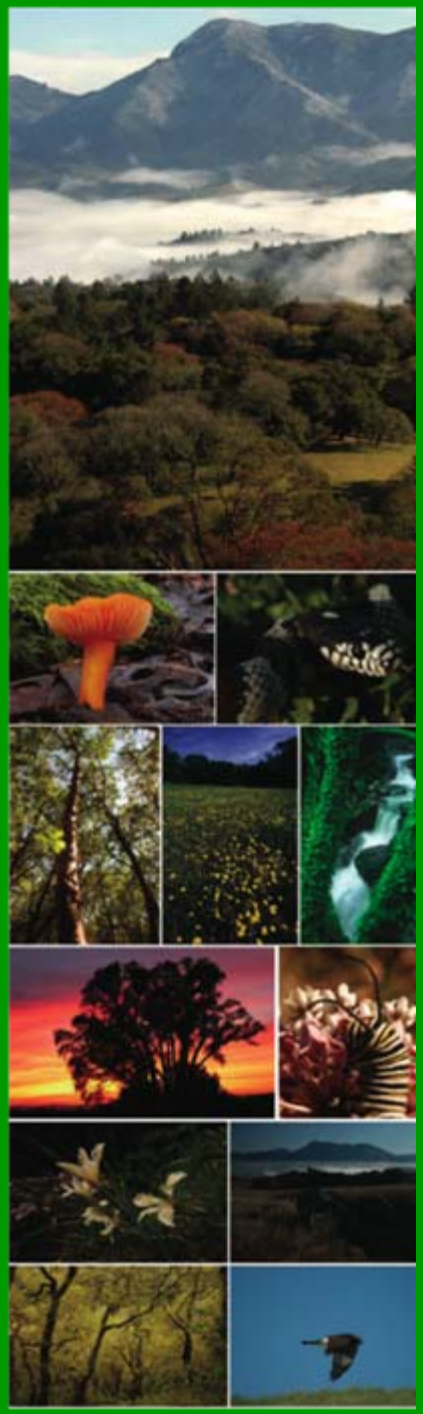


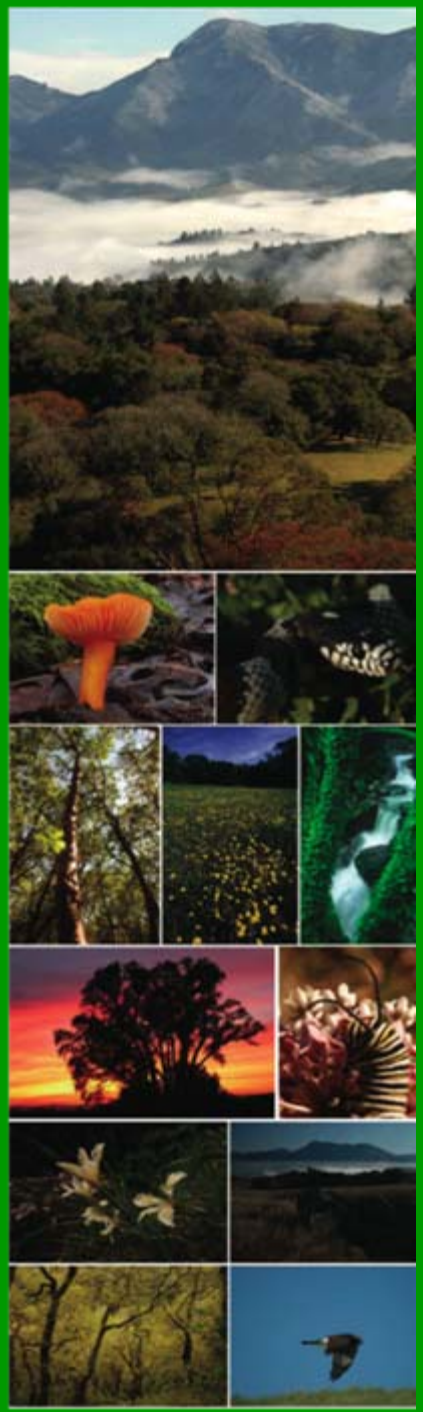
# Downscaling future climate scenarios to the watershed scale: a North San Francisco Bay Estuary case study


**Lorraine E. Flint and Alan L. Flint**
**U.S. Geological Survey, Sacramento CA**

**Stuart Weiss**
**Creekside Center for Earth Observation**
**Menlo Park CA**

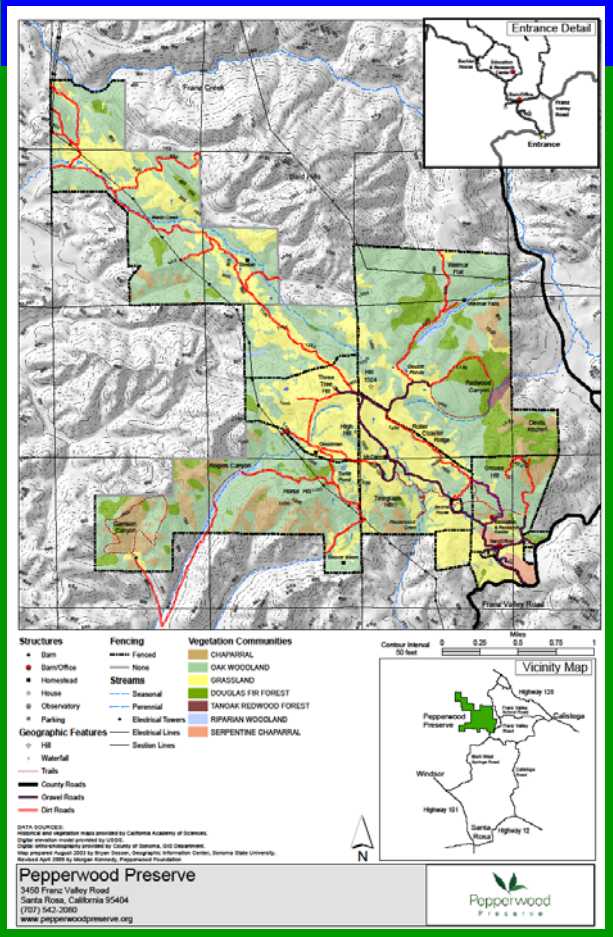
**Lisa Micheli and Morgan Kennedy**
**Dwight Center for Conservation Science at Pepperwood**
**Santa Rosa, CA**


Pepperwood
PRESERVE
Inspiring conservation through science



# MISSION

to advance science-based conservation throughout our region and beyond



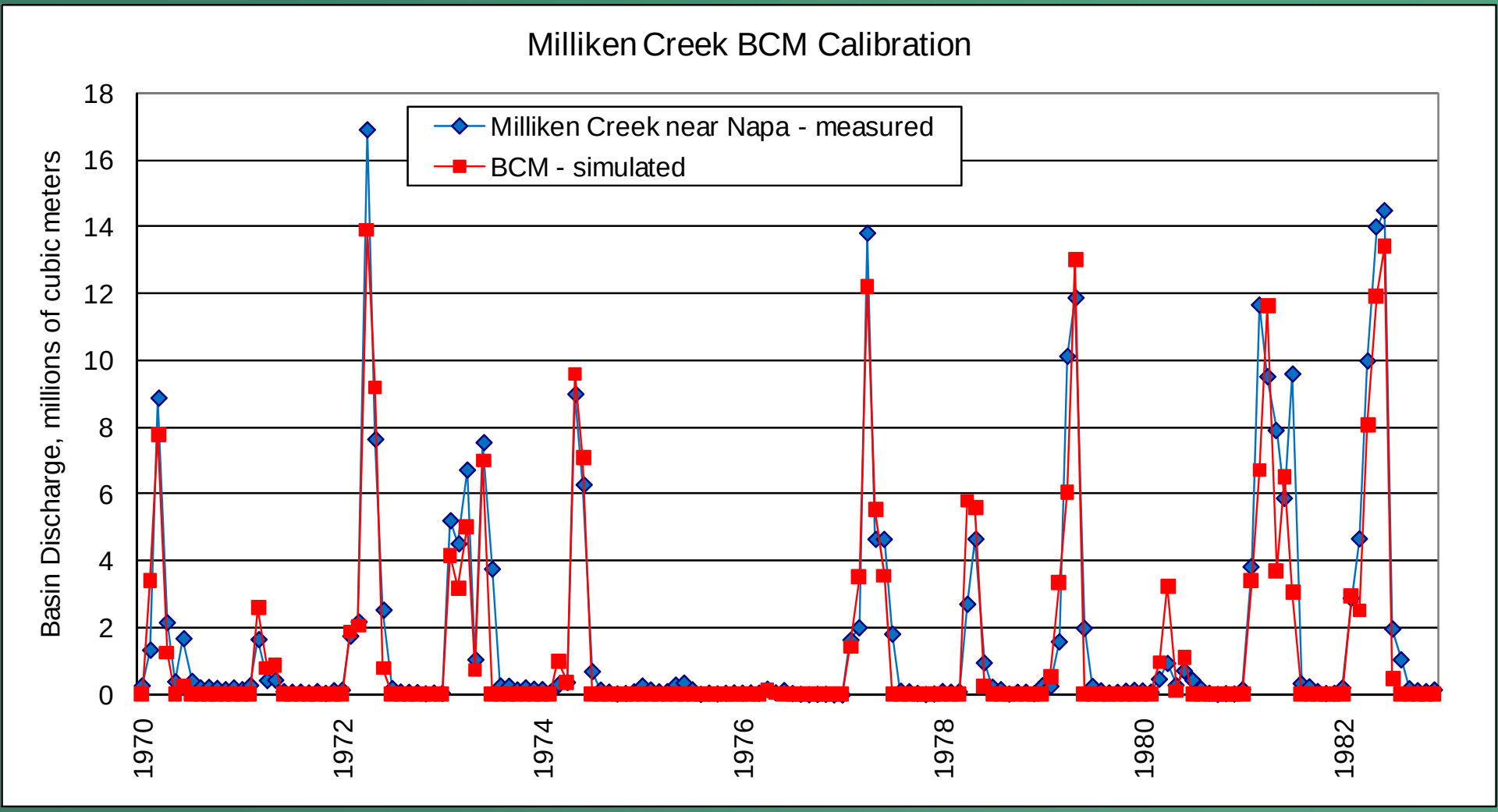
Pepperwood
PRESERVE
Inspiring conservation through science

What do the managers need to know regarding climate change?

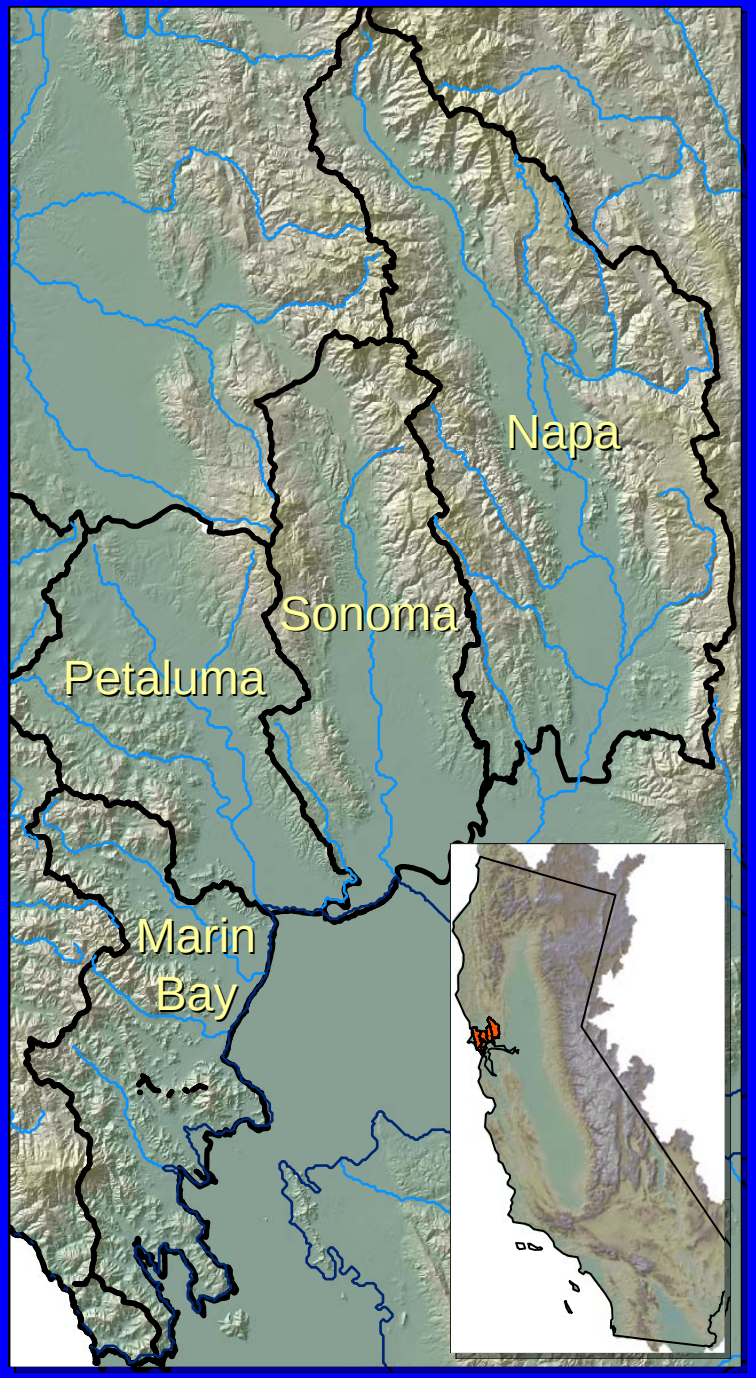
What can the researchers tell us about climate change?

Air temperatures and precipitation are not enough to understand impacts to these guys! We need hydrology projections!

# Basin Characterization Model




Flint and Flint 2007




# North Bay Case Study

Resources

- relatively large populations
- agriculture and viticulture
- important fisheries and wildlife
- unique and valuable landscapes and vegetation

Stressors

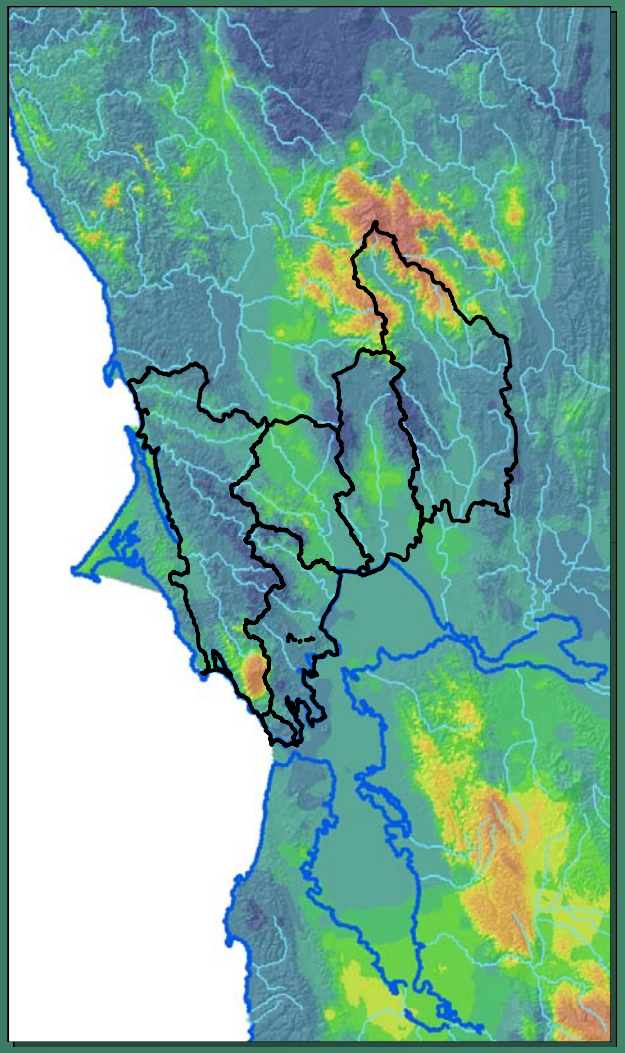
- development and fragmentation of open spaces
- water quantity and quality impairments
- invasive species, pest vectors and related diseases

Approach

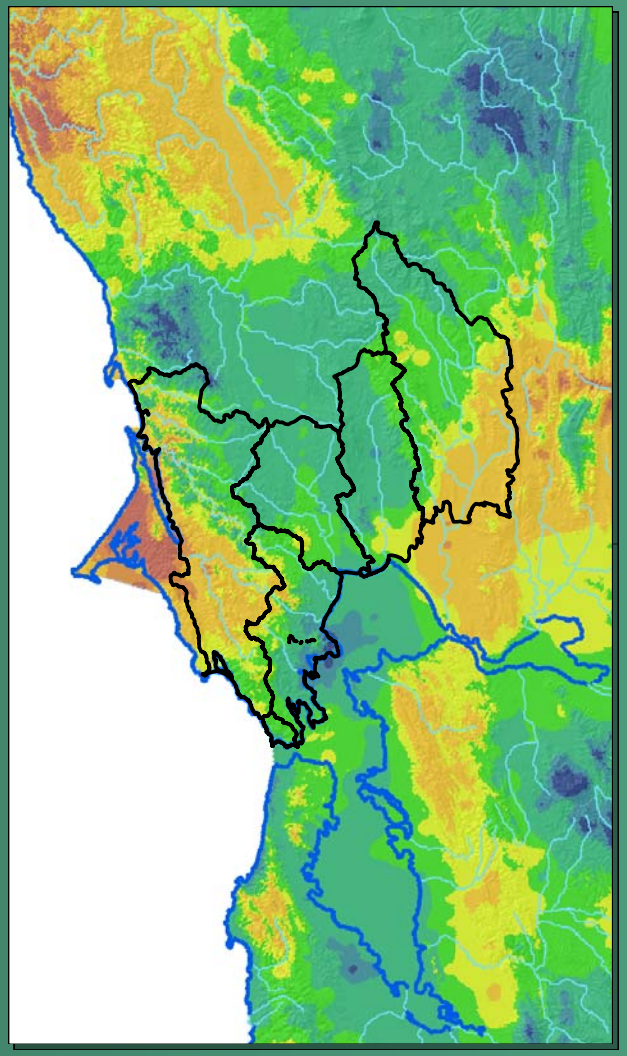
- The North Bay Watershed Association (NBWA) supported this team to develop watershed-specific climate change projections and a guide for managers (due Jan 2011)

# Changes in Annual Climate from 1970-2007

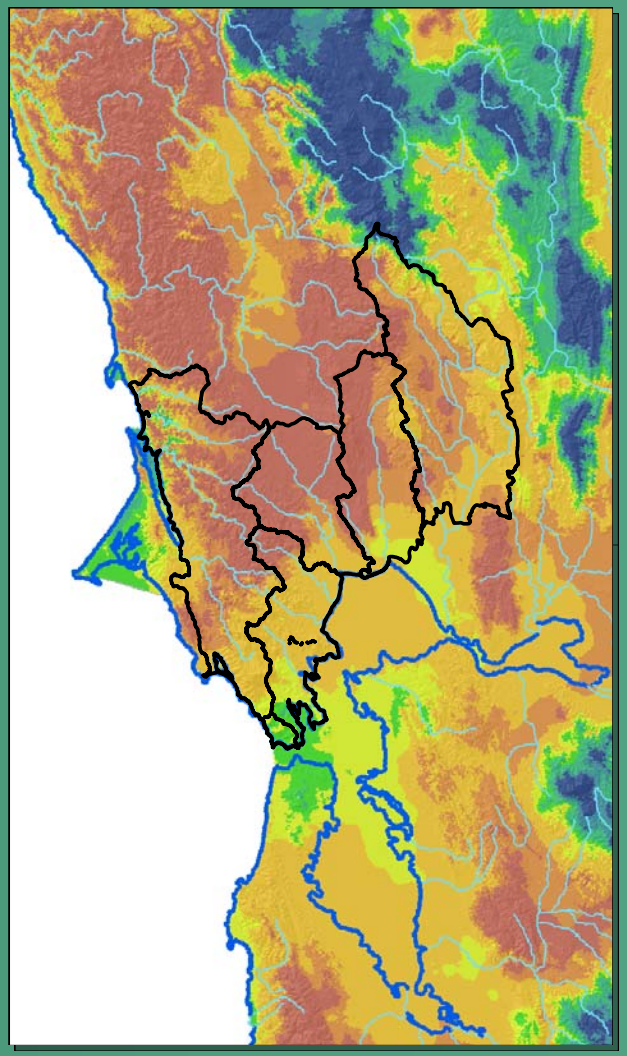
Precipitation



Maximum Air Temperature



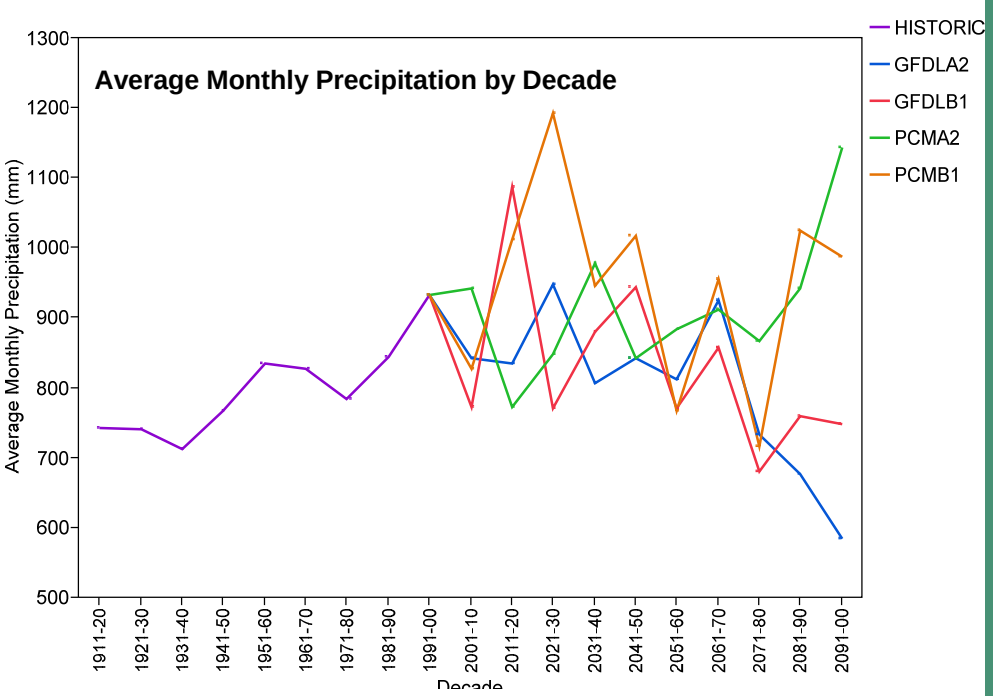
Minimum Air Temperature

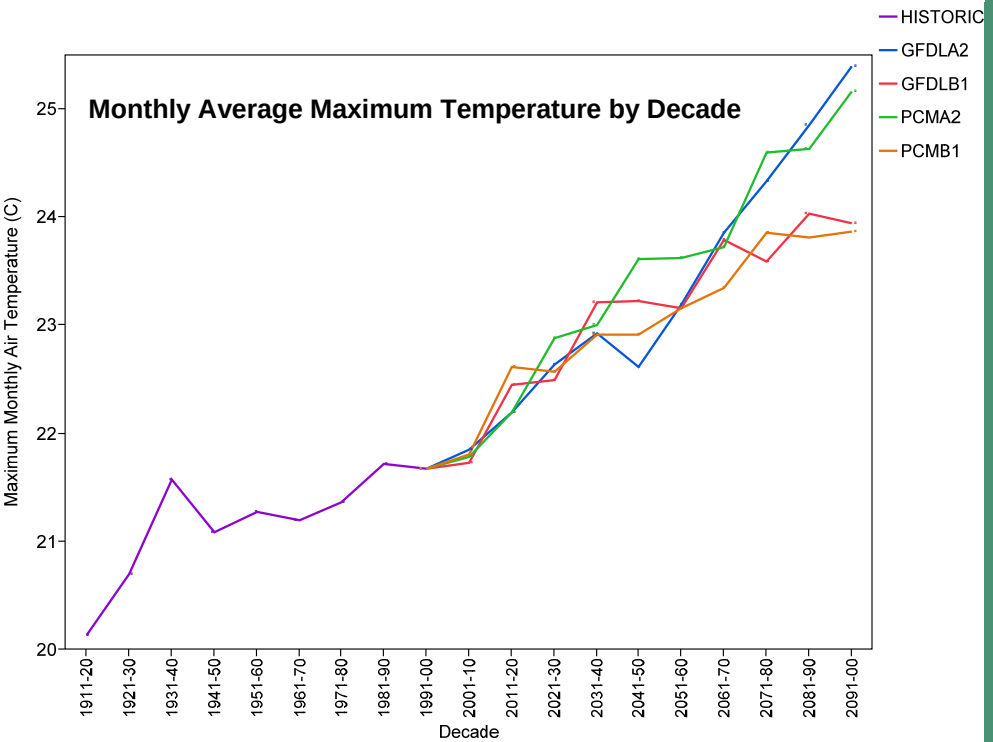


Warm colors drier and warmer, cool colors wetter and cooler

# Climate Change Scenarios

- IPCC Fourth climate assessment provides recent model simulations
- Emission scenarios
  - A2: medium-high emissions
  - B1: low emissions
- Geophysical Fluid Dynamics Lab (GFDL) “dry”
- Parallel Climate Model (PCM) “wet”
- Total of four scenarios: GFDL A2, GFDL B1, PCM A2, PCM B1



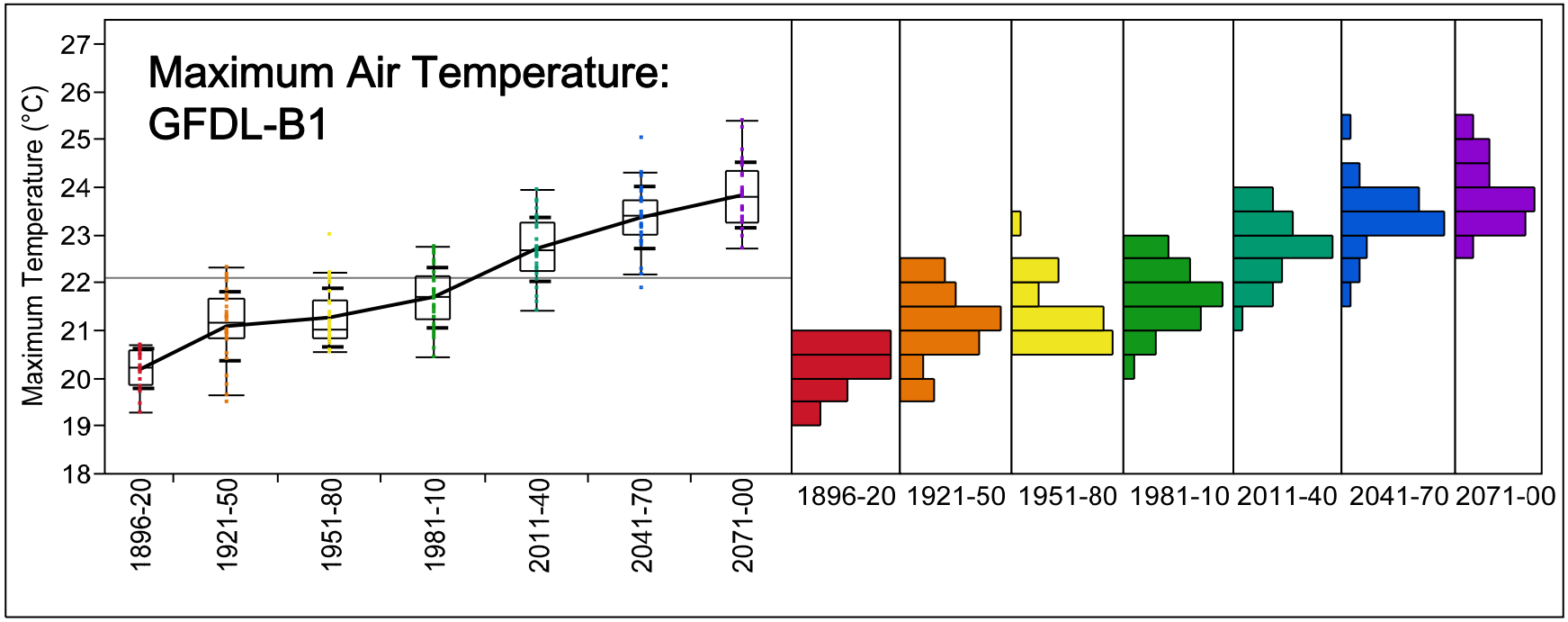



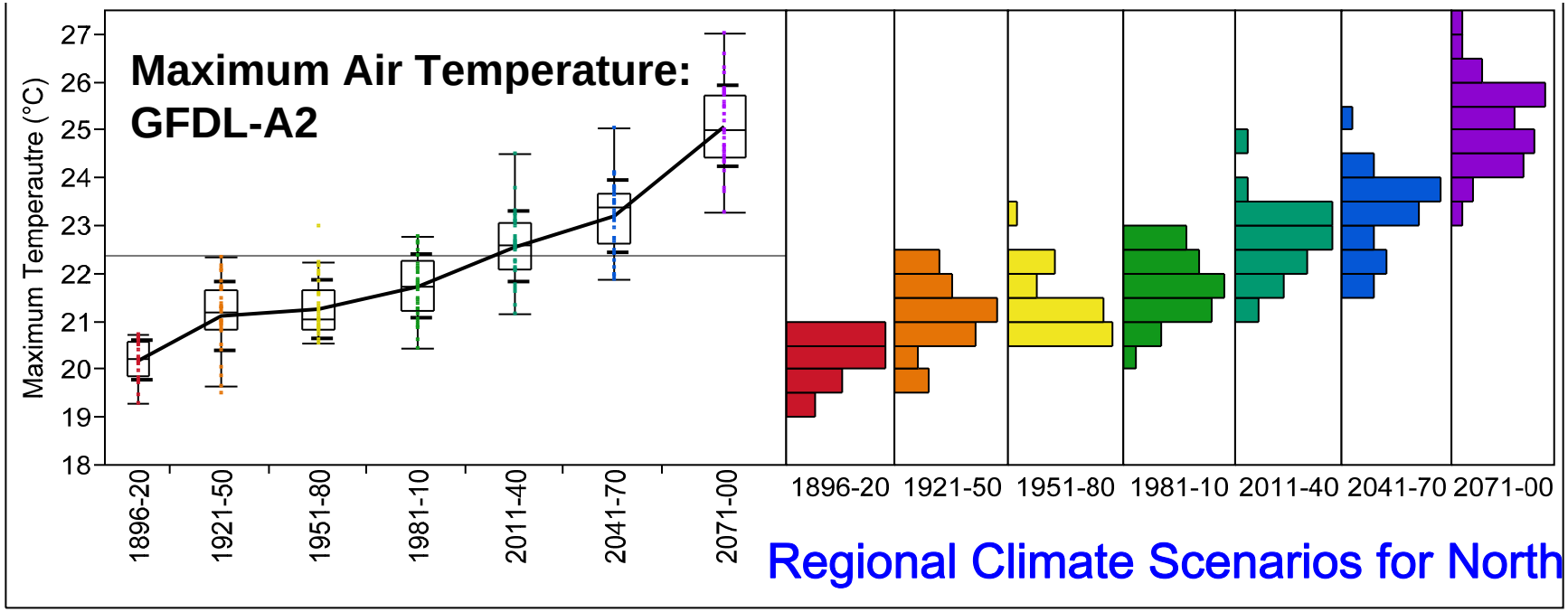

PCM model higher end of century precipitation

GFDL model declines in precipitation

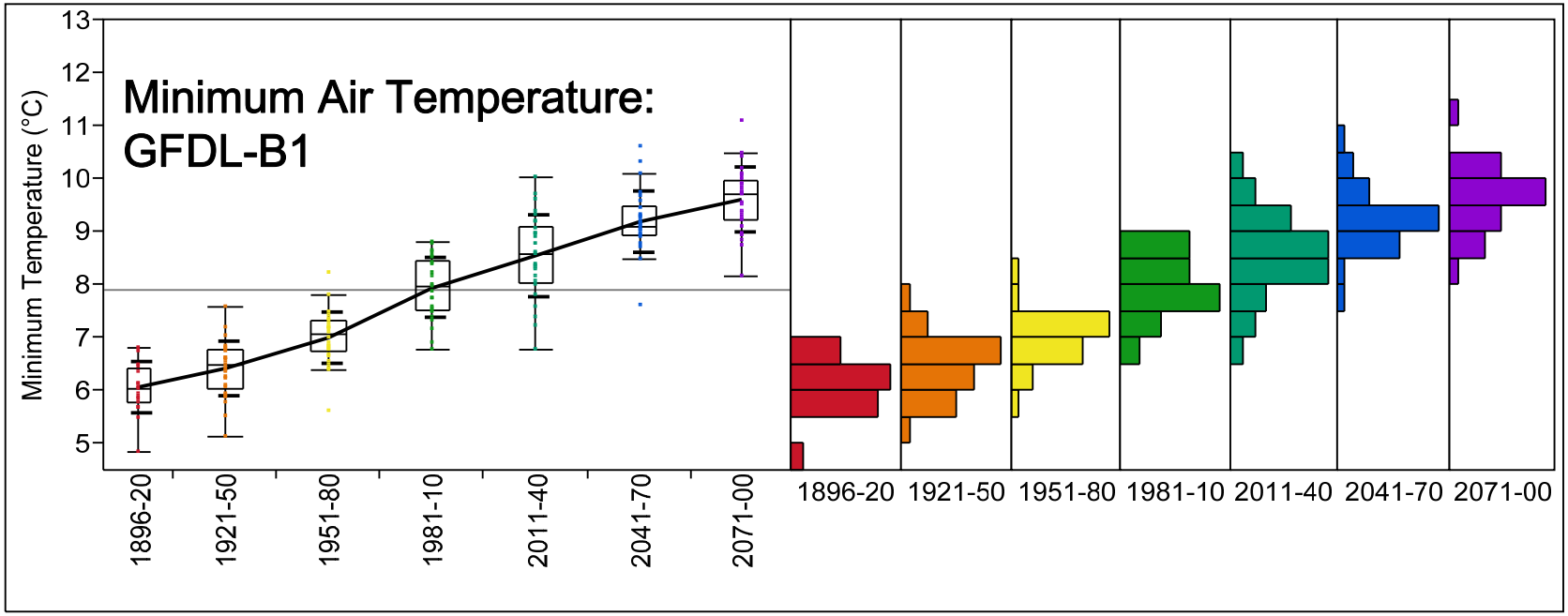
A2 scenario higher end of century temperatures

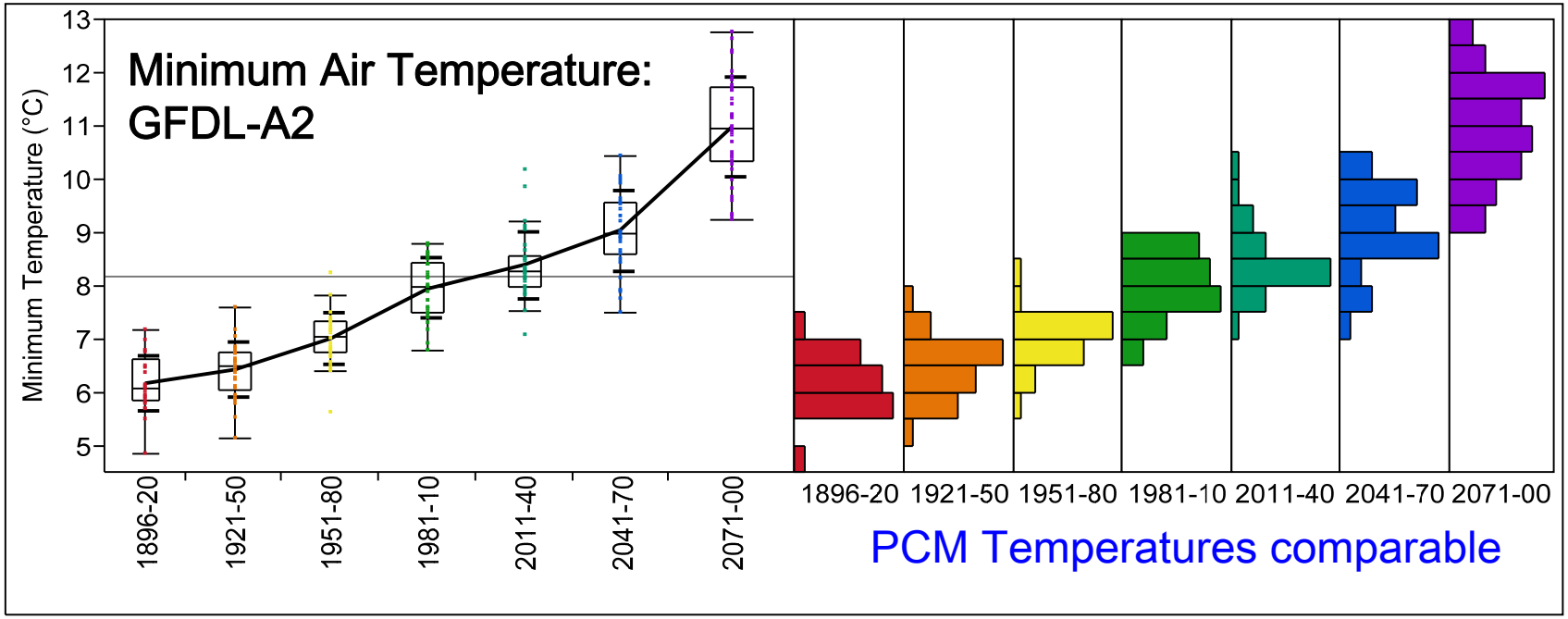
B1 scenario lower end of century temperatures

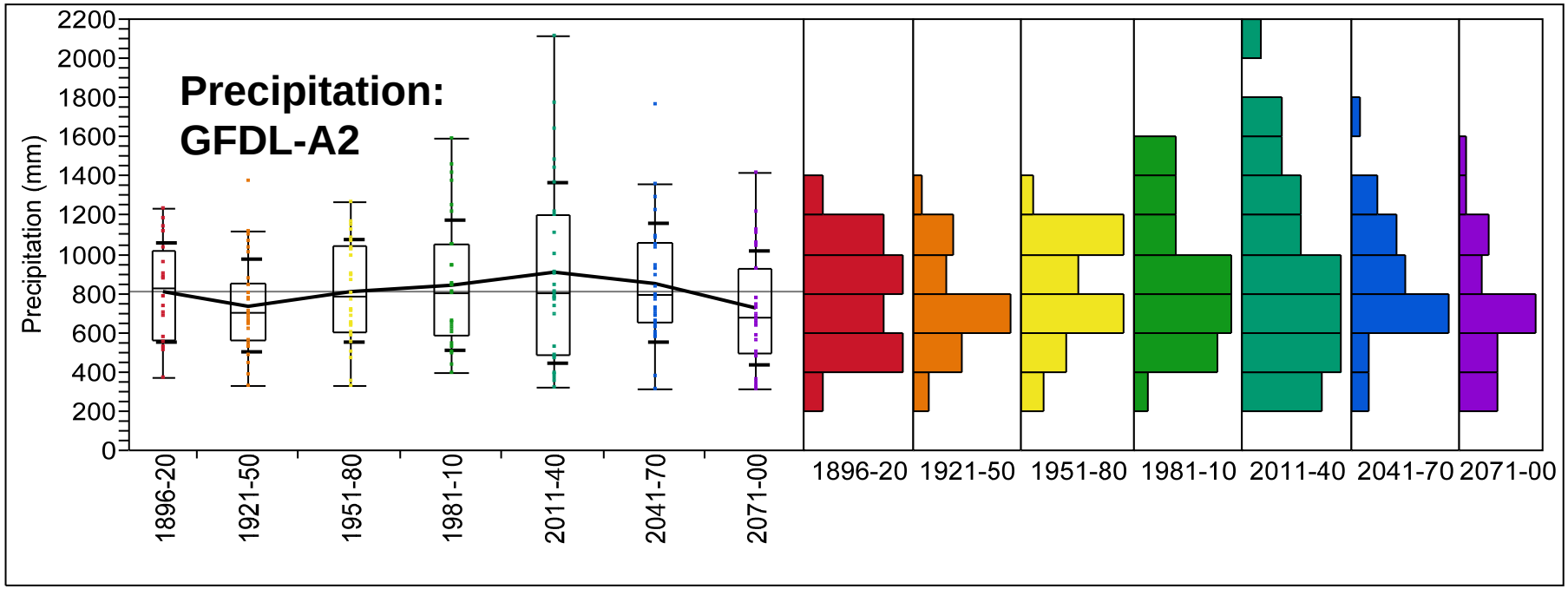


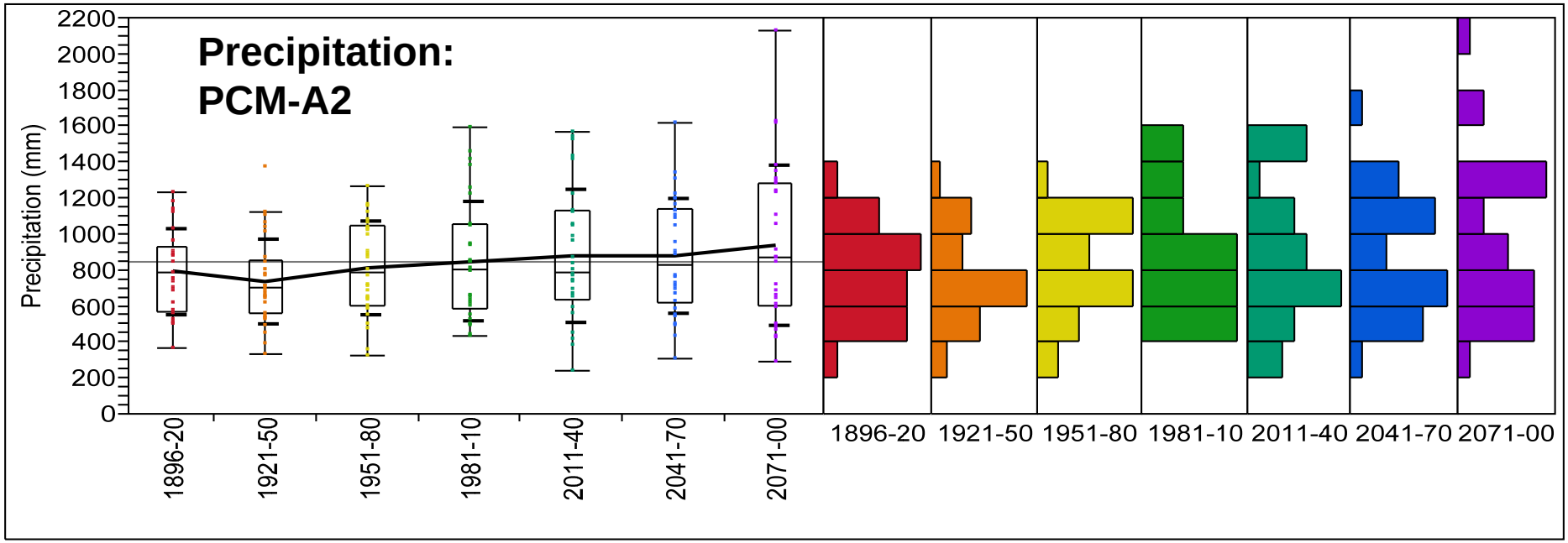



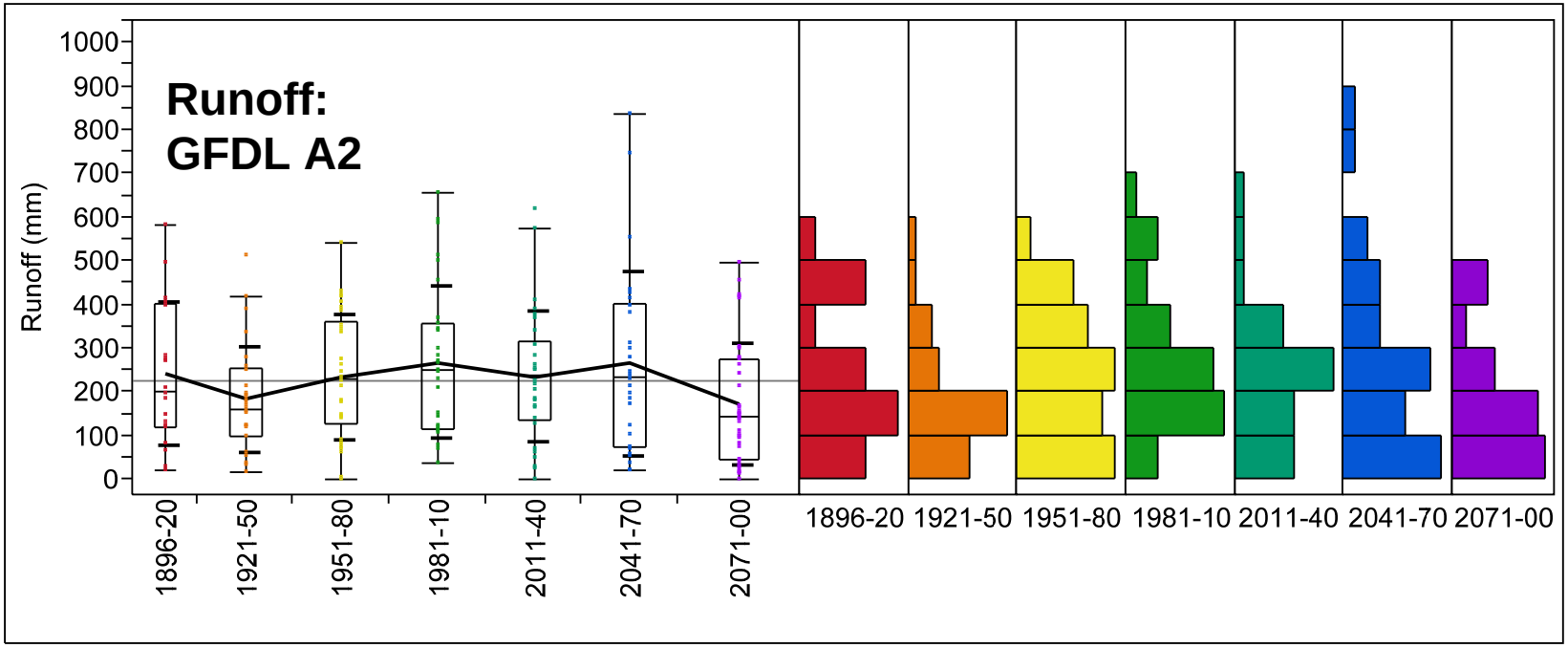

Regional Climate Scenarios for North Bay

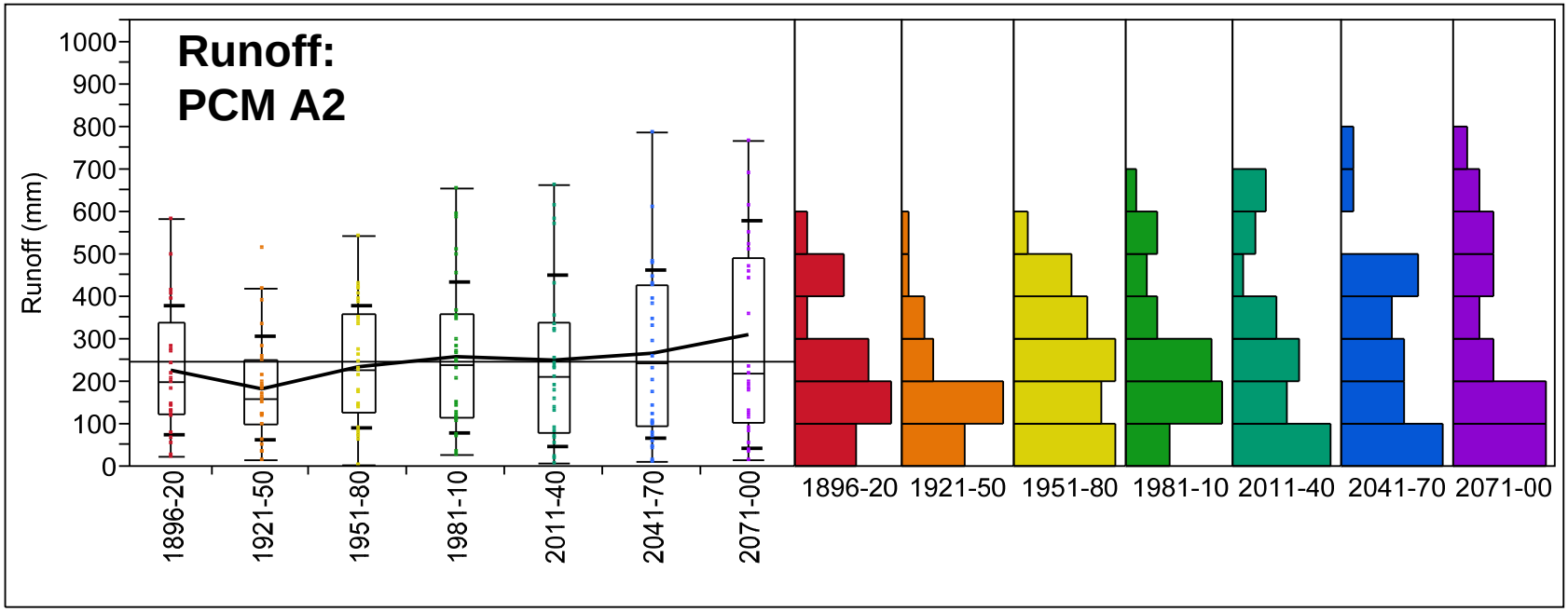

Minimum Air Temperature:
GFDL-B1
Minimum Temperature (°C)
13
12
11
10
9
8
7
6
5
1896-20
1921-50
1951-80
1981-10
2011-40
2041-70
2071-00


Minimum Air Temperature:
GFDL-A2
Minimum Temperature (°C)
13
12
11
10
9
8
7
6
5
1896-20
1921-50
1951-80
1981-10
2011-40
2041-70
2071-00
PCM Temperatures comparable

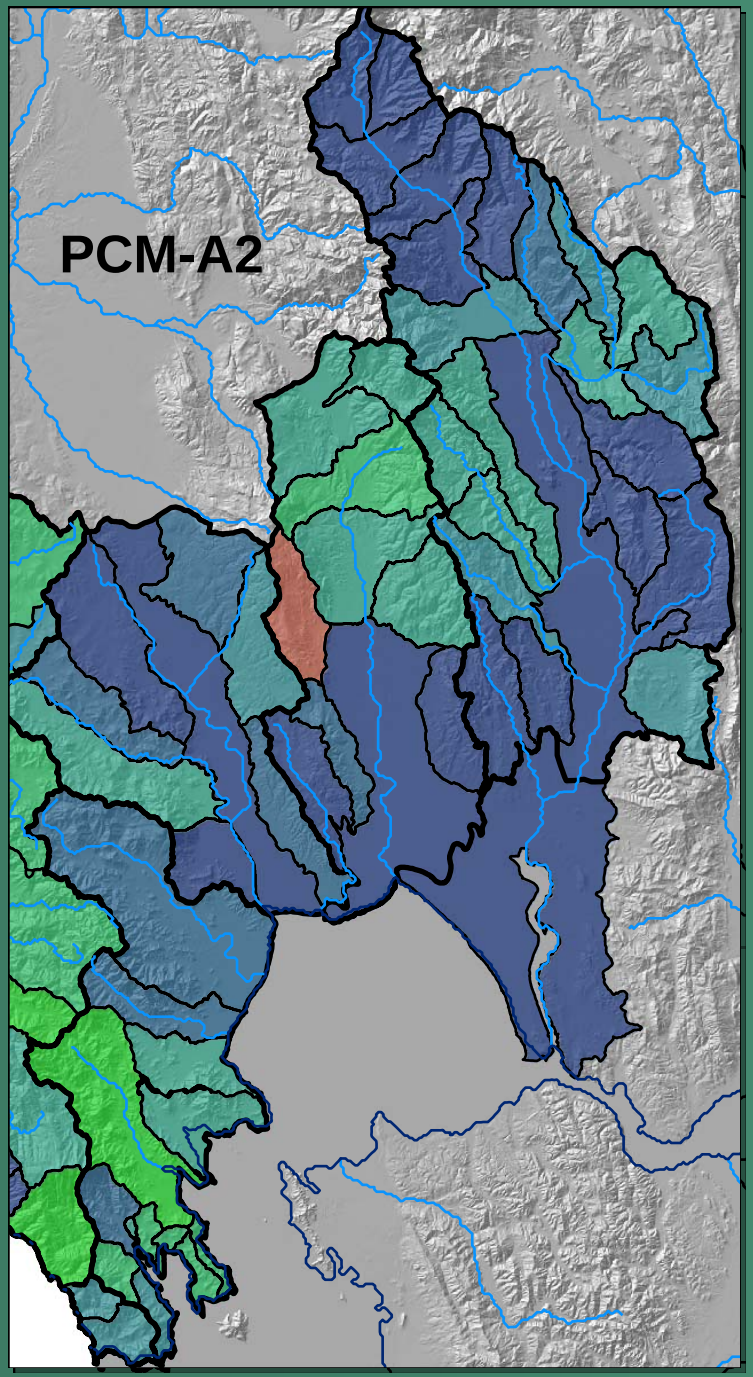

Precipitation:
GFDL-A2
Precipitation (mm)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1896-20
1921-50
1951-80
1981-10
2011-40
2041-70
2071-00

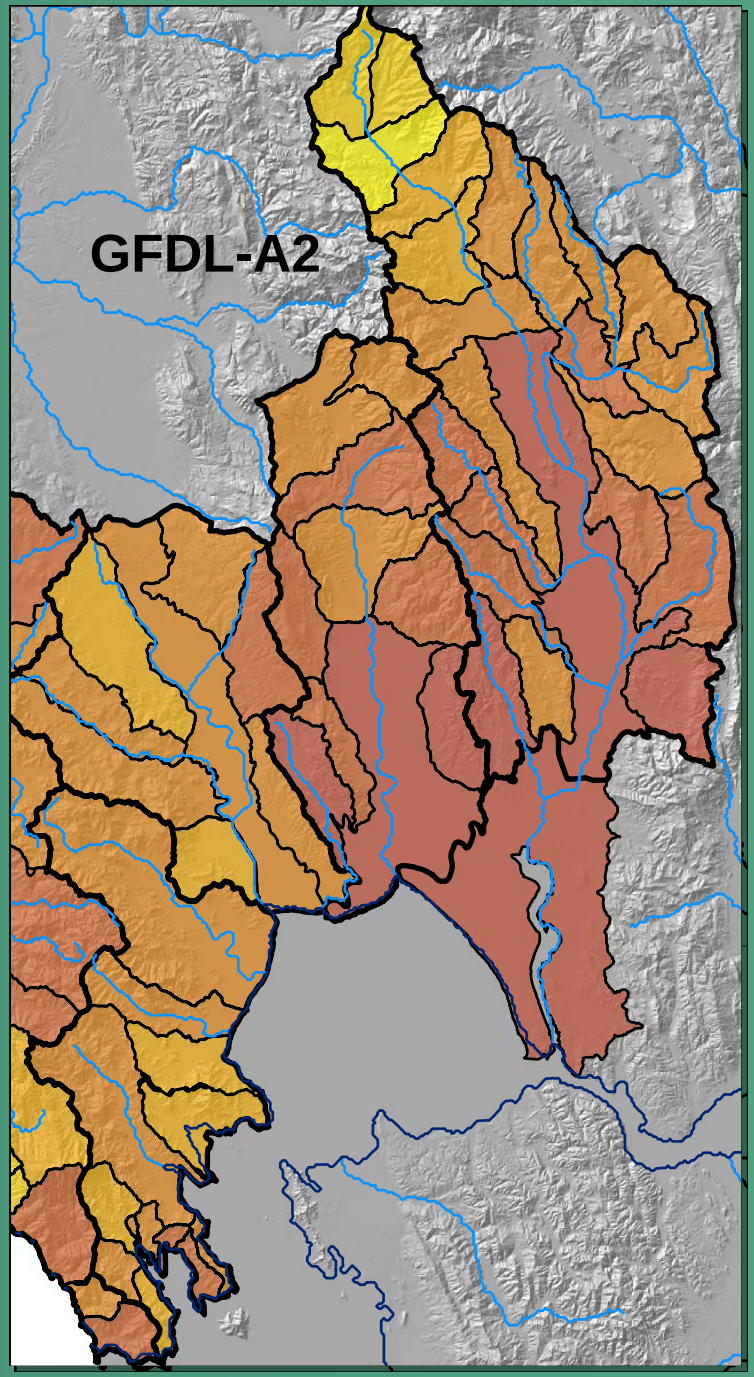

Precipitation:
PCM-A2
Precipitation (mm)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1896-20
1921-50
1951-80
1981-10
2011-40
2041-70
2071-00


Runoff:
GFDL A2
Runoff (mm)
0
100
200
300
400
500
600
700
800
900
1000
1896-20
1921-50
1951-80
1981-10
2011-40
2041-70
2071-00


Runoff:
PCM A2
Runoff (mm)
0
100
200
300
400
500
600
700
800
900
1000
1896-20
1921-50
1951-80
1981-10
2011-40
2041-70
2071-00

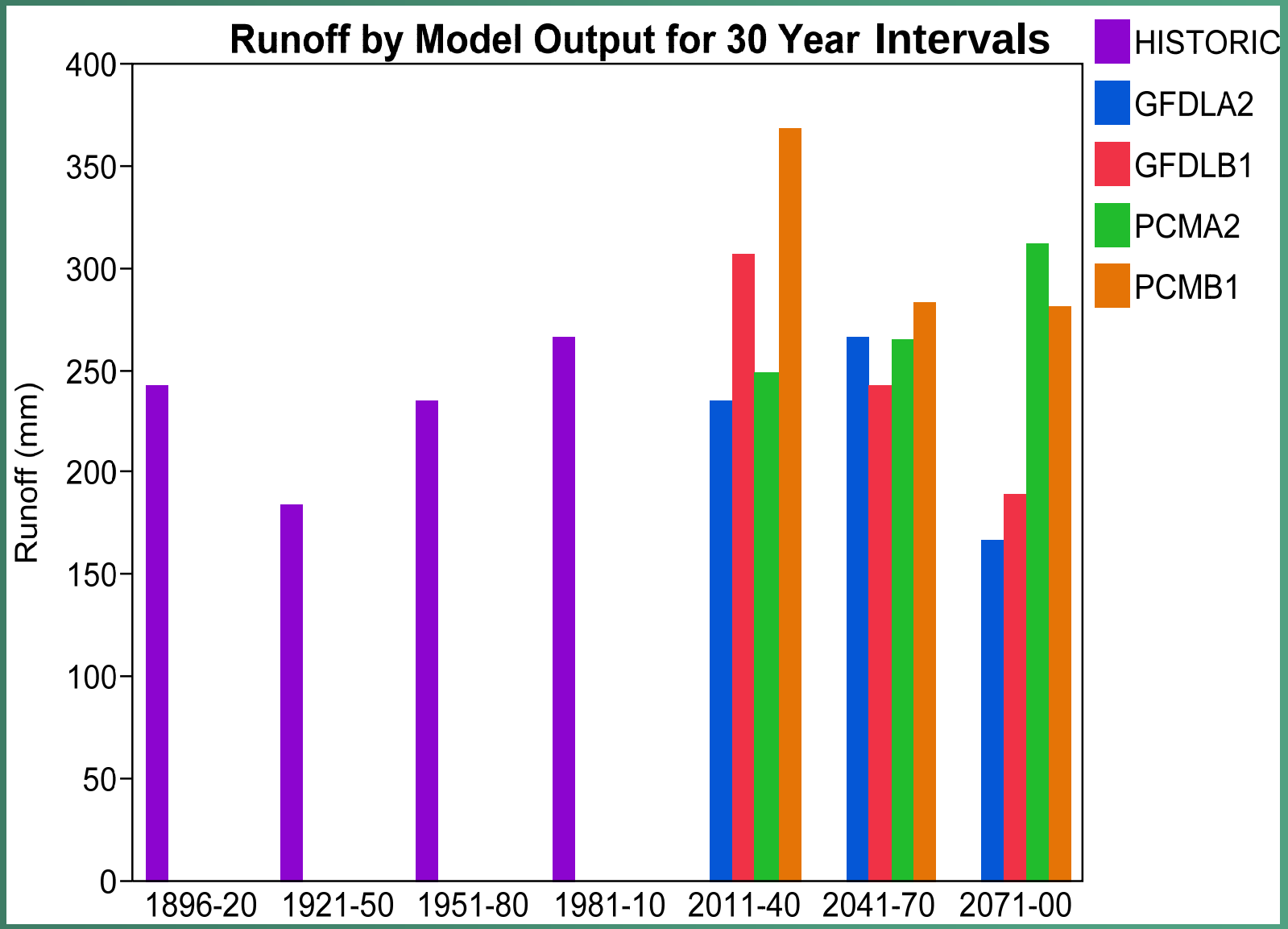
# Runoff



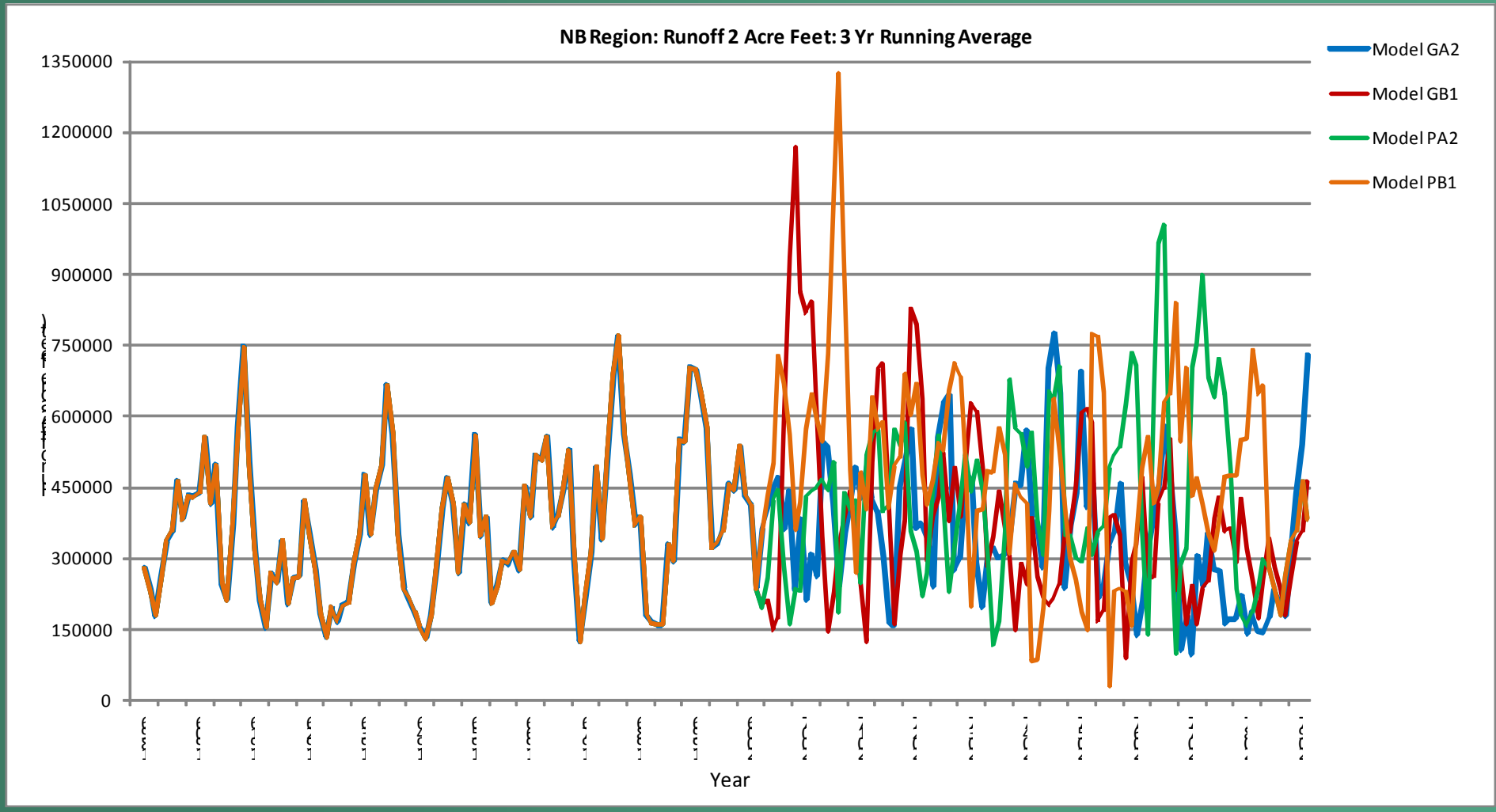

Percent Change
Between
1981-2010 and
2071-2100

- -40 - -35
- -30 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 70

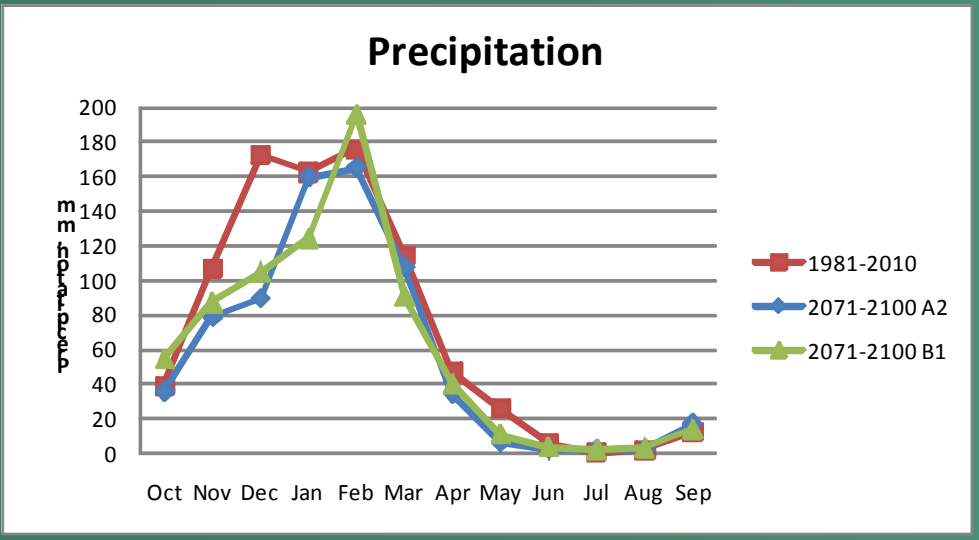


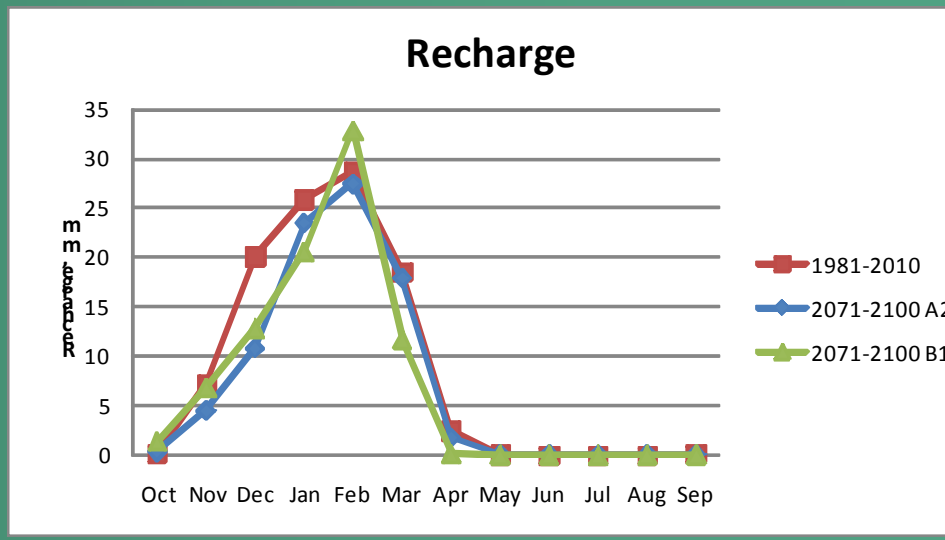

Focus on long-term trends, statistics for 30-yr intervals, clear visualizations, range of scenarios (drier-warmer, wetter warmer)

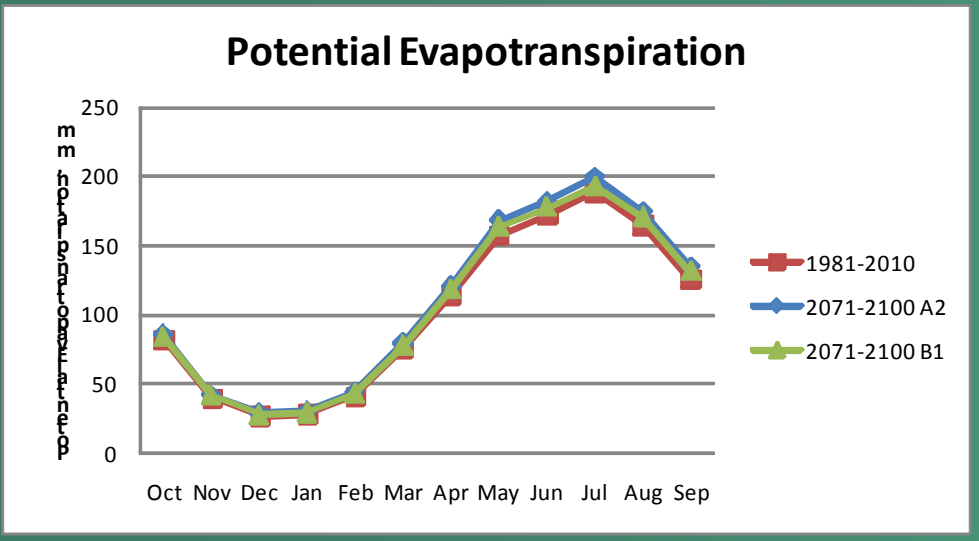
# Regional Basin Discharge Estimates

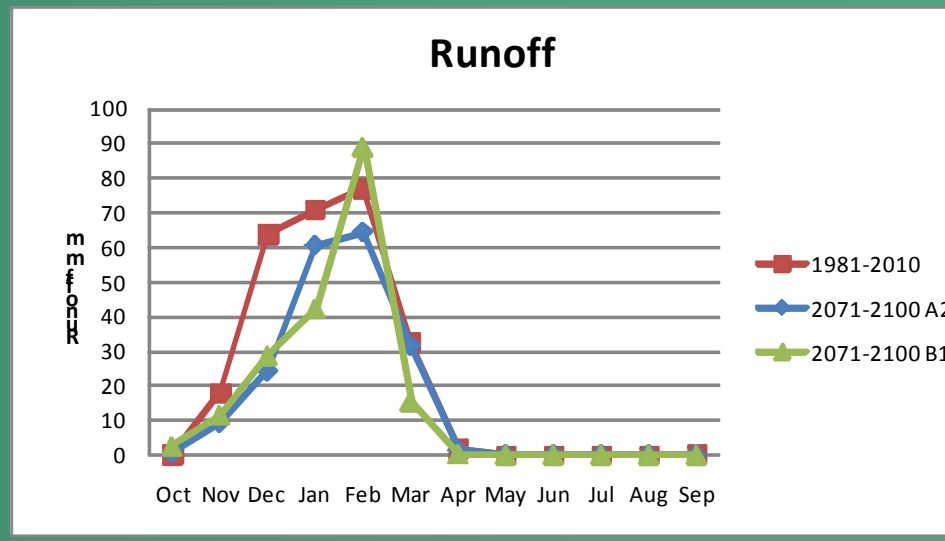


# Seasonal Shifts: GFDL model
# Napa River Monthly Average Flows, St Helena Gage



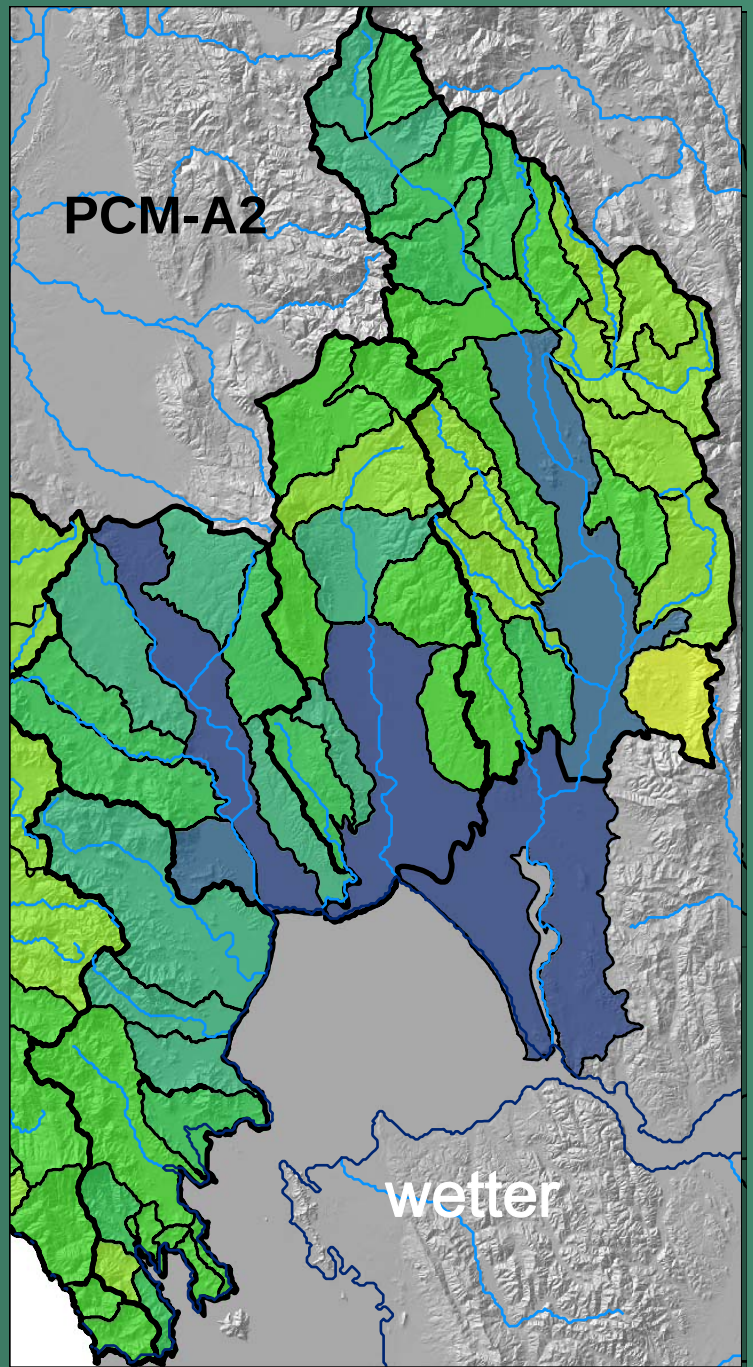




For warmer-wetter scenario, reduced flows in early and late portion of wet season=

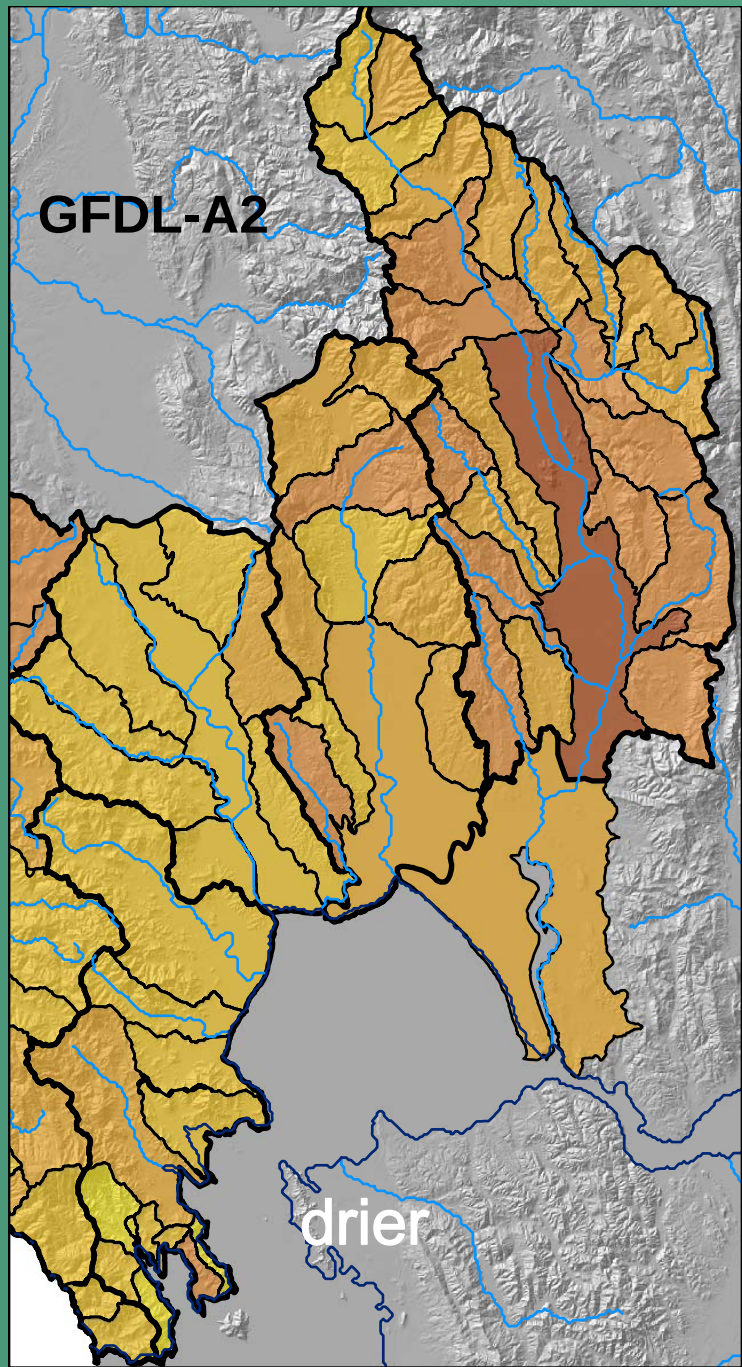
Longer summer/dry season conditions, peaks occur during midwinter

# Recharge

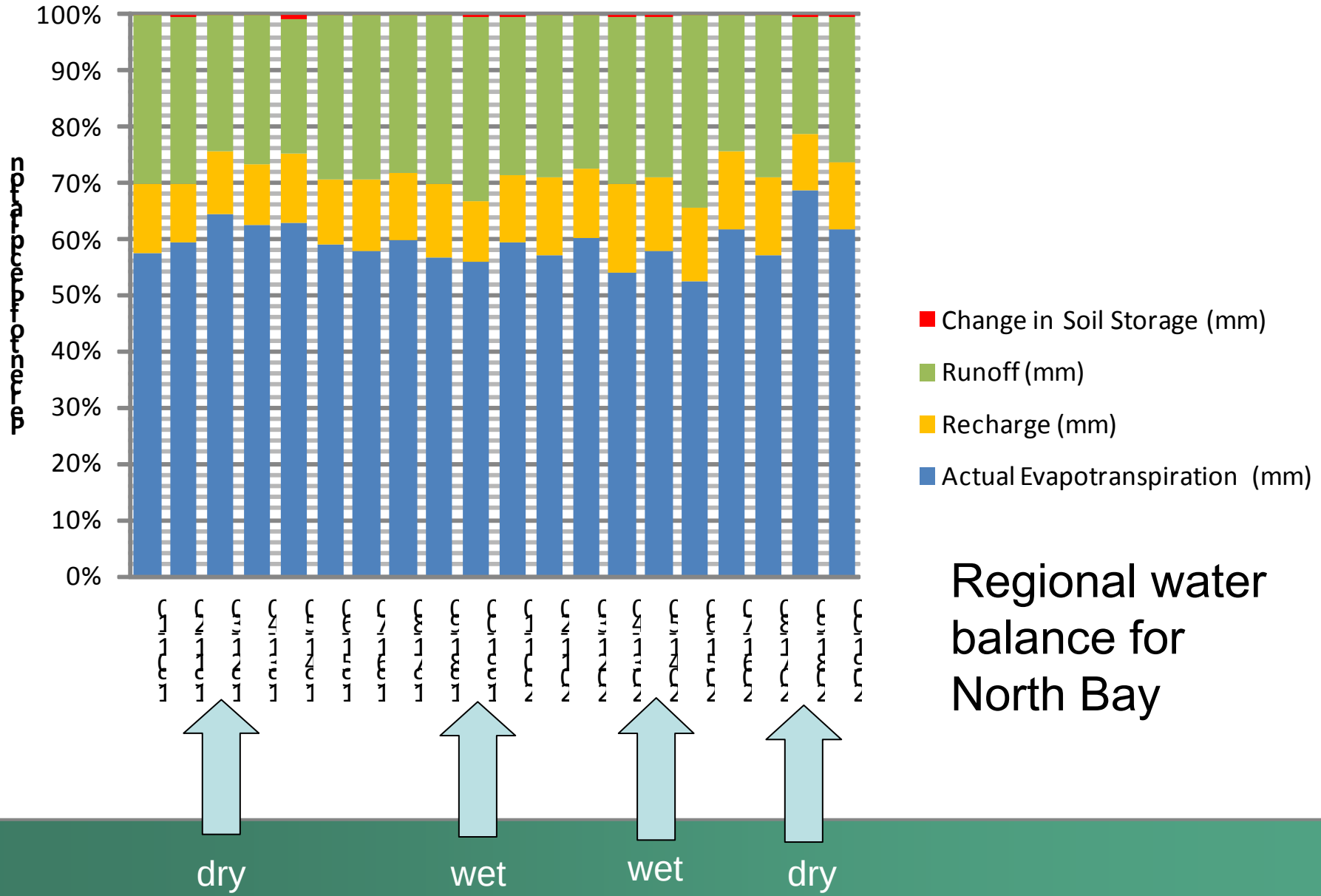



Percent Change
Between
1981-2010 and
2071-2100

- -40 - -35
- -35 - -30
- -30 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 60
- 60 - 80



# Changes in Water Balance Components: small changes have big impacts

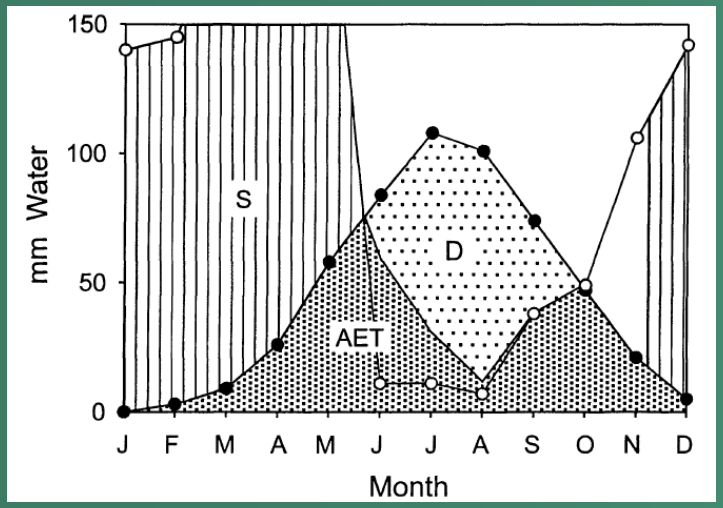



Regional water balance for North Bay

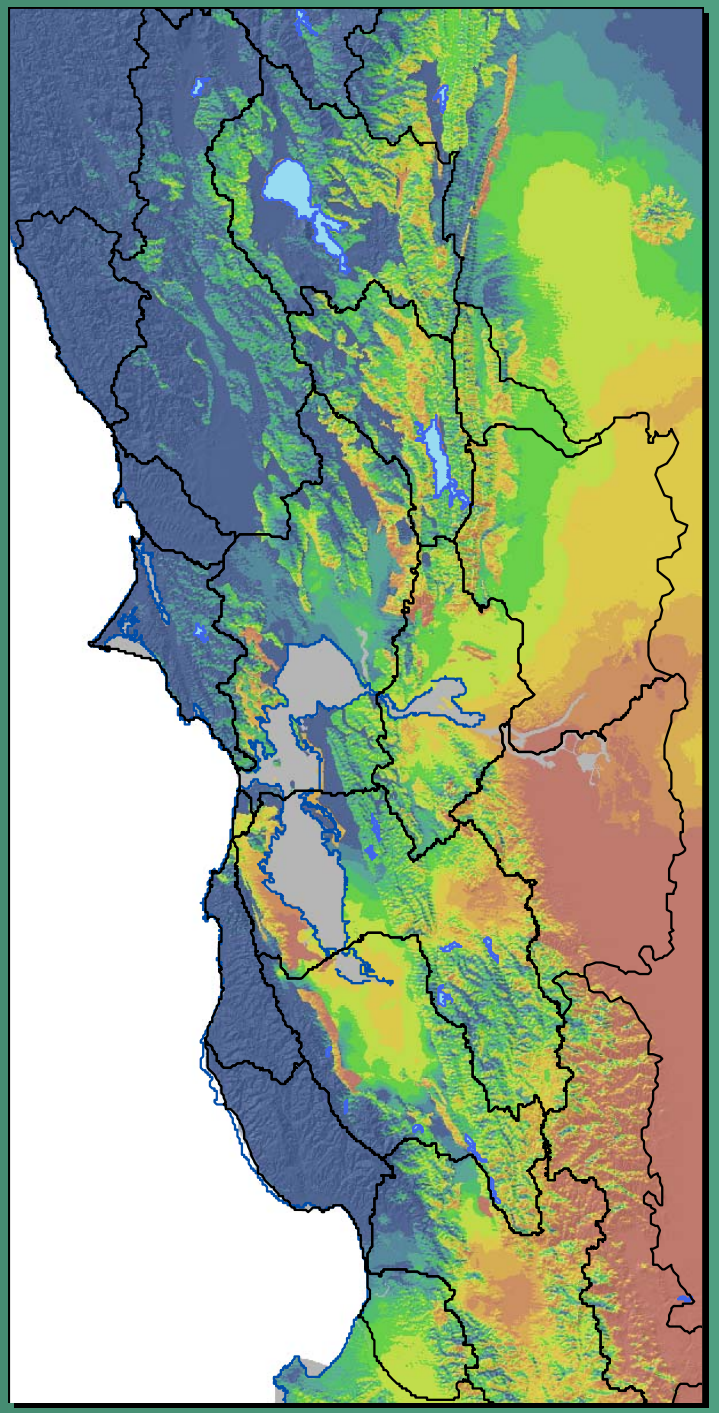
# Climatic Water Deficit

Annual evaporative demand that exceeds available water

Potential – Actual Evapotranspiration

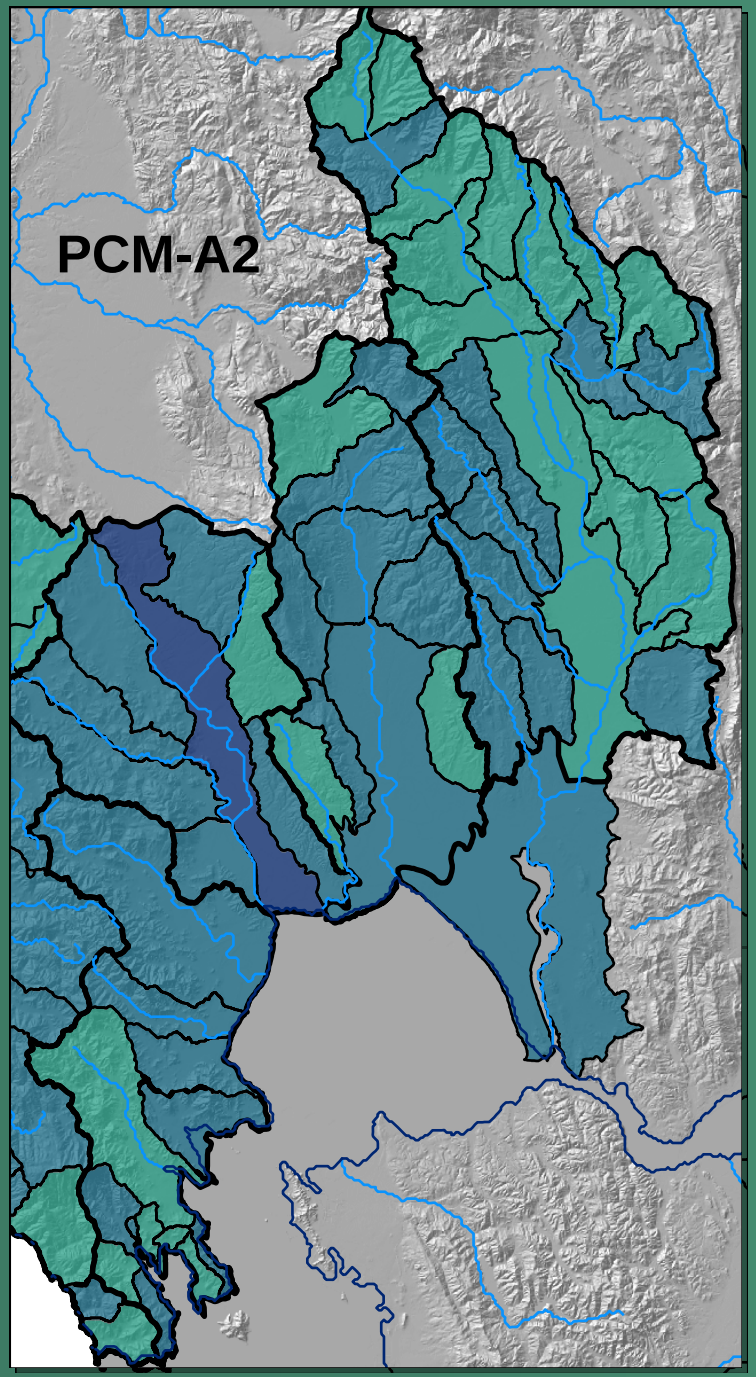



Stephenson 1998



2001
(mm/yr)

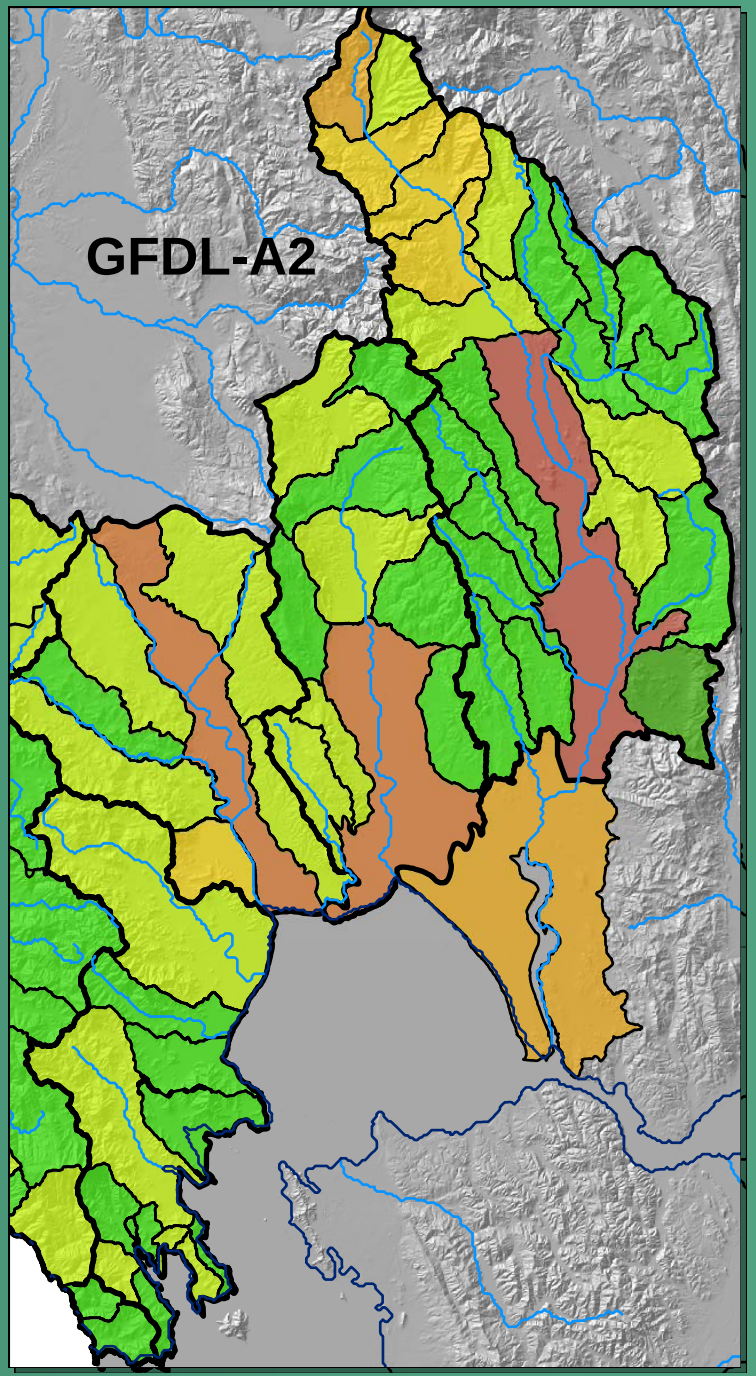
- <775
- 775 - 800
- 800 - 825
- 825 - 850
- 850 - 875
- 875 - 900
- 900 - 925
- 925 - 950
- 950 - 975
- 975 - 1000




# Climatic Water Deficit

Percent Change Between 1981-2010 and 2071-2100

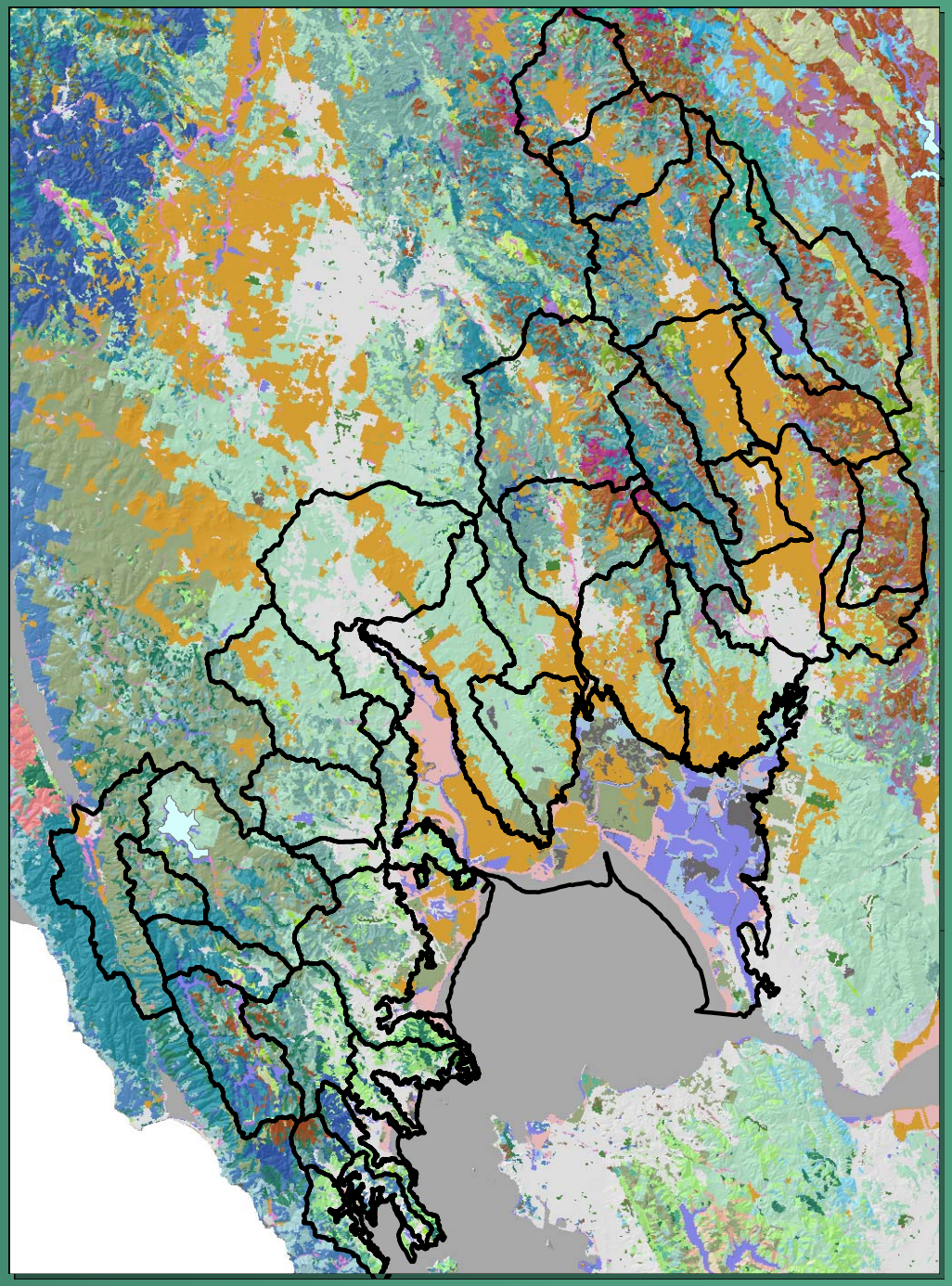
- < 4
- 4 - 8
- 8 - 12
- 12 - 16
- 16 - 20
- 20 - 24
- 24 - 28
- 28 - 32
- 32 - 36
- 36 - 45



# Vegetation Mapping

*from Bay Area Open Space Council*
*Upland Habitat Goals Project*

**Climatic water deficit as a control on vegetation expression across landscape**



# Summary

- Analyses from fine-scale modeling on the basis of 4 scenarios indicate
  - Air temperature will increase, precipitation is variable
  - Ecosystems will become more stressed due to increased CWD
  - Impacts are variable across the region
    - Water availability is uncertain across the region
    - Local “resilient” areas may maintain vegetation populations despite stresses and declines

# We need real-time regional climate-ecosystem monitoring

North Bay Climate Adaptation Initiative: Sonoma County monitoring network

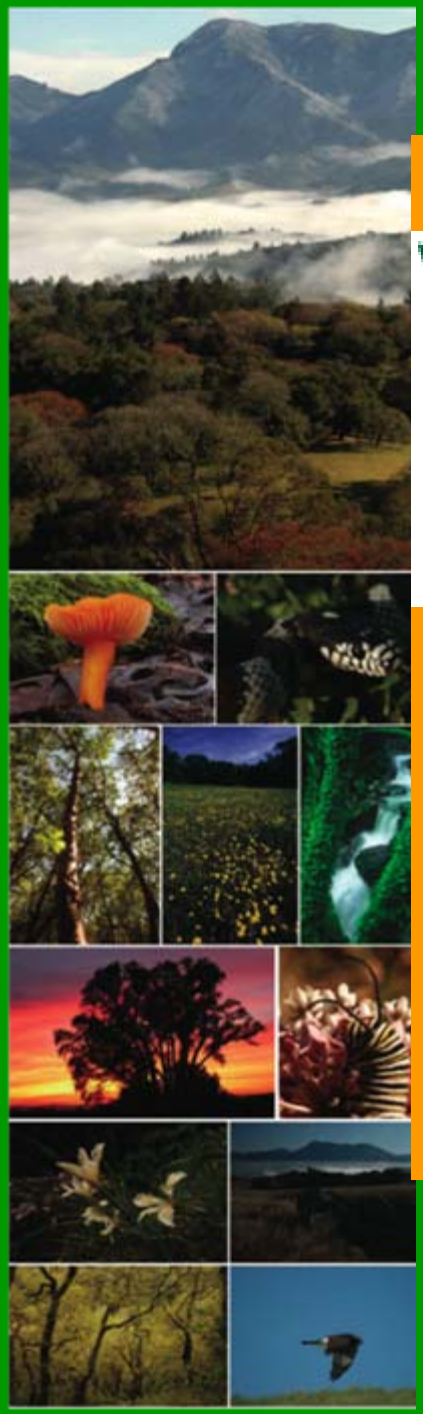
Data sharing tools

Network of practitioners: broadcast lessons learned

# Summary

Next steps: evaluate effects on

- Water quantity: human supply, streams, riparian and uplands
- Habitat conversion
- Sediment transport
- Water quality



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PRESERVE
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# THANK YOU

lmicheli@pepperwoodpreserve.org

707-591-9310 x 203