



NCAR

NA-CORDEX Overview

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National Center for Atmospheric Research

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A. Frigon, W. Gutowski, E. Kjellström, R. Laprise, S. McGinnis, G. Nikulin,
J. Sinocca, L. Sushama, and K. Winger

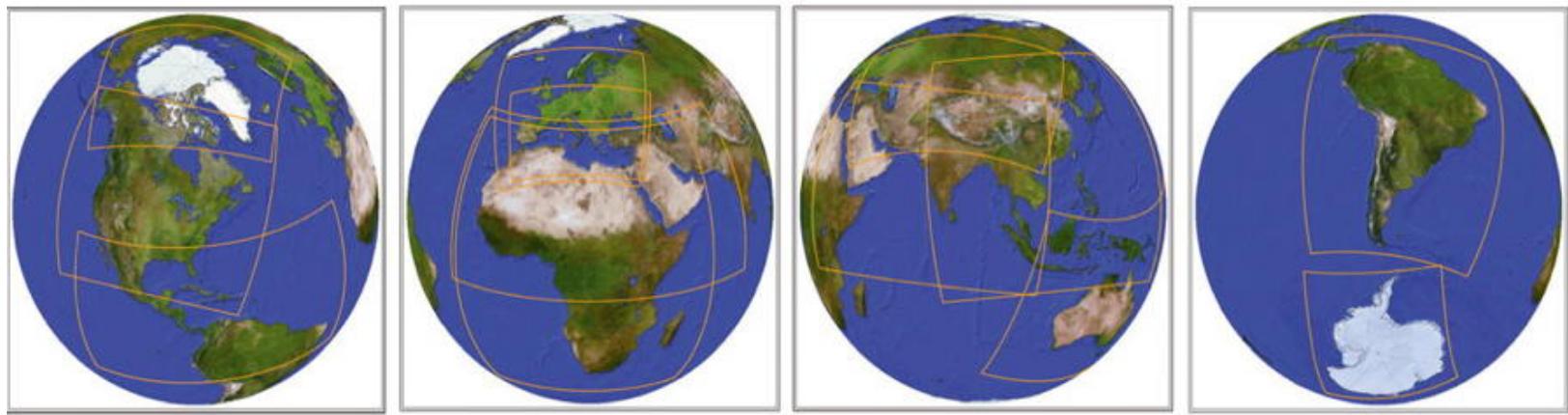
CLIVAR Summit

August 2017

National Center for Atmospheric Research



<http://www.cordex.org>



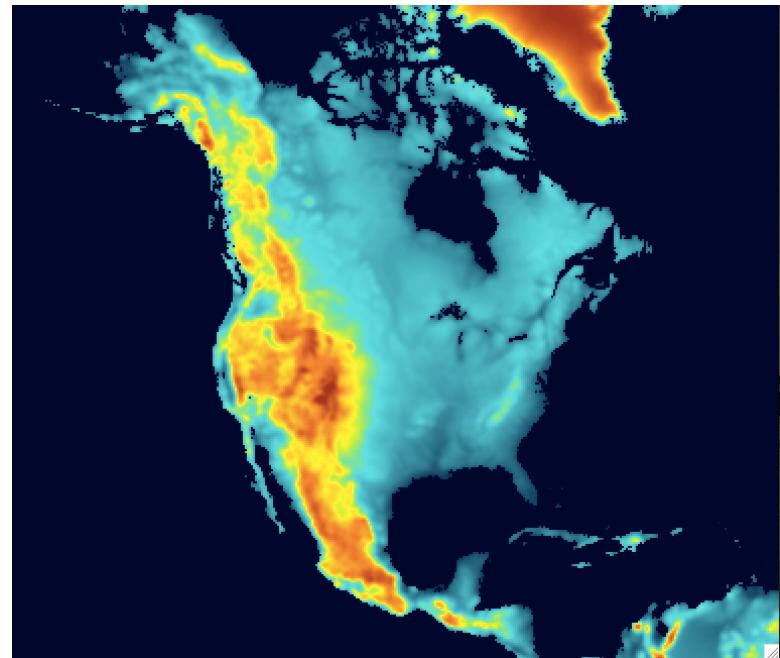
The CORDEX vision is to advance and *coordinate* the science and application of regional climate downscaling through global partnerships.

Selective specs:

- Must use full domain.
- 1950-2100
- 50km, 25km, some domains also have 12km simulations.
- Post-processed output is provided in a common format similar to data in the CMIP archive.



- ERA-Interim Driven Simulations
 - 1990-2009
 - 9 RCMs
- GCM-driven Simulations
 - 6 RCMs, 5 CMIP5 GCMs
 - 150 yr transient simulations.
 - 1950-2100
 - 25-km & 50-km resolution
 - RCP8.5 future scenario
 - Some also use RCP 4.5
 - One simulation uses RCP 2.6



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	GFDL-ESM2M (2.5)	MPI-ESM-LR (3.6)	HadGEM2-ES (4.6)	CanESM2 (3.7)	EC-EARTH (3.3)	MPI-ESM-MR (3.4)
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		
CRCM5^ (UQAM & OURANOS)	25km	25km*		50km 25km*		50km 25km*
RCA4 (SMHI)				50km	50km	

*In progress

^With and without nudging depending on
institute.

Orange = RCP 4.5 and RCP 8.5

Black = RCP 8.5 Only

Purple = RCP 2.6, RCP 4.5, and RCP 8.5

		50 km / 0.44°					25 km / 0.22°						
		GFDL	Had	MPI	Can	ECE		GFDL	Had	MPI	Can	ECE	
RCP 8.5	O-CRCM						O-CRCM	X		X	X		O-CRCM
	RegCM4	X	X	X			RegCM4	X	X	X			RegCM4
	WRF	X	X	X			WRF	X	X	X			WRF
	U-CRCM5			X	X		U-CRCM5			X			U-CRCM5
	CanRCM4				X		CanRCM4				X		CanRCM4
	RCA4				X	X	RCA4						RCA4
	HIRHAM5					X	HIRHAM5						HIRHAM5
		GFDL	Had	MPI	Can	ECE		GFDL	Had	MPI	Can	ECE	
RCP 4.5	O-CRCM5						O-CRCM5						O-CRCM5
	RegCM4						RegCM4						RegCM4
	WRF						WRF						WRF
	U-CRCM5			X	X		U-CRCM5						U-CRCM5
	CanRCM4				X		CanRCM4				X		CanRCM4
	RCA4				X	X	RCA4						RCA4
	HIRHAM5					X	HIRHAM5						HIRHAM5
		GFDL	Had	MPI	Can	ECE		GFDL	Had	MPI	Can	ECE	
		50 km / 0.44°					25 km / 0.22°						

3 x 2 x 2 (+1) subexperiment comparing RCM, GCM, and resolution.

Subensemble comparing RCP 4.5 with RCP 8.5 at fixed resolution.

2 x 2 subexperiment comparing emissions scenario and resolution.

NA-CORDEX



- Hosting a short-list of the most commonly used variables on NCAR's ESG node, with access via na-cordex.org
 - Sponsored by: DOD's ESTCP
 - Includes 'value-added' products:
 - bias-corrected variables using KDDM
 - different time-averages
 - data interpolated to a common grid
- What's available right now?
 - From almost all simulations except the new CRCM5 simulations and a couple of WRF simulations...
 - Precipitation
 - Temperature
 - Daily minimum temperature
 - Daily maximum temperature



NA-CORDEX



<https://na-cordex.org/>

<https://www.earthsystemgrid.org/search/cordexsearch.html>

NA-CORDEX Search

NA-CORDEX Documentation: Explanation of Dataset Facets

Variables	Experiment	Driver	Model	Frequency	Grid	Bias Correction
<input type="checkbox"/> pr	<input type="checkbox"/> eval	<input type="checkbox"/> ERA-Int	<input type="checkbox"/> CRCM5	<input type="checkbox"/> fixed	<input type="checkbox"/> NAM-11	
<input type="checkbox"/> tas	<input type="checkbox"/> hist	<input type="checkbox"/> CanESM2	<input type="checkbox"/> CRCM5-OUR	<input type="checkbox"/> 30m	<input type="checkbox"/> NAM-22	<input type="checkbox"/> kddm
<input type="checkbox"/> tasmax	<input type="checkbox"/> rcp26	<input type="checkbox"/> EC-EARTH	<input type="checkbox"/> CRCM5-UQAM	<input type="checkbox"/> 1hr	<input type="checkbox"/> NAM-44	<input type="checkbox"/> raw
<input type="checkbox"/> tasmin	<input type="checkbox"/> rcp45	<input type="checkbox"/> GFDL-ESM2M	<input type="checkbox"/> CanRCM4	<input type="checkbox"/> 3hr	<input type="checkbox"/> NAM-22i	
	<input type="checkbox"/> rcp85	<input type="checkbox"/> HadGEM2-ES	<input type="checkbox"/> HIRHAM5	<input type="checkbox"/> 6hr	<input type="checkbox"/> NAM-44i	
		<input type="checkbox"/> MPI-ESM-LR	<input type="checkbox"/> RCA4	<input type="checkbox"/> day		
		<input type="checkbox"/> MPI-ESM-MR	<input type="checkbox"/> RegCM4	<input type="checkbox"/> mon		
			<input type="checkbox"/> WRF	<input type="checkbox"/> seas		
				<input type="checkbox"/> ann		
				<input type="checkbox"/> ymon		

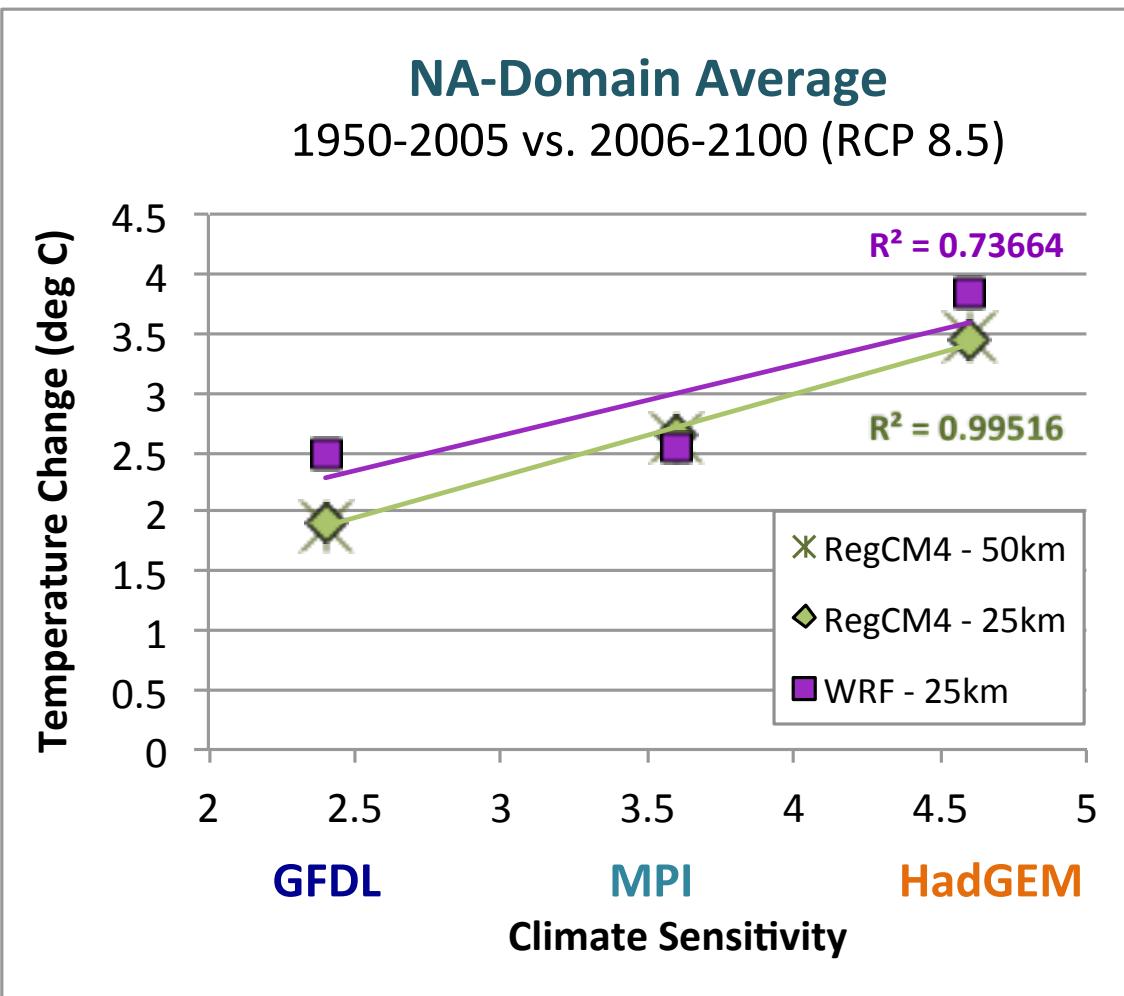
Now with spatial and temporal subsetting!

We will be adding other commonly requested surface variables to this archive. I.e. variables that are commonly used in impacts models. E.g. huss, hurs, uas, vas, rsds. For other variables, you will need to contact the point of contact for each simulation. Or, find them in the main CORDEX ESGF archive or the modeling group's archive (e.g. for the CRCM5, HIRHAM, and RCA runs).

Next Steps

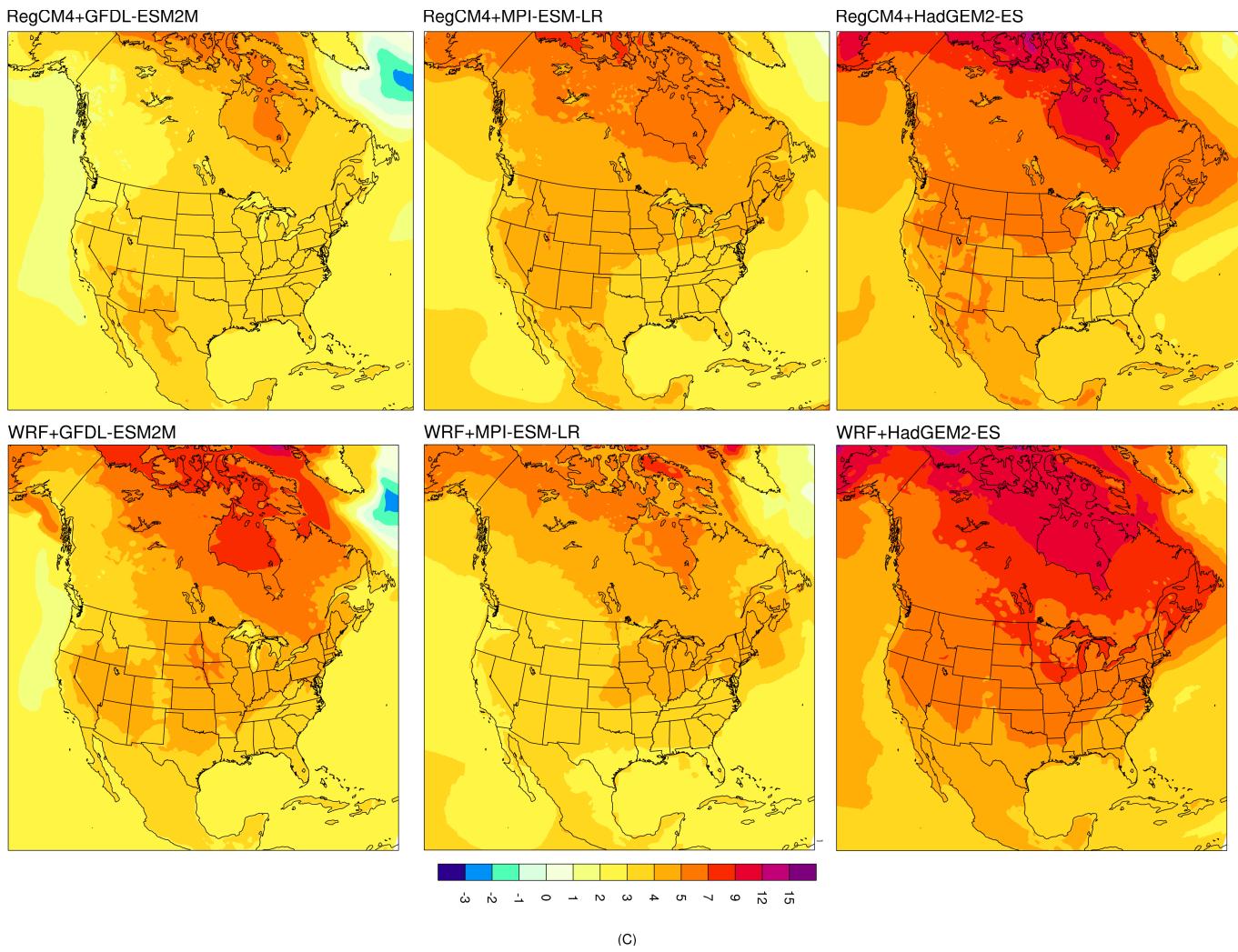
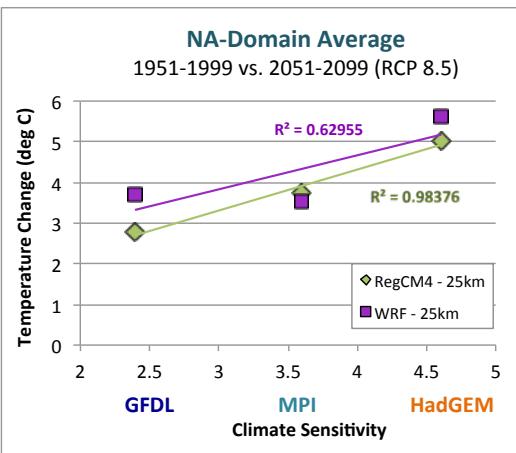
- NA-CORDEX is still a work in progress.
- Select variables from contributed simulations will continue to be archived at na-cordex.org
 - Surface variables with at least daily means and sub-daily precipitation (when available).
 - pr, tmin, tmax, tas, snow, huss, uas, vas, ps, rsds, fixed fields.
 - Seasonal bias and climate change plots for pr and tas from all simulations will be added to the website soon, as well as some guidance on usage.
- Opportunity for some results to be used in the next U.S. National Climate Assessment.
 - Particularly, a comparison between these dynamical downscaled simulations and a statistically-downscaled set.

Climate Sensitivity



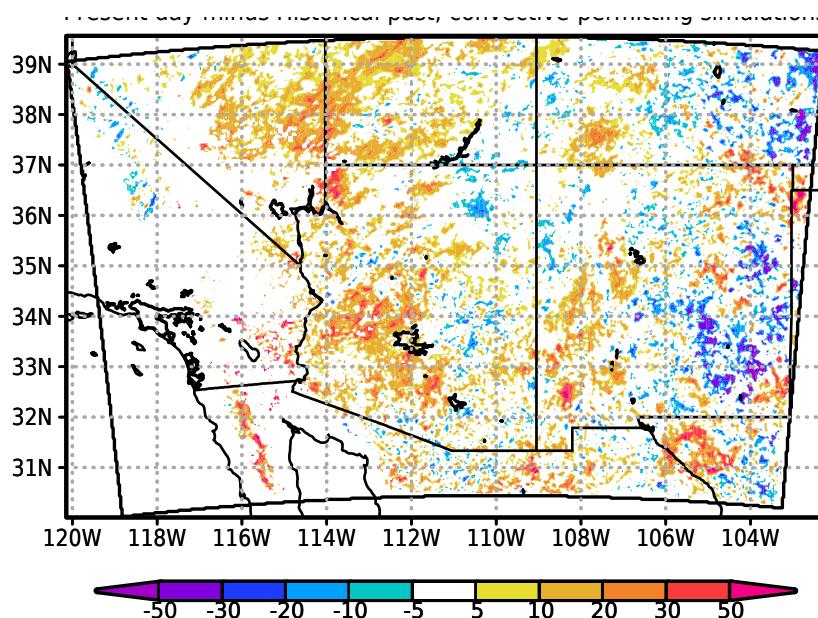
	GFDL (2.5)	MPI (3.6)	HadGEM2 (4.6)
RegCM4	25km 50km	25km 50km	25km 50km
WRF	25km 50km	25km 50km	25km 50km

Climate Sensitivity

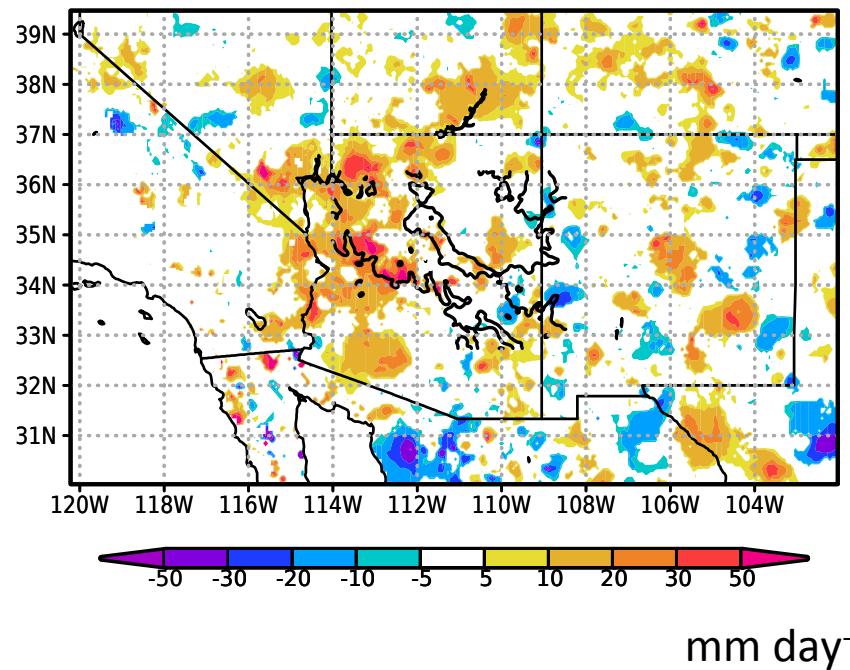


CP severe weather event simulations (reanalysis downscaled) vs. observed significant changes in extreme precipitation: **1950 - 1970 vs. 1990 - 2010**

WRF model: $\Delta x = 2.5 \text{ km}$ (CPM)



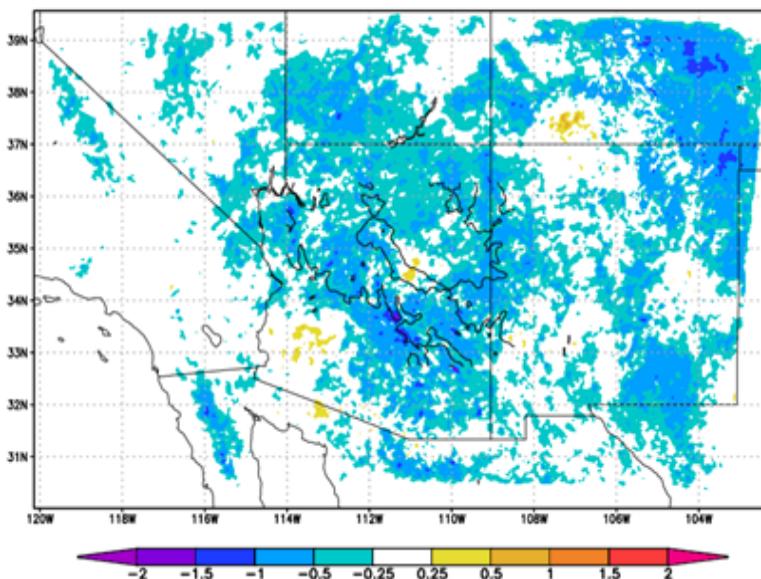
Station observations (Livneh)



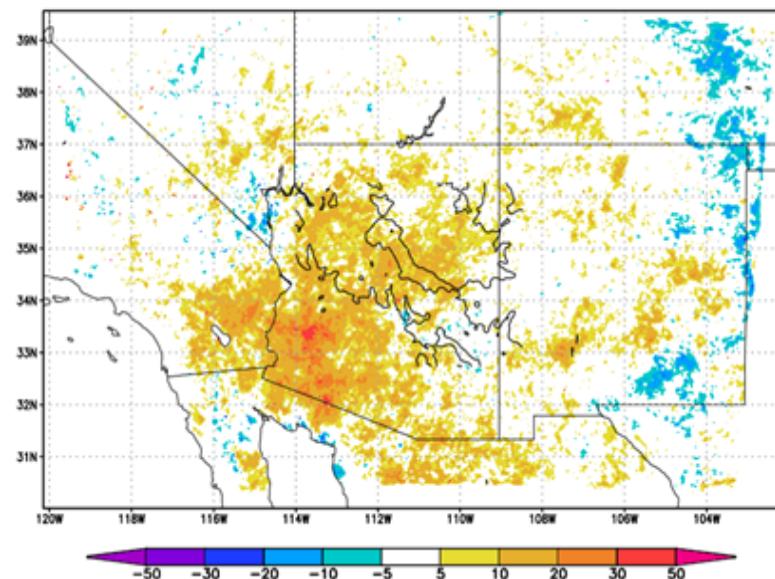
*Luong et al. (2016, J. Appl.
Meteor. and Climatol., in press)*

Significant changes in precipitation (mm day^{-1})
Convective-permitting severe weather event simulations
Use dynamically downscaled CMIP3
and NA-CORDEX data as the boundary forcing
2021-2040 minus 1991-2010

Mean trend from the ensemble of 4 models



Extreme trend from the ensemble of 4 models



Castro et al. (2016 AMS meeting)

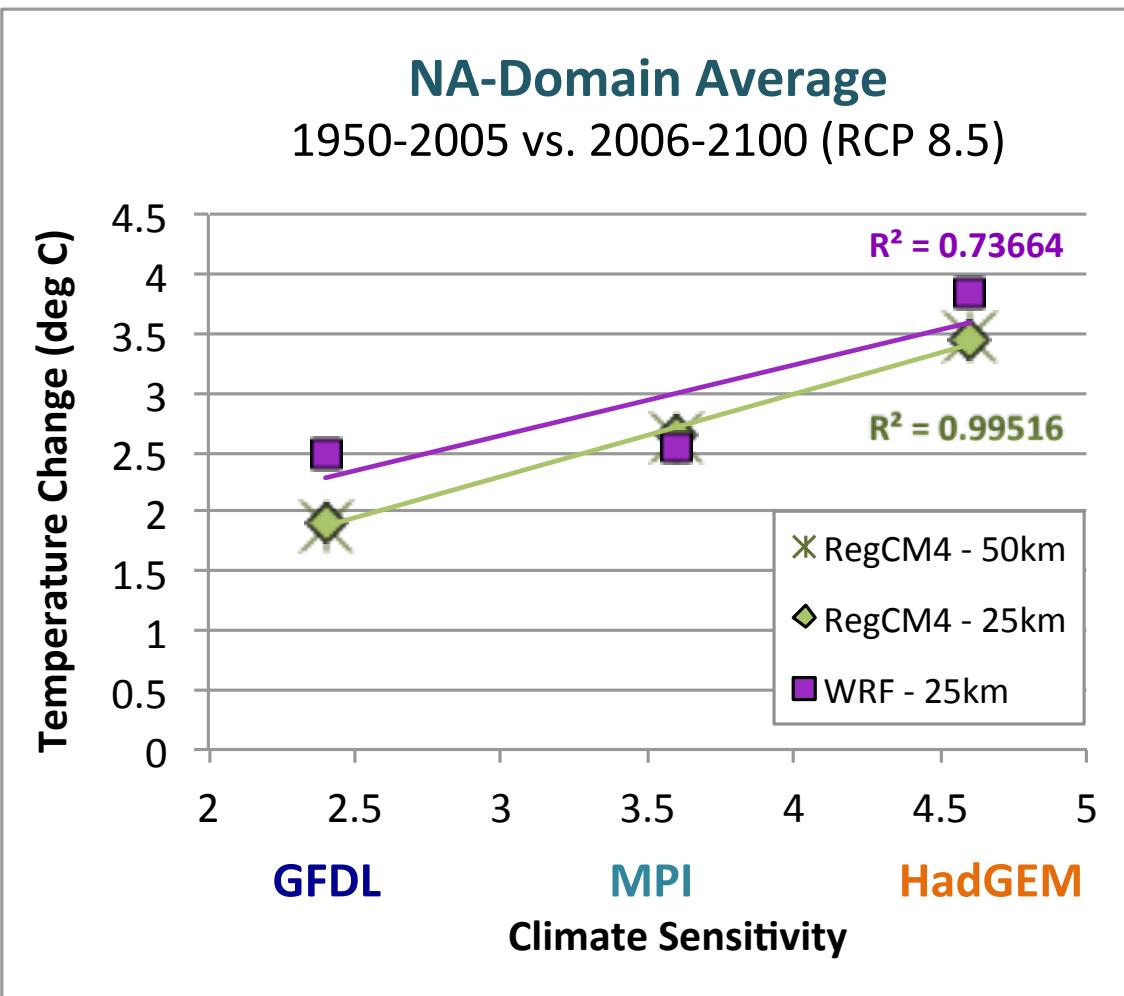
A map of North America showing atmospheric data. The map uses a color gradient where cooler temperatures are represented by blues and warmer temperatures or specific atmospheric conditions are represented by yellows and reds. There are distinct features of higher intensity (red/yellow) along the western coast of North America, particularly over the Pacific Ocean and parts of the continent, indicating areas of significant atmospheric activity or heating.

na-cordex.org

Previous analyses I've discussed in past "overview and sample results" versions of this talk.

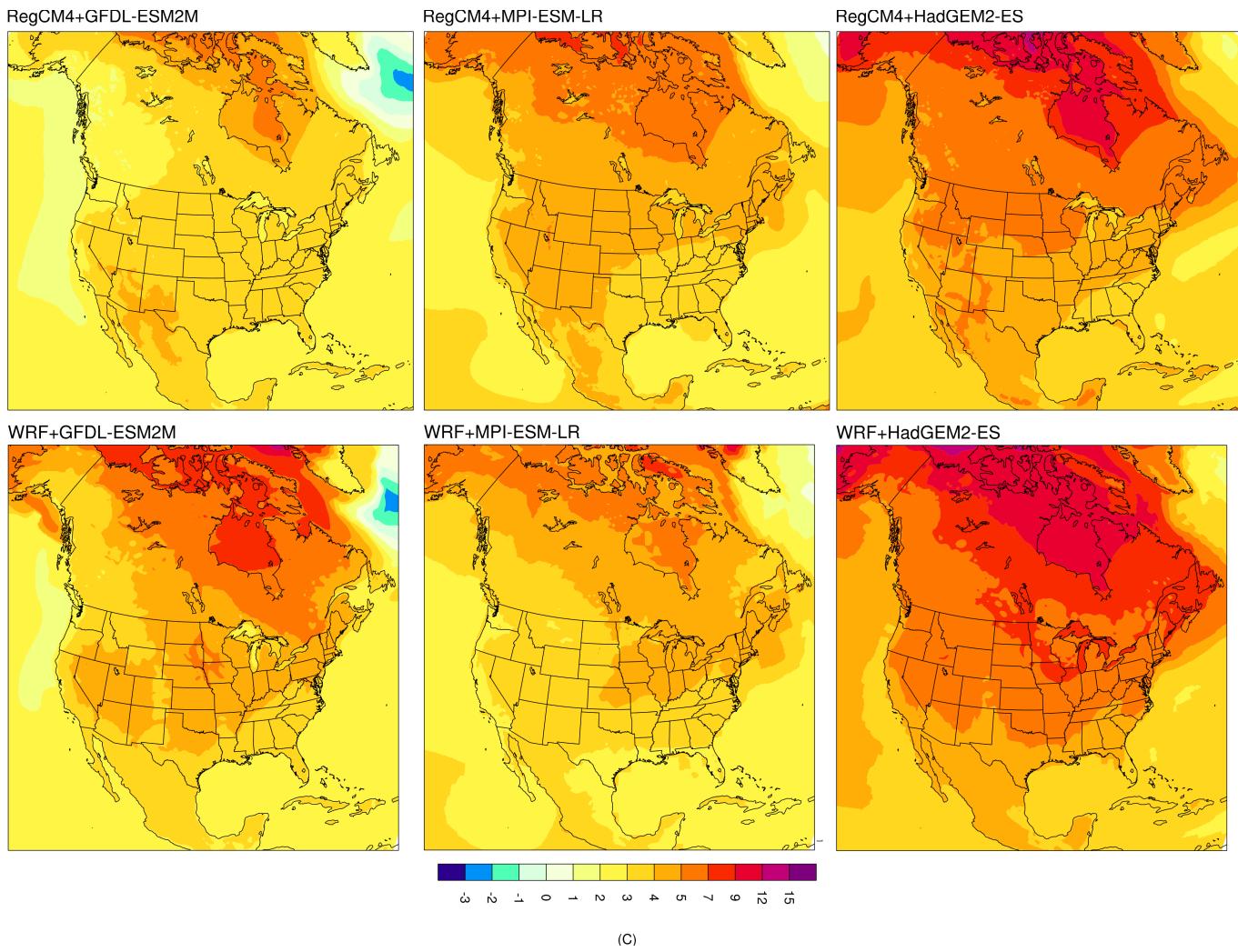
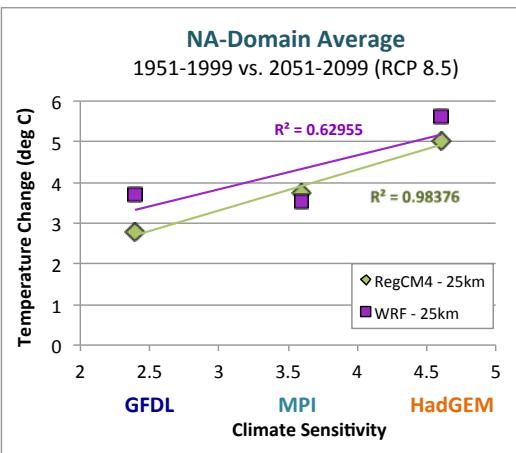
EXTRA SLIDES

Climate Sensitivity

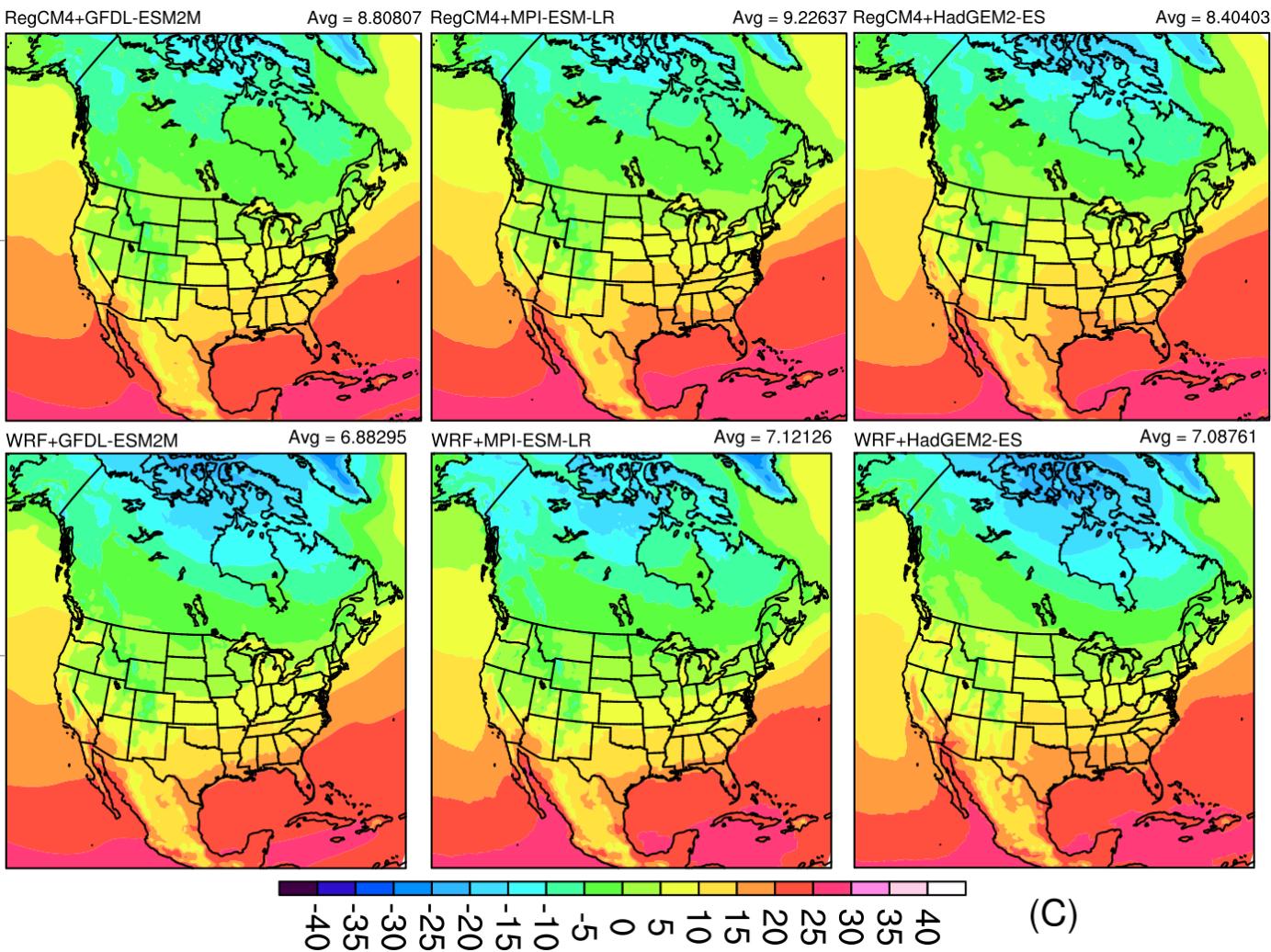
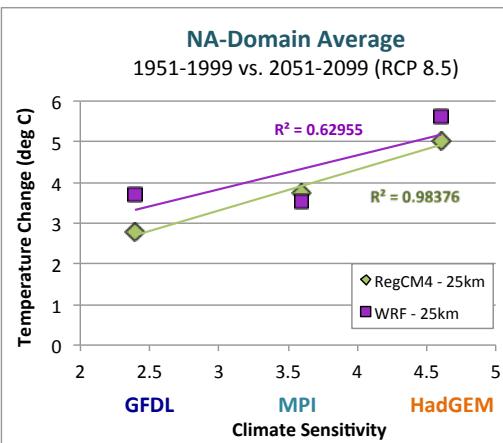


	GFDL (2.5)	MPI (3.6)	HadGEM2 (4.6)
RegCM4	25km 50km	25km 50km	25km 50km
WRF	25km 50km	25km 50km	25km 50km

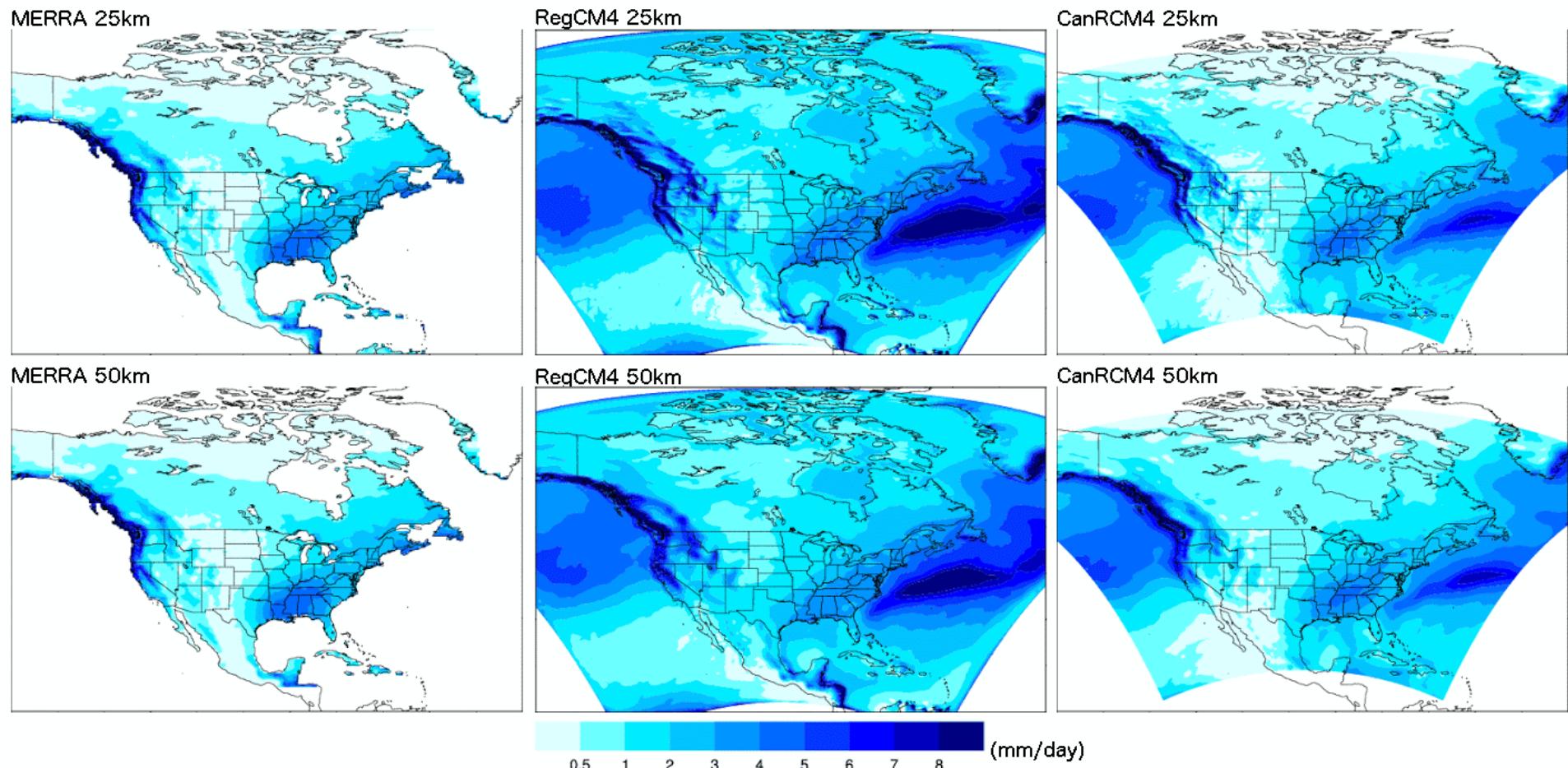
Climate Sensitivity



Climate Sensitivity



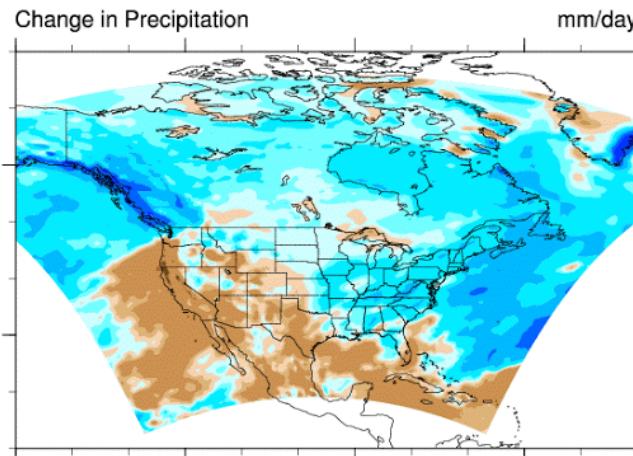
ERAI-Driven DJF Precipitation



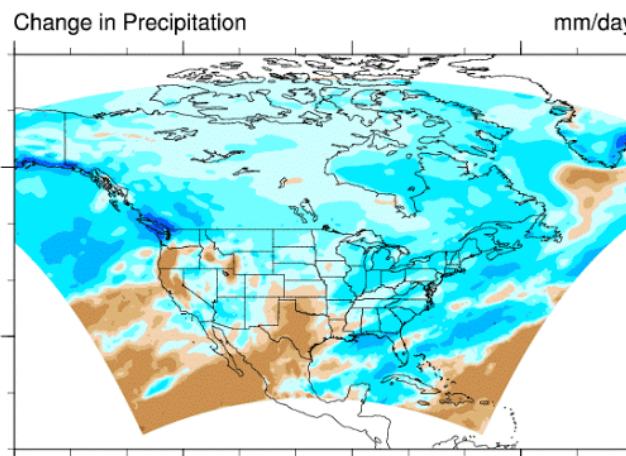
1990-2009

EC-EARTH-driven

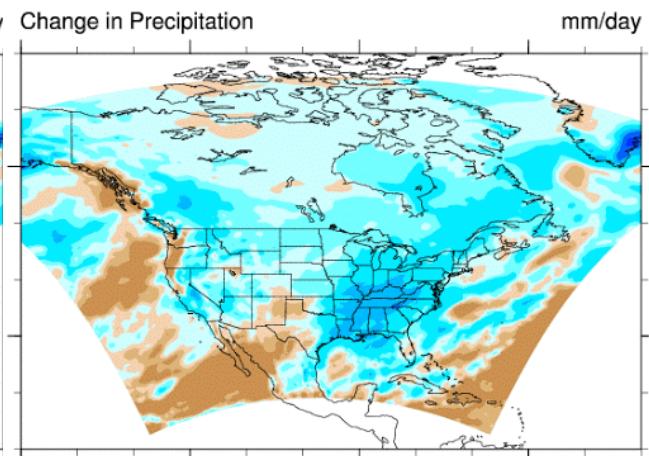
HIRHAM5-EC-EARTH NAM-44 rcp45 DJF



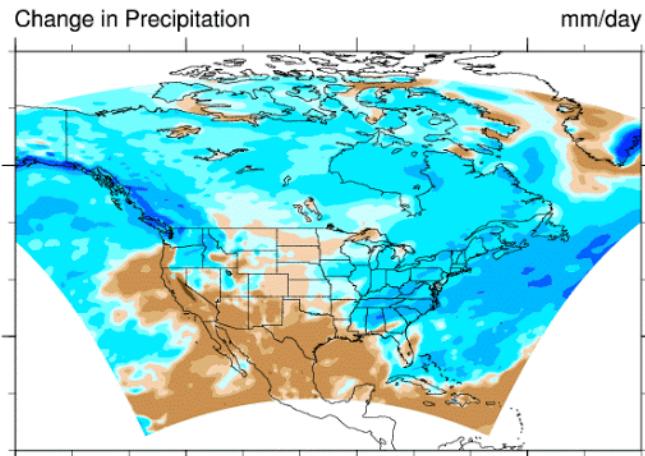
RCA4-EC-EARTH NAM-44 rcp45 DJF



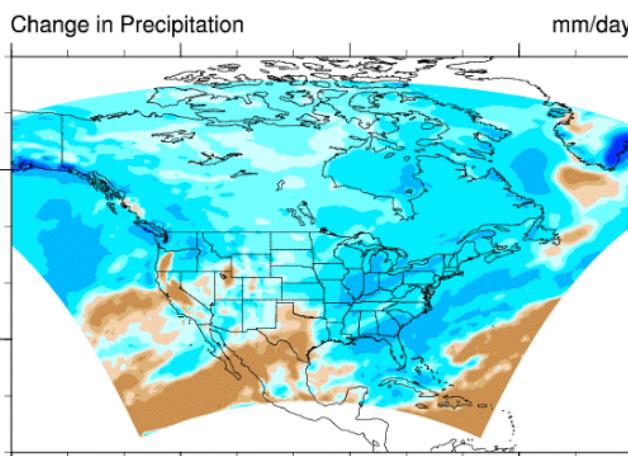
RCA4-EC-EARTH NAM-44 rcp26 DJF



HIRHAM5-EC-EARTH NAM-44 rcp85 DJF



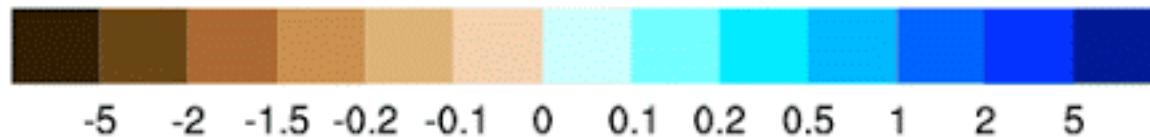
RCA4-EC-EARTH NAM-44 rcp85 DJF



1971-99

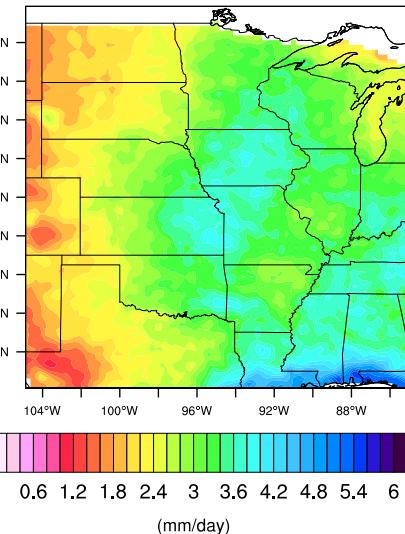
VS.

2041-69

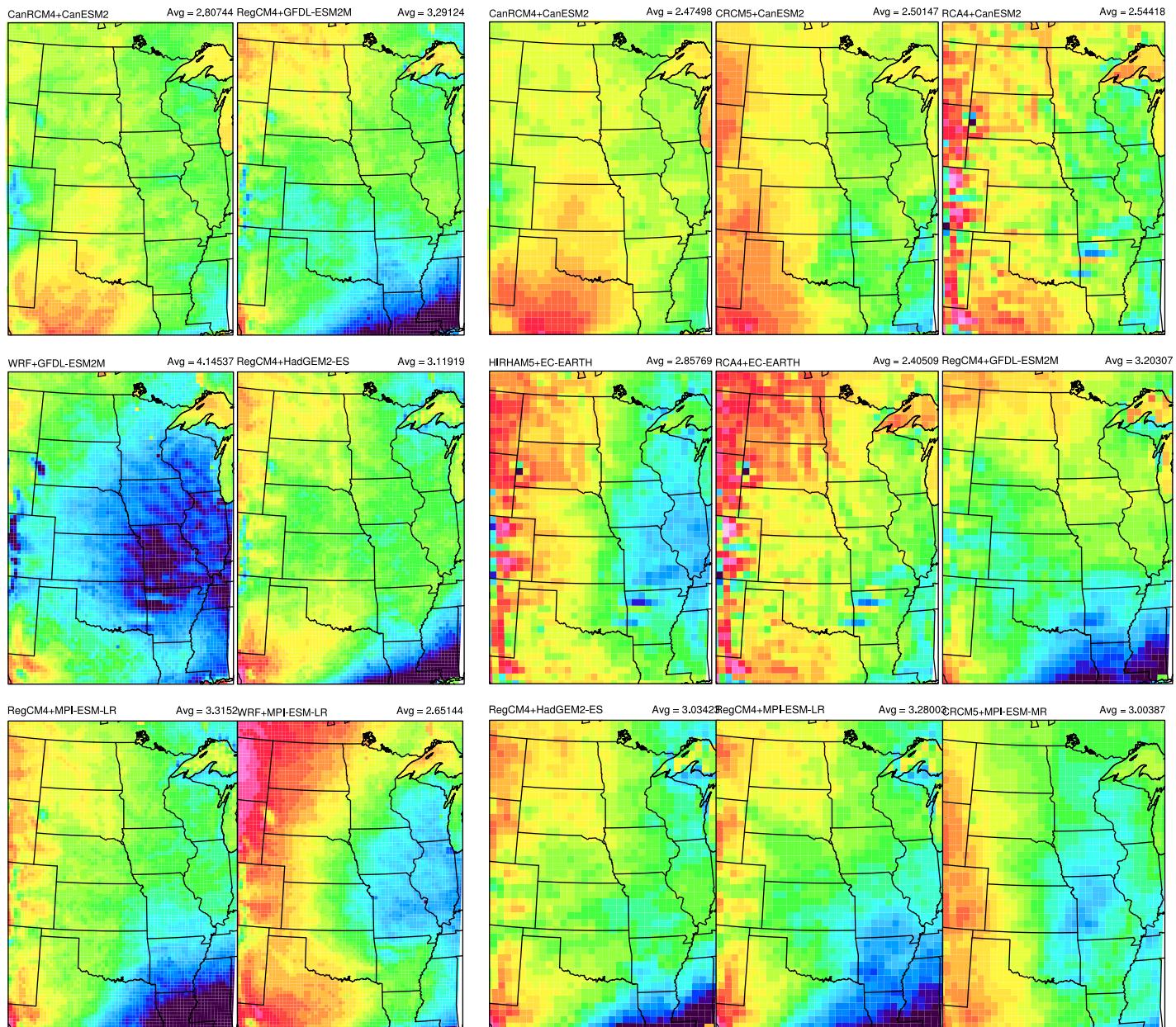


CORDEX Sample Results: 1971-1999 MJJA CUS Precipitation

CPC Daily Analysis

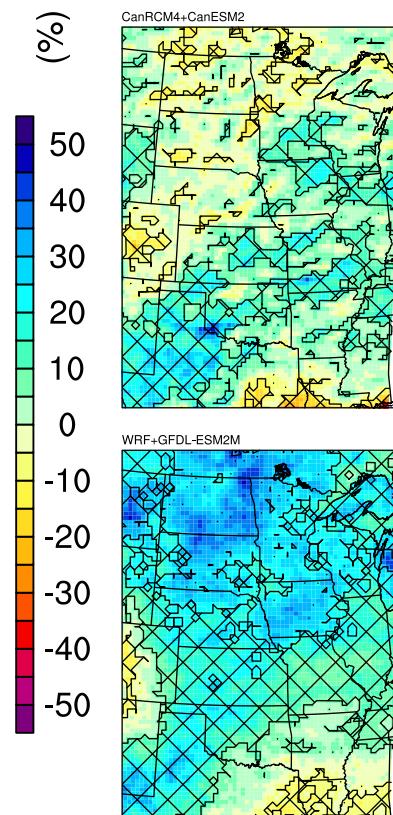


25km



CORDEX Sample Results: 1971-1999 vs. 2071-2099 MJJA

25km



CanRCM4+CanESM2

RegCM4+GFDL-ESM2M

WRF+GFDL-ESM2M

RegCM4+HadGEM2-ES

RegCM4+MPI-ESM-LR

WRF+MPI-ESM-LR

50km

CanRCM4+CanESM2

CRCM5+CanESM2

RCA4+CanESM2

HIRHAM5+EC-EARTH

RCA4+EC-EARTH

RegCM4+GFDL-ESM2M

RegCM4+HadGEM2-ES

RegCM4+MPI-ESM-LR

CRCM5+MPI-ESM-MR

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

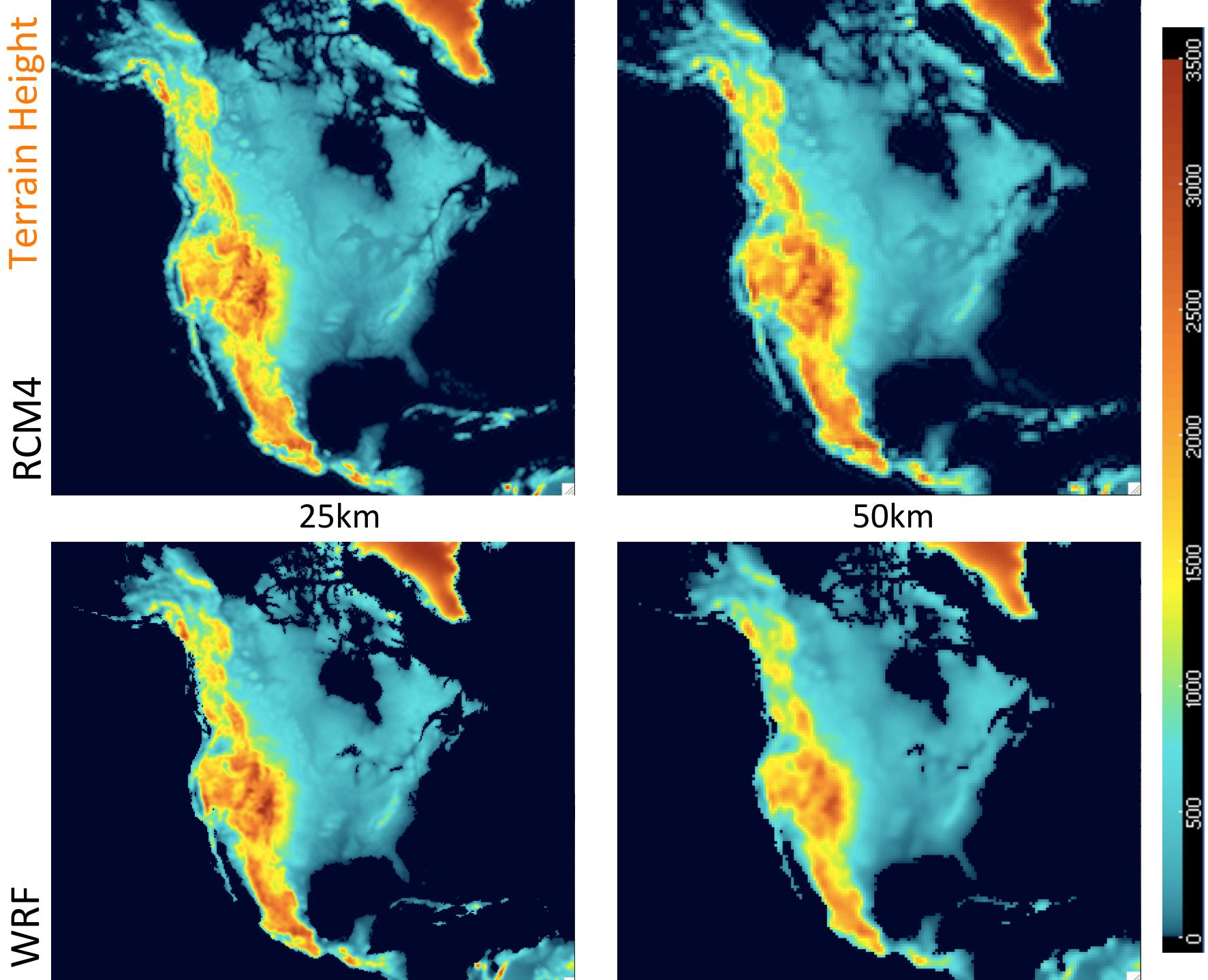
(not a direct comparison – too many differences between models)

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

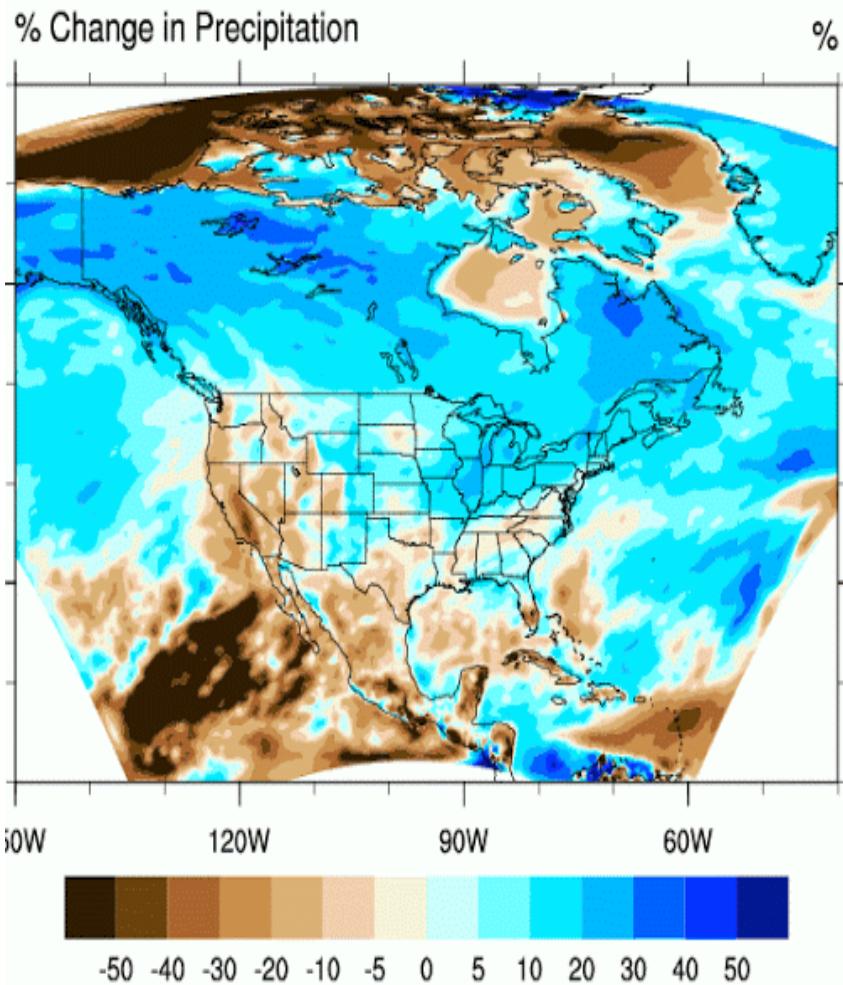
- 150 years @ 25km
 - 720,000 core hours
 - 2160 wall clock hours = 90 days
 - 95 TB (more variables saved)
 - 2,689,008 grid points
- 150 years @ 12.5km
 - 5,760,000 core hours
 - 17,280 wch = 720 days
 - 381 TB



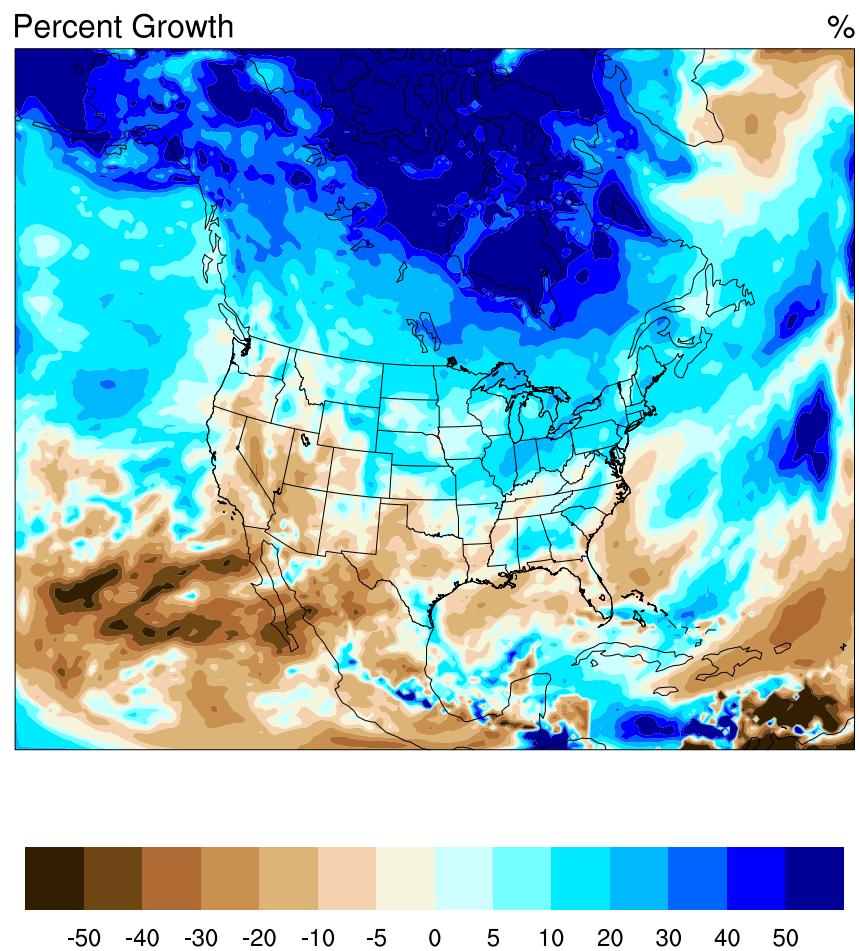
Simulation Hiccups

Using tos (left) vs. ts (right) for the SST LBC

RegCM4-HadGEM2 NAM-44 rcp85 DJF

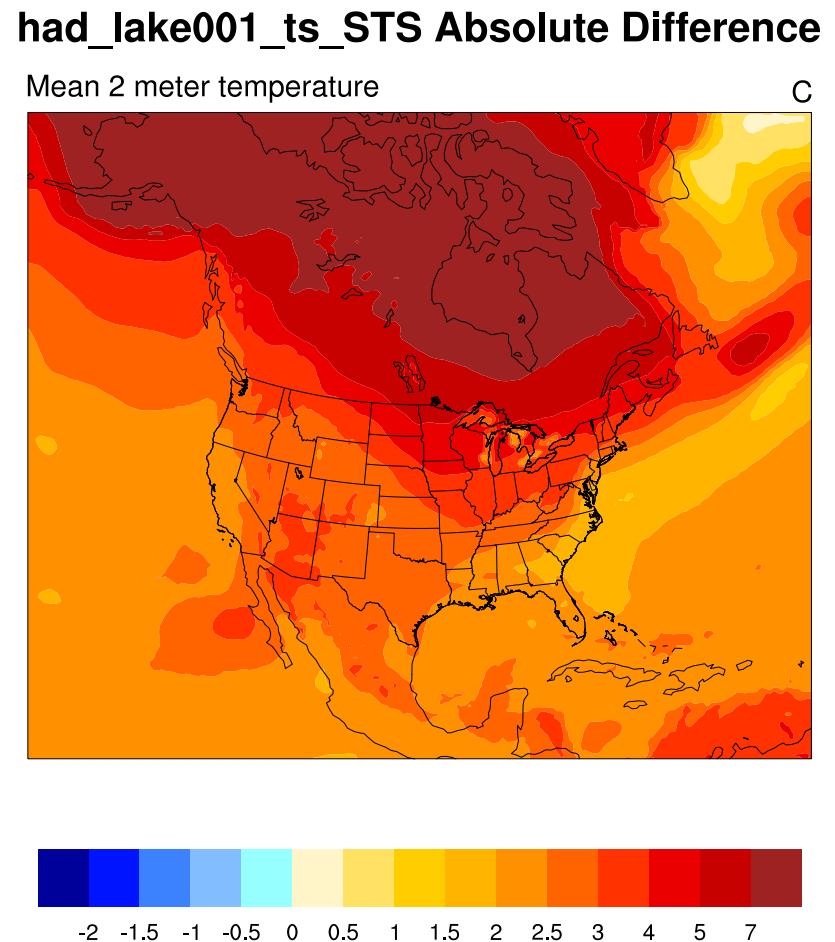
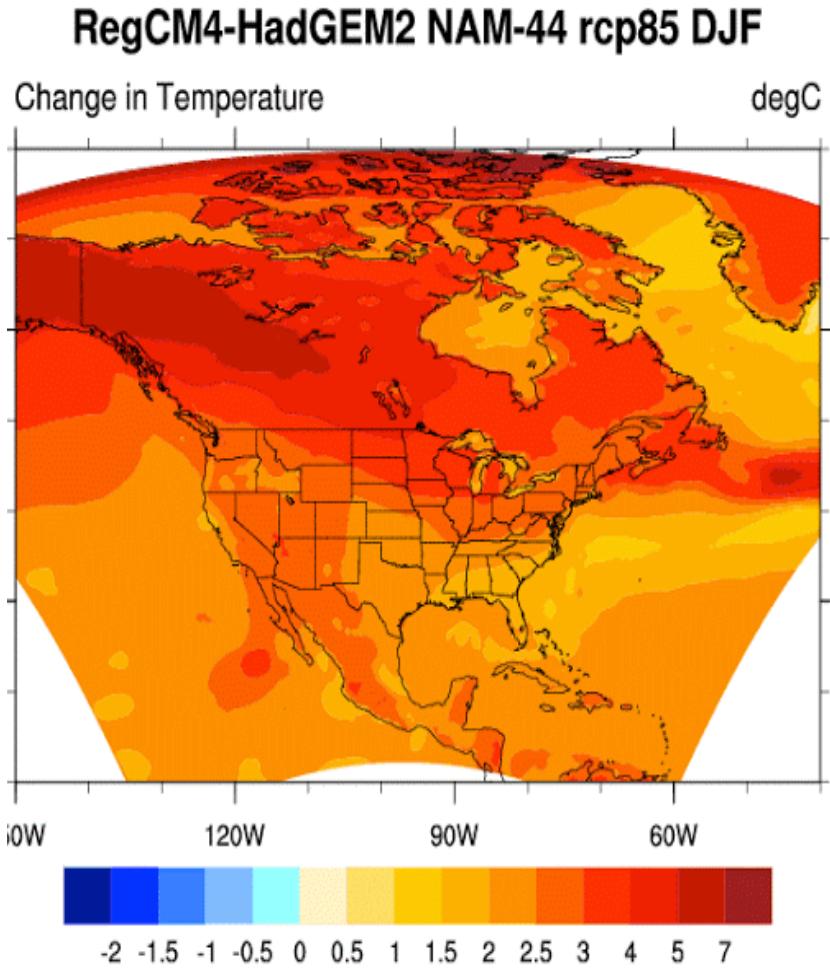


had_lake001_ts_STS % Difference

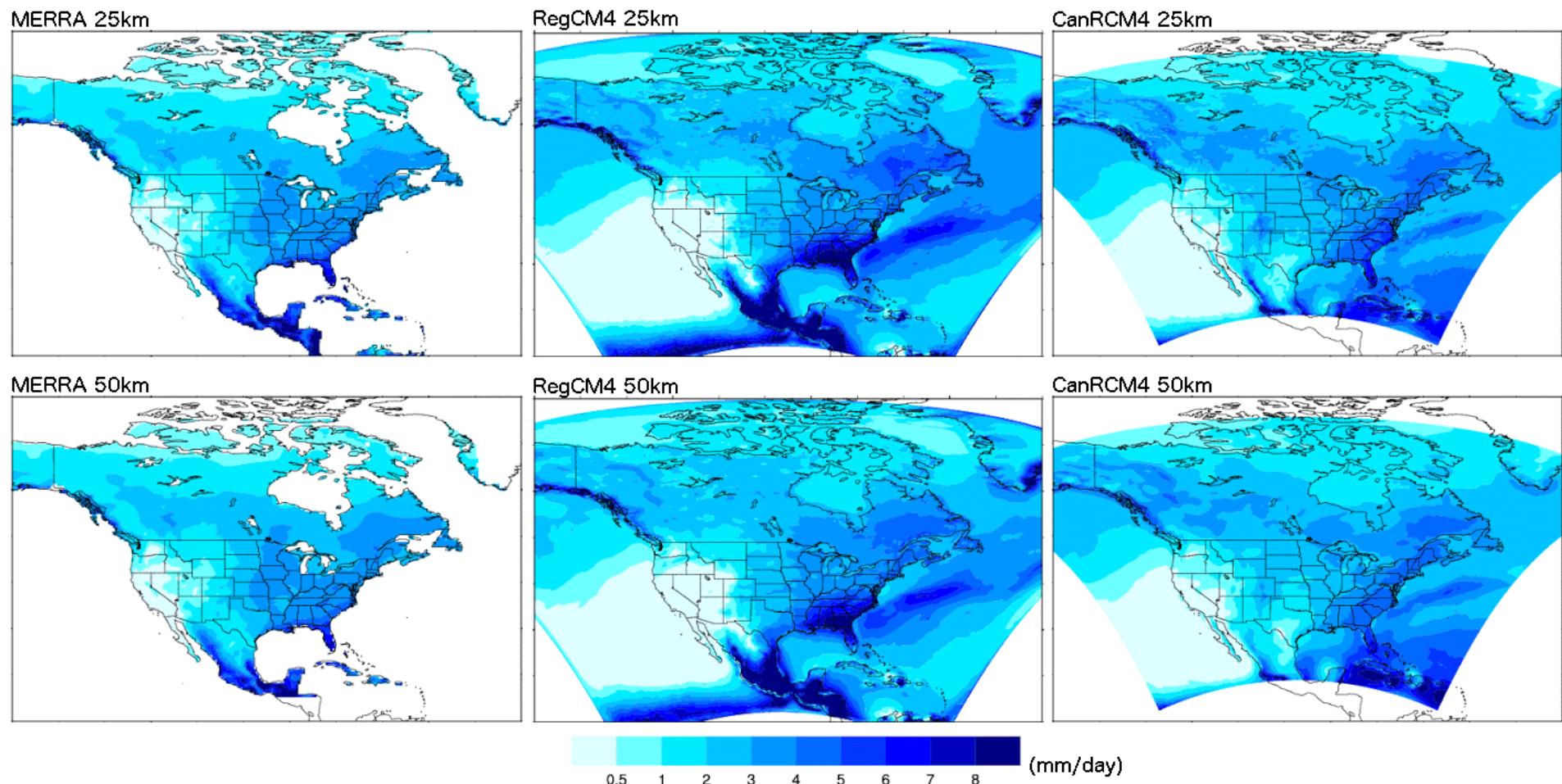


Simulation Hiccups

Using tos (left) vs. ts (right) for the SST LBC



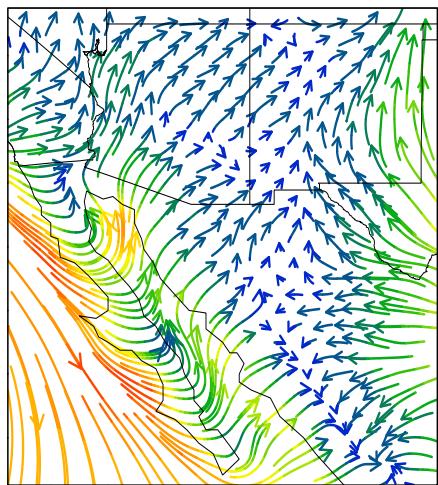
ERAI-Driven JJA Precipitation



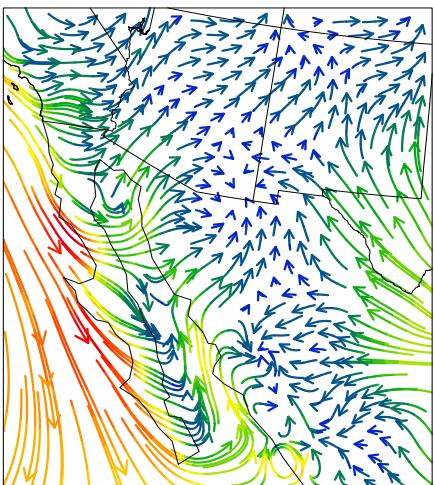
1990-2009

JJAS Surface Moisture Flux

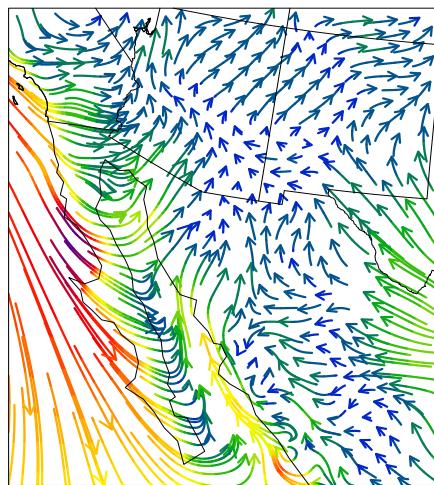
CFSR



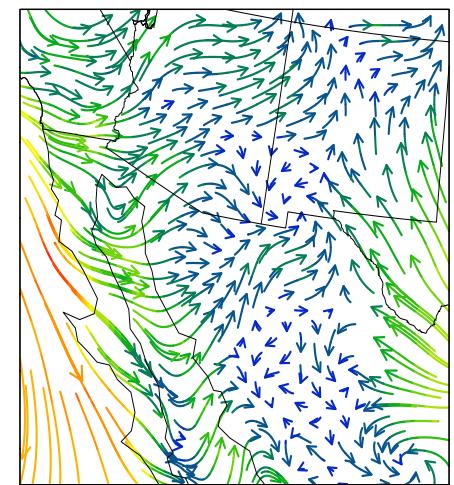
RCM4-erain 50km



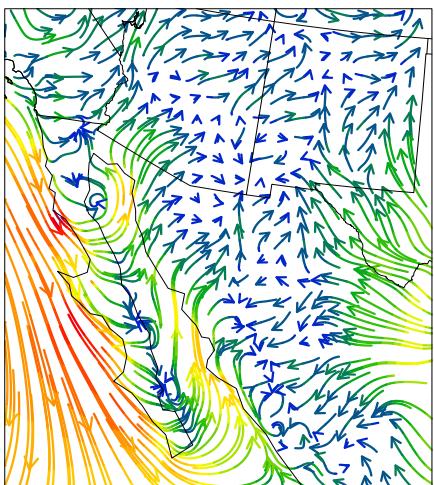
RCM4-mpi 50km



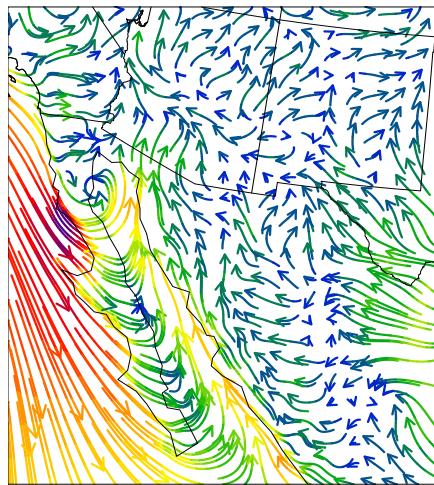
RCM3-ncep 50km



RCM4-erain 25km



RCM4-mpi 25km



Major Differences:

- Different reanalysis.
- Southern boundary further south.
- Emanuel over ocean.

