From Global Projections to Regional Predictions

The Nested Regional Climate Model

www.nrcm.ucar.edu

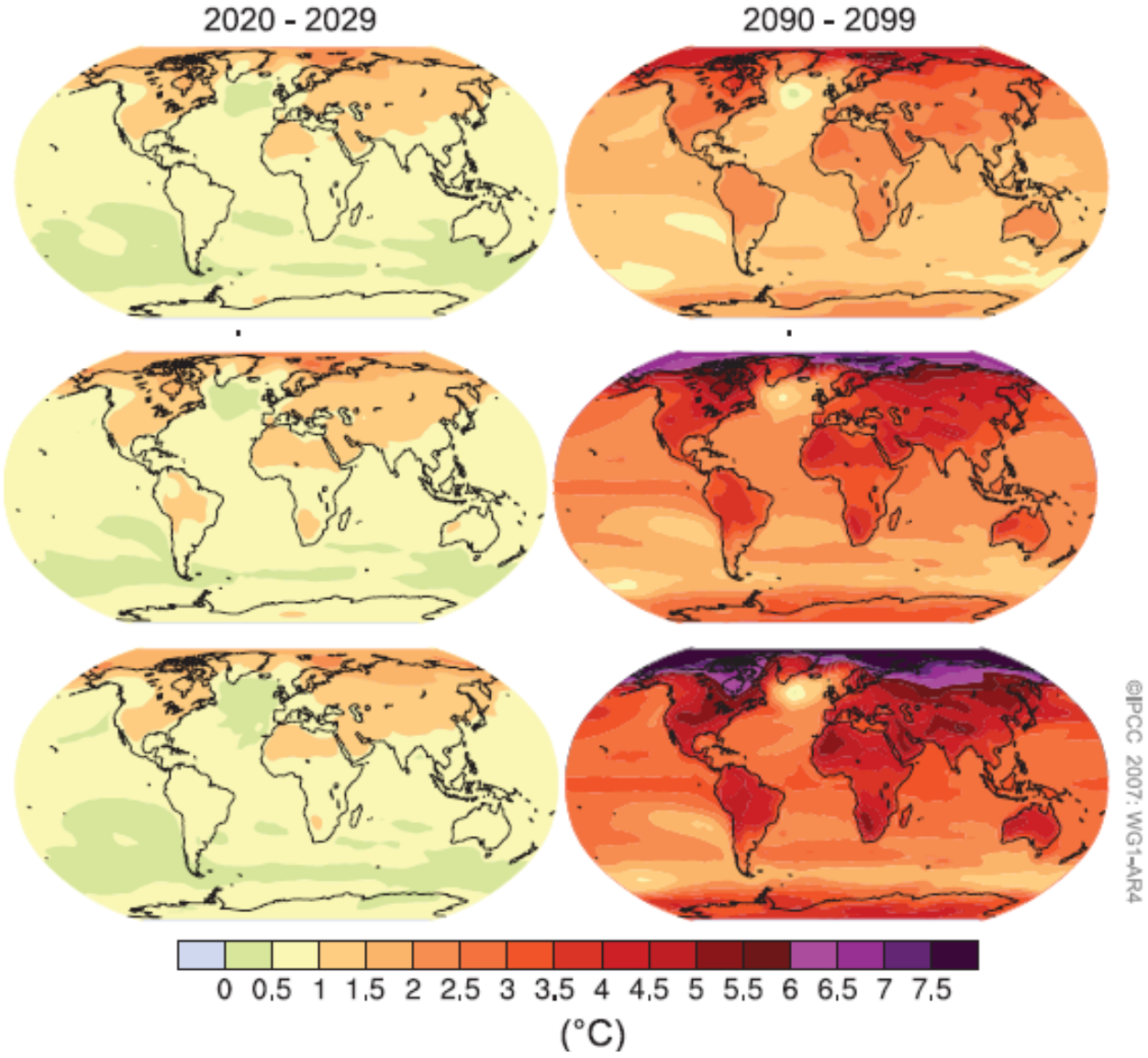
Jim Hurrell

Climate and Global Dynamics Division

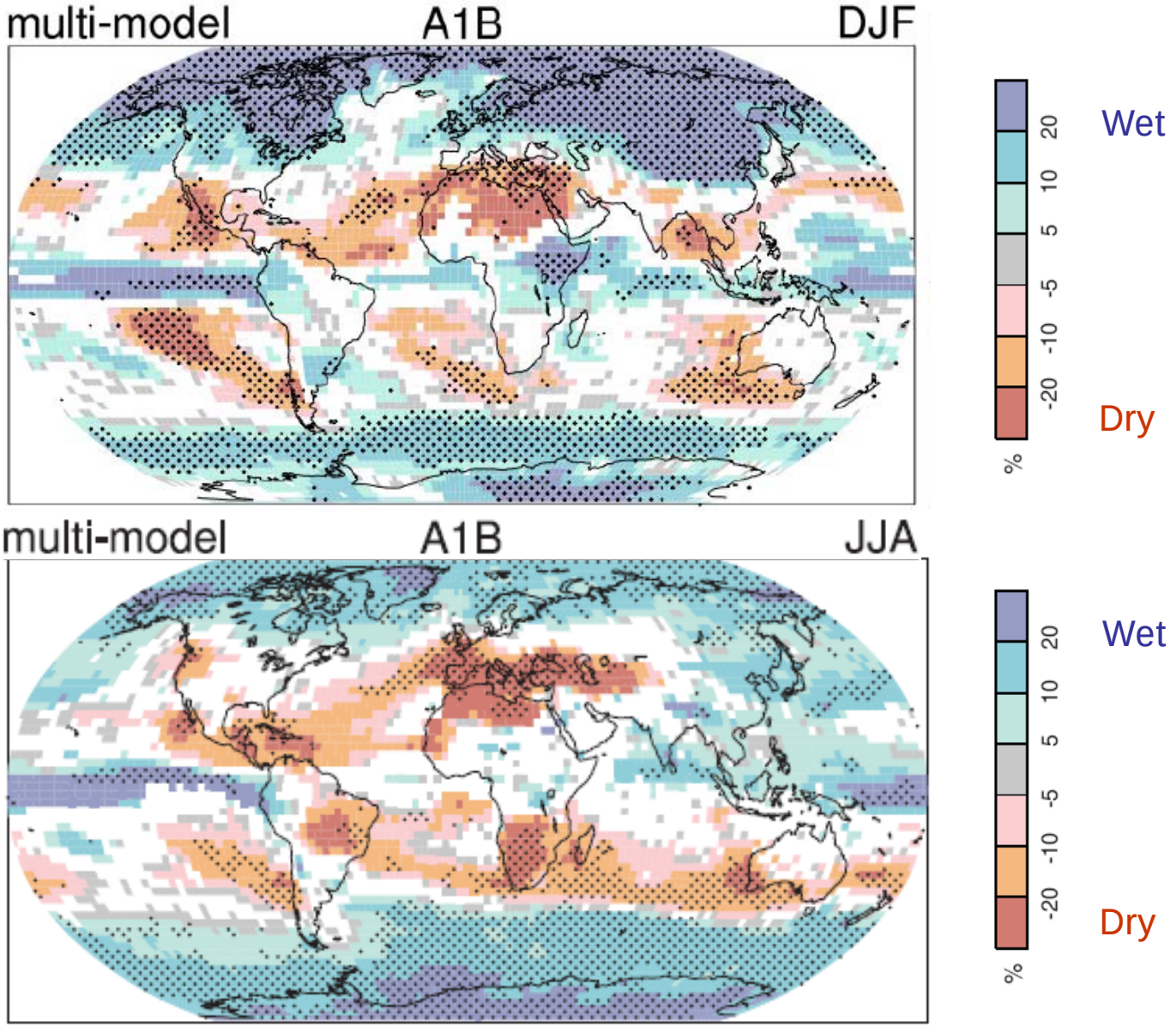
Projection of Future Warming

Lower CO_2 Increases

Higher CO_2 Increases

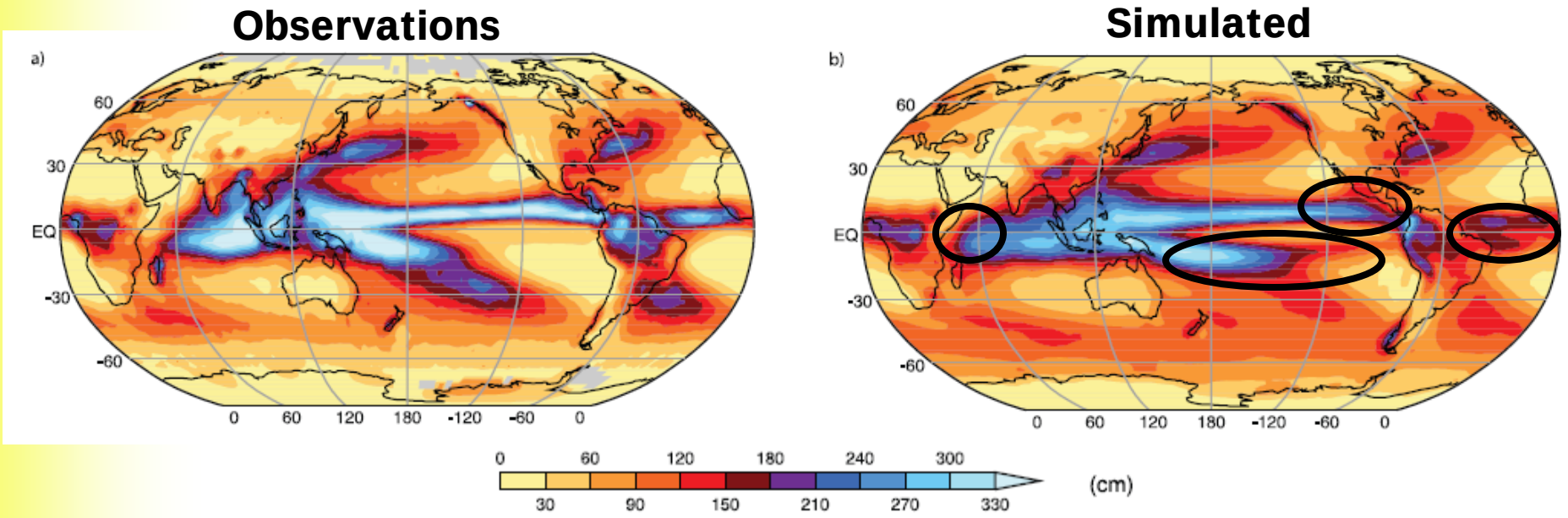


Projection of Precipitation Change



WGI of IPCC (2007)

Rainfall Biases



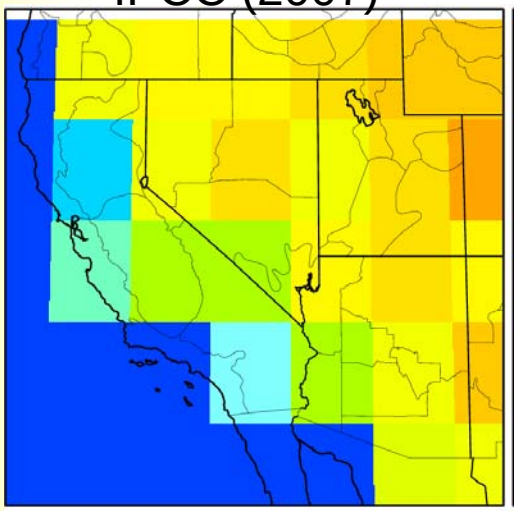
"Models still show significant errors … The ultimate source of most is that many important small-scale processes are not represented explicitly in models …"

Randall et al. 2007

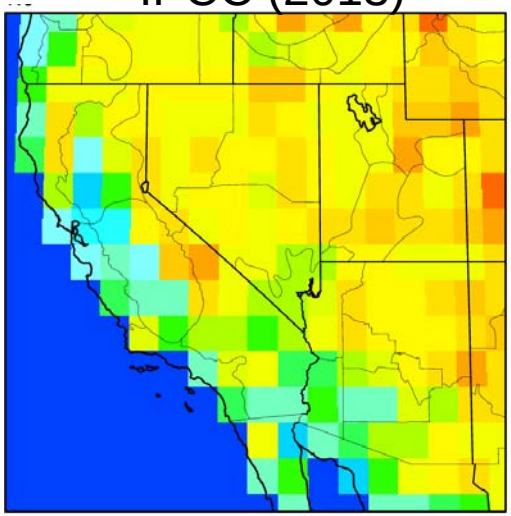
Improving Predictions of Regional Changes in Weather and Climate

- Goal of NRCM is to seamlessly integrate weather (WRF), high resolution ocean (ROMS) and climate models (CCSM) to:
  - better capture and investigate important space/time scale interactions
  - develop approaches for reducing biases
  - inform the development of next-generation Earth System Models
  - apply to model to challenging science and important societal questions
  - assist decision-makers to plan for regional changes

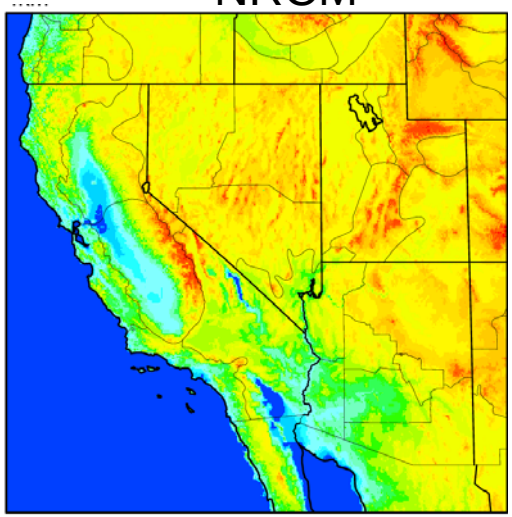
IPCC (2007)



IPCC (2013)

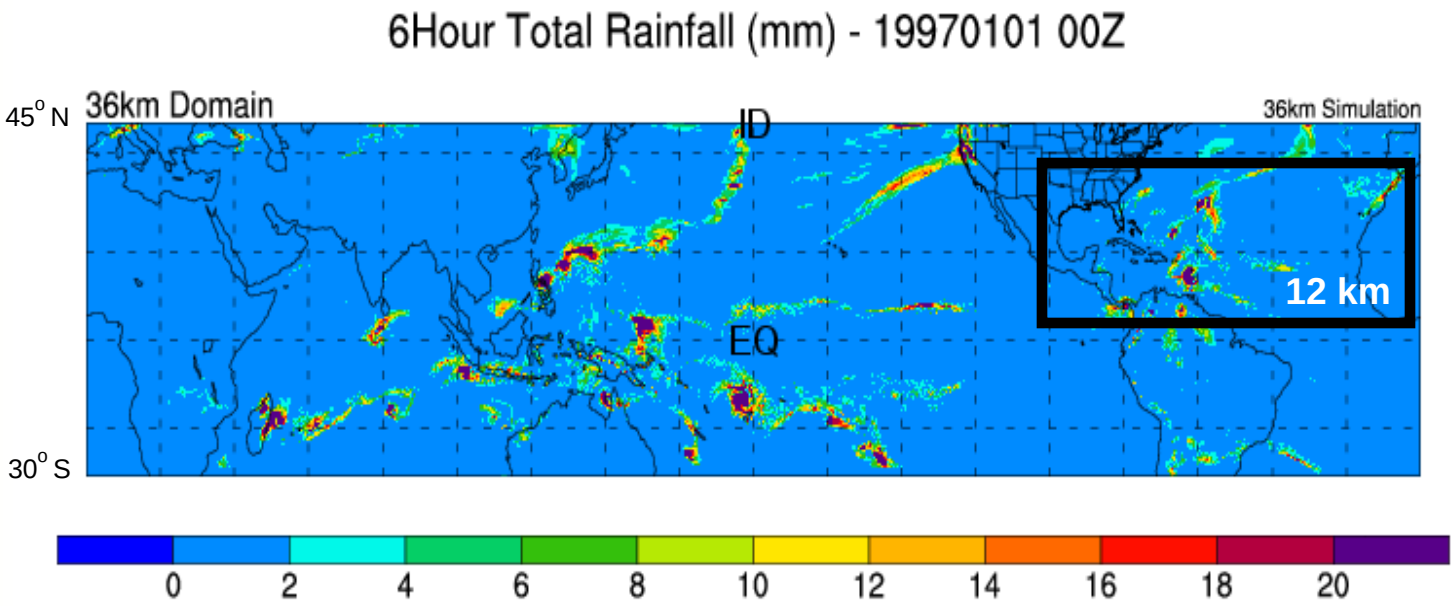


NRCM



The Nested Regional Climate Model Phase 1: 1996-2000 & 2000-2005 Tropical Simulations

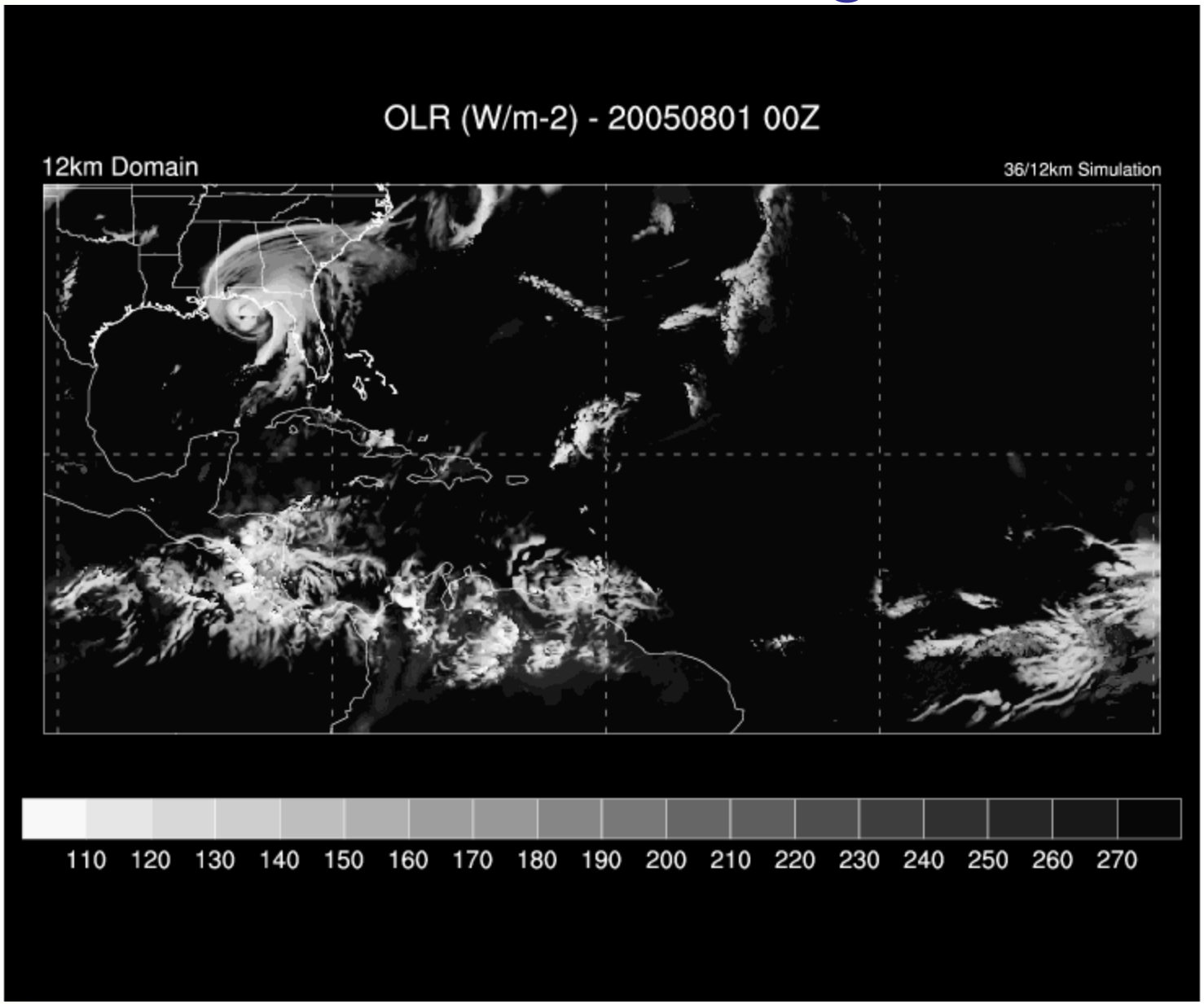
Tropical Channel, 36 km, N/S boundaries
1-way nested into NCEP Reanalysis



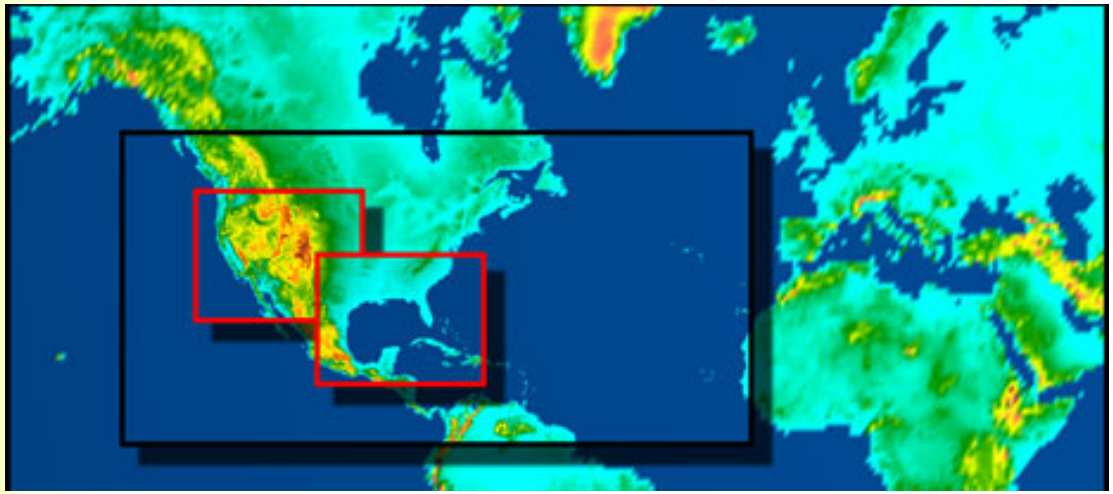
Results to be published in Special Issue of *Climate Dynamics*

- J. Hurrell, Coordinating Editor
- ~12 papers documenting the experimental framework, NRCM strengths and weaknesses, including relevant comparisons to CAM

12 km Simulation of August 2005



North Atlantic and North American Regional Climate Changes



The goal is to simulate the effects of climate change on precipitation across the intermountain West States and tropical cyclones, with a focus on the Gulf of Mexico.

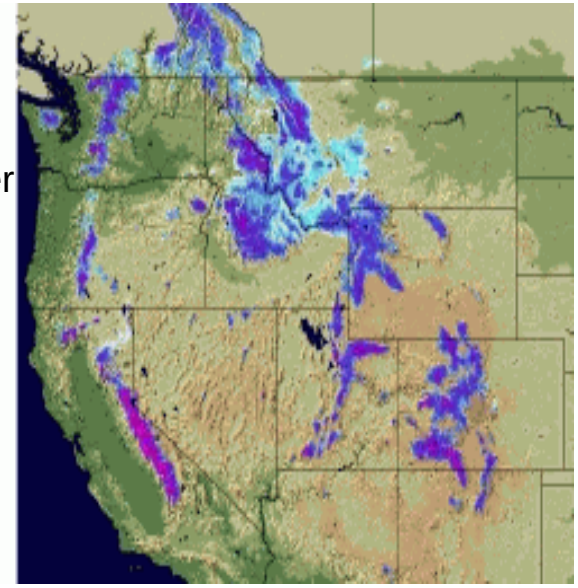
- 36, 12 and 4 km WRF domains nested into CCSM
- 1996-2005, then time slices out to 2055
- Multi-member ensembles for each period
- Dedicated time on NCAR IBM Power 6 (July-Nov 2008):
  - 24 nodes (~20% of total number of processors)
  - 36 (12) km simulations use 128 (256) processors per job
  - Used 3.9M processor hours and generated > 300 Tb of data

April Snow Depth

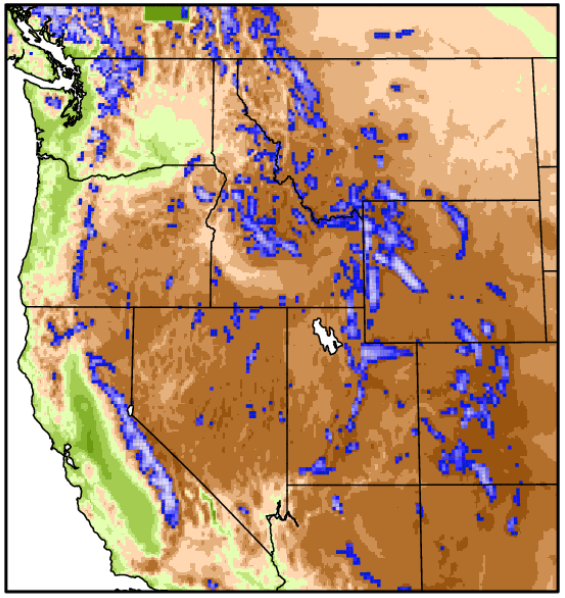
Observations

National Hydrologic Remote Sensing Center

Climatology

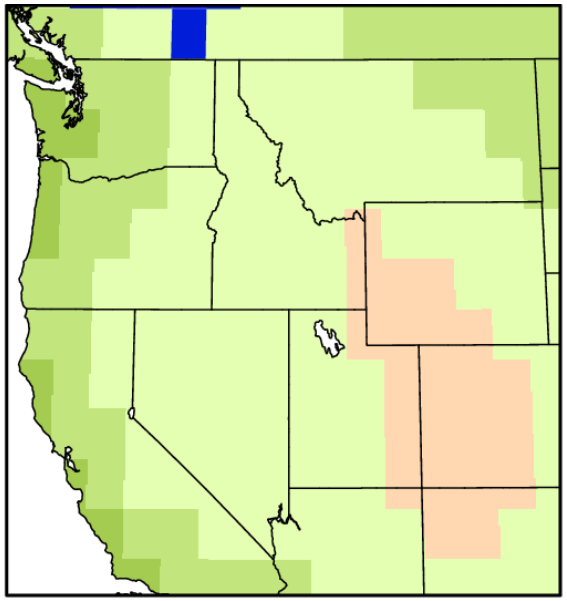


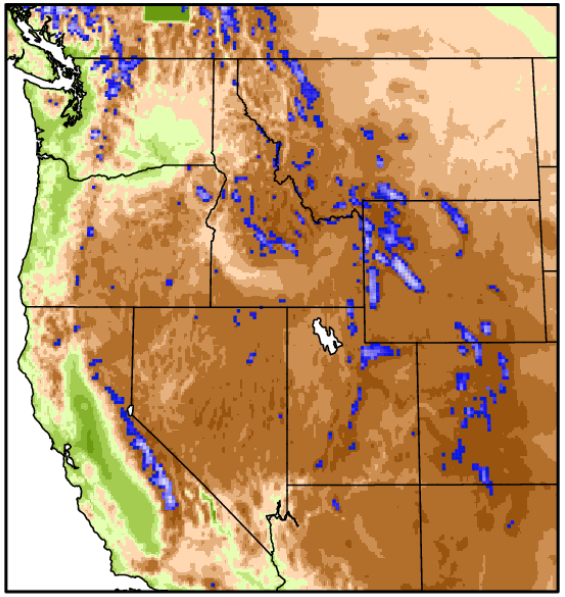
NRCM 12 km

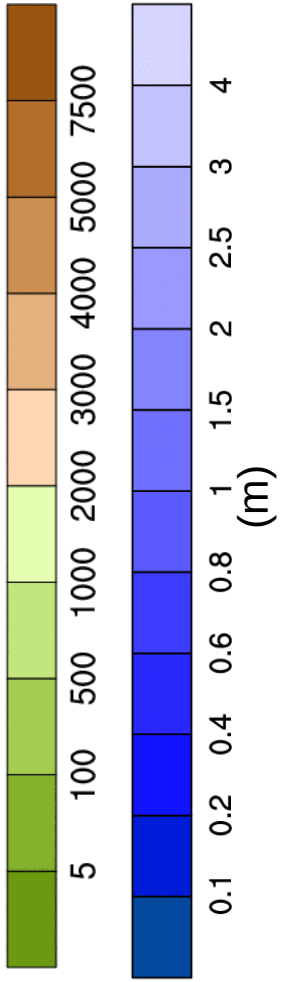


CCSM3 T85

2045-2050







The Nested Regional Climate Model

(www.nrcm.ucar.edu)

- Practical approach to high-resolution climate modeling:
  - *Coupling weather and climate models to:*
    - *utilize the best of both;*
    - *improve fidelity of global climate simulations*
    - *provide forecasts of changes in high impact weather/climate*
- Inform development of next-generation models
  - *Unified atmospheric modeling system capable of predictions from hours to decades*
    - *non-hydrostatic dynamics with conservation properties for climate*
    - *coupled data assimilation system*
    - *capacity to run efficiently on massively-parallel computing system*
- Support as priority "Frontier" in NCAR strategic plan
  - *Western Governor's Assoc. and California Water Agencies (western water)*
  - *DOE, Offshore Oil Industry and Reinsurance Industry (hurricanes)*
  - *DOE, NRL, CREW, Colorado, local industry (wind energy production)*

Thank You