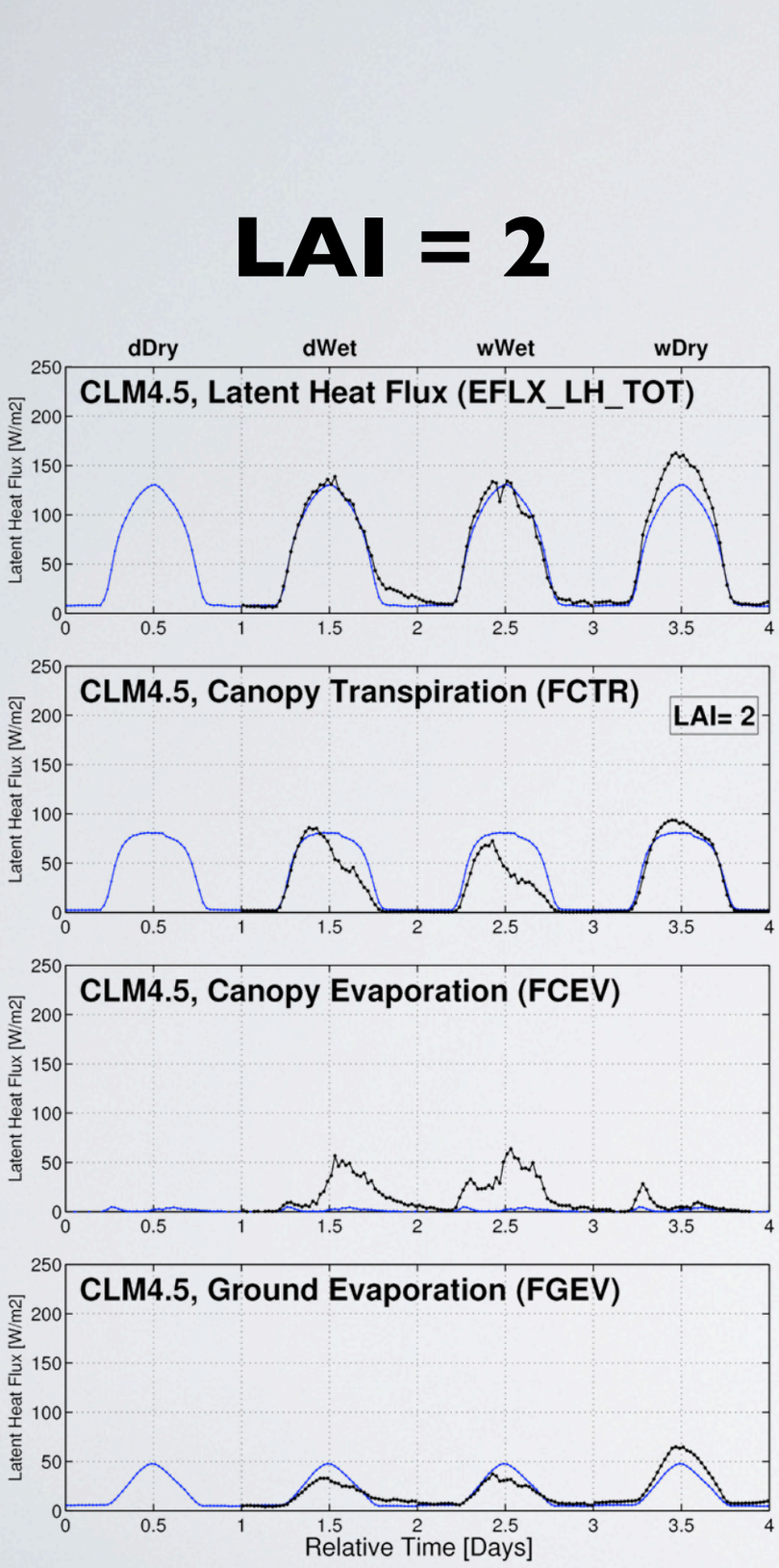


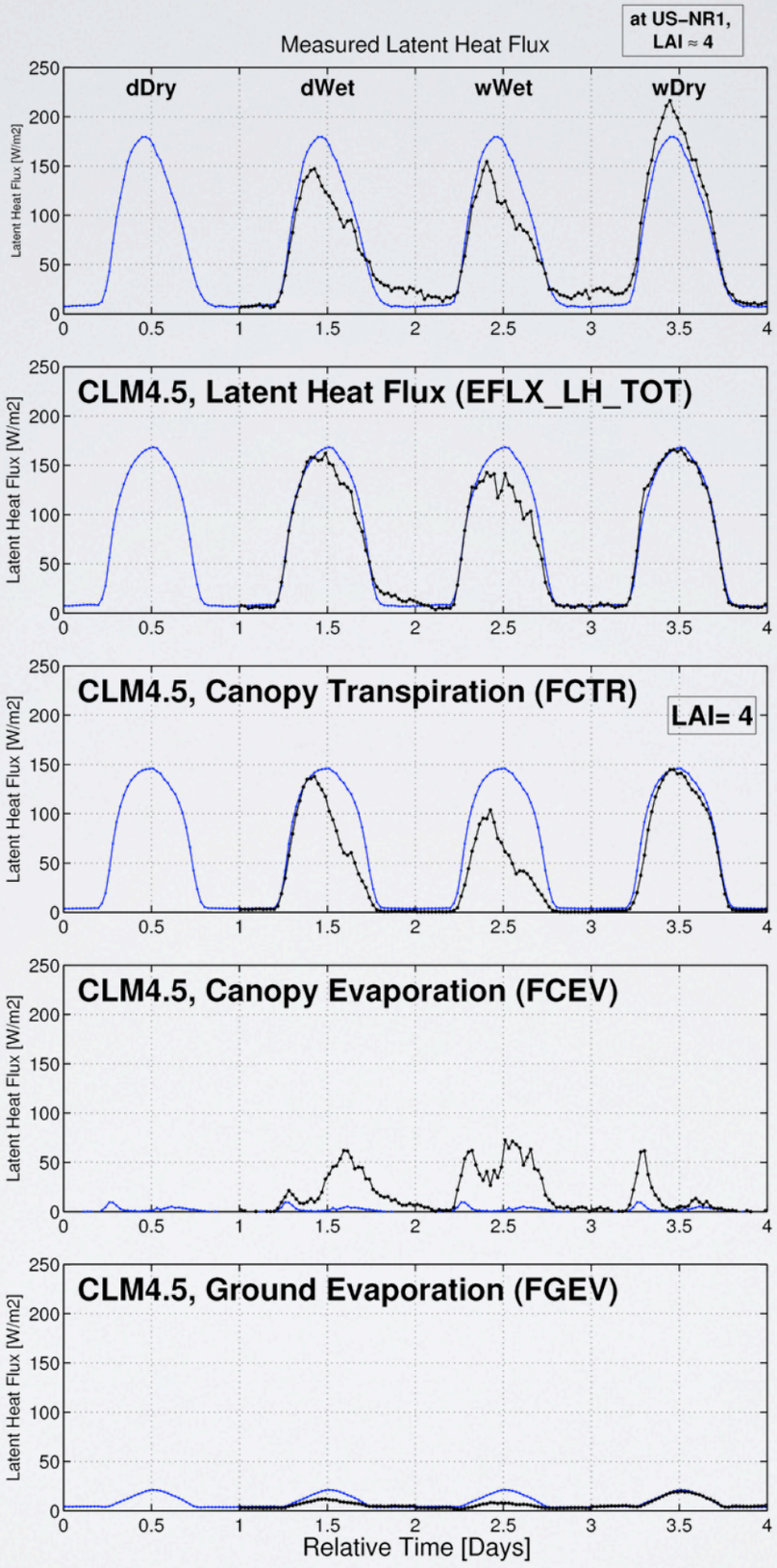
Latent Heat Flux Components of CLM4.5



Latent Heat Flux Components of CLM4.5

LAI = 2

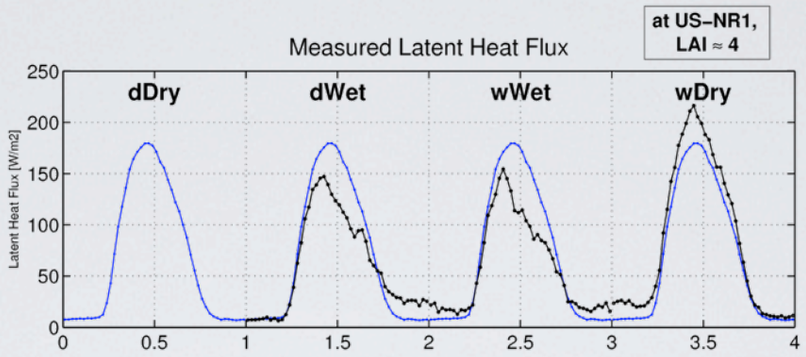


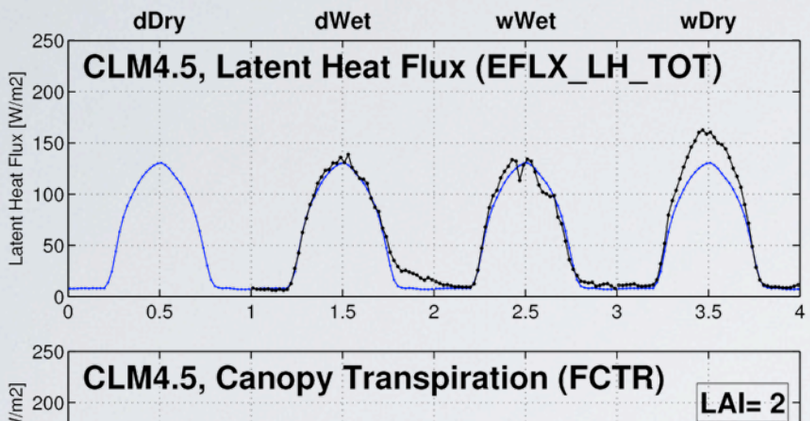


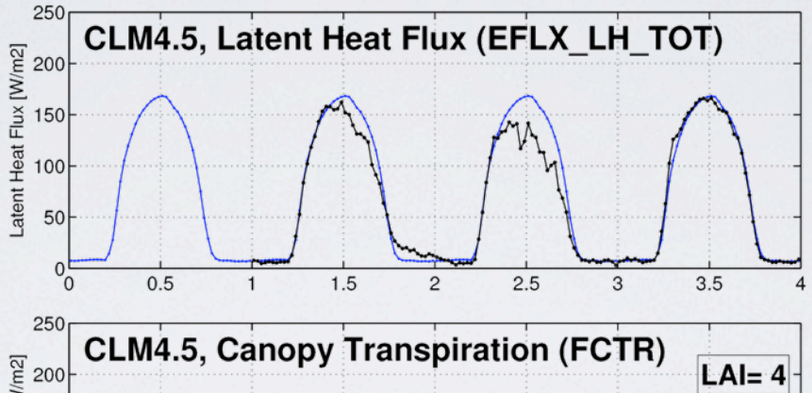
Latent Heat Flux Components of CLM4.5

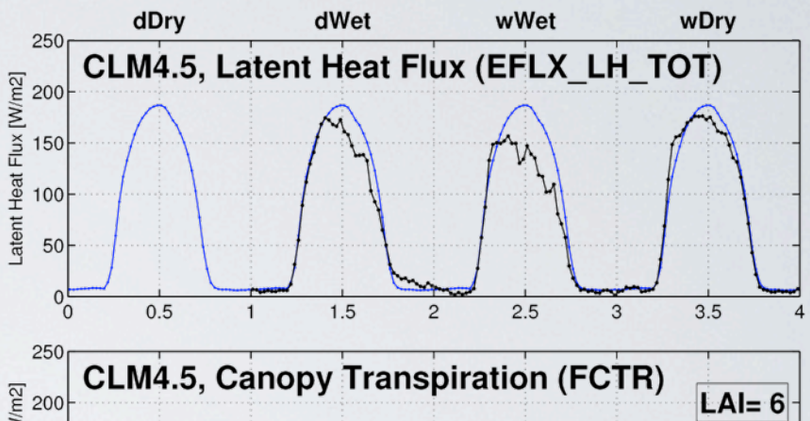
LAI = 2

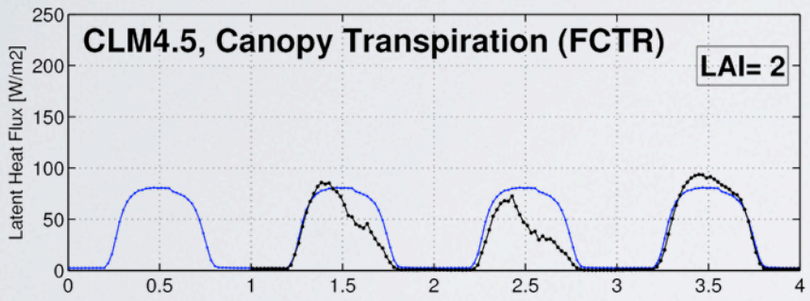
LAI = 6

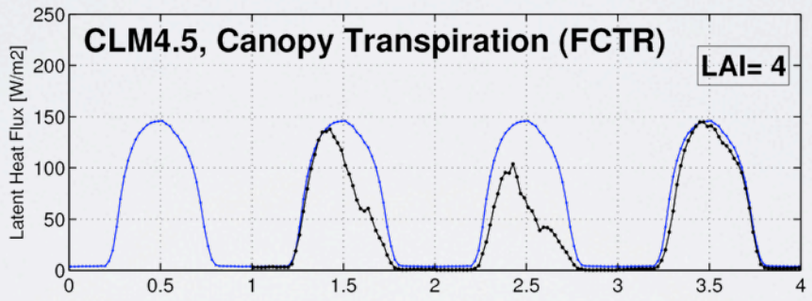


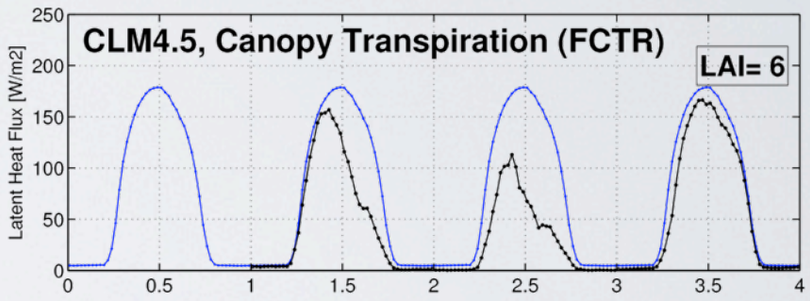


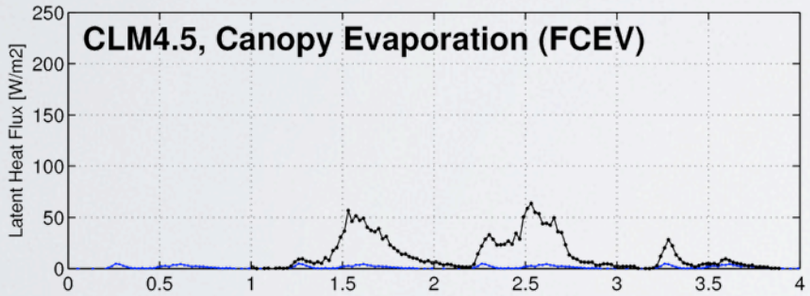


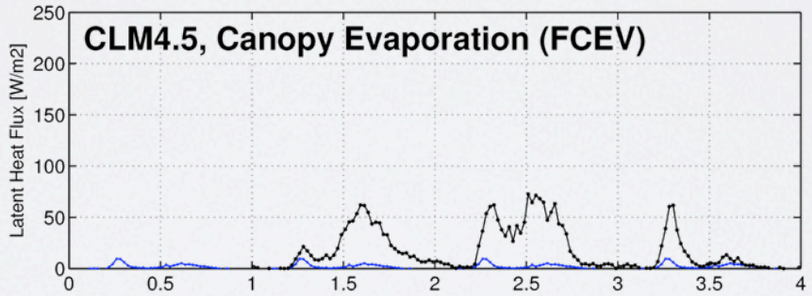


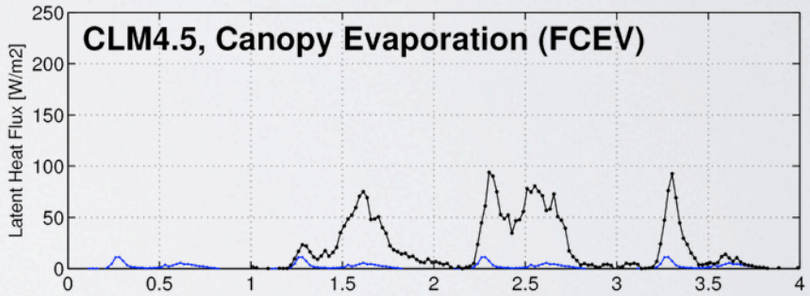


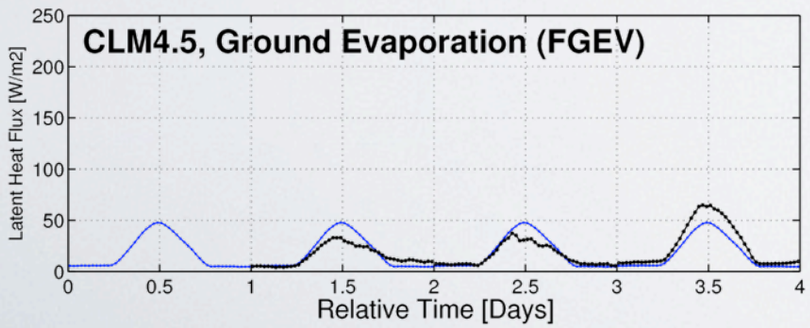


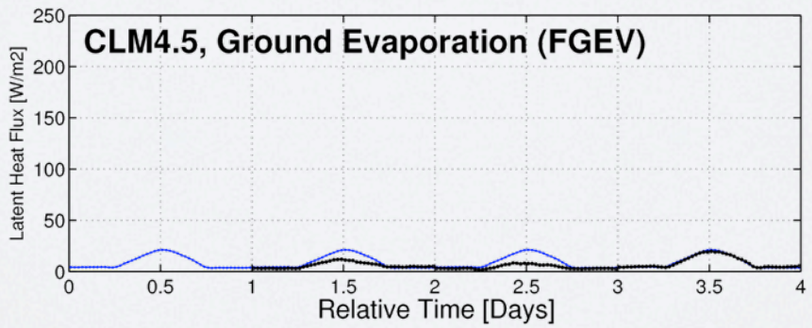


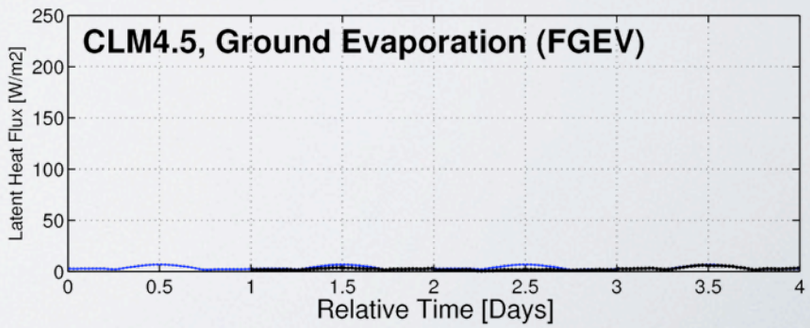








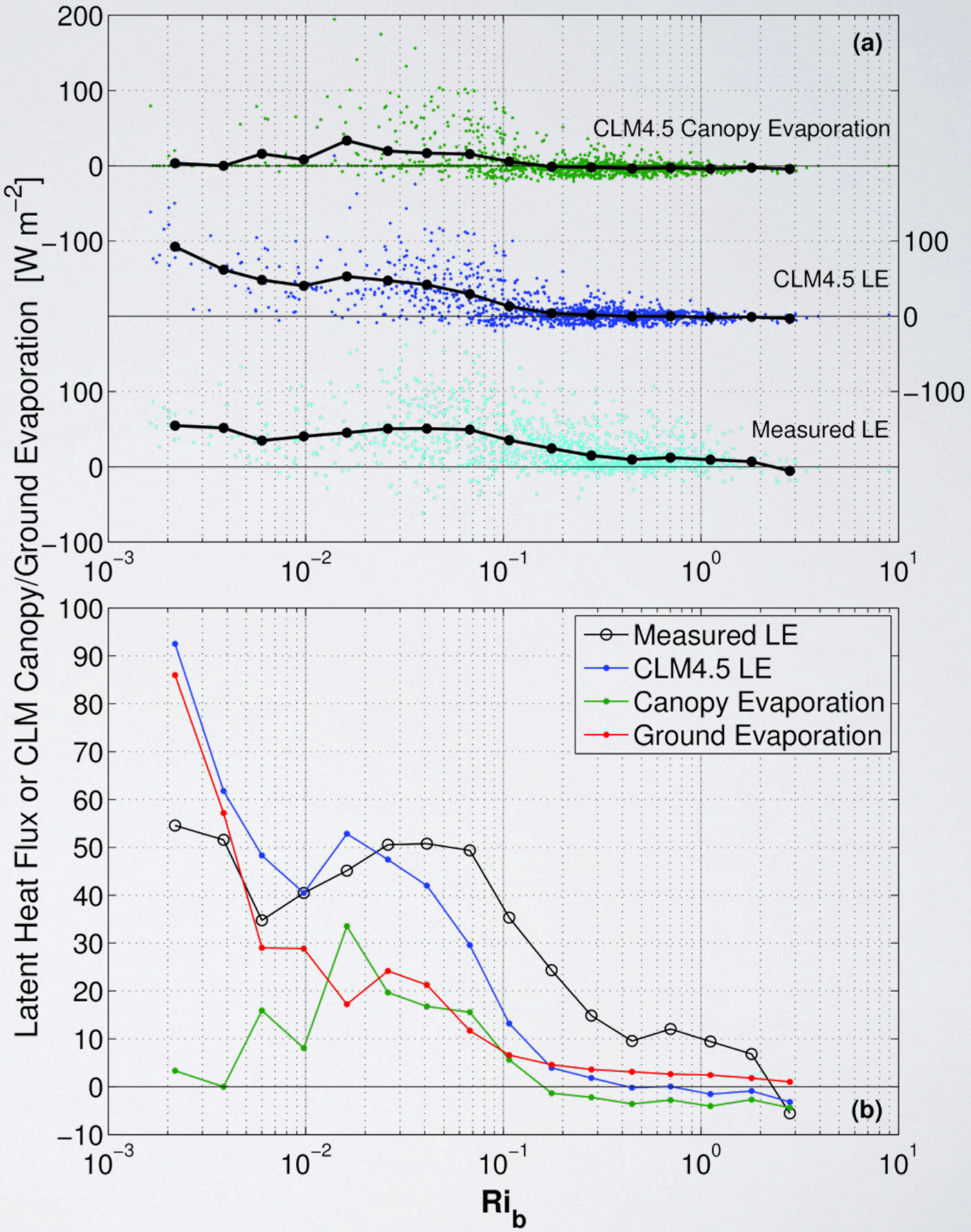




Latent Heat Flux vs Stability

*** Latent Heat Flux vs bulk Richardson Number (Ri_b)**

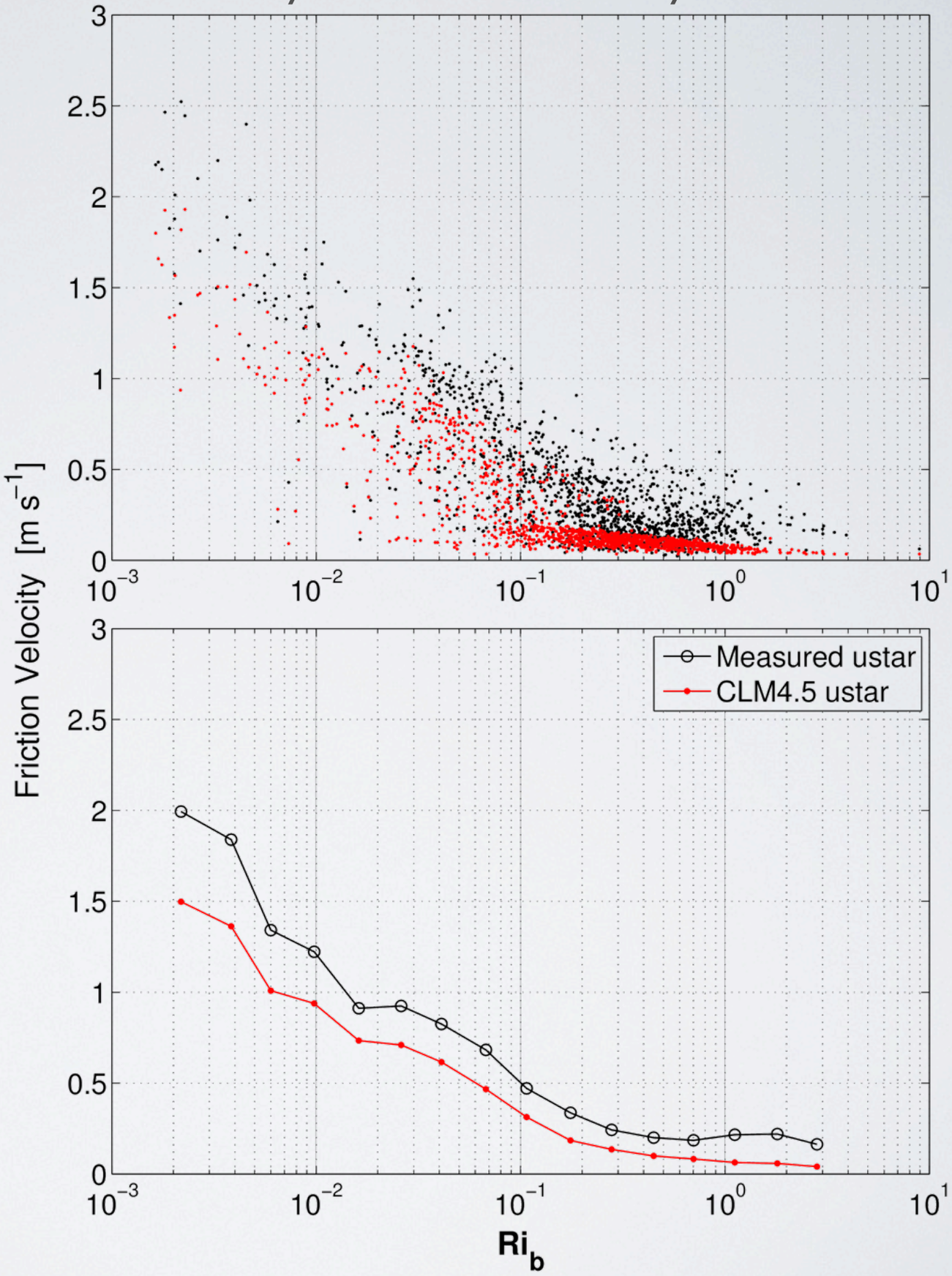
*** wDry periods between 0-4 LST**



Friction Velocity vs Stability

*** ustar vs bulk Richardson Number (Ri_b)**

*** wDry periods between 0-4 LST**



Latent Heat Flux vs Stability (w/ u* increase)

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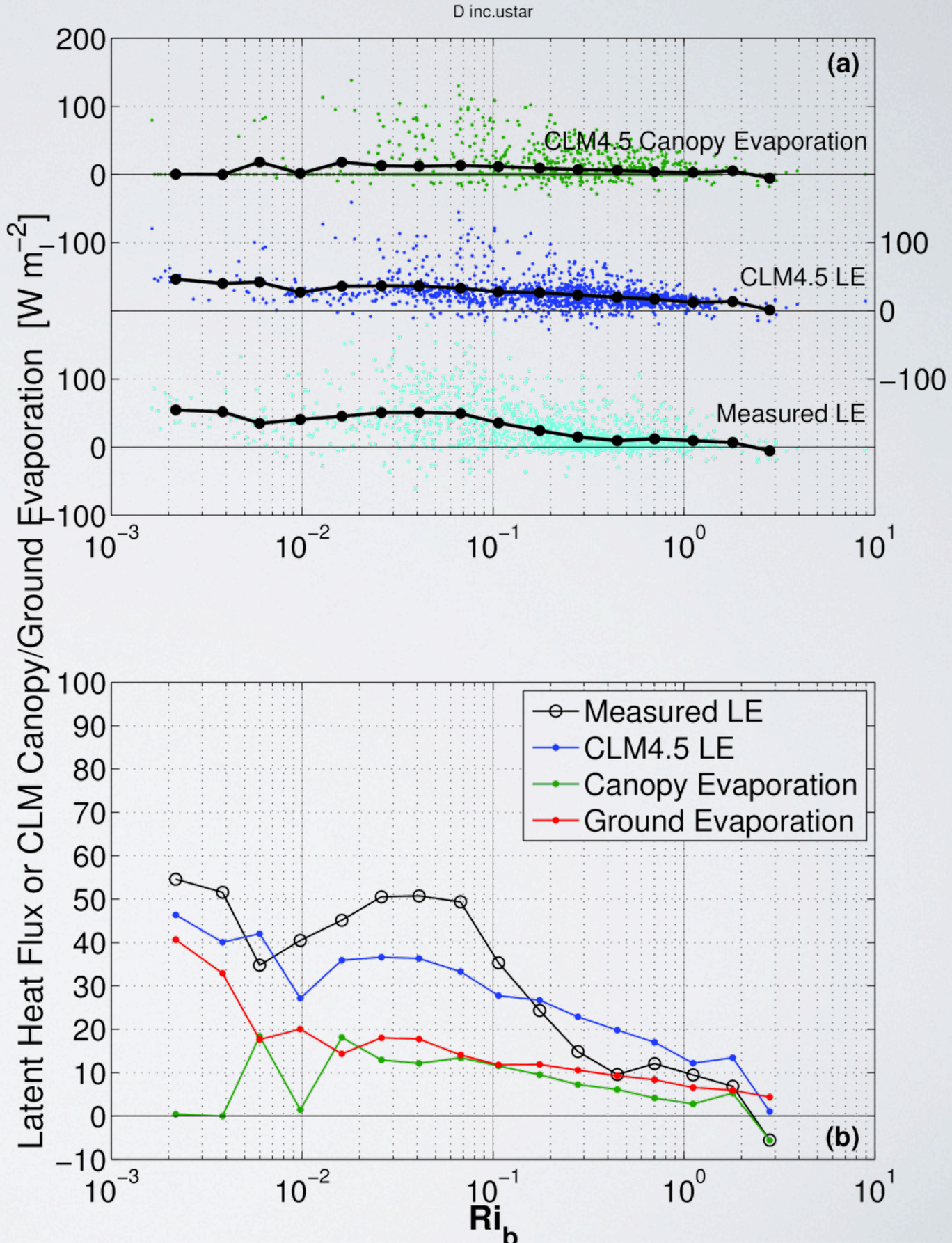
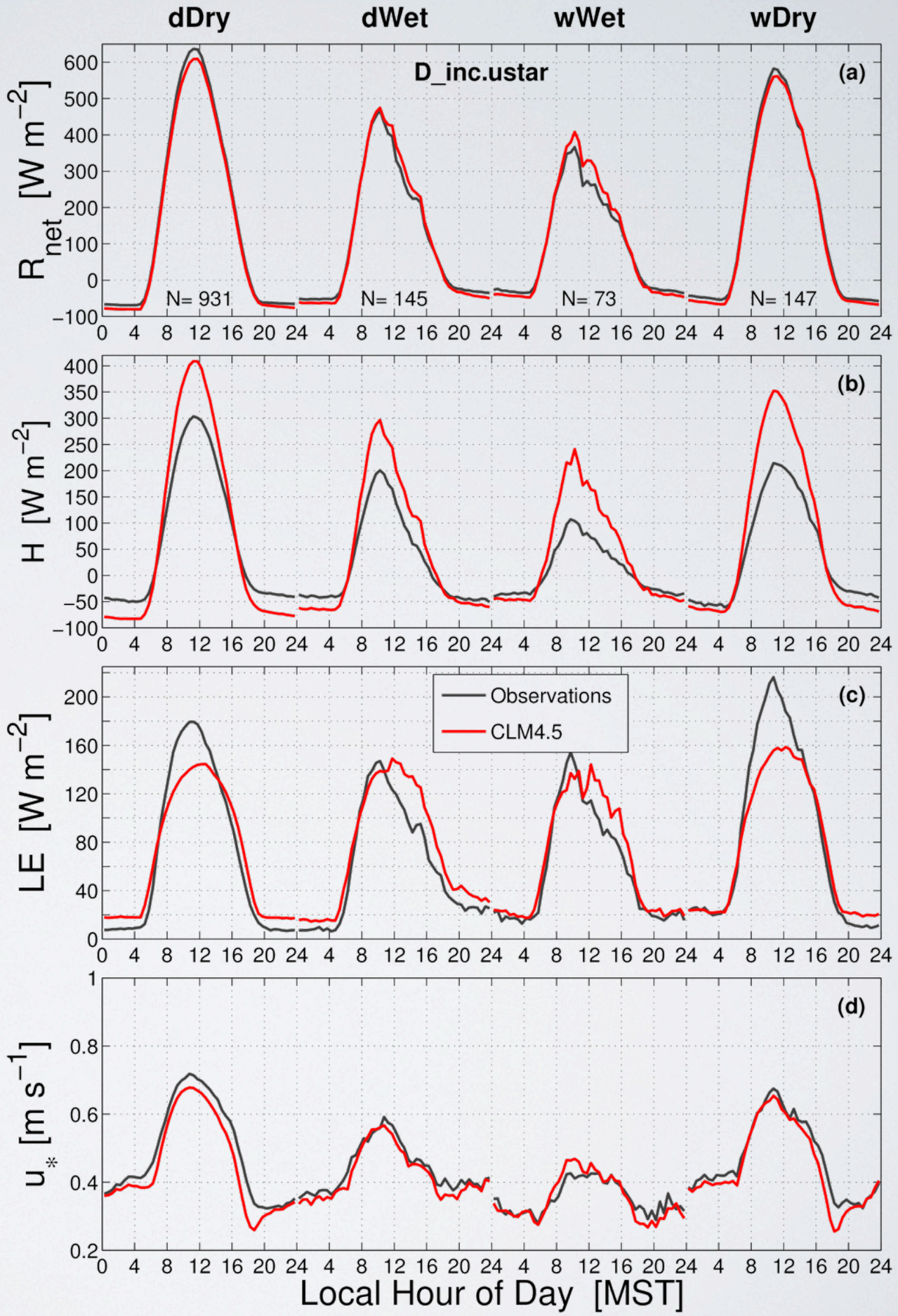


Observations versus CLM

*** CLM results with an ad-hoc increase to u* of 0.2 m/s**



Conclusions and Future Plans

- In partially-wet (wDry) conditions, observations show an increase in mid-day latent heat flux that is not reproduced in CLM LE (for LAI≈ 4).
- At night: (1) CLM ground and canopy evaporation are smaller than observed LE, (2) CLM friction velocity is smaller than the observations, (3) Suspect that low u_* is at least the partial cause of too small CLM soil and/or canopy evaporation.
- Ad-hoc increase to CLM ustar increases nocturnal LE, but for both wet and dry conditions.
- Are results site specific? Repeat this analysis at another "less complicated" flux site (looked at Howland and Metolius)?
- M-O Similarity inappropriate in strongly stable conditions—what to use instead?
- What results would be achieved using a continuous, multi-level canopy model (e.g., ACASA)?

COMMENTS/QUESTIONS?

sean@ucar.edu

Latent Heat Flux Comparison: CLM vs Obs