NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Welcome to the Noah-MP Workshop June 1- 3, 2024

Roy Rasmussen NCAR

Climate extremes over GLOBE

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Hyperresolution global land surface modeling: Meeting a grand challenge for monitoring Earth's terrestrial water

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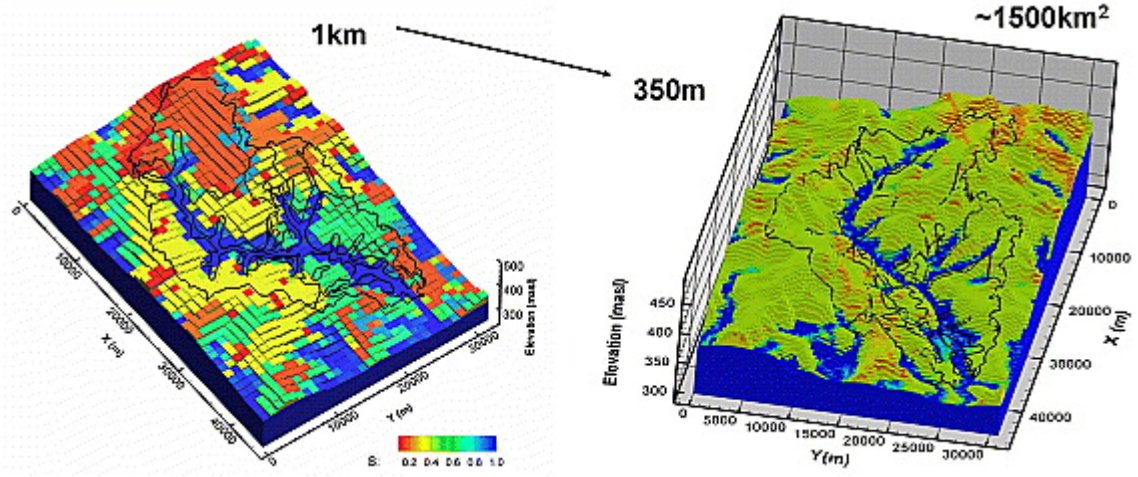
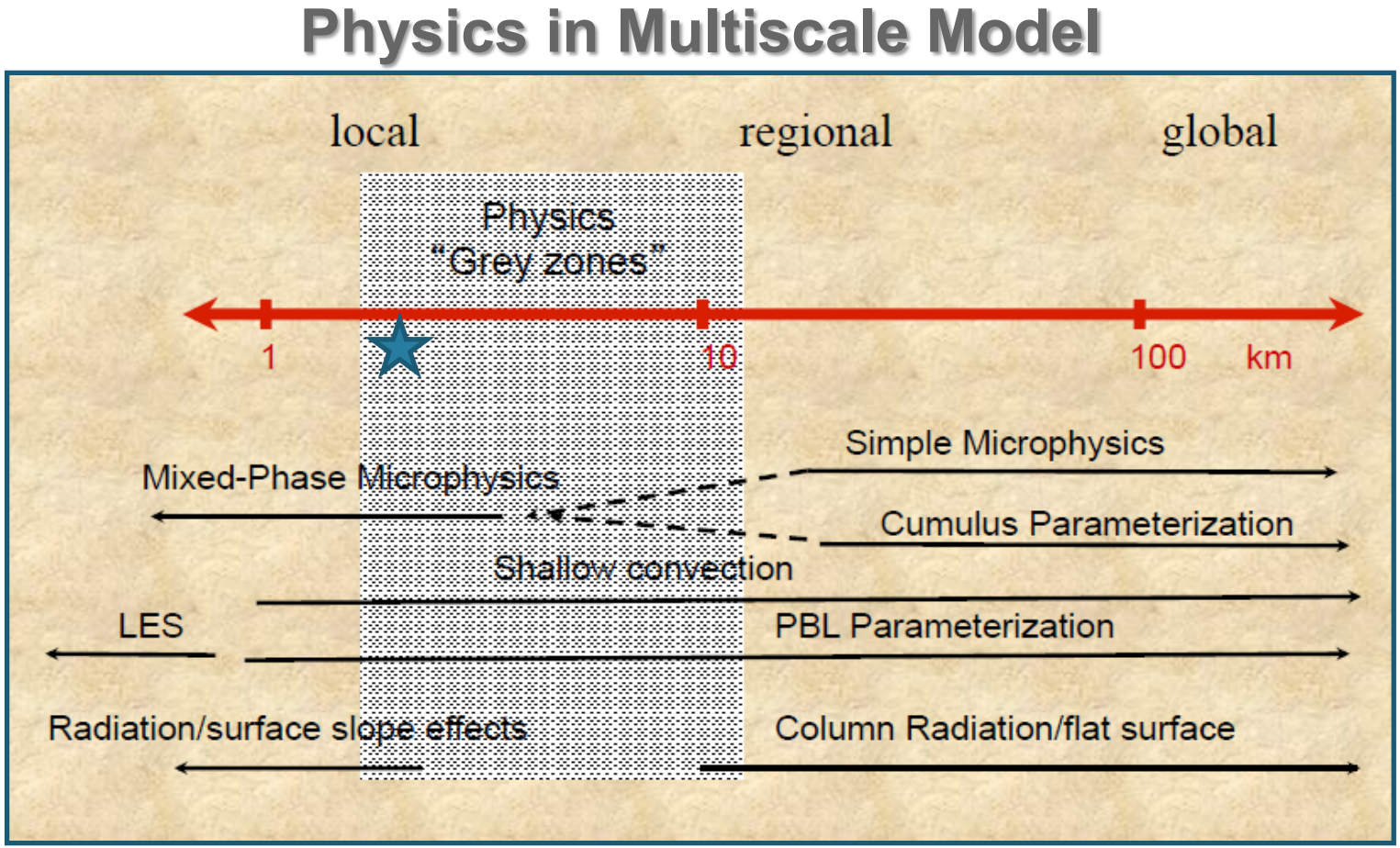


Motivation

Hyper-resolution: Another way of saying Convective Permitting on the atmospheric side.

Section in paper: 2.1. Surface and Subsurface Interactions

Land Surface parameterization improvements?



Global Hydrological cycle:

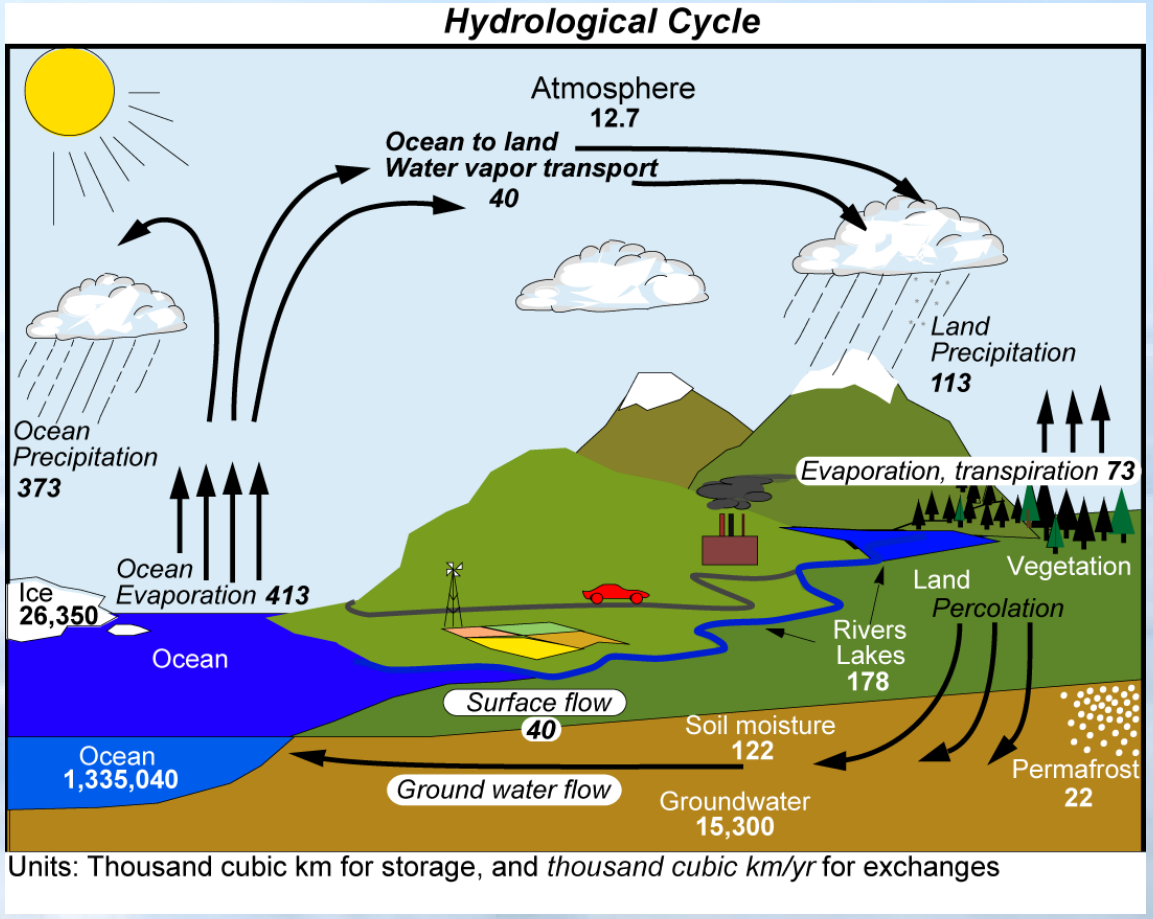
1. Mean
2. Annual cycle
3. Diurnal Cycle of precipitation, intensity, duration and frequency.
4. Trends

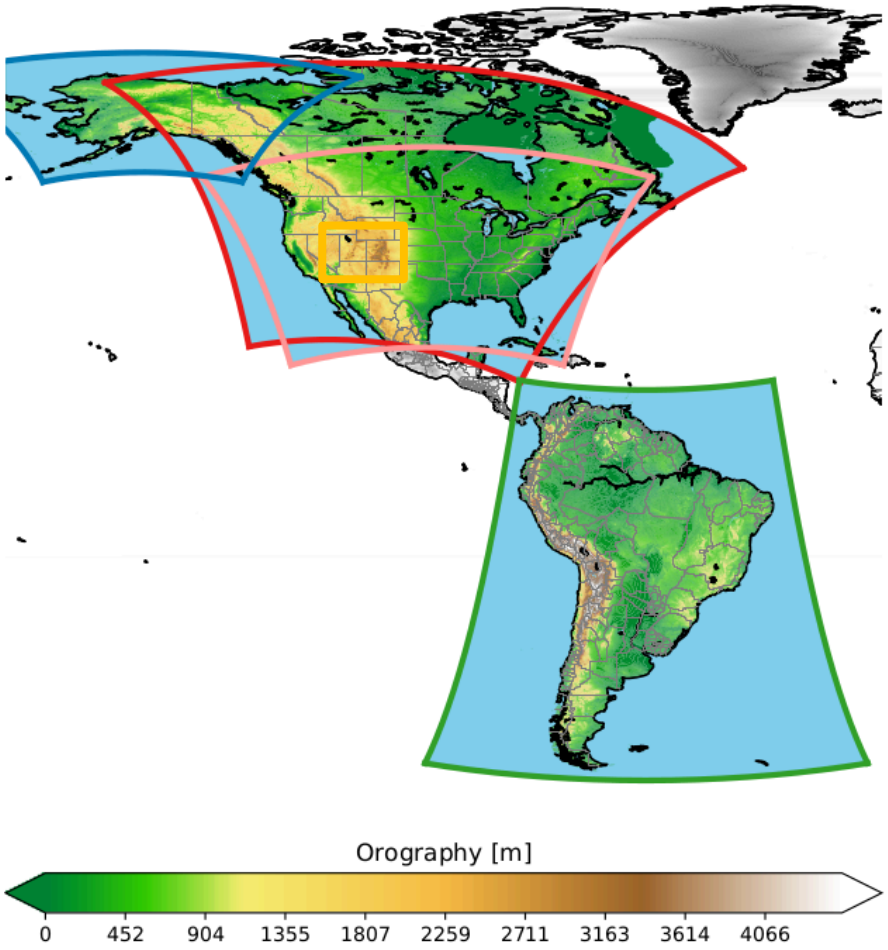
Can we do this for each month of the year?

For each region?

Can we do time series?

Trenberth et al. 2004





NCAR/RAL Kilometer-Scale Climate Simulations

CO-Headwaters [Ikeda et al. 2010, Rasmussen et al. 2011. 2014]

- Reanalysis downscaled
- 2001-2008
- dx=4 km
- future – PGW, RCP8.5

CONUS-1 [Liu et al. 2017, Clim Dyn. Prein et al. 2017, Ikeda et al. 2021]

- Reanalysis downscaled
- 2001-2013
- dx=4 km
- fuure – PGW, RCP8.5

CONUS-2 (done)

- GCM downscaled
- 1995-2014
- dx=4 km

CONUS404 [Done, USGS funded]

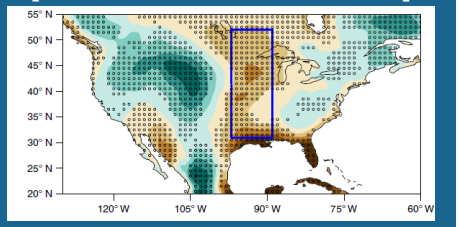
- Reanalysis downscaled
- 1979-2019
- dx=4 km. Future: PGW, RCP7.0

South America (done)

- Reanalysis downscaled
- 20-years
- dx=4 km
- Future: PGW, RCP8.5

Convective Precipitation Diurnal Cycle

(CAUSES) project
[Lin et al. 2017, Nat. Com.]



Significant improvement in diurnal cycle of precipitation intensity, duration and frequency

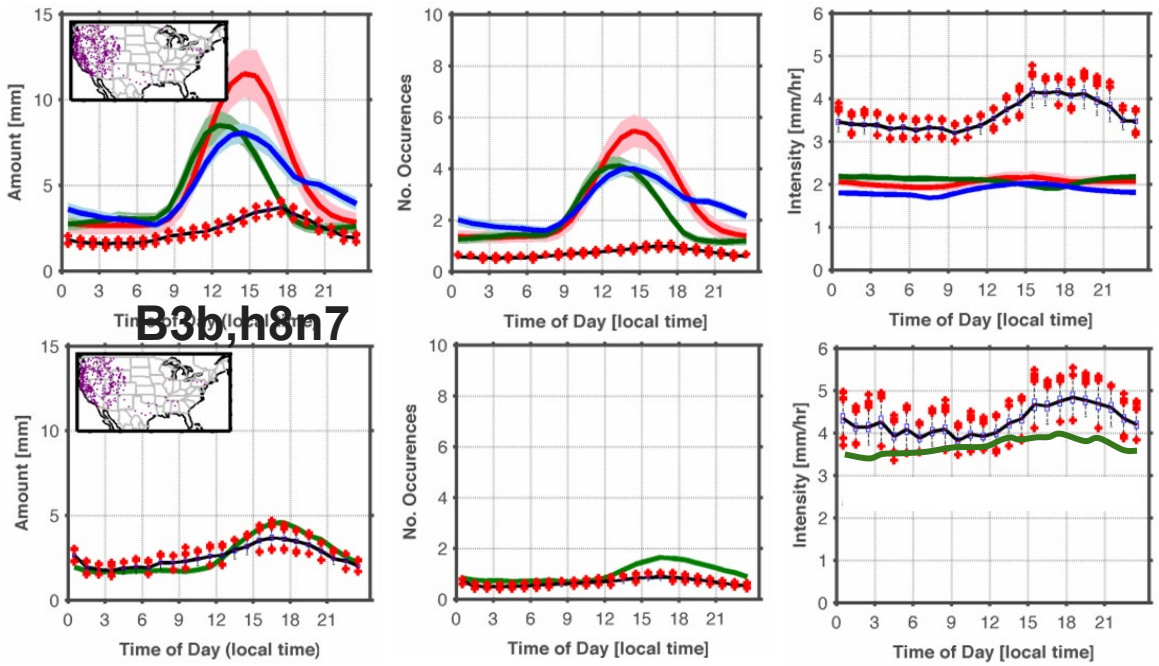
WRF 36 km

- Observations
- Kain-Fritsch
- Tiedtke
- NSAS

CONUS1 WRF 4 km

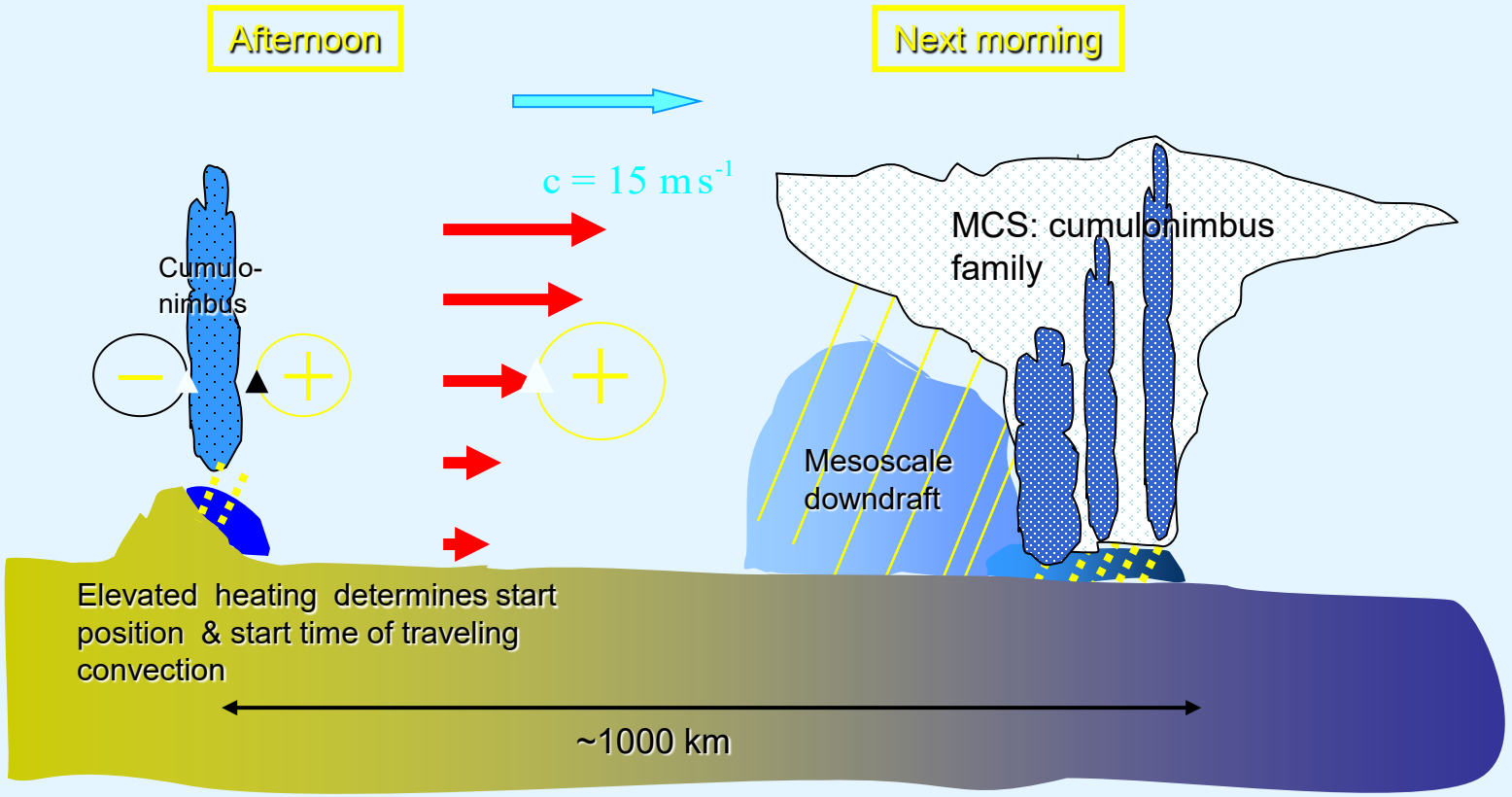
- Observations
- WRF-4km

Amount



[Mooney et al. 2016; Ban et al. 2015]

Simulating Mesoscale Convective Systems (MCS) downstream of mountains



WRF - Current Climate

May - 01 - 00:00

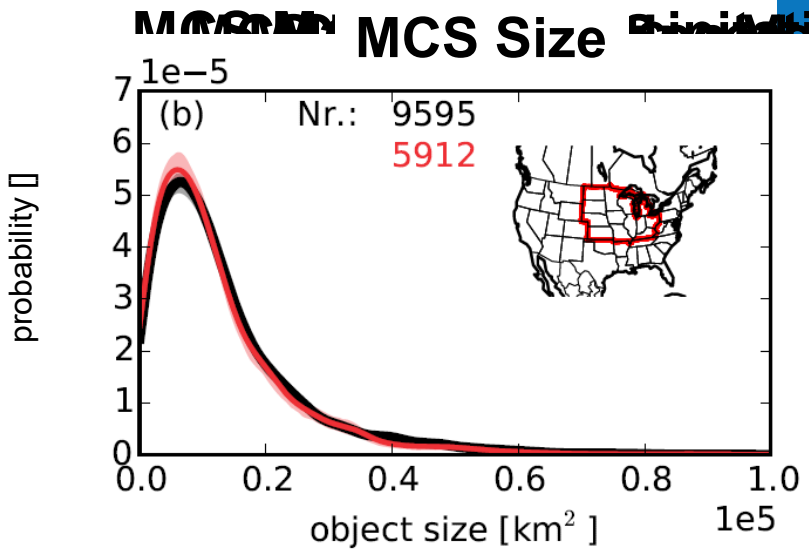
STAGE4 - Observation

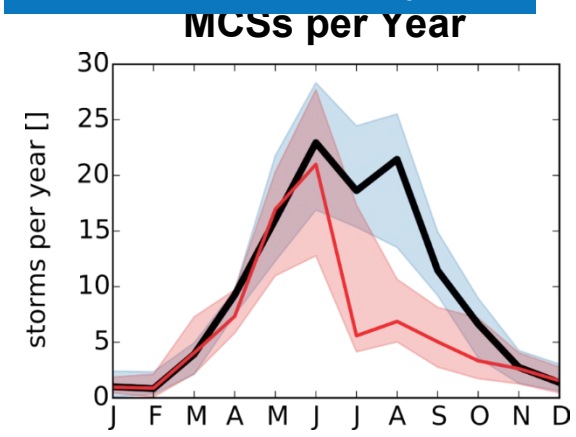
May - 01 - 00:00

All MCS tracks from 13-years (2001-2013)
Tracks fade out after 7-days

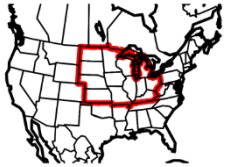
[Prein et al. 2017, Clim. Dyn.]

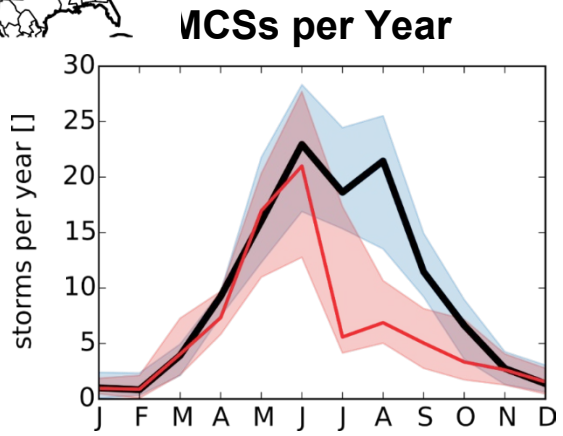
- Realistic representation of MCS attributes
- But underestimation of MCS frequency

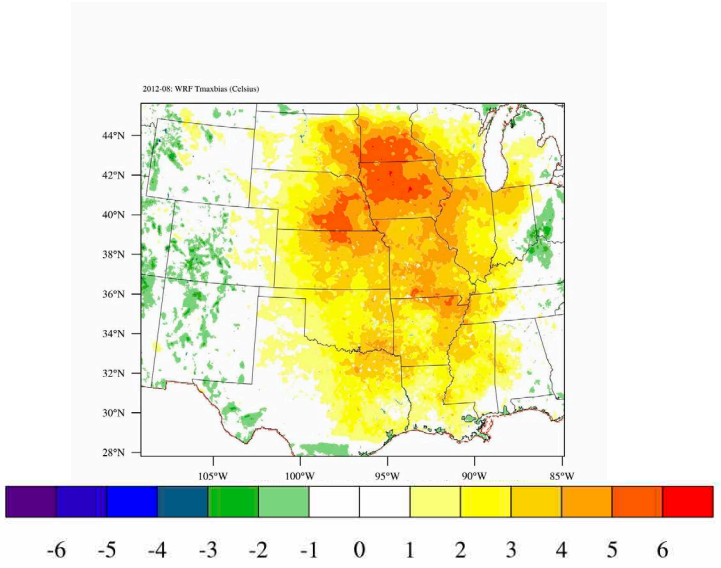




Frequency of MCSs







Temperature bias relative to PRISM

August

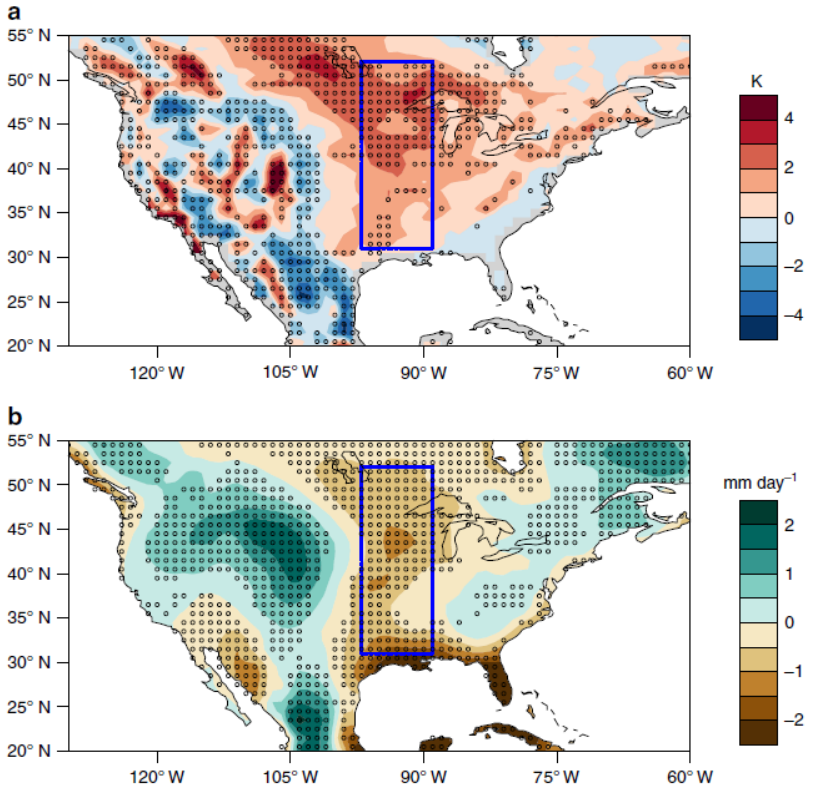
[Barlage et al. 2020, in preparation]

Dry & Warm Bias in CMIP5 GCMs

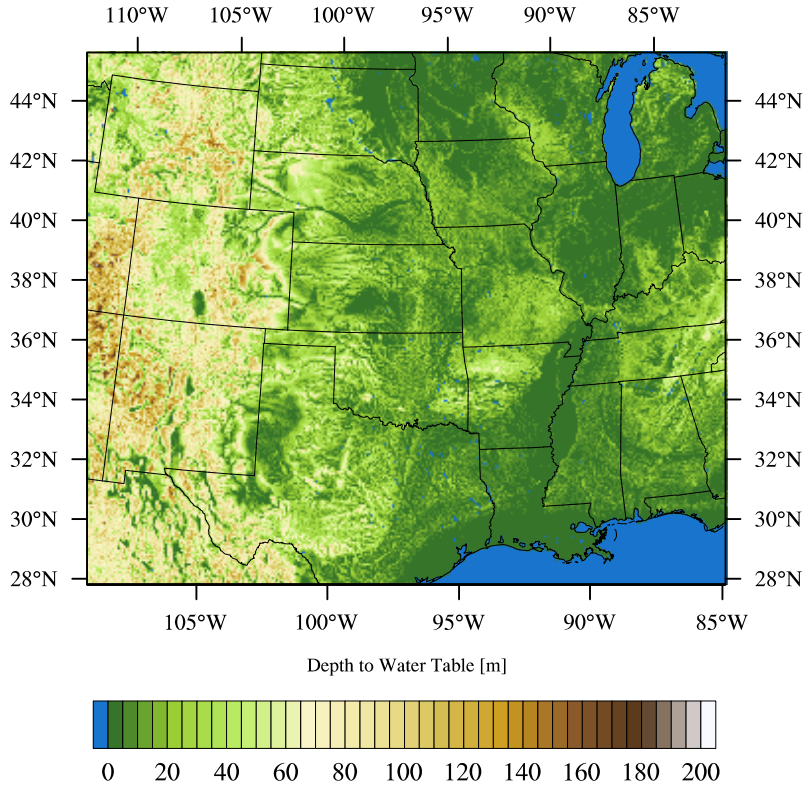
Clouds Above the United States and Errors at the Surface (**CAUSES**) project

The precipitation deficit is associated with the widespread failure of models in capturing strong rainfall events in summer over the central U.S.

[Lin et al. 2017, Nat. Com.]



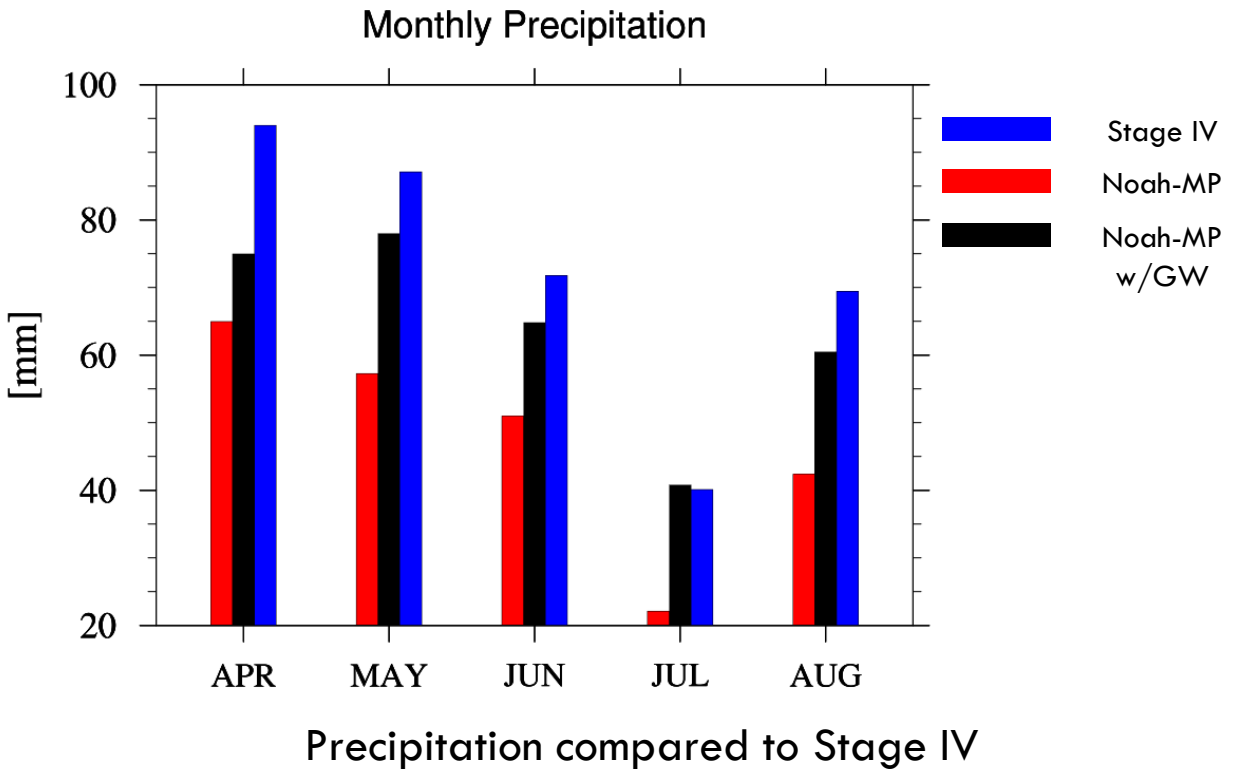
Warm & Dry Bias in Central US



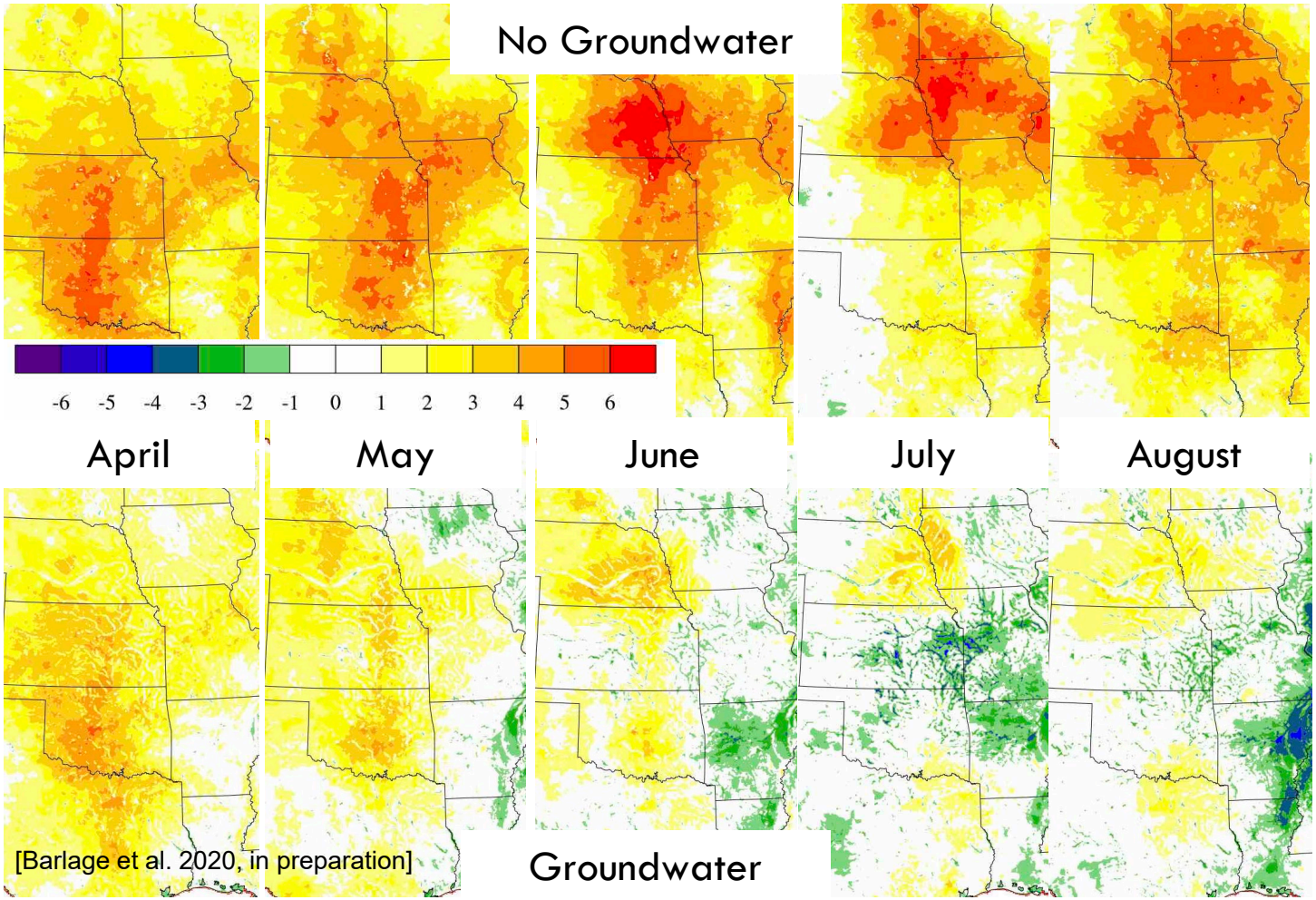
[Barlage et al. 2020, in preparation]

- Region of warm bias consistent with locations where **water table near surface**
- Development and test of **new ground water scheme in Noah-MP**
  [Fan et al, JGR 2007; Miguez-Macho et al., JGR 2007]

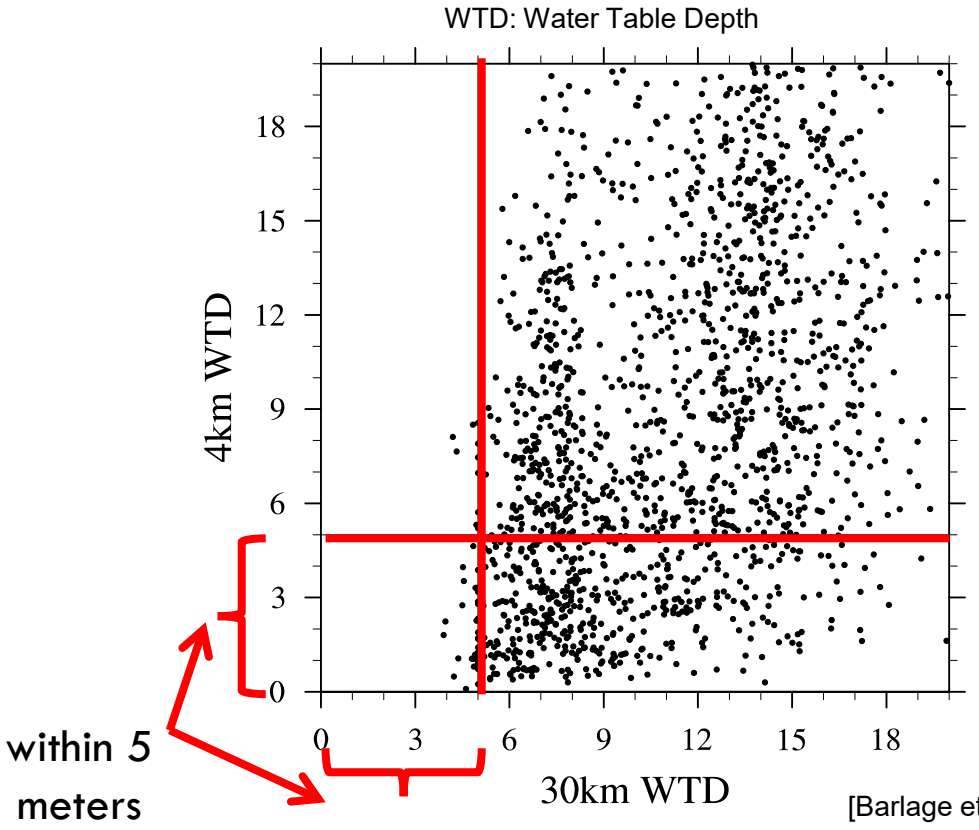
Warm & Dry Bias in Central US



[Barlage et al. 2020, in preparation]


No Groundwater
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
April
May
June
July
August
[Barlage et al. 2020, in preparation]
Groundwater

Ground Water Depth



Significant sub-grid variability is missed when using coarse resolution

[Barlage et al. 2020)

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NCAR Water System research has shown that convective permitting modeling (4 km horizontal grid spacing or less) allows us to capture the mean precipitation cycle (mean, annual cycle, diurnal(over continental regions (CONUS and South America.

5. Next step: Improved representation of the land surface!