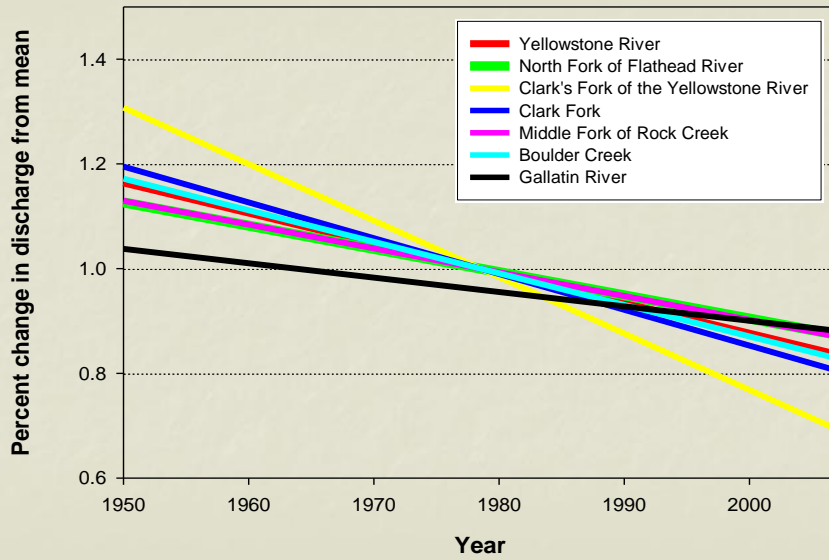


Montana Mean August stream Discharge 1950-2007

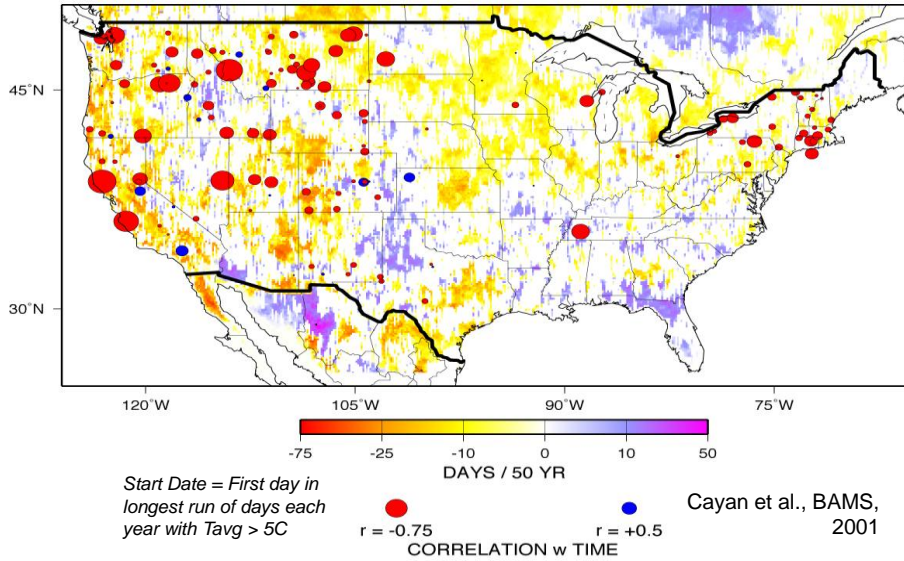


ECOSYSTEM RESPONSES

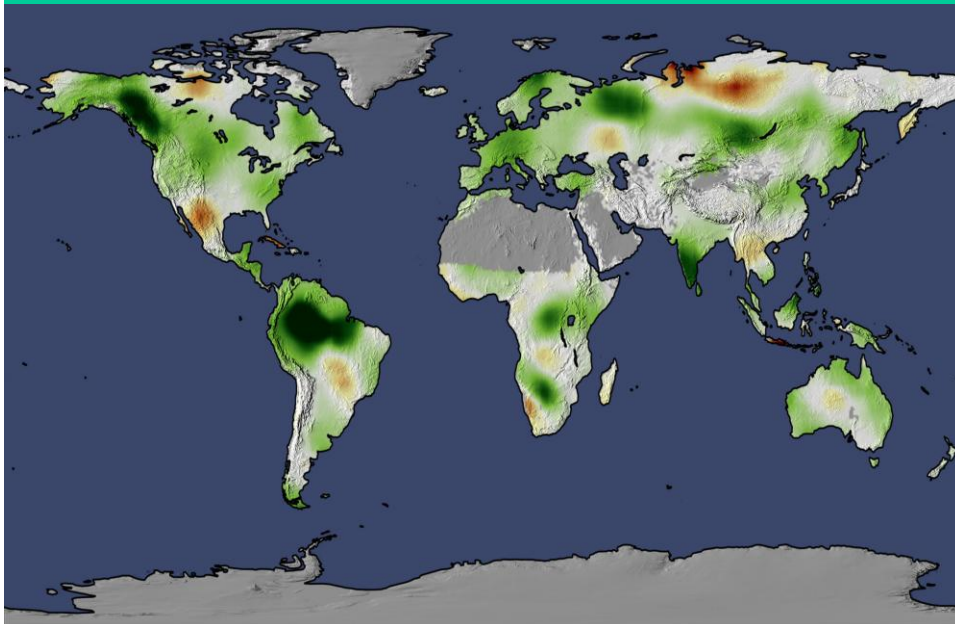


The warming has lengthened growing seasons and hastened green-up dates.

SHADES: TRENDS OF BEGIN DATE OF GROWING SEASON, 1950-99, FROM TEMPERATURES
DOTS: TRENDS IN LILAC FIRST-BLOOM DATES (Sites with 20+ yrs of record)



Change in Terrestrial NPP from 1982 to 1999.

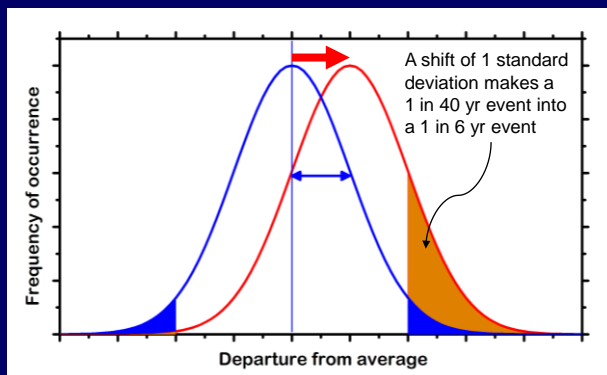


Nemani et al., Science June 6th 2003

Calculus of extremes

The distribution of weather events around the climatic average often follows a 'bell-shaped' curve.

Climate change can involve change in the average, or the spread around the average (standard deviation), or both.



A shift in the distribution of temperatures has a much larger relative effect at the extremes than near the mean.

IPCC - WGI

Missoula July 07 Records

- Hottest Temperature Ever – 107
- Warmest Night Ever – 71
- Average Temp – 78.1 – 11.2 F above average
 - Breaks the old record by 3.3F
- Most number of 100 F days – 11
 - Old record – 6 in 1936
- Most number of nights 60F and above – 18
 - Old record – 10 in 1985
- Driest July on record at Missoula Airport
 - 0.03” – old Airport record is 0.09”

From Gene Petrescu, NWS, Missoula

THIS WILL BE A NORMAL JULY IN 2050!!

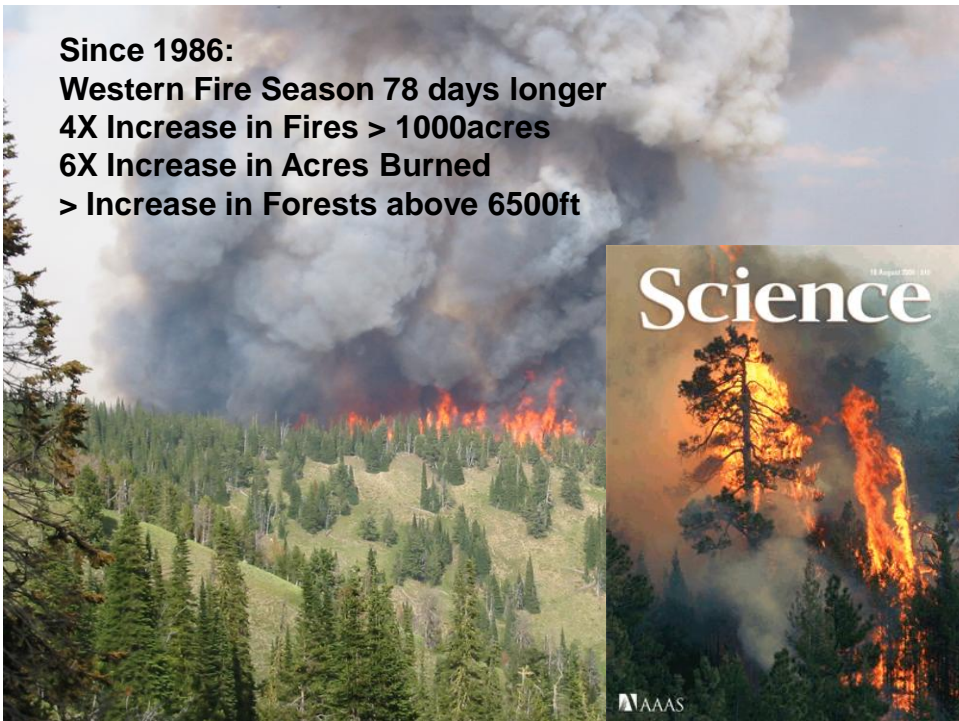
Space Shuttle picture of Montana Fires August 13, 2007



Livingston, MT

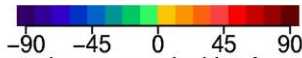
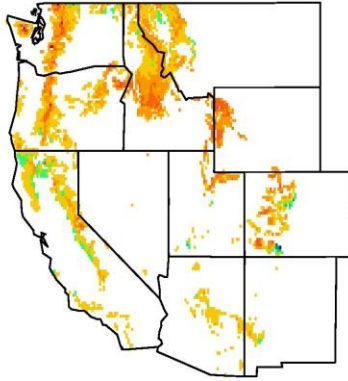


Since 1986:
Western Fire Season 78 days longer
4X Increase in Fires > 1000 acres
6X Increase in Acres Burned
> Increase in Forests above 6500ft



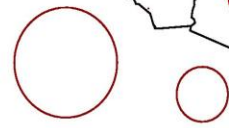
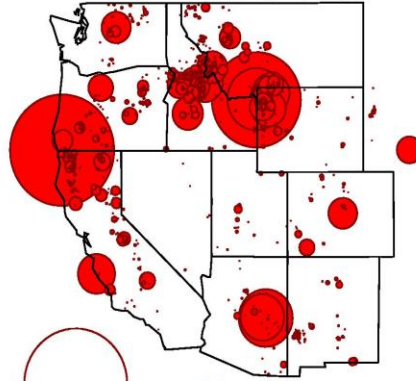
Wildfires accelerate 1970 – 2003 with early snowmelt, longer, drier summers

Change in Average Moisture Deficit
1987–2003 versus 1970–1986



percent change scaled by forest area

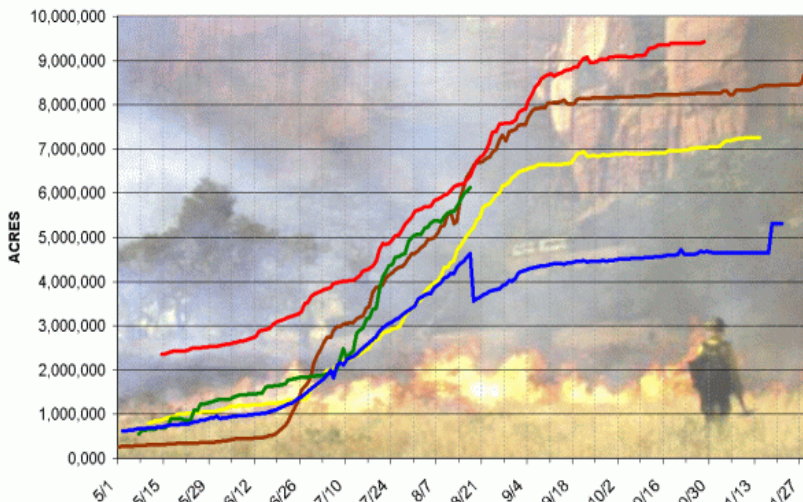
Large Forest Wildfires
in Years with Early Spring



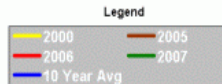
200,000 ha 100,000 ha

Westerling et al Science 2006, Running, Science 2006

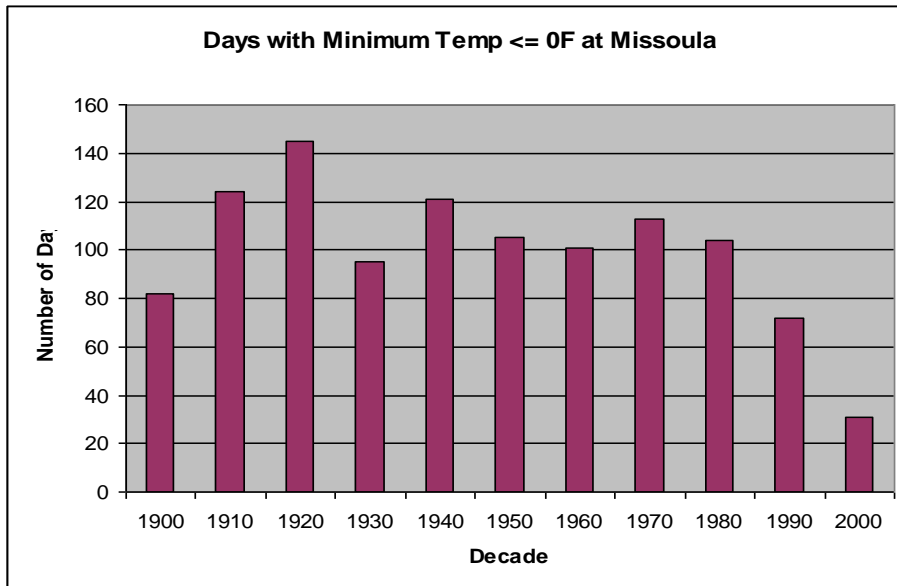
WILDLAND ACRES BURNED 2007



August 17, 2007



DAYS/Decade <0degF



From Gene Petrescu, NWS, Missoula

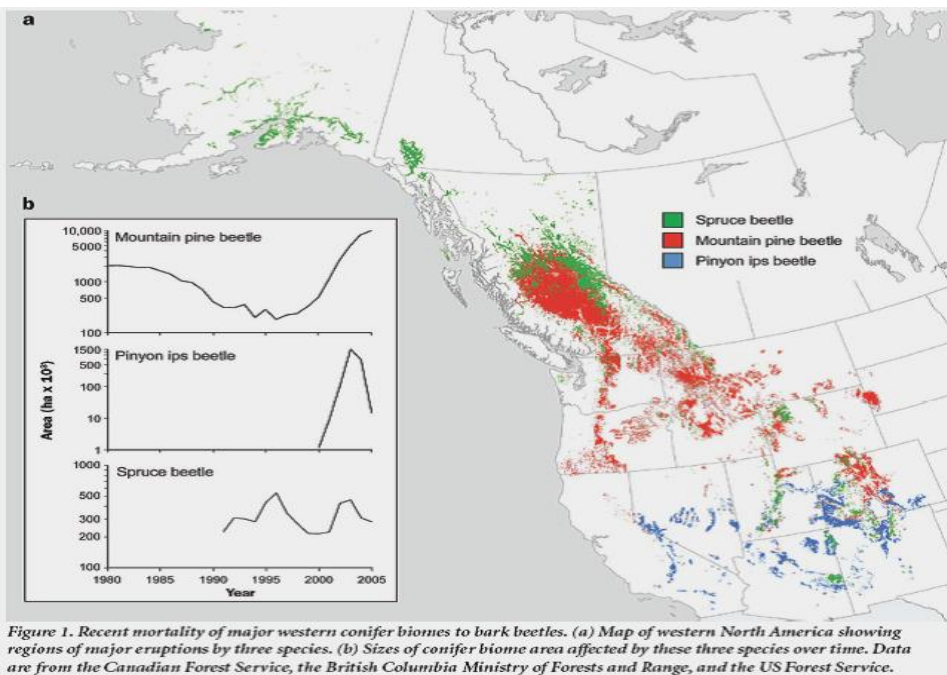
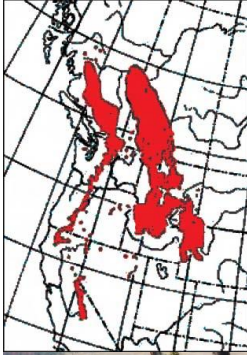


Figure 1. Recent mortality of major western conifer biomes to bark beetles. (a) Map of western North America showing regions of major eruptions by three species. (b) Sizes of conifer biome area affected by these three species over time. Data are from the Canadian Forest Service, the British Columbia Ministry of Forests and Range, and the US Forest Service.

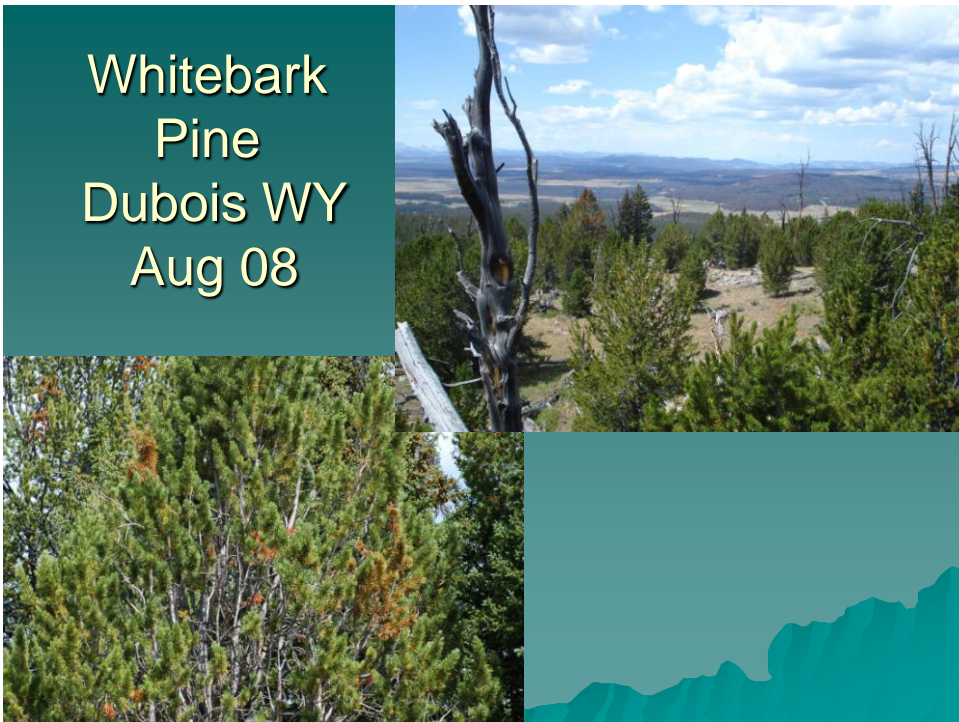
Raffa et al Bioscience 2008.

Union Pass, WY August 2008

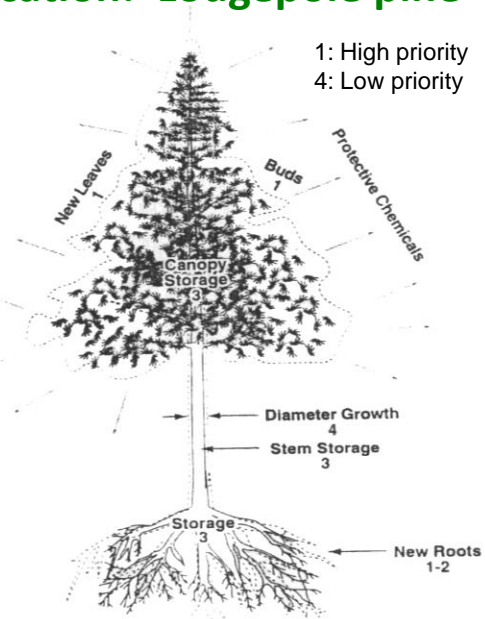
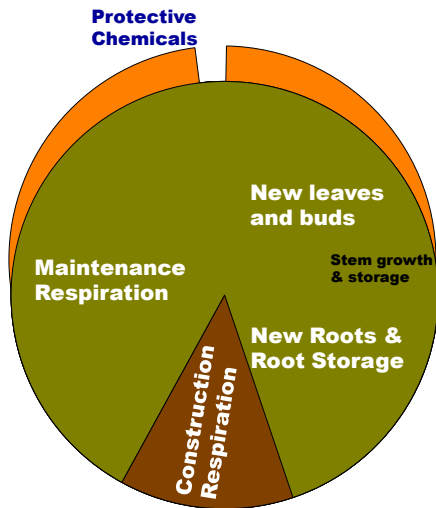


Photo, Diana Six

Whitebark
Pine
Dubois WY
Aug 08



Potential Carbon Allocation: Lodgepole pine



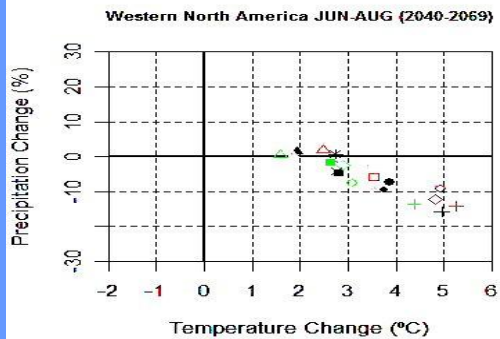
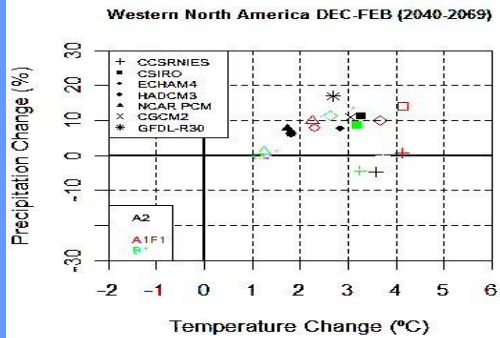
After Waring & Pitman, 1985

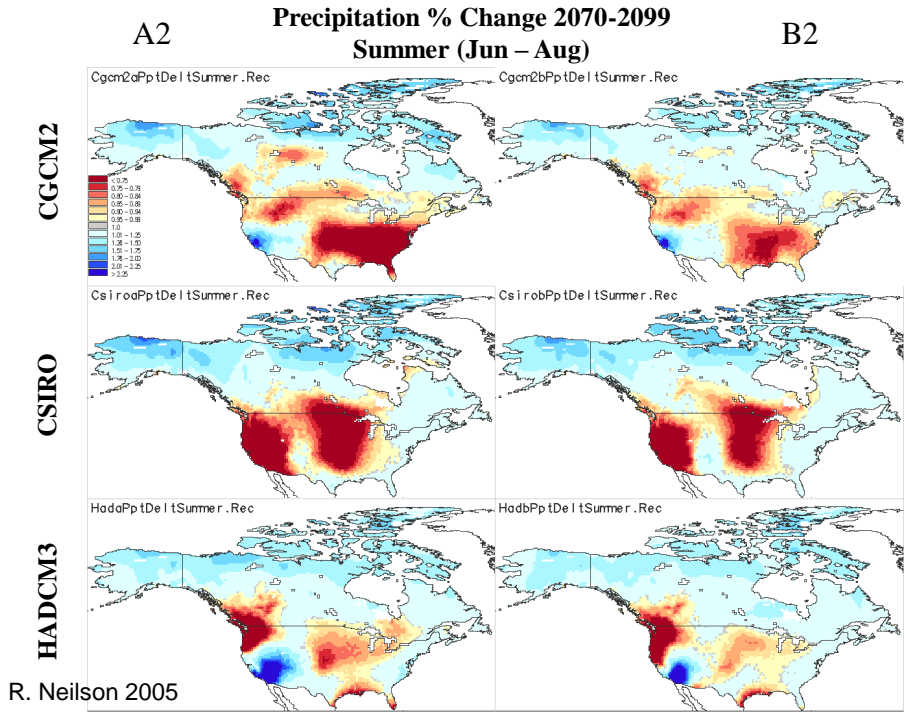
**IPCC 4th
Assessment GCMs**

**All Year
3 deg warmer**

**BUT
Winter – wetter**



Summer – drier





**By 2050 Global Climate Models project
Montana to be 5deg F. warmer in
summer, but receive 10% less rainfall
*40% Increase in Summer Evaporative Demand!!***

***Water Management
Recreation versus Agriculture***

The MonDak Region has an enormous amount of potential for irrigation development.