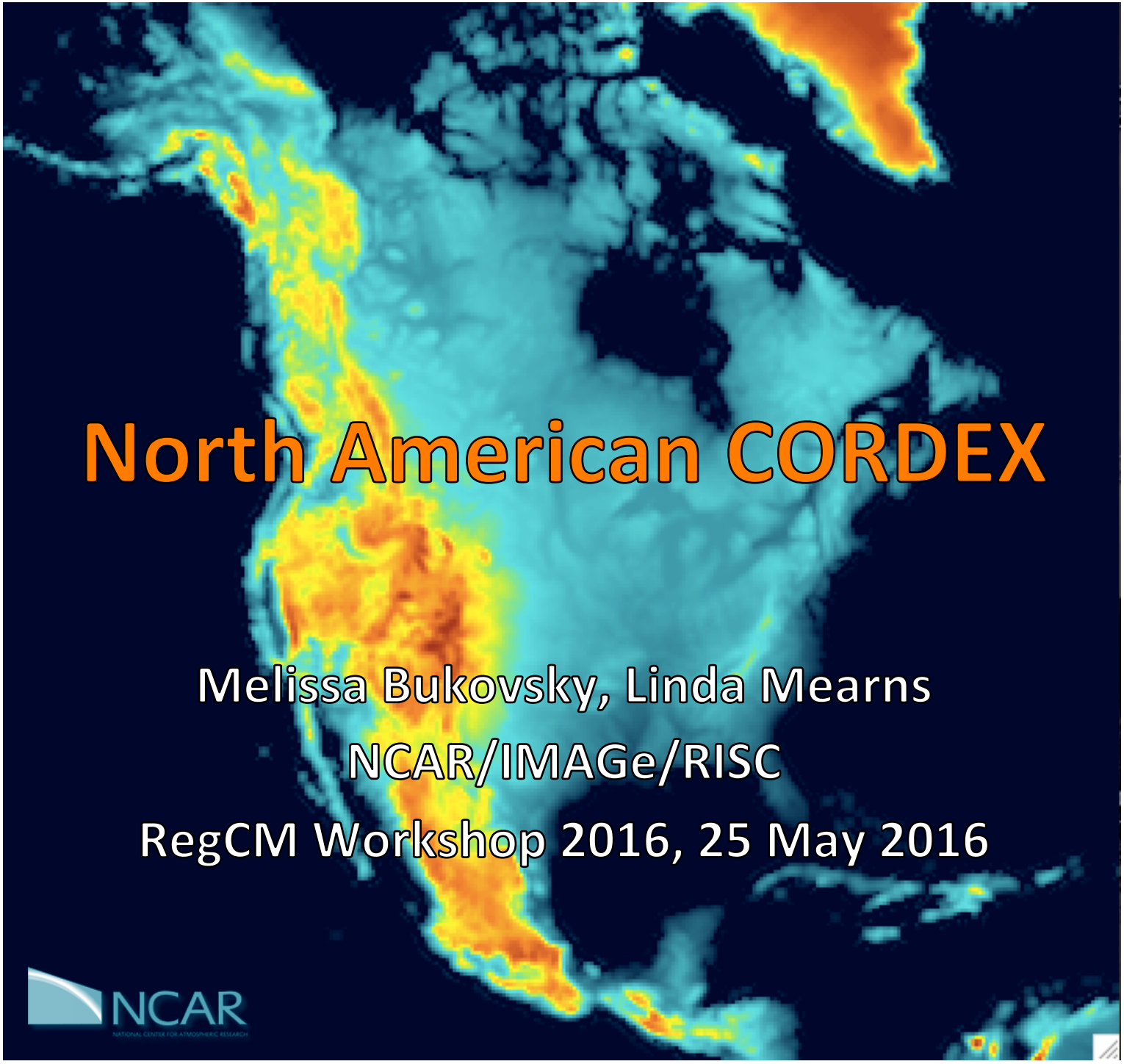


North American CORDEX

Melissa Bukovsky, Linda Mearns

NCAR/IMAGe/RISC

RegCM Workshop 2016, 25 May 2016

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

NA-CORDEX.org

- Plan to host short-list of most commonly used variables from all completed simulations at NCAR, with access at na-cordex.org
  - For now, contact modeler or download data on ESG, depending on run. More information on website.
- ERA-Interim Simulations: 1990-2009
  - 9 RCMs
- 5 RCMs, 5 CMIP5 GCMs
- 1950-2100
- 25-km & 50-km resolution
- RCP8.5 future scenario (some also with RCP 4.5)

NA-CORDEX.org

- For this analysis and comparison with NARCCAP:
  - Baseline: 1971-1999
  - Future: 2041-2069
- Focus on RegCM

- NARCCAP = North American Regional Climate Change Assessment Program

NA-CORDEX.org

	GFDL-ESM2M (2.5)	MPI-ESM-LR (3.6)	HadGEM2-ES (4.6)	CanESM2 (3.7)	EC-EARTH (3.3)
RegCM4 (Iowa State & NCAR°)	25km 50km	25km° 50km°	25km 50km		
WRF (U. of Arizona & NCAR°)	25km*° 50km*°	25km 50km	25km*° 50km		
HIRHAM5 (DMI)					50km
CanRCM4 (CCCma)				25km 50km	
RCA4 (SMHI)				50km	50km

*Not available yet (I'm working on them still), all others complete or nearly complete.

- Orange = RCP4.5 and RCP8.5, all others RCP 8.5 only.

RegCM Configuration

NA-CORDEX RegCM4 rc13

- Grell CPS w/ FC closure over land, Emanuel over ocean
- SUBEX MPS
- BATS
- No sea ice
- Lake model off (too bad)
- 164x192x18 (50km)
- 328x384x18 (25km)

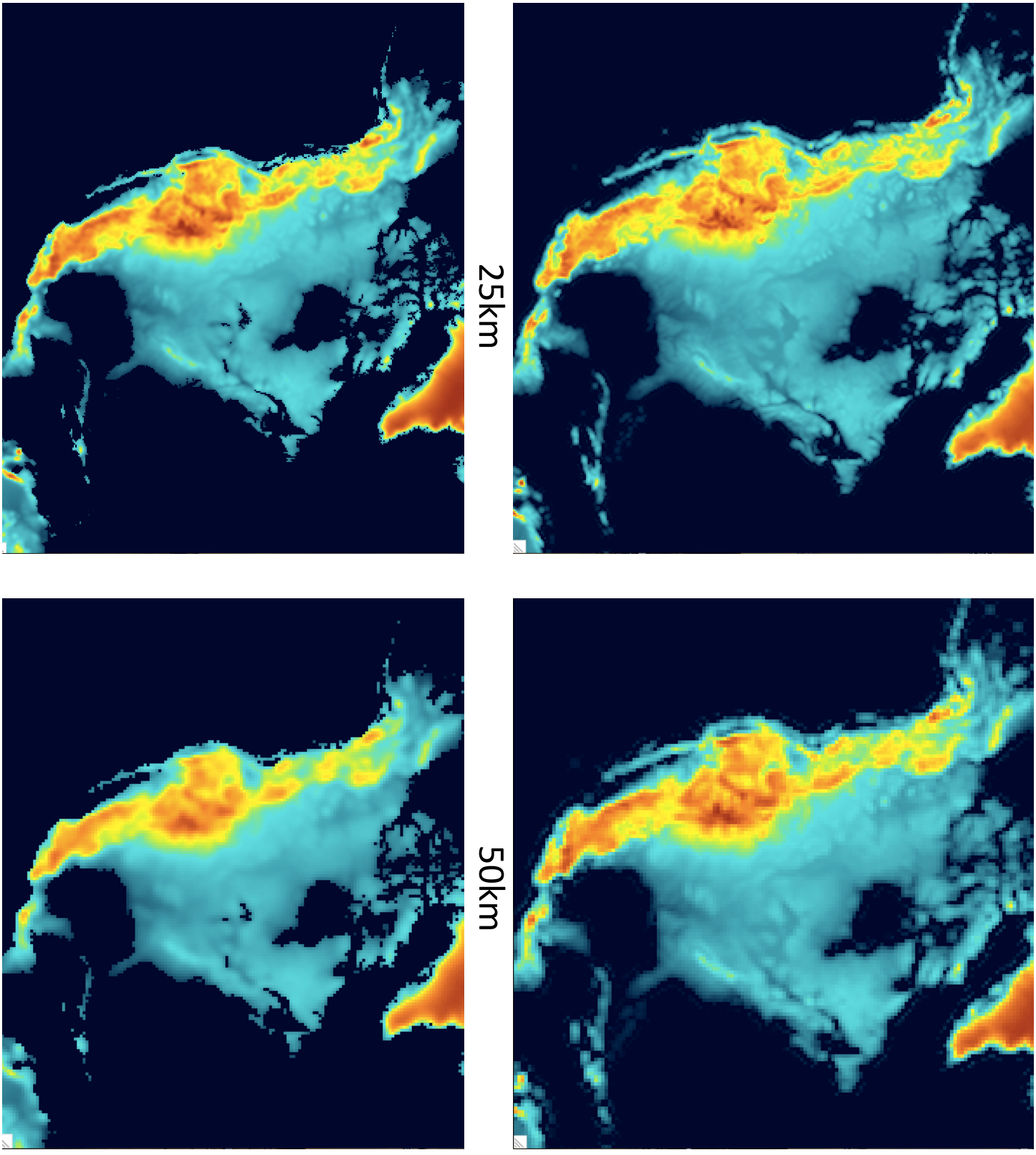
NARCCAP RegCM3

- Grell CPS w/ FC closure
- SUBEX MPS
- BATS
- No sea ice
- Lake model off (not a working option at the time)
- 160x130x18 (50km)

WRF

RCM4

Terrain Height



Run Cost: One example, based on completed simulations on NCAR's Yellowstone.

(not a direct comparison – too many differences between models)

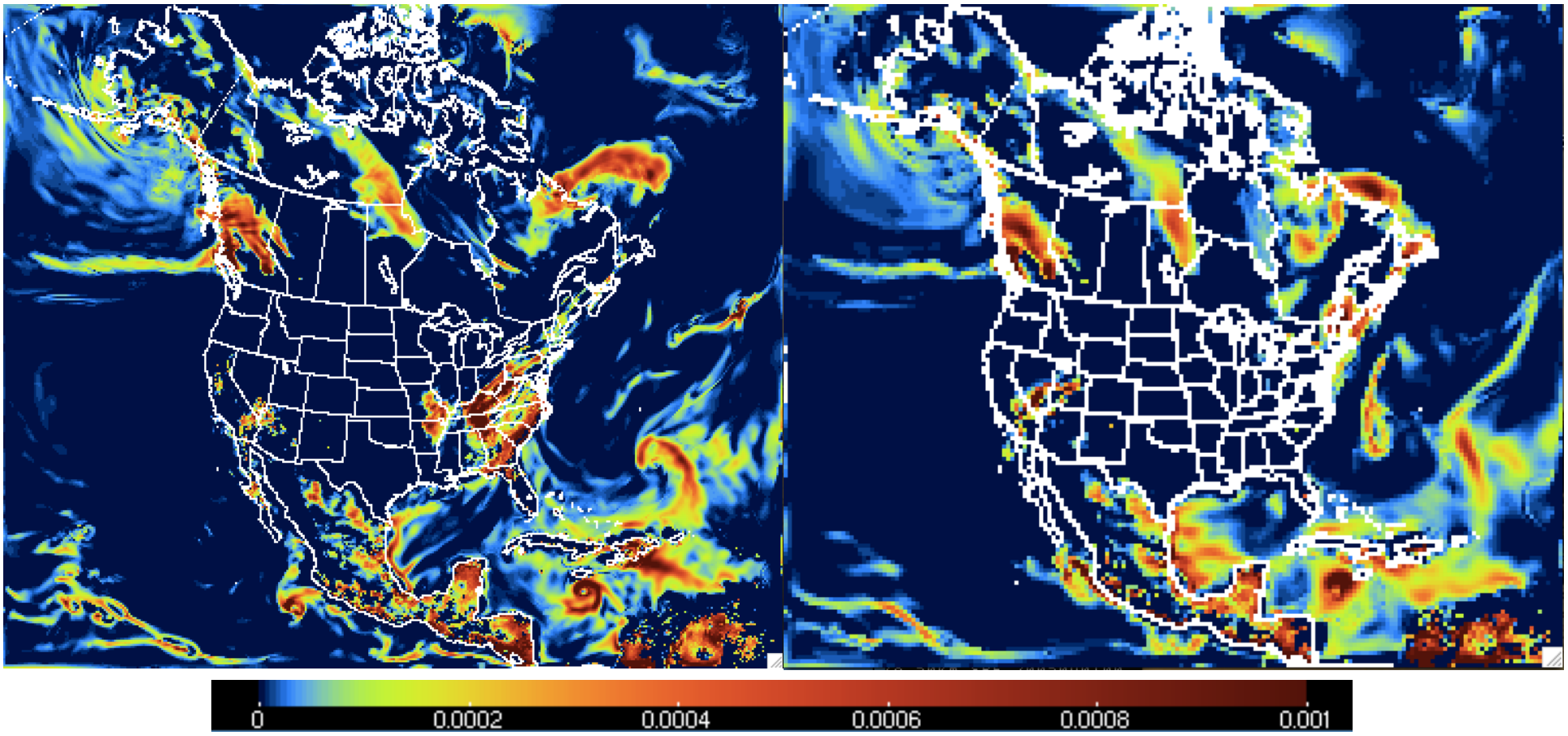
RegCM4

- 150 years @ 25km
  - 323,000 core hours
  - 900 wall clock hours = 38 days
  - 41 TB
  - 2,267,136 grid points
- 150 years @ 12.5km
  - 2,580,000 core hours
  - 7,200 wch = 300 days
  - 162 TB

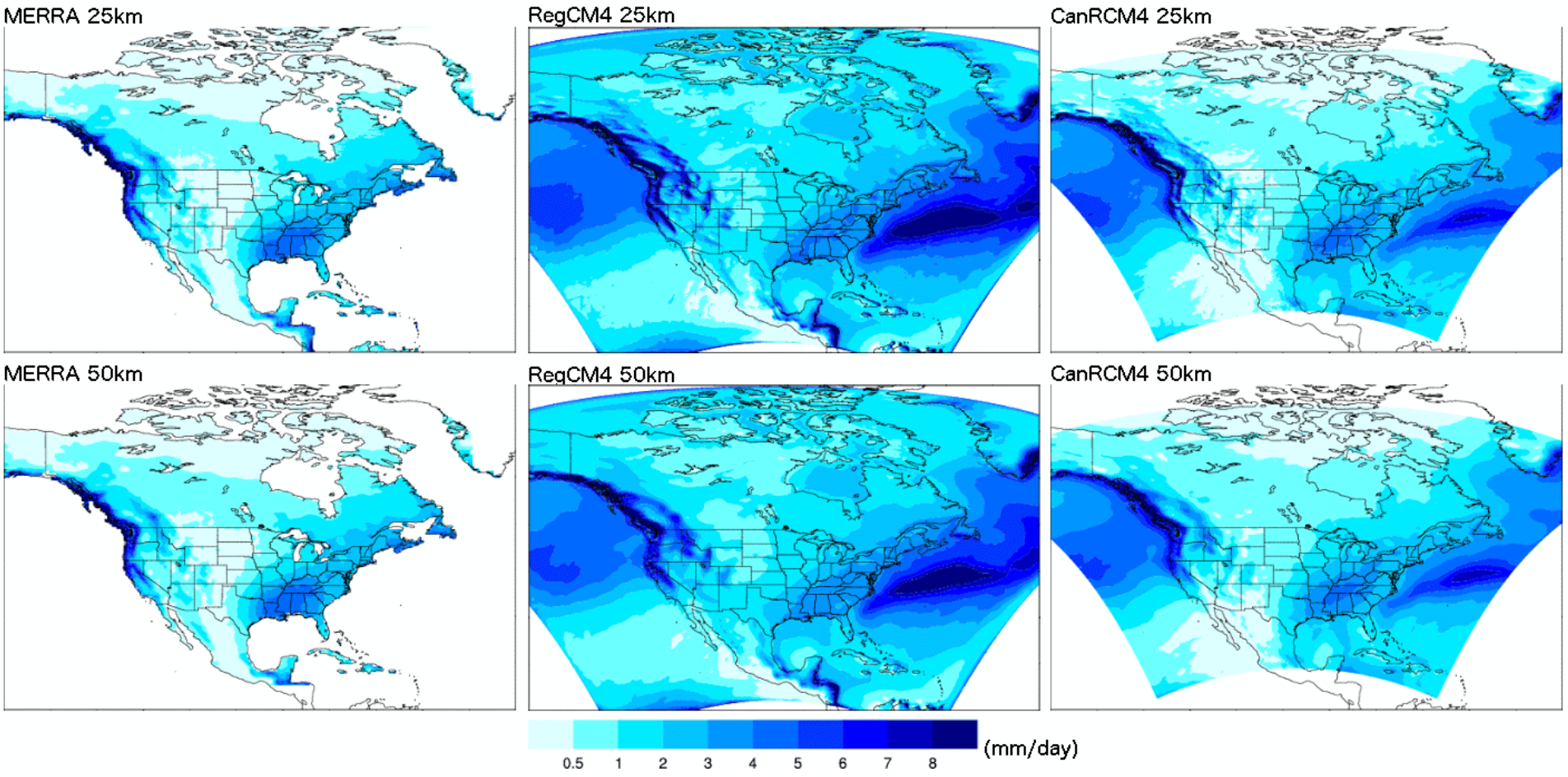
WRF

- 150 years @ 25km
  - 720,000 core hours
  - 2160 wall clock hours = 90 days
  - 95 TB (more variables saved)
  - 2,689,008 grid points
- 150 years @ 12.5km
  - 5,760,000 core hours
  - 17,280 wch = 720 days
  - 381 TB

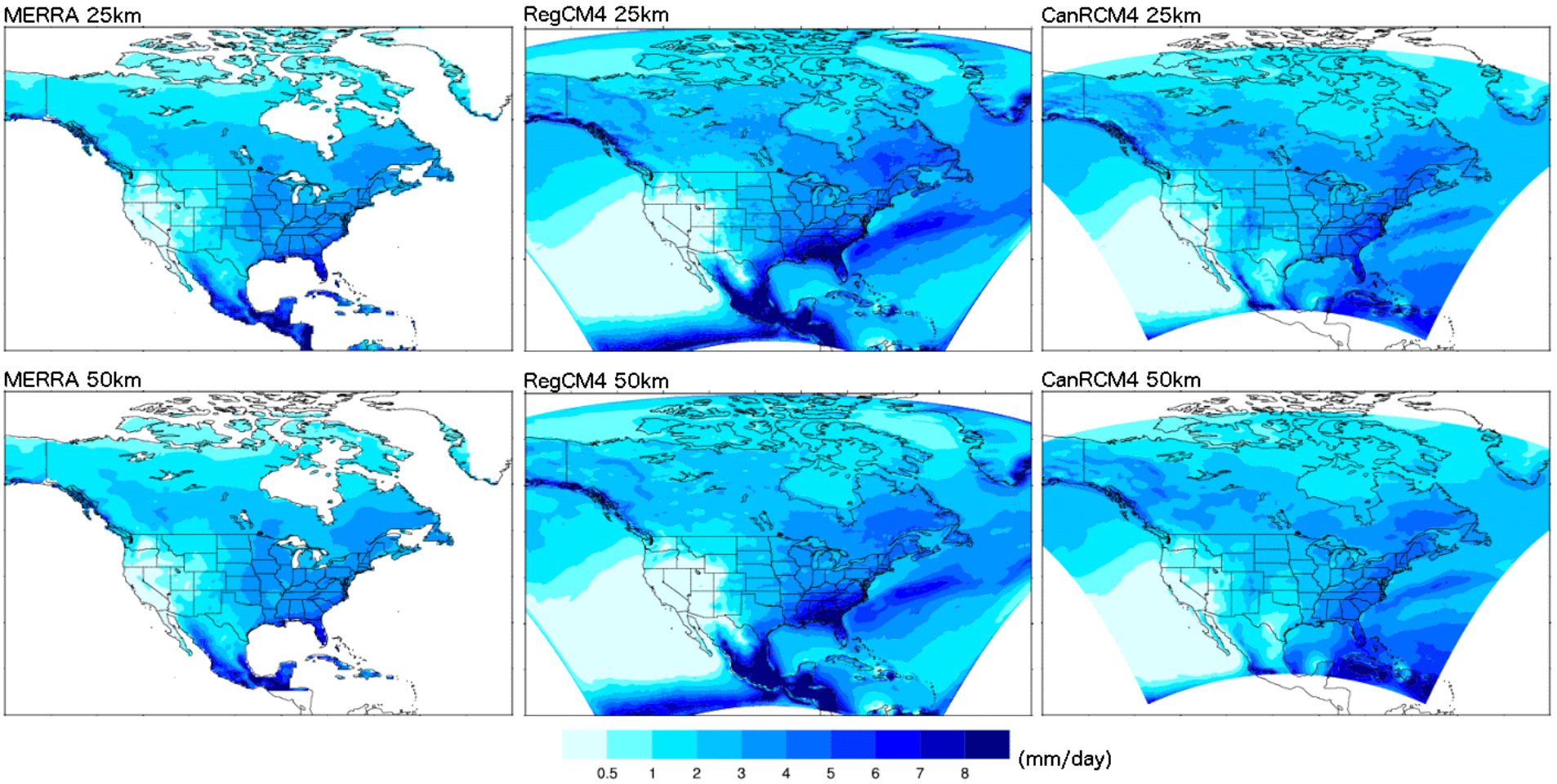
29 September 2005, 15 UTC



ERAI-Driven DJF Precipitation

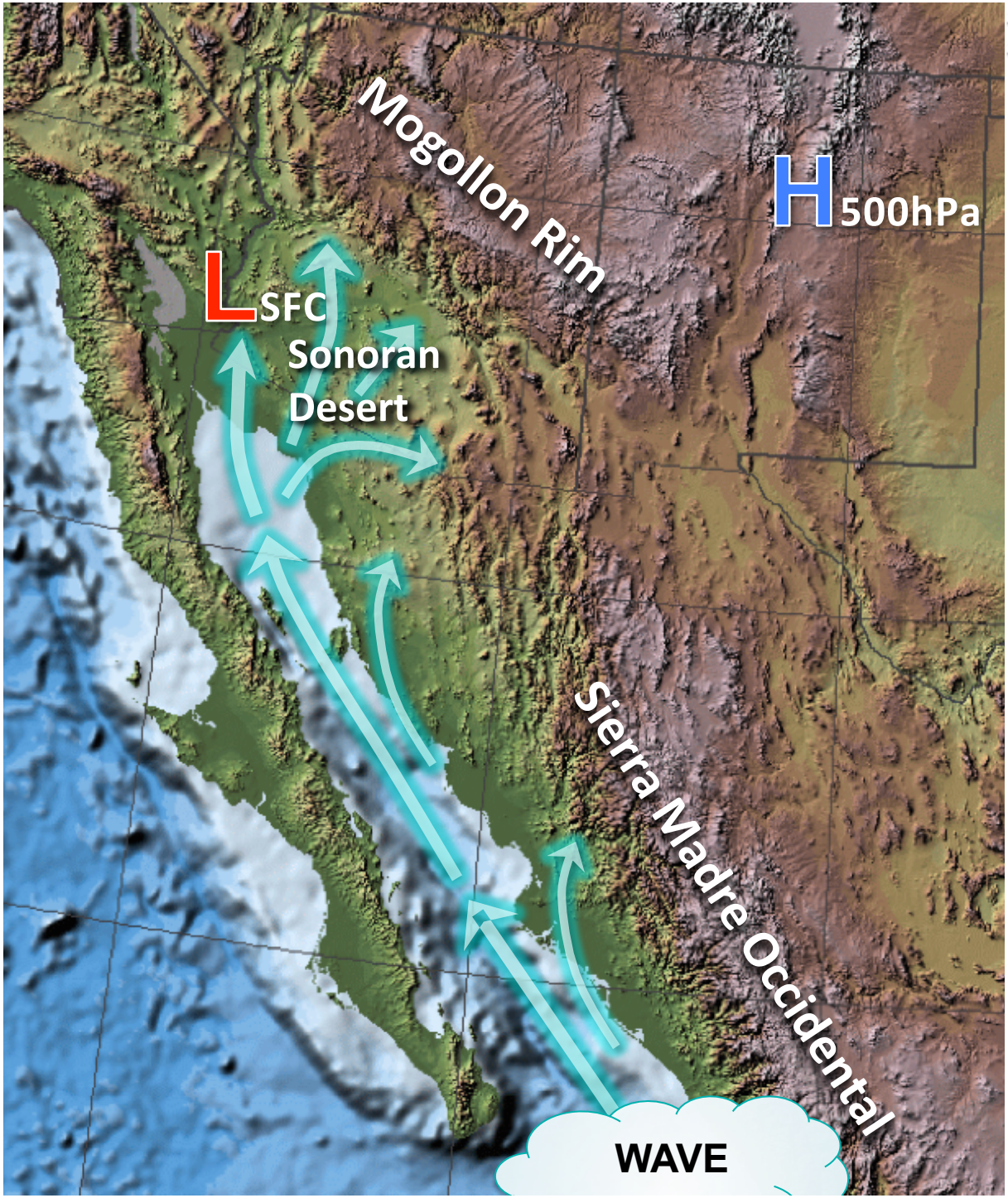


ERAI-Driven JJA Precipitation



Added Value with Regional Modeling

THE NORTH AMERICAN MONSOON

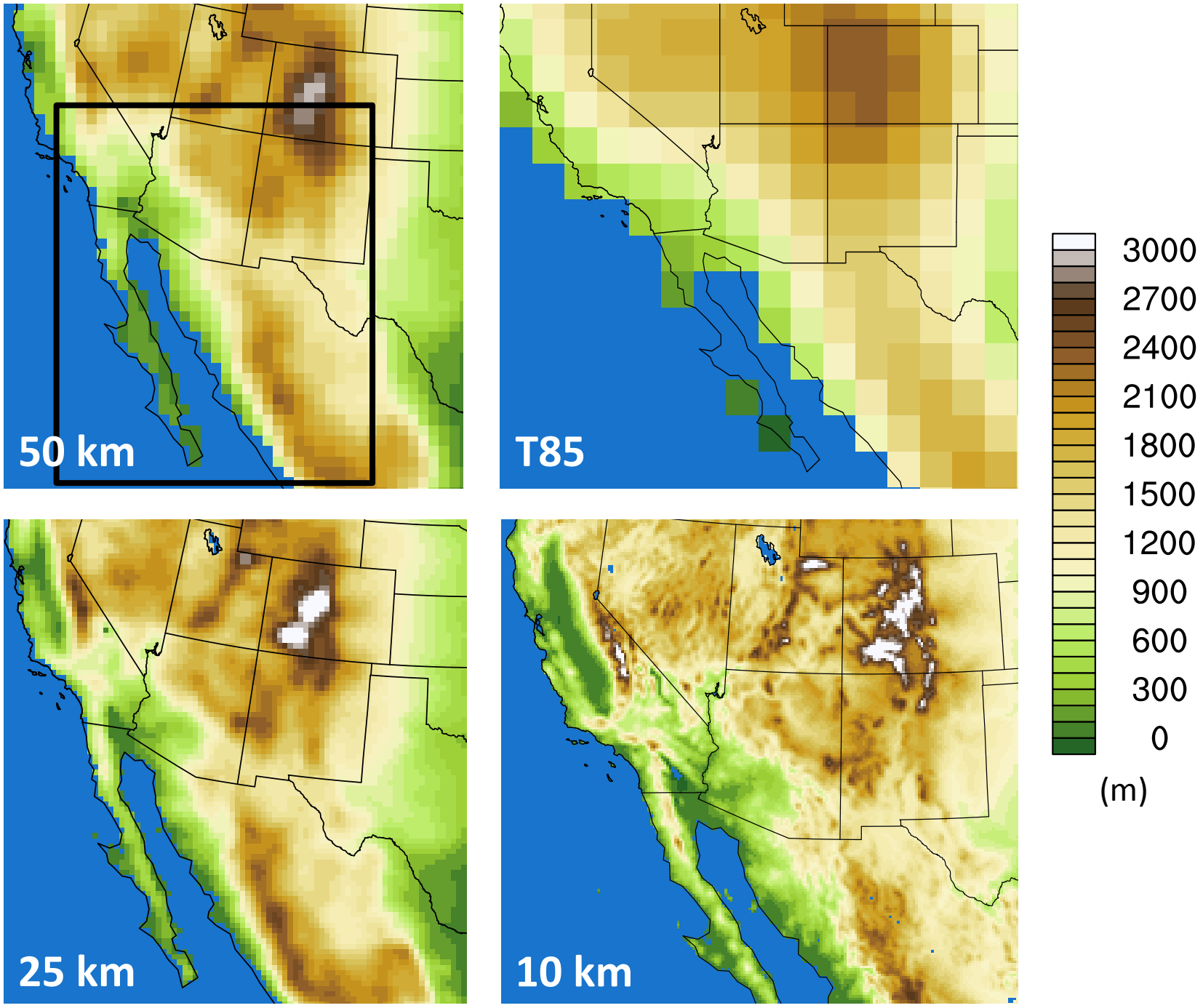


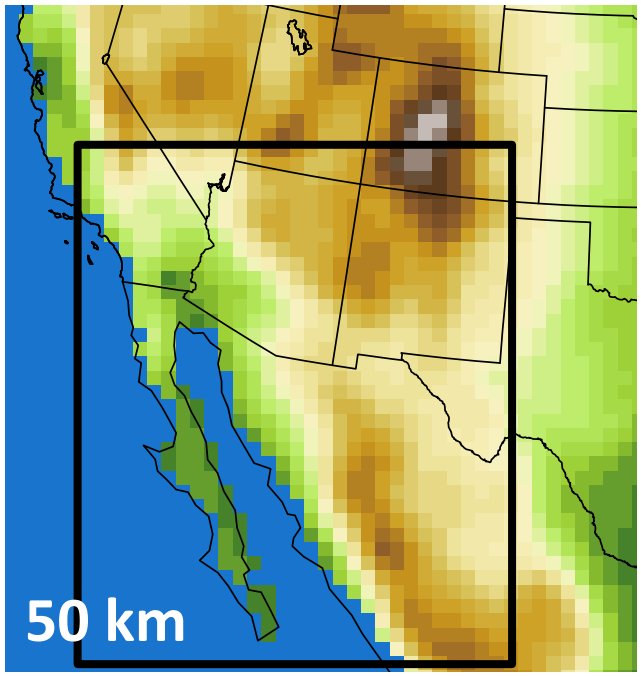
Shaded Relief - Land and Ocean
Source: U.S. Geological Survey

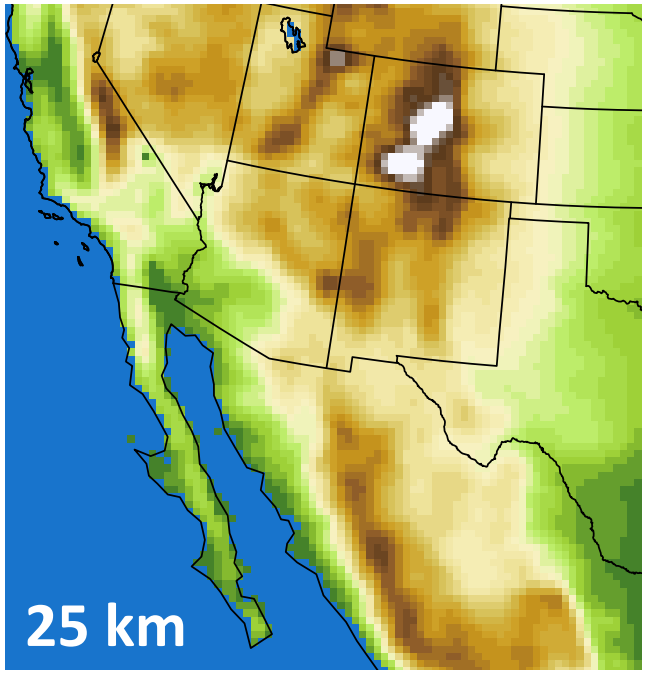
Shaded Relief - Land and Ocean

Elevation in Feet	Bathymetry in Feet
10000 - 20320	> -749
9500 - 9999	-750 to -1499
9000 - 9499	-1500 to -2999
8500 - 8999	-3000 to -5999
8000 - 8499	-6000 to -8999
7500 - 7999	-9000 to -11999
7000 - 7499	-12000 to -15999
6500 - 6999	< -16000
6000 - 6499	
5500 - 5999	
5000 - 5499	
4500 - 4999	
4000 - 4499	
3500 - 3999	
3000 - 3499	
2500 - 2999	
2000 - 2499	
1500 - 1999	
1000 - 1499	
500 - 999	
250 - 499	
1 - 249	
-282 - 0	

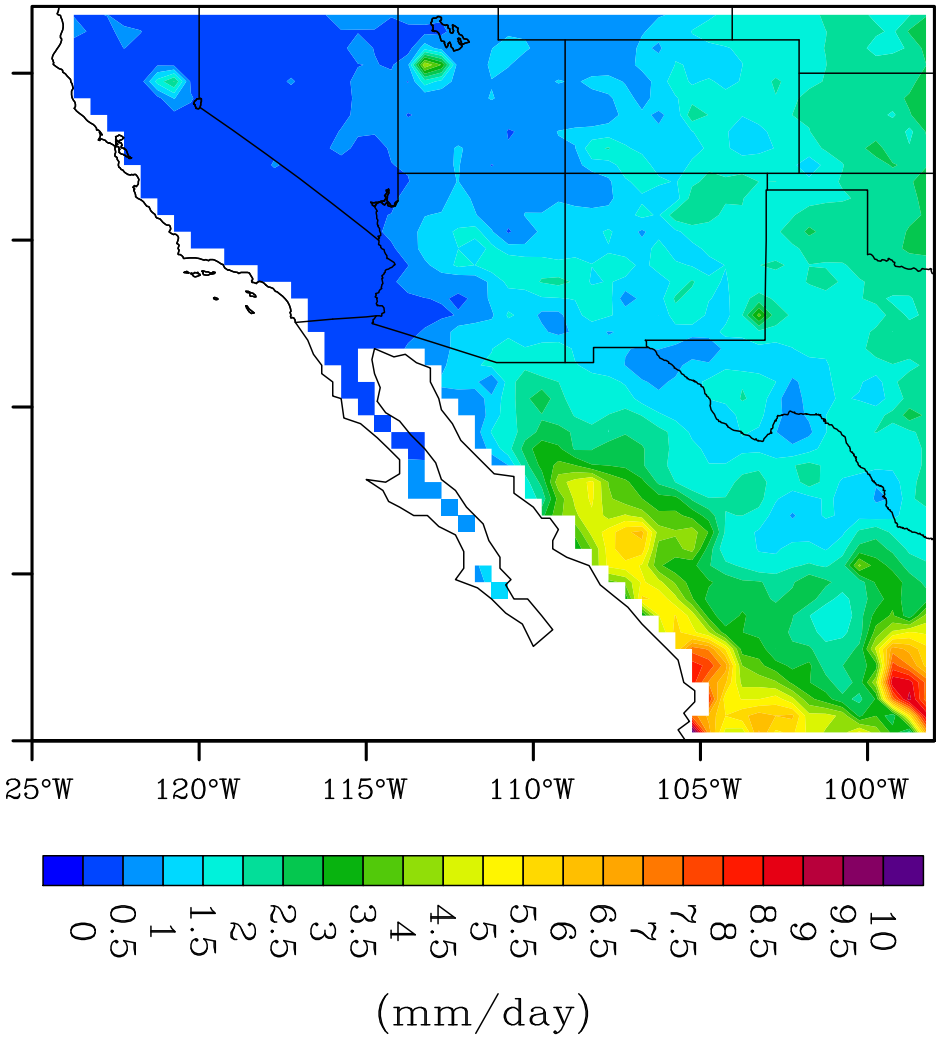
Bathymetric intervals only apply to ocean bodies


50 km
T85
25 km
10 km
3000
2700
2400
2100
1800
1500
1200
900
600
300
0
(m)



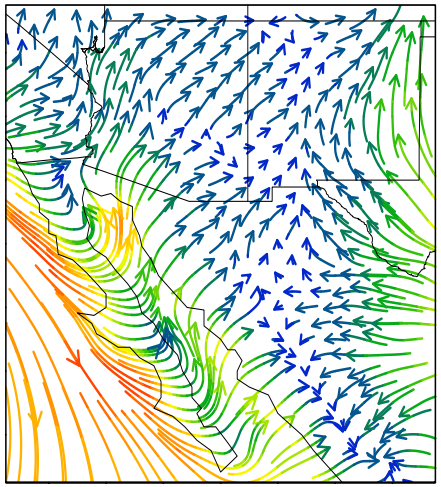


JJAS Average Precipitation

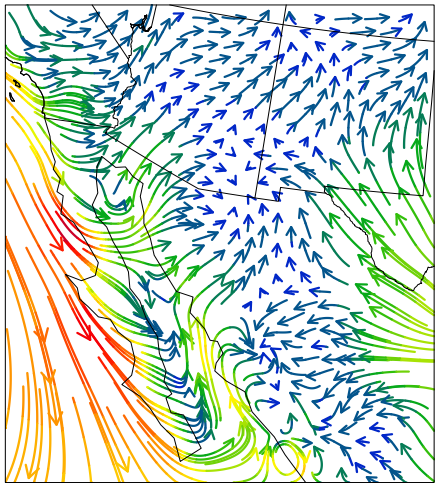


JJAS Surface Moisture Flux

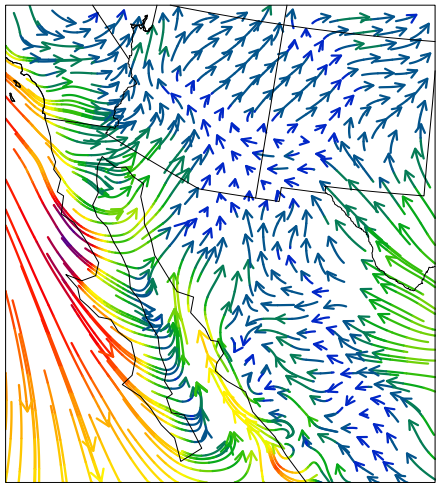
CFSR



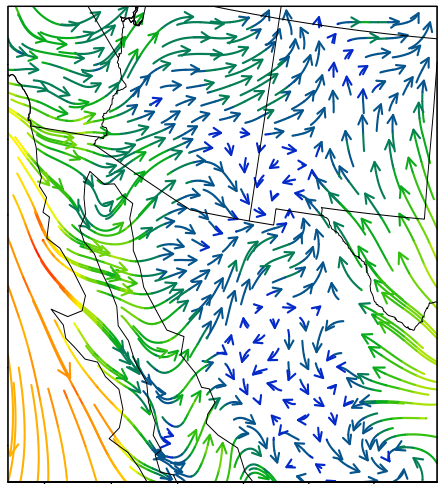
RCM4-erain 50km



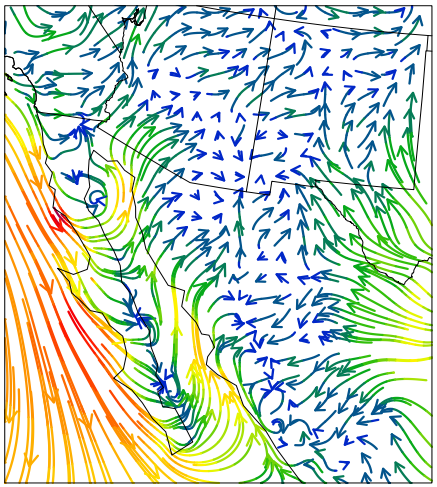
RCM4-mpi 50km



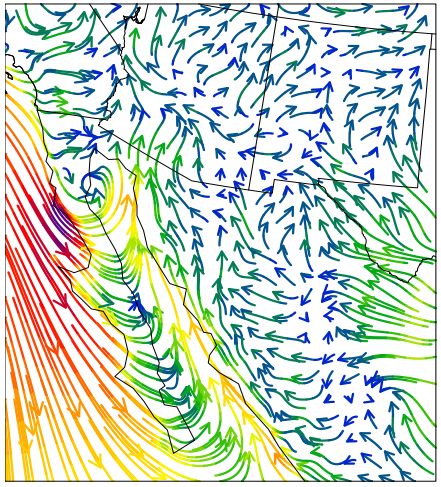
RCM3-ncep 50km

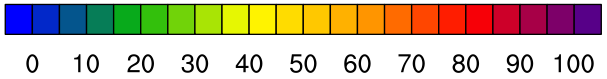


RCM4-erain 25km



RCM4-mpi 25km



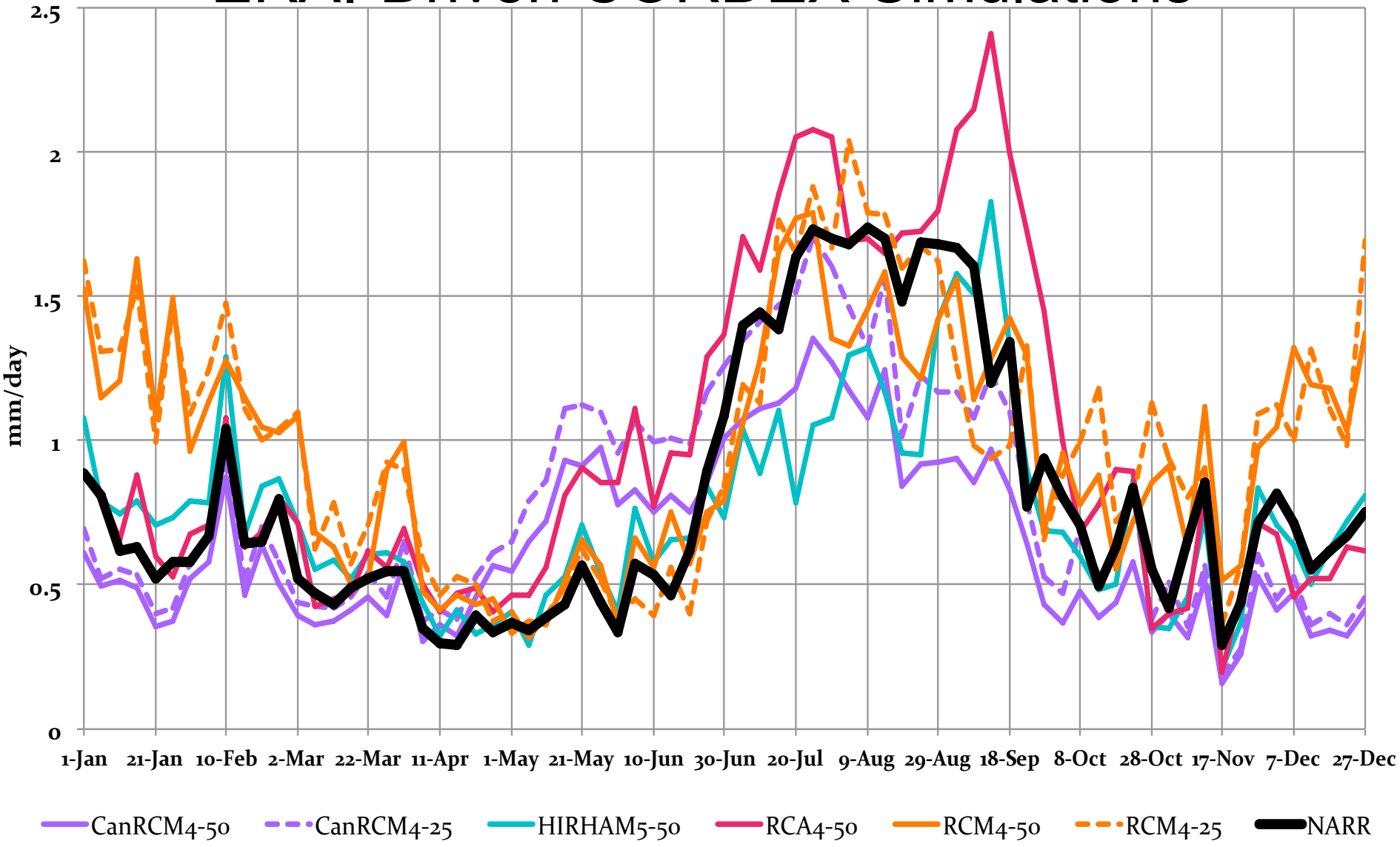


Major Differences:

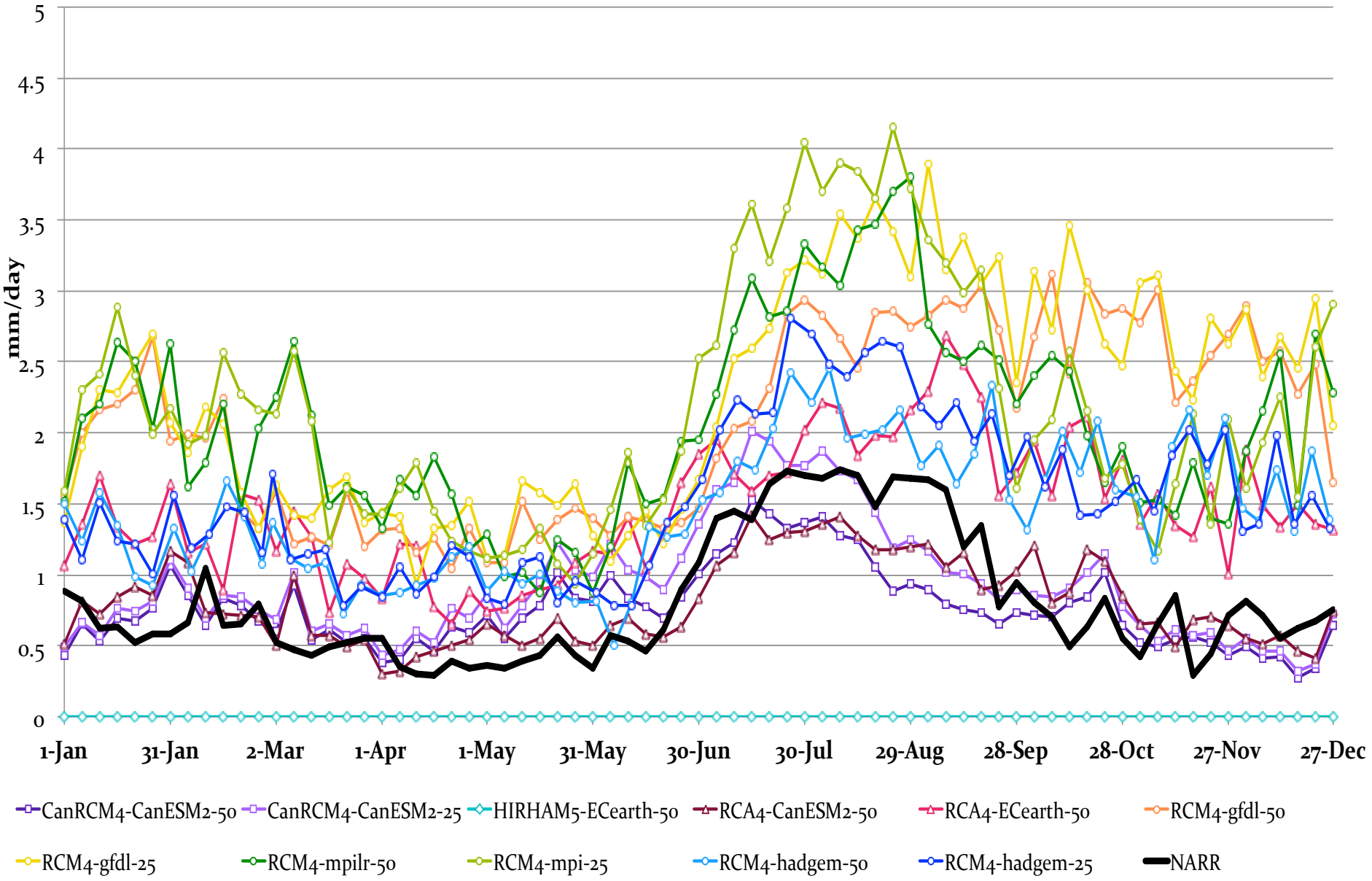
- Different reanalysis for ERA-interim only (different SSTs).
- Southern boundary further south.
- Emanuel over ocean.

1990-2009 5-day Average Precipitation Climatology

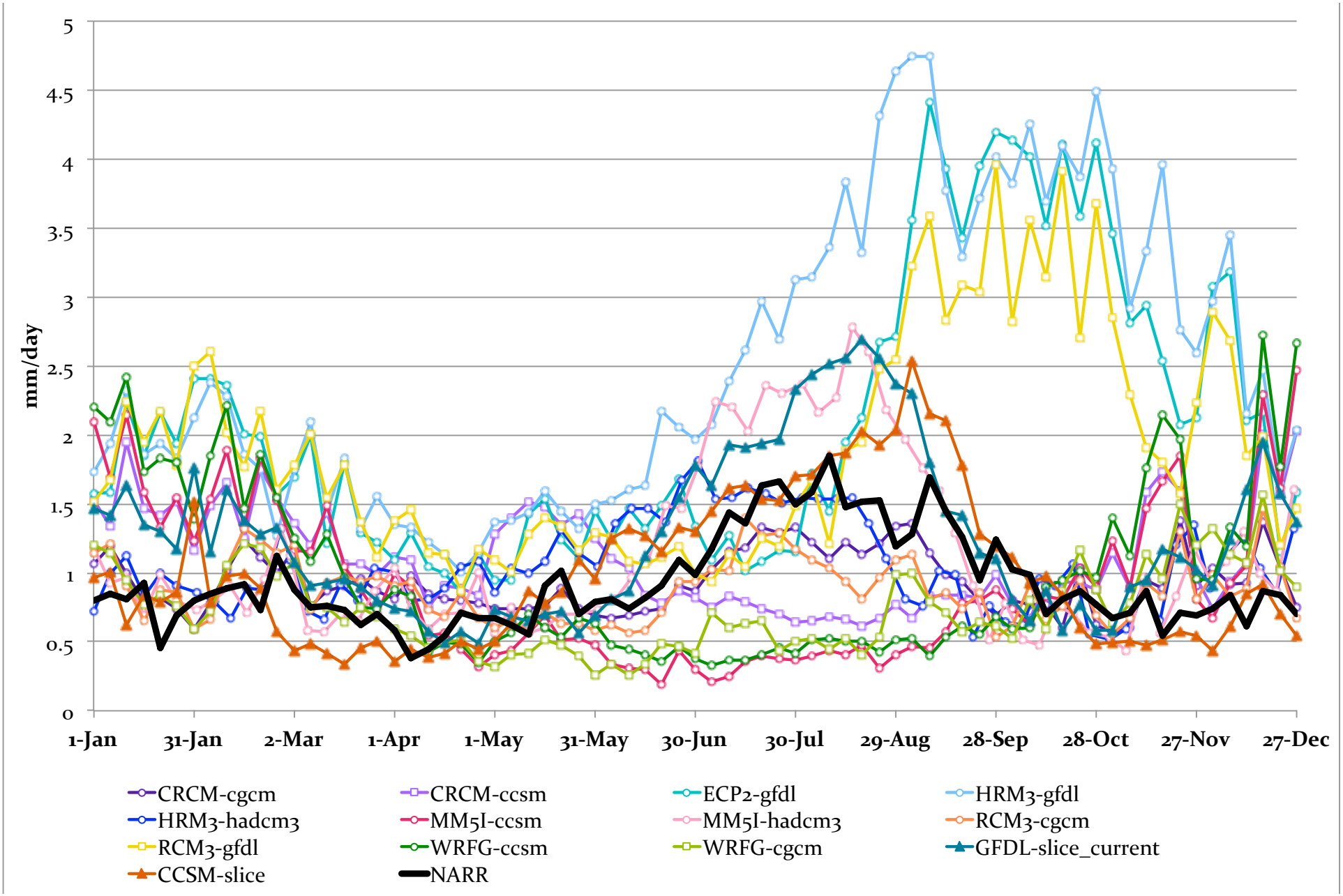
ERAI-Driven CORDEX Simulations

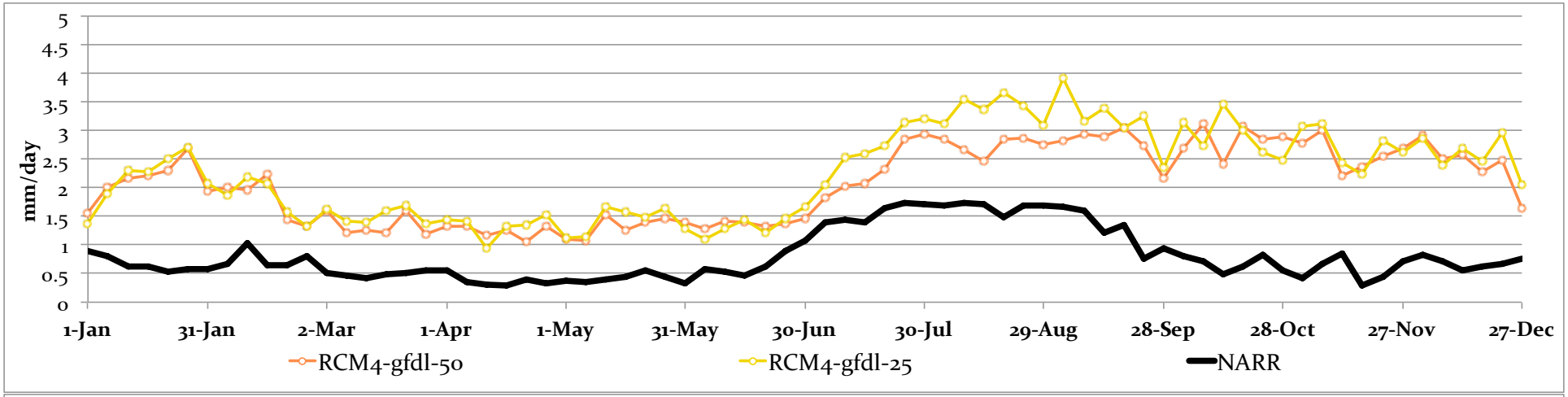


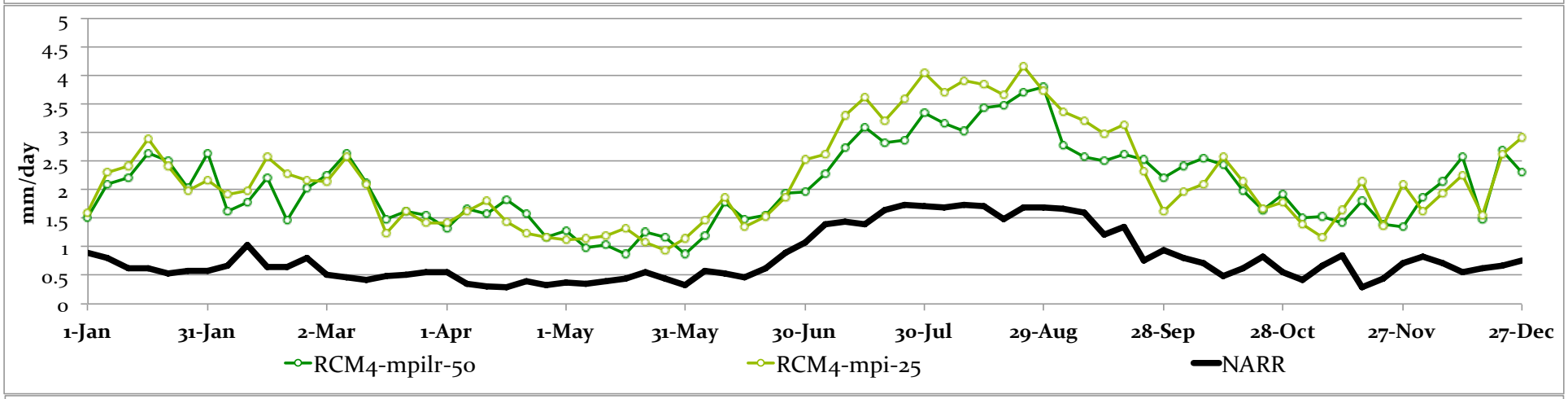
1971-1999 GCM-Driven: NA-CORDEX

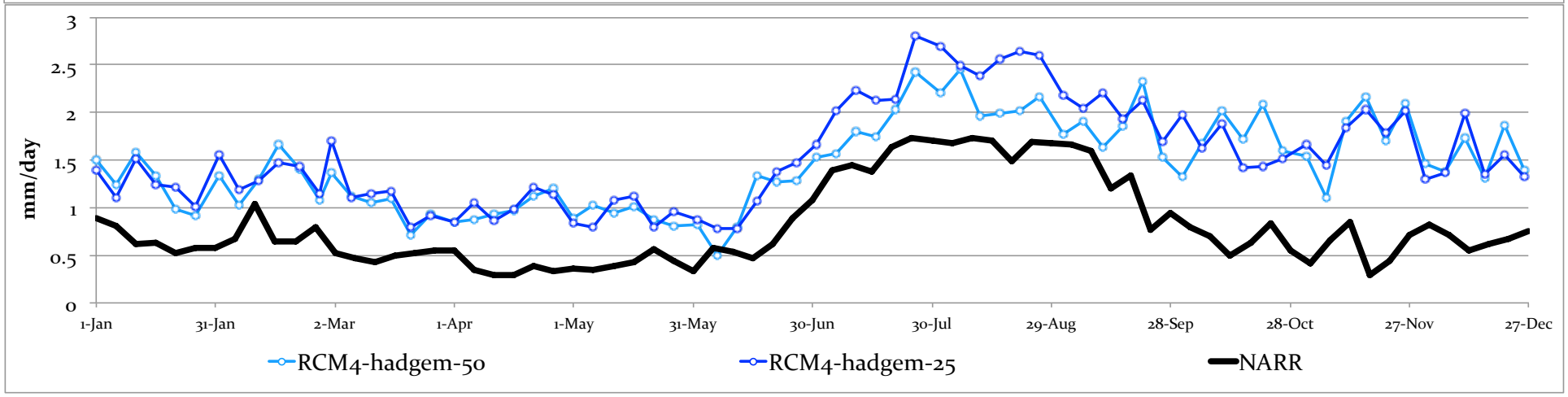


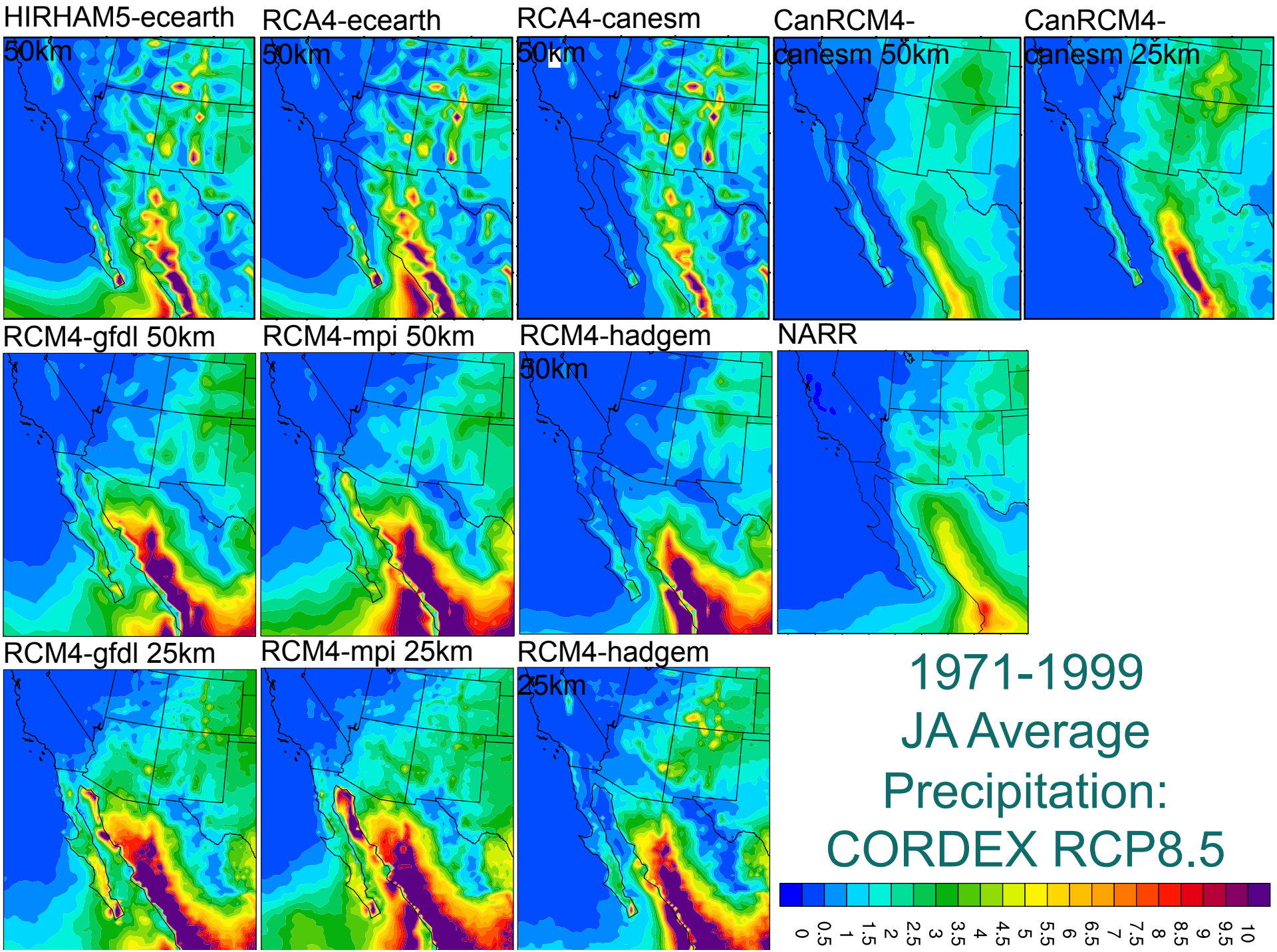
1971-1999 GCM-driven: NARCCAP

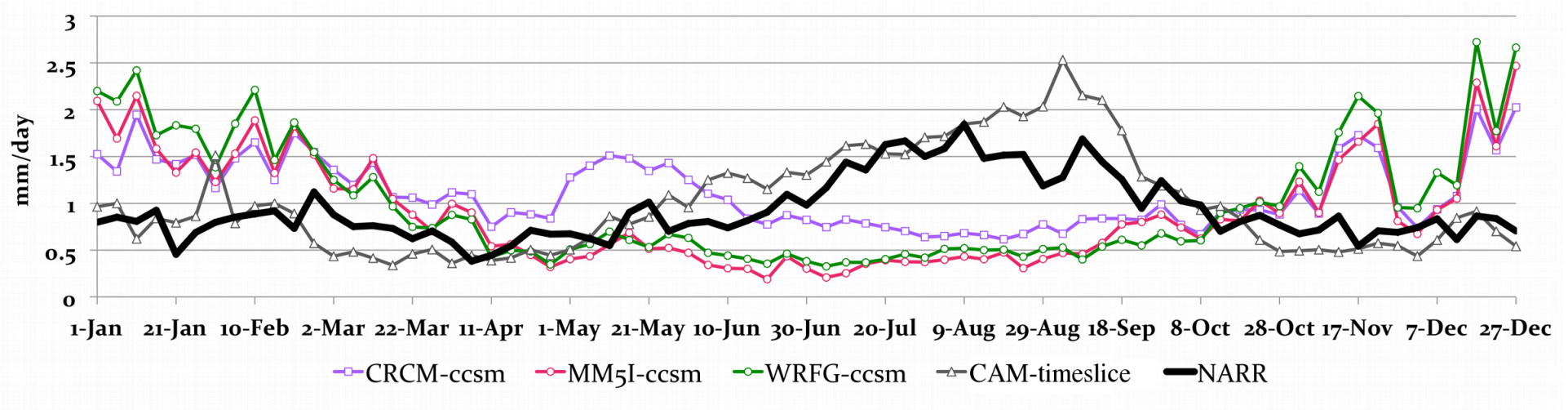



mm/day
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1-Jan
31-Jan
2-Mar
1-Apr
1-May
31-May
30-Jun
30-Jul
29-Aug
28-Sep
28-Oct
27-Nov
27-Dec
RCM4-gfdl-50
RCM4-gfdl-25
NARR


mm/day
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1-Jan
31-Jan
2-Mar
1-Apr
1-May
31-May
30-Jun
30-Jul
29-Aug
28-Sep
28-Oct
27-Nov
27-Dec
RCM4-mpilr-50
RCM4-mpi-25
NARR

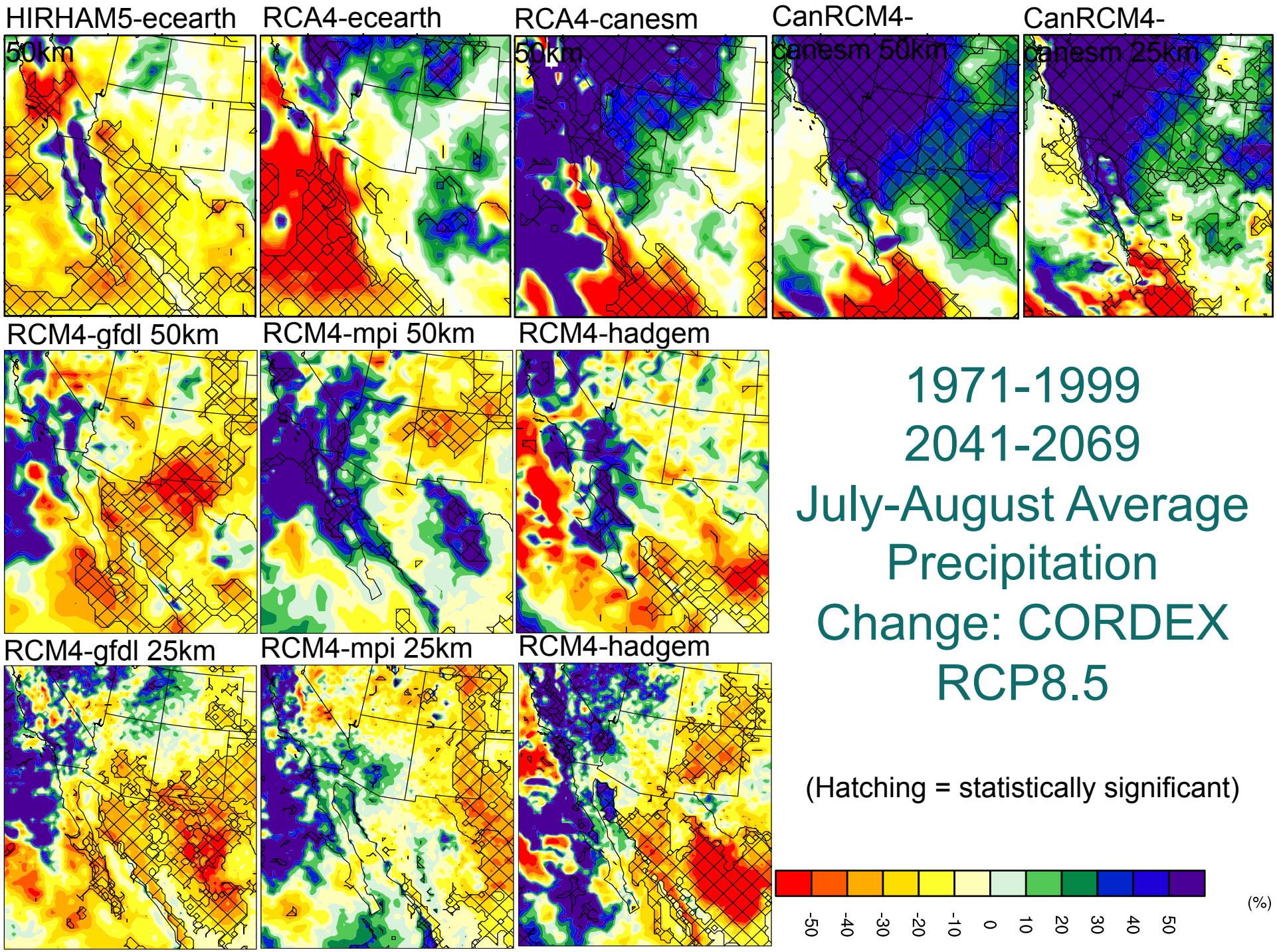

mm/day
3
2.5
2
1.5
1
0.5
0
1-Jan
31-Jan
2-Mar
1-Apr
1-May
31-May
30-Jun
30-Jul
29-Aug
28-Sep
28-Oct
27-Nov
27-Dec
RCM4-hadgem-50
RCM4-hadgem-25
NARR


HIRHAM5-ecearth 50km
RCA4-ecearth 50km
RCA4-canesm 50km
CanRCM4-canesm 50km
CanRCM4-canesm 25km
RCM4-gfdl 50km
RCM4-mpi 50km
RCM4-hadgem 50km
NARR
RCM4-gfdl 25km
RCM4-mpi 25km
RCM4-hadgem 25km
1971-1999
JA Average
Precipitation:
CORDEX RCP8.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10

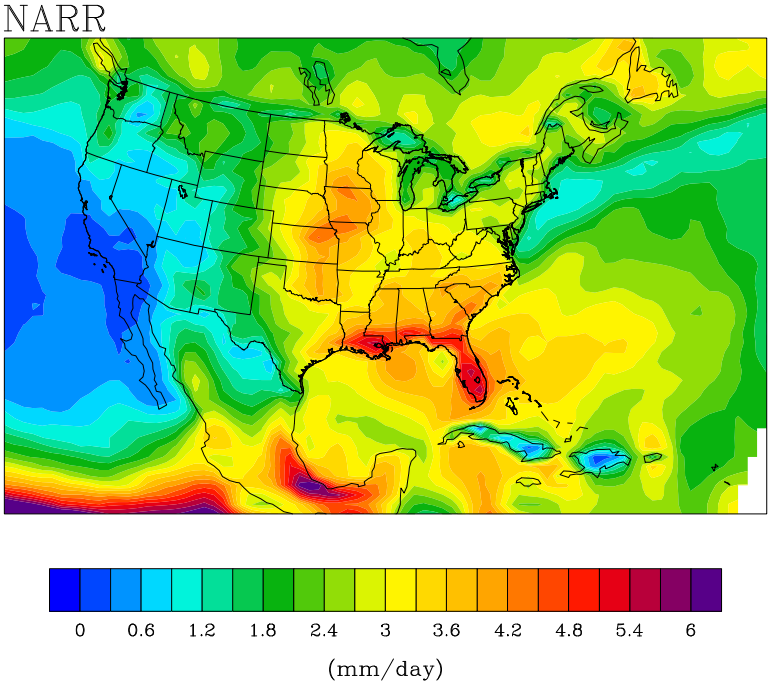


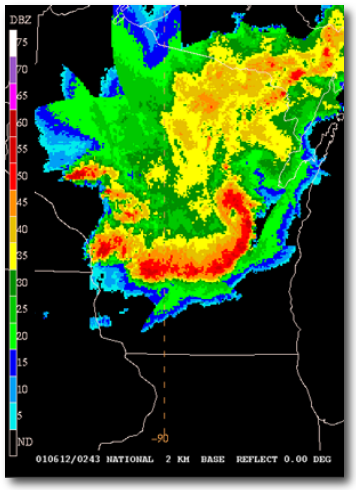
CCSM-driven NARCCAP Simulations: Useless Added Value

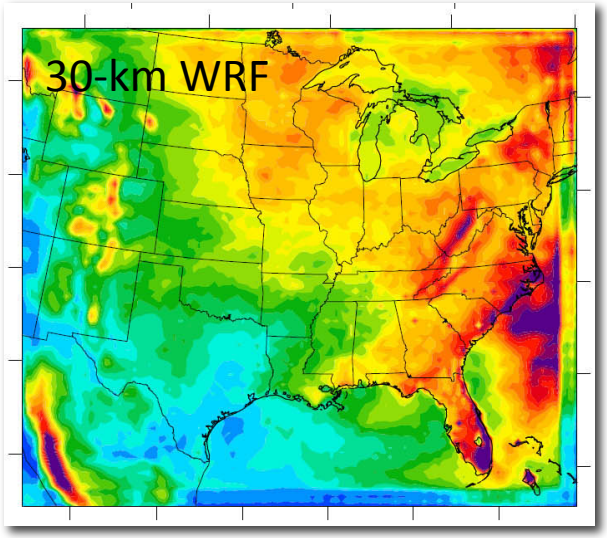
- Dry low-mid level moisture bias at western and southern boundaries inherited from the CCSM.
- SSTs over Gulf of Mexico are too cold.
- Monsoon high is too strong and about 800-km southwest of where it should be, flow is less tropical in origin.
- Little-to-no tropical easterly wave activity.
- ENSO too frequent and too weak.
- Moves to a more El Niño-like state in the future, which drives future drying. This change is not deemed credible (van Oldenborgh et al. 2005).


HIRHAM5-ecearth 50km
RCA4-ecearth
RCA4-canesm 50km
CanRCM4-canesm 50km
CanRCM4-canesm 25km
RCM4-gfdl 50km
RCM4-mpi 50km
RCM4-hadgem
RCM4-gfdl 25km
RCM4-mpi 25km
RCM4-hadgem
1971-1999
2041-2069
July-August Average Precipitation Change: CORDEX RCP8.5
(Hatching = statistically significant)
-50 -40 -30 -20 -10 0 10 20 30 40 50
(%)

The Diurnal Cycle of Convection

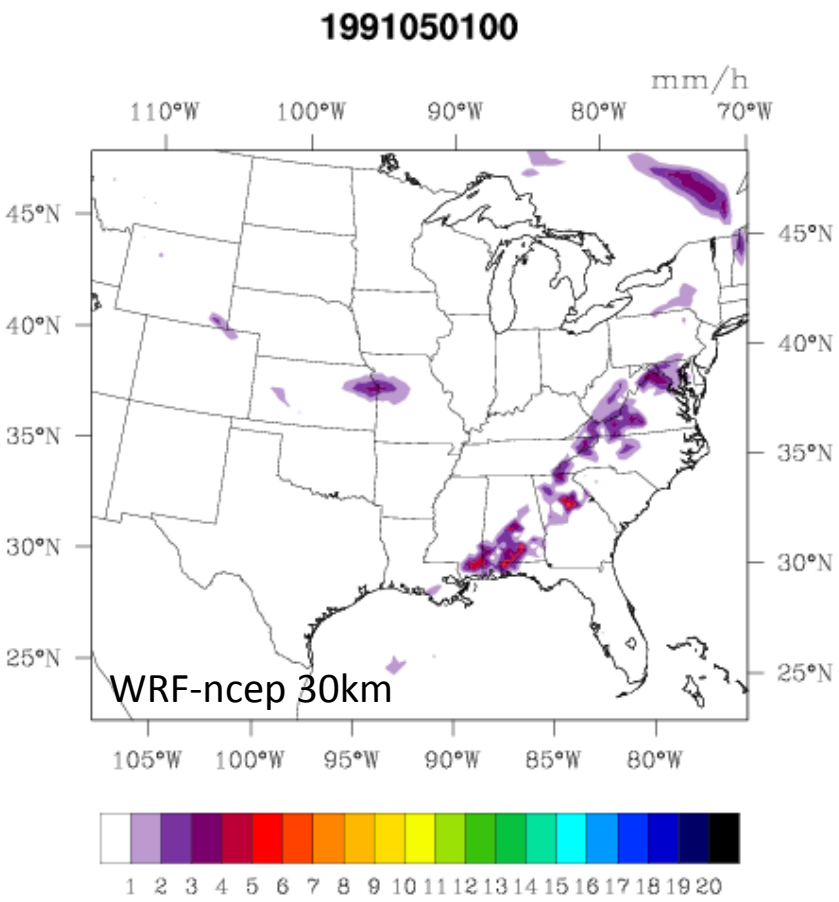


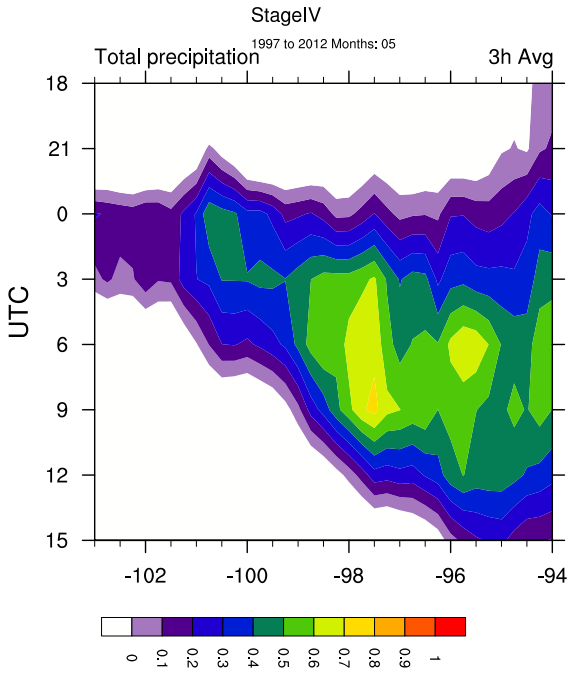




MJJA Average Precipitation

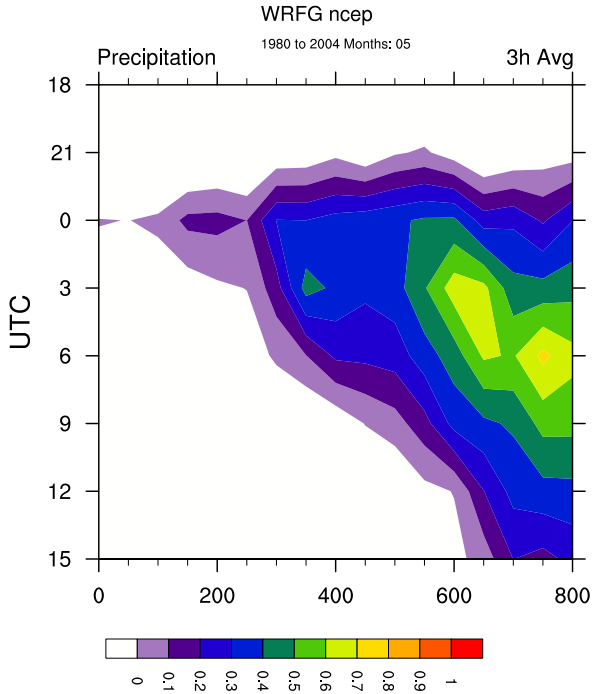
- Is it possible to capture the diurnal cycle of convection in the U.S. Great Plains without explicit convection?
- If so, is for the right reason?





Stage IV Radar interpolated up to 50-km

Southern Plains



50km WRFG-ncep NARCCAP

Southern Plains

Bukovsky, M.S., J.S. Kain, and M.E. Baldwin, 2005: Bowing convective systems in a popular operational model: **Are they for real?** Wea. Forecasting, 21, 307-324.

Bukovsky, M.S., and D.J. Karoly, 2011: A regional modeling study of climate change impacts on warm-season precipitation in the central U.S. J. Climate, 24, 1985-2002.

So Now What?

- NA-CORDEX is a work in progress.
- Select variables from contributed simulations will be archived at na-cordex.org
  - Surface variables with daily and monthly means, possibly 3h precipitation
  - Bias corrected variables also, and interpolated data on a common grid, with guidance on usage.
- WRF runs (with HadGEM and GFDL) to be completed.
- Perform analyses on winter precipitation in the Southern Mississippi River Basin region and the Colorado River Basin.
- Opportunity for some results to be used in the next U.S. National Climate Assessment (due by end of summer).

The End

bukovsky@ucar.edu

Bukovsky et al. 2013: Towards assessing NARCCAP regional climate model credibility for the North American monsoon: Current climate simulations. J. Climate, 26, 8802-8826.

Bukovsky et al. 2015: Towards assessing NARCCAP regional climate model credibility for the North American monsoon: Future climate simulations. J. Climate, 28, 6707-6728 .

Bukovsky et al. 2016: A credible, poleward shift in warm-season precipitation projected for the U.S. Southern Great Plains. J. Climate, in review.