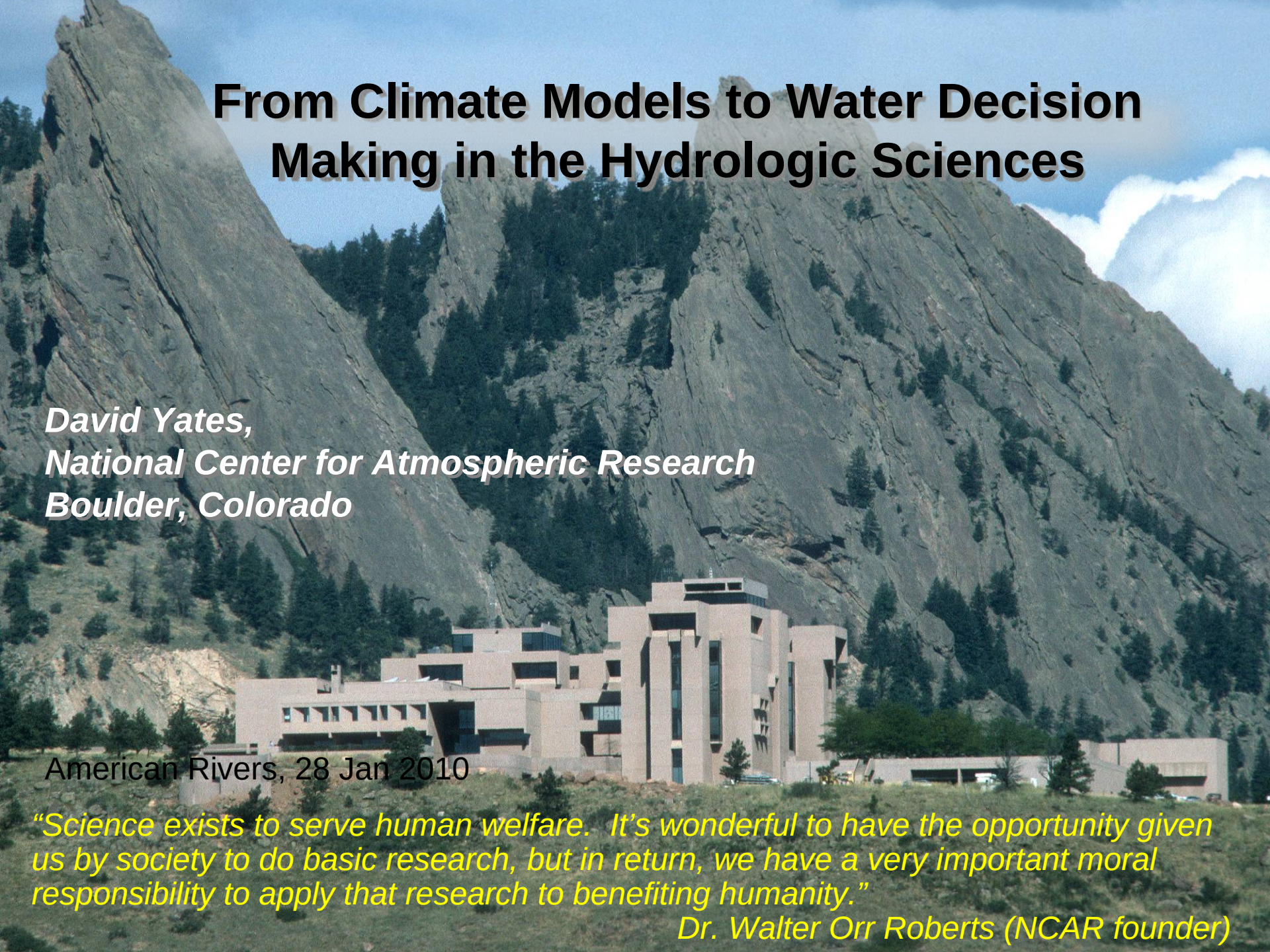
From Climate Models to Water Decision Making in the Hydrologic Sciences



David Yates,
National Center for Atmospheric Research
Boulder, Colorado

American Rivers, 28 Jan 2010

"Science exists to serve human welfare. It's wonderful to have the opportunity given us by society to do basic research, but in return, we have a very important moral responsibility to apply that research to benefiting humanity."

Dr. Walter Orr Roberts (NCAR founder)

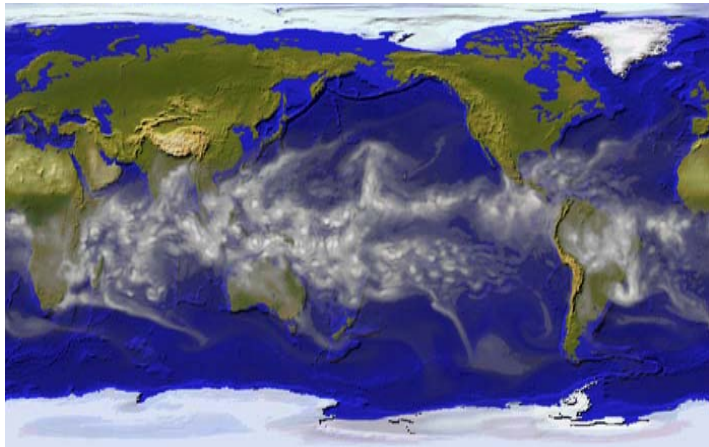
NCAR Scientific facilities

National Science Foundation Research & Development Center

- 900 Staff, 500 Scientists/Engineers
- Basic Research & Societal Applications
- Atmospheric and related sciences

1. Advanced Observational Facilities

2. Supercomputers, data and networks

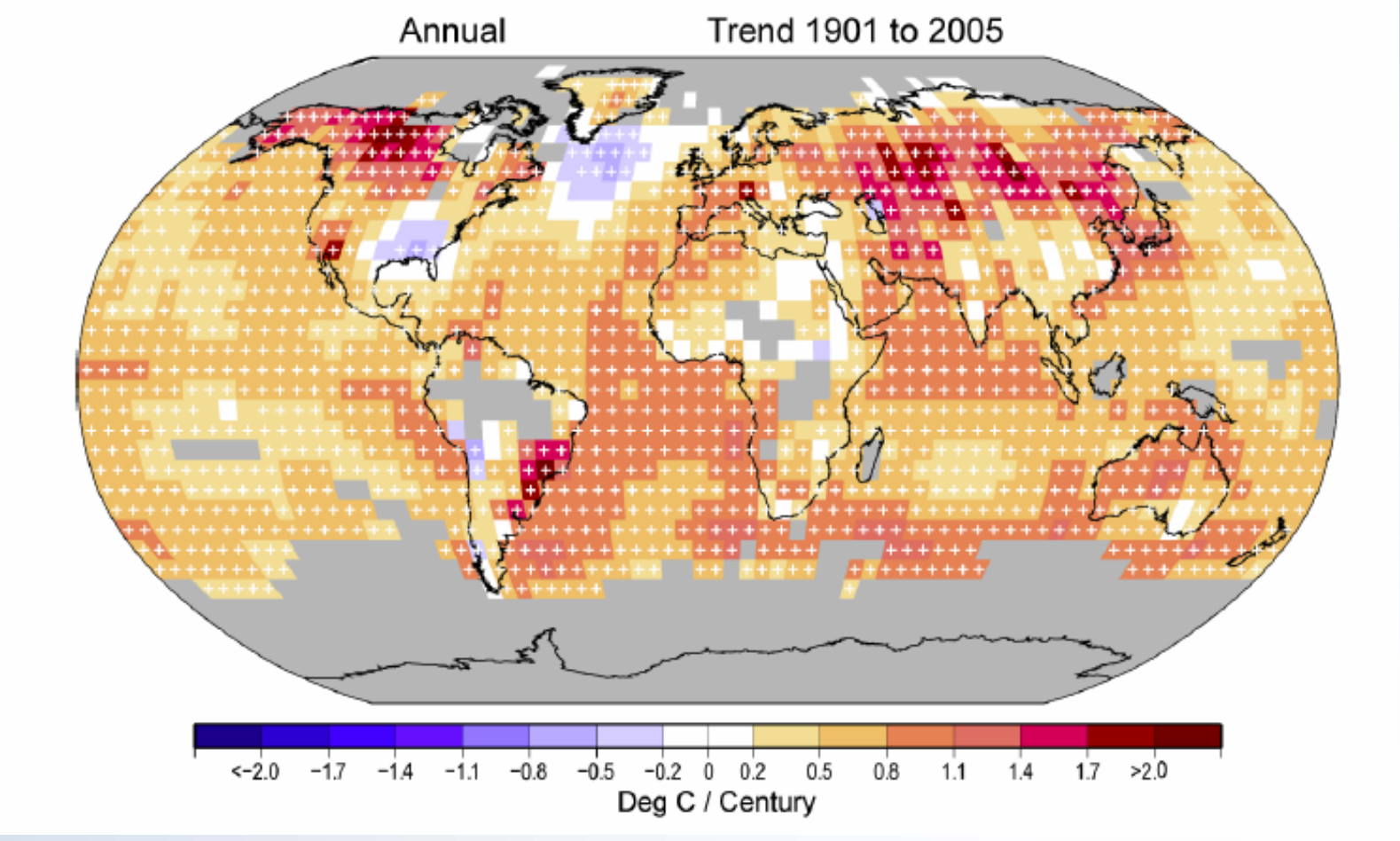


3. International Collaborative Research Environment

Source: *NASA ISS007-E-10807 (July 21, 2003, 35 mm lens).*

At sunset over the Pacific Ocean, anvil tops of thunderclouds cast long shadows

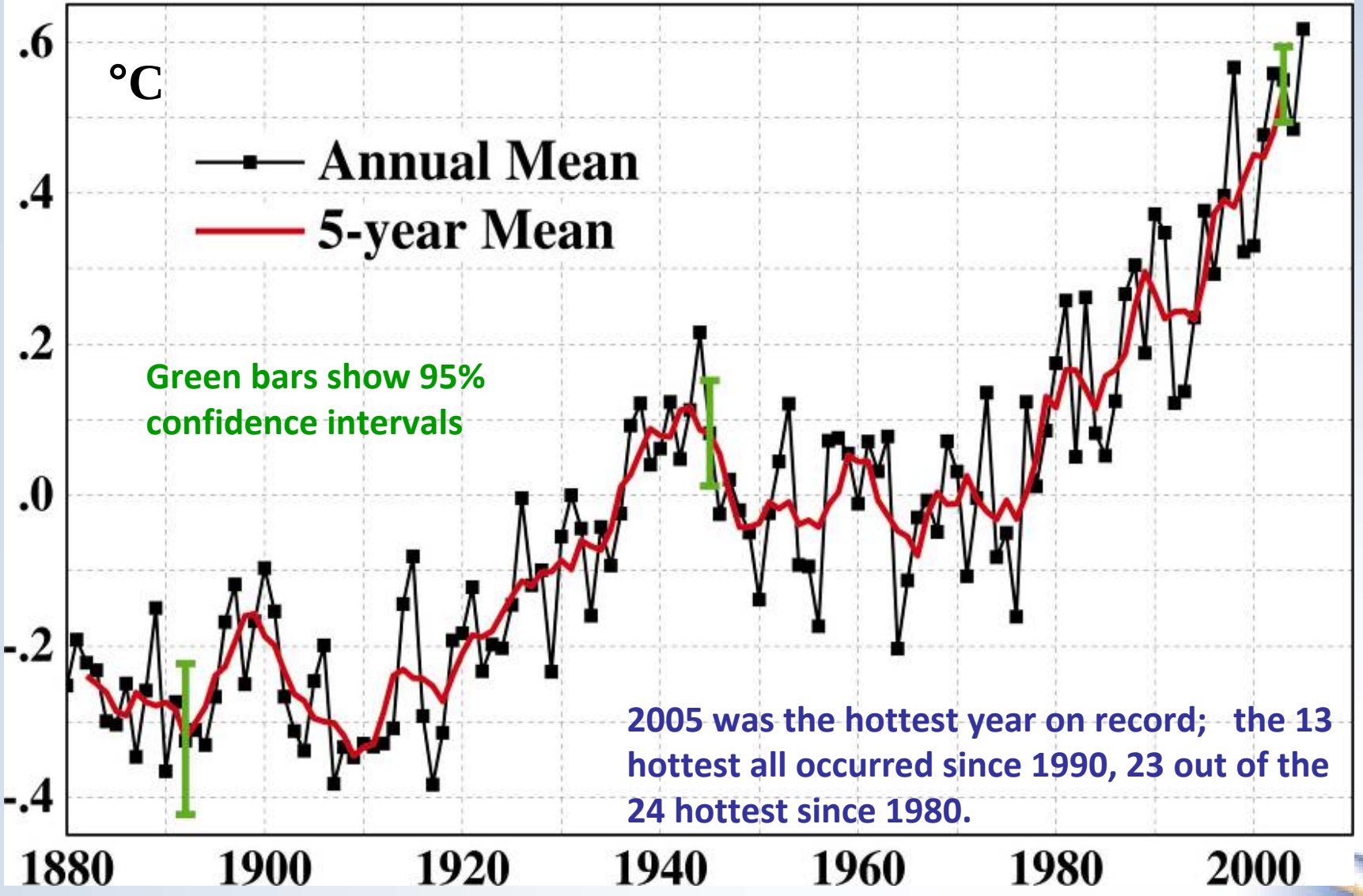
The World Has Warmed- Observations



Globally averaged, the planet is about 0.75°C warmer than it was in 1860.

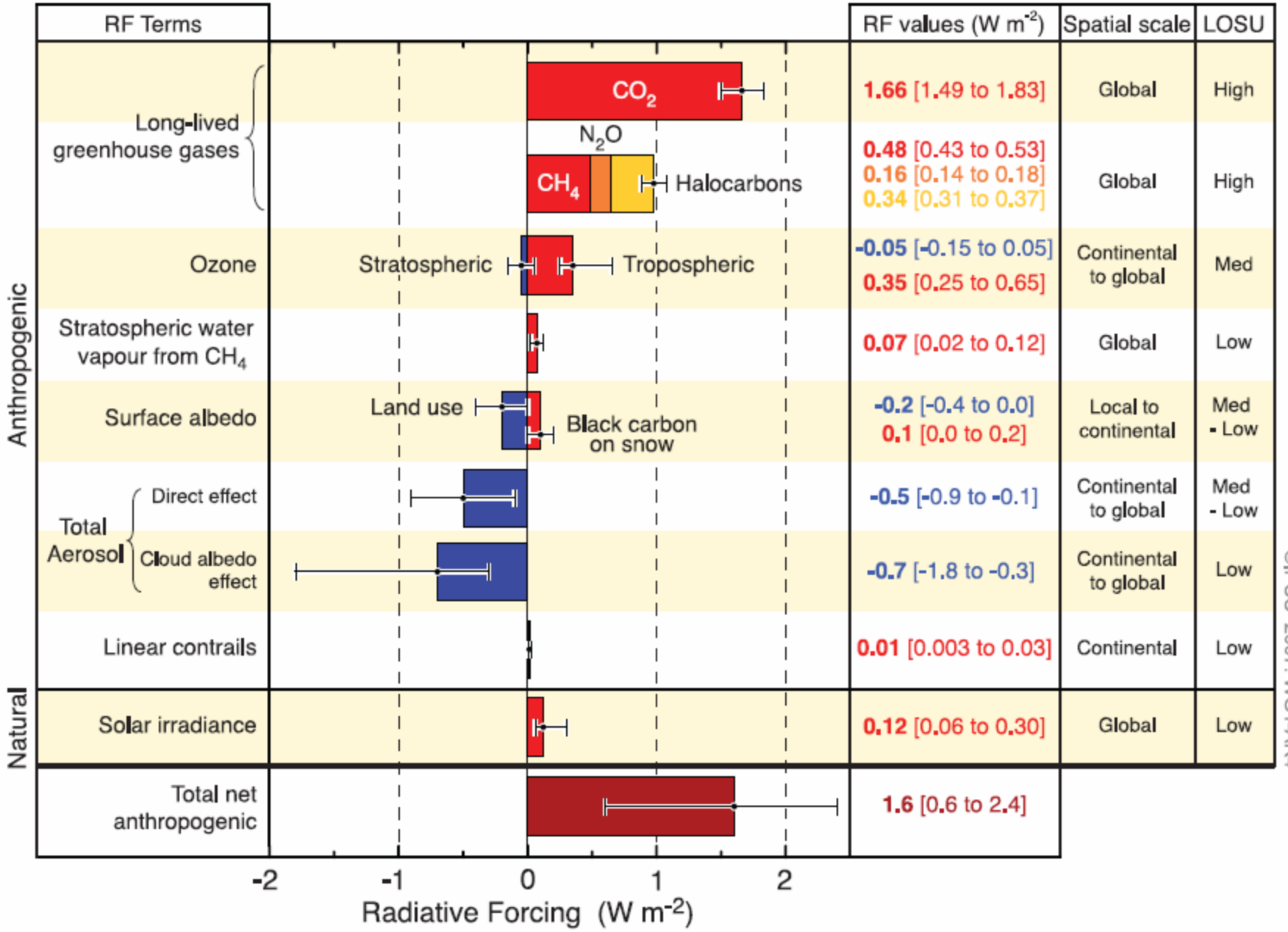
NCAR

Global surface temperature since 1880

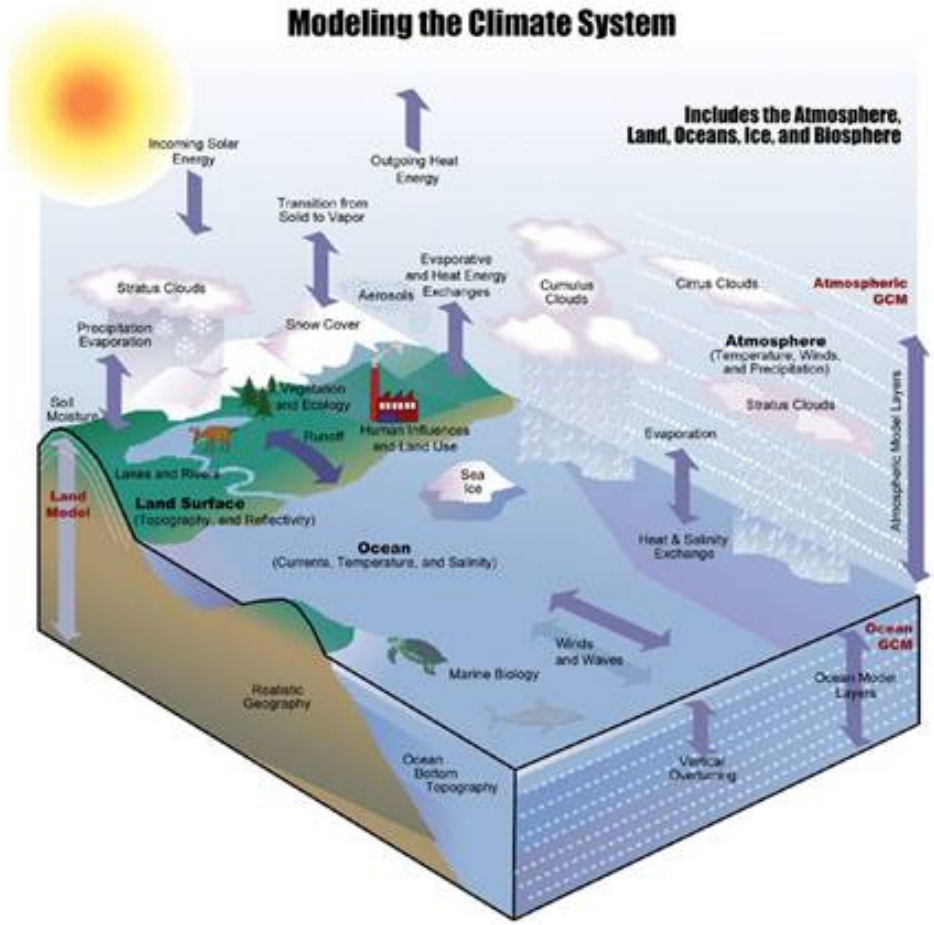


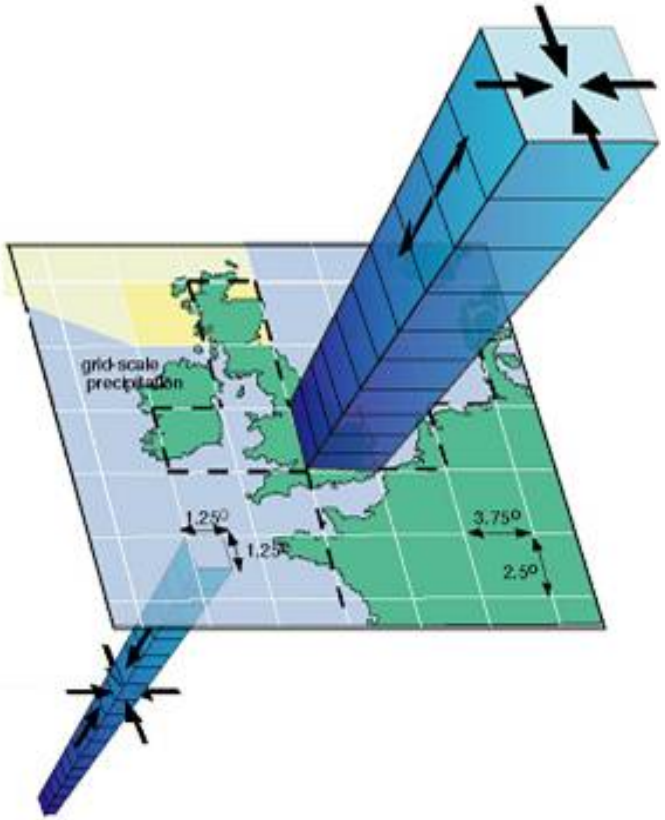
J. Hansen et al., *PNAS 103*: 14288-293 (26 Sept 2006)

Radiative Forcing Components

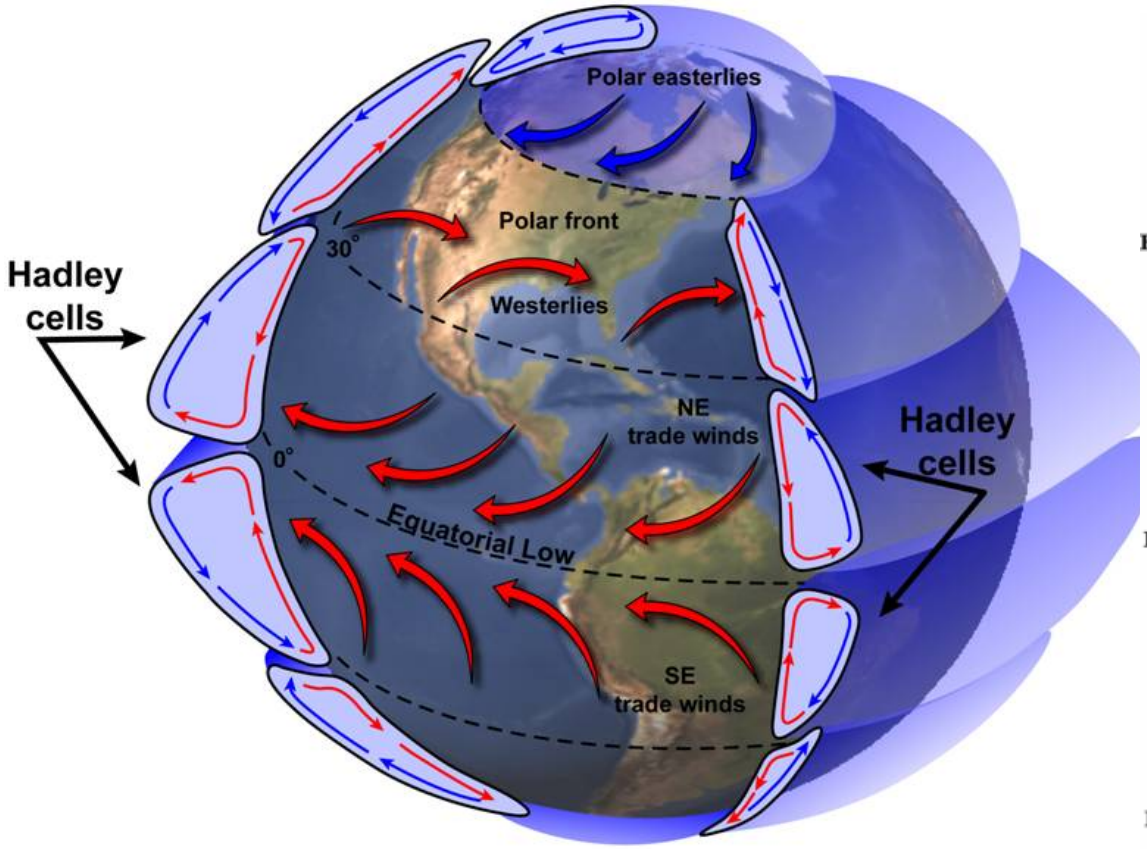


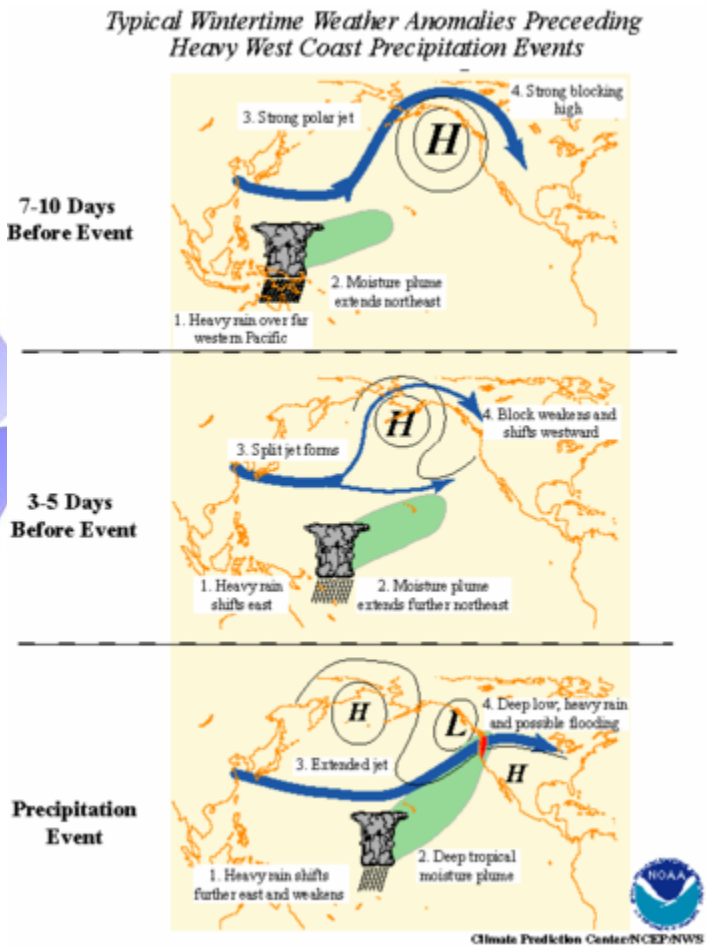
Global Climate Models



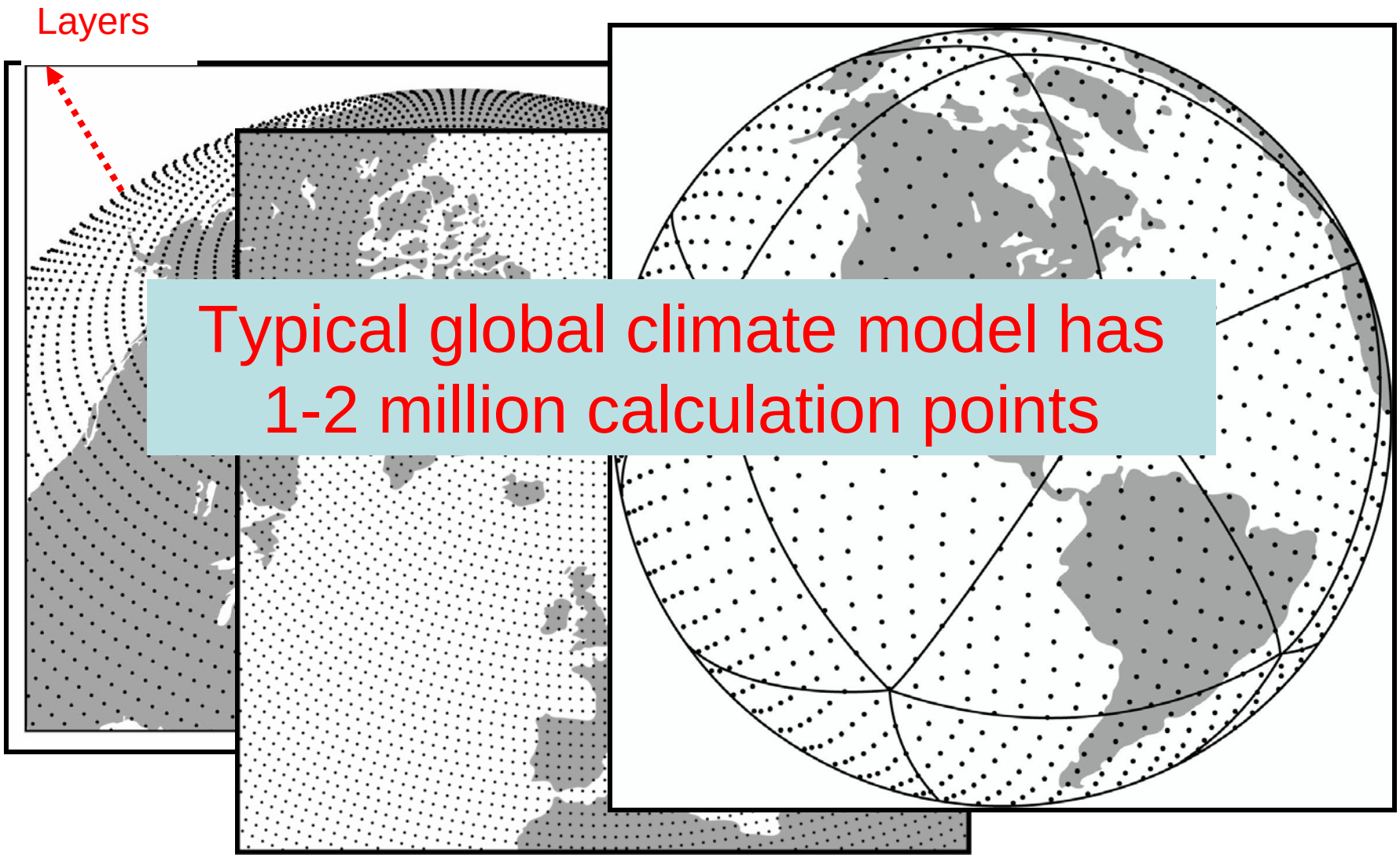


The Hadley cells are the main way the atmosphere transports energy polewards in low latitudes

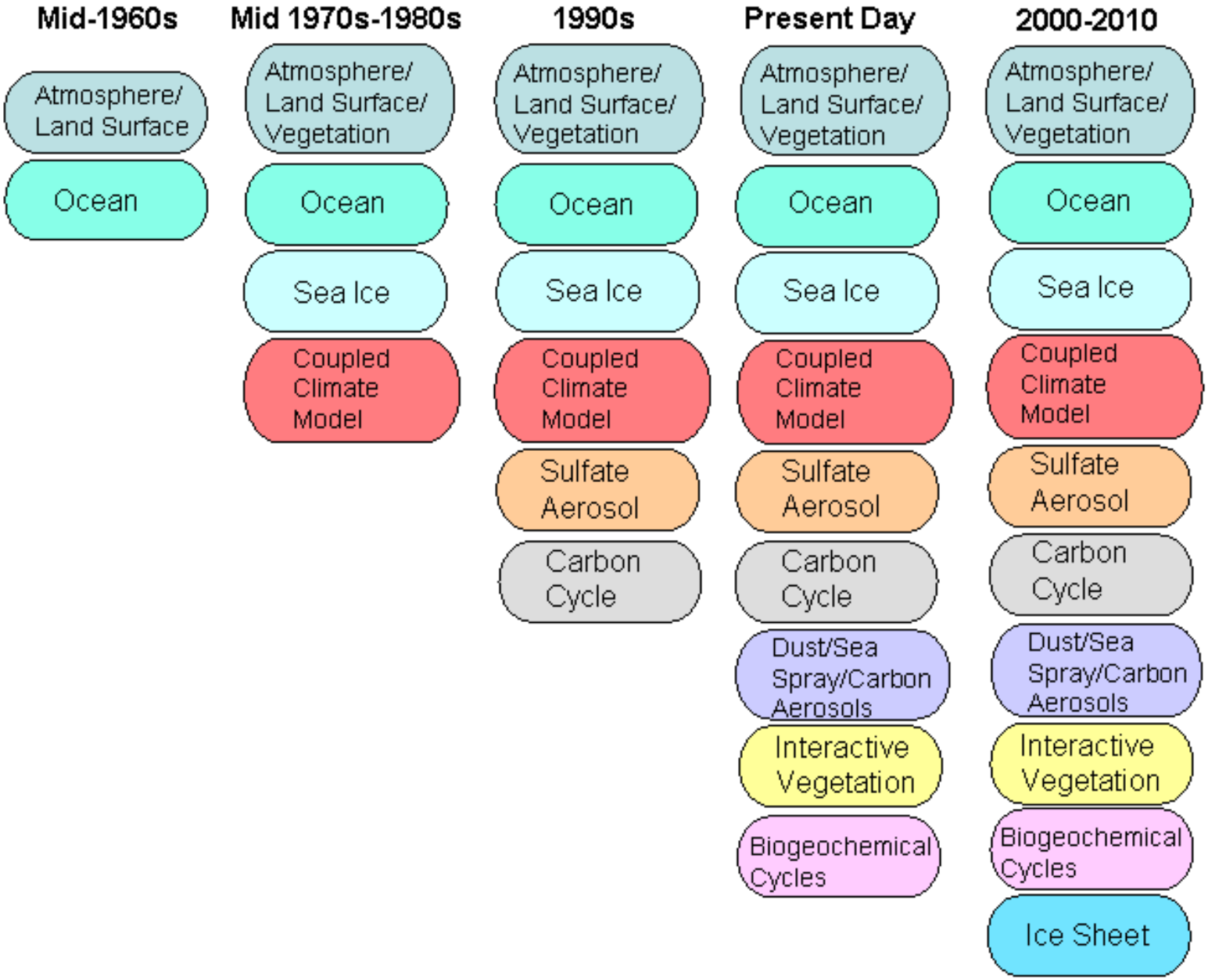




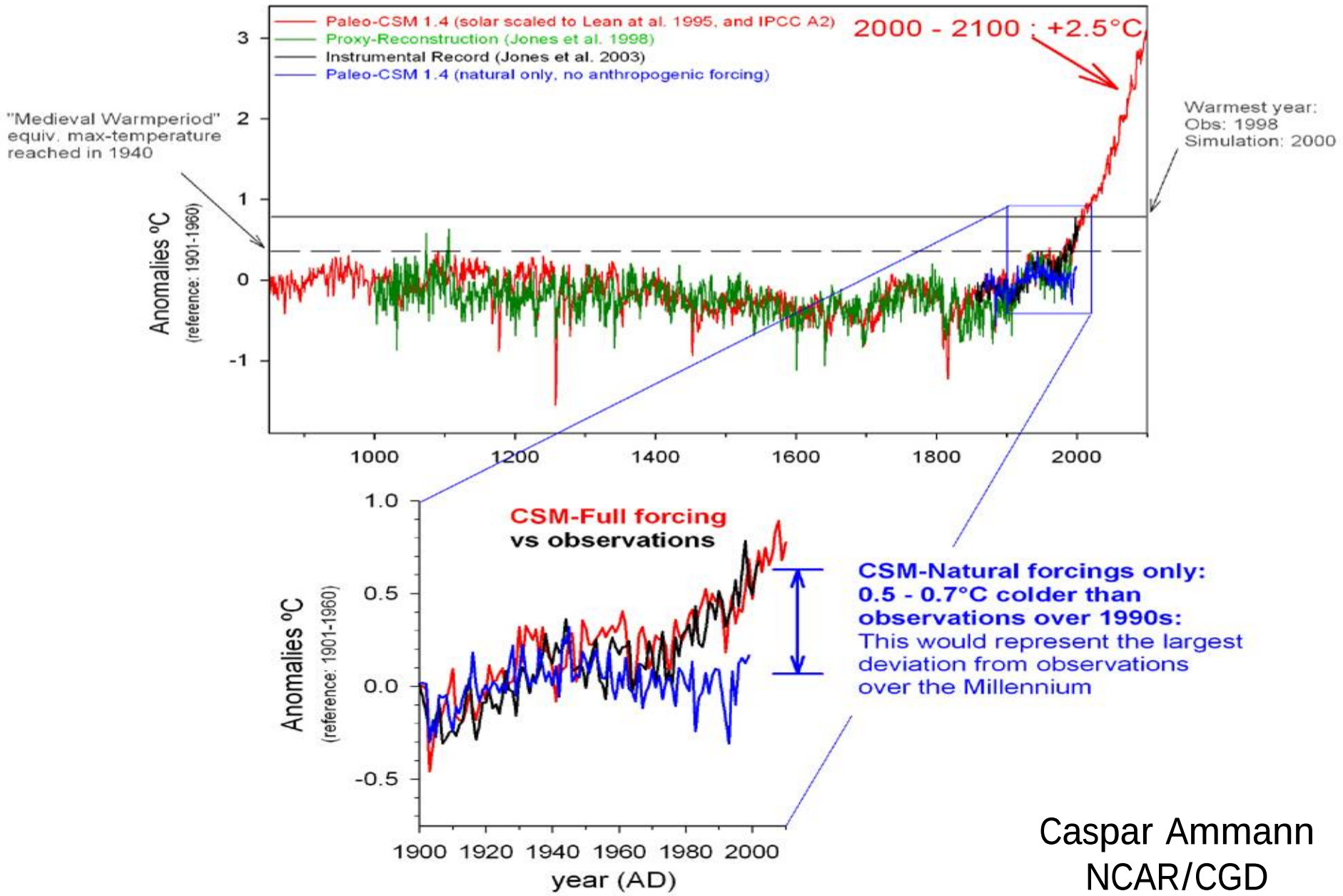
A grid of points over Earth



Timeline of Climate Model Development



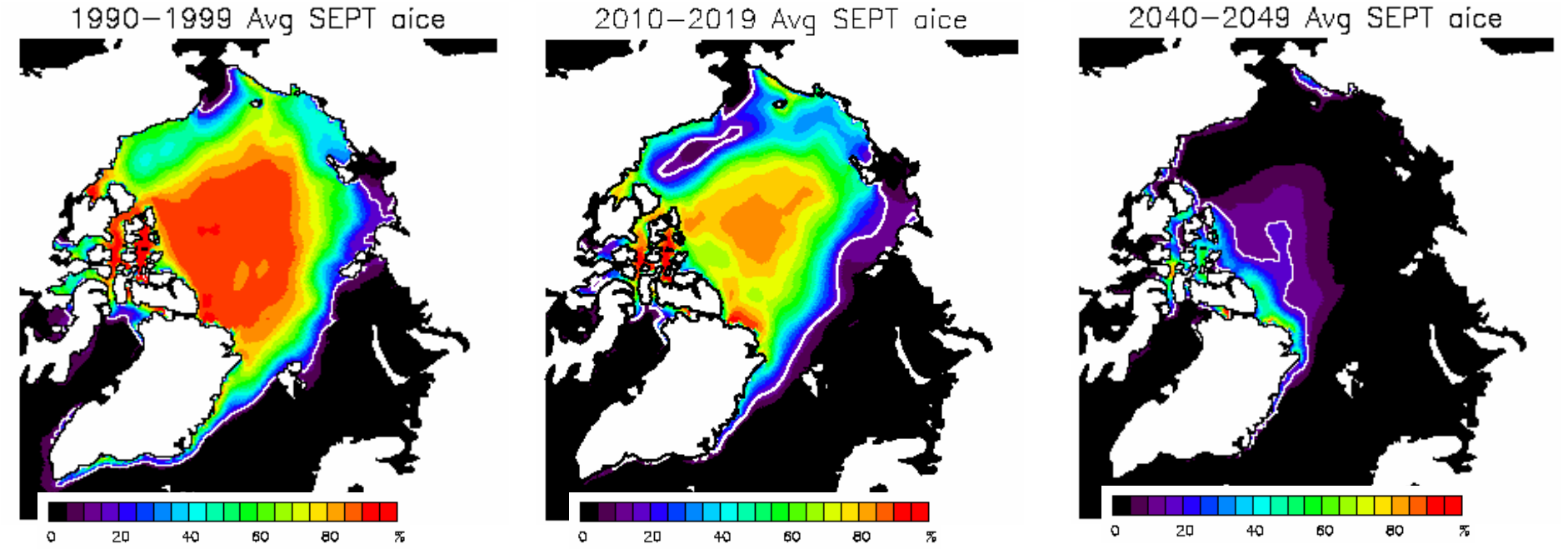
Climate of the last Millennium

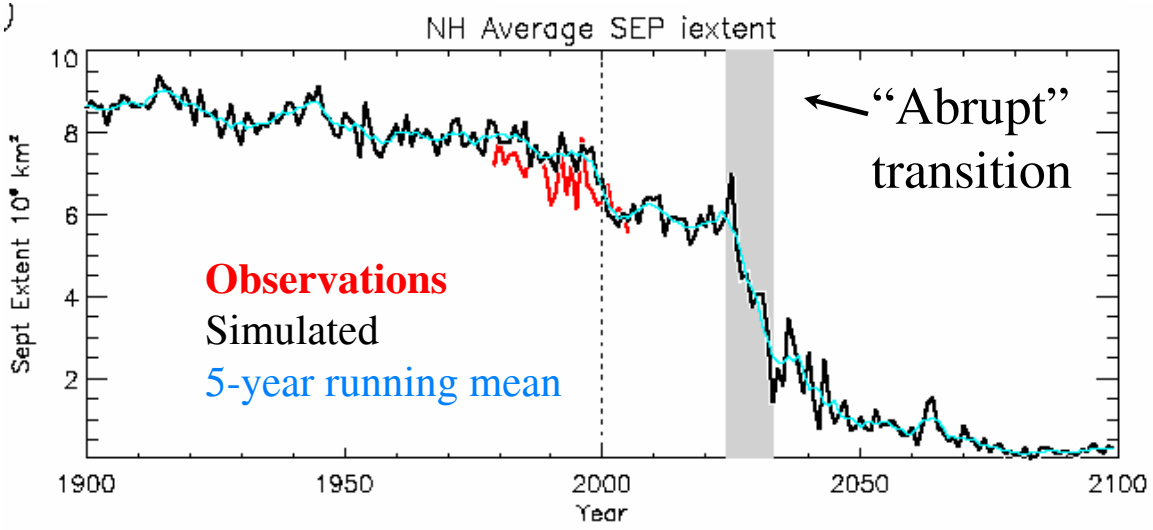


Caspar Ammann
NCAR/CGD

Simulation of Future Climate

Abrupt Transitions in the Summer Sea Ice





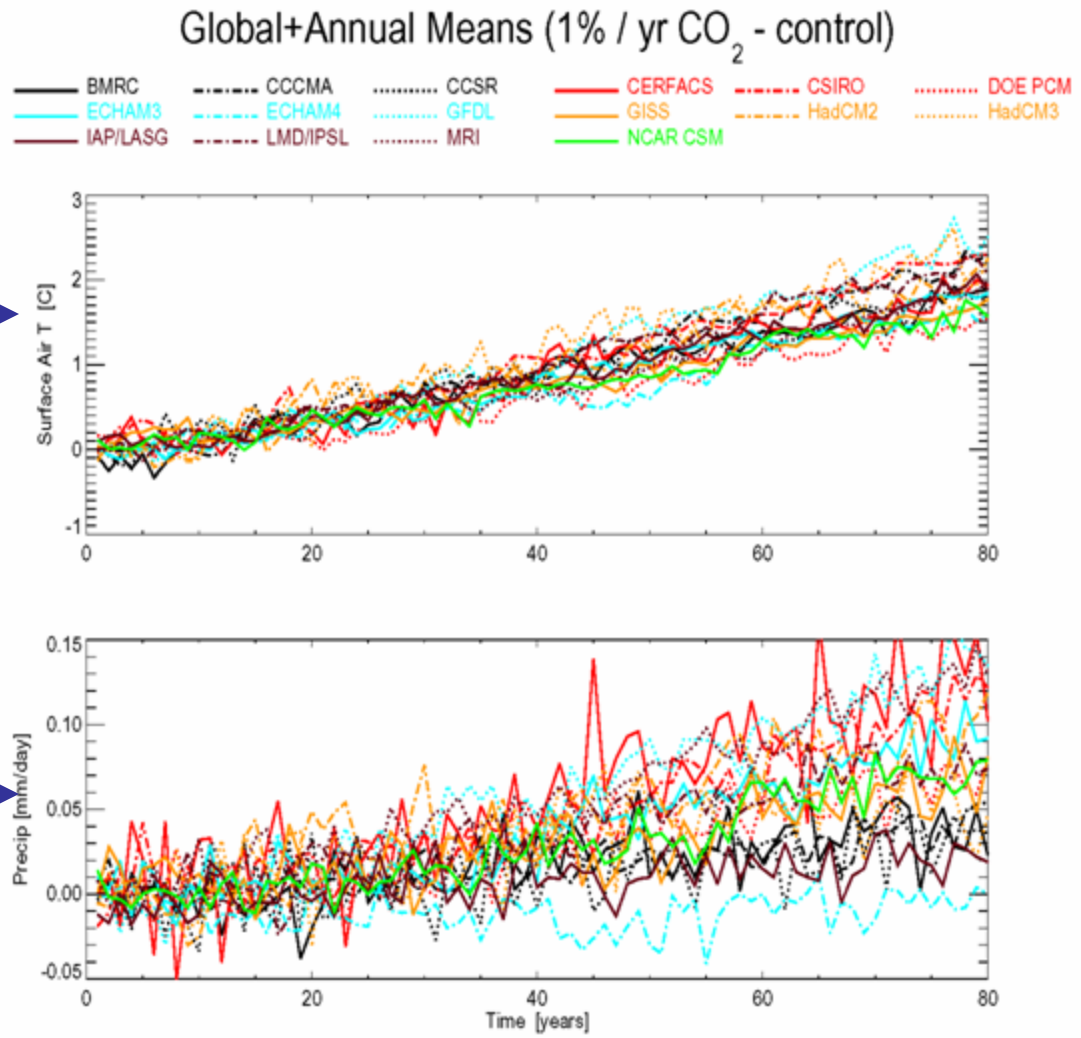
- Gradual forcing results in abrupt Sept ice decrease
- Extent decreases from 80 to 20% coverage in 10 years.

The Precip Challenge

80 yr. Temp. Rise →

CMIP

80 yr. Precipitation Trend ? →

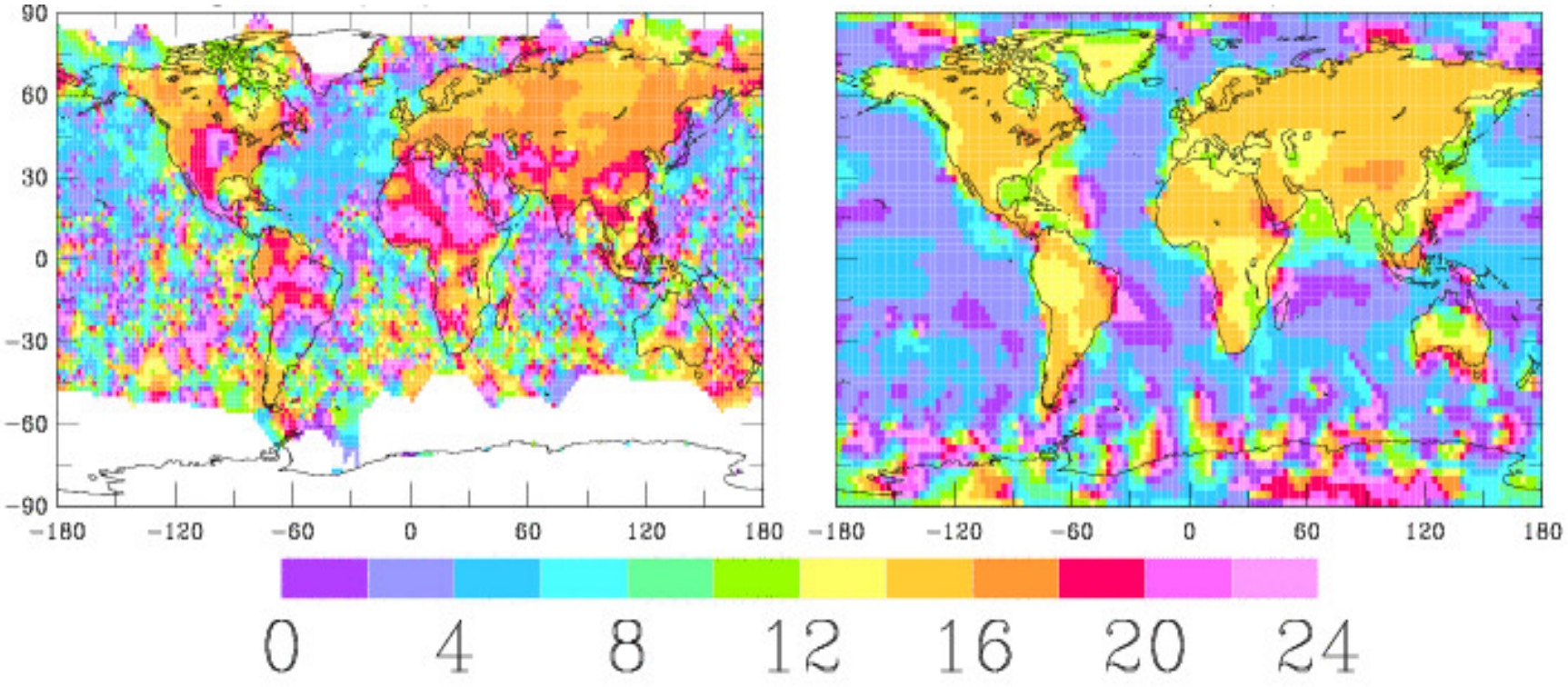


Covey et al. 2003

Diurnal Cycle of Convective Precipitation for JJA

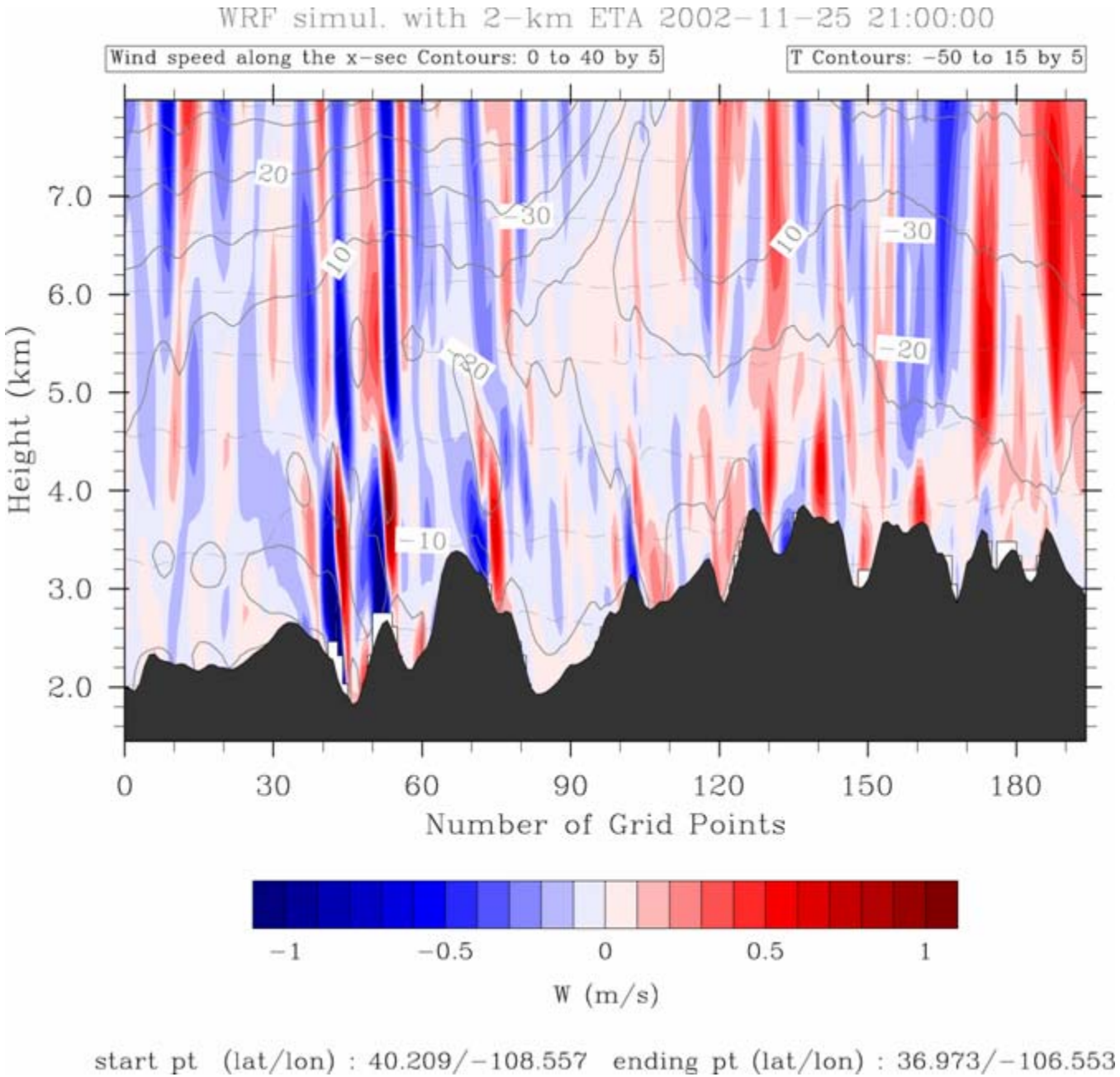
Observed Frequency 1976-97
Time of maximum

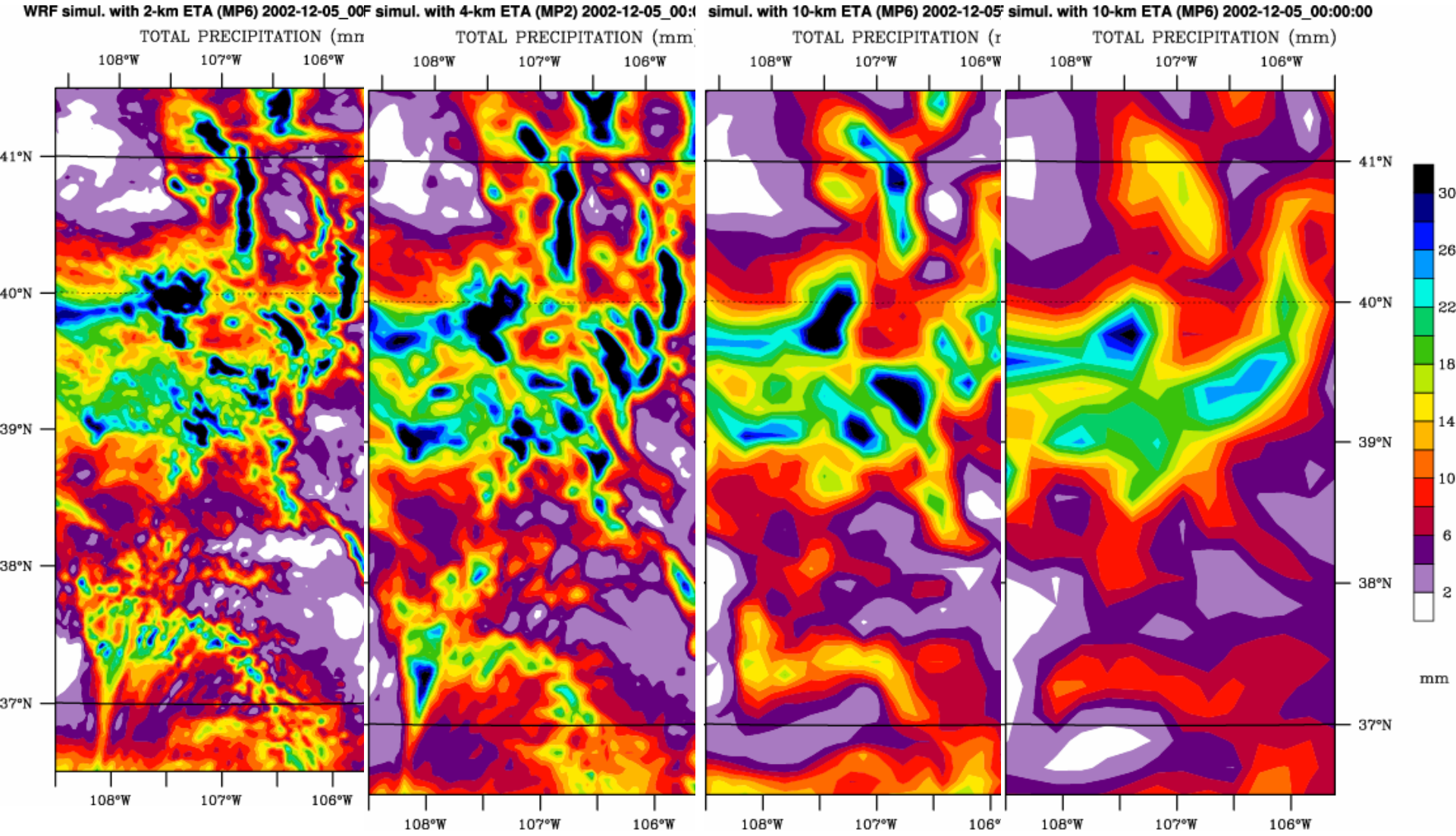
CCSM Frequency 1983-88
Time of maximum



Modeled frequency occurs about 2 hours earlier than observed

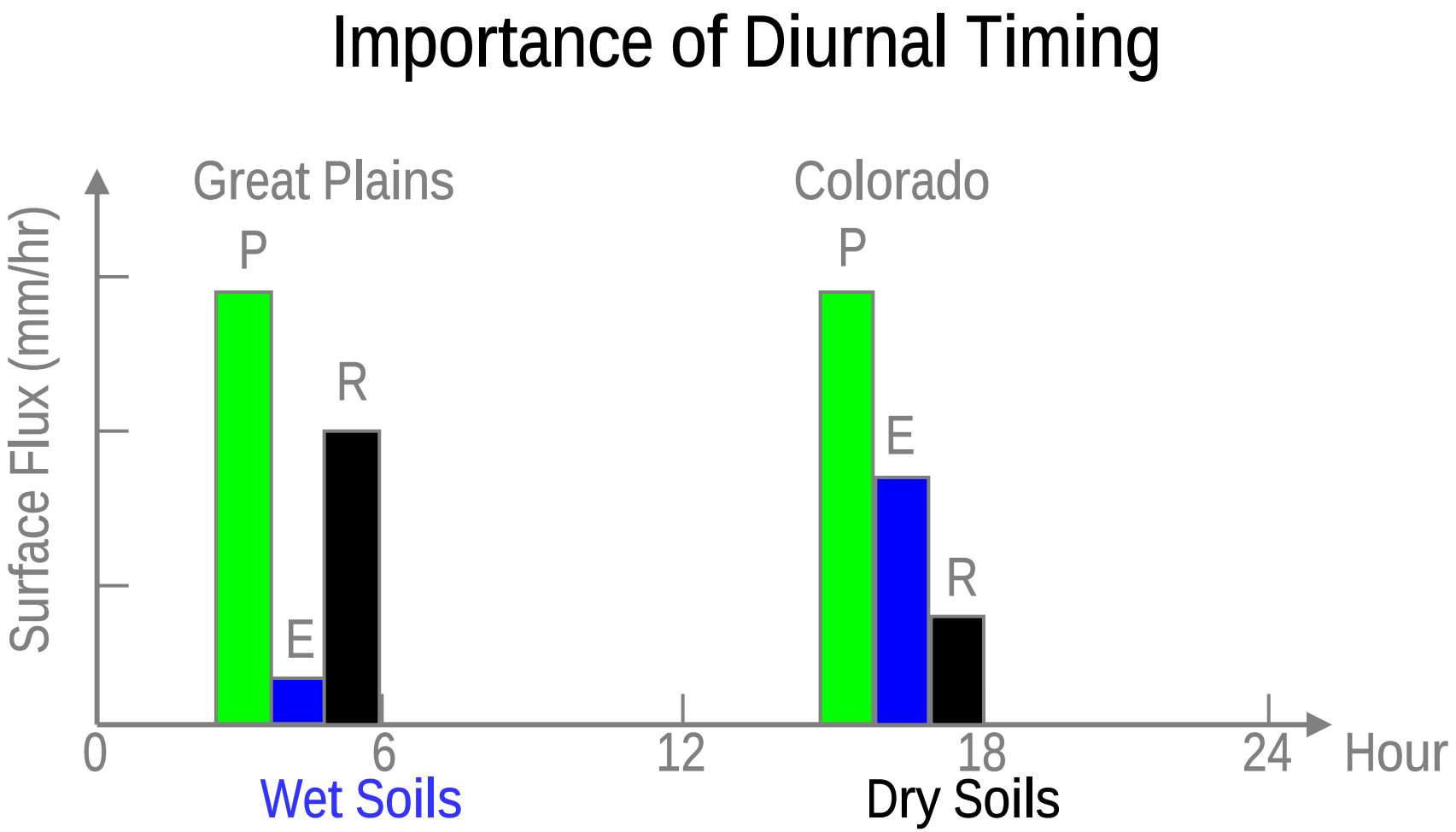
Dai and Trenberth 2003


WRF simul. with 2-km ETA 2002-11-25 21:00:00
Wind speed along the x-sec Contours: 0 to 40 by 5
T Contours: -50 to 15 by 5
Height (km)
7.0
6.0
5.0
4.0
3.0
2.0
0
30
60
90
120
150
180
Number of Grid Points
-1
-0.5
0
0.5
1
W (m/s)
start pt (lat/lon) : 40.209/-108.557 ending pt (lat/lon) : 36.973/-106.553



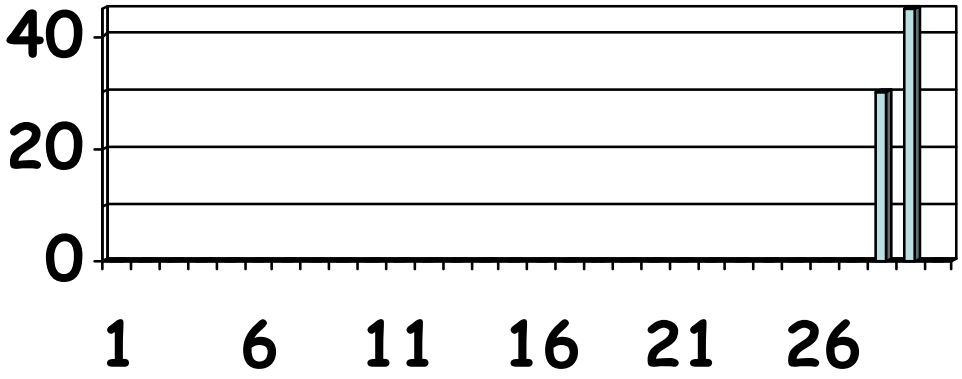
2 km 4 km 10 km 20 km

Why Do We Care about Precip. Characteristics?



Daily Precipitation at 2 stations

A



drought
wilting plants

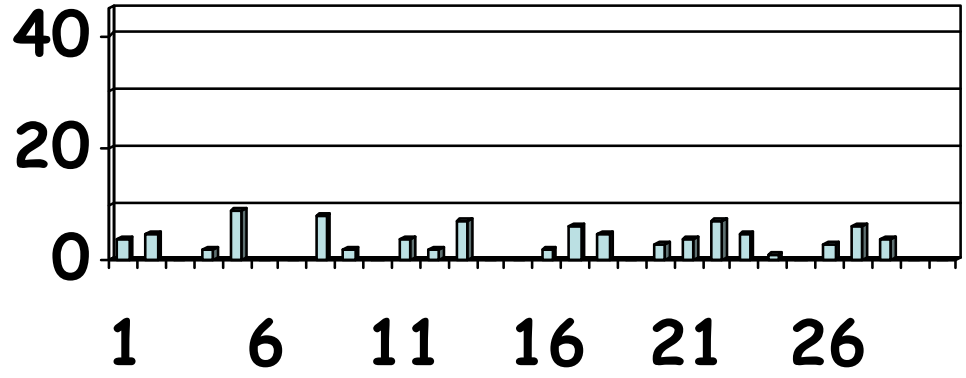
wild fires

local
floods

Monthly
Amount 75 mm

Frequency 6.7%
Intensity 37.5 mm

B

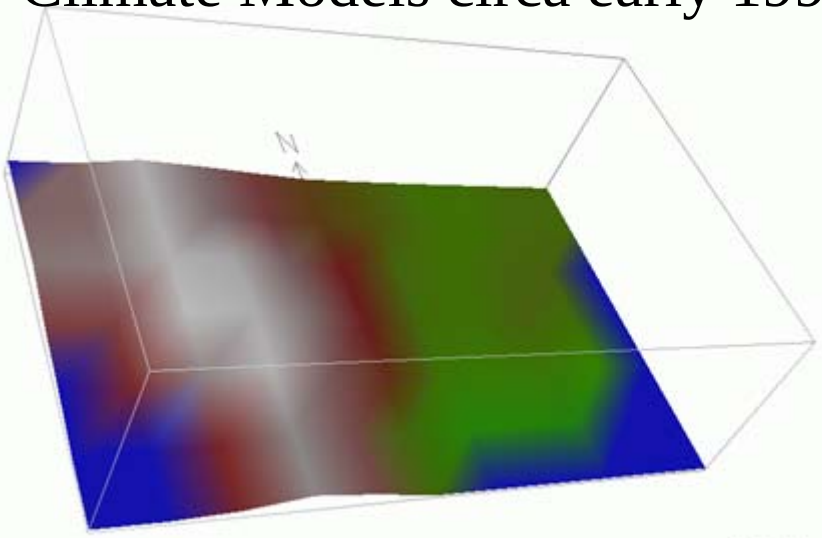


soil moisture replenished
virtually no runoff

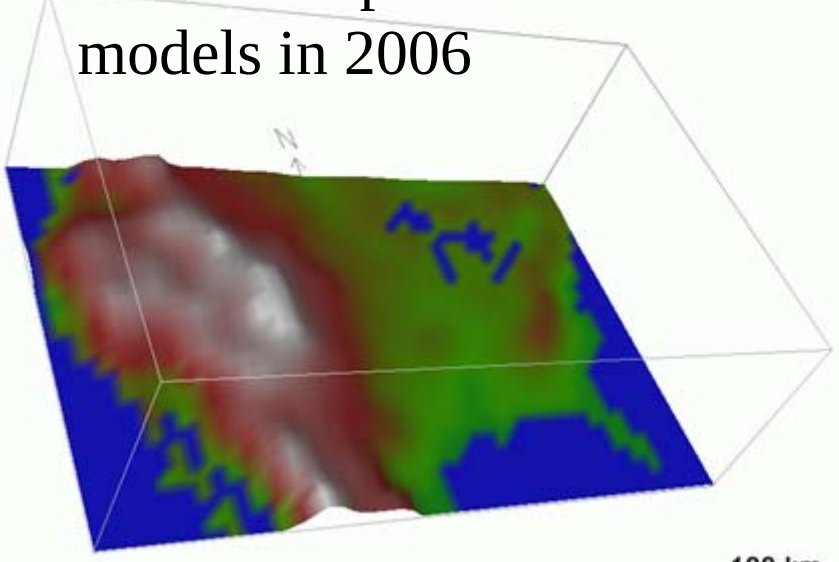
Amount 75 mm

Frequency 67%
Intensity 3.75 mm

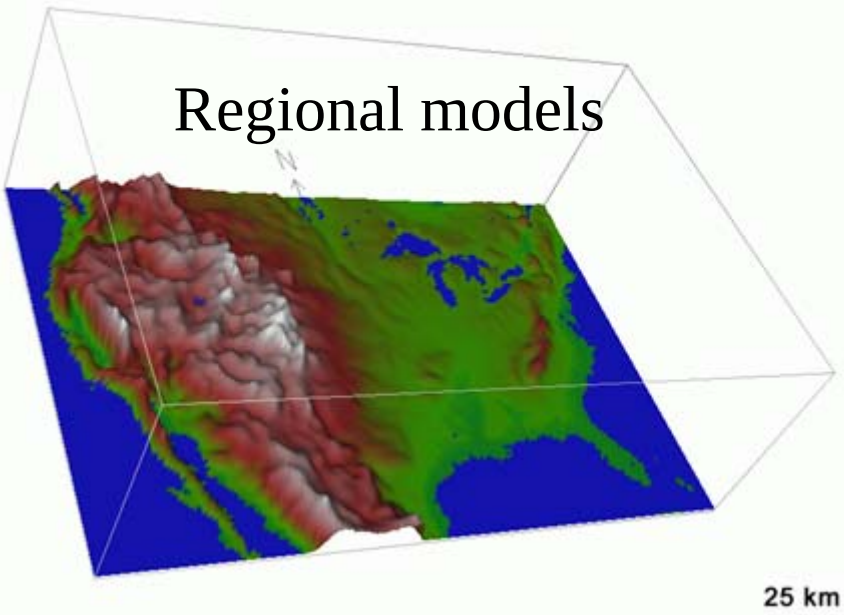
Climate Models circa early 1990s



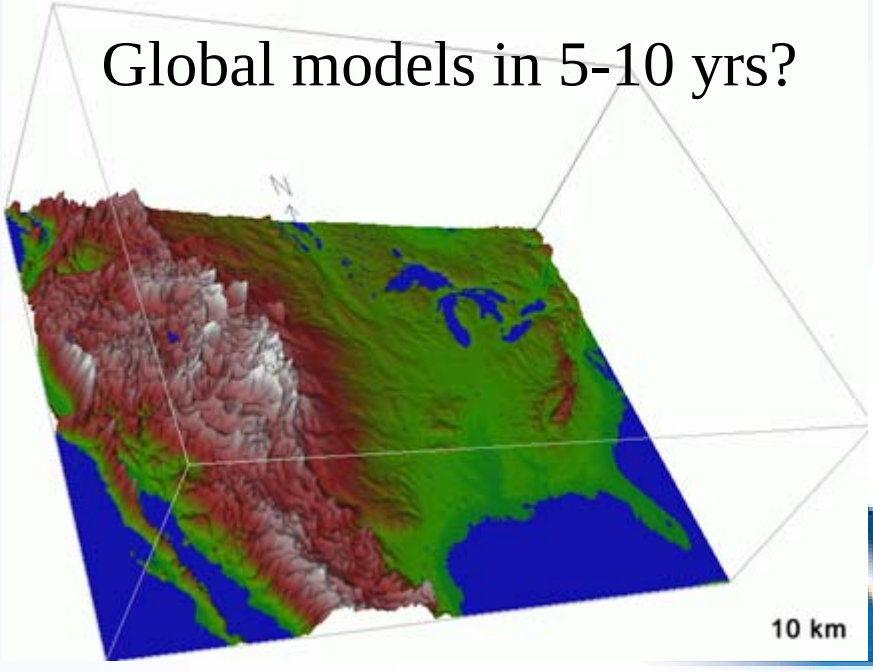
Global coupled climate models in 2006



Regional models



Global models in 5-10 yrs?




CCSM CAM3
Aug 01 Hour 0
NCAR

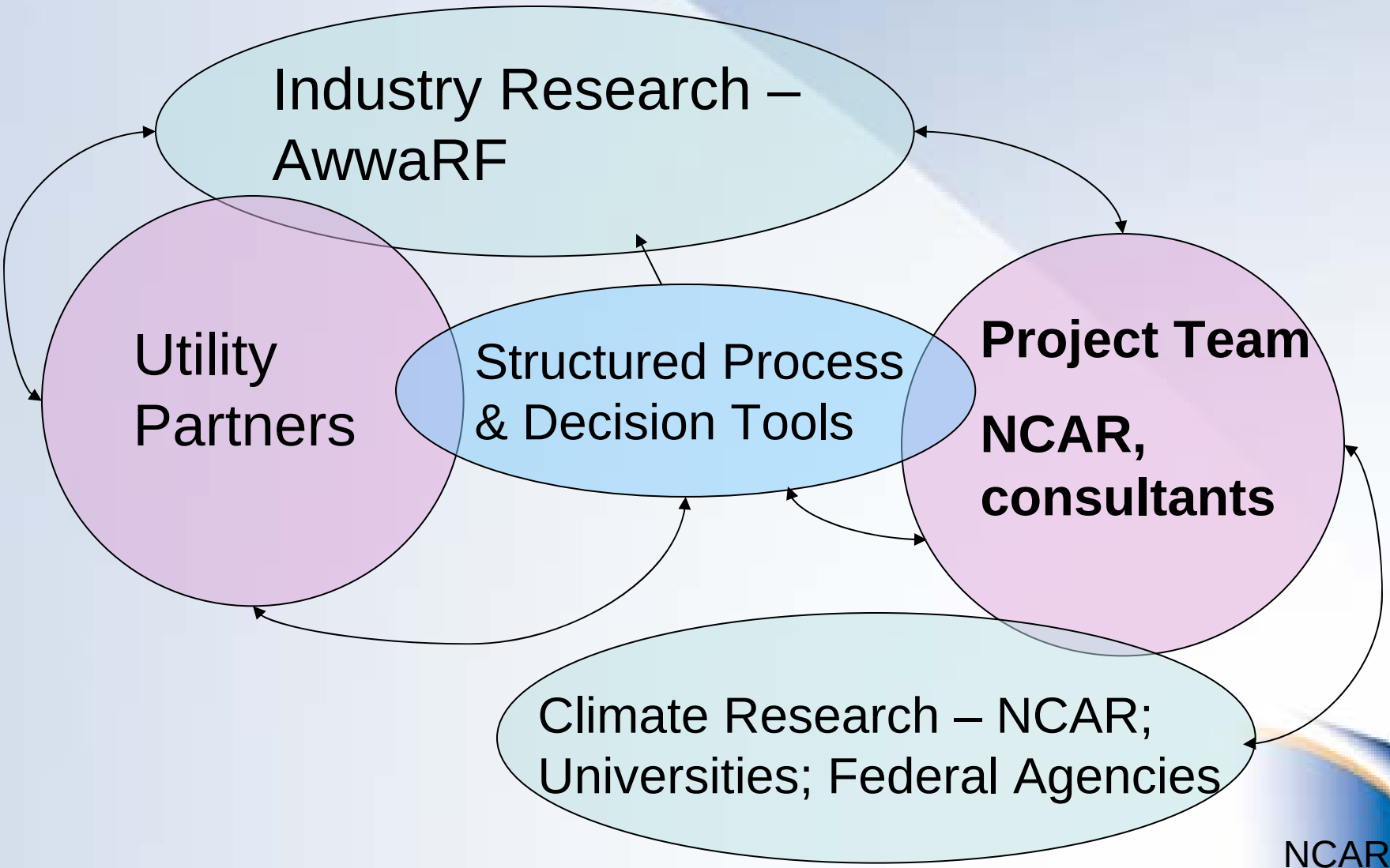
Water Res Fnd-NCAR

- AwwaRF-NCAR Climate Change Primer
- Develop structured process to explicitly consider CC into decision making
- Work with partnering utilities from the very start

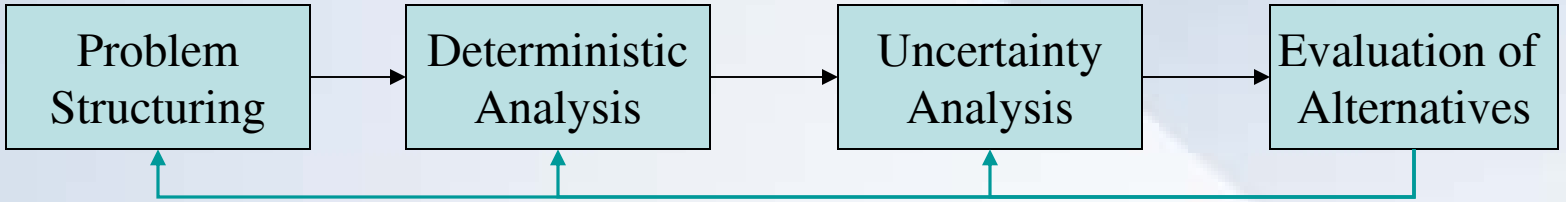
- Inland Empire of Southern California
- Regional Utility Alliance in California, CABY
- Colorado Springs, CO
- Boston, MA
- Durham, NC
- Palm Beach County, FL
- New York City, NY
- Portland, OR

NCAR

Partnership Design and Decision Tools



Decision Analysis Approach



Goals, alternatives, information, values

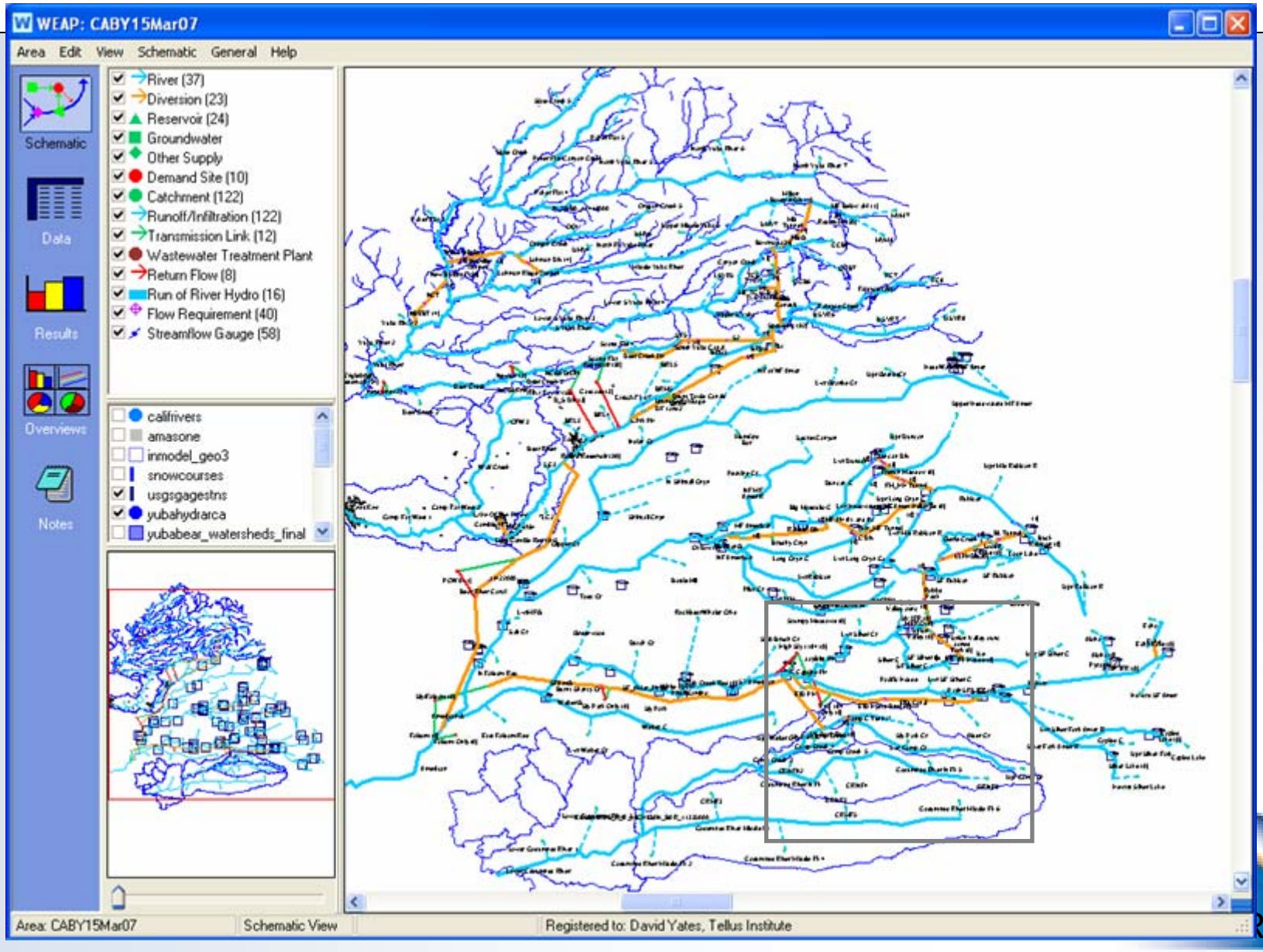
Model of the decision; Sensitivity analysis to identify key variables

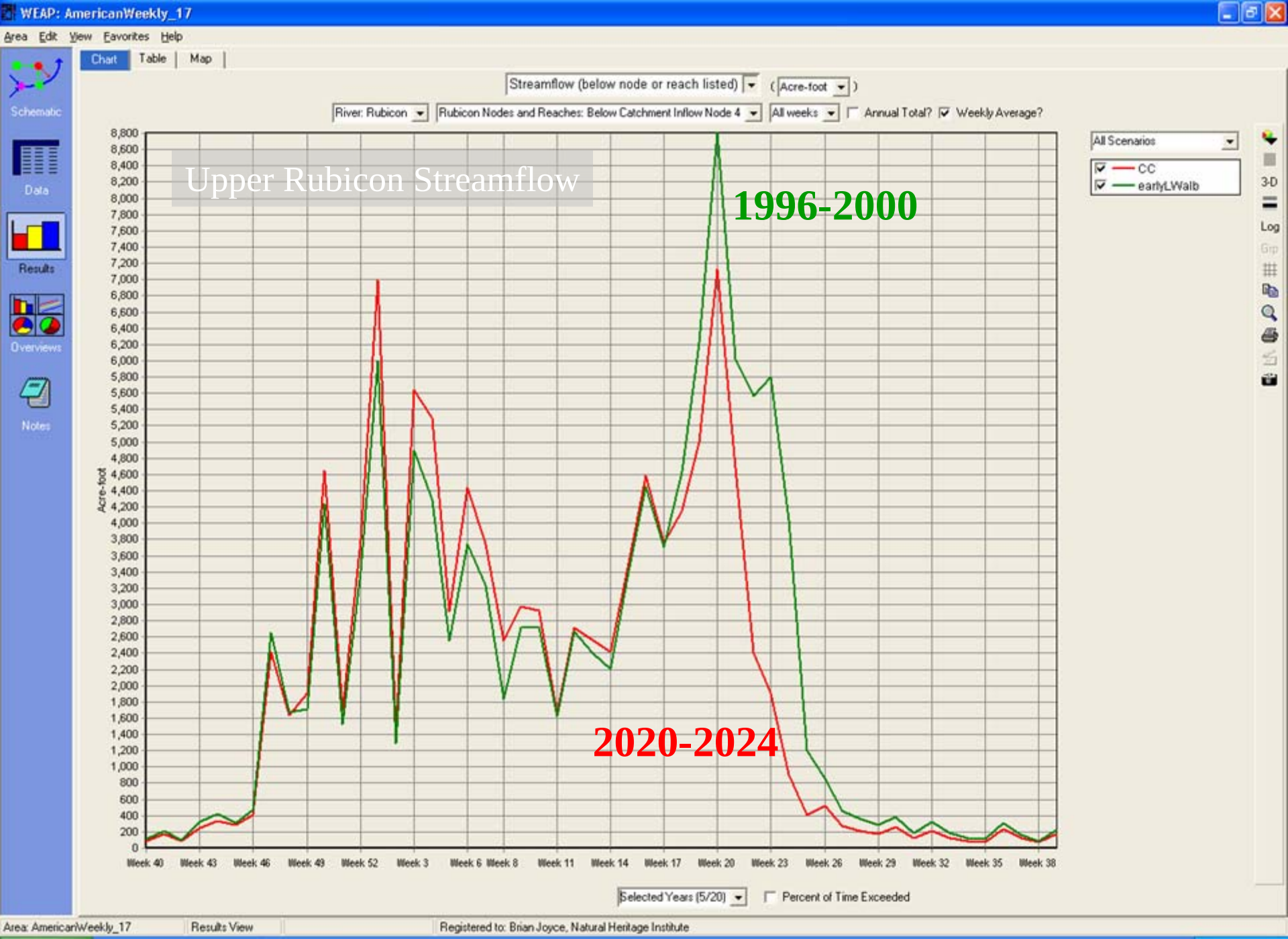
Represent key variables with probabilities; Determine best plan under uncertainty

iterations

We Really want to Support Decision Making

The Regional CABY Model in WEAP




WEAP: AmericanWeekly_17
Area Edit View Favorites Help
Chart Table Map
Schematic
Data
Results
Overviews
Notes
Streamflow (below node or reach listed)
Acre-foot
River: Rubicon
Rubicon Nodes and Reaches: Below Catchment Inflow Node 4
All weeks
Annual Total?
Weekly Average?
Upper Rubicon Streamflow
1996-2000
2020-2024
All Scenarios
CC
earlyLWalb
3-D
Log
Grp
Acre-foot
8,800
8,600
8,400
8,200
8,000
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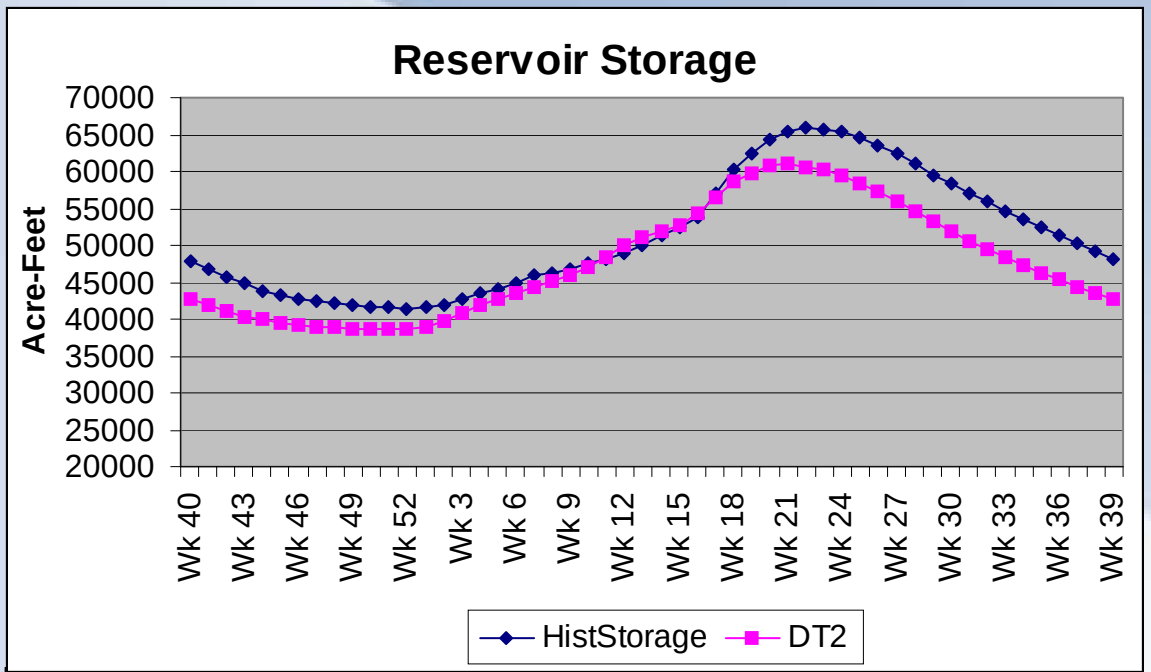
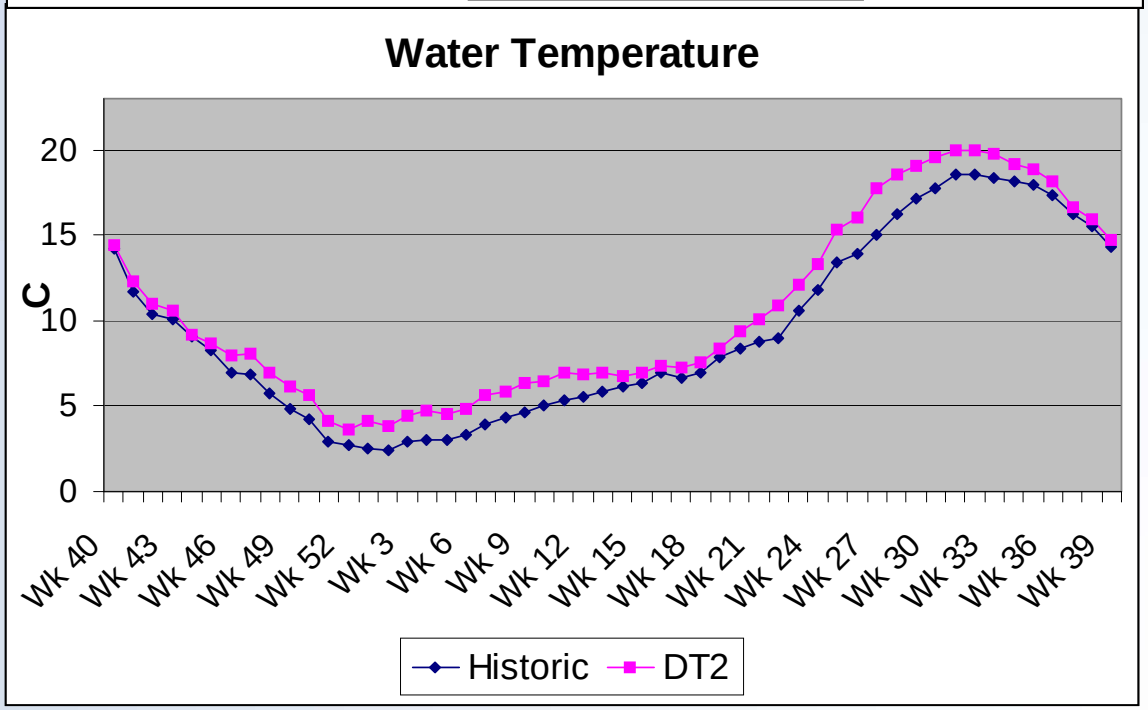
400
200
0
Week 40
Week 43
Week 46
Week 49
Week 52
Week 3
Week 6
Week 8
Week 11
Week 14
Week 17
Week 20
Week 23
Week 26
Week 29
Week 32
Week 35
Week 38
Selected Years (5/20)
Percent of Time Exceeded
Area: AmericanWeekly_17
Results View
Registered to: Brian Joyce, Natural Heritage Institute



Reservoir Storage



Water Temperature

http://www.isse.ucar.edu/awwarf/

http://www.awwarf.org

http://sei-us.org

http://weap21.org

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