



Climate Change Modeling

Can you get what you want?

October 28, 2009

Elissa Lynn

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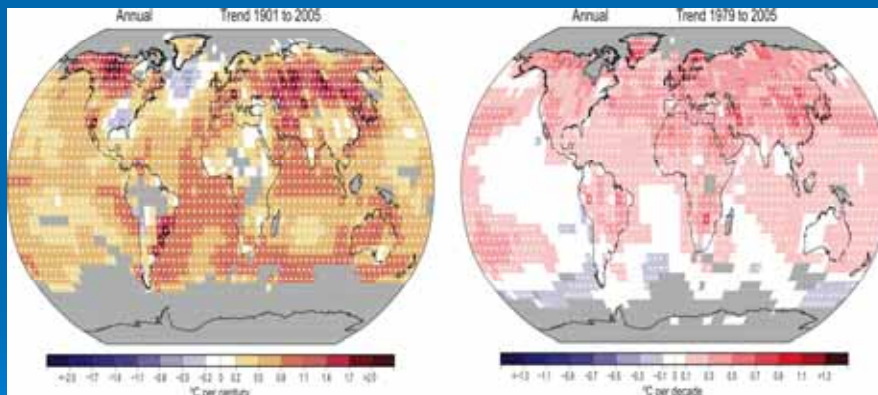


Background

- M.S., Atmospheric Sciences
 - Climate modeling
- B.A., Physics
- 17 year TV Meteorologist
- Emmy Award, Literacy Awards
- Teacher/ College Instructor
- Senior Meteorologist; Outreach



Climate Change





10 Warmest Years on Earth

1. **2005**
2. **1998**
3. **2002**
4. **2003**
5. **2007**
6. **2006**
7. **2004**
8. **2001**
9. **1997**
10. **2008**

Seven of eight warmest years have occurred since 2001



(Since 1880, source National Climate Data Center)



Temperature Trends

Global ly:
10 warmest years
since 1997

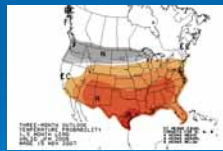


128 year record; Climatic Data Center



Temperature Trends

United States:
6 of 10 warmest
since 1998



Source: NASA, NCDC, AMS



Temperature Trends

California:
1934 still hottest



Source: CA State Climatologist



Climate Change vs. Global Warming



Climate Change vs. Global Warming

NOT just hotter



Climate Change vs. Global Warming

NOT just hotter

Precipitation; More-Less

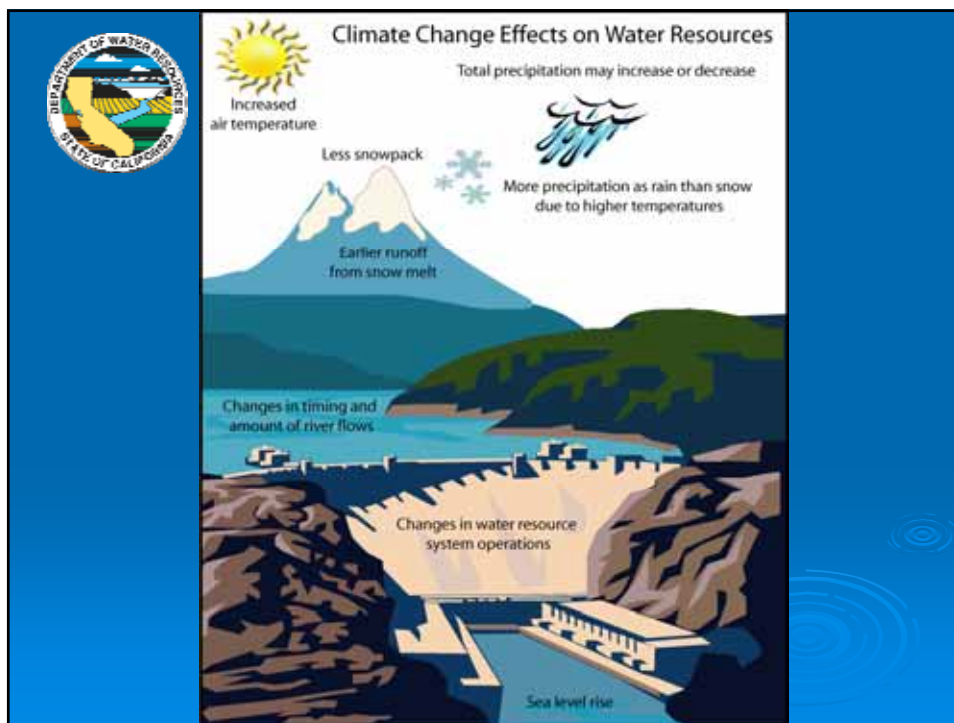
Different spatial distribution of Rain

Changing Snow Levels

Sea-level Rise

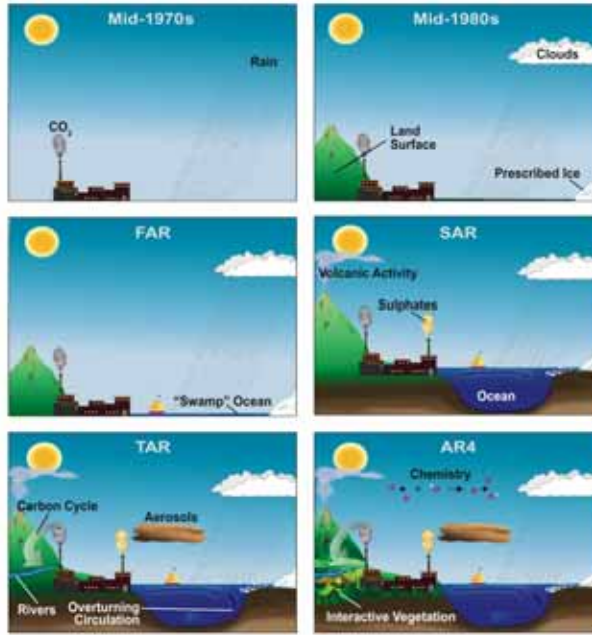
Air Quality

Atmosphere/Ocean Circulation





The World in Global Climate Models



Why so complicated?

Data collection

Computer model variability

Feedback mechanisms?

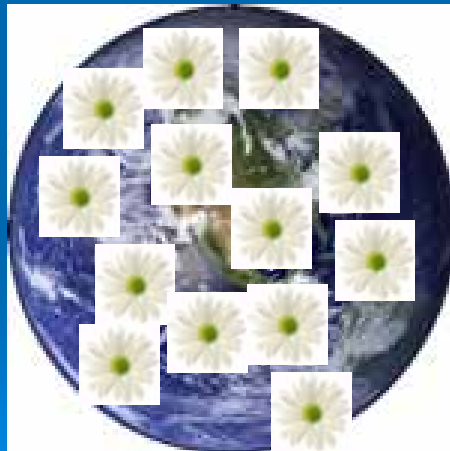
Spatial Resolution



Daisy World

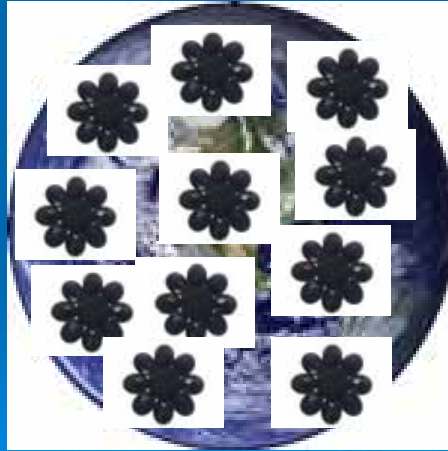


Daisy World





Daisy World



MODELING stuff

Math Equations = Parameterization

PHYSICS not terribly hard



MODELING stuff

**Some processes
poorly understood, handled**

Especially CLOUDS



MODELING stuff

**Can't model things
we don't understand**

Feedback Mechanisms



MODELING stuff

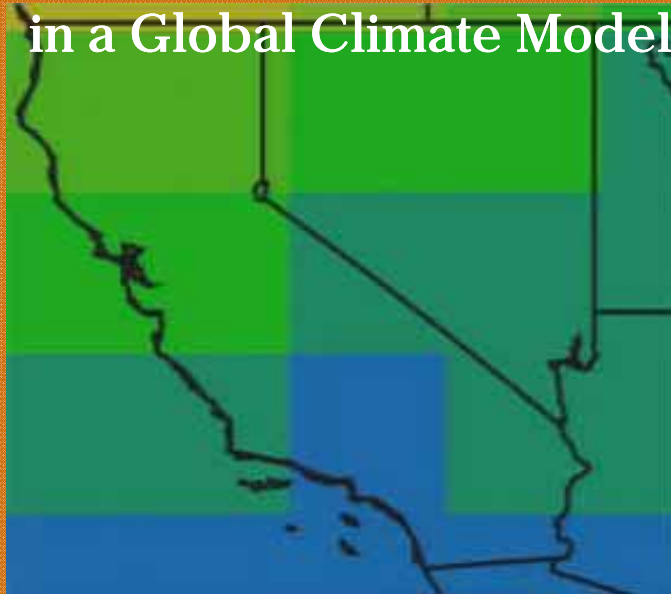
Long-range trends,
Larger-scale answers

Resolution Too Coarse



California

in a Global Climate Model





MODELING stuff

Models have Bias

**You need to quantify
UNCERTAINTY**



MODELING stuff

Real World responding faster!

**How to make
DECISIONS?**



Observed Impacts in California

1° F Increase/ 100 yrs

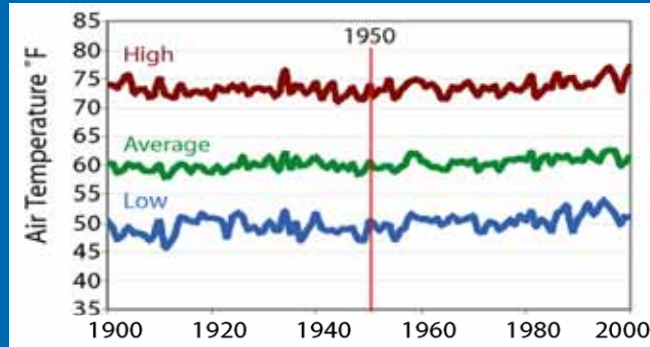


Observed Impacts in California

1° F Increase/ 100 yrs
Warmer at night
Warmer in winter



CA temps 1900-1950 vs. 1950-2000

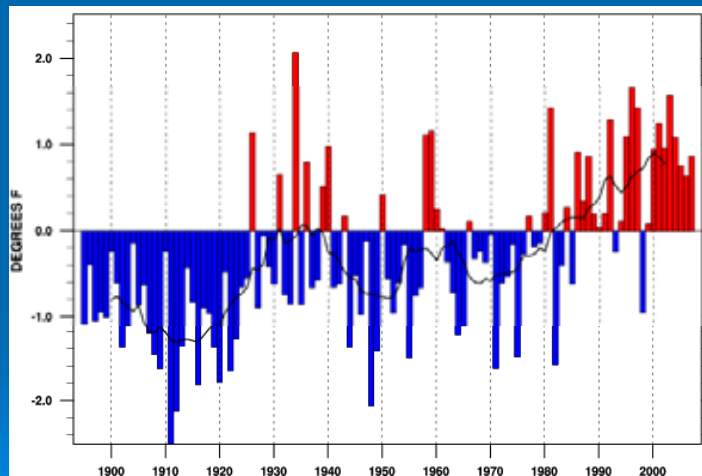


Highs	▲0.6° F
Average	▲0.9° F
Lows	▲1.4° F



CA Mean Temperatures

°F

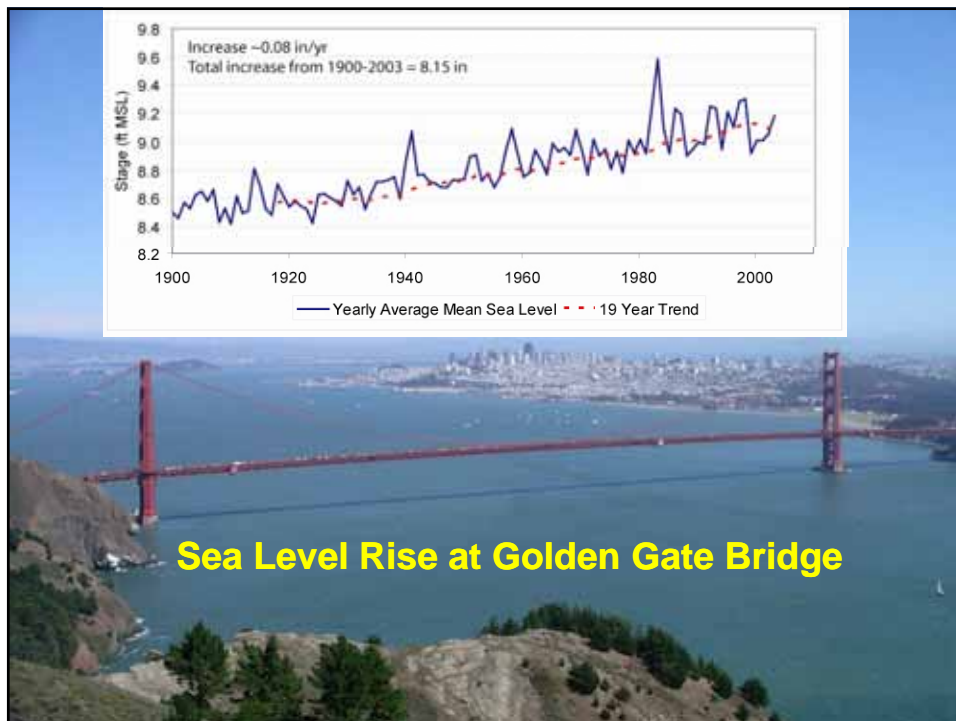


Source: Western Region Climate Center



Observed Impacts in California

1° F Increase/ 100 yrs
Warmer at night
Warmer in winter
7" sea level rise





Sea Level Rise

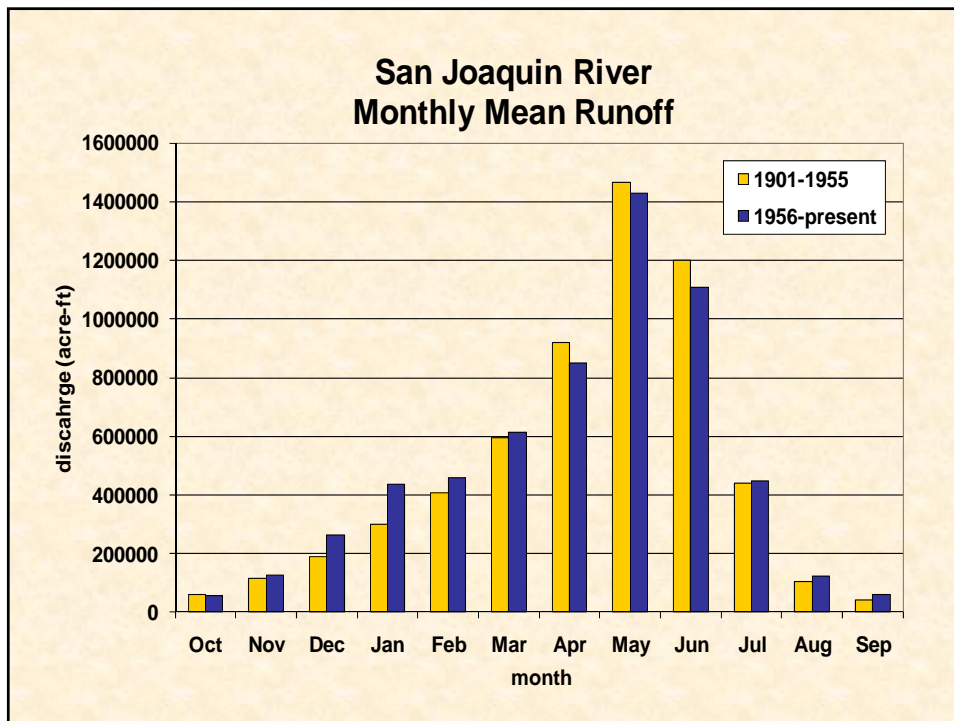
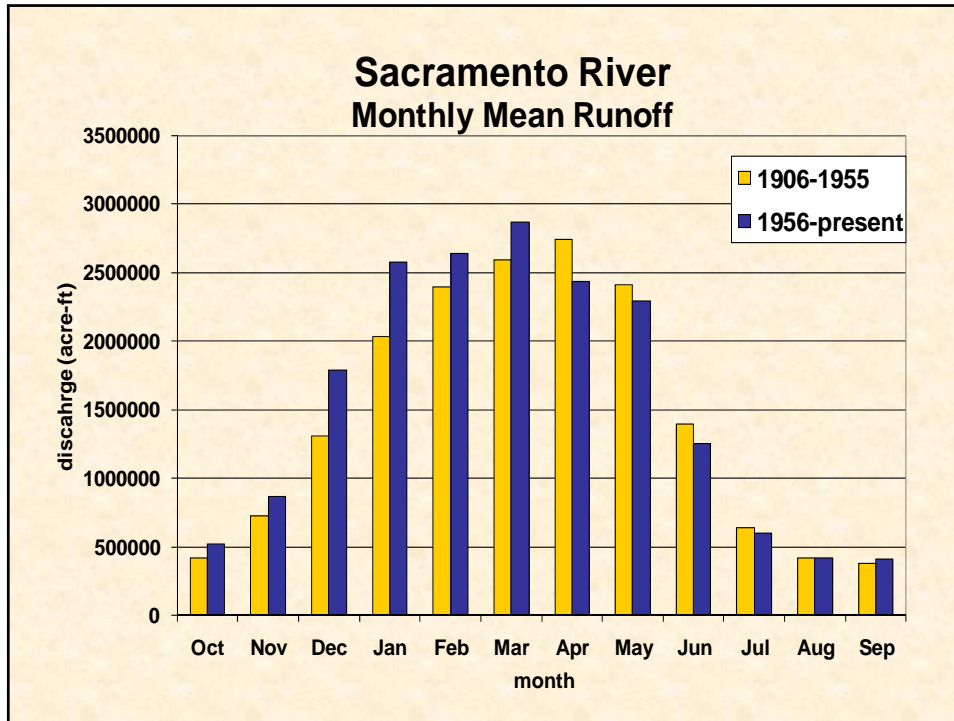
- Thermal expansion of the ocean #1
- Melting of polar ice caps, glaciers
- Vertical land movement



Observed Impacts in California

1° F Increase/ 100 yrs
Warmer at night
Warmer in winter
7" sea level rise
Earlier Snowmelt







Observed Impacts in California

1° F Increase/ 100 yrs

Warmer at night

Warmer in winter

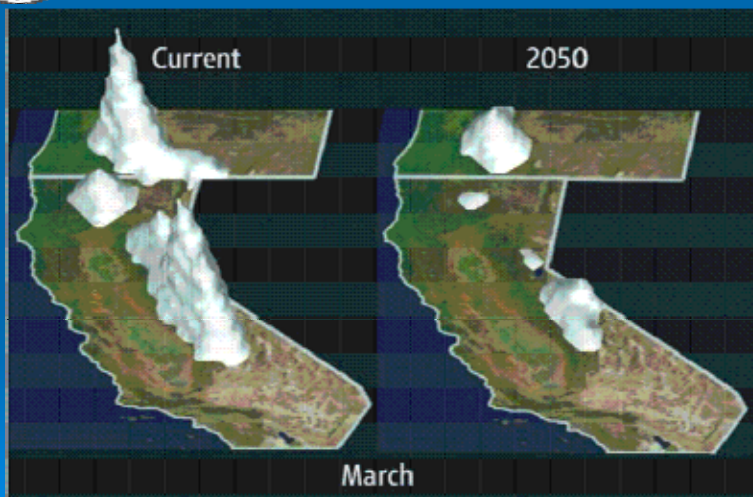
7" sea level rise

Earlier Snowmelt

Snowpack Loss: 10% already



Snowpack Reduction



Source: Scripps Institute of Oceanography



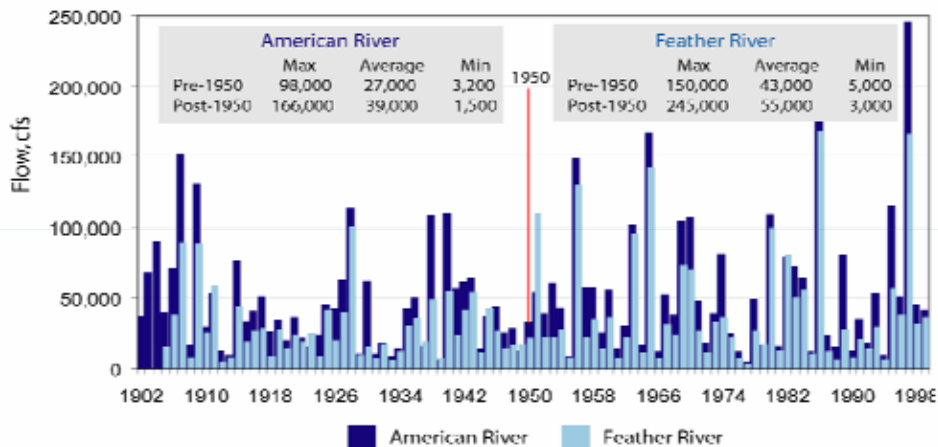
Observed Impacts in California

1° F Increase/ 100 yrs
Warmer at night
Warmer in winter
7" sea level rise
Earlier Snowmelt
Snowpack Loss: 10% already
Increasing River Peak Flows



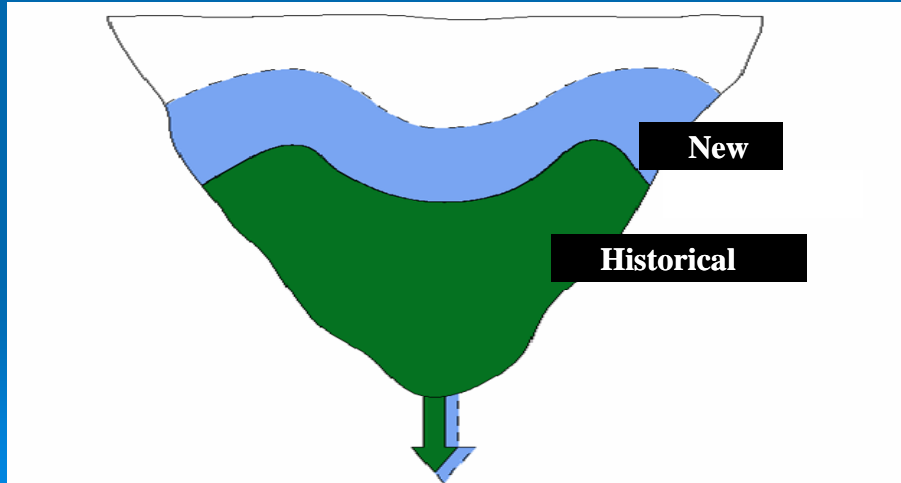
Peak 3-day River Flows

20th Century Annual Peak 3-Day Flows
without the Influence of Reservoirs





More as Rain \Rightarrow bigger flood



What about Me?



What about Me?

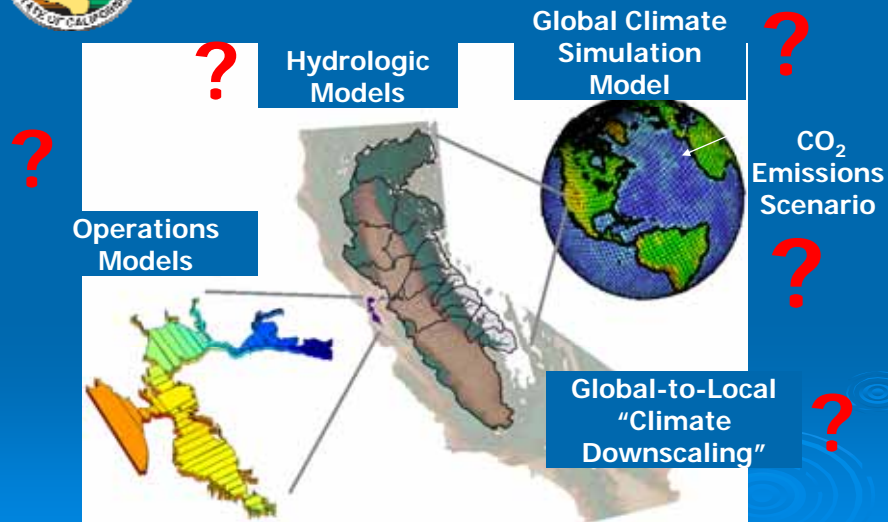
Climate models do not SCALE well

Regional Impacts vary

Can they give local information?



We've got Issues!

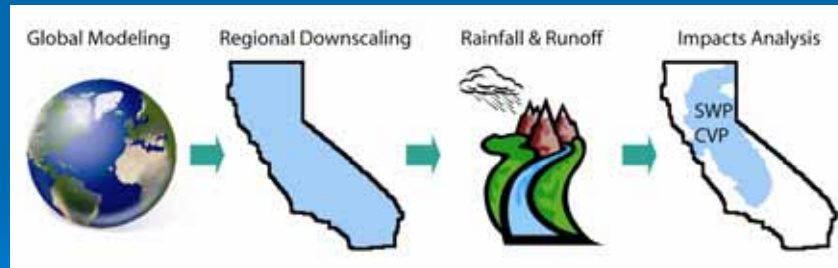


Adapted from Cayan and Knowles, SCRIPPS/USGS, 2003



Downscaling

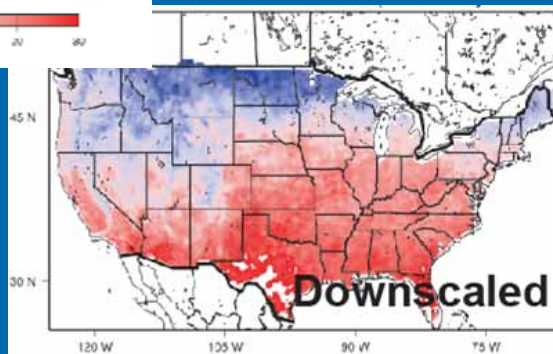
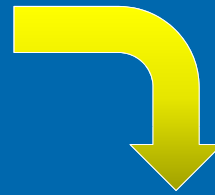
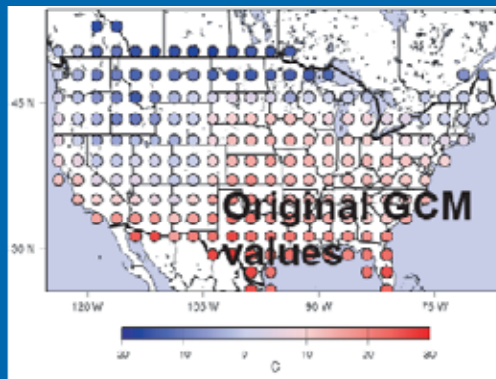
Converting **Global** model output into **Regional or Local** information



More specific, Higher resolution, More useful

Courtesy Jamie Anderson, DWR

SWP= State Water Project CVP=Central Valley Project



Images from Mike Dettinger, USGS



Downscaling Methods

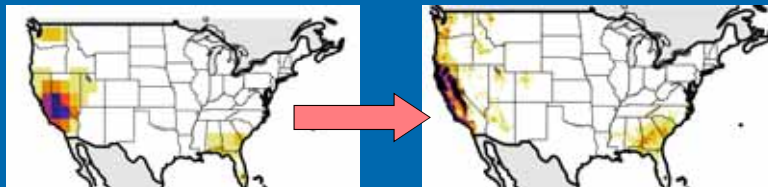
Dynamical

Statistical

Empirical



Downscaling



Who's Doing What?
What data is available?

Figure: Maurer (Santa Clara), Hidalgo (Scripps)



Take Home Message

- Difficult challenges
- Work / Resources being committed
- Some data already available
- Several years away from detail,
but enough information for you to plan

EARLY



Thank You's

**Dr. Michael Anderson, DWR
State Climatologist**

**John Andrew, DWR
Asst. Deputy Dir, Climate Change**

**Jamie Anderson
DWR, Bay-Delta Office**

**Mike Dettinger, USGS - Scripps
Phil Duffy, Climatecentral.org
Ed Maurer, Santa Clara Univ.
Hugo Hidalgo/Dan Cayan, Scripps
Levi Brekke, USBR**