

# **Land-Surface Characteristics and Mesoscale Predictability over the MATERHORN Study Region**

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**Based on work led by....**

**Jeff Massey**

**Collaborators**

**Jason Knievel, Sebastian Hoch, Will Cheng, Eric Pardyjak, and Derek Jensen**

**Sponsor**

**Office of Naval Research**

# The Materhorn Proposal

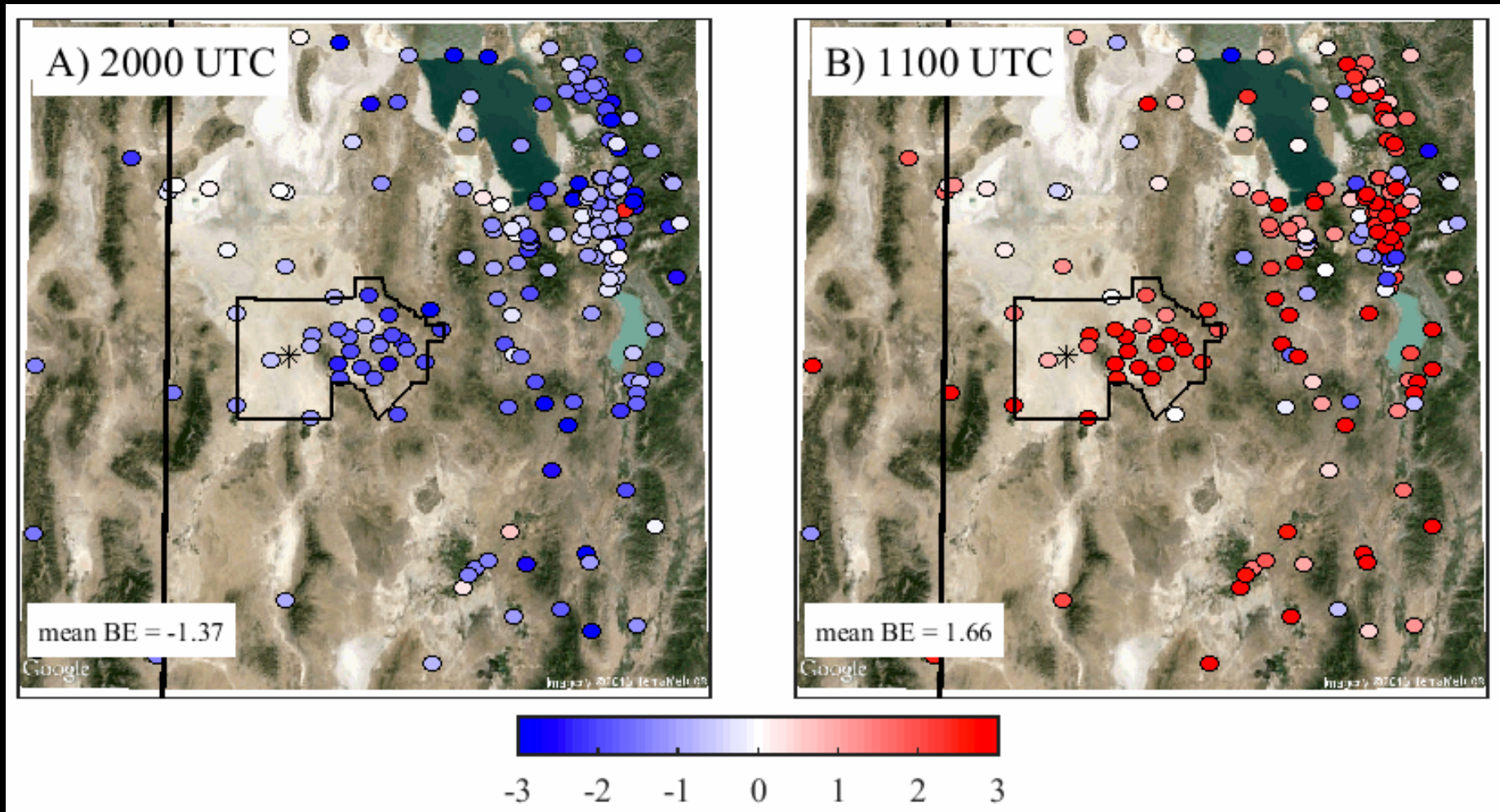
*“With the data collected during Intensive Operational Periods (IOPs), outputs of WRF and COAMPS will be verified and major deficiencies identified. Through validation and sensitivity results, we expect to determine the relative importance of systematic model error, local forcing uncertainties (e.g., topographic and land-surface characteristics) and analysis uncertainties in the prediction of local atmospheric conditions. These will form the basis of modifications to be proposed for WRF and COAMPS.”*

# The Problem

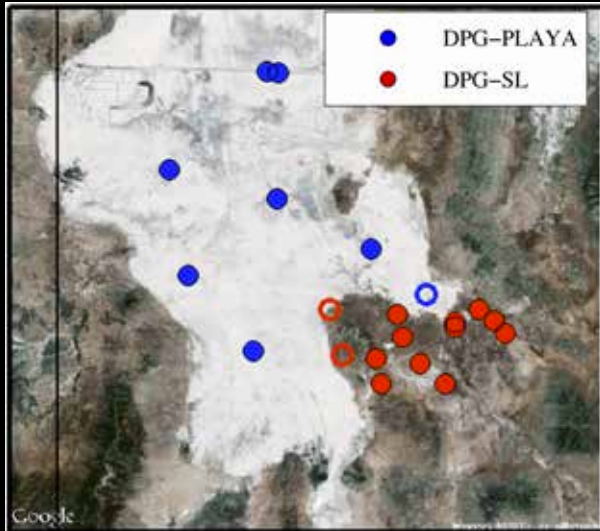
4DWX 8-month temperature biases

Afternoon

Morning



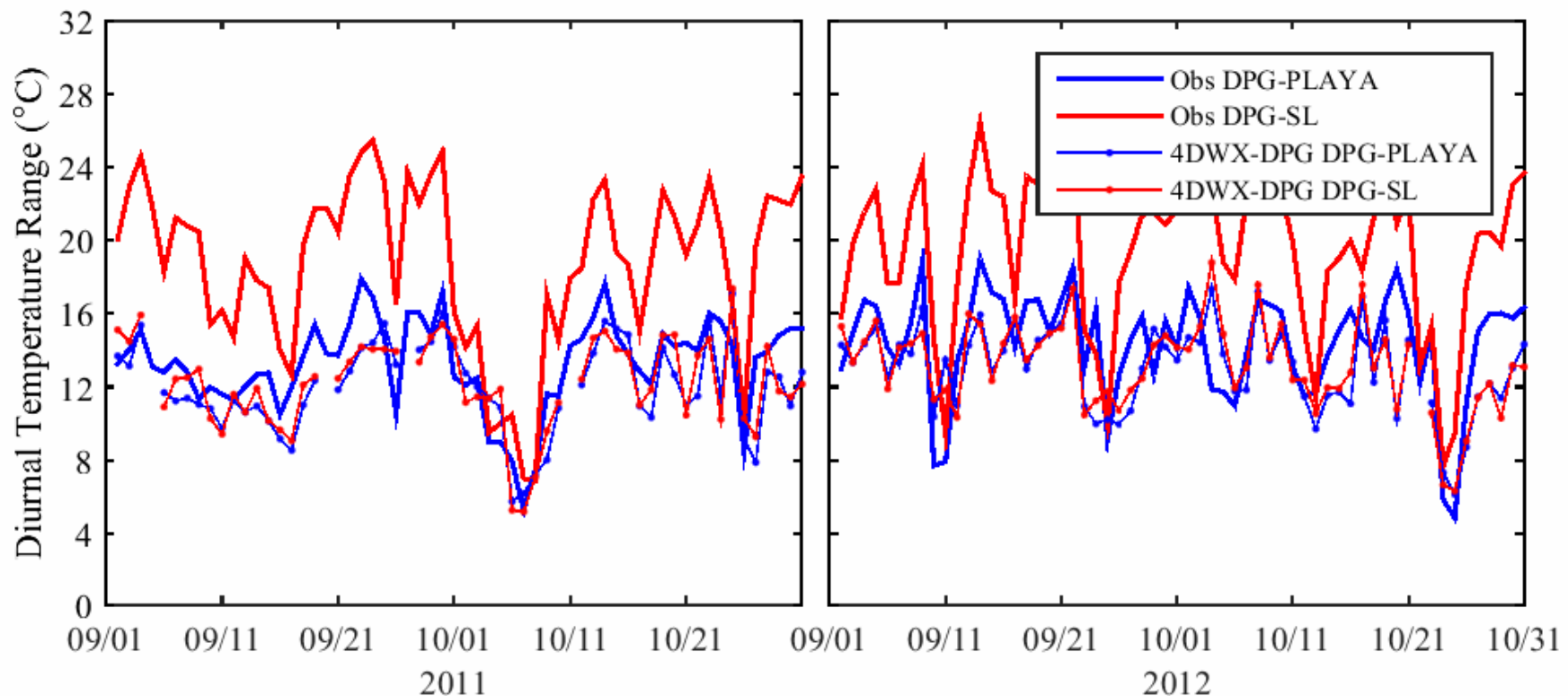
# The Problem



Biases smallest over playa, largest over “desert shrub”

Playa:  $T_{\max}$ ,  $T_{\min}$ , and Diurnal Temperature Range well simulated

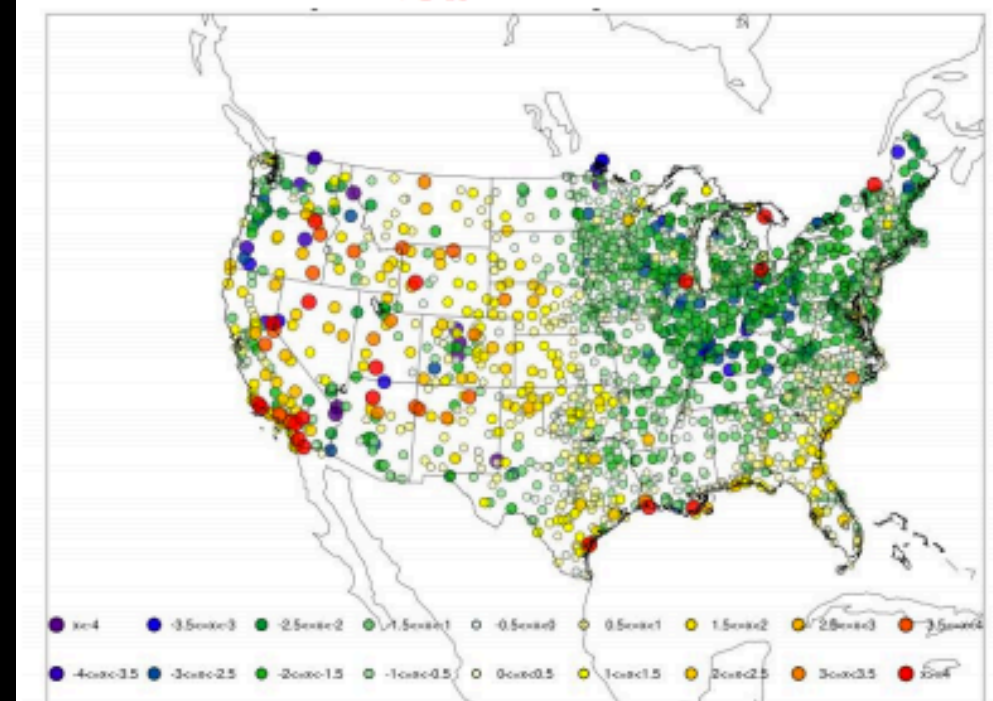
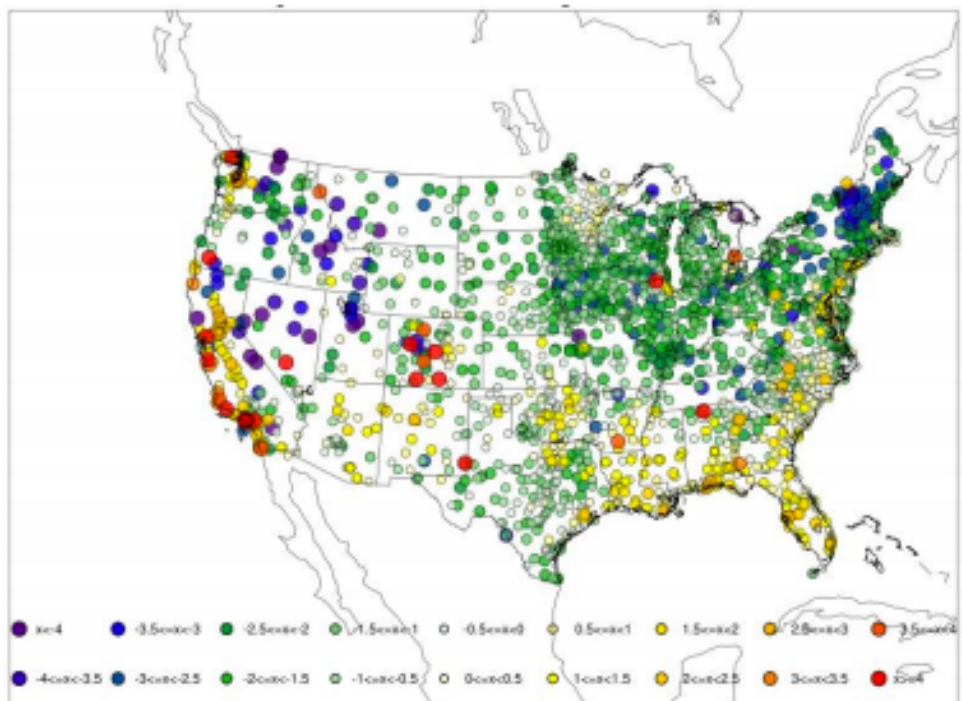
Desert Shrub: Diurnal Temperature Range underpredicted



# The Problem

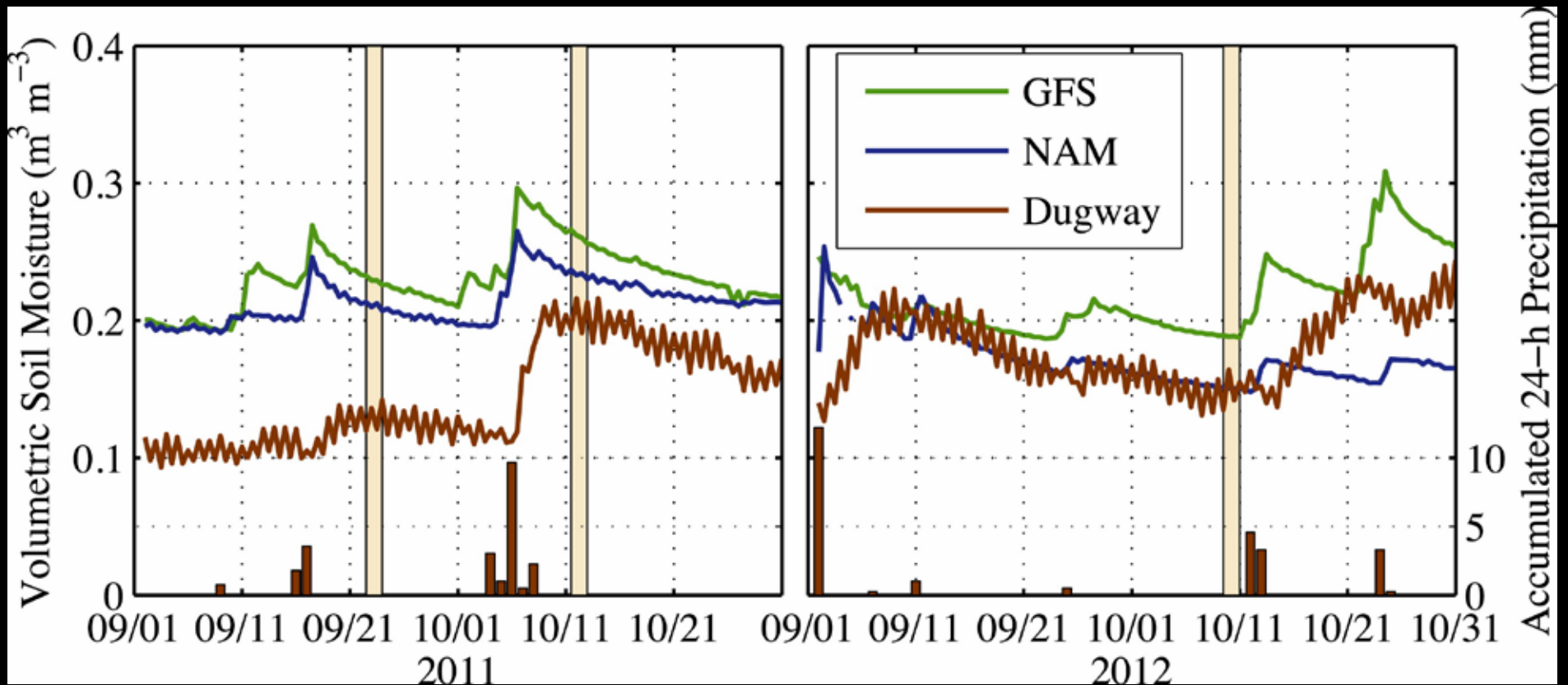
Afternoon – 0000 UTC

Morning – 1200 UTC



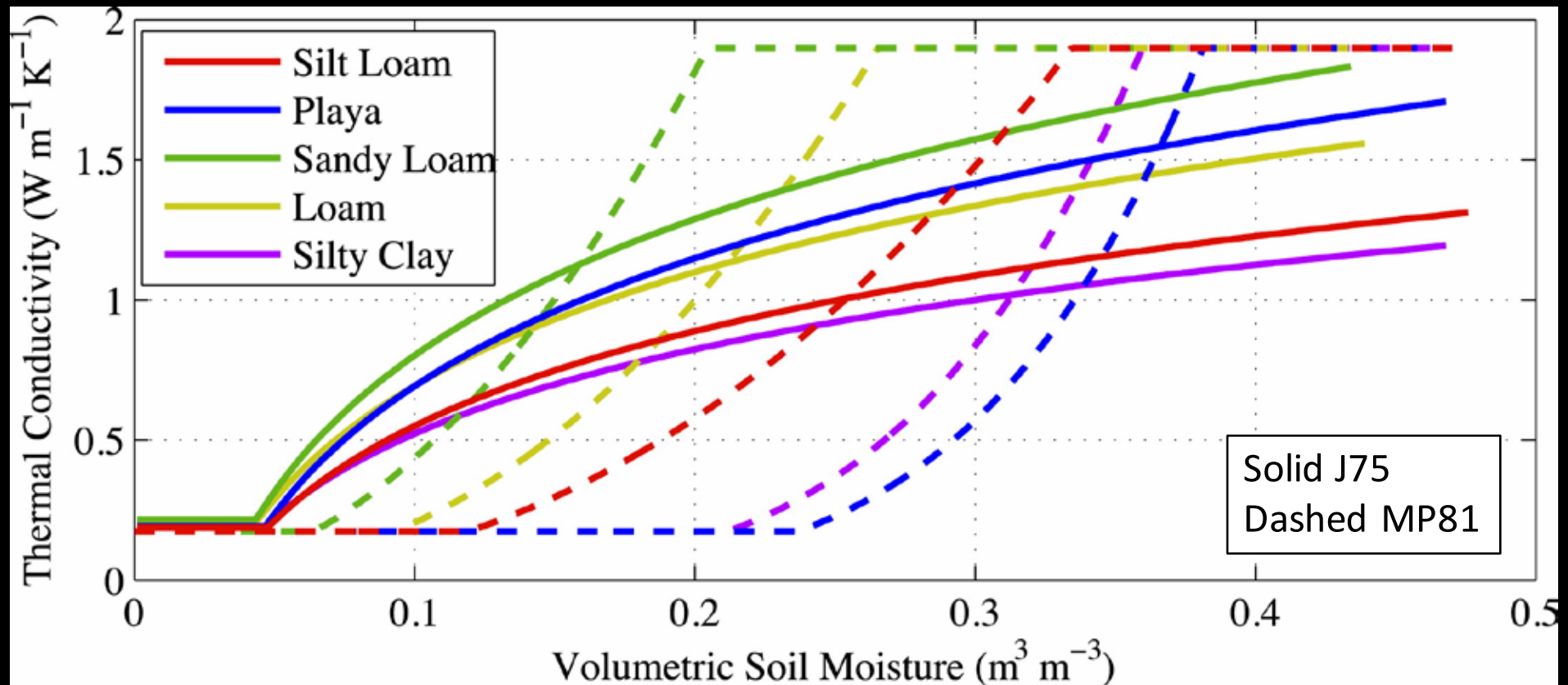
3-month WRF validation showing similar biases exist over much of interior west

# Major Contributors



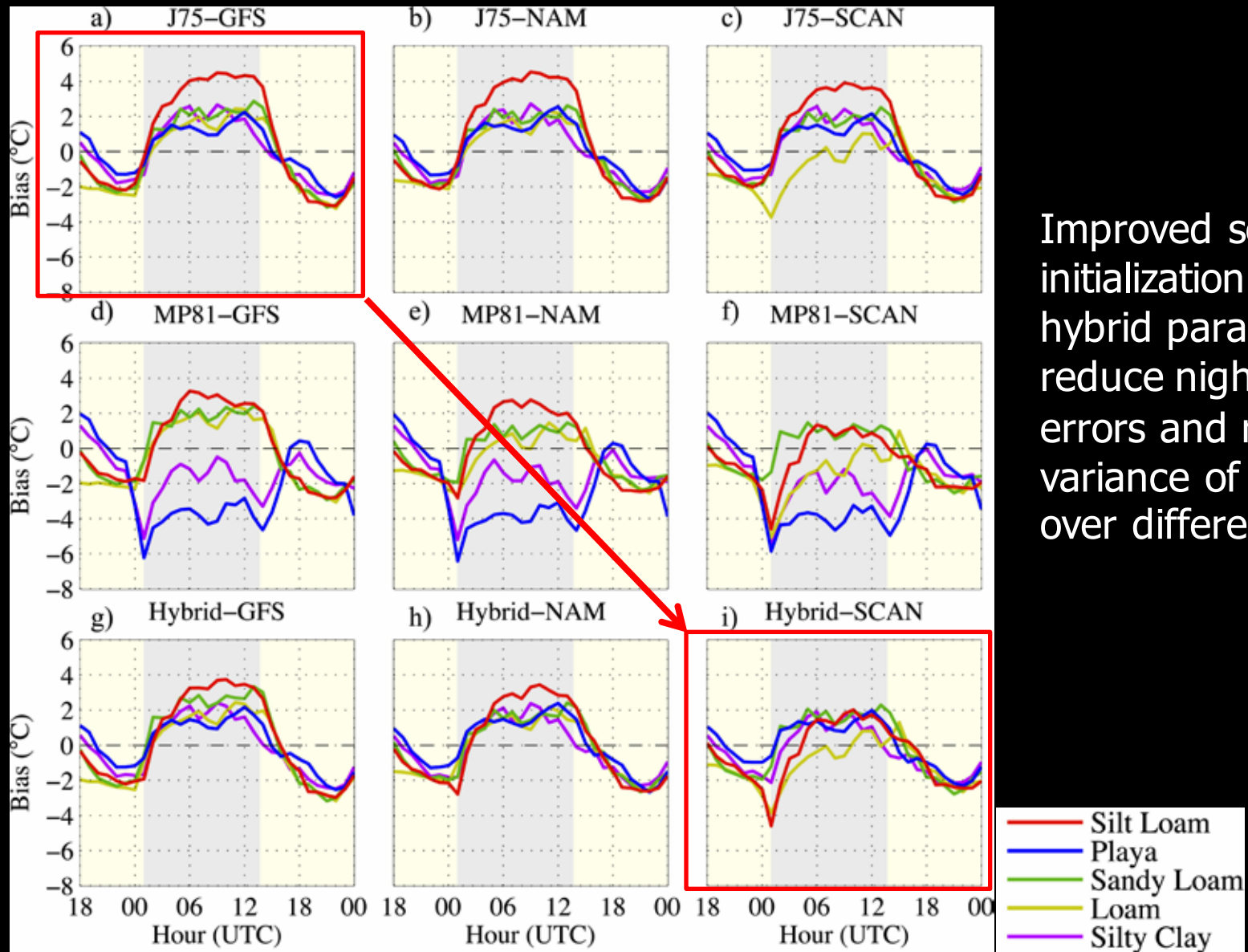
Systematic overprediction of soil moisture by operational models

# Major Contributors



Use of inappropriate parameterization (J75) of thermal conductivity for silt loam and sandy loam soils

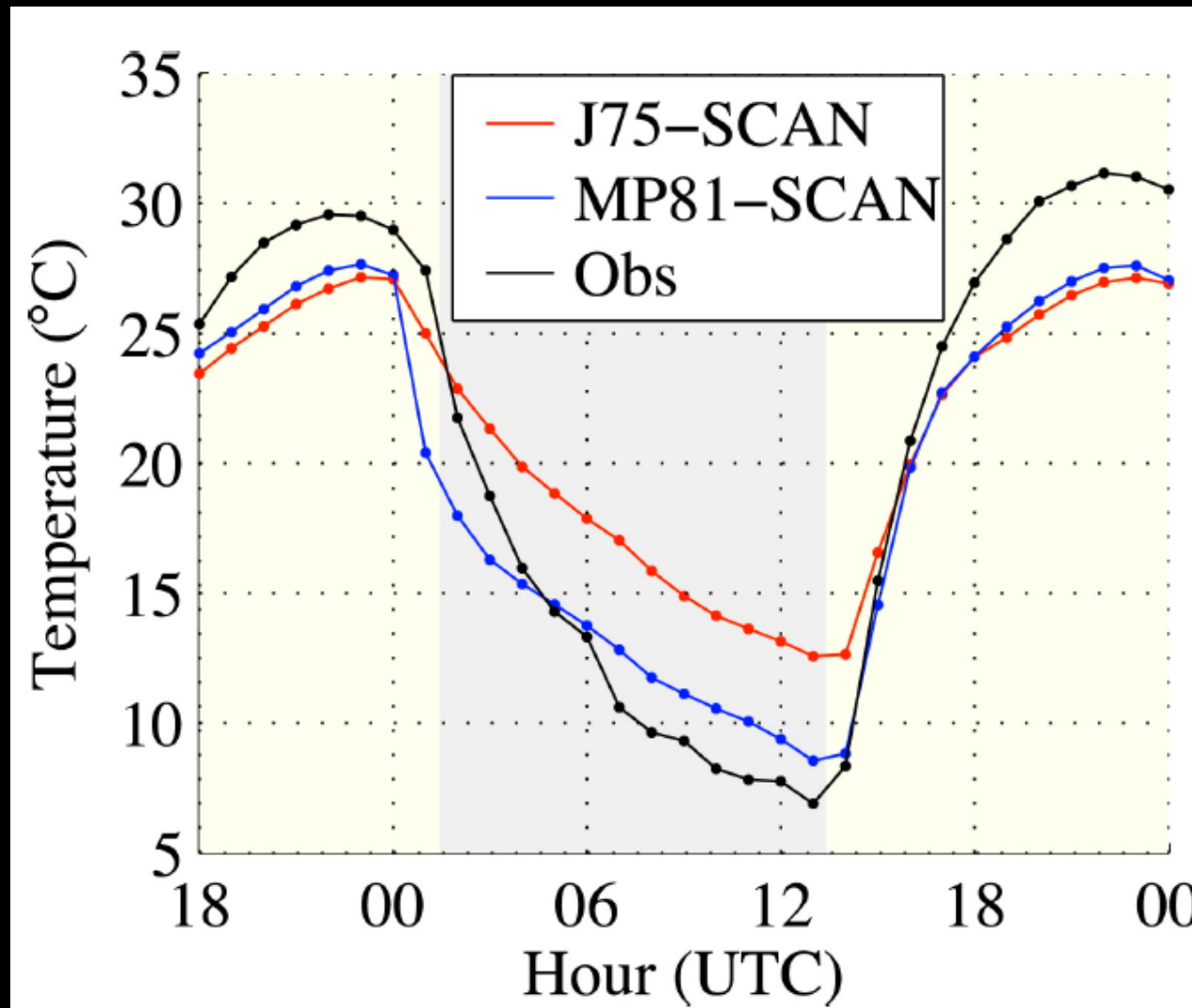
# Case Study



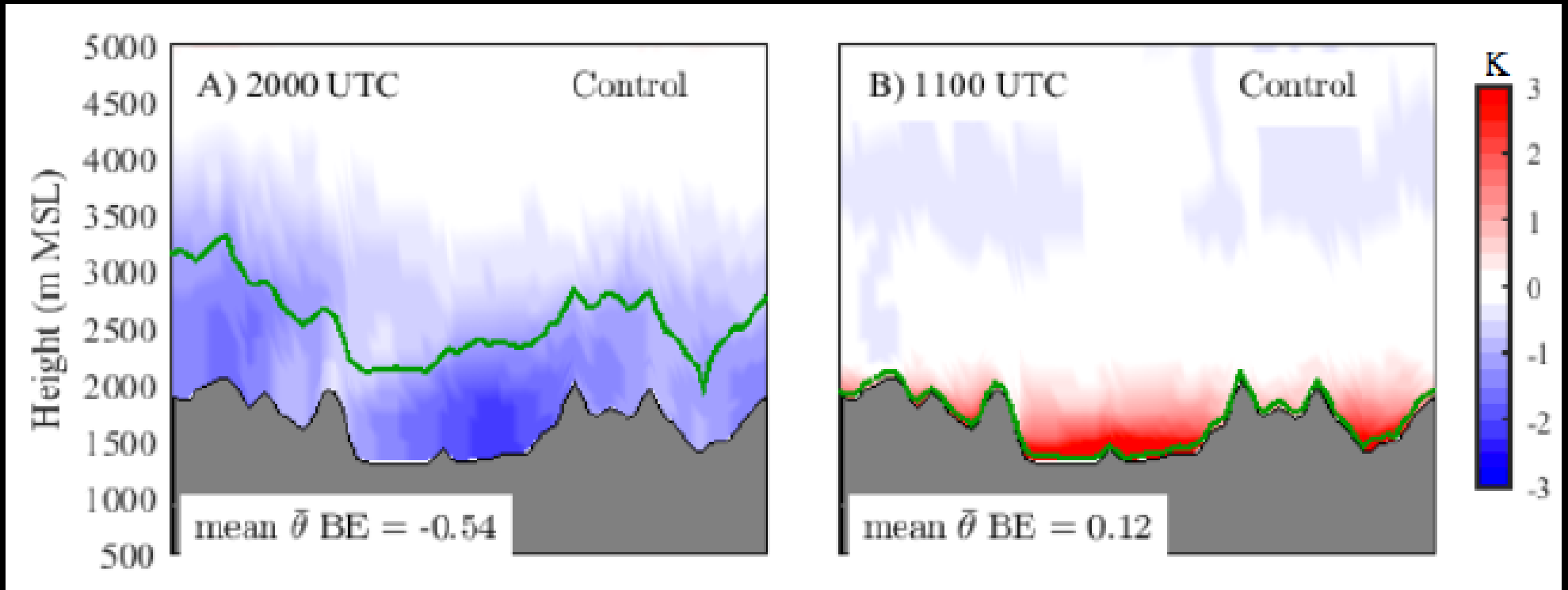
Improved soil moisture initialization and the hybrid parameterization reduce nighttime bias errors and reduce the variance of bias errors over different soil types



# Less Afternoon Bias Improvement



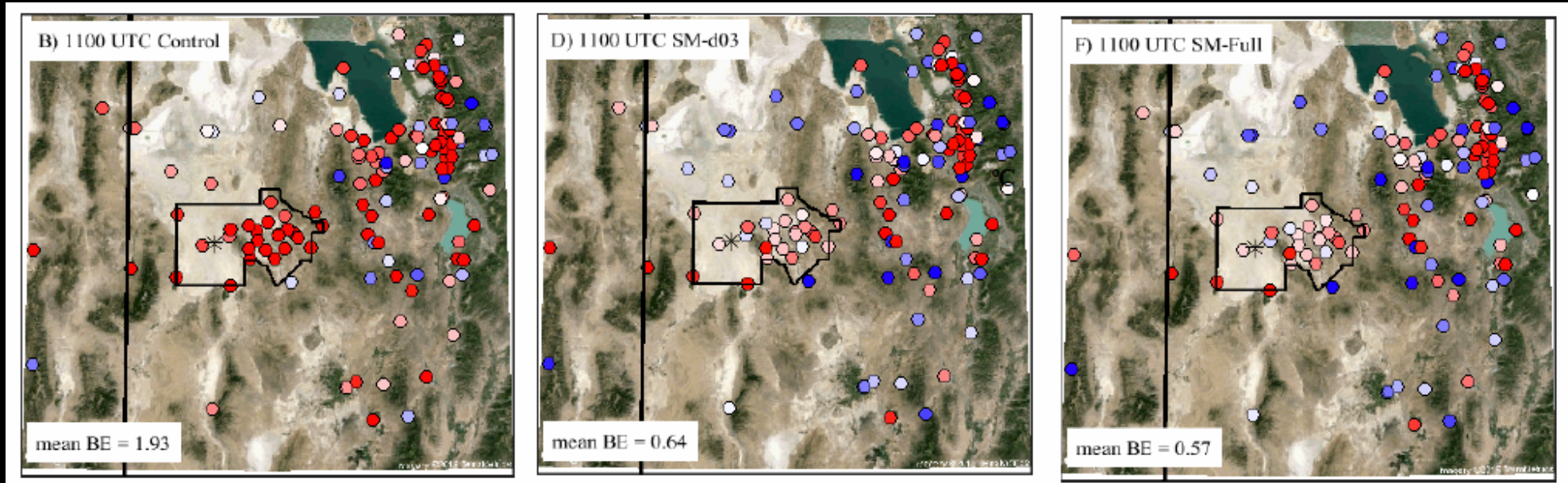
# Why?



Afternoon bias is a regional effect

Morning bias is a local effect

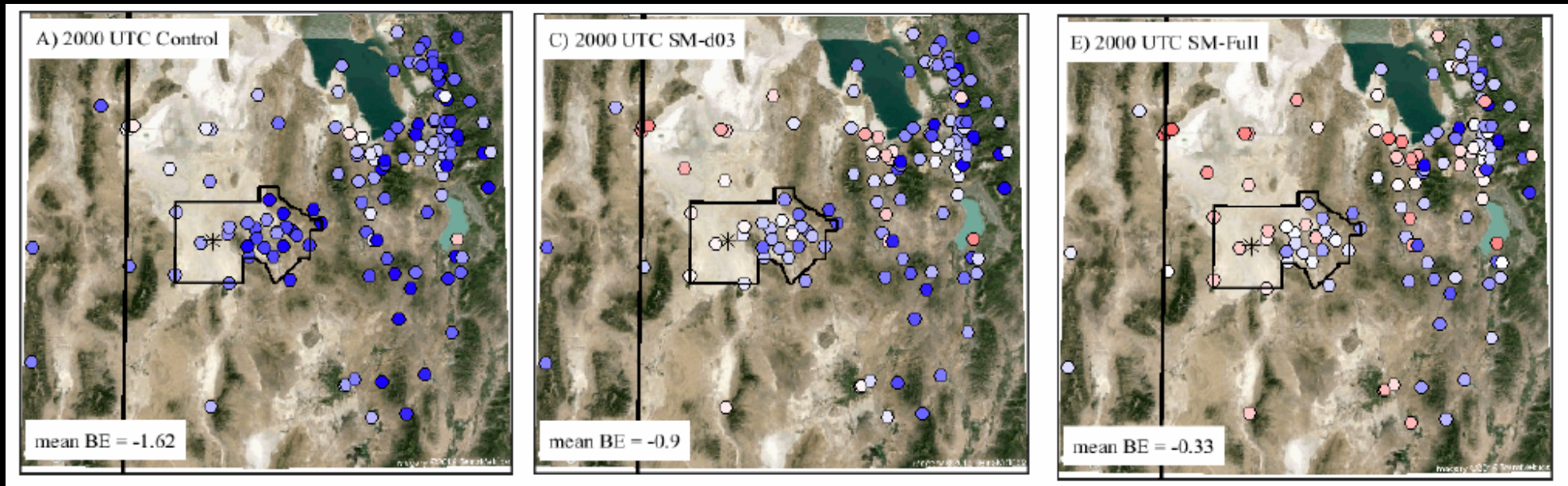
# Nighttime: Local



Control → D03 Only → ~~Entire Great Basin~~

Nighttime warm bias improves most  
with corrections only to domain 3 (DPG area)

# Daytime: Regional



Control



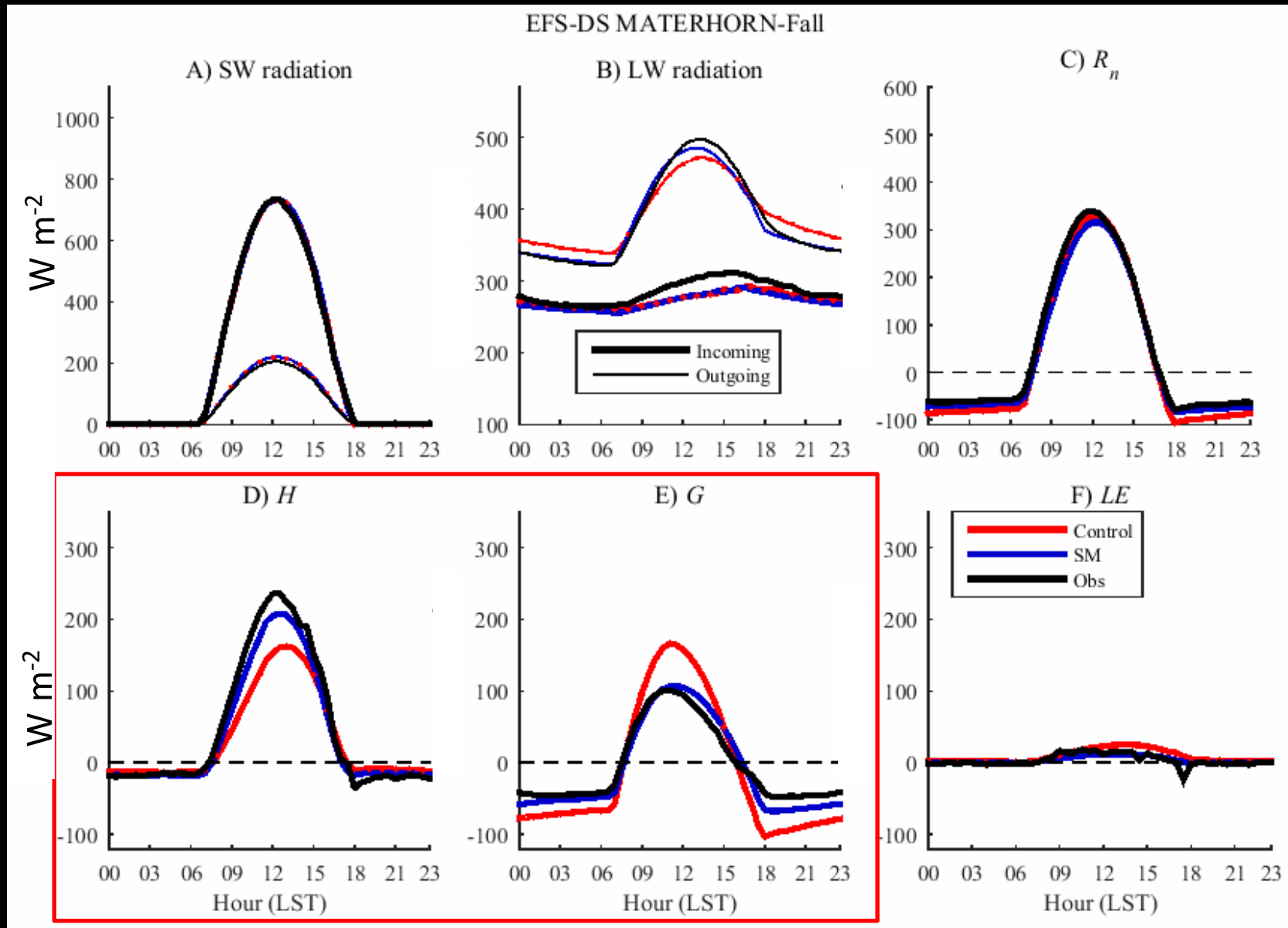
D03 Only



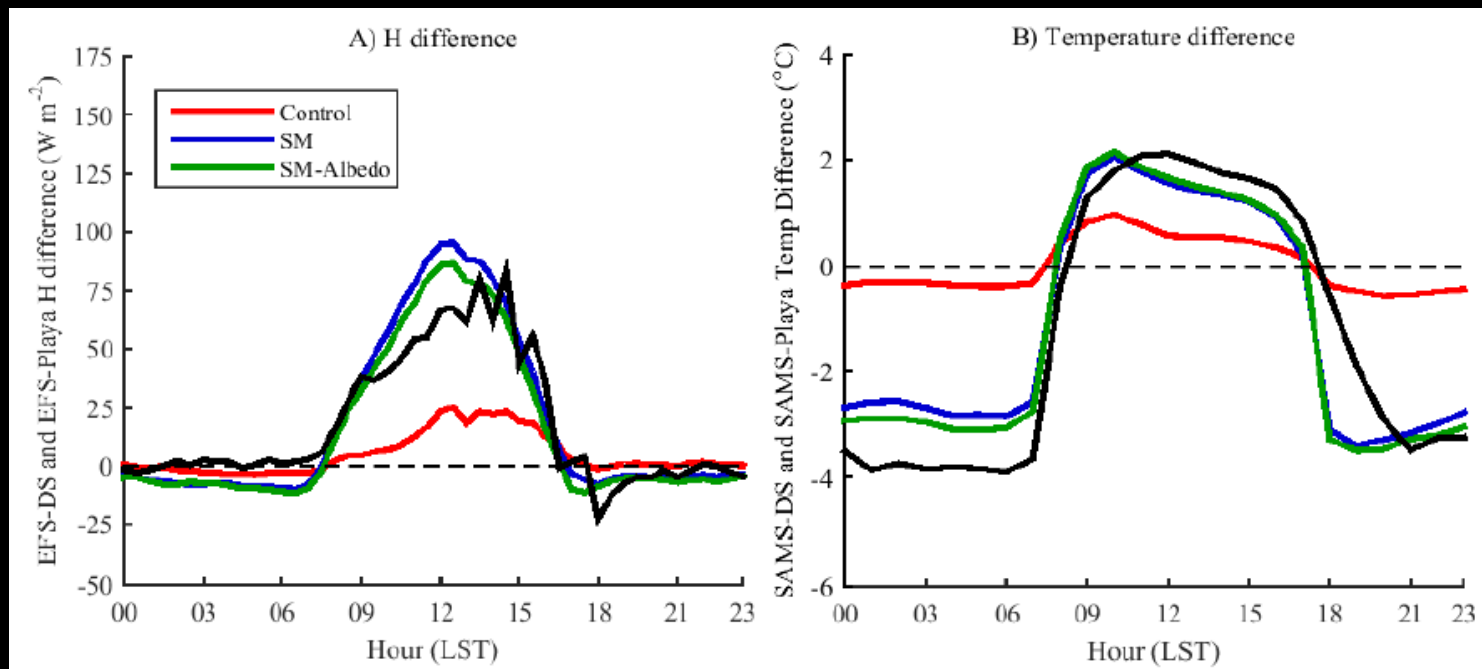
Entire Great Basin

Daytime warm bias affected by local and regional soil moisture analysis and parameterization

# Surface Energy Balance

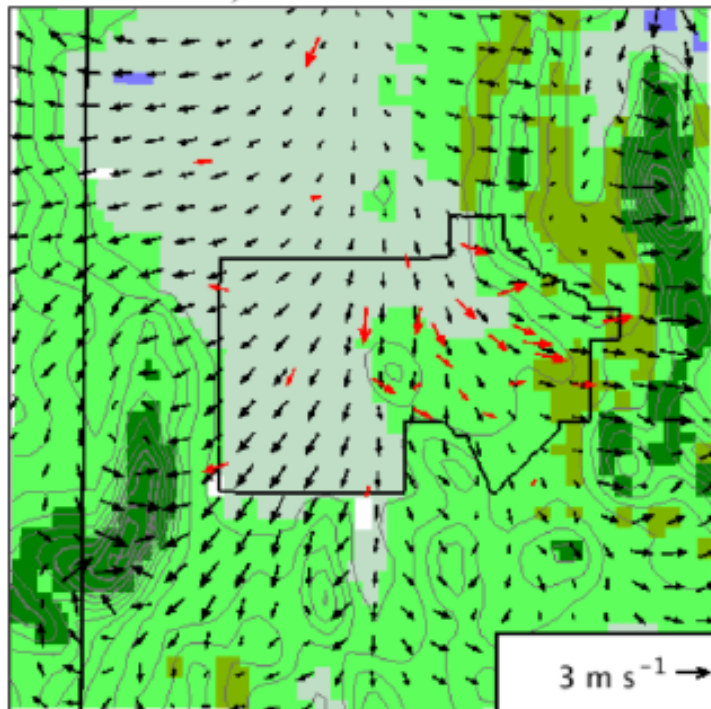


# Influence on Thermally Driven Flows

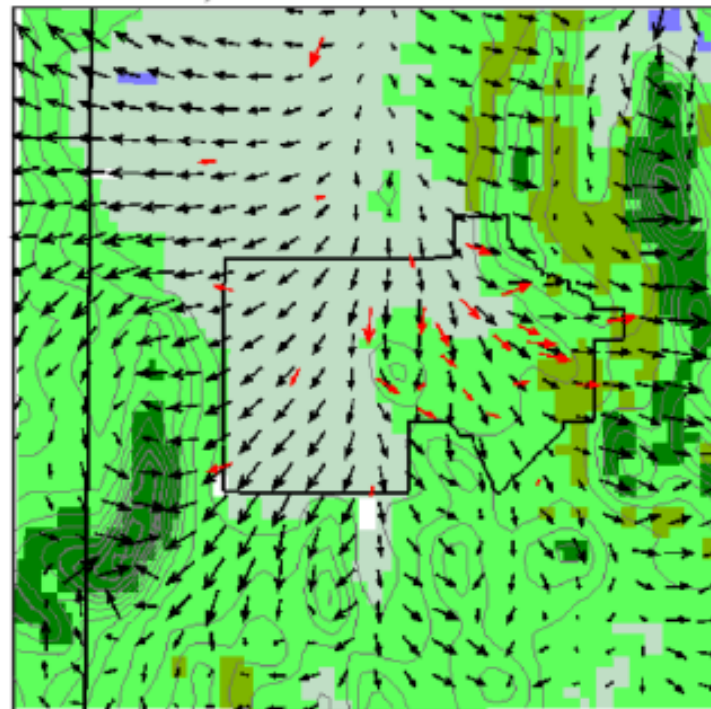


Daytime

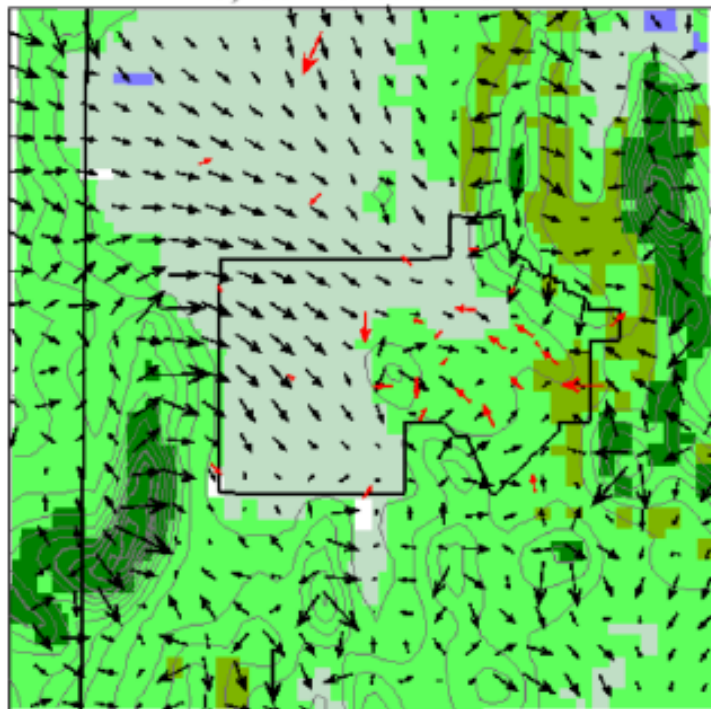
A) Control 1400 LST



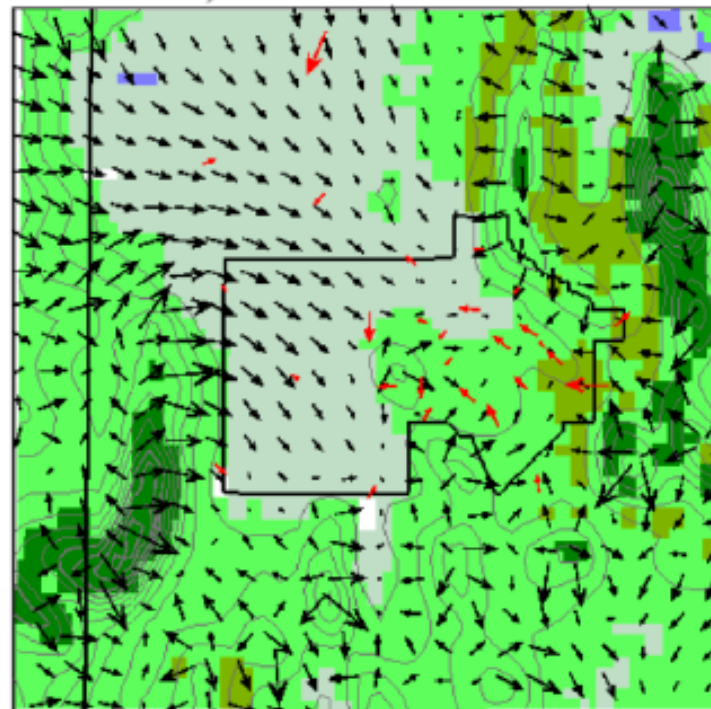
B) SM-Albedo 1400 LST



C) Control 0500 LST



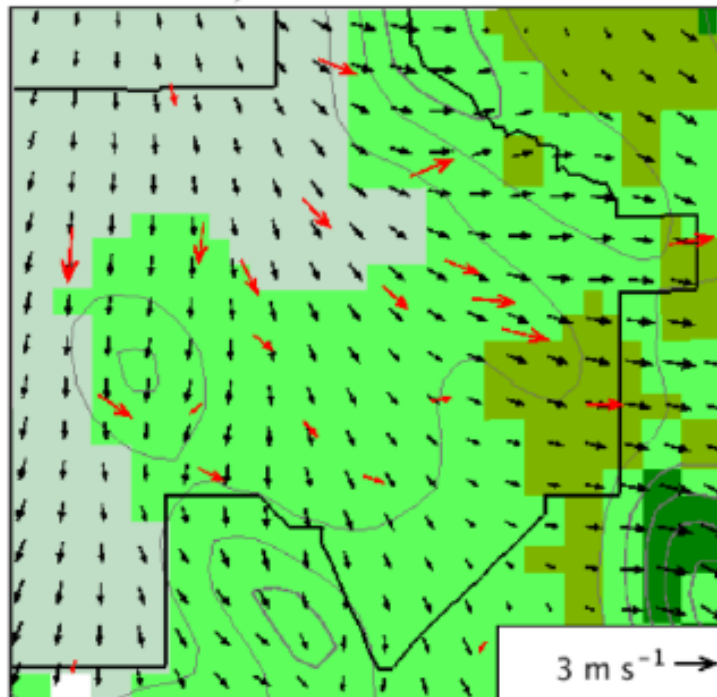
D) SM-Albedo 0500 LST



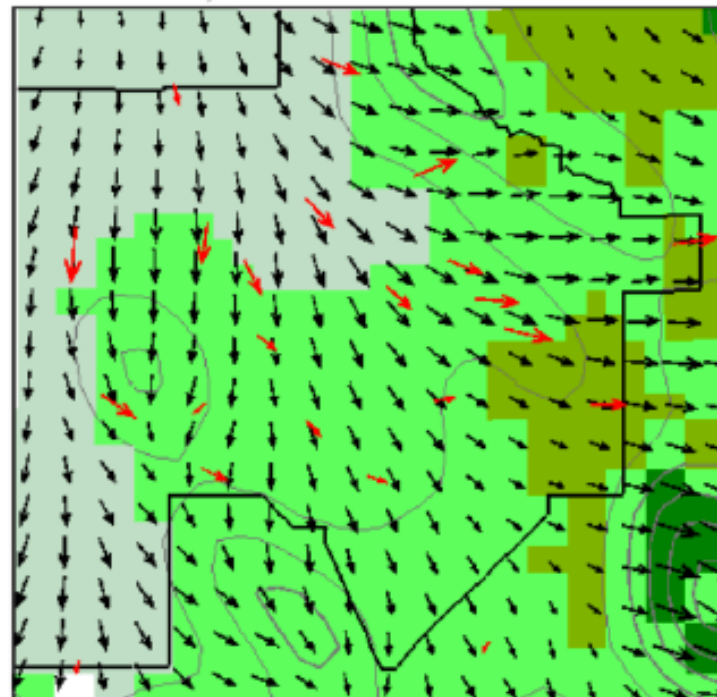
Nighttime

Daytime

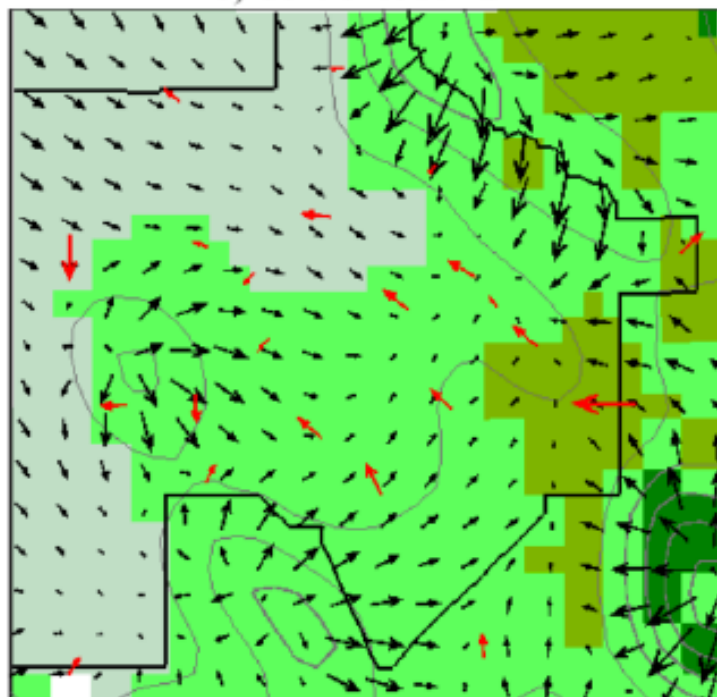
A) Control 1400 LST



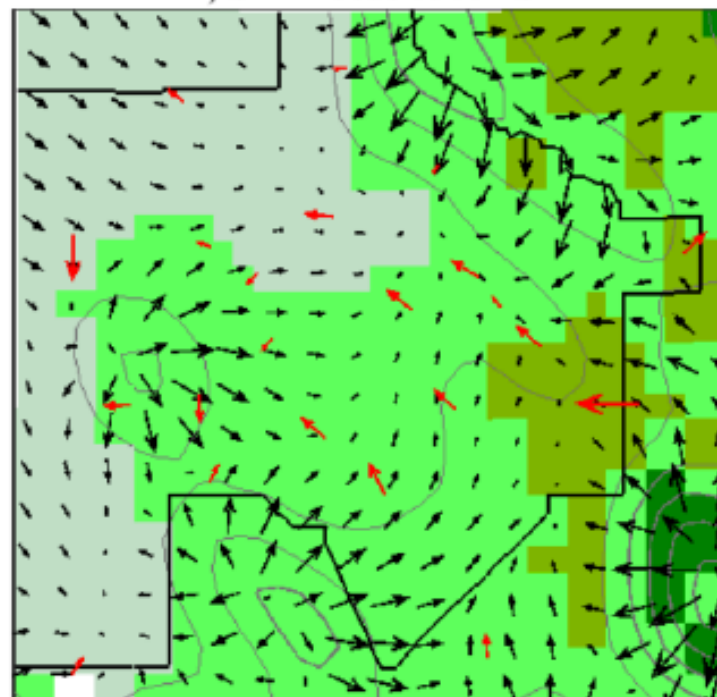
B) SM-Albedo 1400 LST



C) Control 0500 LST



D) SM-Albedo 0500 LST



Nighttime

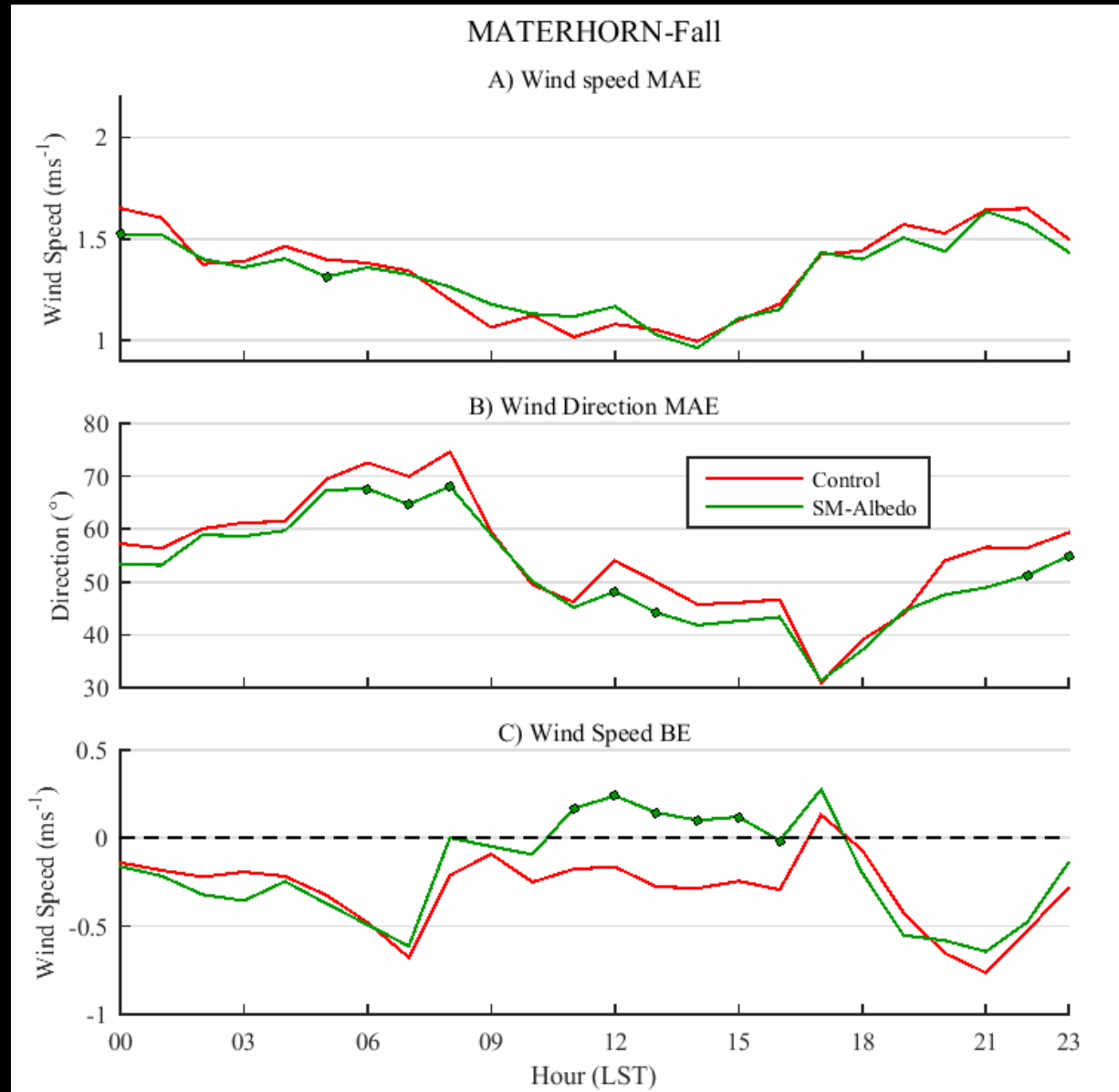


# Mean Wind Errors

Little wind speed improvement  
(MAE)

Minor wind direction improvement  
(significant only @ a few hours)

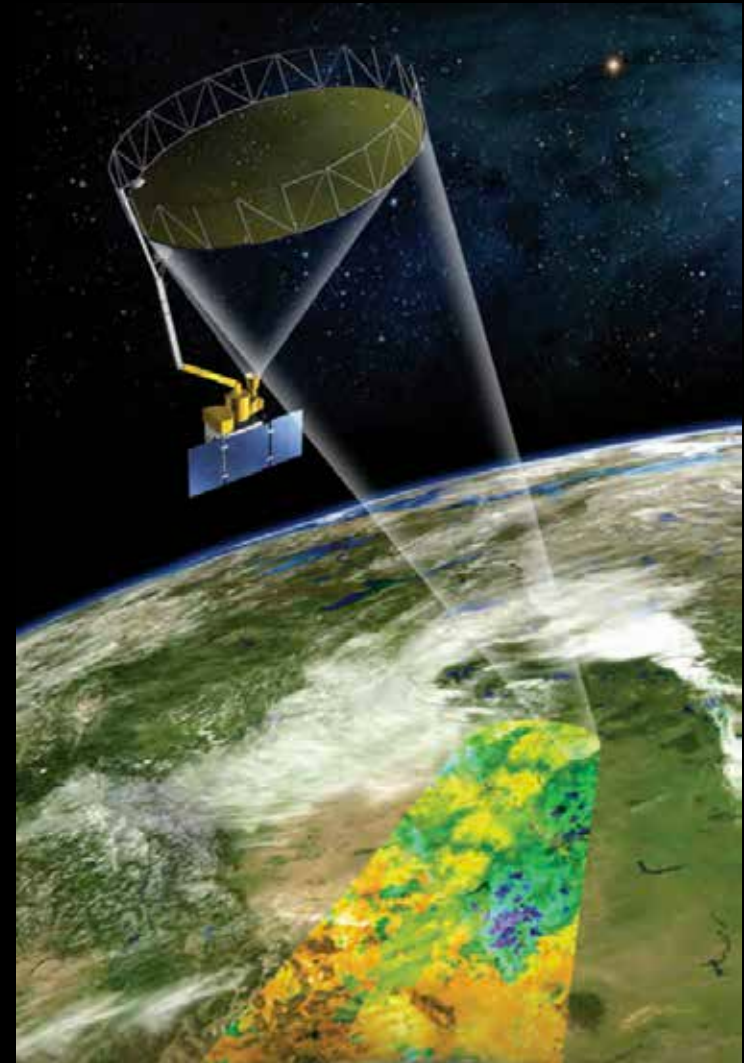
Improvement in wind speed  
bias error in afternoon  
(some “overshoot”)



# Summary

- WRF exhibits pronounced nighttime warm bias and daytime cold bias over desert shrub region
  - Playa biases much smaller
- Can be improved using observed soil moisture & the MP81 thermal conductivity parameterization in silt loam and sandy loam soils
- Nighttime improved by better “local” soil moisture analyses
- Daytime improvement requires local and regional soil moisture analyses
- Improving local wind forecasts is a tougher nut to crack

# Future Complications...



NASA Soil Moisture Active Passive Mission  
(SMAP)

# Gory Details

- Massey, J. D., W. J. Steenburgh, S. W. Hoch, and J. C. Knievel, 2014: Sensitivity of near-surface temperature forecasts to soil properties over a sparsely vegetated dryland region. *J. Appl. Meteor. Clim.*, **53**, 1976-1995.
- Massey, J. D., W. J. Steenburgh, J. C. Knievel, and W. Y. Y. Cheng, 2015: Regional soil-moisture biases and their influence on WRF model temperature forecasts over the Intermountain West. *Wea. Forecasting*, in review [Available on request].
- Massey, J. D., W. J. Steenburgh, S. W. Hoch, D. D. Jensen, and E. R. Pardyjak, 2016: Simulated and observed surface energy balance contrasts and resulting playa breezes during the Materhorn field campaigns. Coming soon!