Historical Severe December-January Floods in Yosemite Valley,

with implications for climate change

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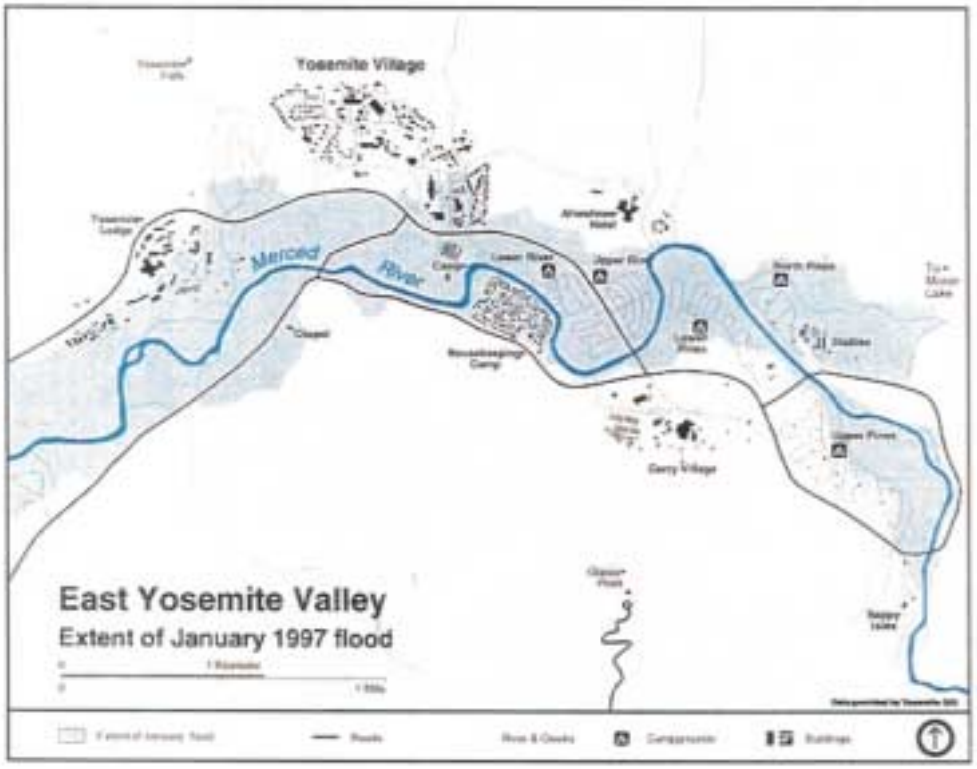
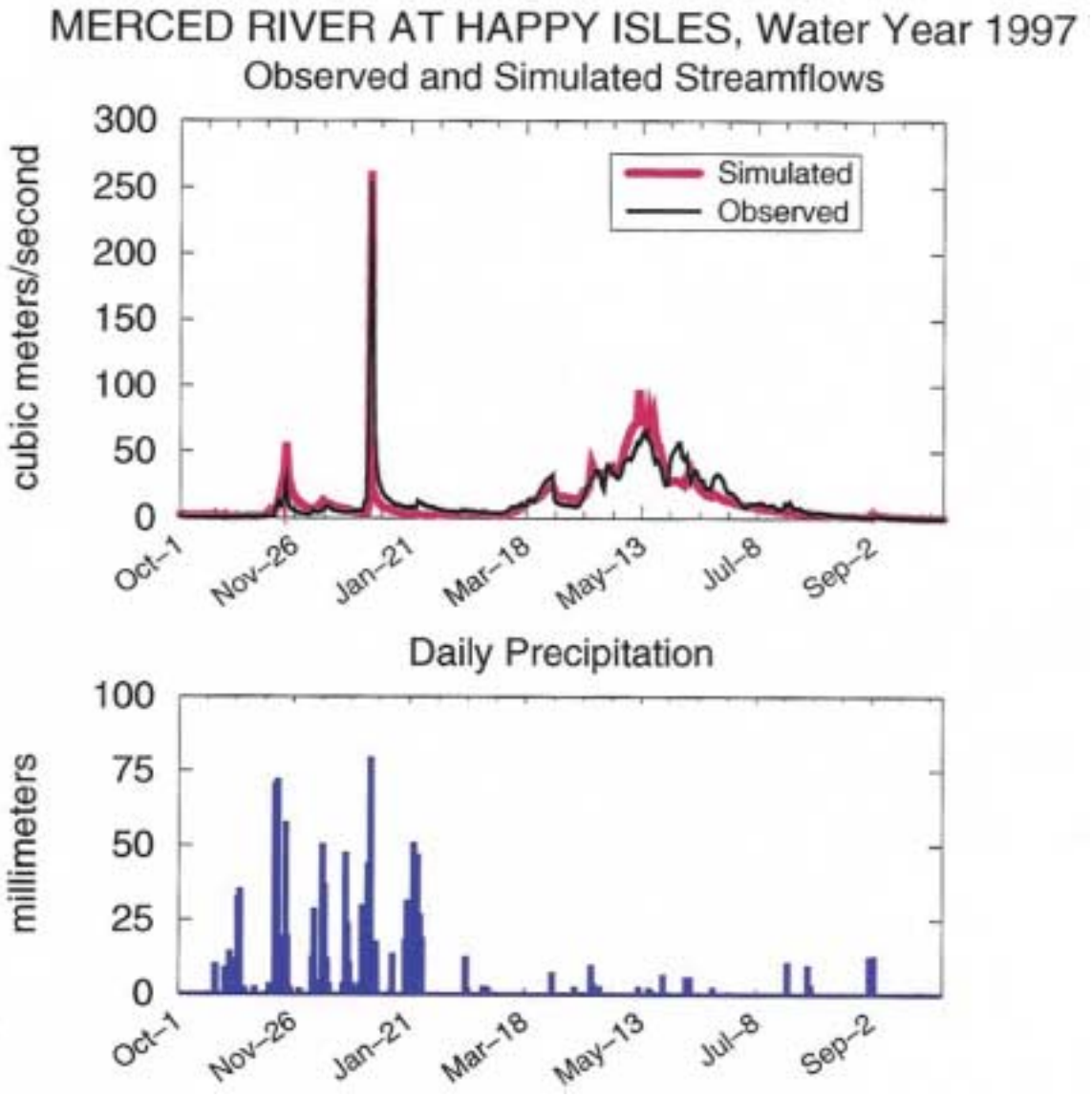
USGS
science for a changing world

NEW YEAR'S FLOODS IN YOSEMITE



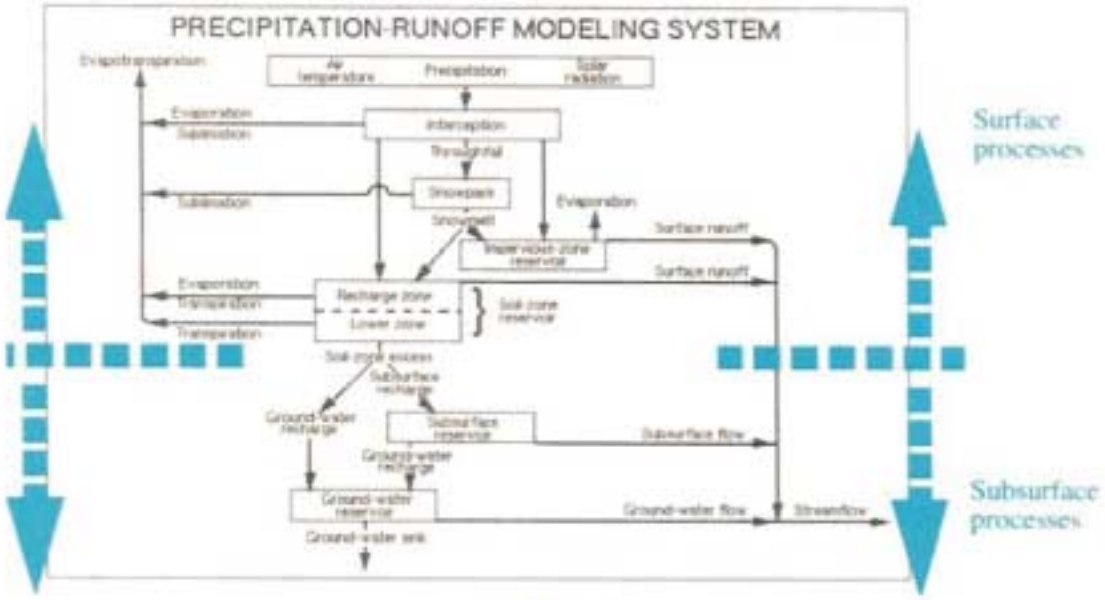

MERCED RIVER AT HAPPY ISLES, Water Year 1997
Observed and Simulated Streamflows
cubic meters/second
300
250
200
150
100
50
0
Simulated
Observed
Oct–1
Nov–26
Jan–21
Mar–18
May–13
Jul–8
Sep–2
Daily Precipitation
millimeters
100
75
50
25
0
Oct–1
Nov–26
Jan–21
Mar–18
May–13
Jul–8
Sep–2

The US Geological Survey's PRECIPITATION-RUNOFF MODELING SYSTEM (PRMS)

Representation at surface:

100m x 100m Hydrologic-Response Units

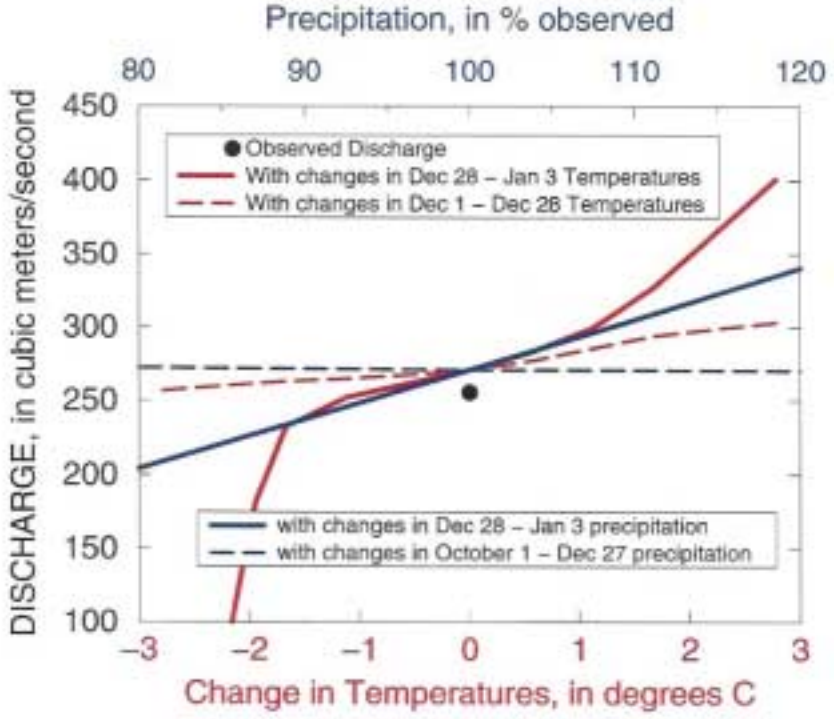
MERCED RIVER, YOSEMITE NATIONAL PARK



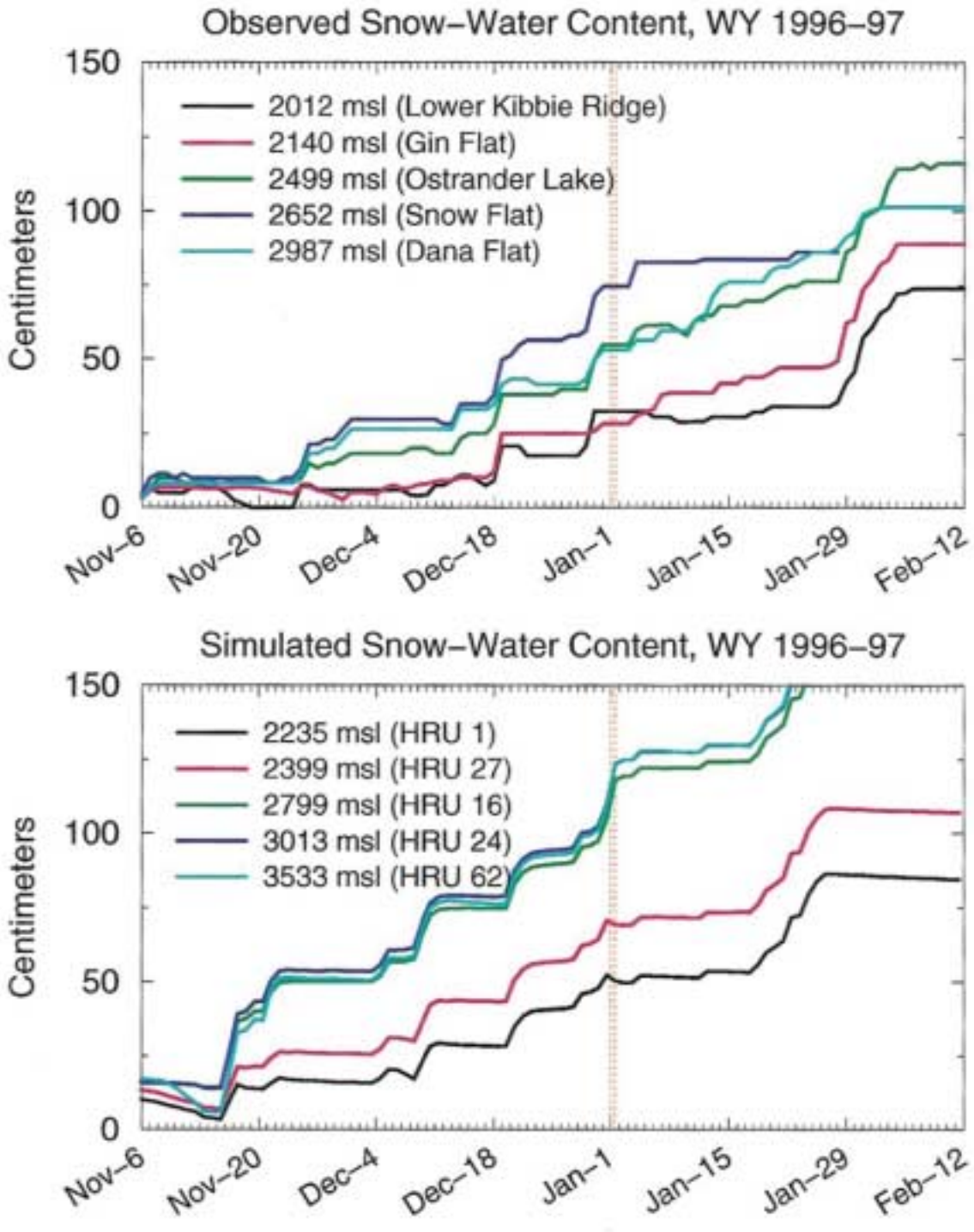
Representation at depth:

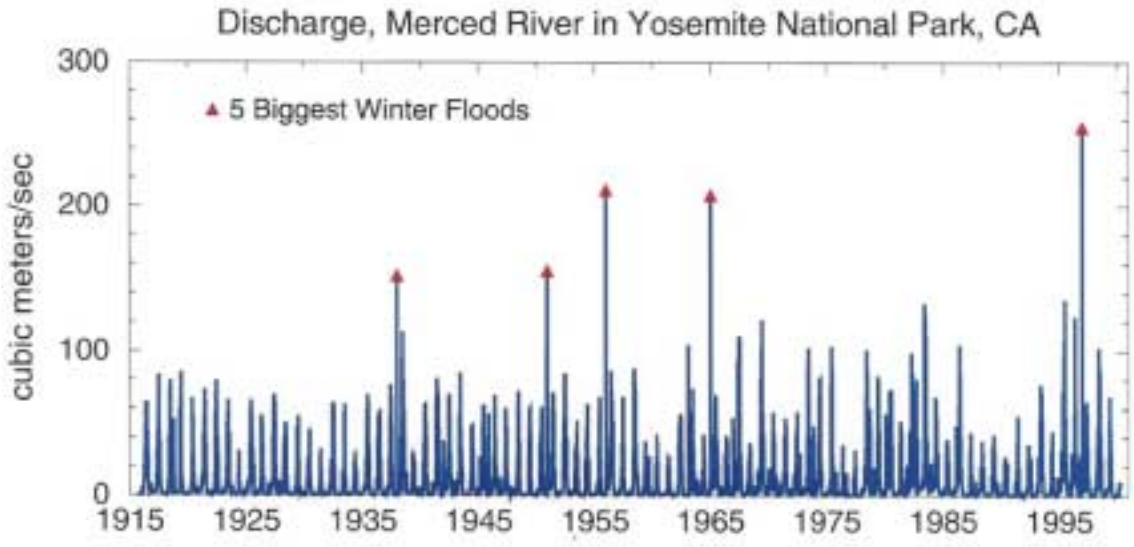
Subbasin-scale subsurface flow reservoirs (covering 500 km^2)

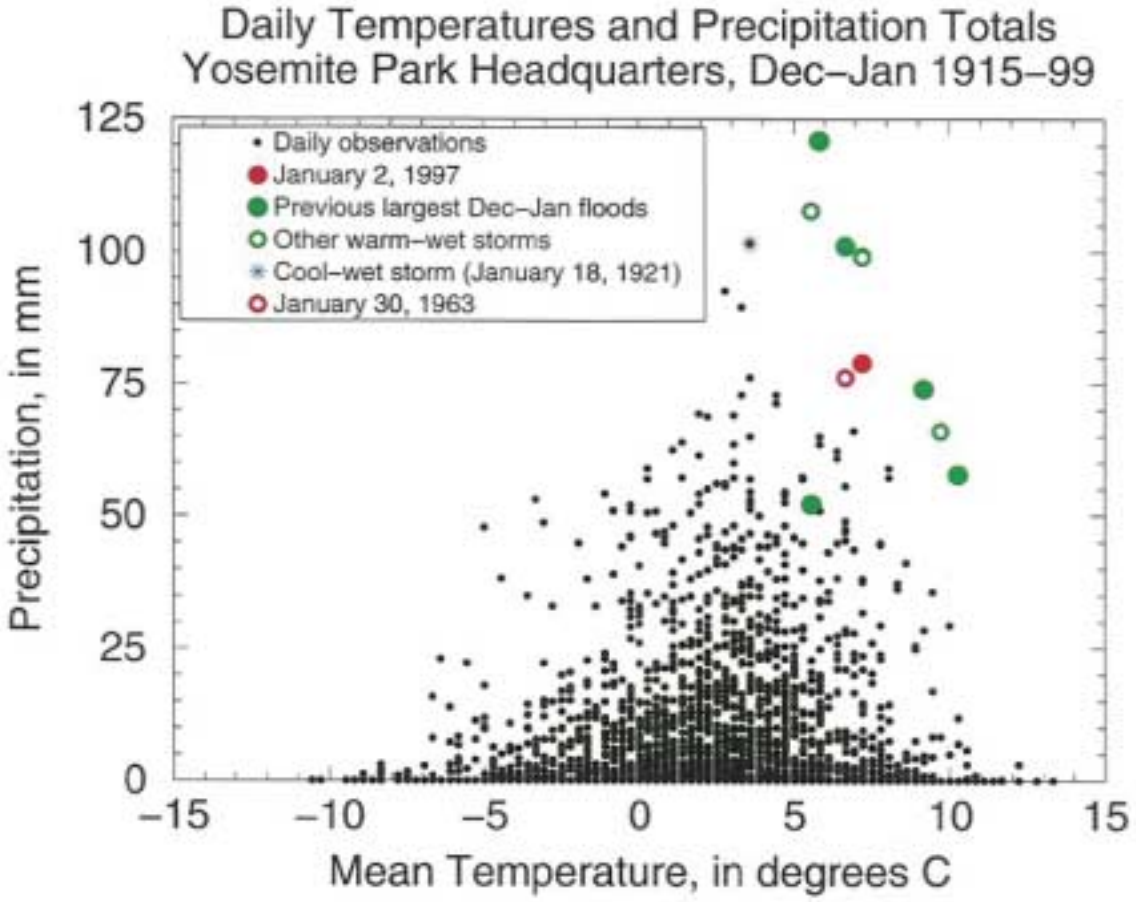
SENSITIVITY OF NEW YEARS 1997 FLOOD AT HAPPY ISLES TO CHANGES IN PRECIPITATION AND TEMPERATURES

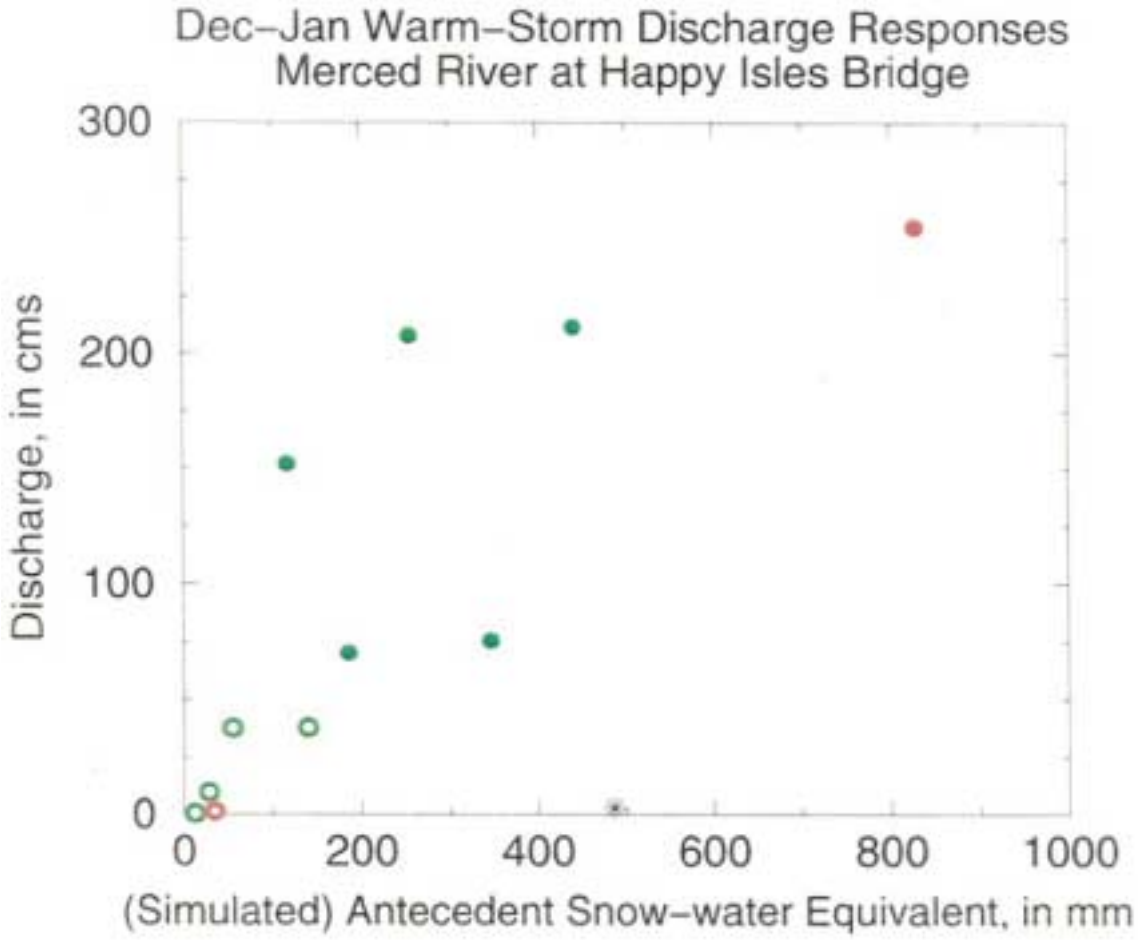


Merced River Basin (and vicinity)



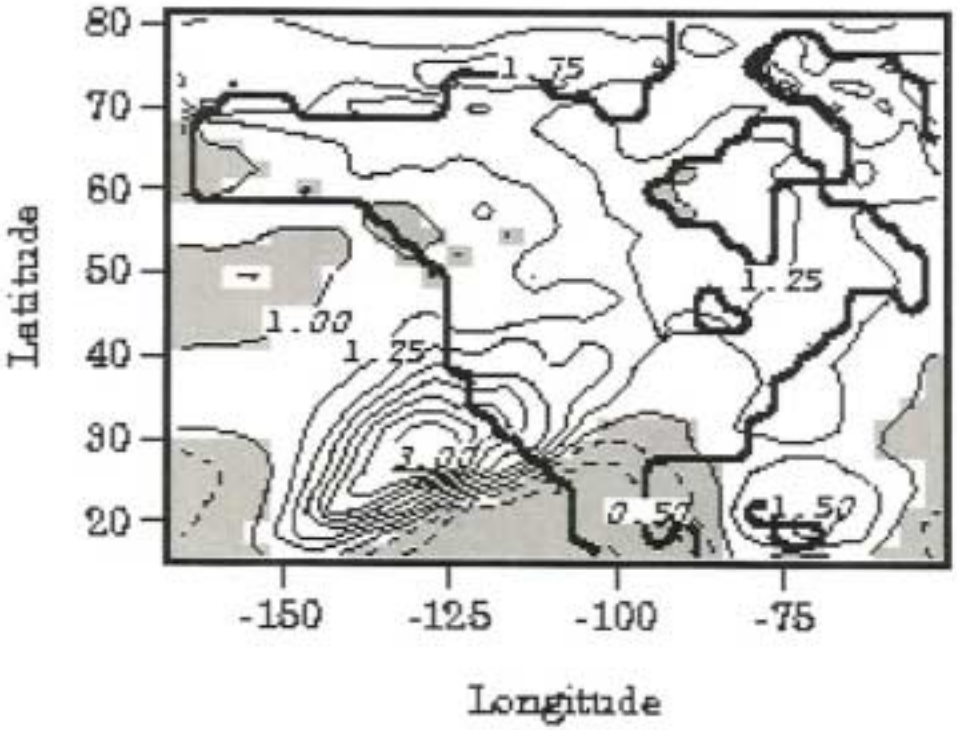

Discharge, Merced River in Yosemite National Park, CA
5 Biggest Winter Floods
cubic meters/sec
300
200
100
0
1915
1925
1935
1945
1955
1965
1975
1985
1995

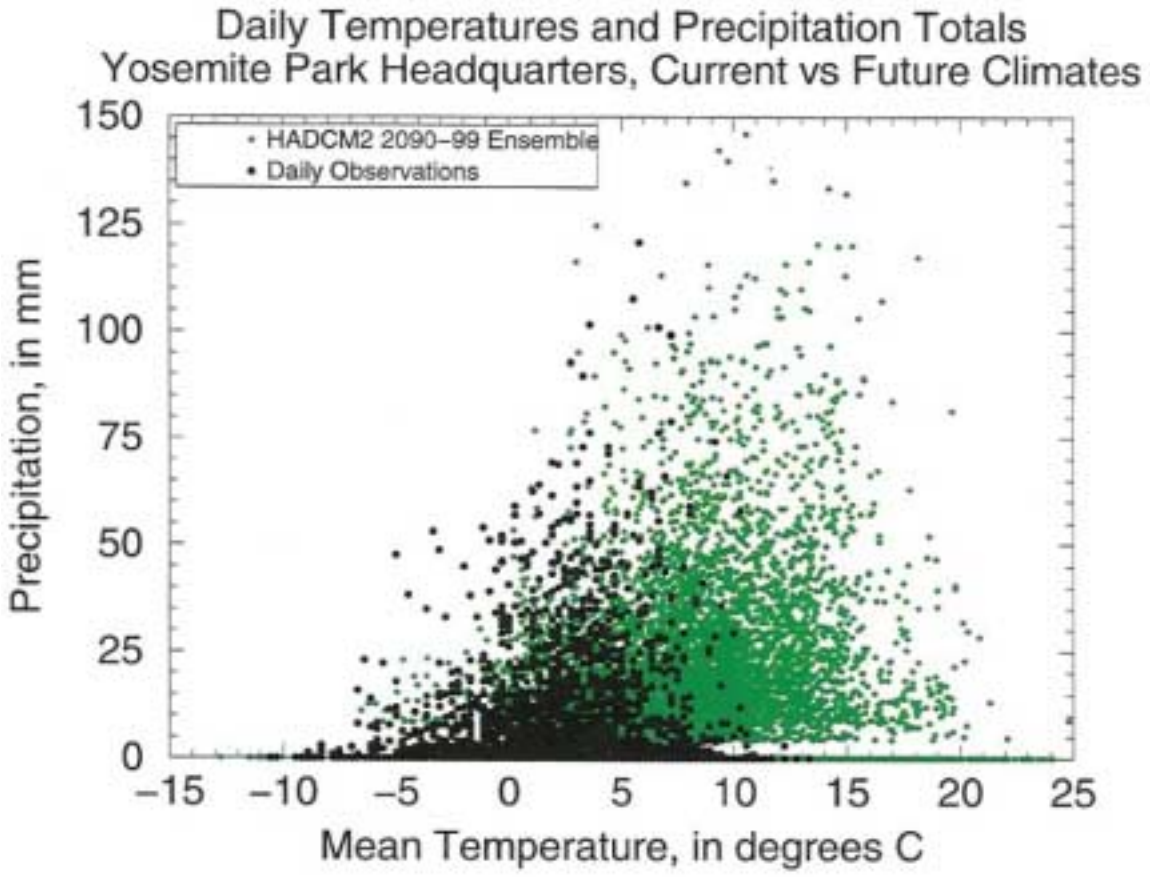

Daily Temperatures and Precipitation Totals
Yosemite Park Headquarters, Dec–Jan 1915–99
Daily observations
January 2, 1997
Previous largest Dec–Jan floods
Other warm–wet storms
Cool–wet storm (January 18, 1921)
January 30, 1963
Precipitation, in mm
125
100
75
50
25
0
–15
–10
–5
0
5
10
15
Mean Temperature, in degrees C

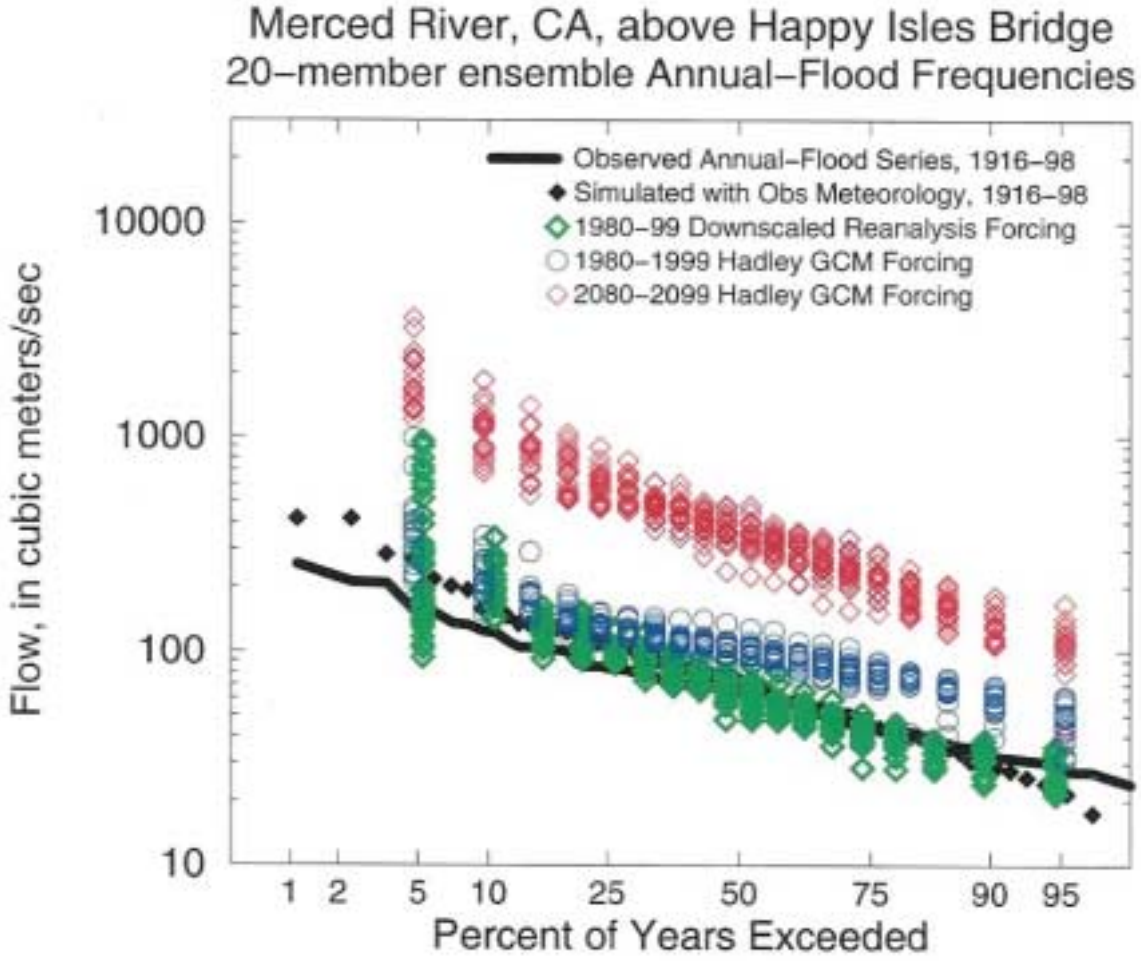

Dec–Jan Warm–Storm Discharge Responses
Merced River at Happy Isles Bridge
Discharge, in cms
300
200
100
0
0
200
400
600
800
1000
(Simulated) Antecedent Snow–water Equivalent, in mm

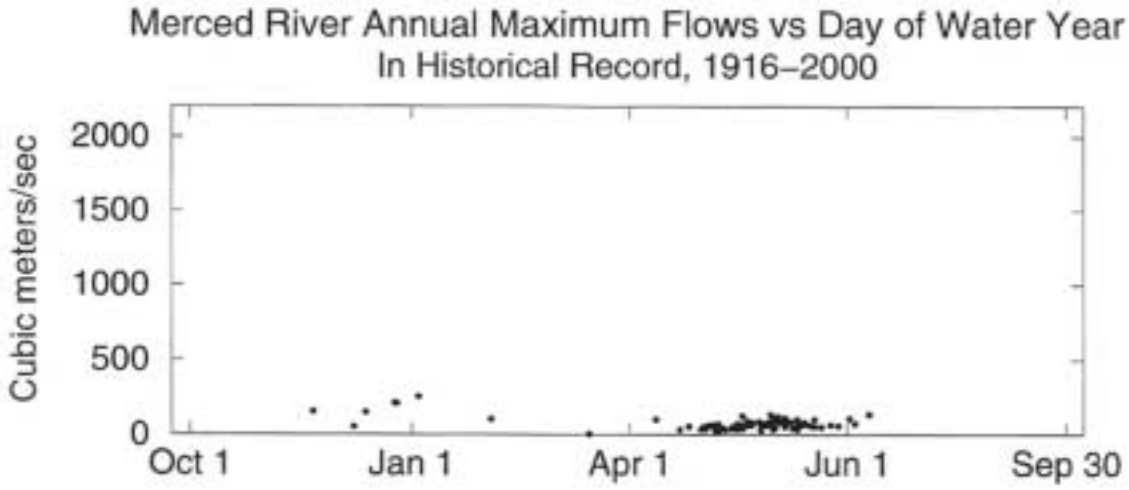
National Assessment 2000
HadCM2-simulated Ratios of Dec-Feb Precipitation Rates

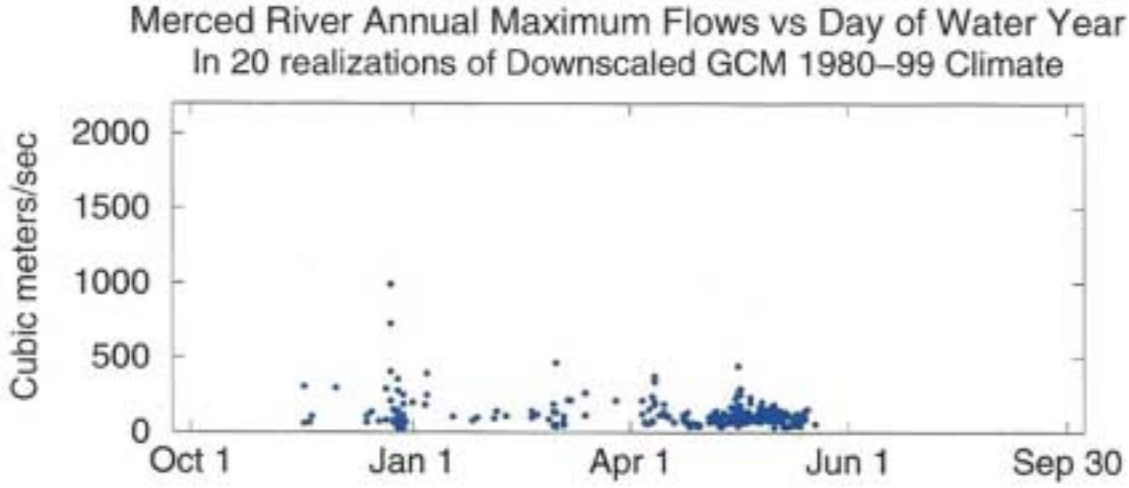
(2090-99) / (1961-90)

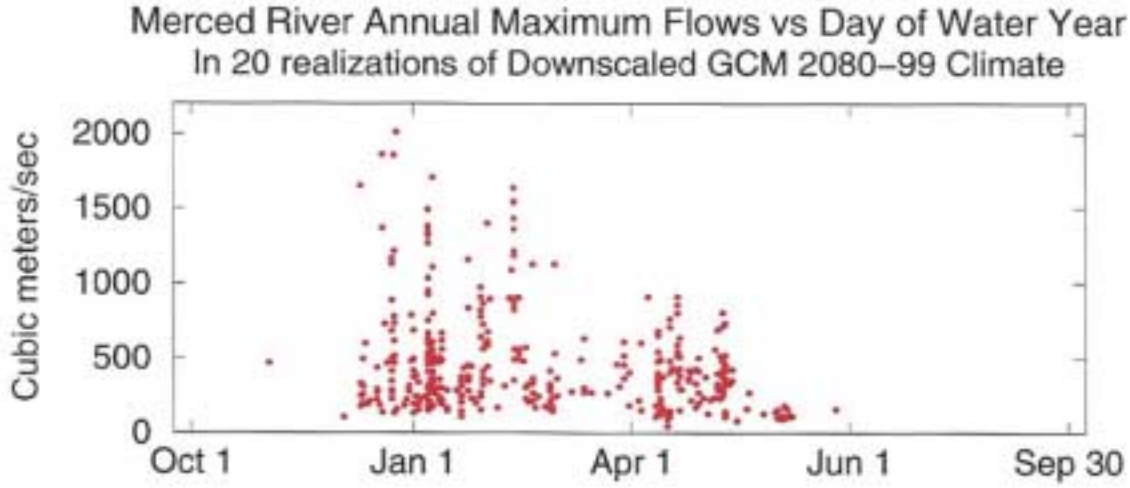



Daily Temperatures and Precipitation Totals
Yosemite Park Headquarters, Current vs Future Climates
HADCM2 2090–99 Ensemble
Daily Observations
Precipitation, in mm
150
125
100
75
50
25
0
–15
–10
–5
0
5
10
15
20
25
Mean Temperature, in degrees C


Merced River, CA, above Happy Isles Bridge
20–member ensemble Annual–Flood Frequencies
Observed Annual–Flood Series, 1916–98
Simulated with Obs Meteorology, 1916–98
1980–99 Downscaled Reanalysis Forcing
1980–1999 Hadley GCM Forcing
2080–2099 Hadley GCM Forcing
Flow, in cubic meters/sec
10000
1000
100
10
1
2
5
10
25
50
75
90
95
Percent of Years Exceeded

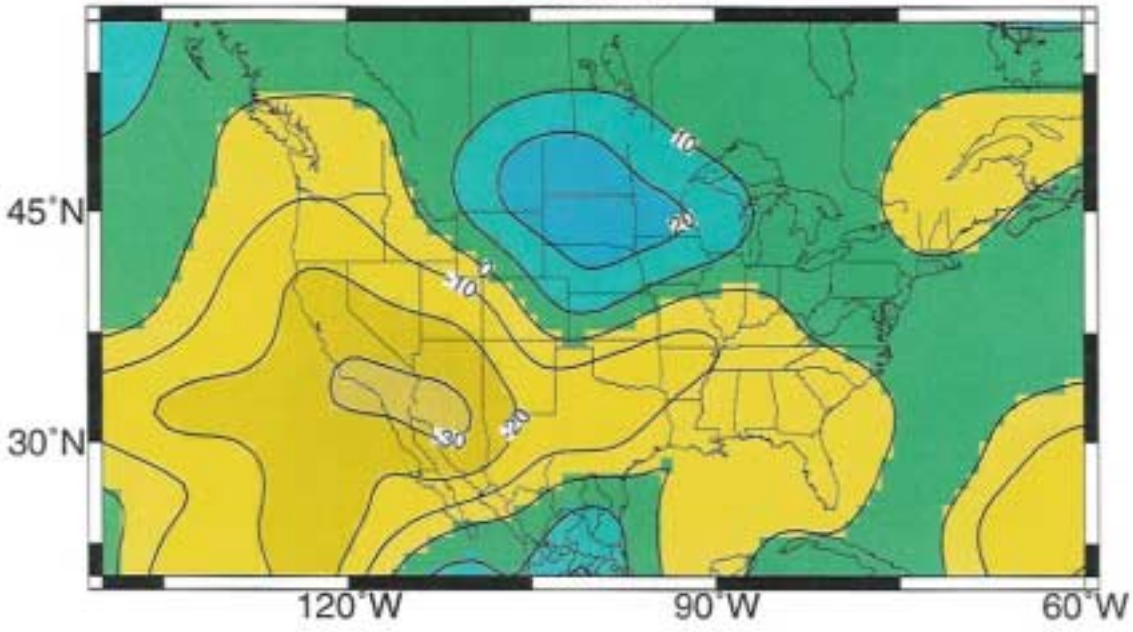

Merced River Annual Maximum Flows vs Day of Water Year
In Historical Record, 1916–2000
Cubic meters/sec
2000
1500
1000
500
0
Oct 1
Jan 1
Apr 1
Jun 1
Sep 30


Merced River Annual Maximum Flows vs Day of Water Year
In 20 realizations of Downscaled GCM 1980–99 Climate
Cubic meters/sec
2000
1500
1000
500
0
Oct 1
Jan 1
Apr 1
Jun 1
Sep 30

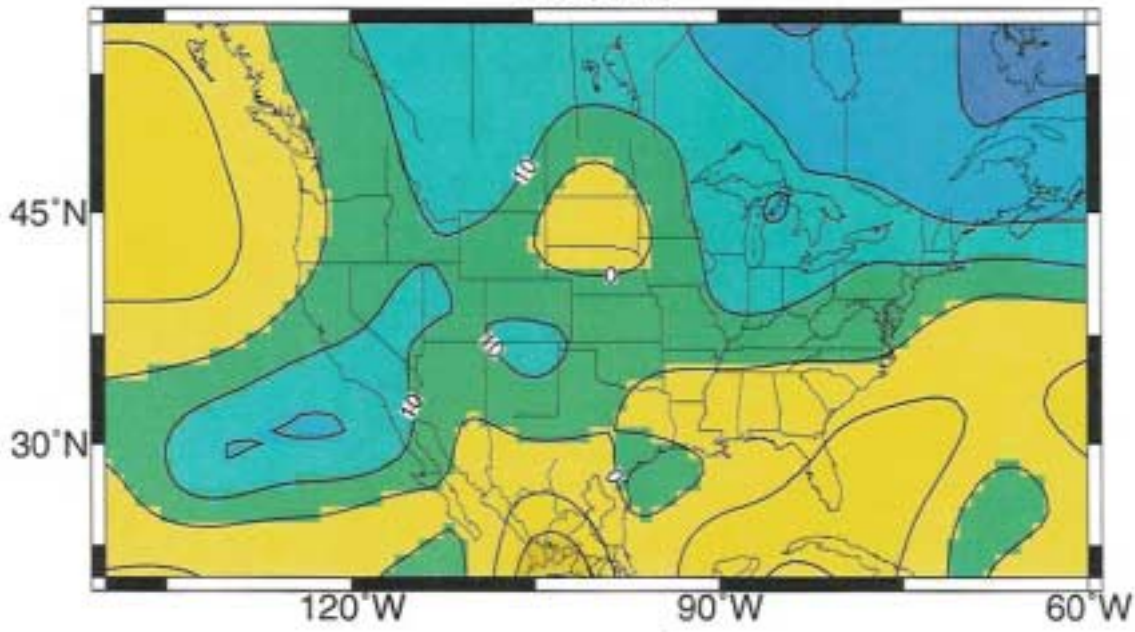

Merced River Annual Maximum Flows vs Day of Water Year
In 20 realizations of Downscaled GCM 2080–99 Climate
Cubic meters/sec
2000
1500
1000
500
0
Oct 1
Jan 1
Apr 1
Jun 1
Sep 30

ACPI DJF Precipitation

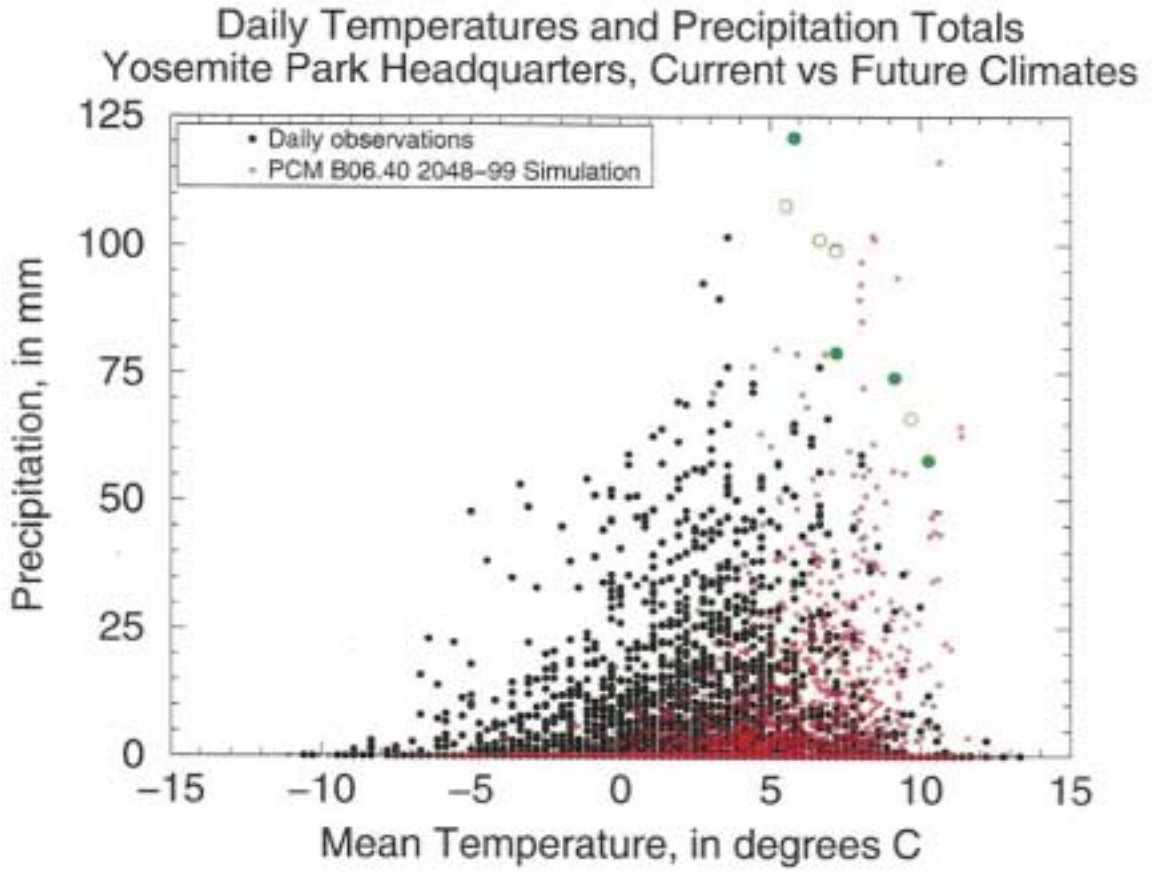
B06.40

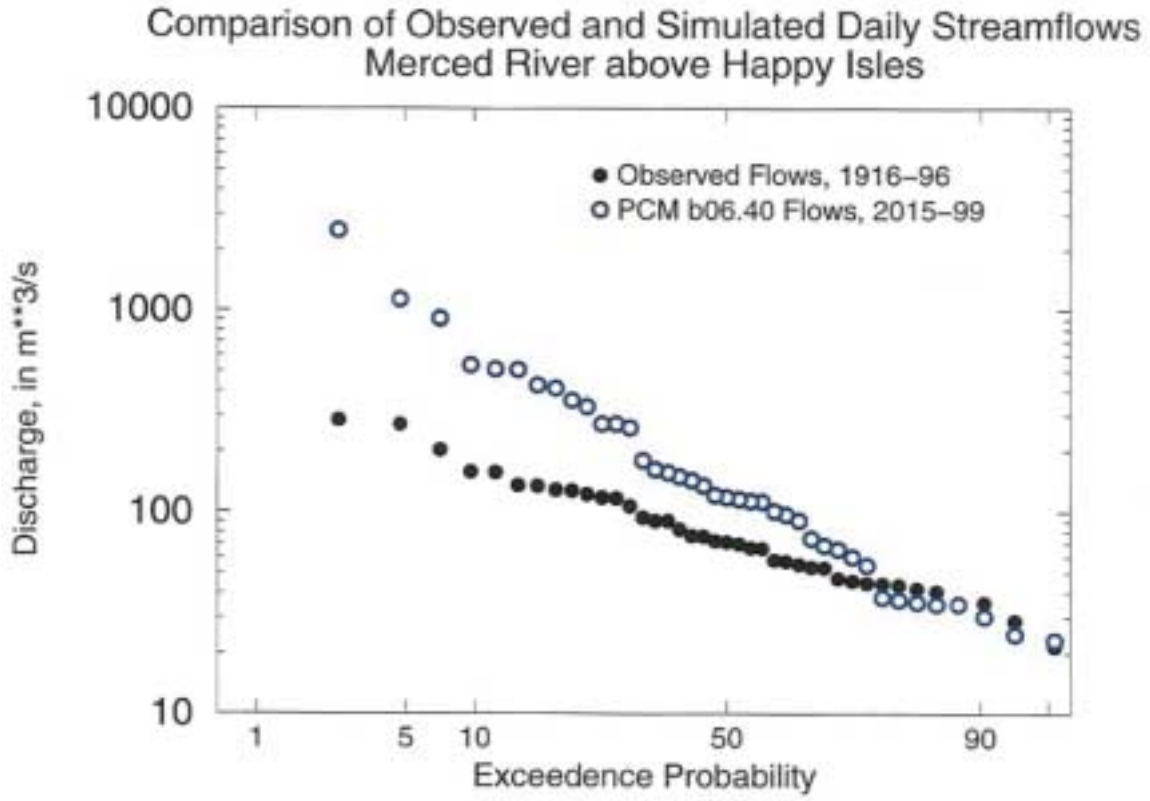


B06.43



{[2090 to 2099] - [2000 to 2009]} / [2000 to 2009]


Daily Temperatures and Precipitation Totals
Yosemite Park Headquarters, Current vs Future Climates
Daily observations
PCM B06.40 2048–99 Simulation
Precipitation, in mm
125
100
75
50
25
0
–15
–10
–5
0
5
10
15
Mean Temperature, in degrees C


Comparison of Observed and Simulated Daily Streamflows
Merced River above Happy Isles
Observed Flows, 1916–96
PCM b06.40 Flows, 2015–99
Discharge, in m**3/s
10000
1000
100
10
1
5
10
50
90
Exceedence Probability

LESSONS for CLIMATE CHANGE in the SIERRA NEVADA

Historically, all of the biggest floods on the Merced at Happy Isles (representative of the highest Sierra basins) have been wintertime warm-wet storms.

The New Years 1997 Flood in this basin was a result of rainfall runoff, much more than snowmelt.

In simulation, the New Years 1997 Flood was "set up" by conditions within a few days of the event (precipitation and temperatures much earlier in the year played little role).

The winter storm that brought about the New Years 1997 Flood was *among* the warmest and wettest, but was not *the* warmest or wettest.

Similar storms have yielded floods or not, depending on storm depths and temperatures, and immediately antecedent snowpack and soil-moisture conditions.

Under projected warmer (and especially warmer & wetter) climate conditions, a whole new population of floods is simulated in the Merced River, centered in the December-January season.