

Use of the regionally-refined CAM-SE for simulations of North American climate

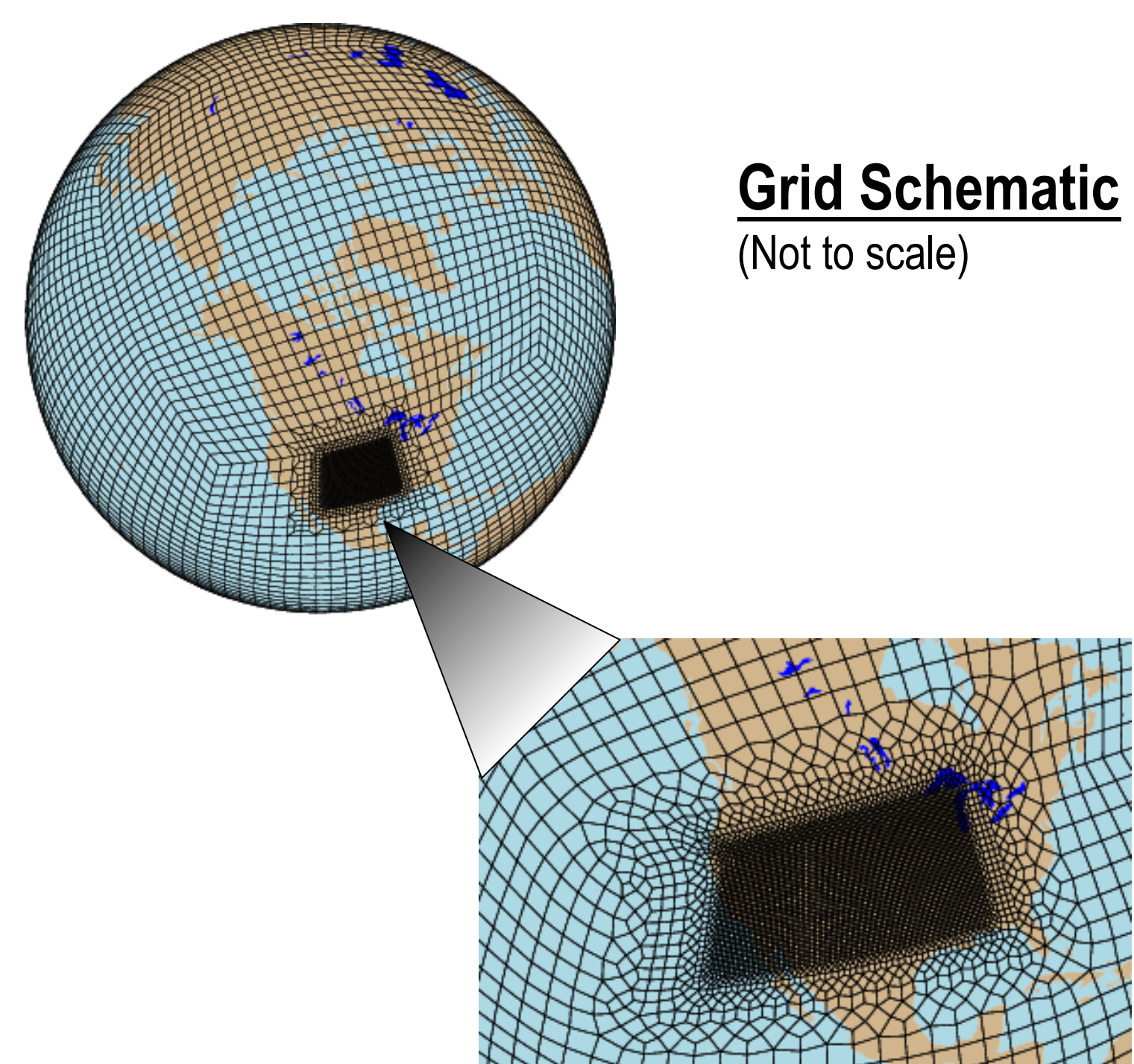
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Introduction

- A global model with regional refinement might be a good model to explore the characteristics of the climate simulation at high-resolution without the computational expense of running high-resolution globally
- But the question remains how much does the behavior in the regional-refined portion of the model characterize the behavior of a uniform high-resolution model?
- Extending previous work for aqua-planets and tropical cyclones (Zarzycki et al. 2014a, 2014b), we explore the ability of the CAM-Spectral Element to simulate North American Climate

Regionally-Refined CAM With the Spectral Element Dycore

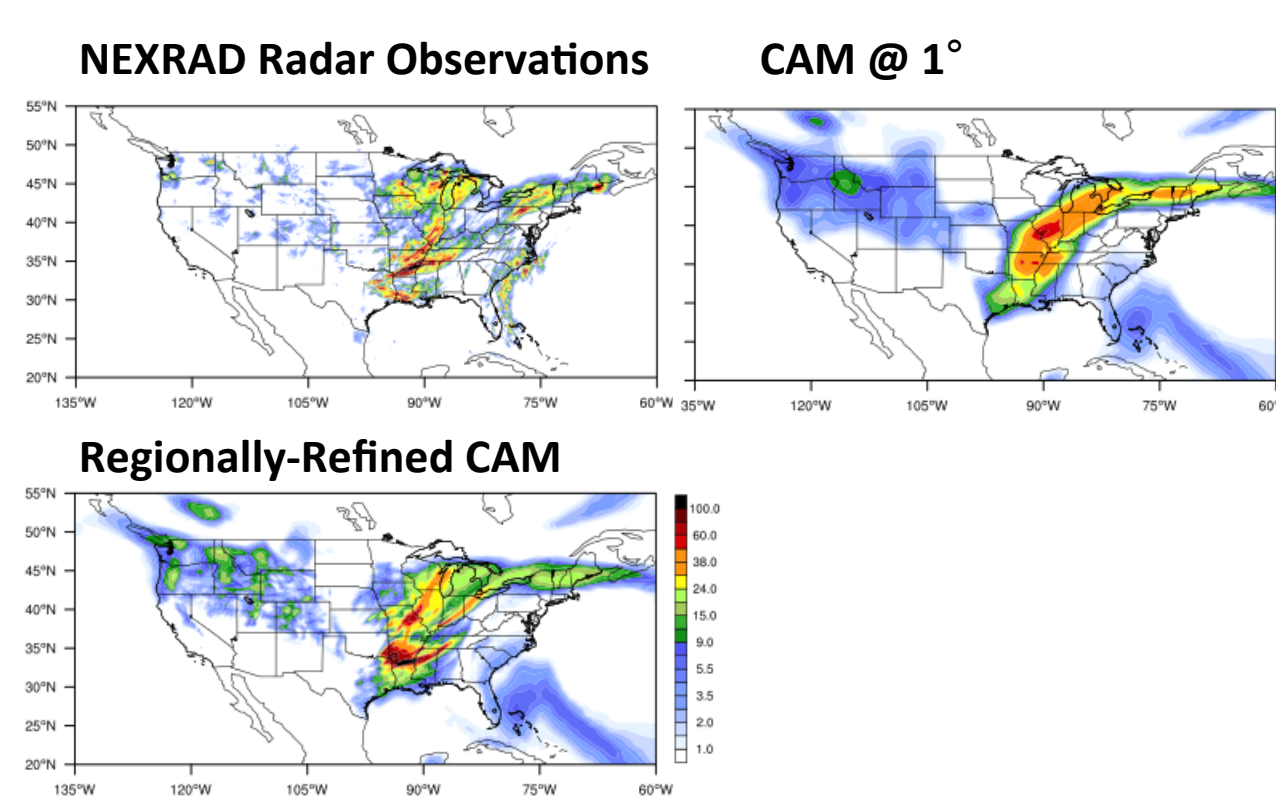


- Model Version: CAM5.1
- High-Resolution Region: 0.125° resolution
- Low Resolution Region: 1.0° resolution

Nudged Simulations

- For some simulations, we nudge the low-resolution portion of the globe to ECMWF-Interim analysis data
- By not nudging the high-resolution region we give the simulation more freedom
- This creates a pseudo-regional model framework
- Nudged simulations were performed for Spring and Summer of 2011 to compare to ARM field-campaign data
- An identical CAM-SE nudged simulation but for a model without regional refinement (called 1° hereafter) was also performed

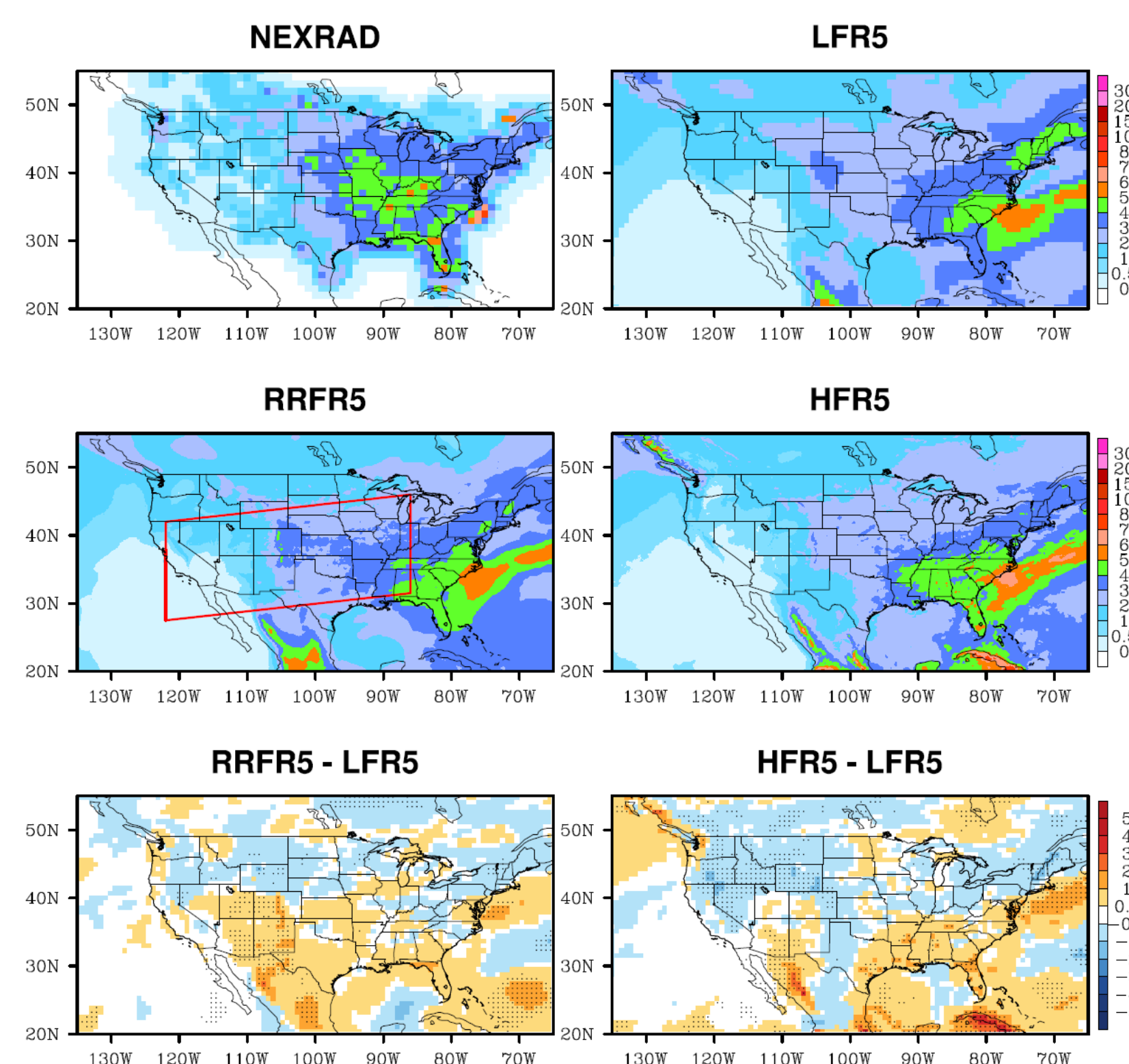
Mean Precipitation, 26 Apr 2011



Warm-Season Mean Precipitation

April – May – June – July Mean Precipitation

NEXRAD = Radar observed precipitation (2009-2013)
LFR5 = 5-year 1° global resolution simulation with pre-industrial climatological sea-surface temperatures
HFR5 = As in LFR5 but for a 5-year 0.125° global resolution simulation
RRFR5 = As in LFR5 but for a 5-year regionally-refined model simulation



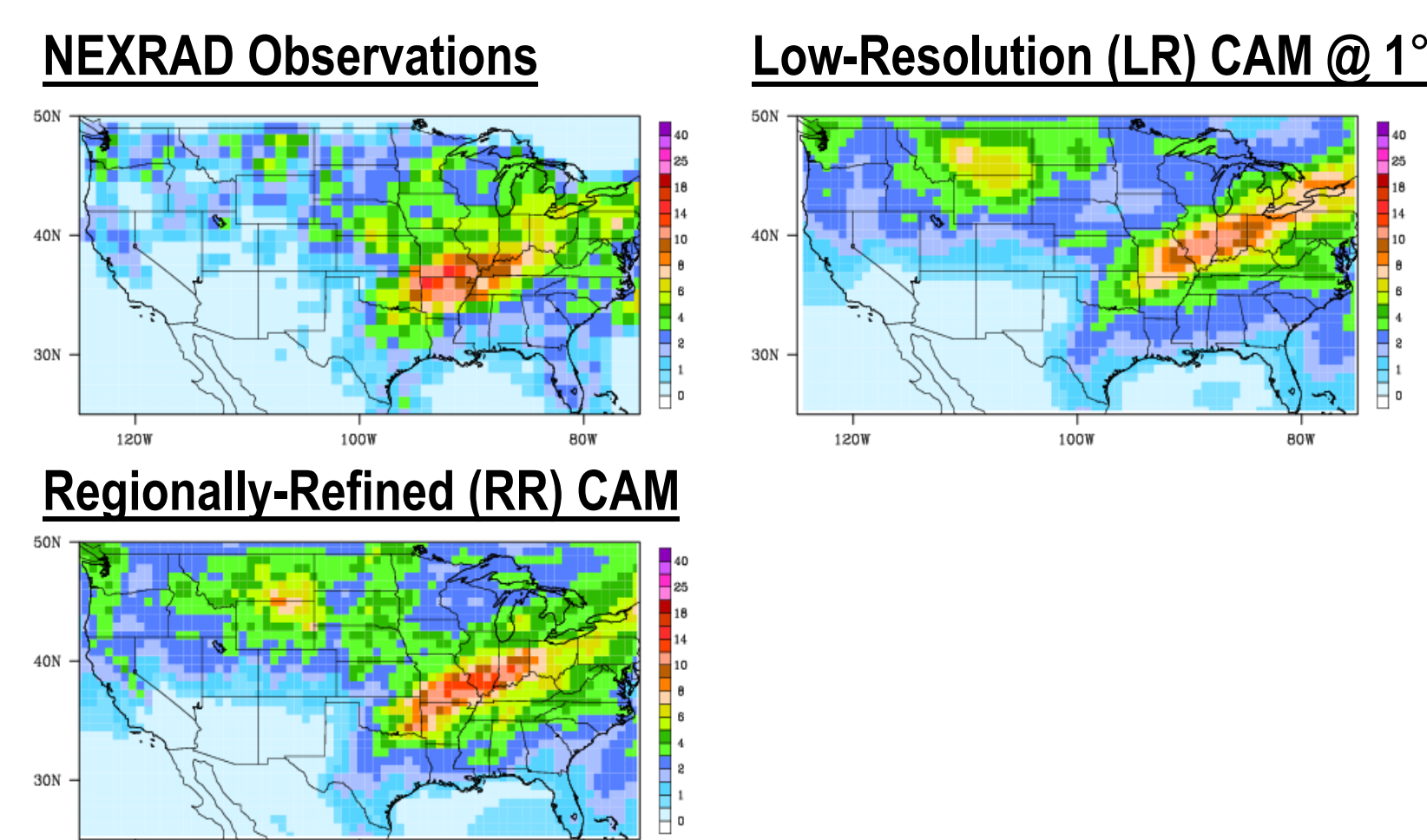
Although it is not always clear that the high-resolution model is a better simulation of mean precipitation, the regionally-refined model shows many of the same differences with the low-resolution model in mean precipitation as a global high-resolution simulation

→ The regionally-refined model can be used to study the impacts of increased resolution on the simulation of precipitation in North America

Mean Precipitation in Nudged Simulations for Spring-Summer 2011

22 April – 6 June 2011 Mean Precipitation

22 April – 6 June is the period of the ARM MC3E Field Campaign



While the differences are small, the regionally-refined CAM (when remapped to the resolution of the 1° model) has a better simulation of mean precipitation – particularly in Oklahoma and Arkansas

→ Nudging is effective in creating deterministic model simulations to match observations for specific periods of time

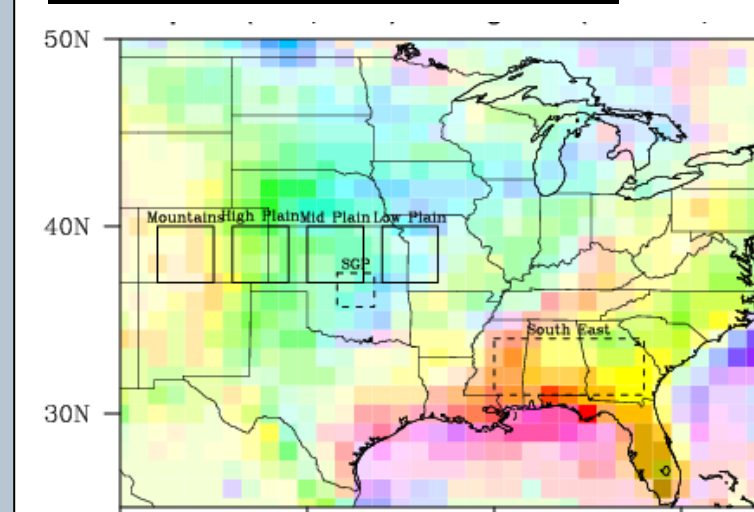
Warm-Season Diurnal Cycle of Precipitation

Diurnal Cycle Phase and Amplitude

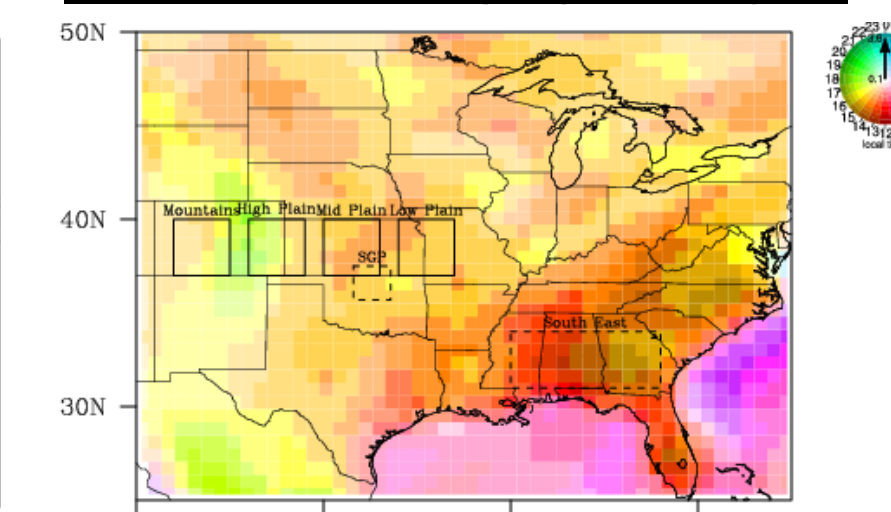
April – May – June – July

Phase in color (hours in local time)
Magnitude in saturation

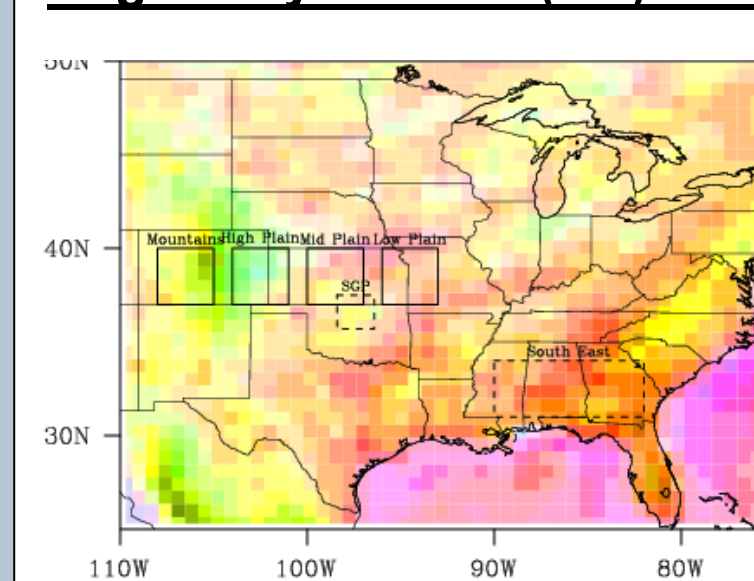
NEXRAD Observations



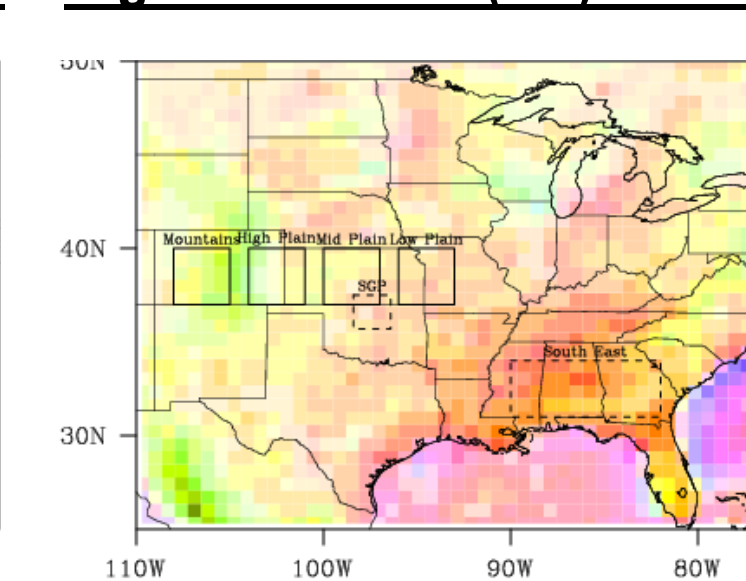
Low-Resolution (LR) CAM @ 1°



Regionally-Refined (RR) CAM



High-Resolution (HR) CAM @ 0.125°

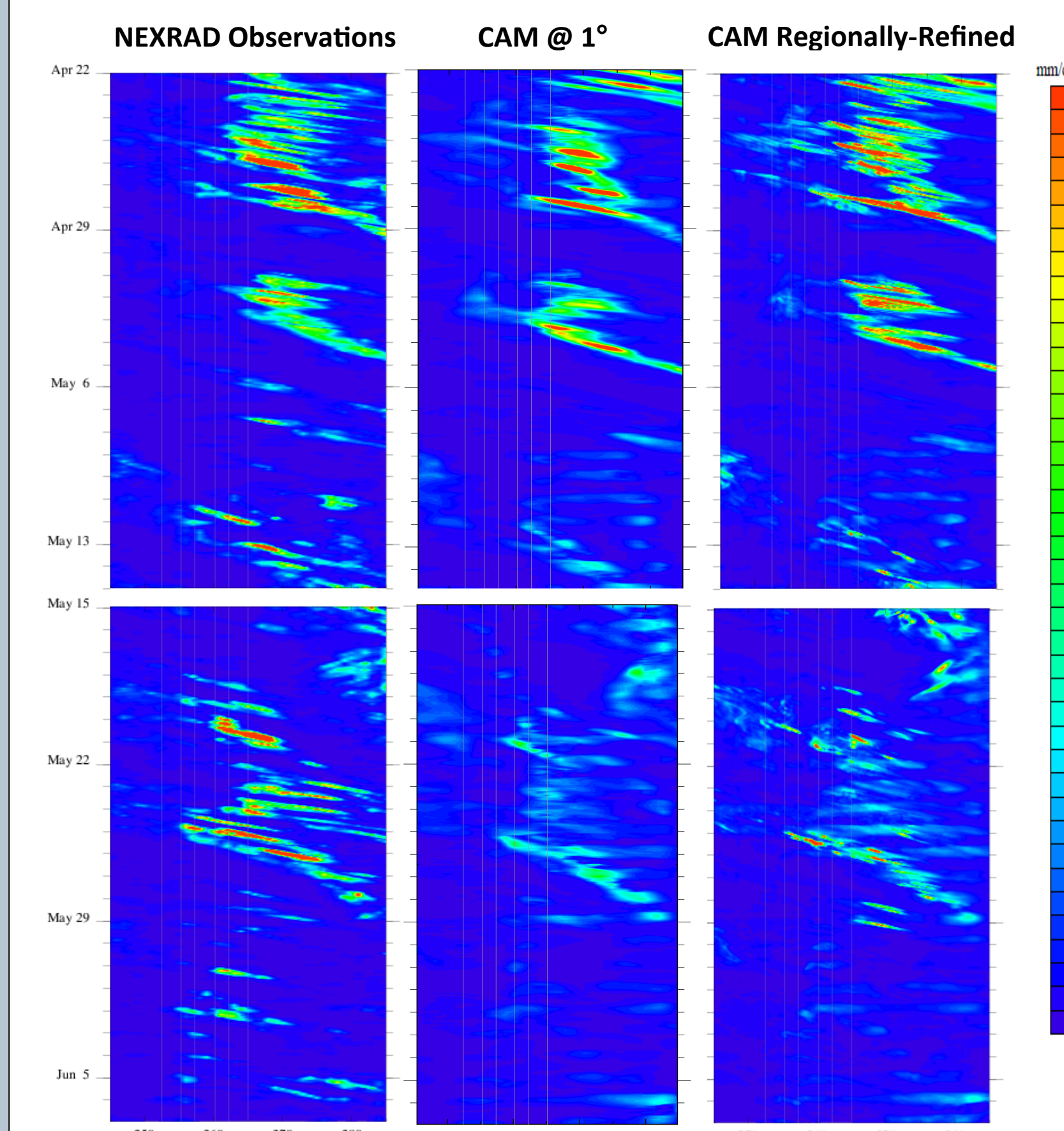


No model version is successful at capturing the nocturnal peak to precipitation in the Central United States, although the high-resolution and regionally-refined models are better in that the amplitude of their incorrect diurnal cycles are weaker than the low-resolution model

Does the model simulate propagating convection?

Precipitation Hovmöller

Time series of 35° – 45° North latitudinally averaged precipitation

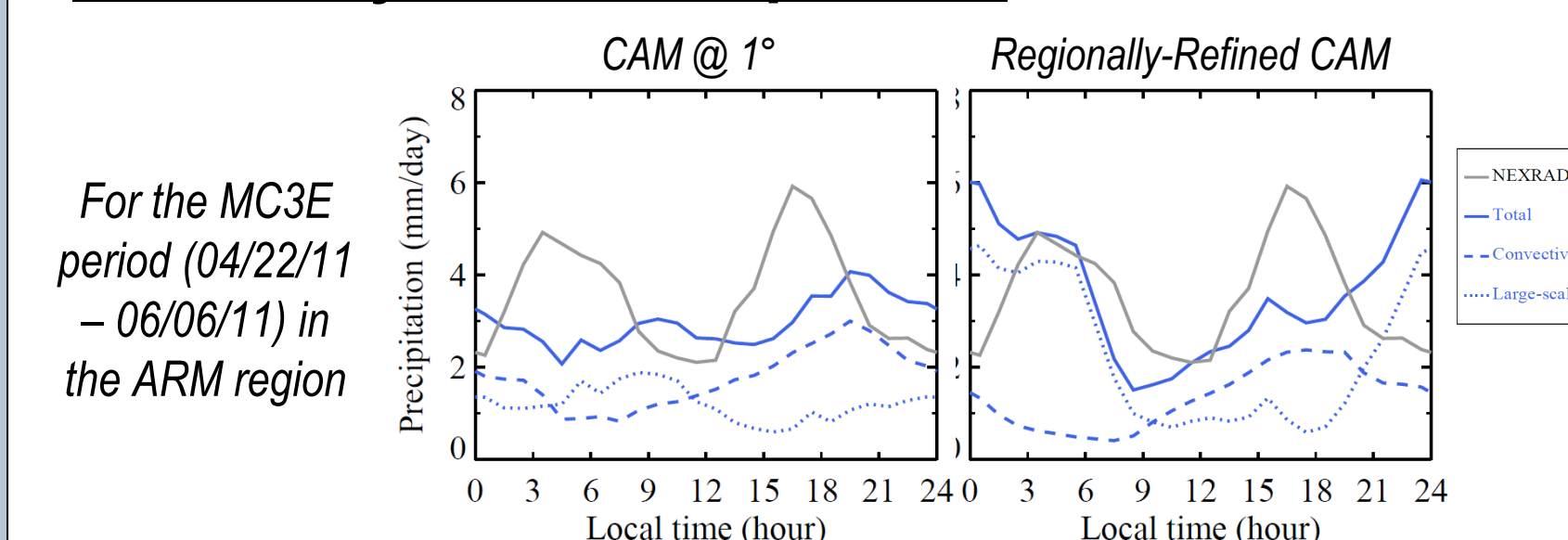


Relative to the low-resolution model, the regionally-refined model simulates both more intense and better eastward propagating precipitation events

However, the regionally-refined model does not simulate the correct intensity, number or propagation speed of the convection, particularly in the second half of the period

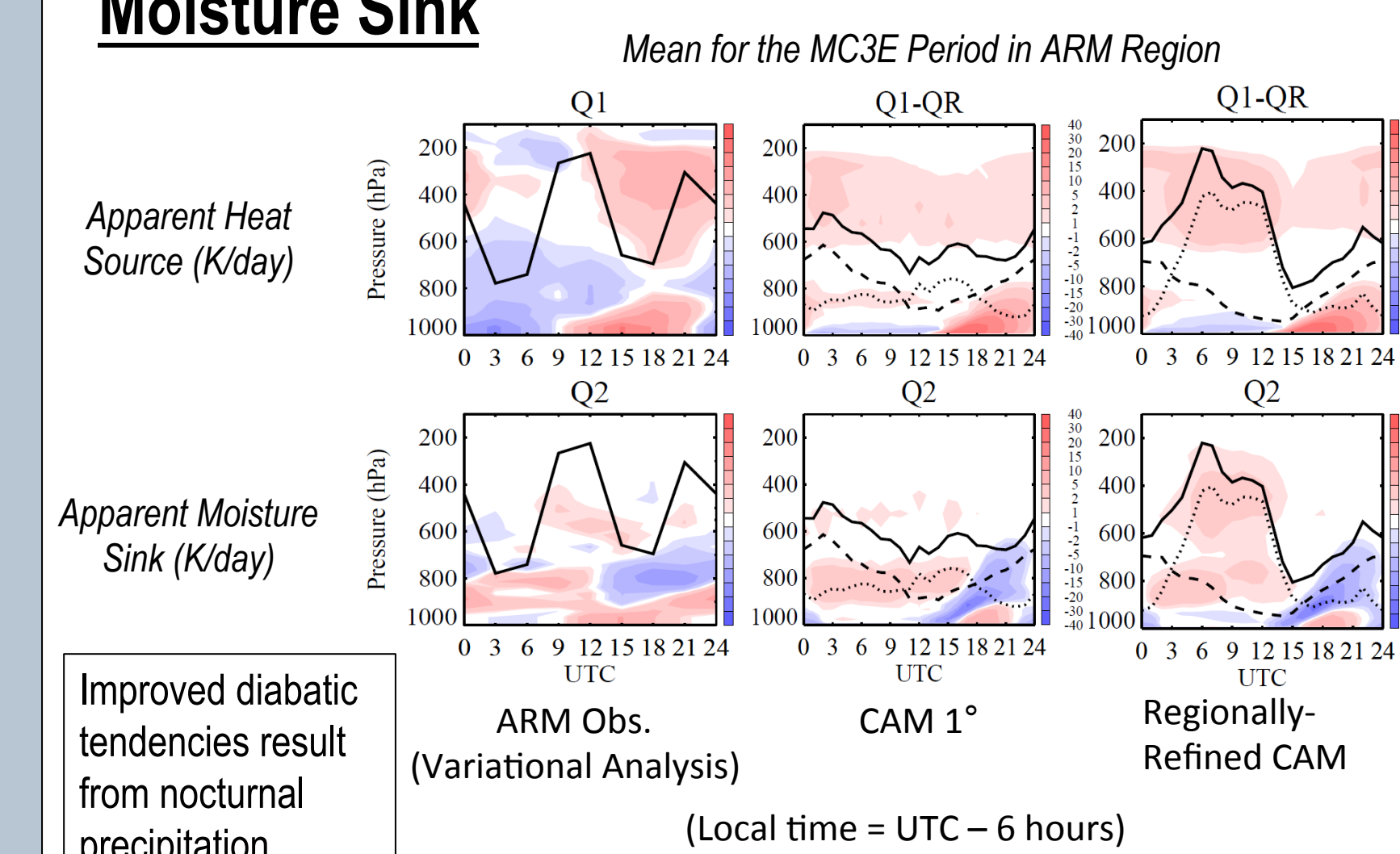
ARM SGP-Site Evaluation

Diurnal Cycle of Precipitation



Nocturnal precipitation – from the “large-scale” or “resolved-scale” parameterization – increases in the regionally-refined model

Diurnal Cycle of Diabatic Heating and Moisture Sink

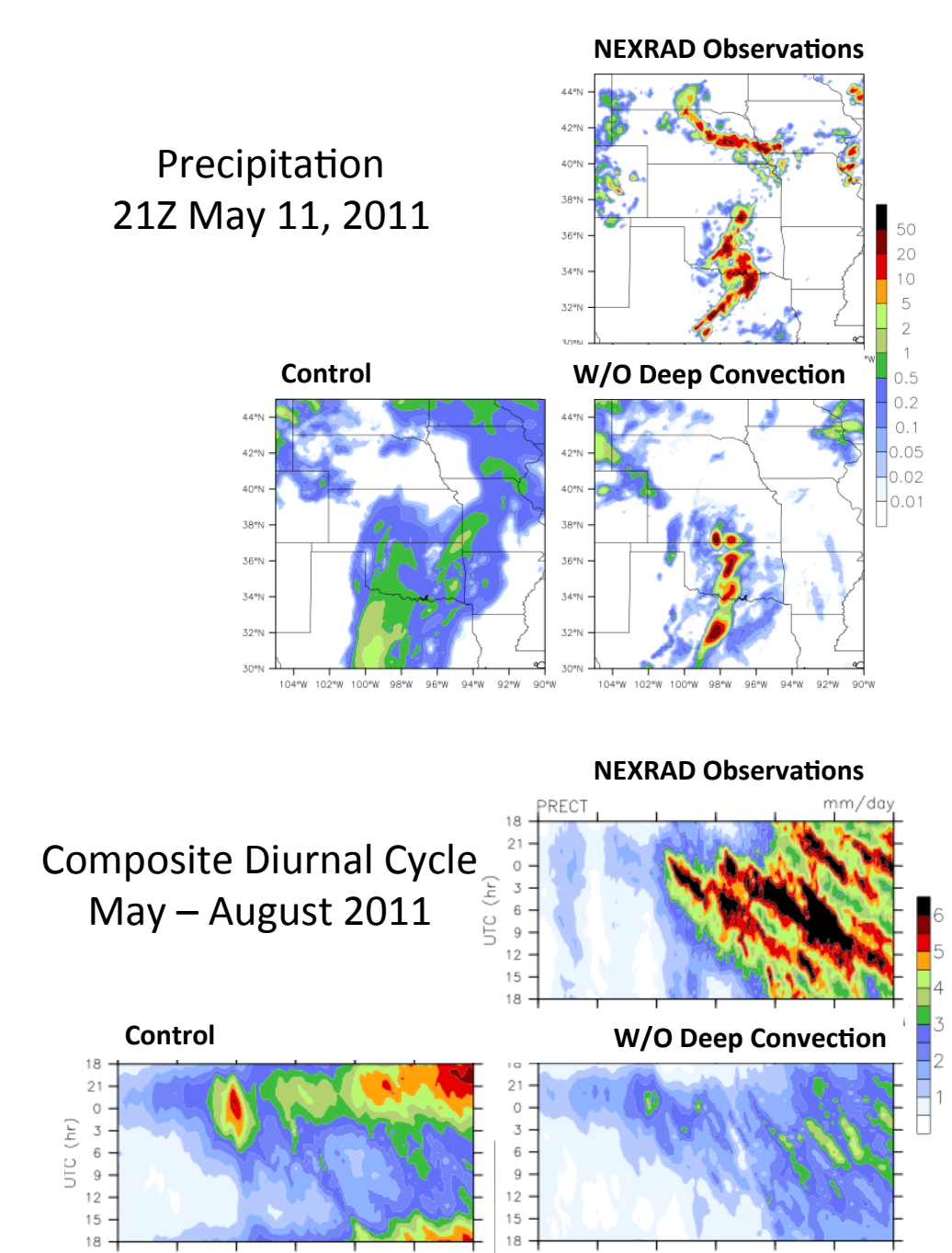


Improved diabatic tendencies result from nocturnal precipitation

Sensitivity to Deep Convection Scheme

Removing the deep convection scheme from the regionally-refined model improves for certain events produces more focused precipitation in better agreement with observations.

However it does not simulate enough nocturnal precipitation, and the propagation speed is too slow



Conclusions

- A version of the regionally-refined CAM has been created to simulate north American climate with high-resolution
 - Nudging has been implemented to facilitate comparison to specific meteorological events
- The regionally-refined model is capable of simulating many of the precipitation features of the global high-resolution model
- The regionally-refined model shows hints of improved simulation of nocturnal propagating convection, which are even more pronounced when the deep convection scheme is shut off