



# **Special Topics in Evaluation of Phase 1**

## **The North American Monsoon**

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2011 NARCCAP Users' Meeting  
April 7, 2011**

# Introduction



- How well is the North American Monsoon simulated in the NARCCAP RCMs?
- How well are the *processes* that make up the monsoon system simulated?
- This is the beginning of an analysis focusing on establishing differential credibility between the RCMs.
  - Going beyond the standard analysis of precipitation and temperature and the use of basic metrics.
  - Impact of errors in processes on projections and the propagation of bias into the future.

# Methods



- Just NARCCAP NCEP-driven simulations in this presentation.
- Focusing on June-September (JJAS).
- For comparison:
  - **NARR** (North American Regional Reanalysis), **32-km** horizontal resolution.
  - **UDEL** (University of Delaware), **1/2 degree** resolution, gridded observations, for land only.
  - **NAME** (North American Monsoon Experiment), **1 degree** resolution, gridded observations from a special observing period during July 2004

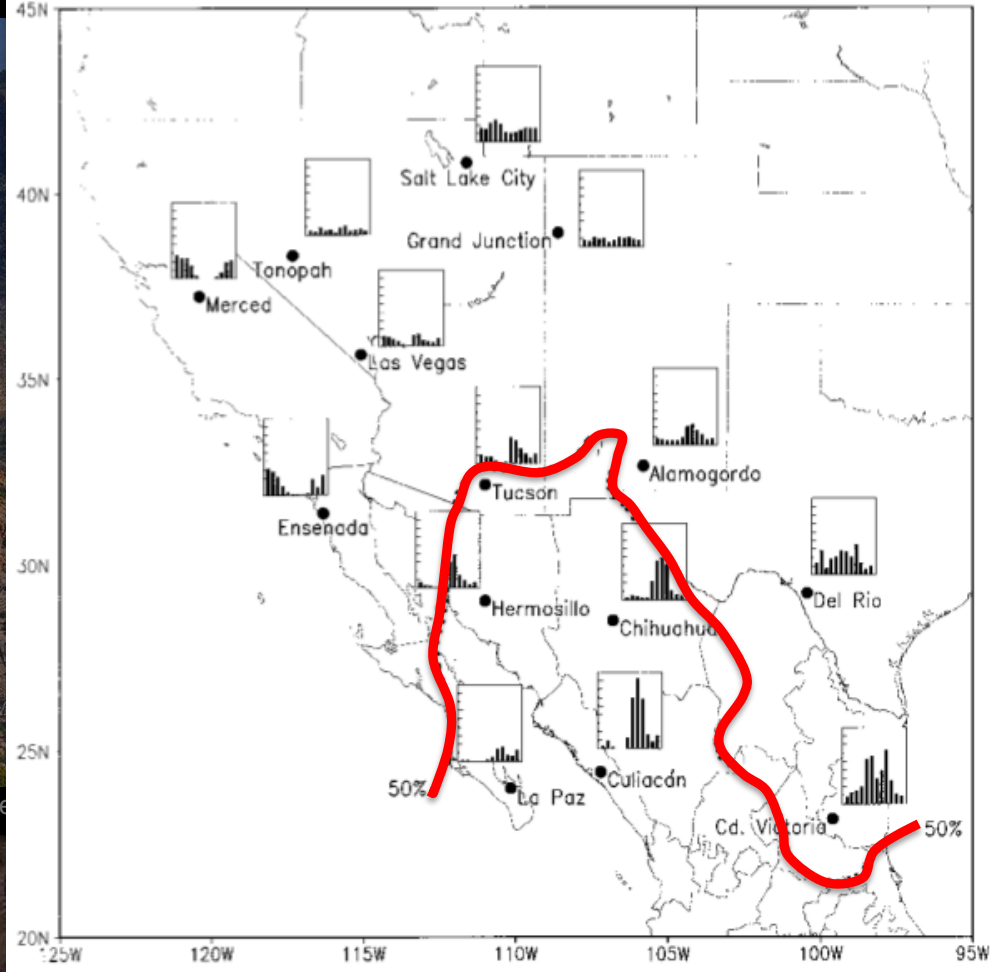
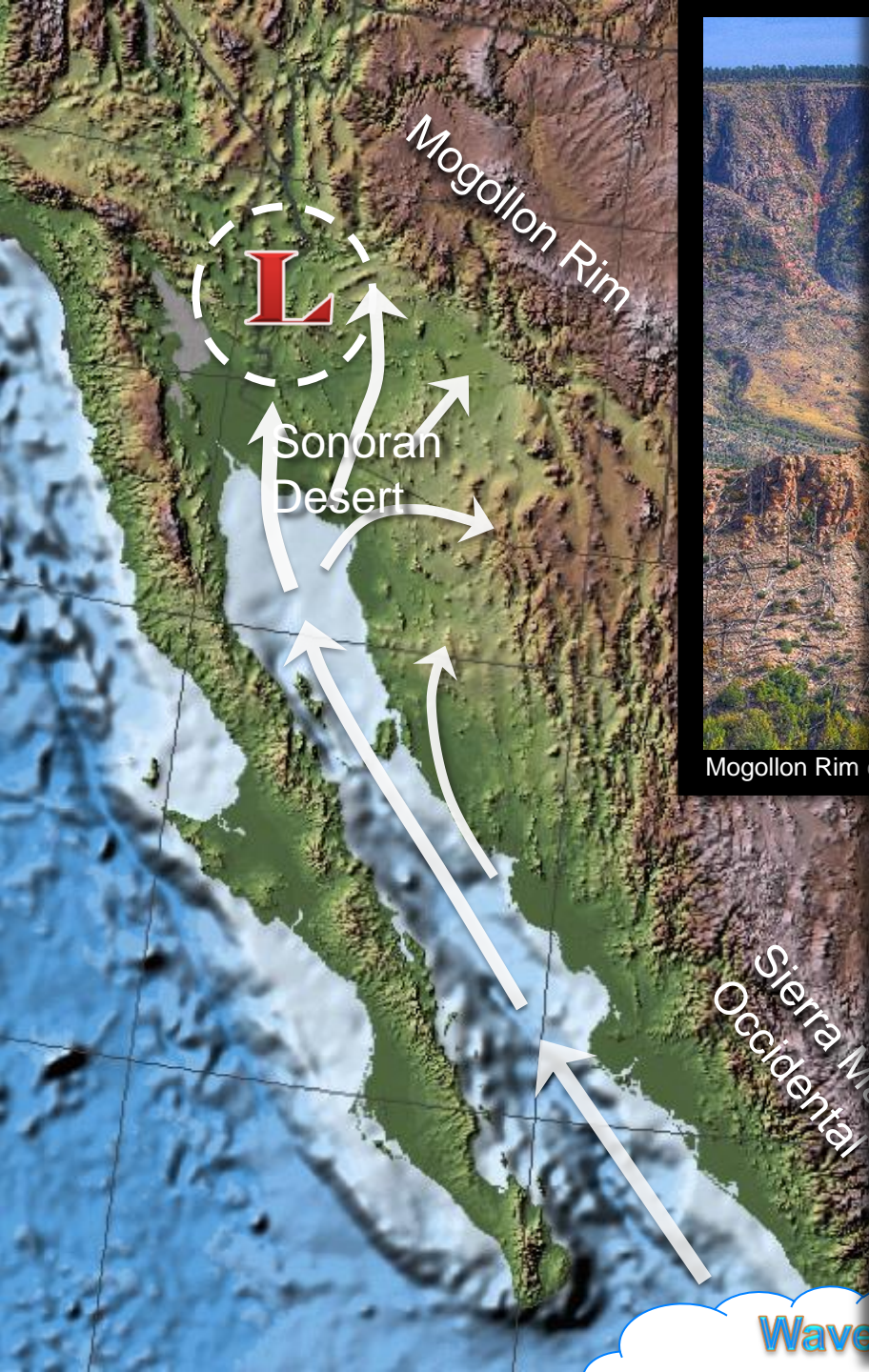
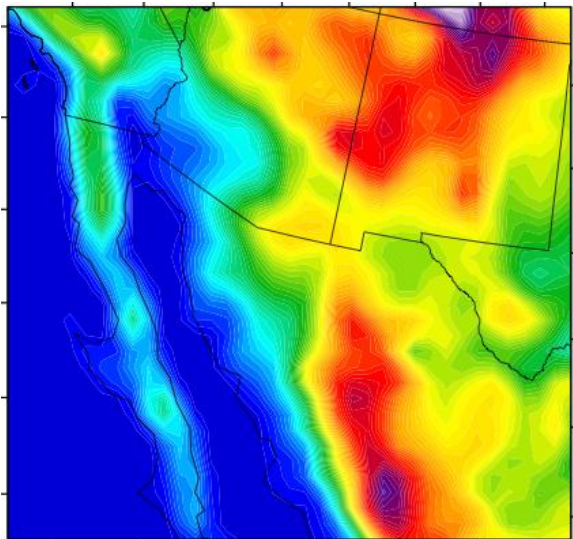


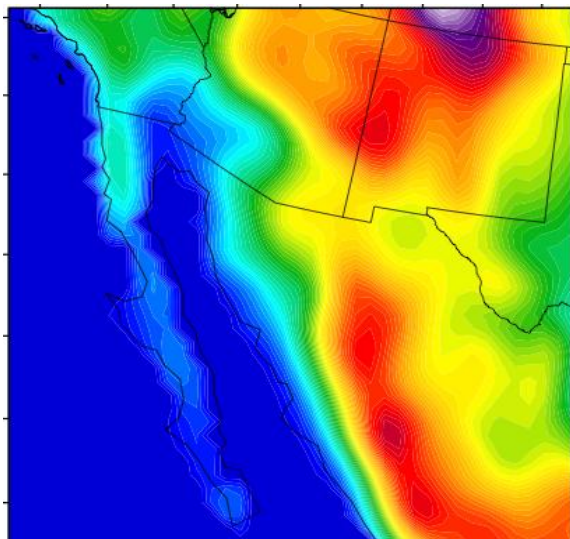
FIG. 2. Seasonal distribution of precipitation across southwestern North America. Note that northwestern Mexico shows the strongest monsoon signal, which diminishes through Arizona, New Mexico, and Nevada. Northeastern Mexico and Texas display early summer–late fall precipitation peaks, while the West Coast has a dry summer Mediterranean distribution (vertical axis of all graphs represents 180 mm with 20 mm increments). Areas south of the broken line receive greater than 50% of their annual rainfall in July, August, and September (after Douglas et al. 1993).

# Model Terrain

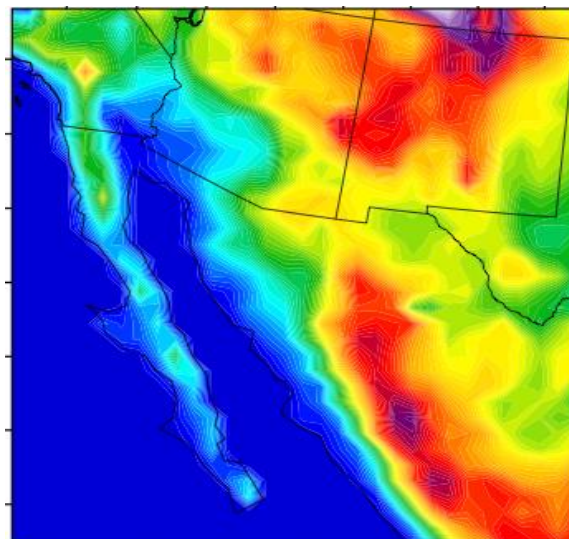
CRCM



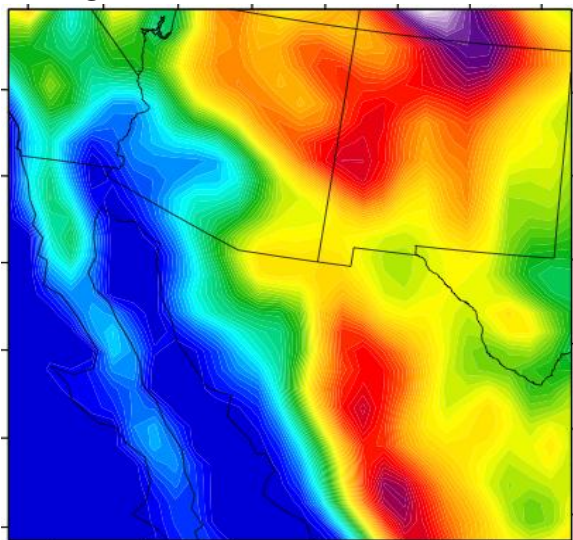
ECP2



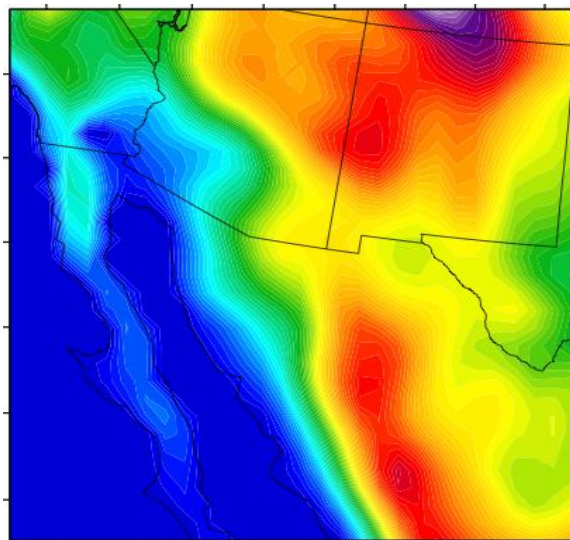
HRM3



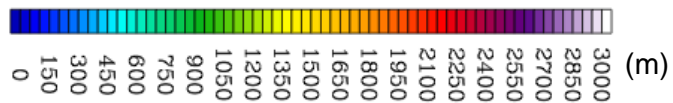
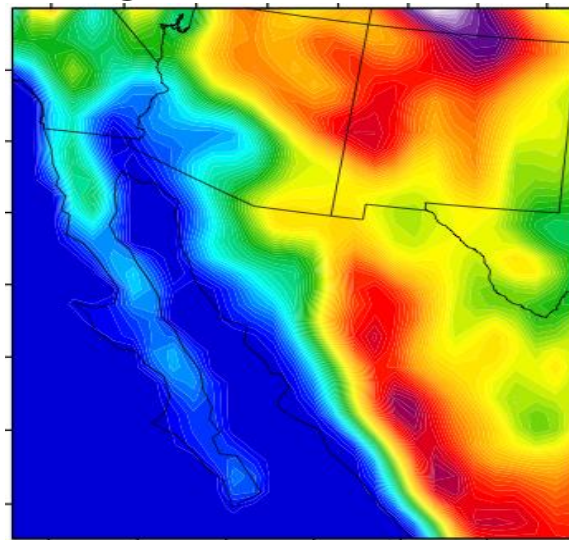
MM5I



RCM3



WRFG



# 1980-2004 Average 2-m Temperature

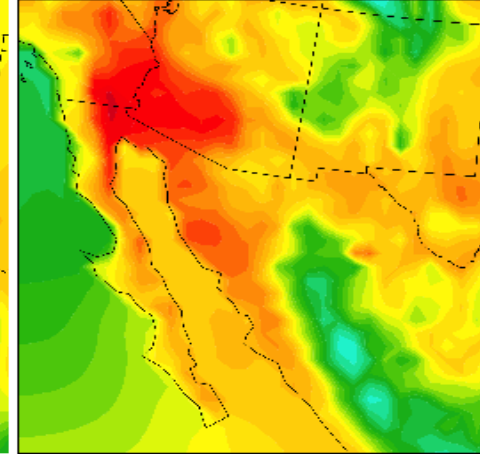
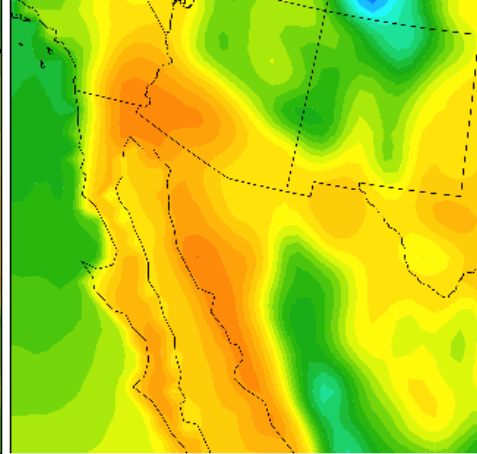
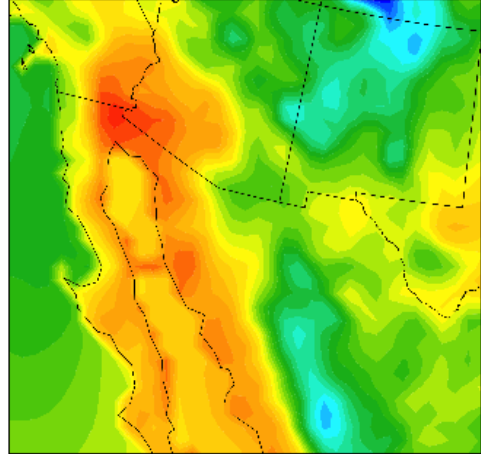
## Area Average

NARR	23.36
CRCM	24.61
ECP2	25.64
HRM3	24.70
MM5I	24.29
RCM3	23.12
WRFG	24.61°C

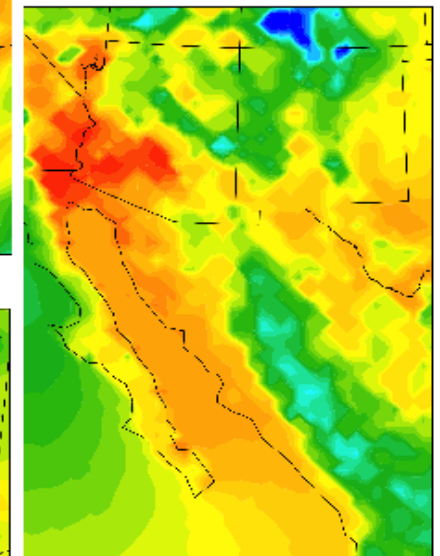
CRCM

ECP2

HRM3



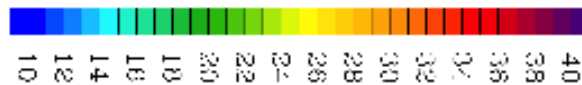
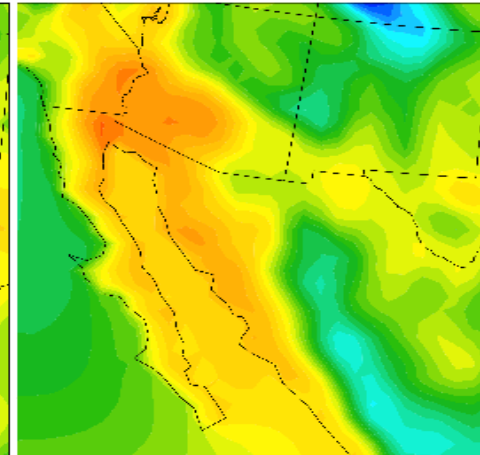
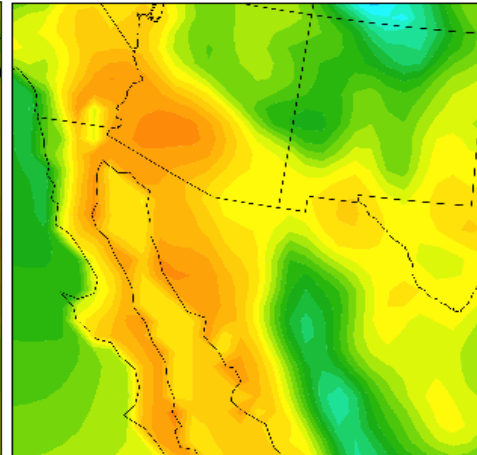
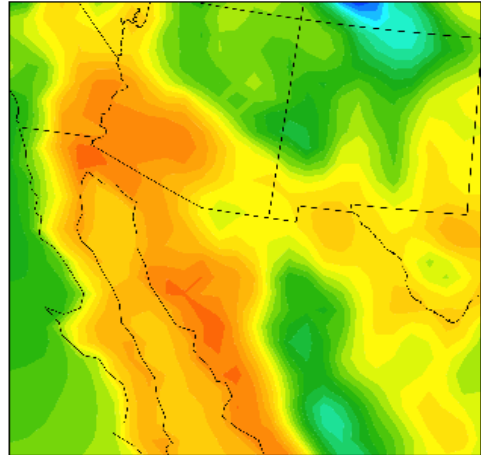
NARR



MM5I

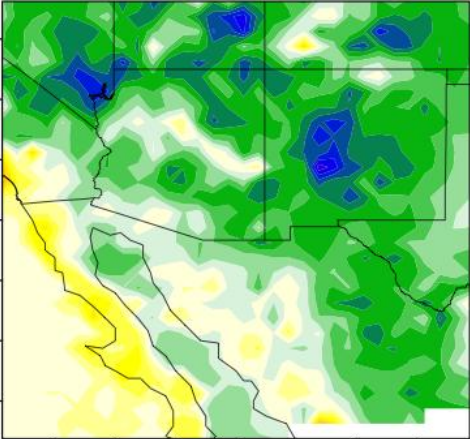
RCM3

WRFG

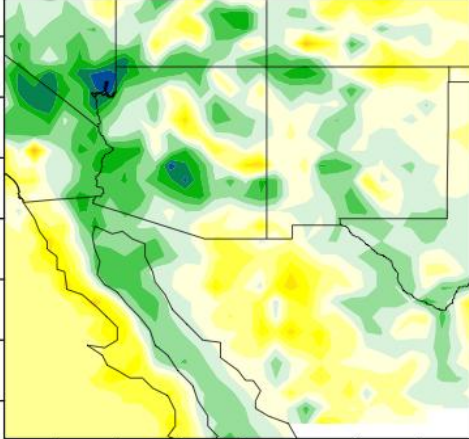


# Average 2m Temperature Bias (vs. NARR): 1980-2004 JJAS

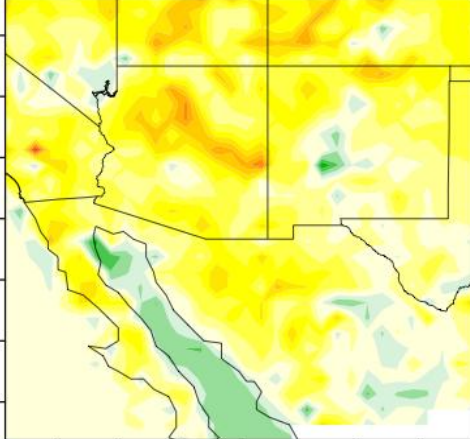
CRCM



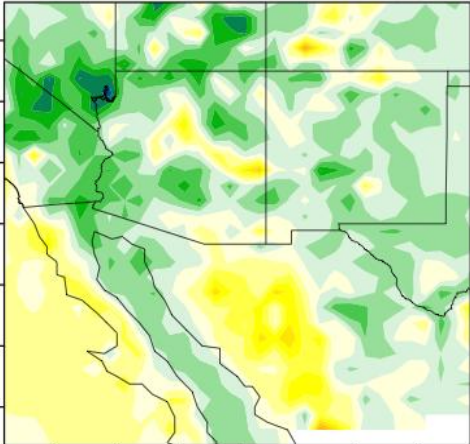
ECP2



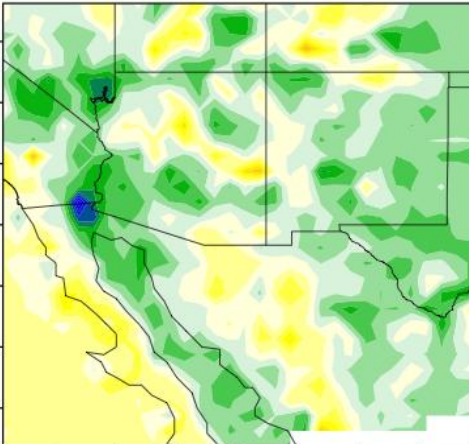
HRM3



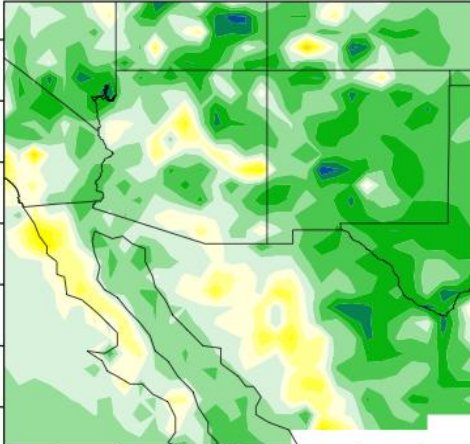
MM5I



RCM3



WRFG



(c)

# 1980-2004 JJAS Average Precipitation Rate

CRCM

ECP2

HRM3

UDEL

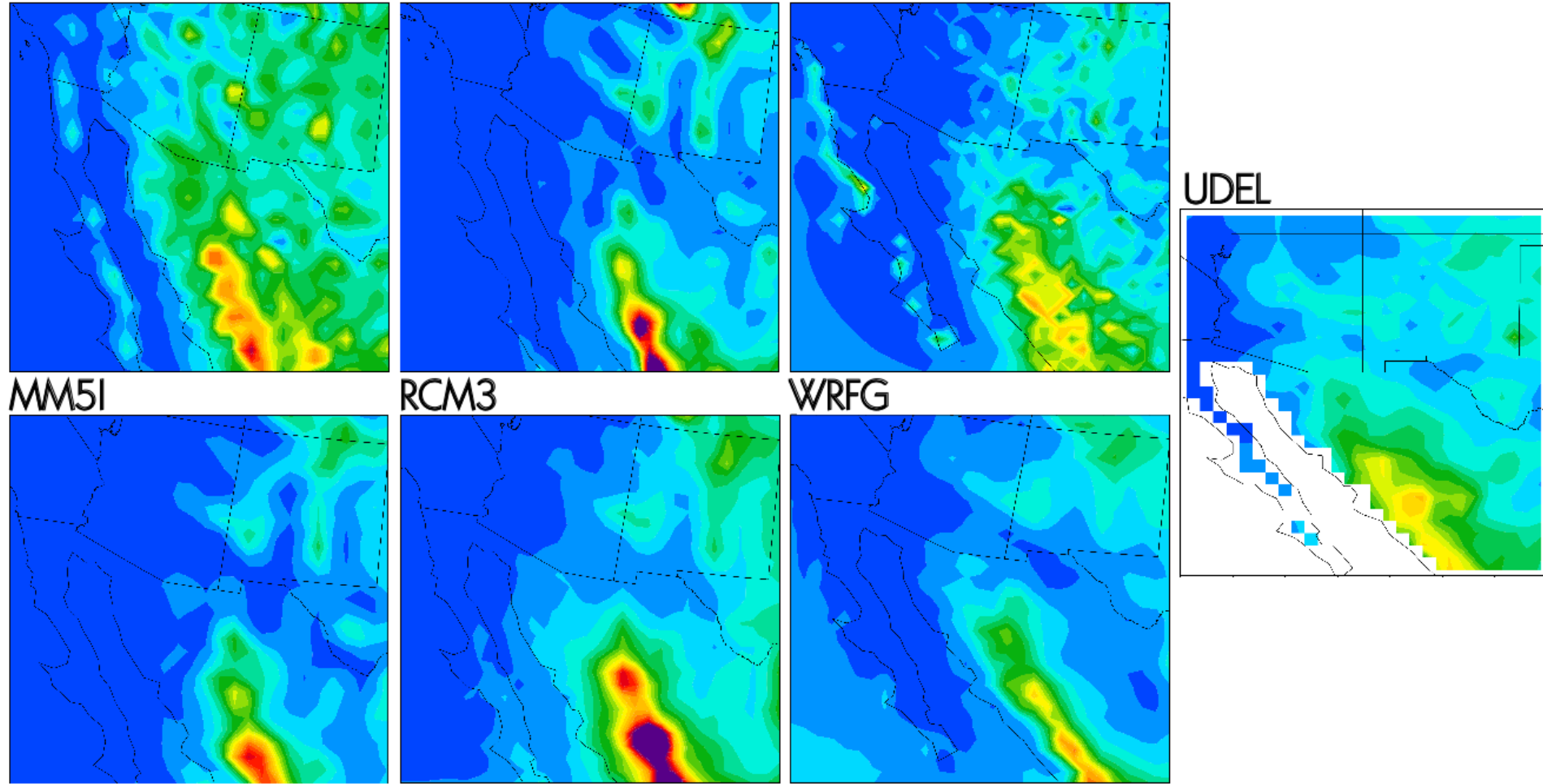
MM5I

RCM3

WRFG

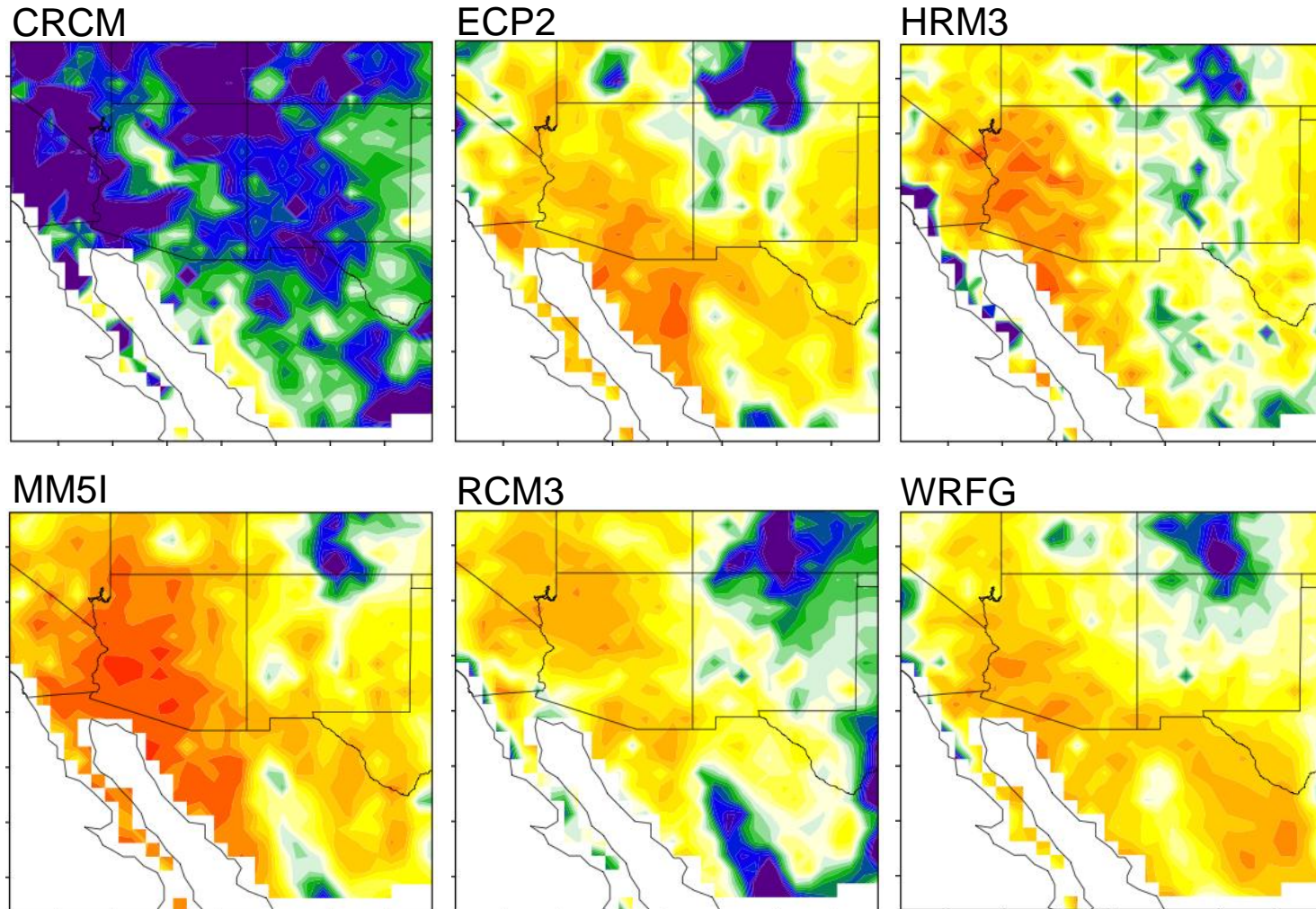


0 1 2 3 4 5 6 7 8 9 10 (mm/day)





# Average Precipitation Bias (vs. UDEL): 1980-2004 JJAS

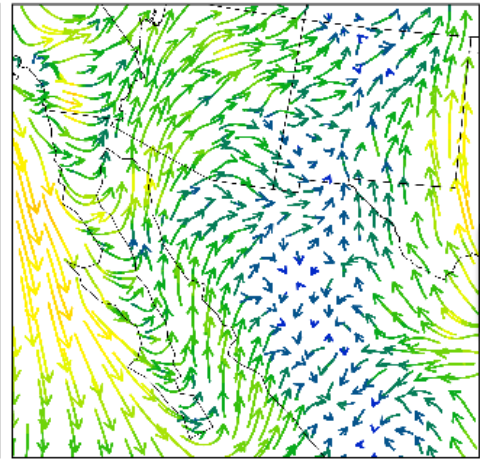
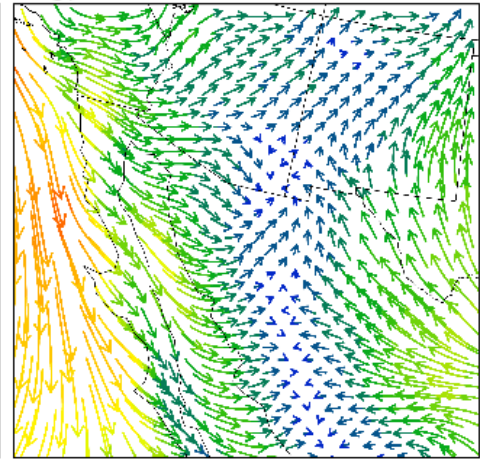
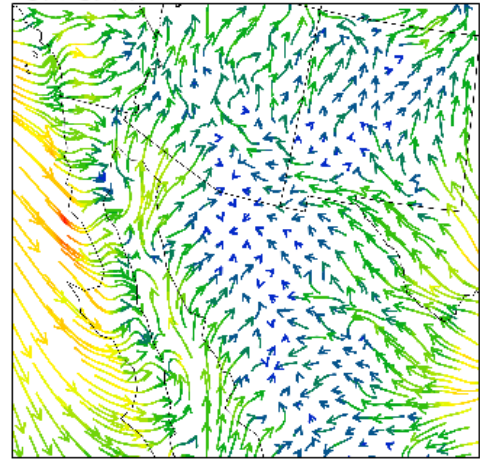


# 1980-2004 JJAS Average 10-m Wind

CRCM

ECP2

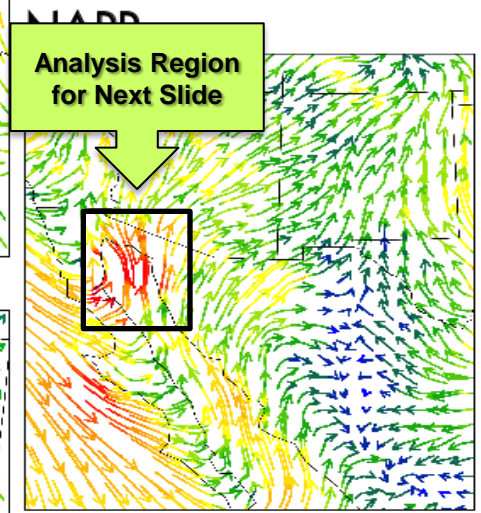
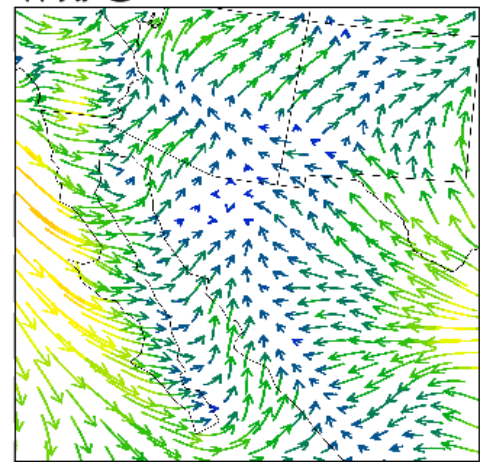
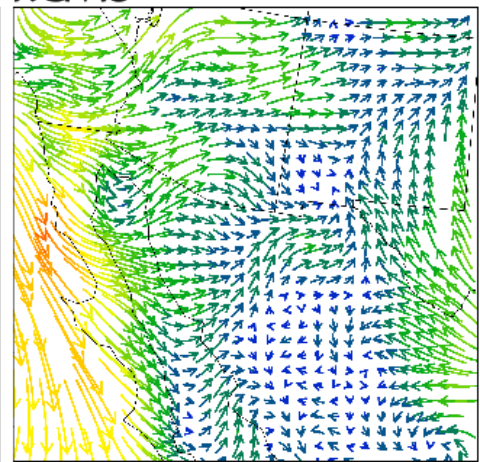
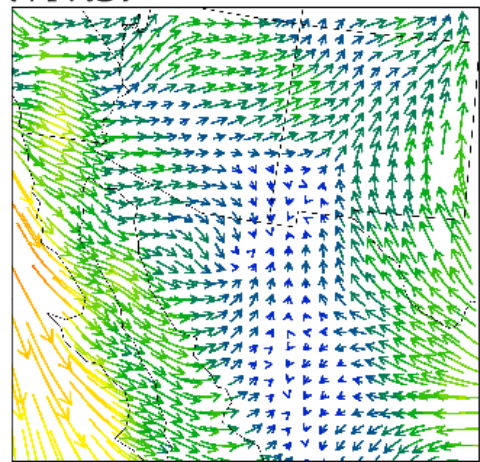
HRM3



MM5I

RCM3

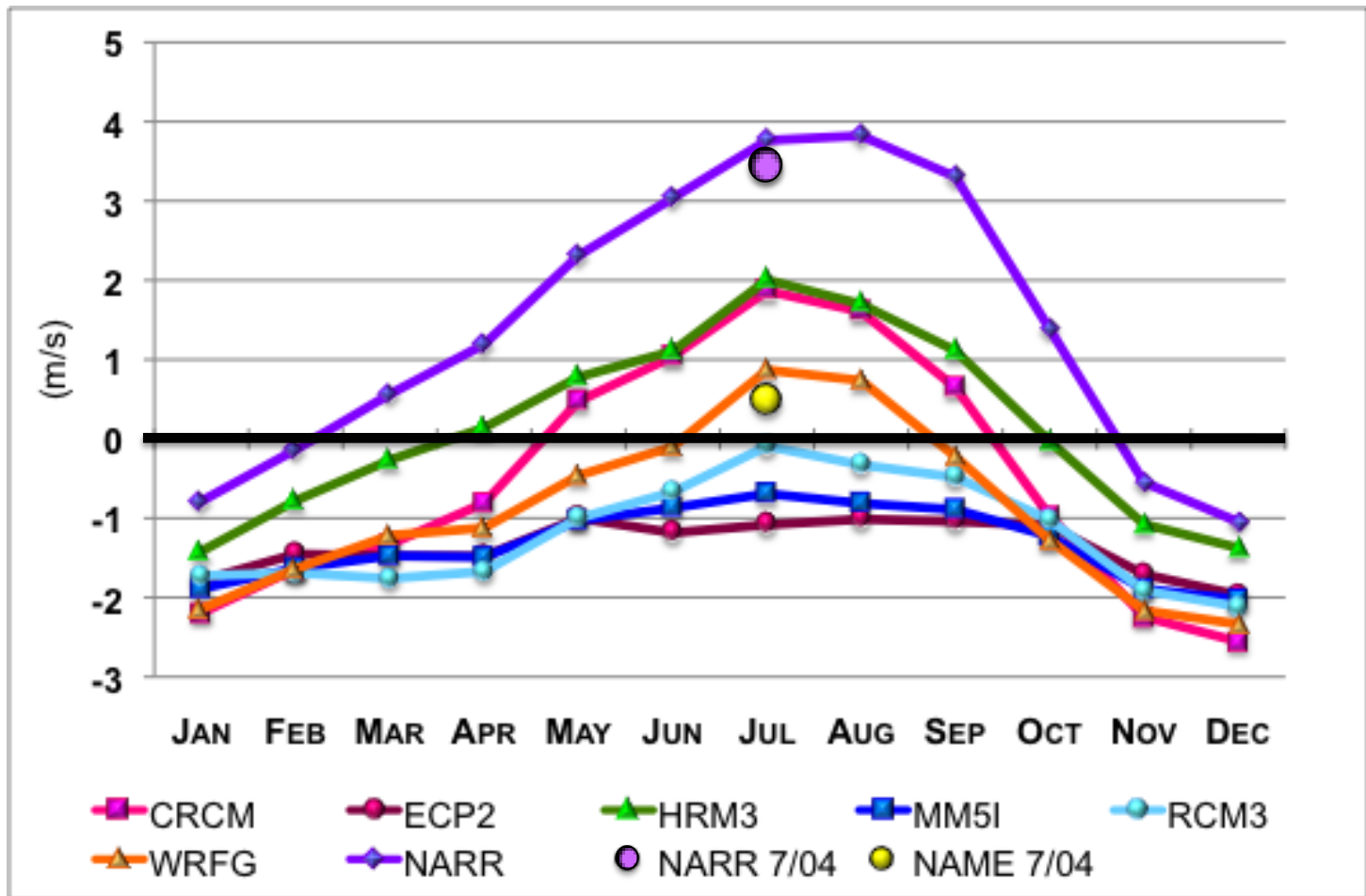
WRFG



Analysis Region for Next Slide

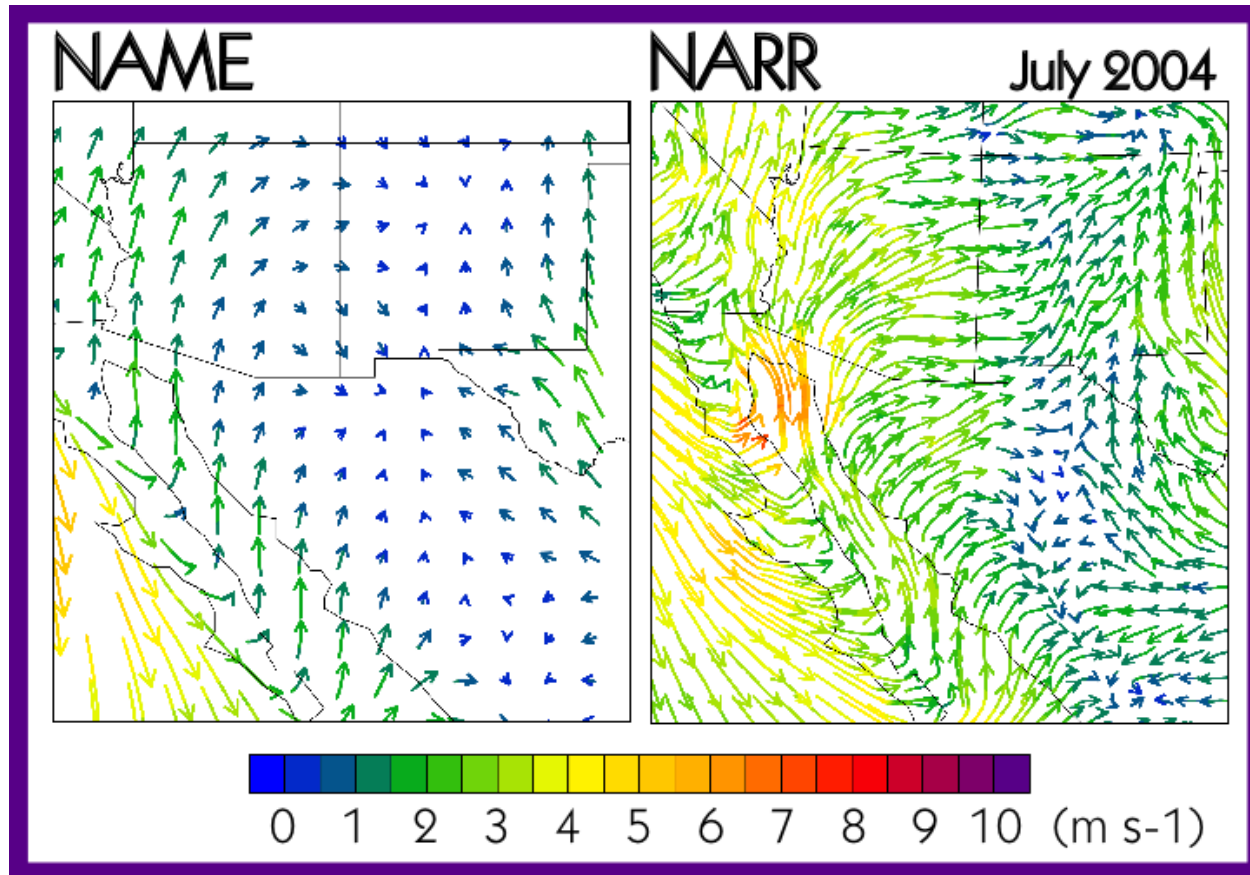


# 1980-2004 Monthly Average\* 10-m North-South Wind Component



\*For the box in the NARR panel on the previous slide.

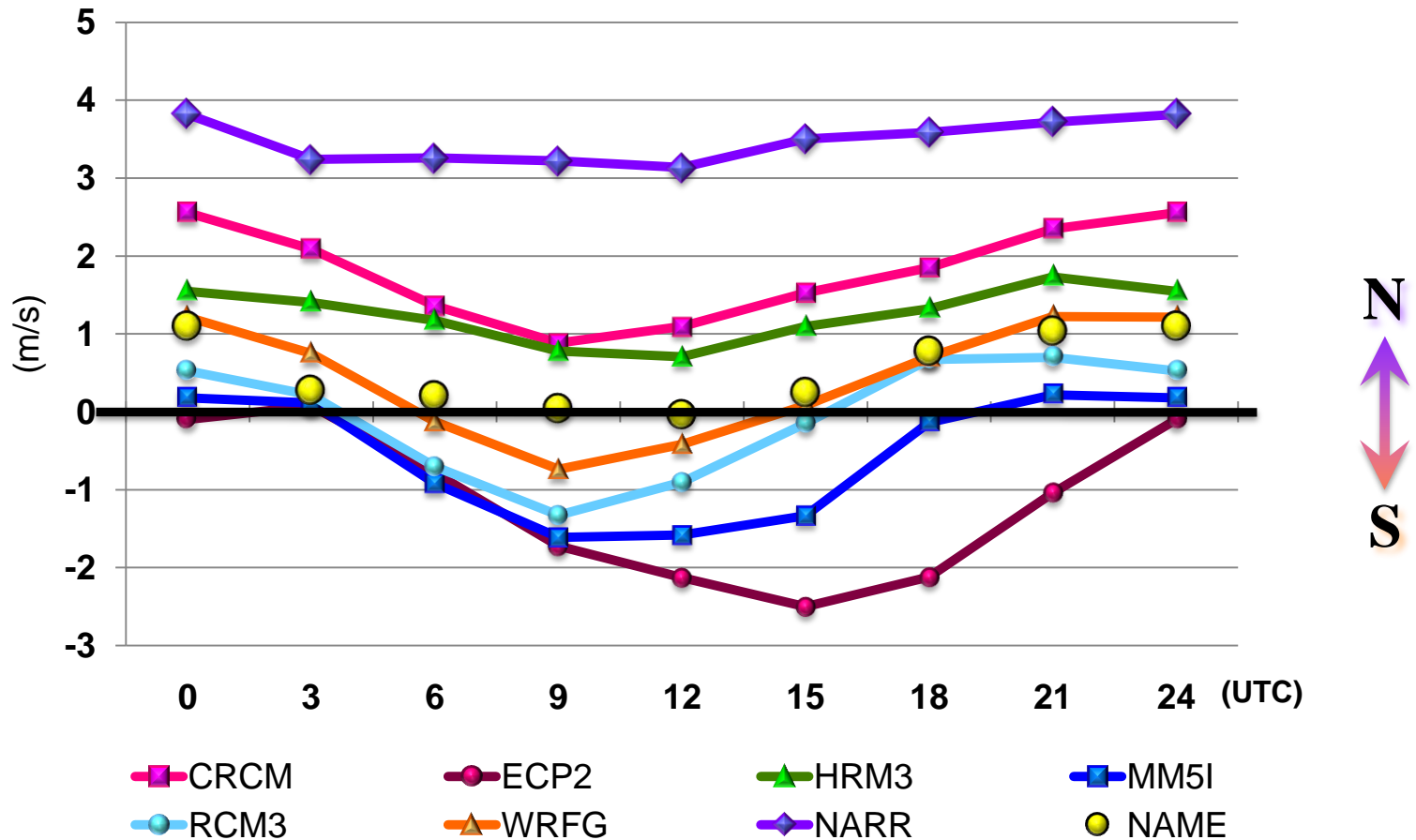
# NARR Wind Bias



The NARR has a strong wind bias over the Gulf of California into AZ relative to the 2004 July average gridded NAME observations (shown right and in above chart), particularly in the northern Gulf.

A version of NARR run for July of 2004 enhanced with more of the NAME observations contains a nearly identical error (not shown here; Ciesielski and Johnson, J. Climate, 2008), implying that this is a systematic problem in the NARR.

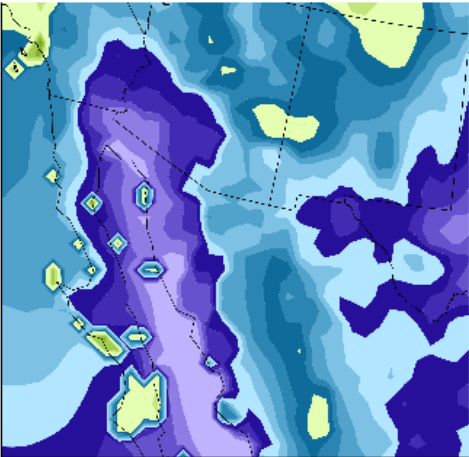
# July 2004 Average Diurnal Cycle\* 10-m North-South Wind Component



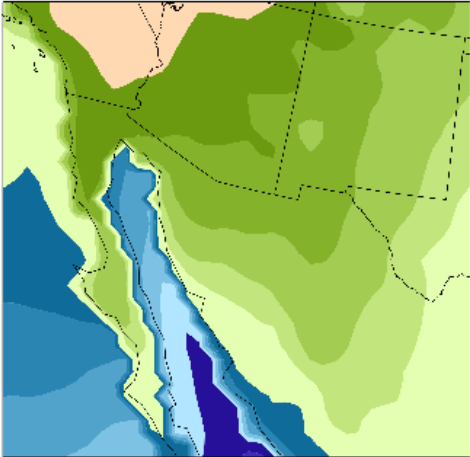
\*For the box in the NARR panel on the previous slide.

# 1980-2004 JJAS Average Specific Humidity

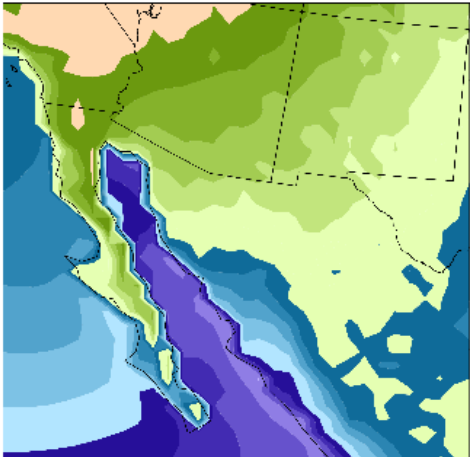
CRCM



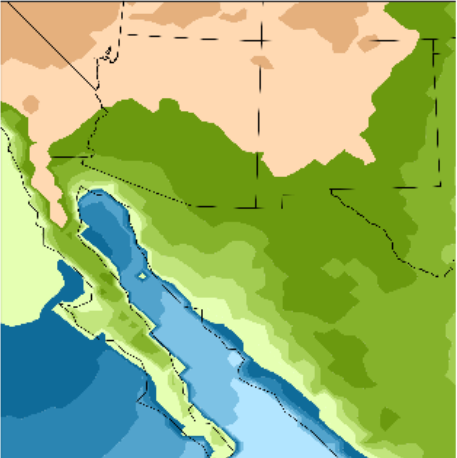
ECP2



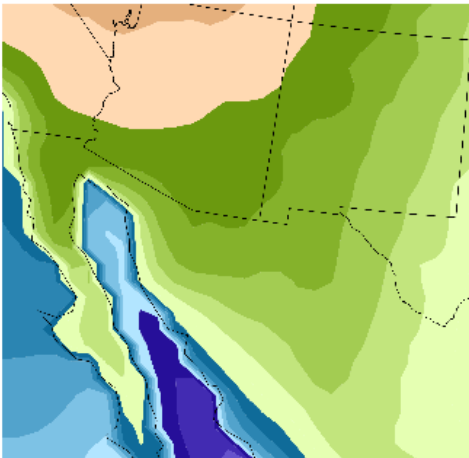
HRM3



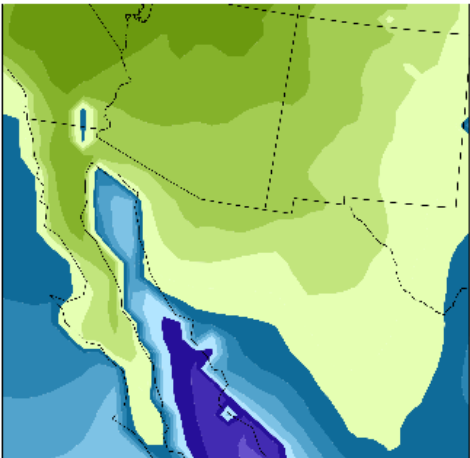
NARR



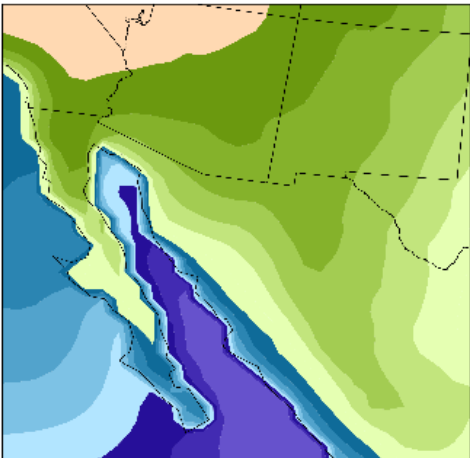
MM5I



RCM3

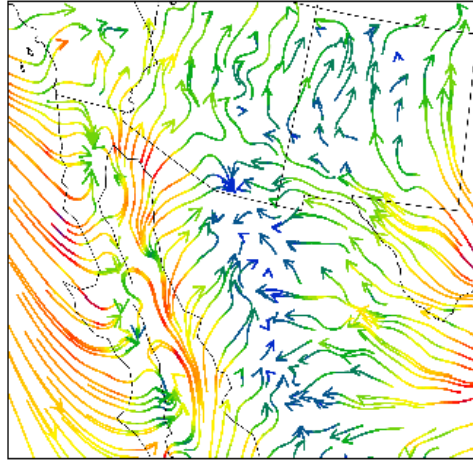


WRFG

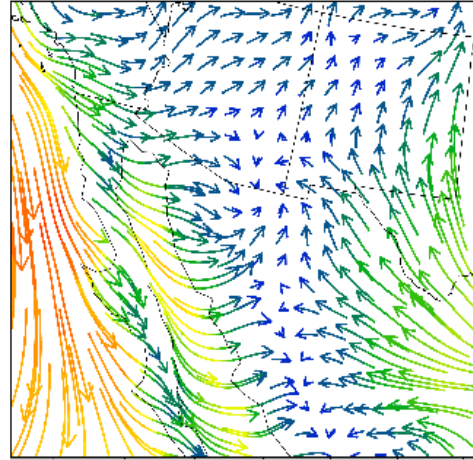


# 1980-2004 JJAS Average Near-Surface Moisture Flux

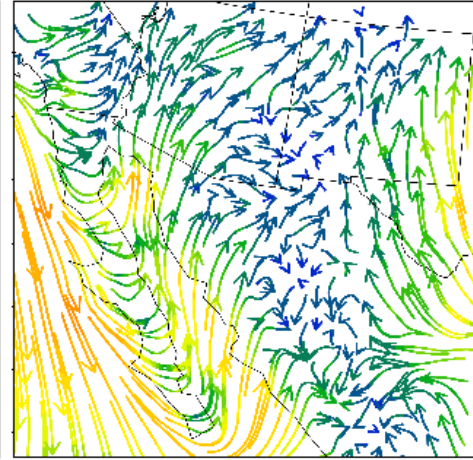
CRCM



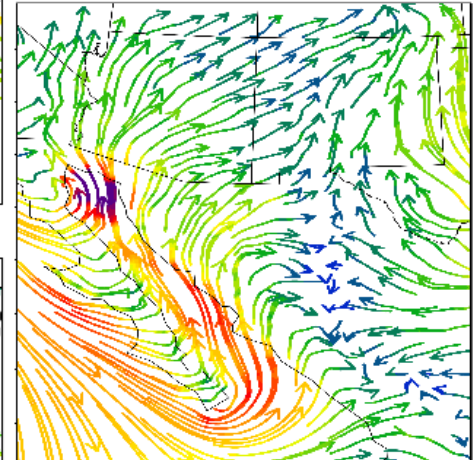
ECP2



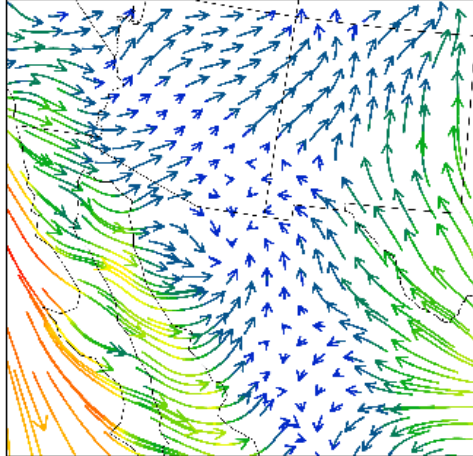
HRM3



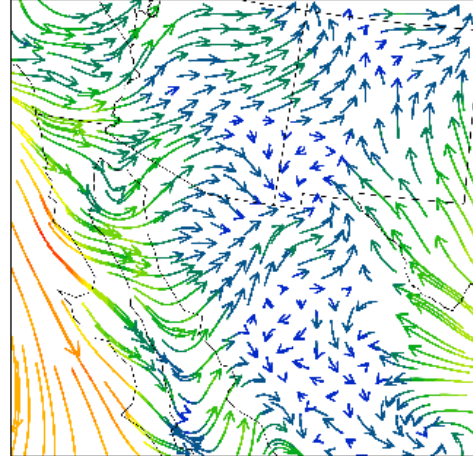
NARR



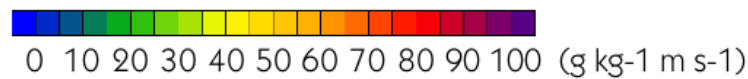
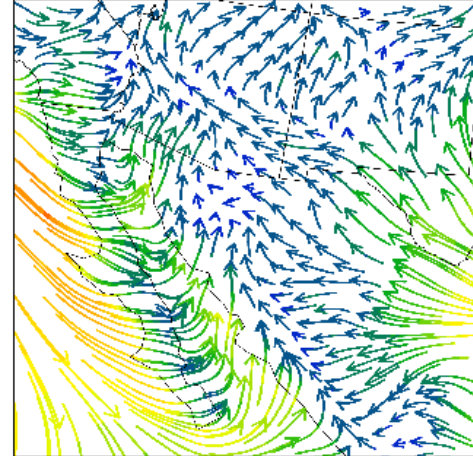
MM5I



RCM3



WRFG



# Discussion

- **When determining model credibility, more should be taken into account than just average precipitation and temperature.**
- **Summary**
  - The HRM3 has a warm bias over the Sonoran Desert, which could strengthen its onshore flow and moisture flux into AZ.
  - The CRCM has an obvious bias in specific humidity in this region.
  - The MM5I and ECP2 do not properly simulate the average monsoon flow in the northern Gulf of California into AZ.
    - The RCM3 has the same problem, but not to the same extent.
  - The only model with no substantial bias in the fields shown is the WRFG.
- This is not to say that the WRFG will not have strong biases in variables/processes in other regions or even in other variables in this one.
  - **i.e. do not assume you could get by using just this model for your analysis**
- **These results do not indicate how any of the models will perform when forced with a GCM.**
- **These results alone do not indicate that any one NARCCAP model simulation of future climate in this region is more credible than another.**
  - A process-based analysis of the GCM-driven simulations of current climate and an analysis of the processes driving their projections of future climate will need to be completed first.

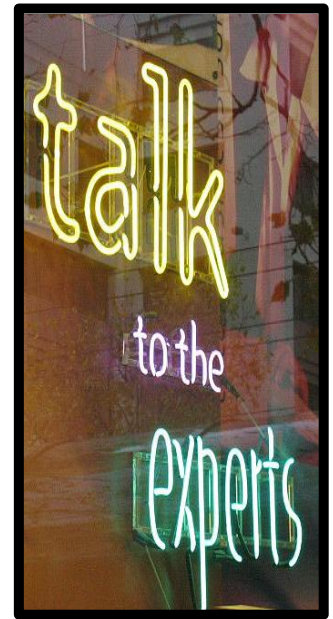




So what did the NARCCAP PI's think about the performance of the RCMs in simulating the NAM?...

# Expert Elicitation & Judgment

- Expert elicitation is, basically, a scientific consensus methodology.
- All elicitation studies relate to questions of expectation, or judgments of likelihood.
- Examples of application to climate change:
  - Morgan et al. (2006) Elicitation of expert judgments of aerosol forcing, Climatic Change.
  - Zickfeld et al. (2010) Expert judgments about transient climate response to alternative future trajectories of radiative forcing, Proceedings of the National Academy of Sciences of the United States of America
- Test experiment completed Oct. 19, 2010 during a NARCCAP PI's meeting at NCAR focusing on the simulation of the North American Monsoon.
- Elicitation studies vary in rigor. Our exercise draws upon best practices for expert elicitation, but it remains pretty basic as far as elicitation exercises go!
- This is a test, this is only a test...



# Exercise Overview

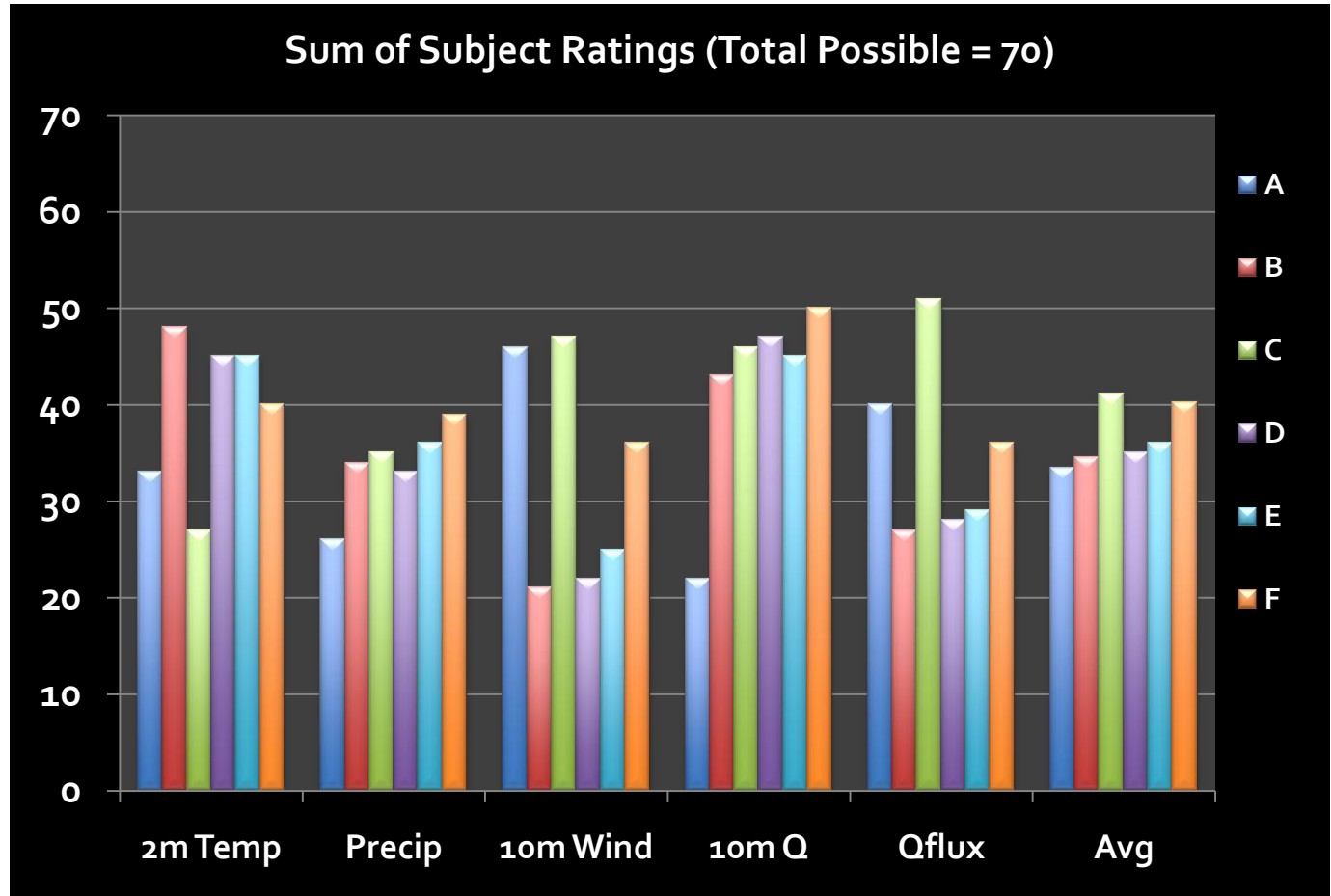


- 7 Participants
- Survey Part A
  - Expert opinion on the usefulness of single-to-multiple RCMs nested in single-to-multiple GCMs in:
    - 1) projecting future regional climate
    - 2) providing credible information to stakeholders for adaptation planning
    - 3) providing credible information to decision-makers about how funds should be allocated for implementing adaptation plans.
  - Establish how experts currently assess regional model performance.
- Survey Part B
  - Rating of model performance on 5 variables relating to the North American Monsoon.
  - Overall rating of models (only 3 subjects chose to complete this section).
  - 2 follow-up questions regarding the experts' opinions on the usefulness of ensemble averages and spread.



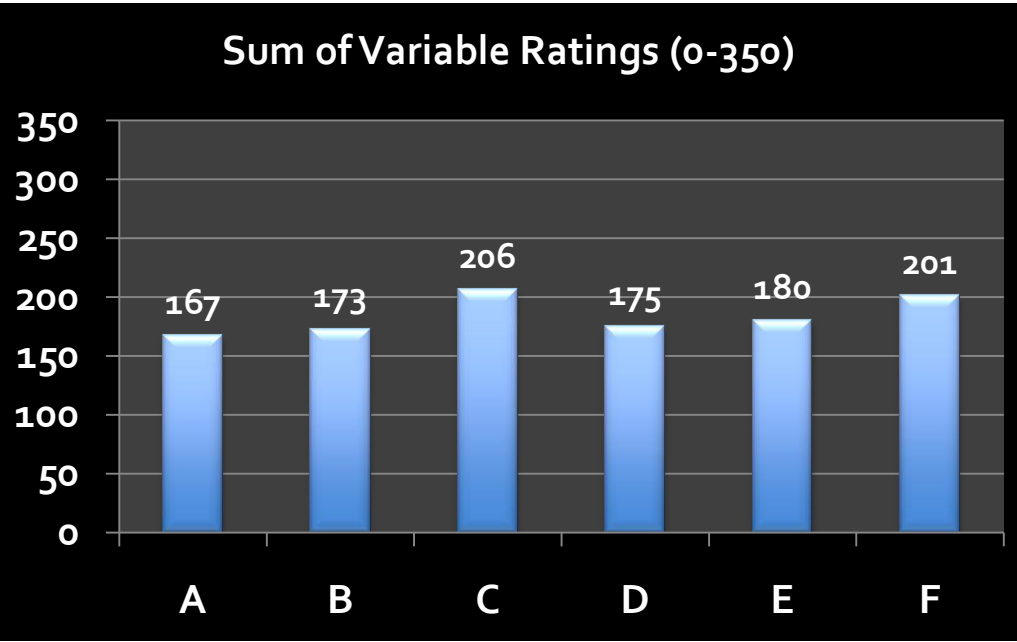
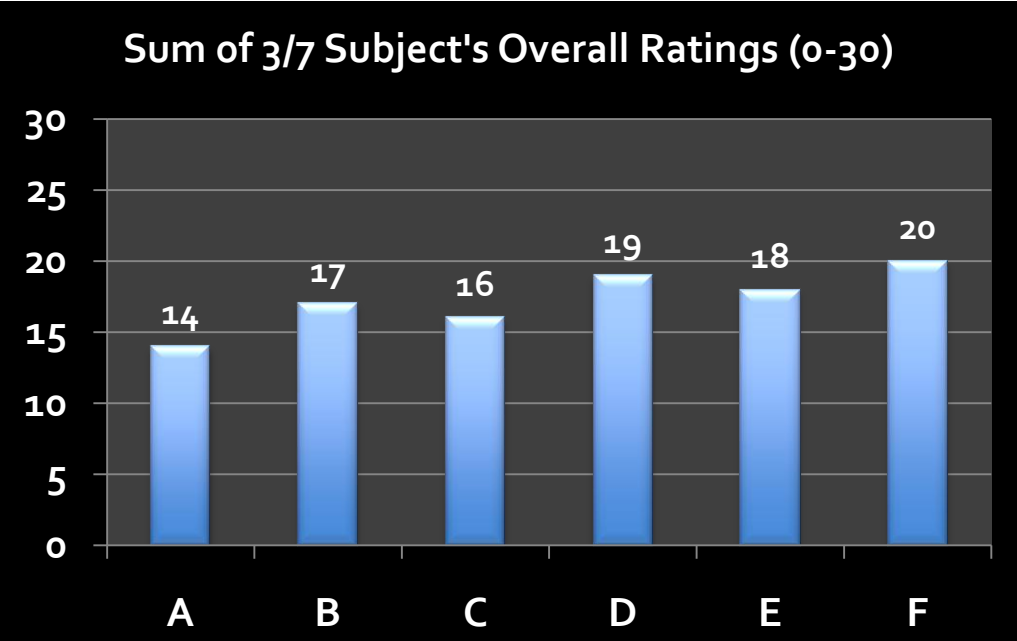
# Part B: Variable Ratings

Models	
A	CRCM
B	ECP2
C	HRM3
D	MM5I
E	RCM3
F	WRFG



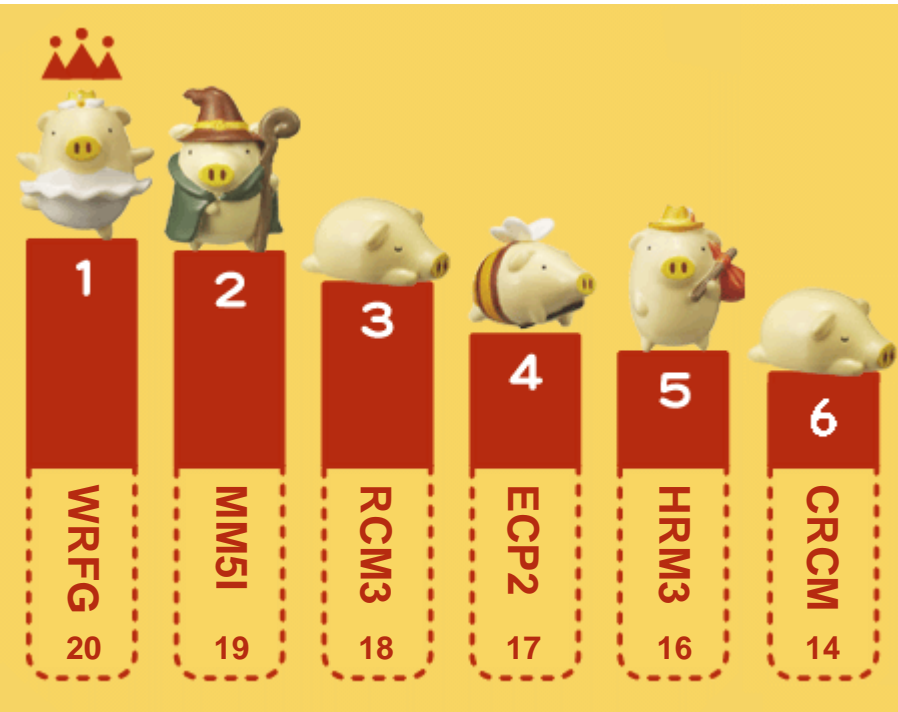
# Overall Ratings

Models	
A	CRCM
B	ECP2
C	HRM3
D	MM5I
E	RCM3
F	WRFG

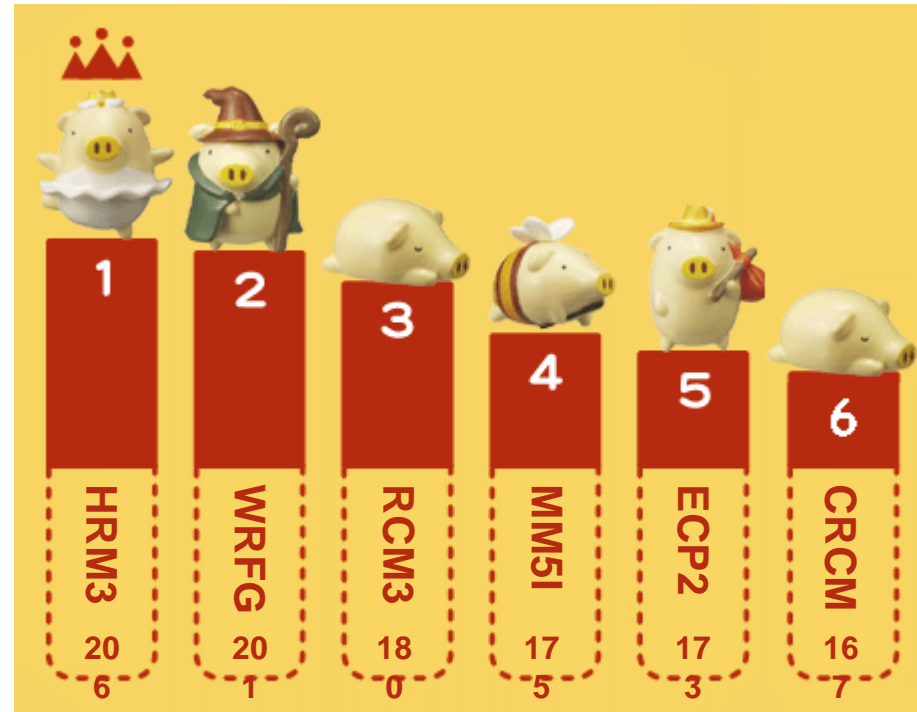


# Overall Rankings

Overall Ranking by Subjects



Overall Ranking by Variable Sums



# Discussion

- This was just a pilot study, the results are in no way determinative, but it may be a useful methodology in helping to determine differential model credibility.
- Please don't use just one NARCCAP model for your analysis because it appeared to do well here, for this region and season, use them all until you have sufficient evidence to do otherwise.





Questions?