



Hydrologic Changes in the Western U.S. from 1916-2003

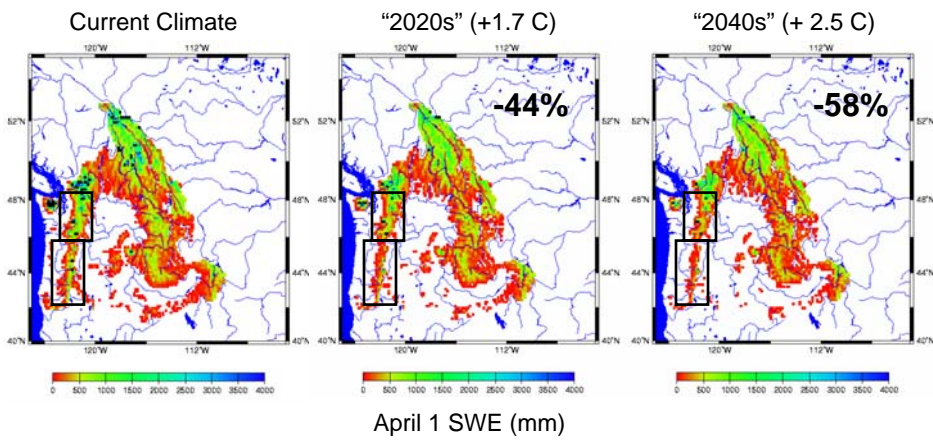
Center for Science in the Earth System
Climate Impacts Group
and Department of Civil and Environmental Engineering
University of Washington

Feb, 2005

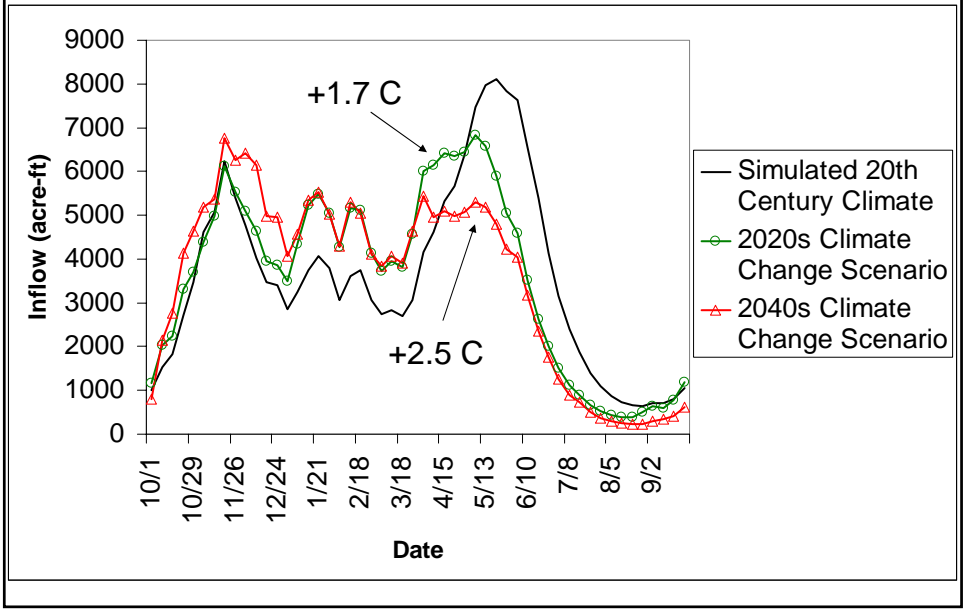
http://www.hydro.washington.edu/Lettenmaier/Presentations/2005/hamlet_cws_feb_2005.ppt

Alan F. Hamlet Philip W. Mote
Martyn Clark
Dennis P. Lettenmaier

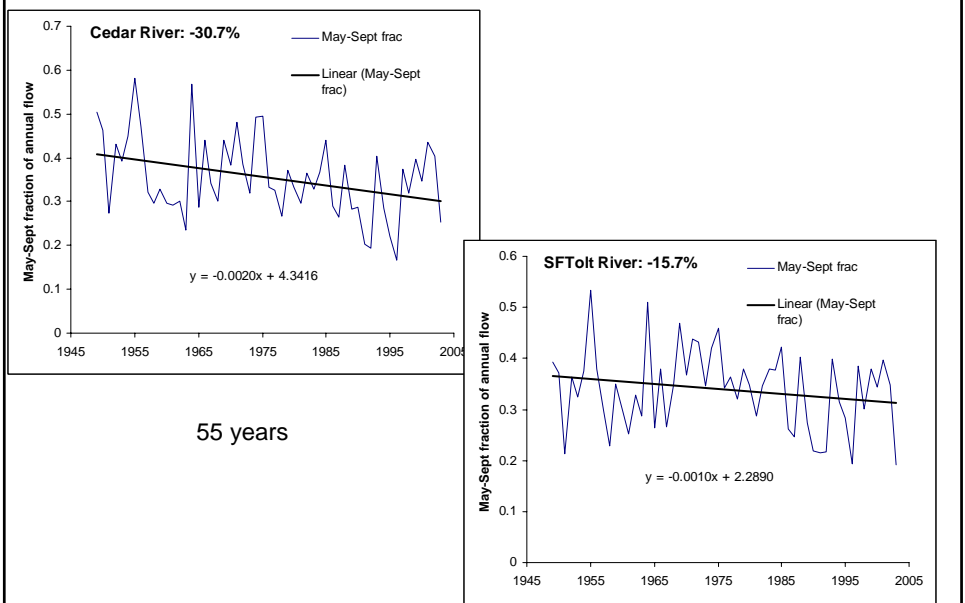
Changes in Simulated April 1 Snowpack for the Cascade Range in Washington and Oregon



Effects to the Cedar River (Seattle Water Supply) for "Middle-of-the-Road" Scenarios



Obs. Summer Water Availability is Declining

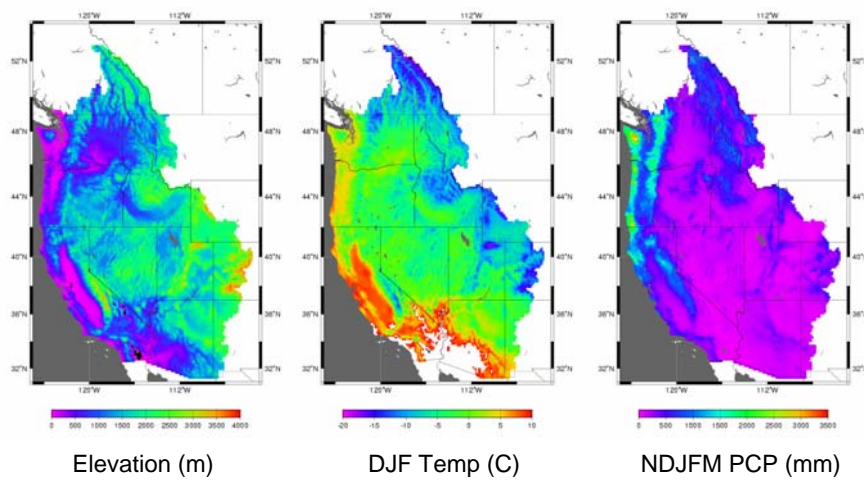


55 years

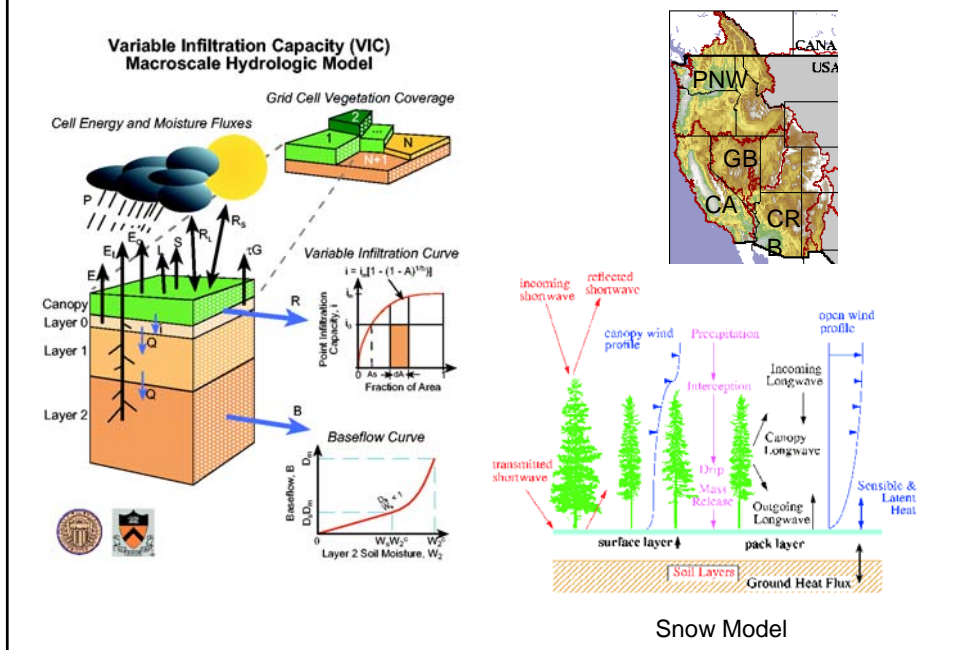
Figures courtesy of Matt Wiley and Richard Palmer at CEE, UW

Observed Climate Change and Hydrologic Impacts for the West

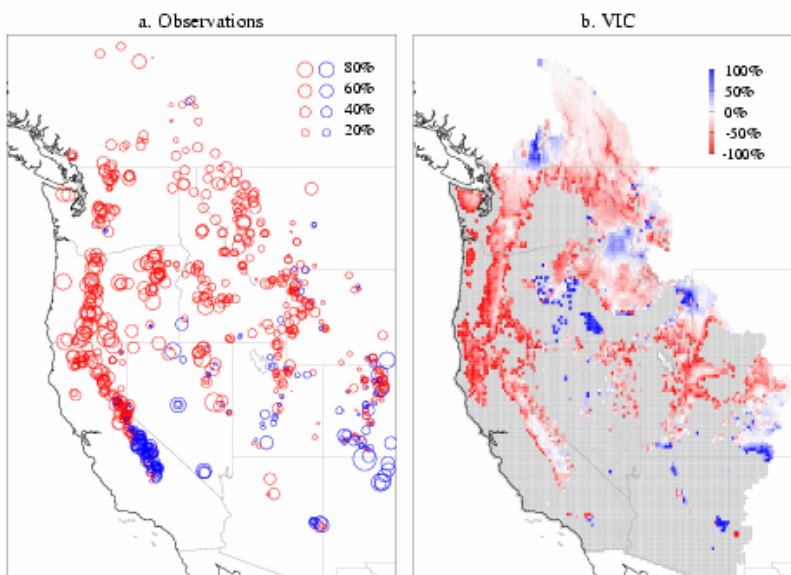
Physical Characteristics of the Mountain West



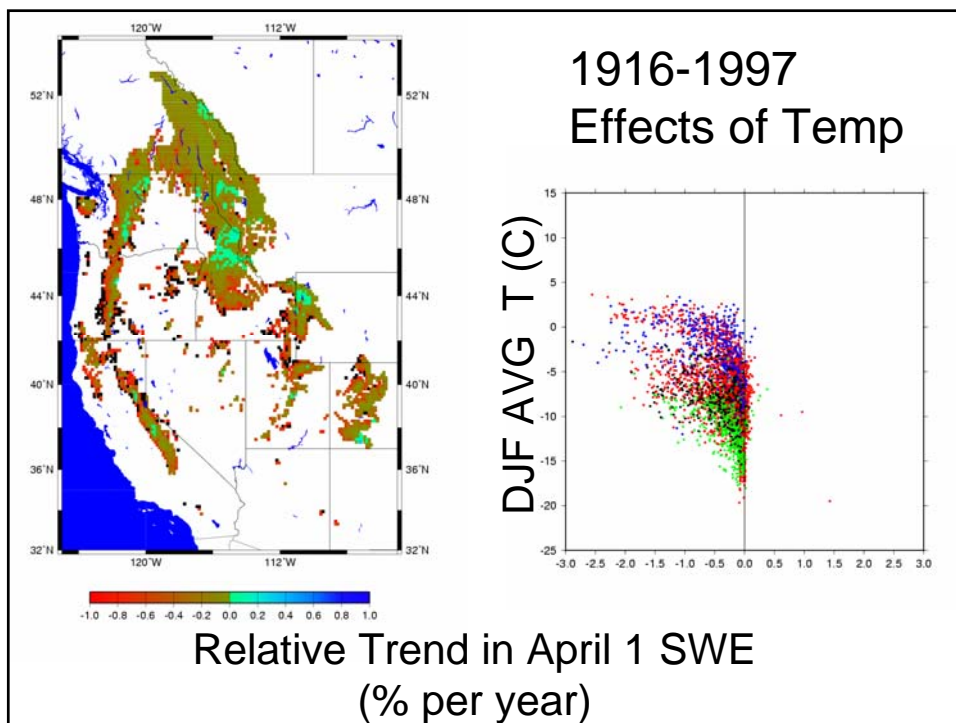
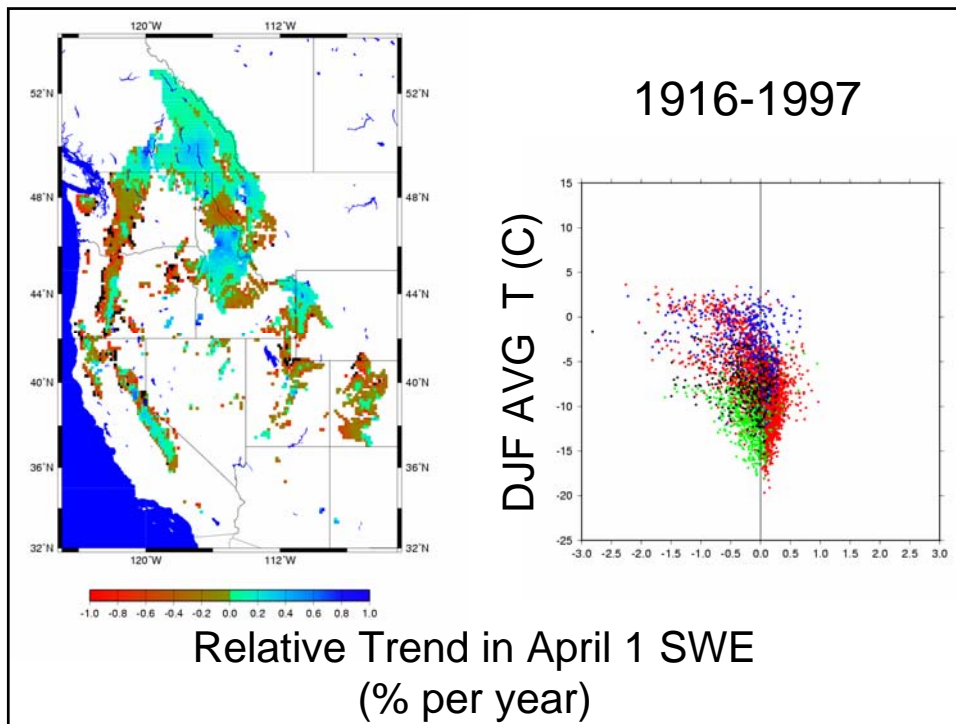
Schematic of VIC Hydrologic Model and Energy Balance Snow Model

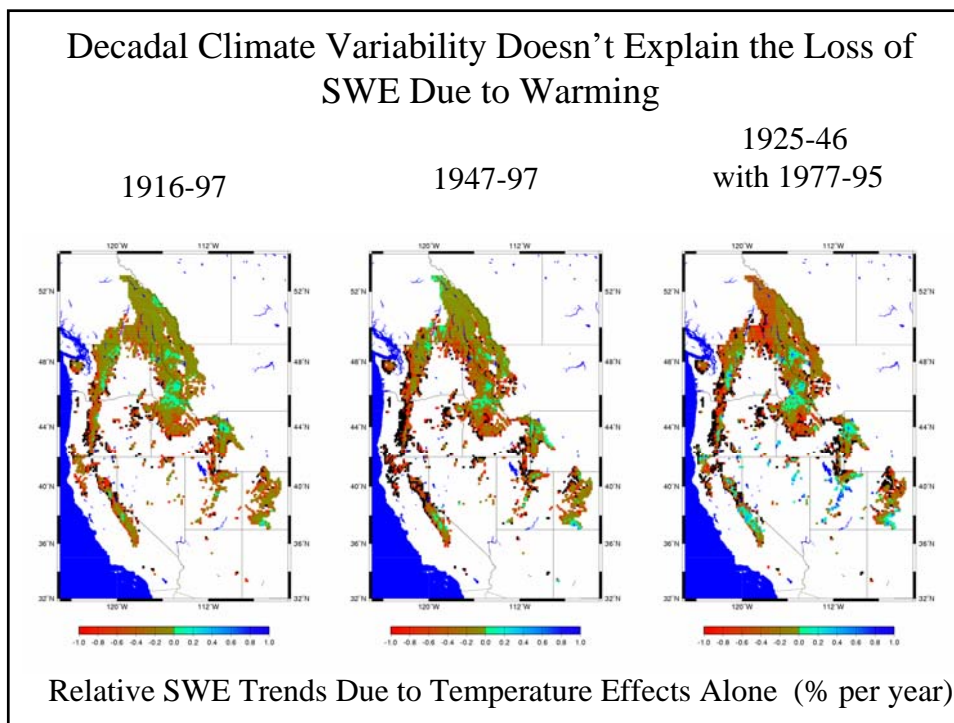
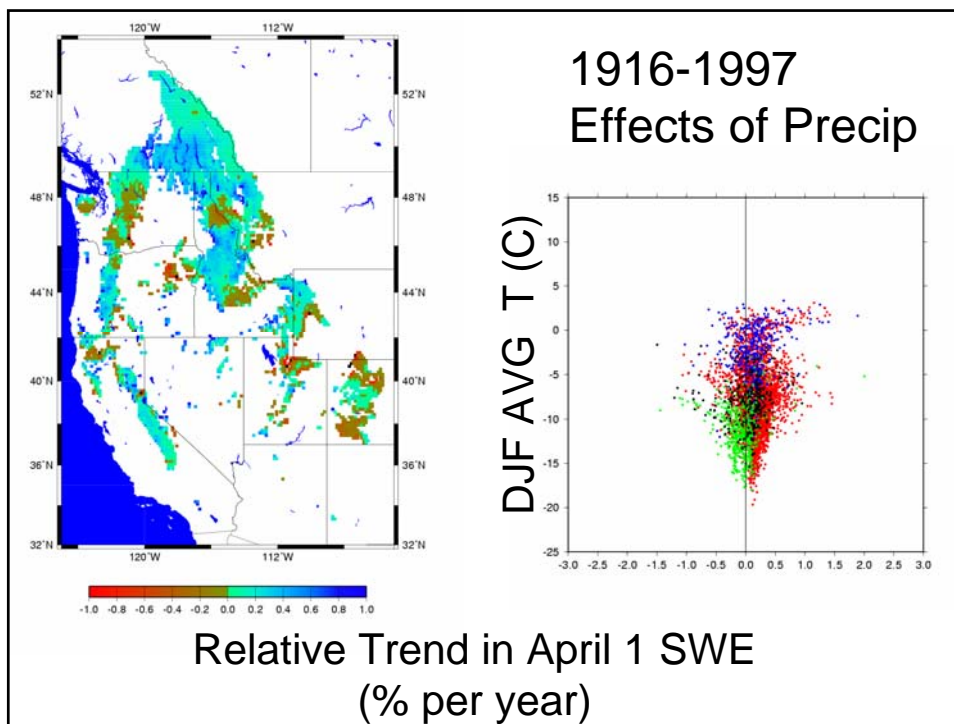


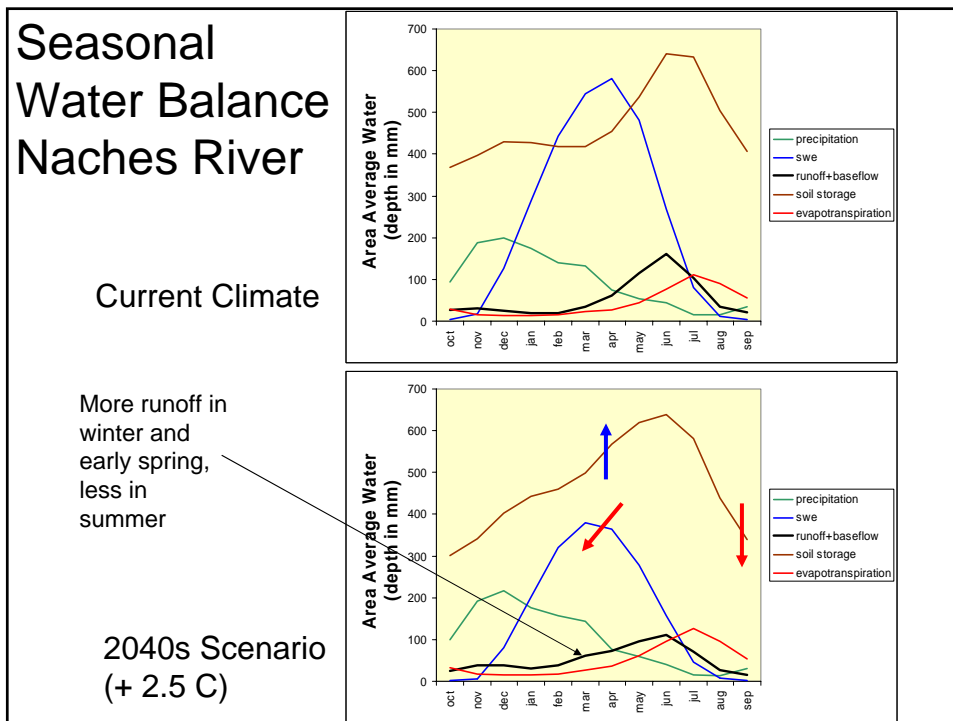
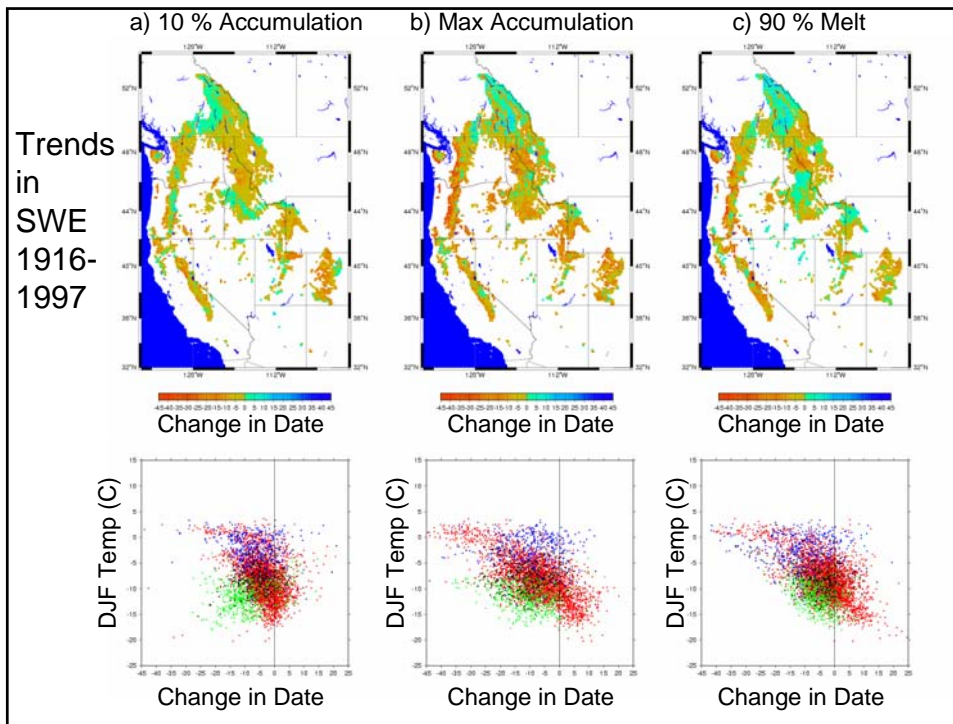
Trends in April 1 SWE 1950-1997

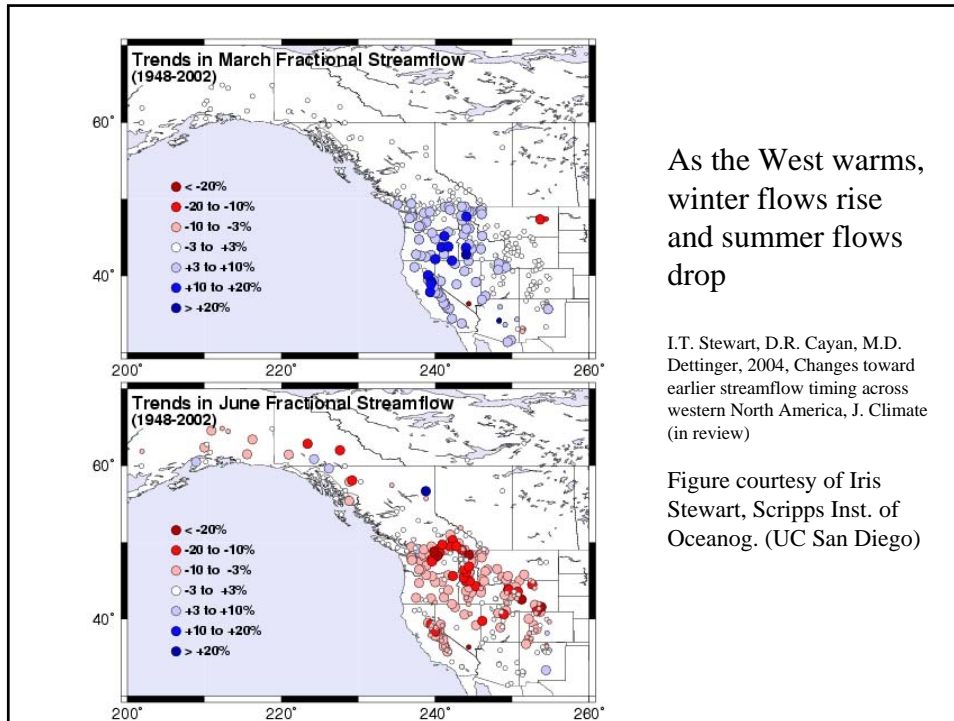


Source: Mote et al. (2005)





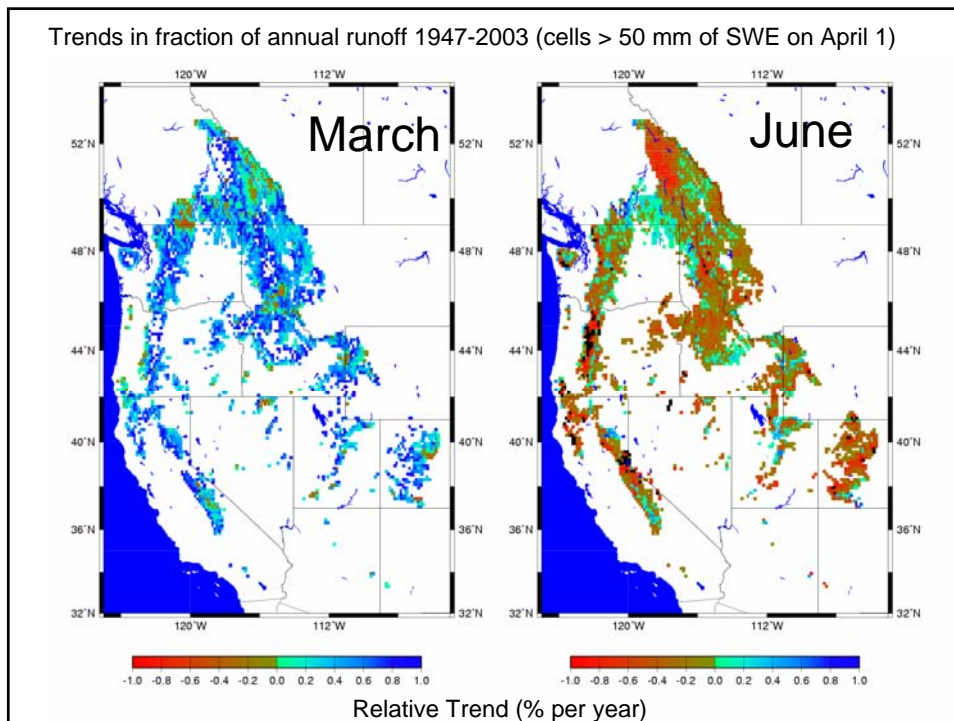


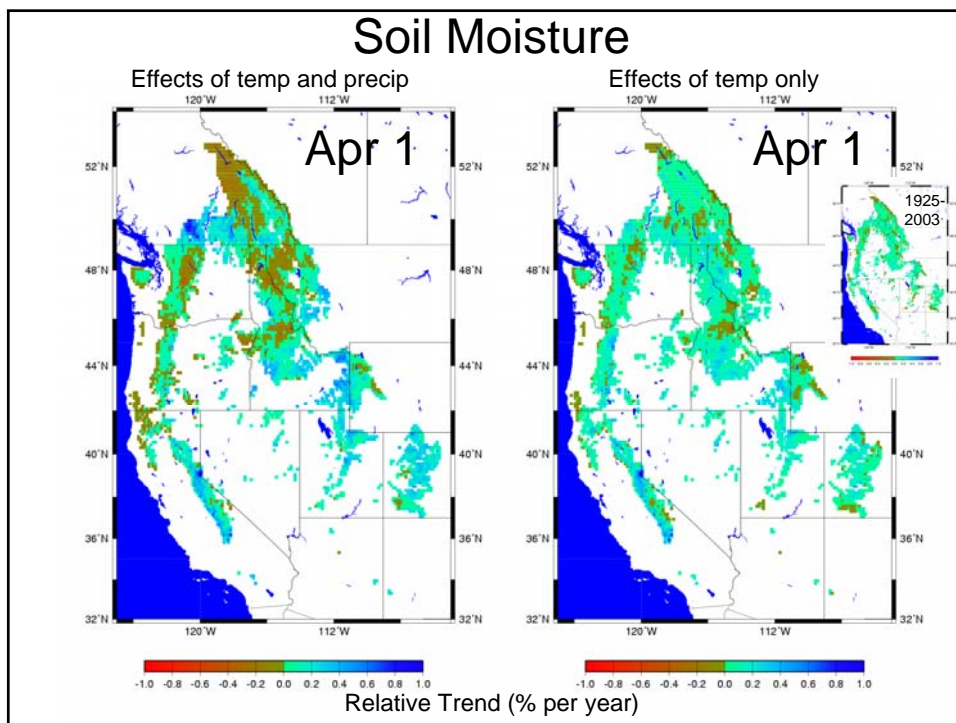
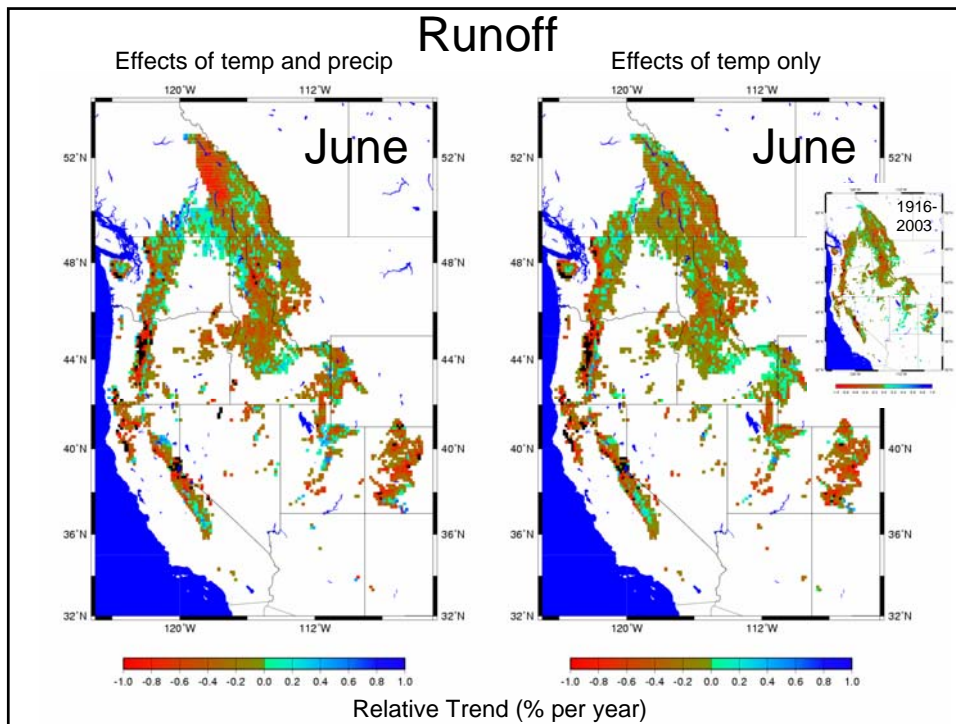


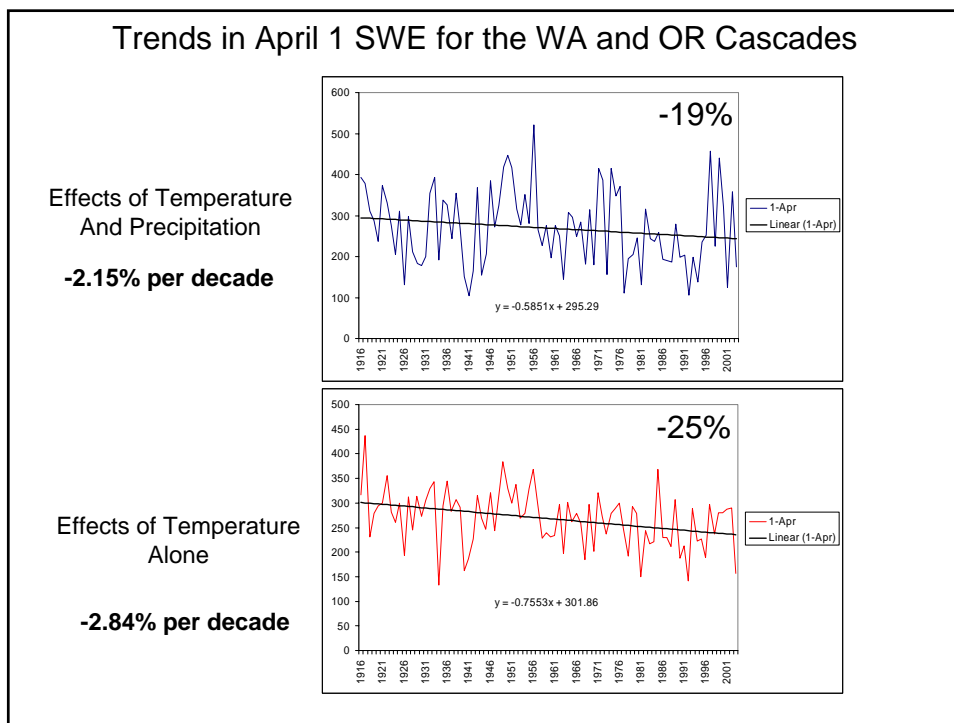
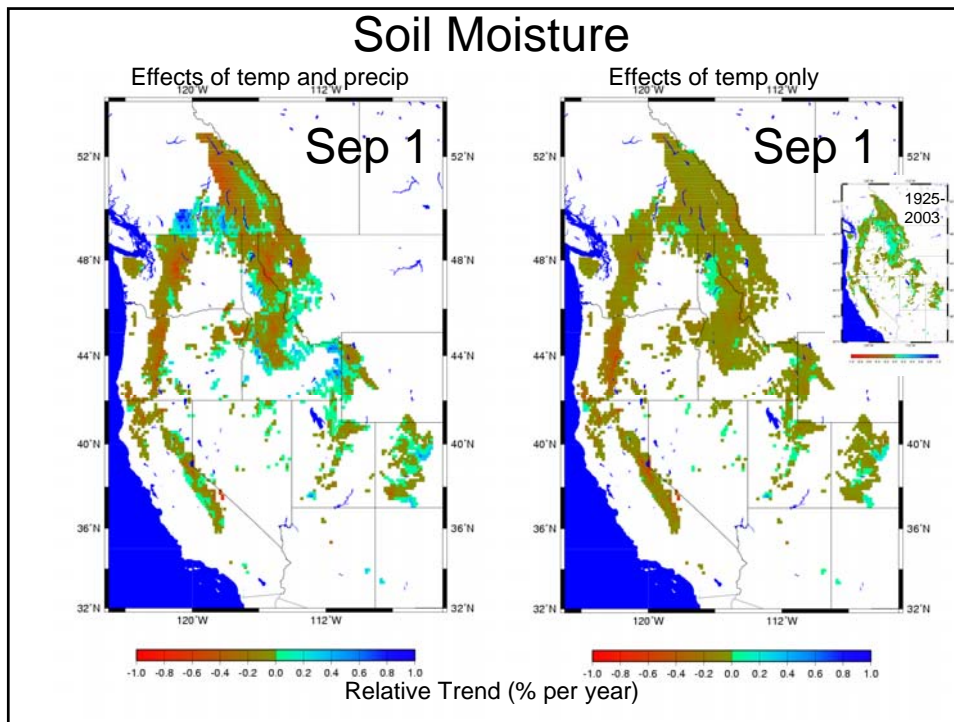
As the West warms,
winter flows rise
and summer flows
drop

I.T. Stewart, D.R. Cayan, M.D. Dettinger, 2004, Changes toward earlier streamflow timing across western North America, *J. Climate* (in review)

Figure courtesy of Iris Stewart, Scripps Inst. of Oceanog. (UC San Diego)



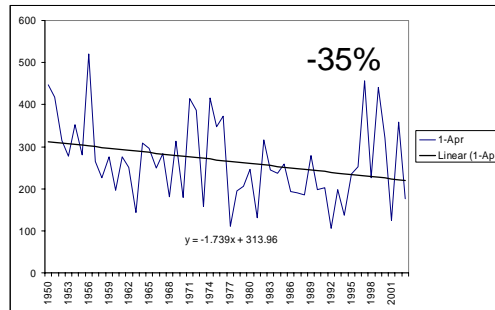




Trends in April 1 SWE for the WA and OR Cascades

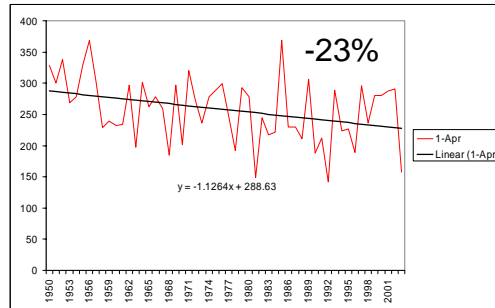
Effects of Temperature
And Precipitation

-6.48% per decade



Effects of Temperature
Alone

-4.25% per decade



Conclusions

- Large-scale changes in the seasonal dynamics of snow accumulation and melt have occurred in the West as a result of increasing regional temperatures.
- The most sensitive areas are coastal mountain ranges with relatively warm winter temperatures (e.g. the Cascades)
- Hydrologic changes include earlier and reduced peak snowpack, more runoff in March, less runoff in June, and corresponding increases in simulated spring soil moisture and decreases in late summer and fall soil moisture.
- Because these effects are shown to be predominantly due to temperature changes, we expect that they will both continue and increase in intensity as global warming progresses in the 21st century.