Sea Level Rise and San Francisco Bay

scenarios for CASCADE study

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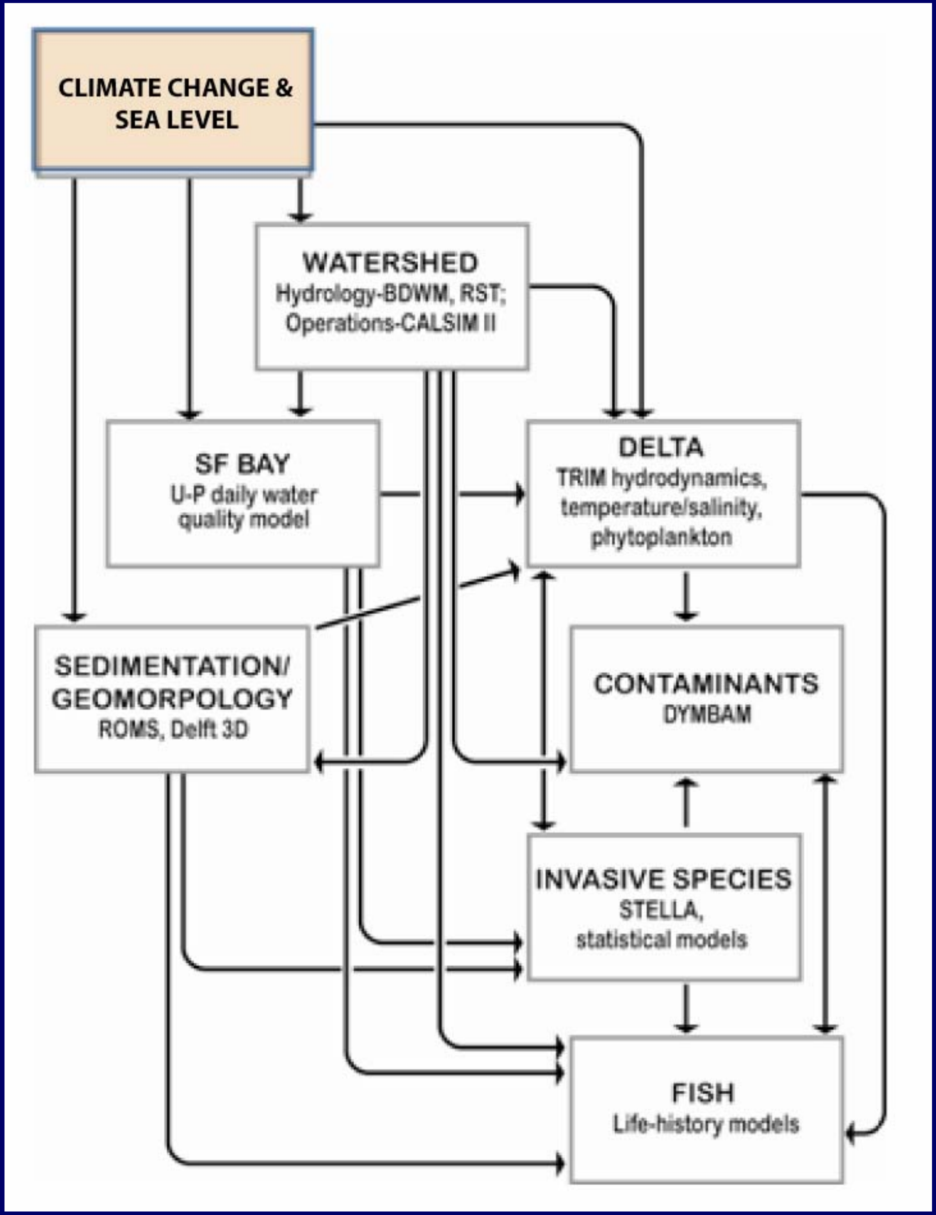
Sponsors:

USGS CASCADE study

California Energy Commission

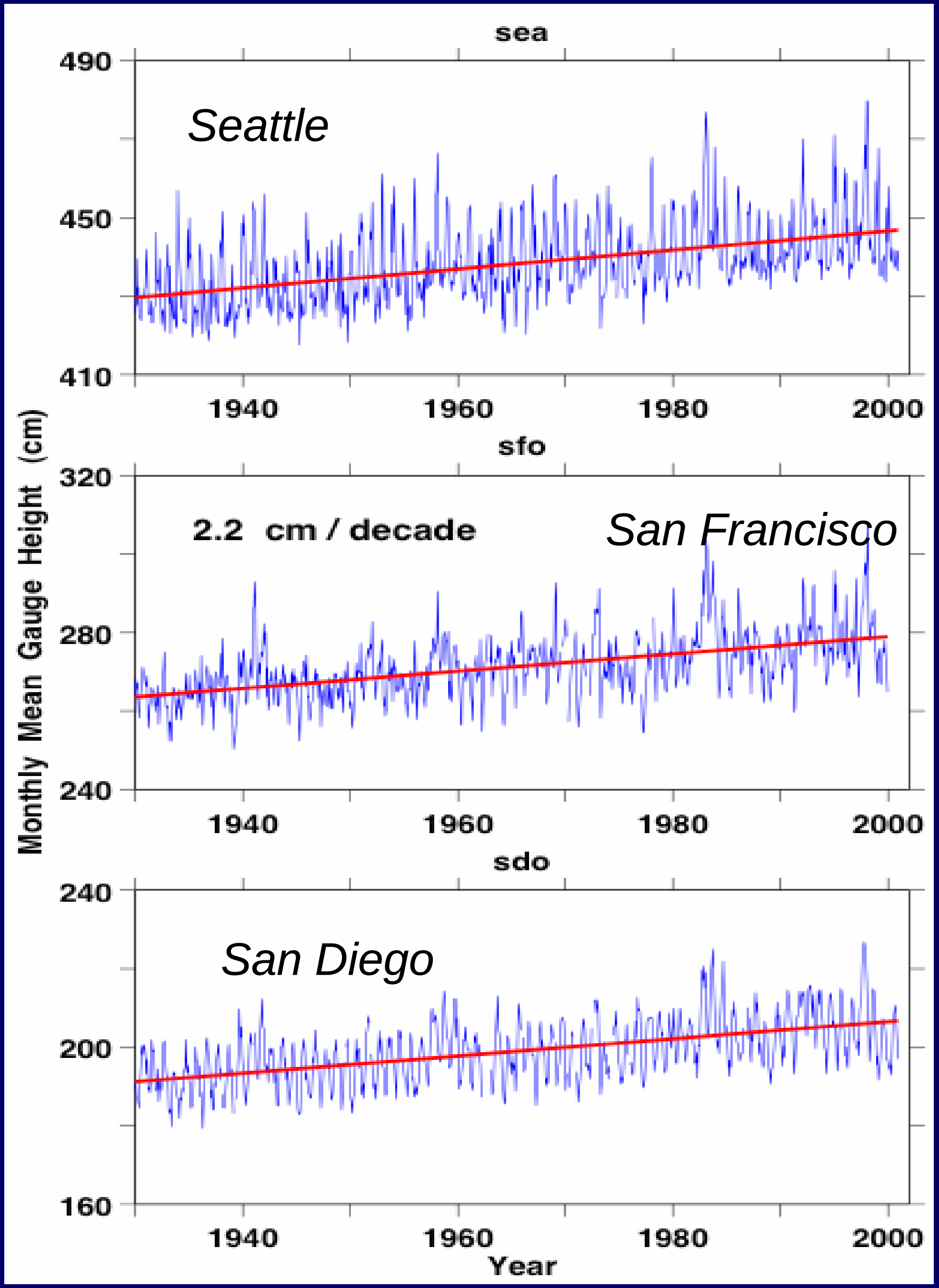
NOAA RISA program

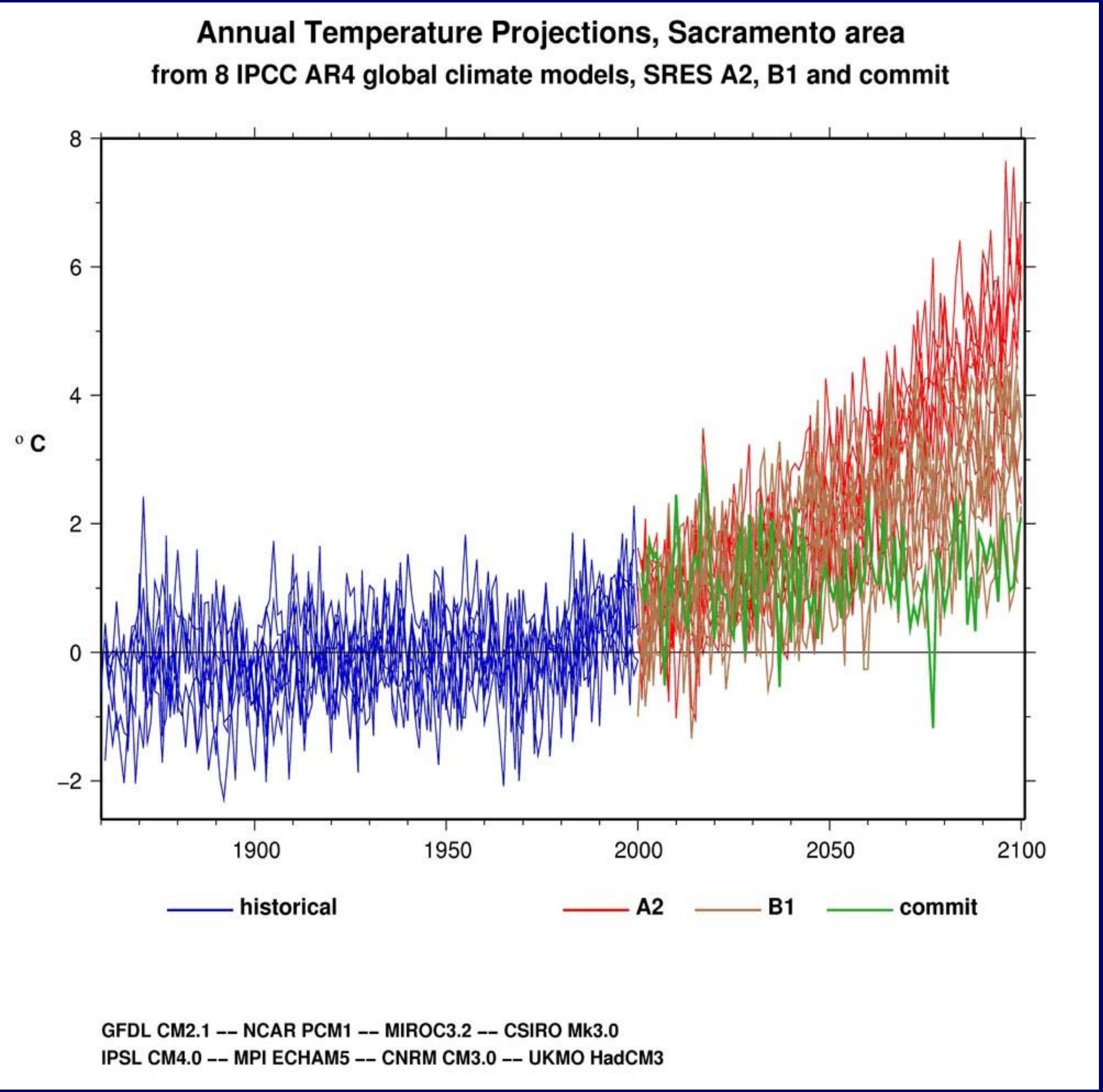

CLIMATE CHANGE & SEA LEVEL
WATERSHED
Hydrology-BDWM, RST;
Operations-CALSIM II
SF BAY
U-P daily water quality model
DELTA
TRIM hydrodynamics, temperature/salinity, phytoplankton
SEDIMENTATION/ GEOMORPOLOGY
ROMS, Delft 3D
CONTAMINANTS
DYMBAM
INVASIVE SPECIES
STELLA,
statistical models
FISH
Life-history models

Well established trends in average sea level rise along the West Coast

Historical tide gage observations of mean sea level at San Francisco Seattle and San Diego exhibit secular increase of ~2cm/decade

This is consistent with estimates of global sea level rise





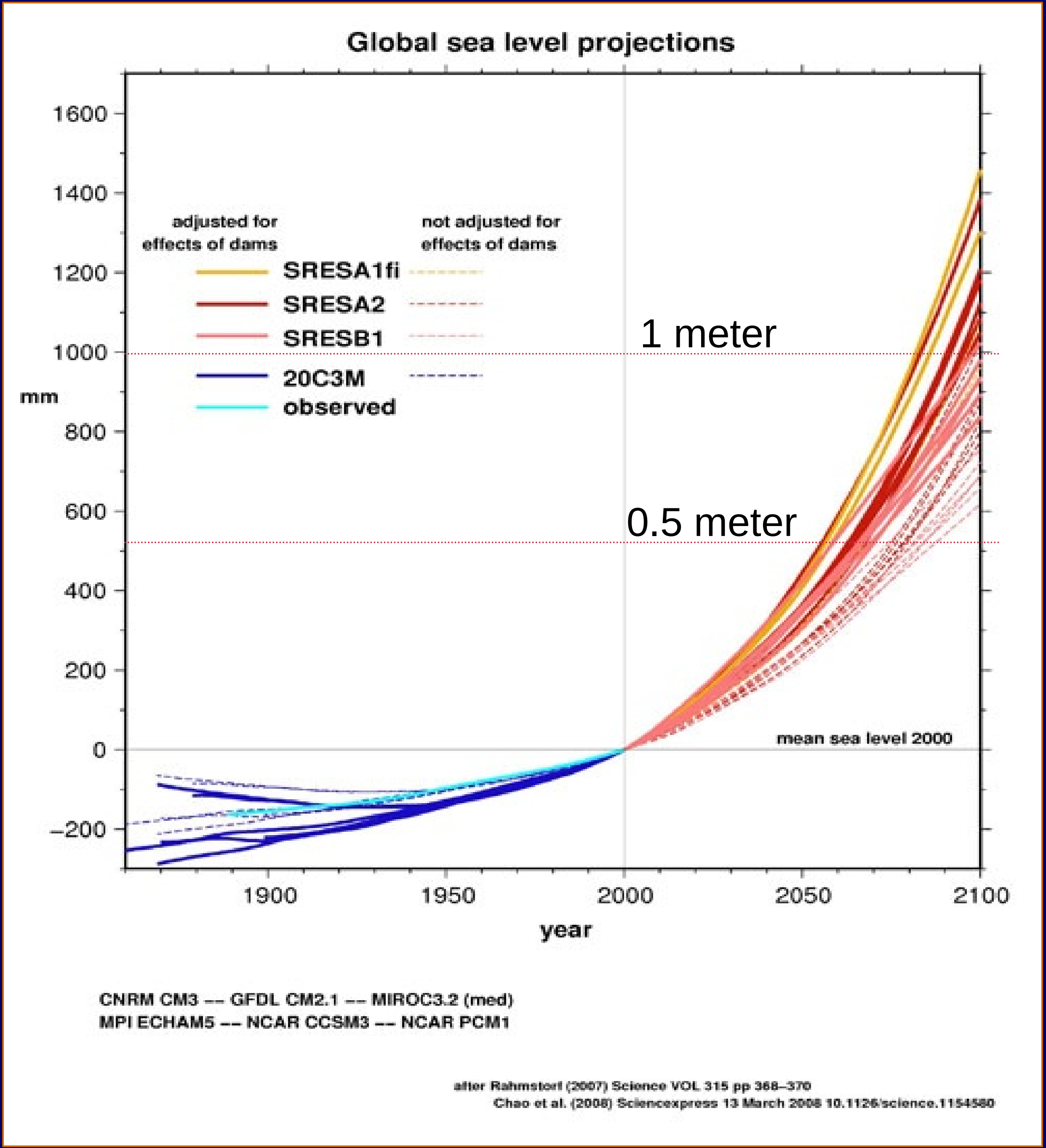
regional and global surface temperatures rise markedly

This impacts Sea level rise

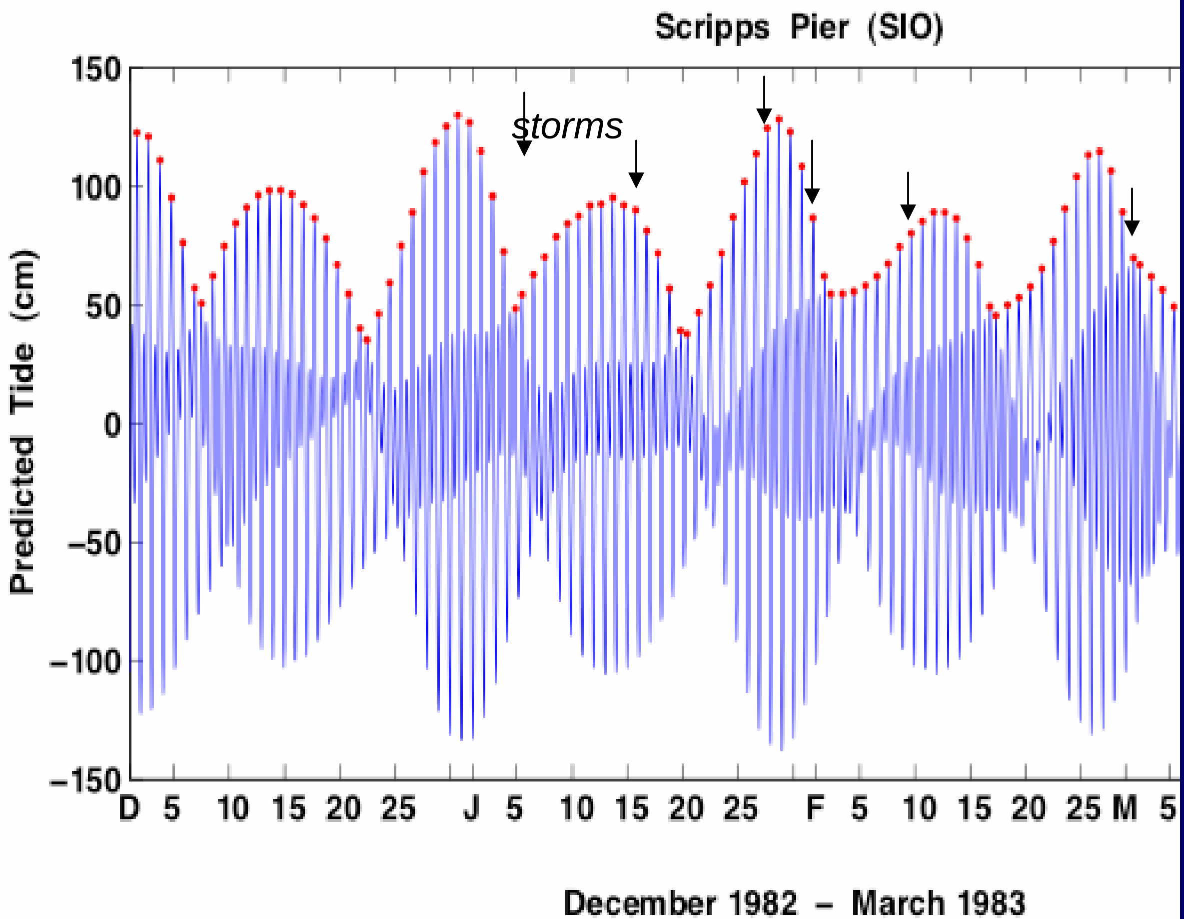
Projected sea levels

from B1 and A2 emission scenarios using Rahmstorf (2007) scheme for each of the three models. Both the original Rahmstorf (dashed curves) and a version adjusted for the affect of reservoirs and dams (solid) are shown.

Historical (blue) and projected simulations (red shades) are shown along with observed global sea level (aqua).



Coincidence of storms and high tides in Winter 1983 -- heavy coastal damage



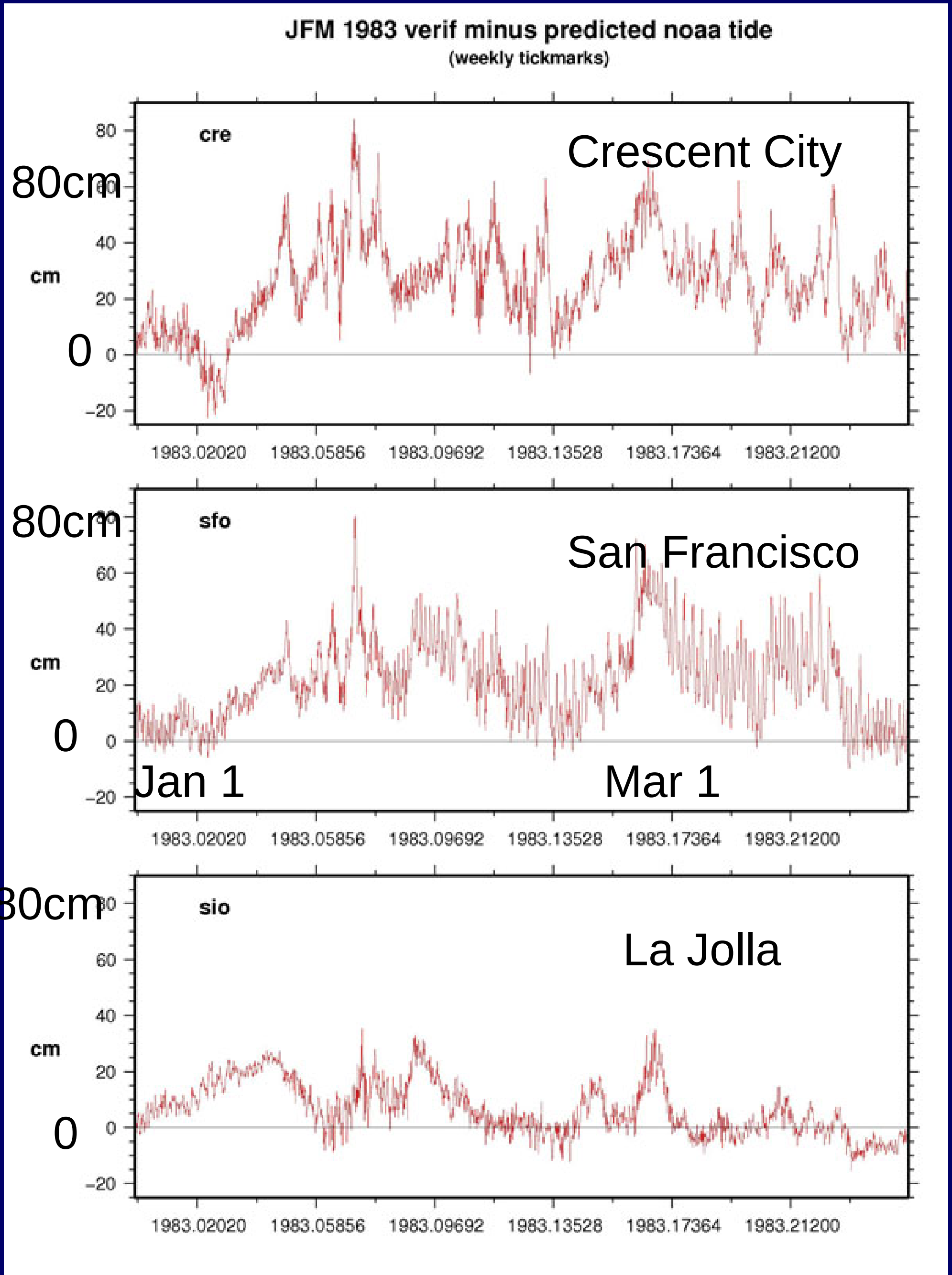
High tide levels vary by about 1 m

Highest storm-forced level = 28 cm

Two high tides and two low daily tides, unequal in amplitude.

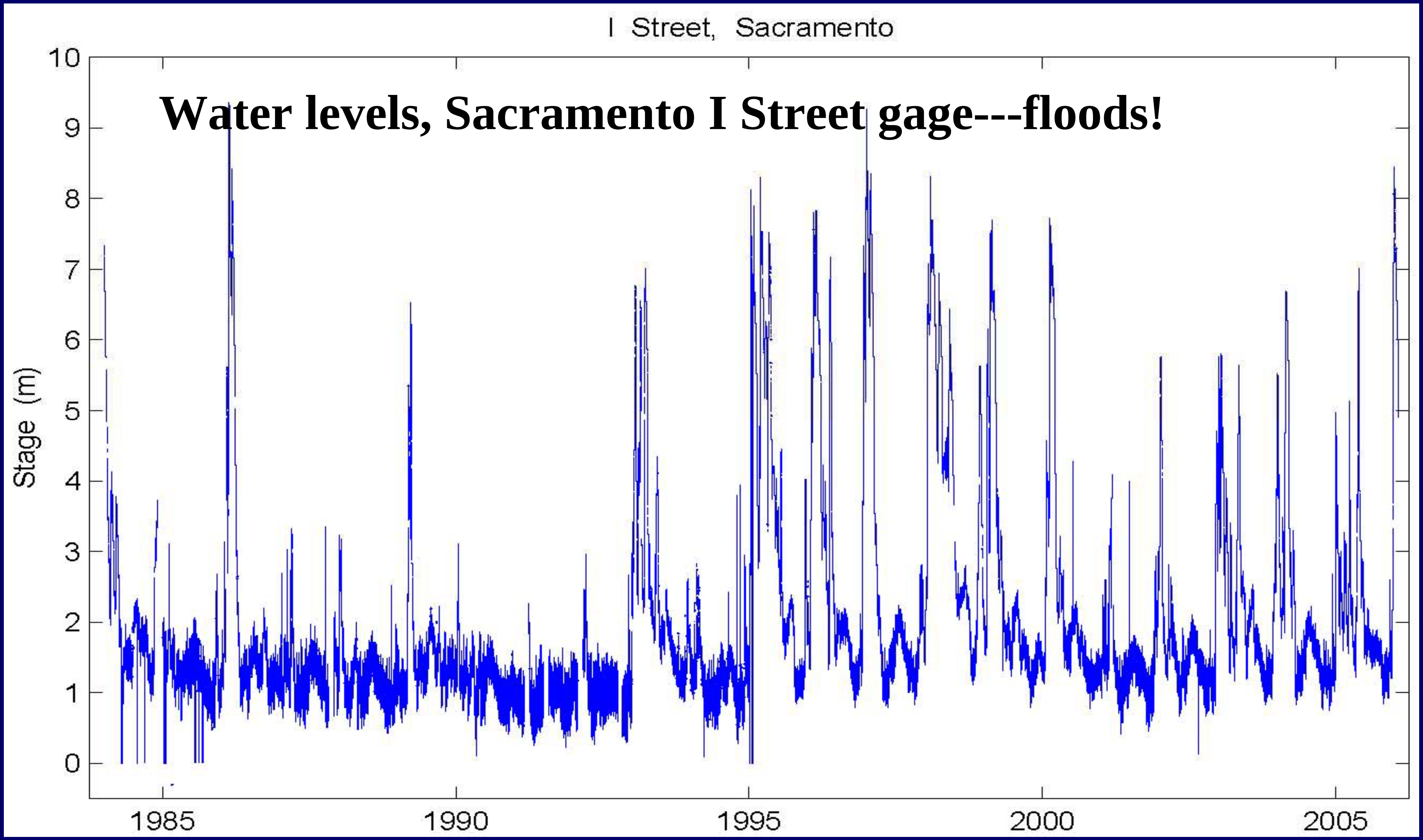
Monthly tidal changes dominated by spring-neap cycle, with two periods of relatively high tides (springs) around full and new moon. One spring tide range per month is usually higher than the other on this coast.

The highest monthly tides in the winter and summer months are higher than those in the spring and fall as a result of lunar and solar declination effects.



El Nino winters
with North Pacific storms
produce large, persistent
sea level excesses

Plots show anomalous
hourly sea level, formed
by removing tide prediction
during Jan-Mar 1983

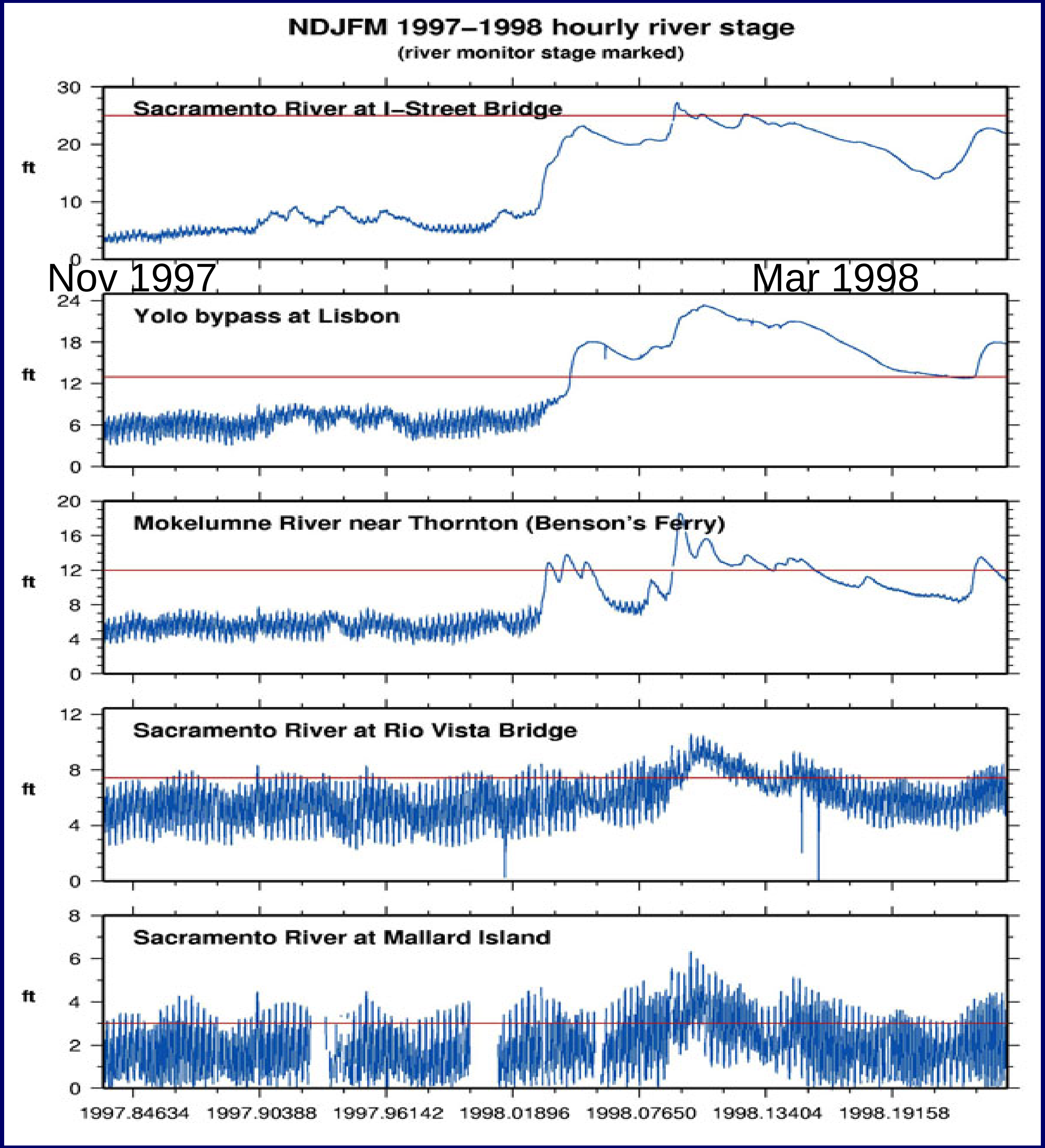


Sacramento River water level is dominated by floods

Sacramento peak flows during the New Years 1997 storm were almost as large as the 1993 Mississippi peak flood flows

Orographic precipitation in Sierra Nevada:

Dettinger, M.D., et al. 2004: Winter orographic-precipitation ratios in the Sierra Nevada – large-scale atmospheric circulations and hydrologic consequences. *J. Hydrometeorology*. **5**(6), 1102–1116.



Winter 1997-98

competition between fresh water inflow and ocean tides

GFDL climate projections (delineated by ▌) are moderate-dry during mid-late century

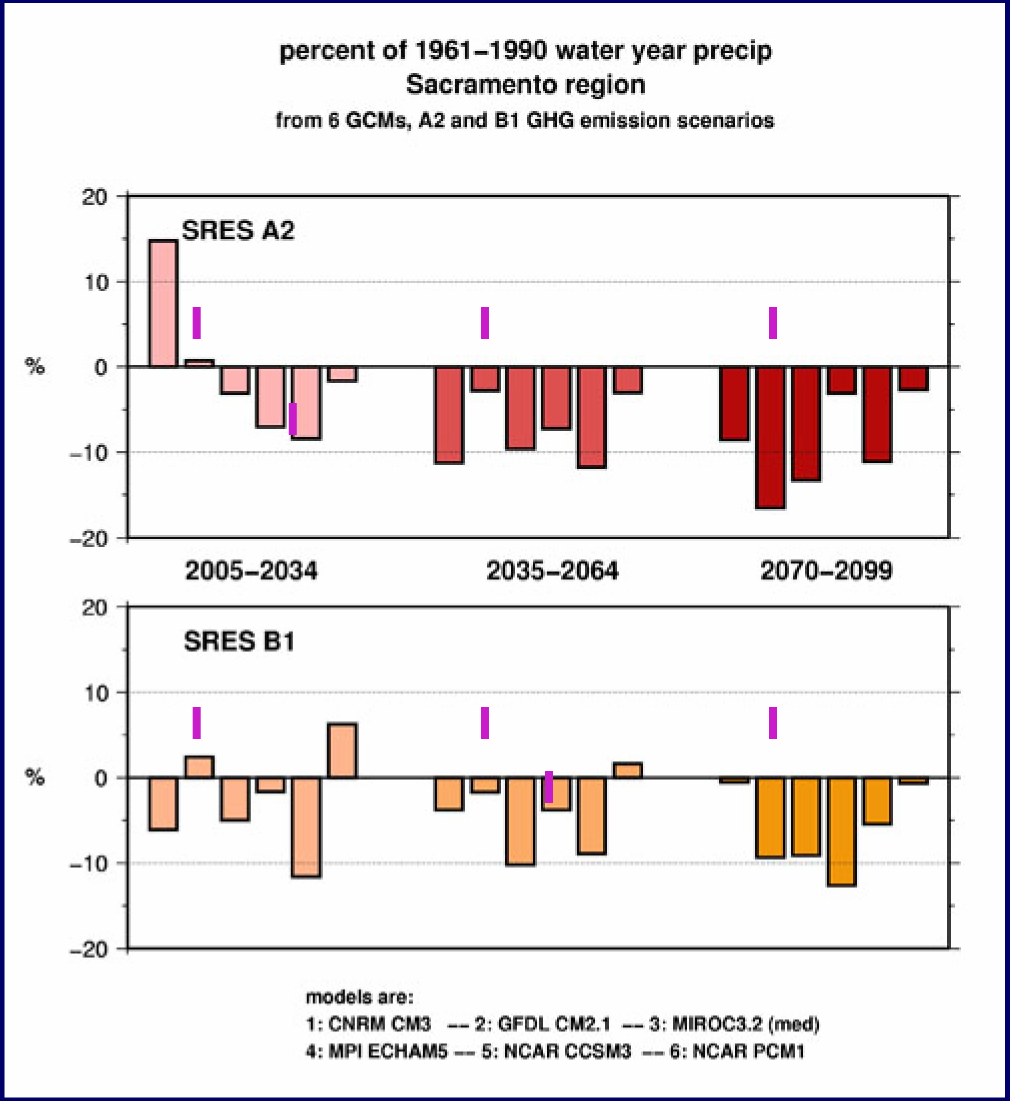
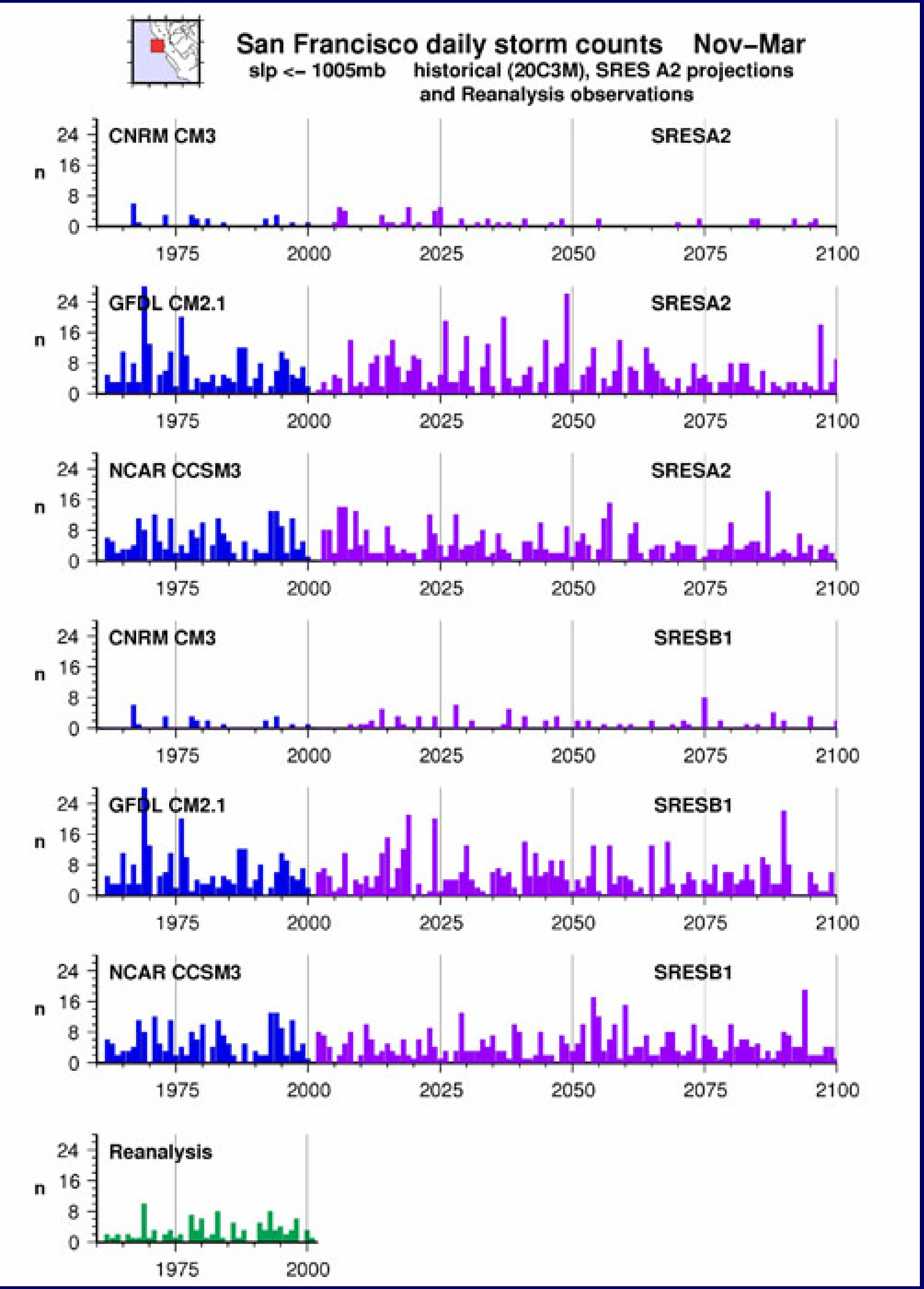
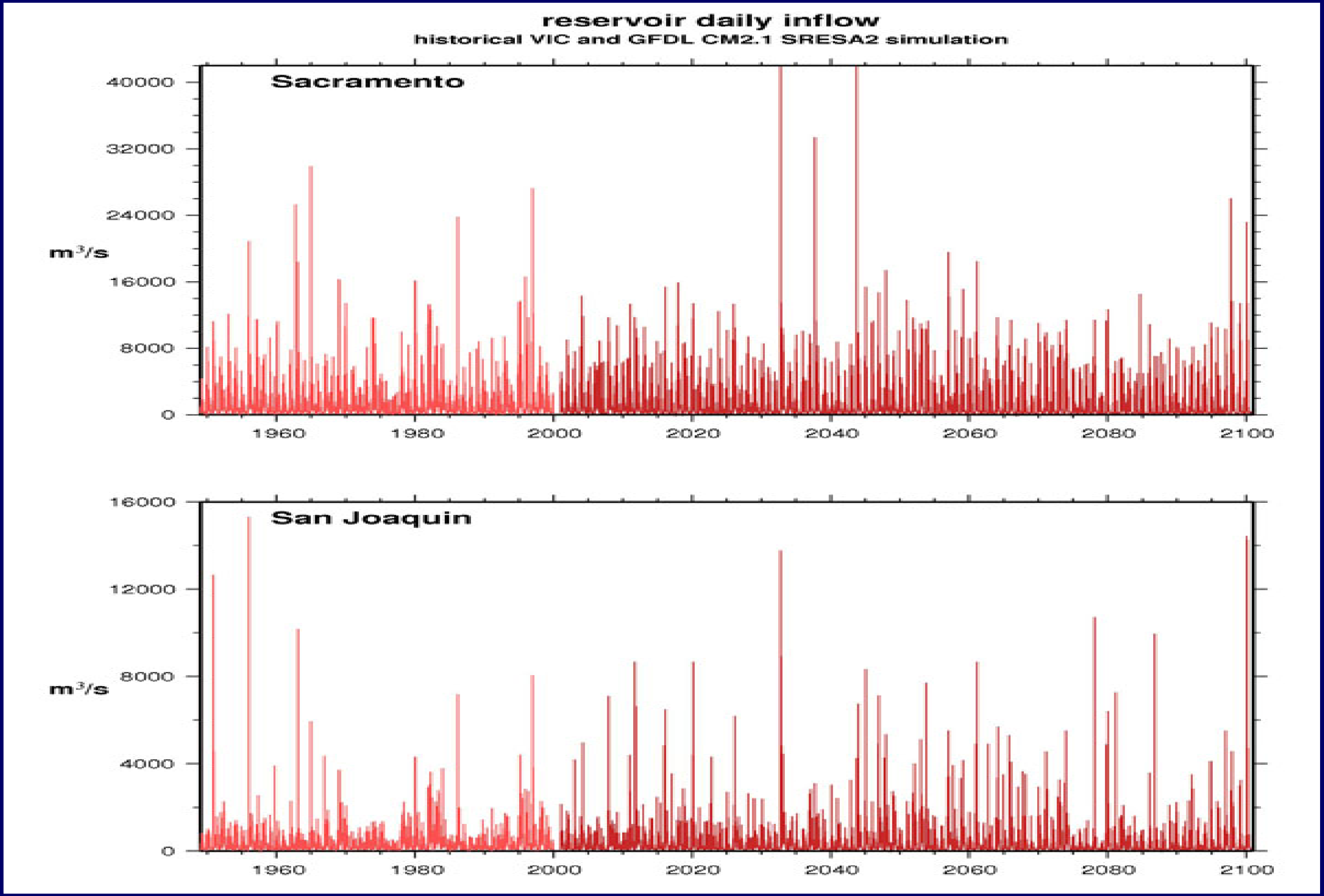


Fig 11

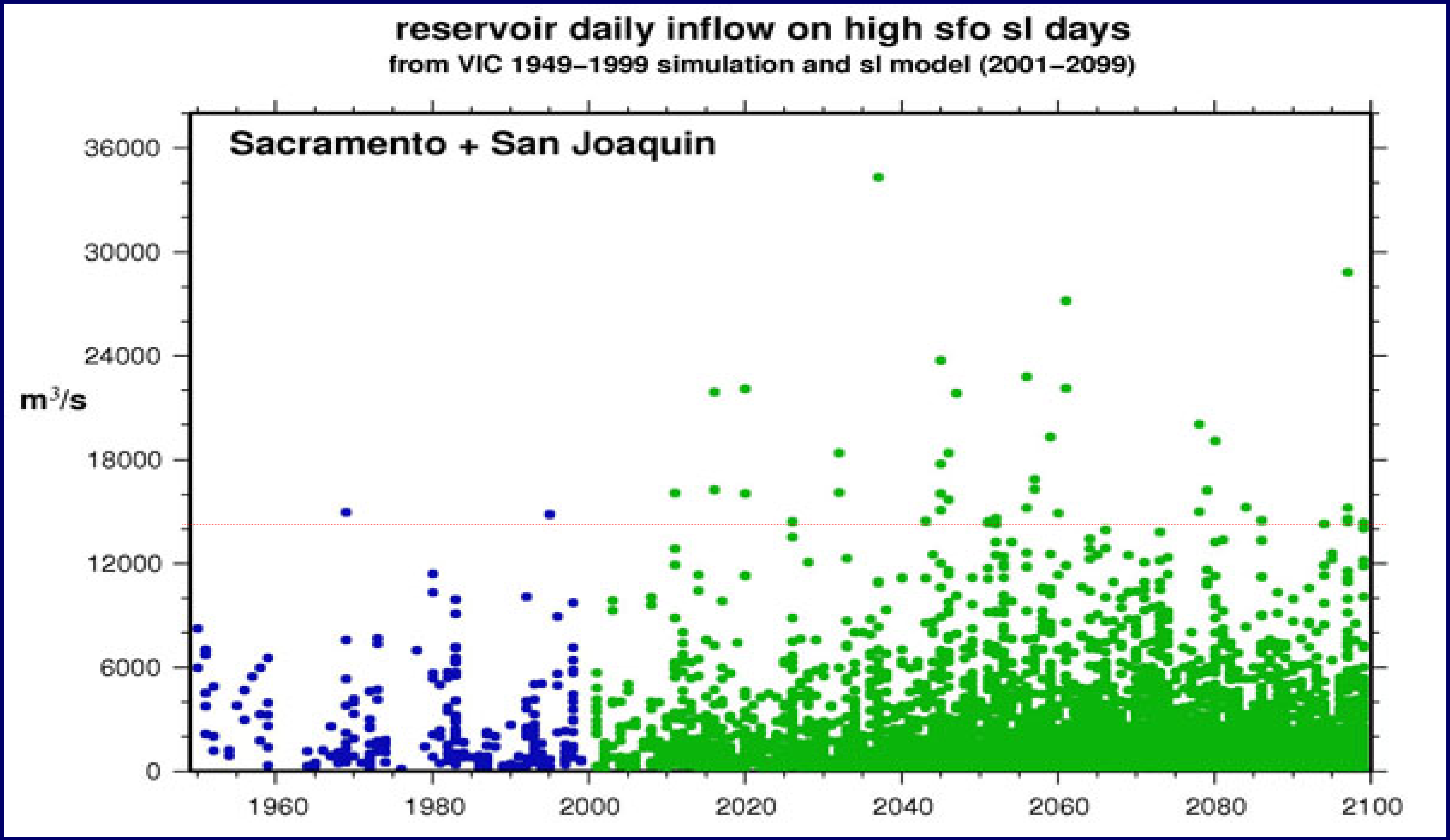
storminess fluctuates
but
not much overall change





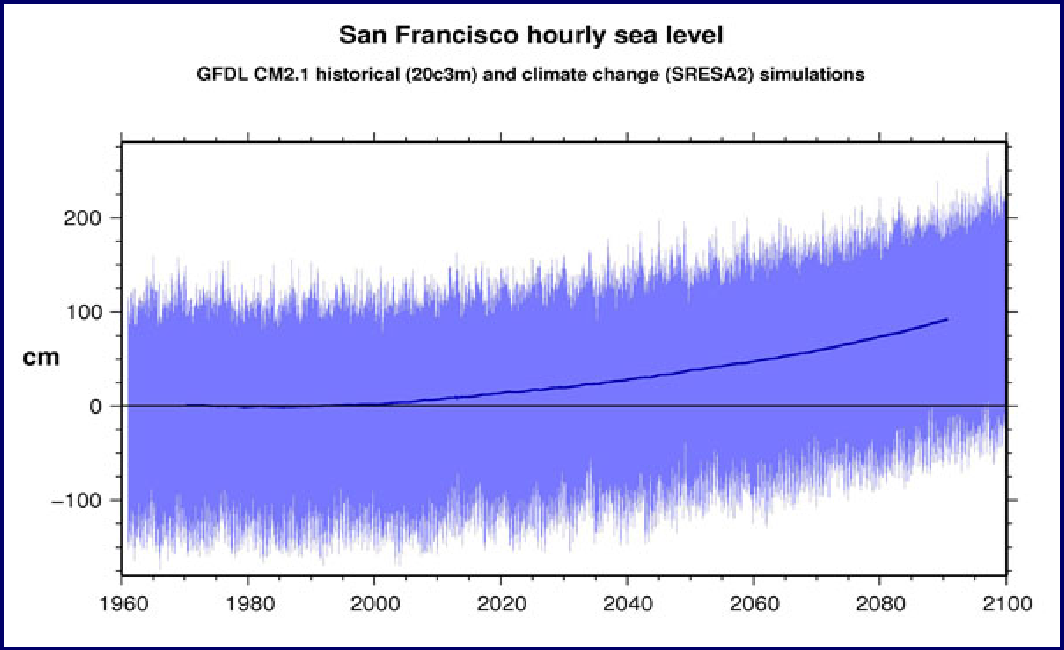
Daily unimpaired flows Sacramento and San Joaquin Rivers
from Sacramento/San Joaquin watershed model
Historical is driven by VIC obs ppt and temp, Projected from GFDL GCM

Noah Knowles



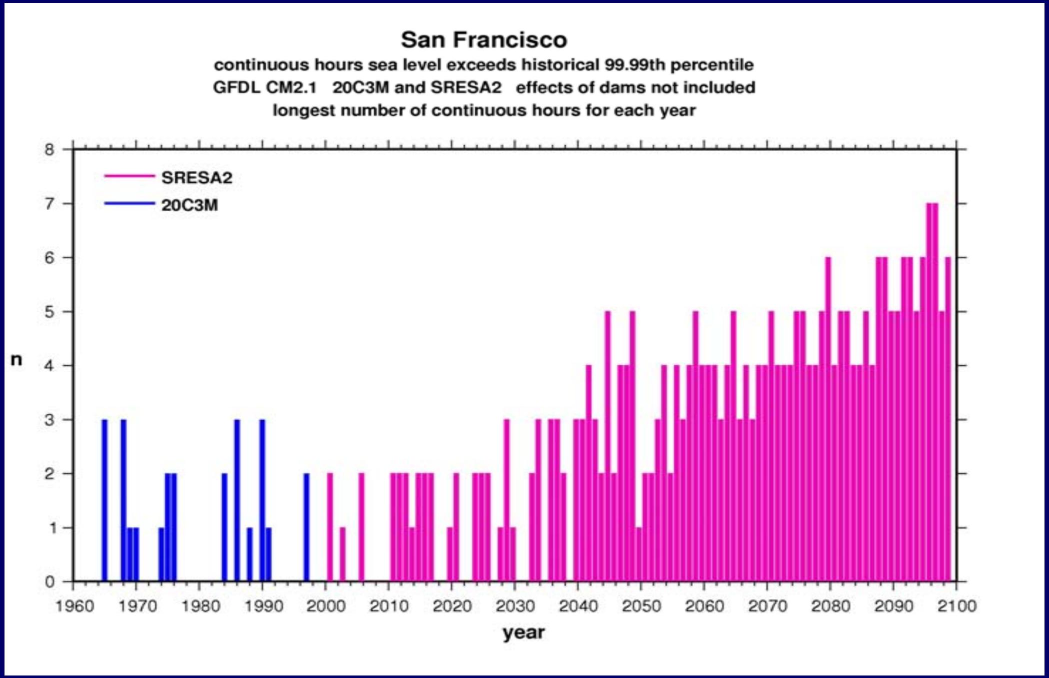
Sacramento+San Joaquin Flows during High San Francisco Sea Levels simulated by Bay watershed model driven by GFDL A2 simulation

marked increase in number and intensity



Projected sea level San Francisco

Under projected global warming, such as in the GFDL A2 simulation sea level rises considerably by 2100, in this scenario by approximately 0.9m.

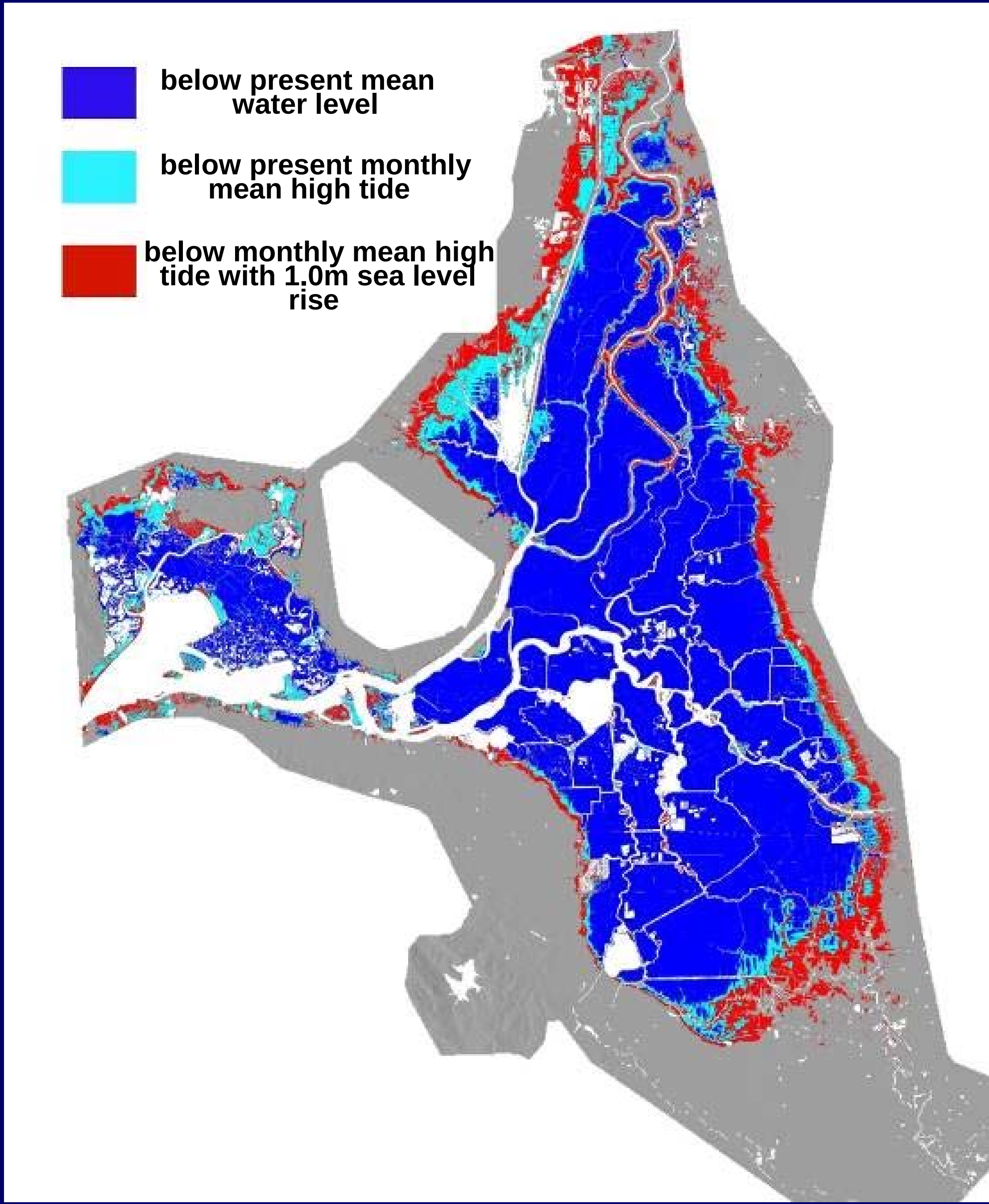


At San Francisco high sea level events, exceeding high threshhold occur increasingly often and persist for longer durations.

Sacramento-San Joaquin Delta

About 300 km^2 newly at risk of monthly inundation under a 1.0 m sea level rise are shown in red.

Most of these areas are currently protected by levees. They would be inundated only if those levees fail or are overtopped.



SUMMARY:

Climate warming projections, combined with recent global sea level rise estimates suggest increases in California open Coast sea levels of 0.5m to more than 1m by 2100.

Weather, short period climate (e.g. ENSO) and tides will continue to accentuate water level-related impacts.

Although some model simulations yield drier conditions in California over the next century, large storms continue to occur at about historical recurrence intervals.

Duration and amplitude of sea level extremes increases

In future decades, Sierra floods would be more active as larger portions of mountain catchments are likely to produce rainfall runoff instead of snowpack.

Events having high open coast sea levels and large fresh water flows into Delta and Bay increase considerably.