Implications of Climate Change for Drought and Wildfire

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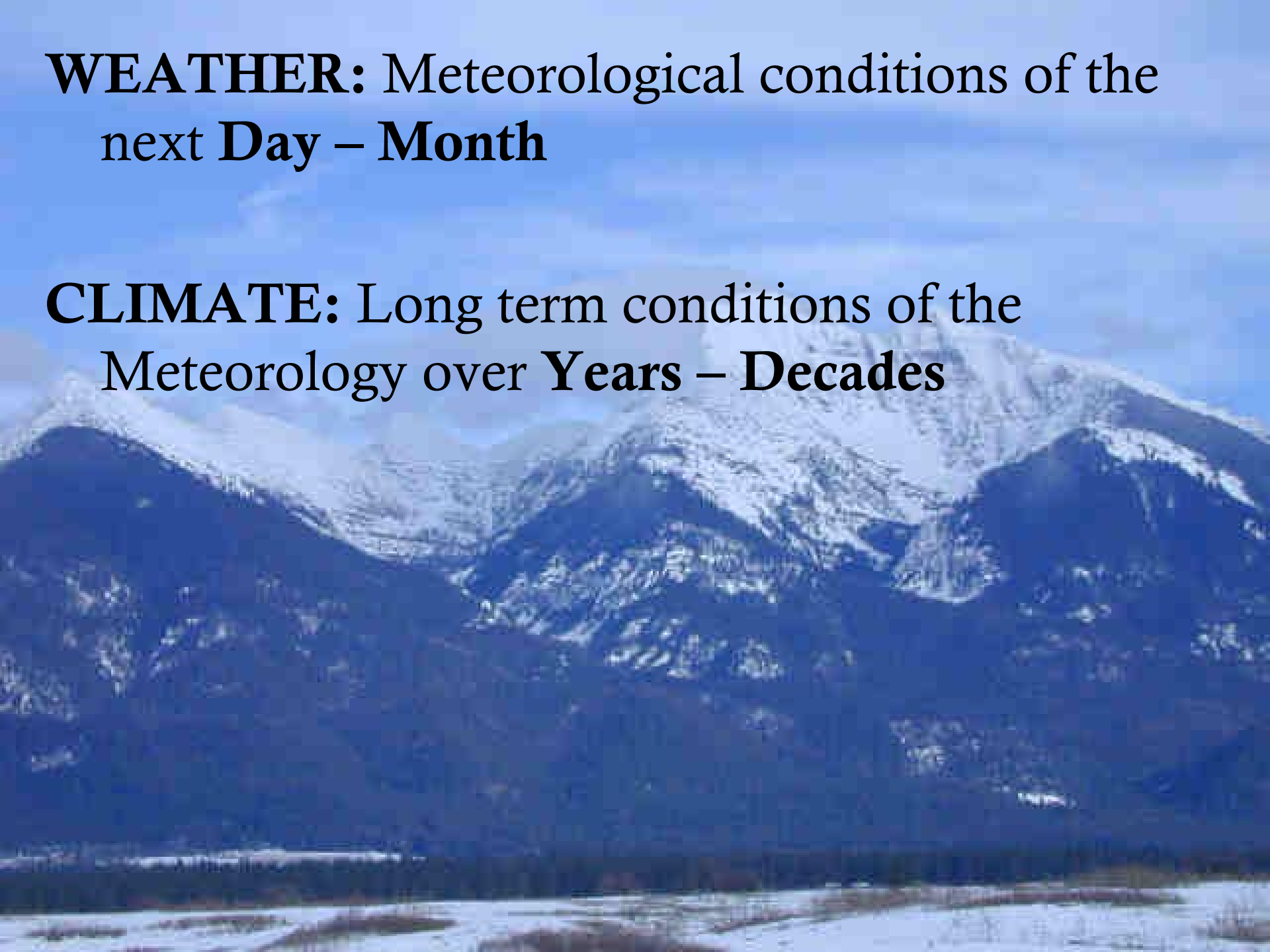
University of Montana

Wildland Fire Leadership Council
Red Lodge, Montana

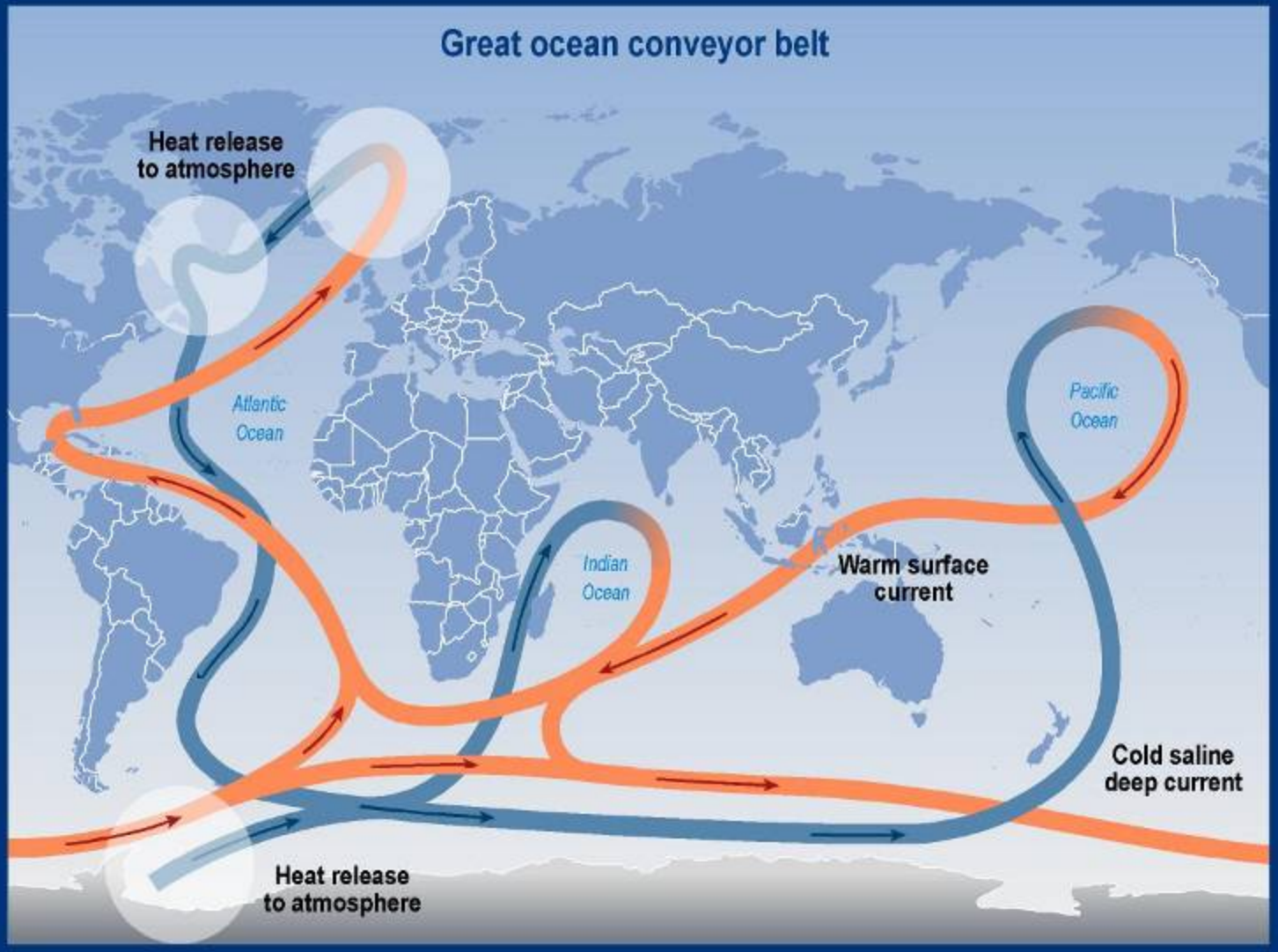
June 20, 2007


2ND-QTR SIZZLE
PROFITS AT 900
COMPANIES (P.74)
PAYING FOR COLLEGE
BEWARE OF THOSE
HIGH 529 FEES (P.96)
TERRORISM WHAT
COMPANIES STILL
NEED TO DO (P.26)
APRIL 3, 2006
www.time.com AOL Keyword: TIME
SPECIAL REPORT GLOBAL WARMING
BE
WORRIED.
BE VERY
WORRIED.
Climate change isn't some vague future problem—it's already damaging the planet at an alarming pace. Here's how it affects you, your kids and their kids as well
EARTH AT THE TIPPING POINT
HOW IT THREATENS YOUR HEALTH
HOW CHINA & INDIA CAN HELP SAVE THE WORLD—OR DESTROY IT
THE CLIMATE CRUSADERS
The Economist
SEPTEMBER 9TH–15TH 2006
www.economist.com
The Blair leadership crisis
The new boss at Ford
An honest in-flight announcement
Catastrophe looms in Darfur
Fancy a Swedish model?
The heat is on
A special report on climate change
SEPTEMBER 2006
A WARMER WORLD



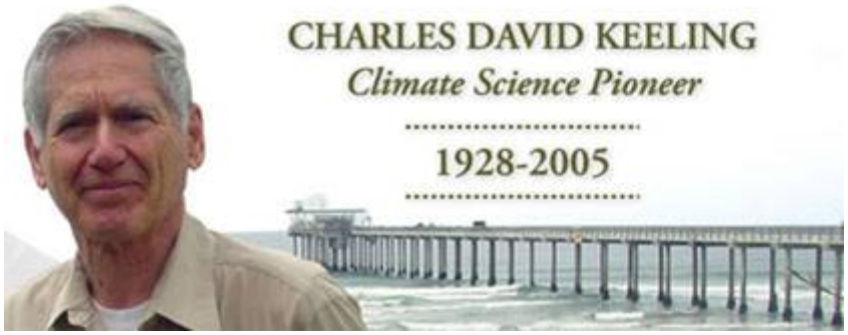
WEATHER: Meteorological conditions of the next **Day – Month**

CLIMATE: Long term conditions of the Meteorology over **Years – Decades**



SYR - FIGURE 4-2

MAUNA LOA OBSERVATORY, HAWAII
MONTHLY AVERAGE CARBON DIOXIDE CONCENTRATION
MLO-145



CO2 CONCENTRATION, (PPM)

390
385
380
375
370
365
360
355
350
345
340
335
330
325
320
315
310

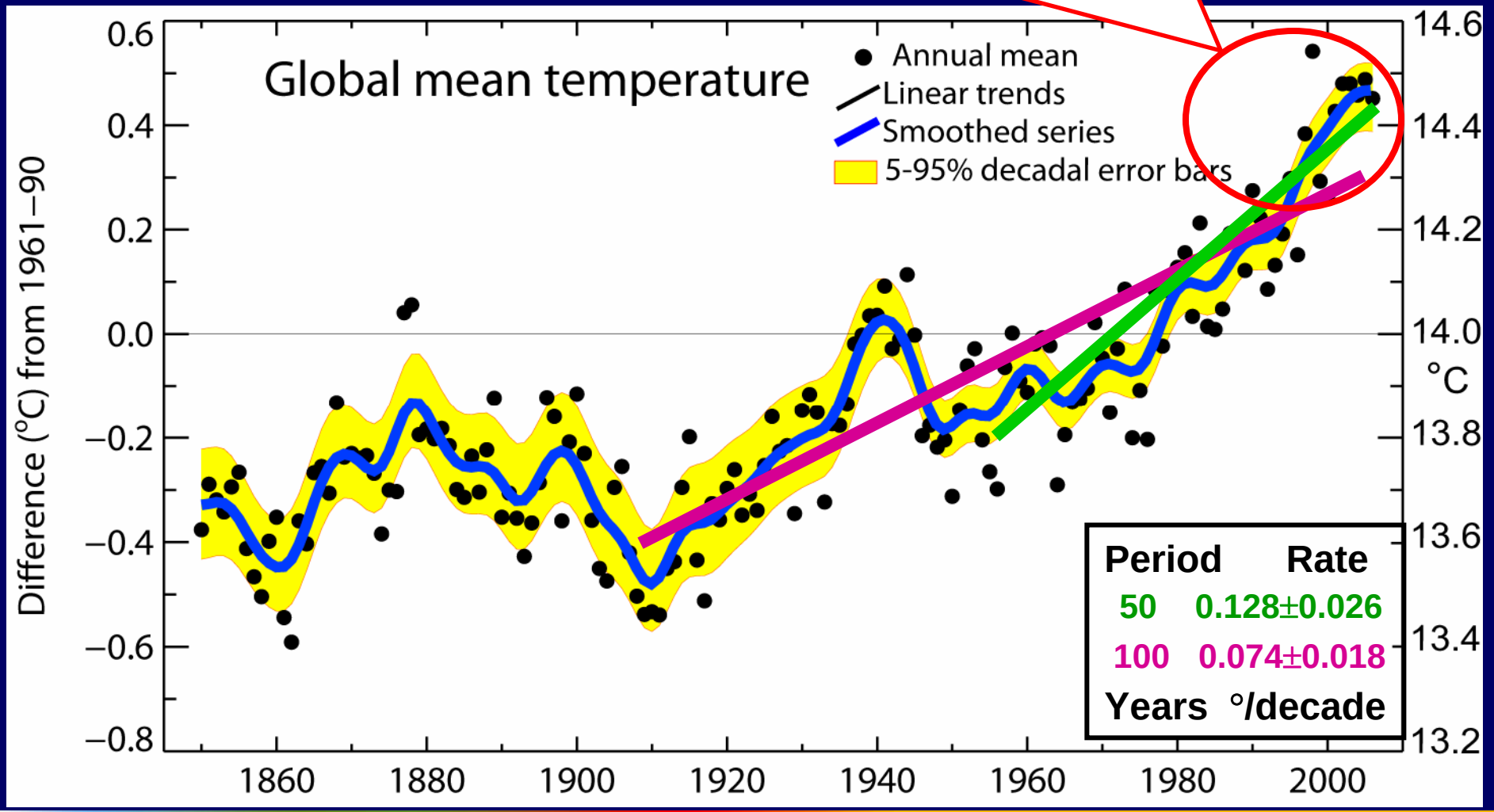
1958 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04

YEAR

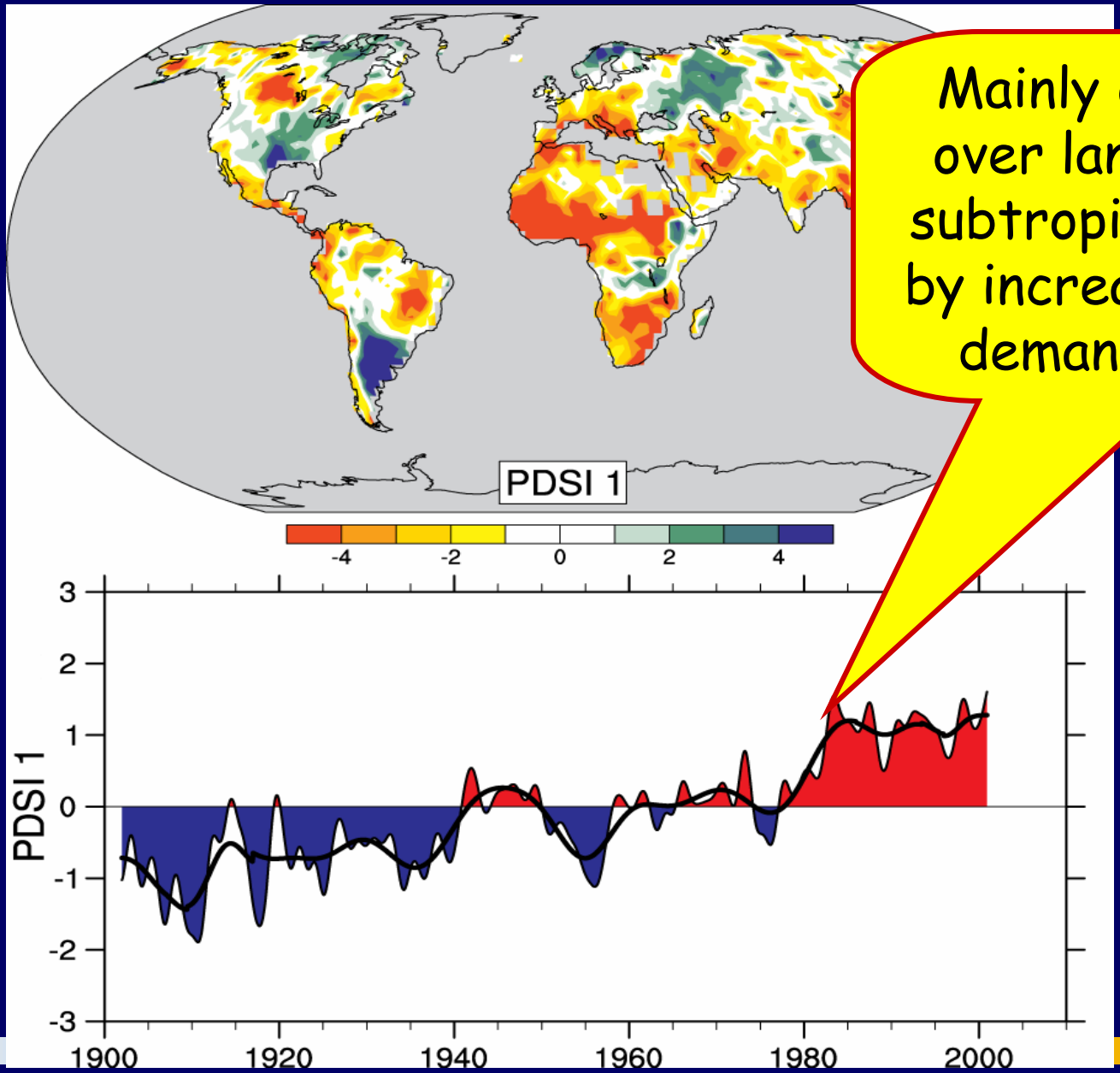
19-May-05

Global mean temper

Warmest 12 years:
1998,2005,2003,2002,2004,2006,
2001,1997,1995,1999,1990,2000



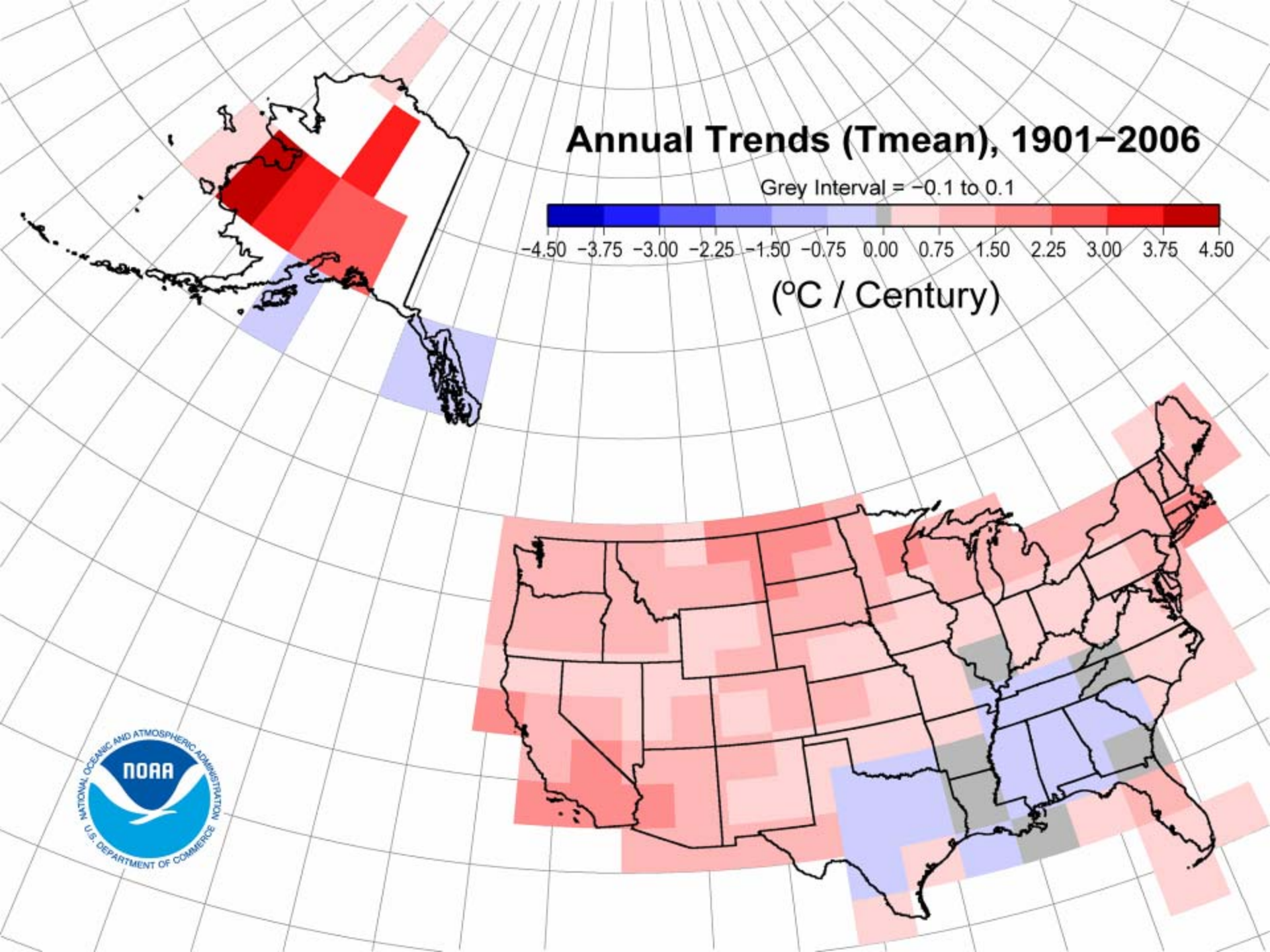
Drought is increasing most places

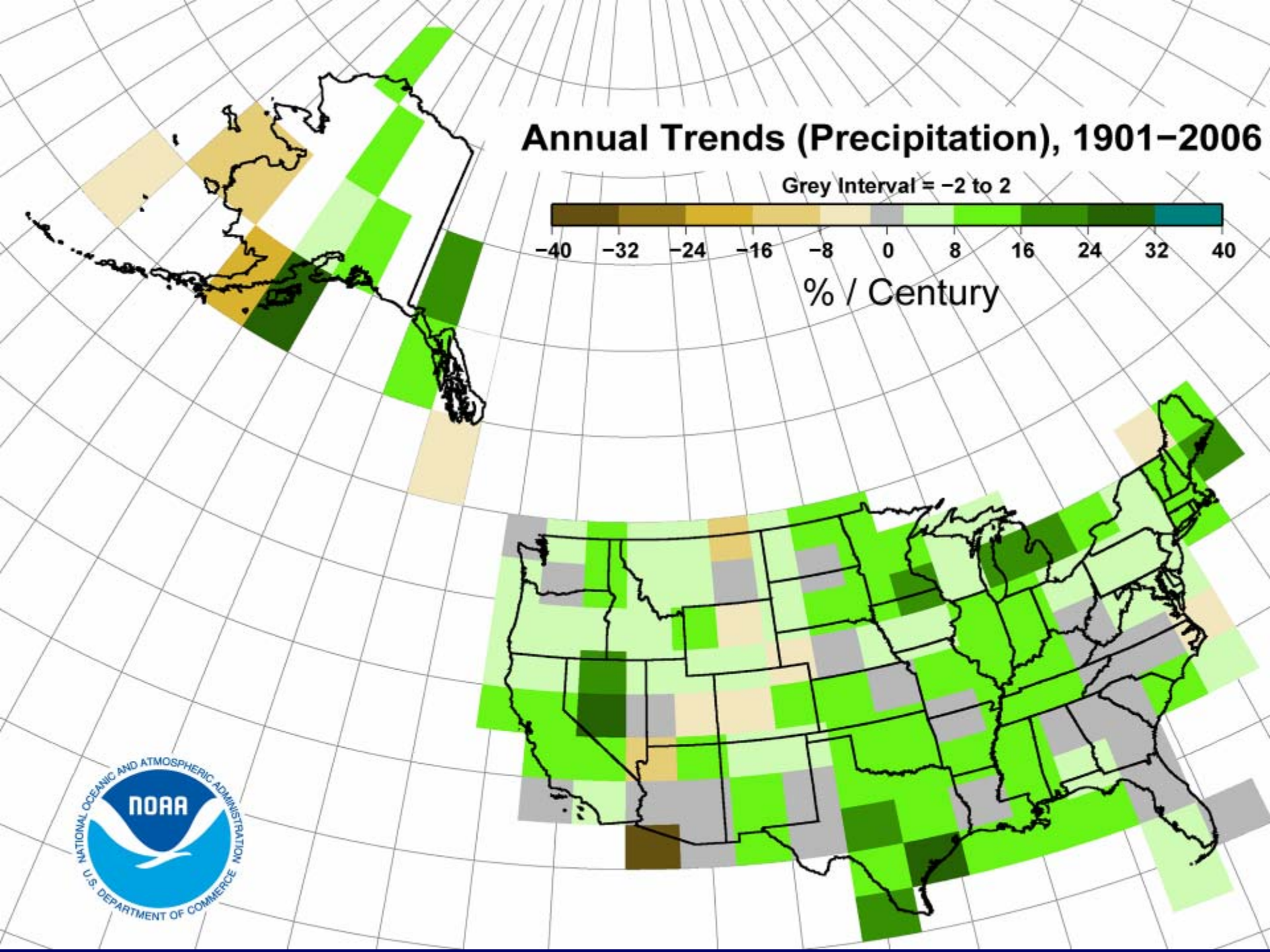


Mainly decrease in rain over land in tropics and subtropics, but enhanced by increased atmospheric demand with warming

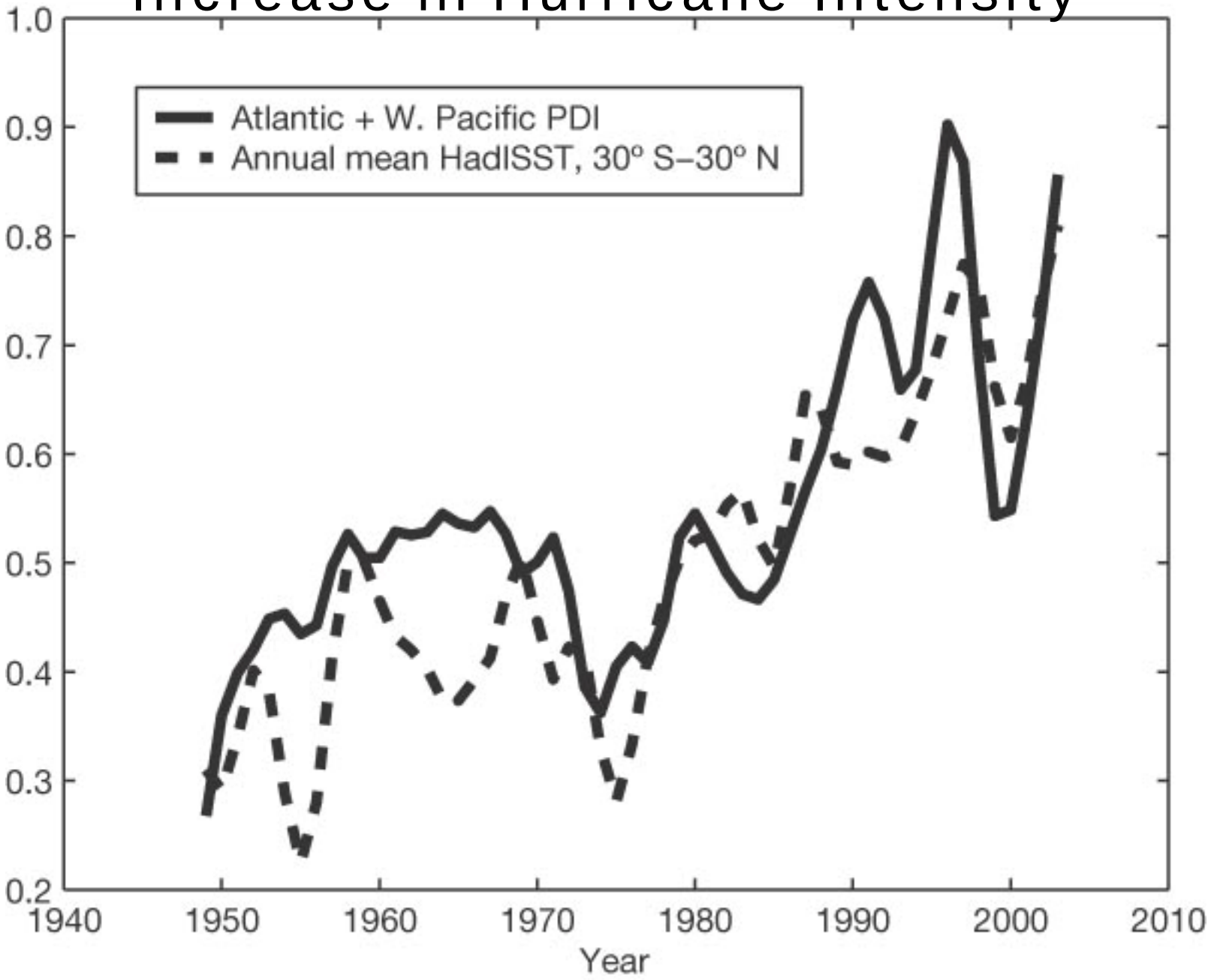
Severity Index (PDSI) for 1900 to 2002.

The time series (below) accounts for most of the trend in PDSI.


Annual Trends (Tmean), 1901–2006
Grey Interval = −0.1 to 0.1
−4.50 −3.75 −3.00 −2.25 −1.50 −0.75 0.00 0.75 1.50 2.25 3.00 3.75 4.50
(°C / Century)
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE


Annual Trends (Precipitation), 1901−2006
Grey Interval = −2 to 2
−40 −32 −24 −16 −8 0 8 16 24 32 40
% / Century
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Increase in Hurricane Intensity



PDI = Potential Destructiveness Index

Emanuel, Nature 4 August 2005

Arctic sea ice gets thinner

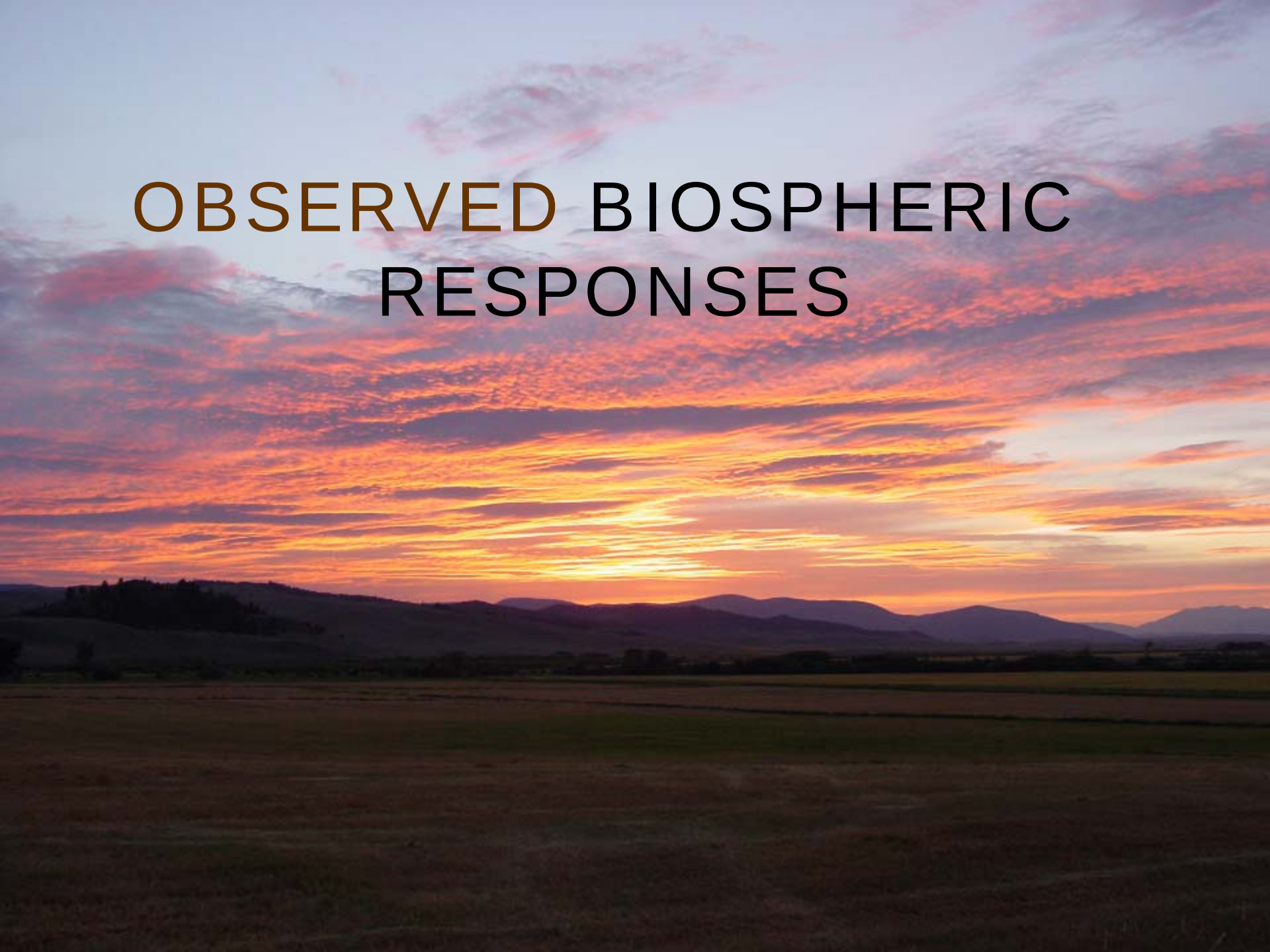
Shepard Glacier - Glacier National Park

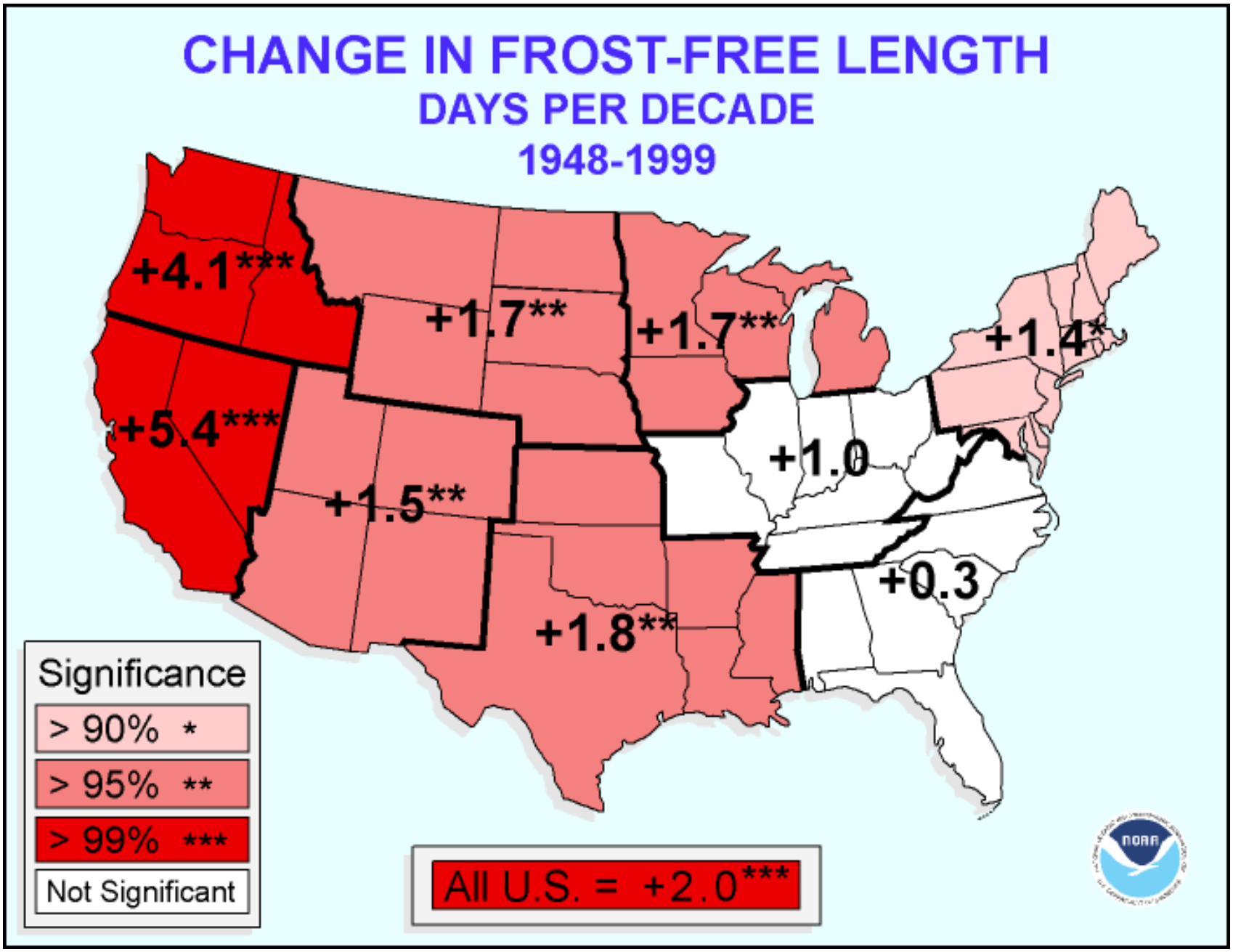
Photo by W.C. Alden, USGS

1913

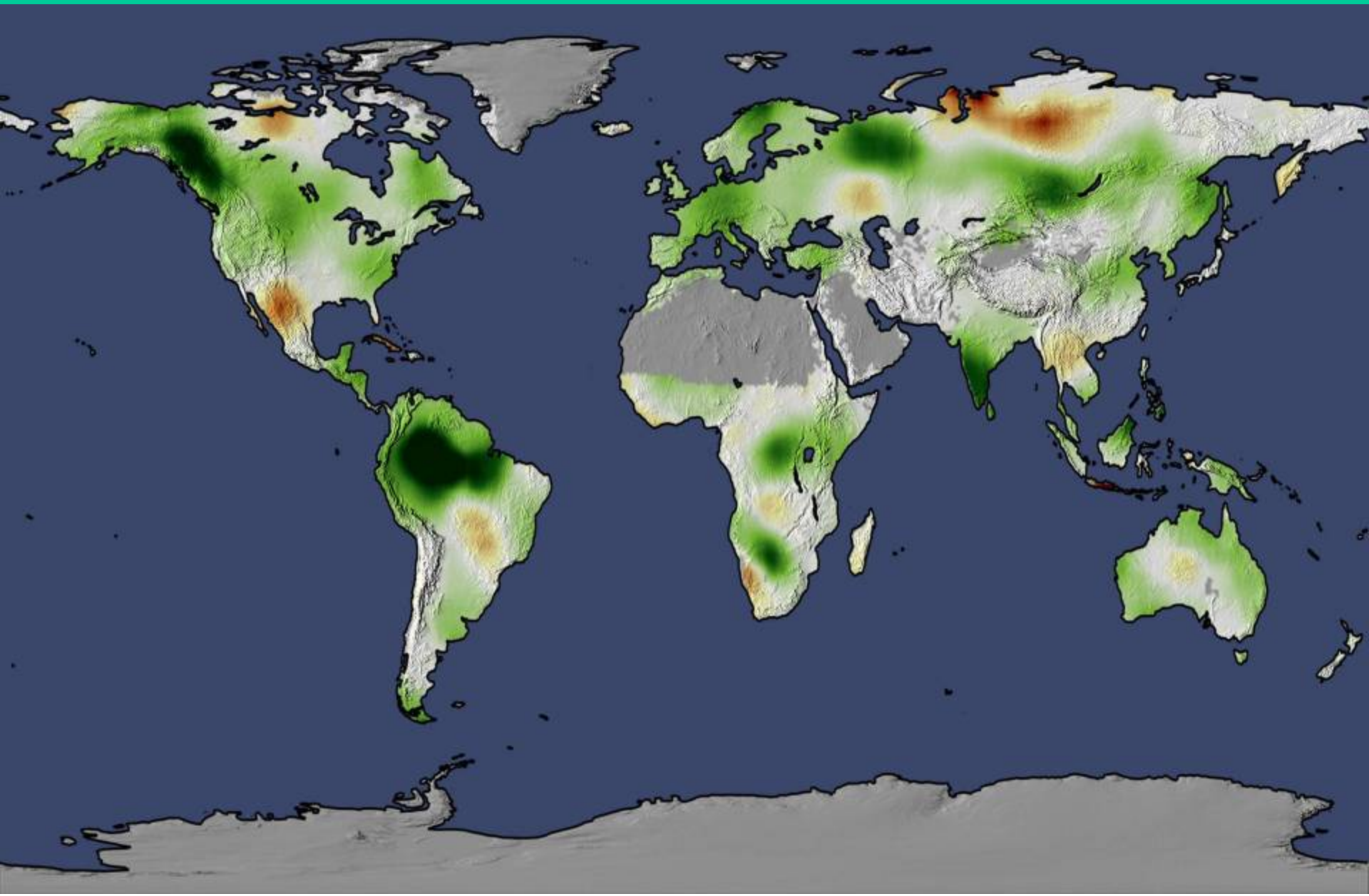
Photo by B. Reardon, USGS

2005


OBSERVED BIOSPHERIC
RESPONSES


CHANGE IN FROST-FREE LENGTH
DAYS PER DECADE
1948-1999
+4.1***
+1.7**
+1.7**
+1.4*
+5.4***
+1.0
+1.5**
+0.3
+1.8**
Significance
> 90% *
> 95% **
> 99% ***
Not Significant
All U.S. = +2.0***
NOAA

Change in Terrestrial NPP from 1982 to 1999.

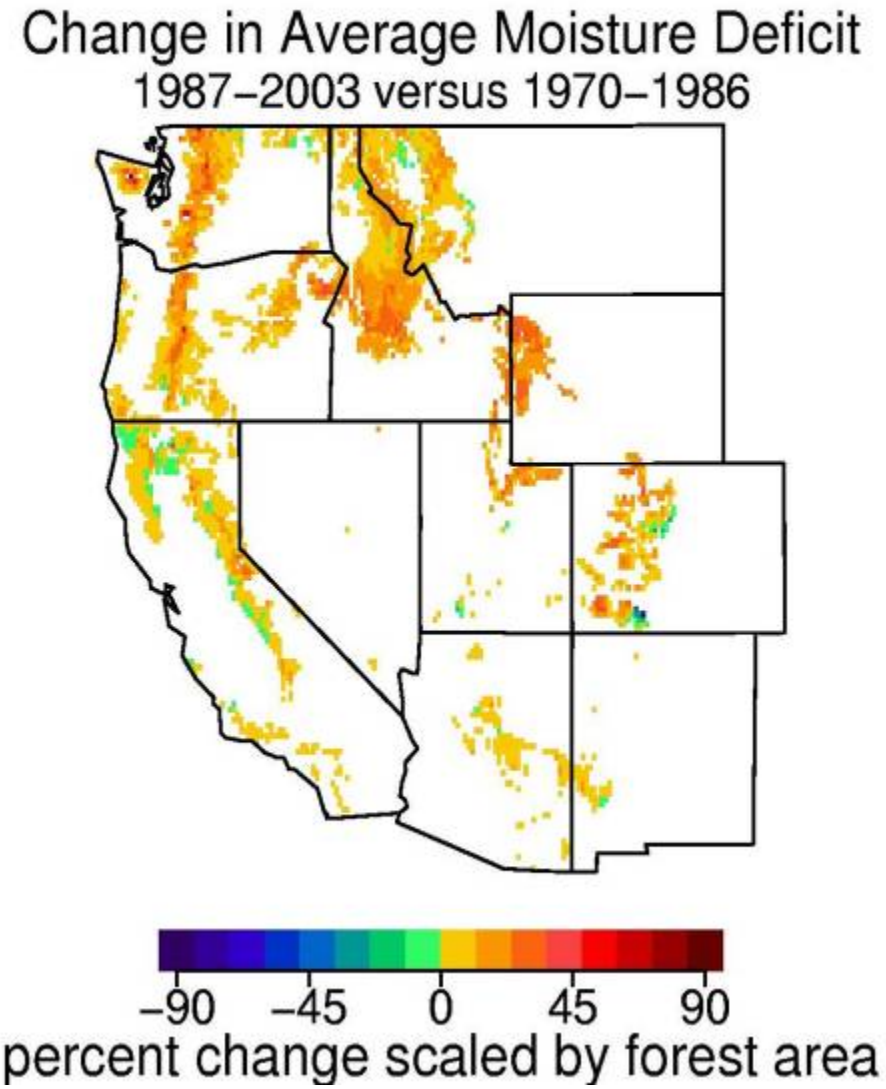


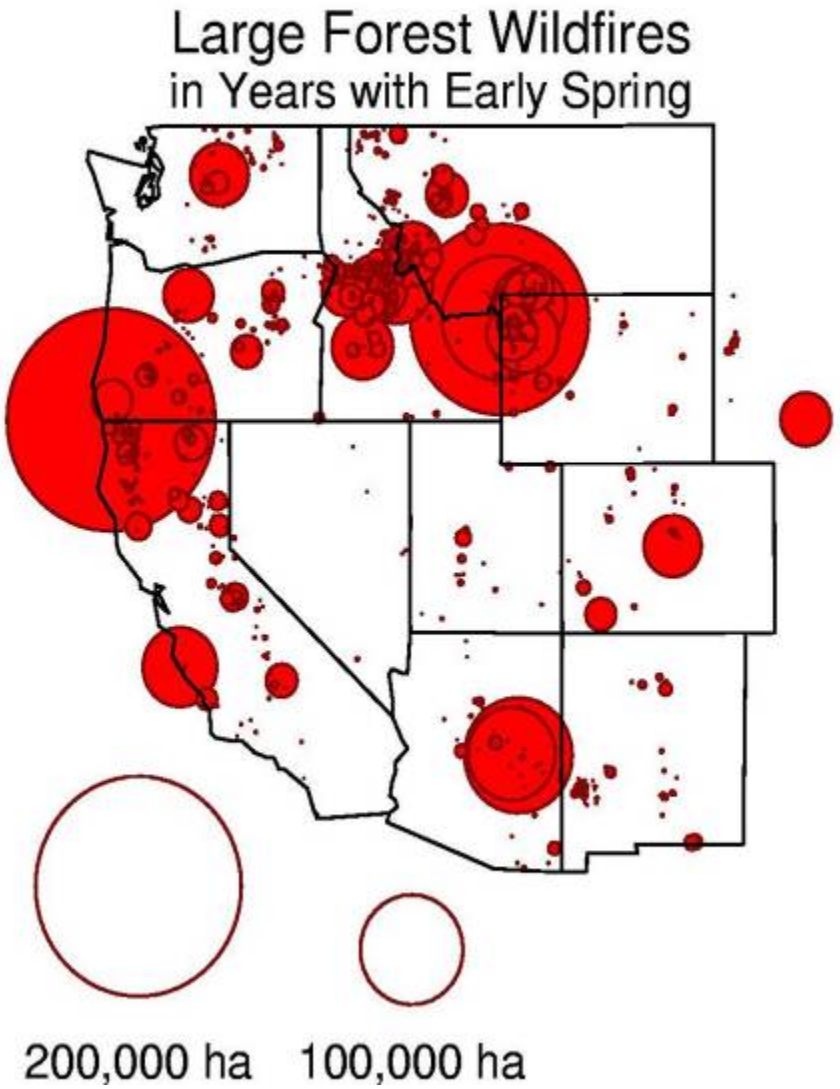
Nemani et al., Science June 6th 2003


Science
18 August 2006 | $10
AAAS

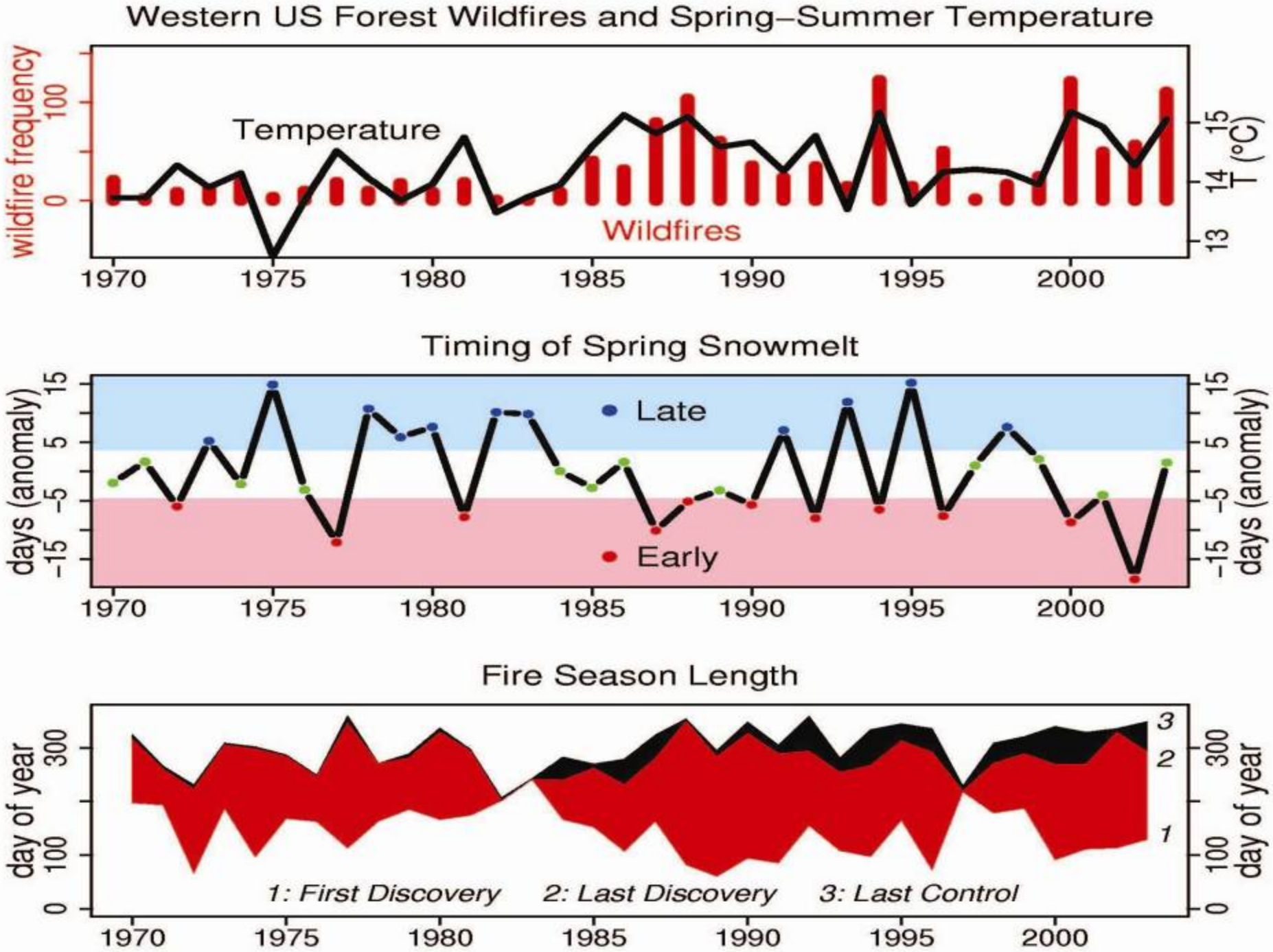
Fires in Montana/Idaho in August 2000 monitored from the EOS/MODIS satellite

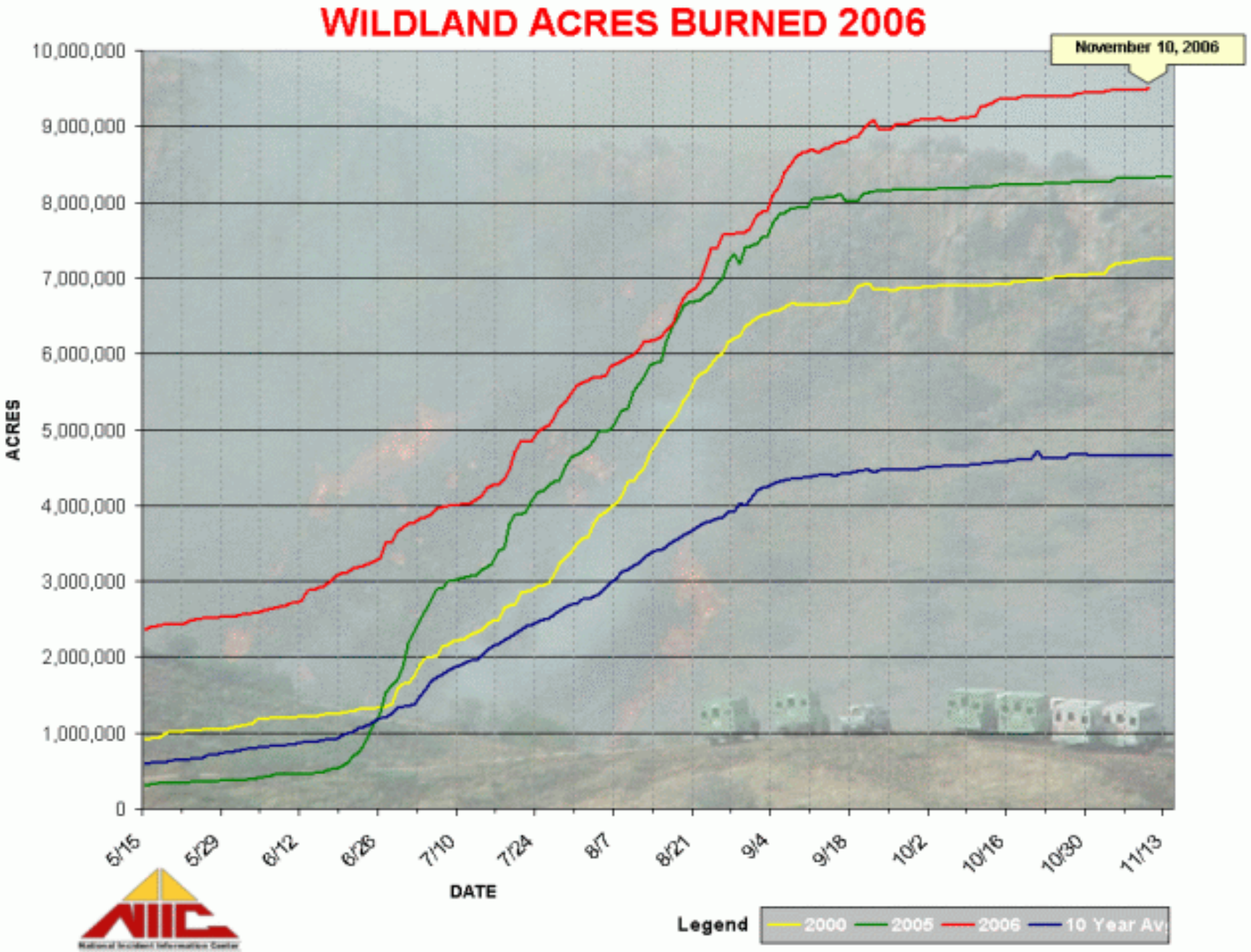
Wildfires accelerate 1970 – 2003 with early snowmelt, longer, drier summers



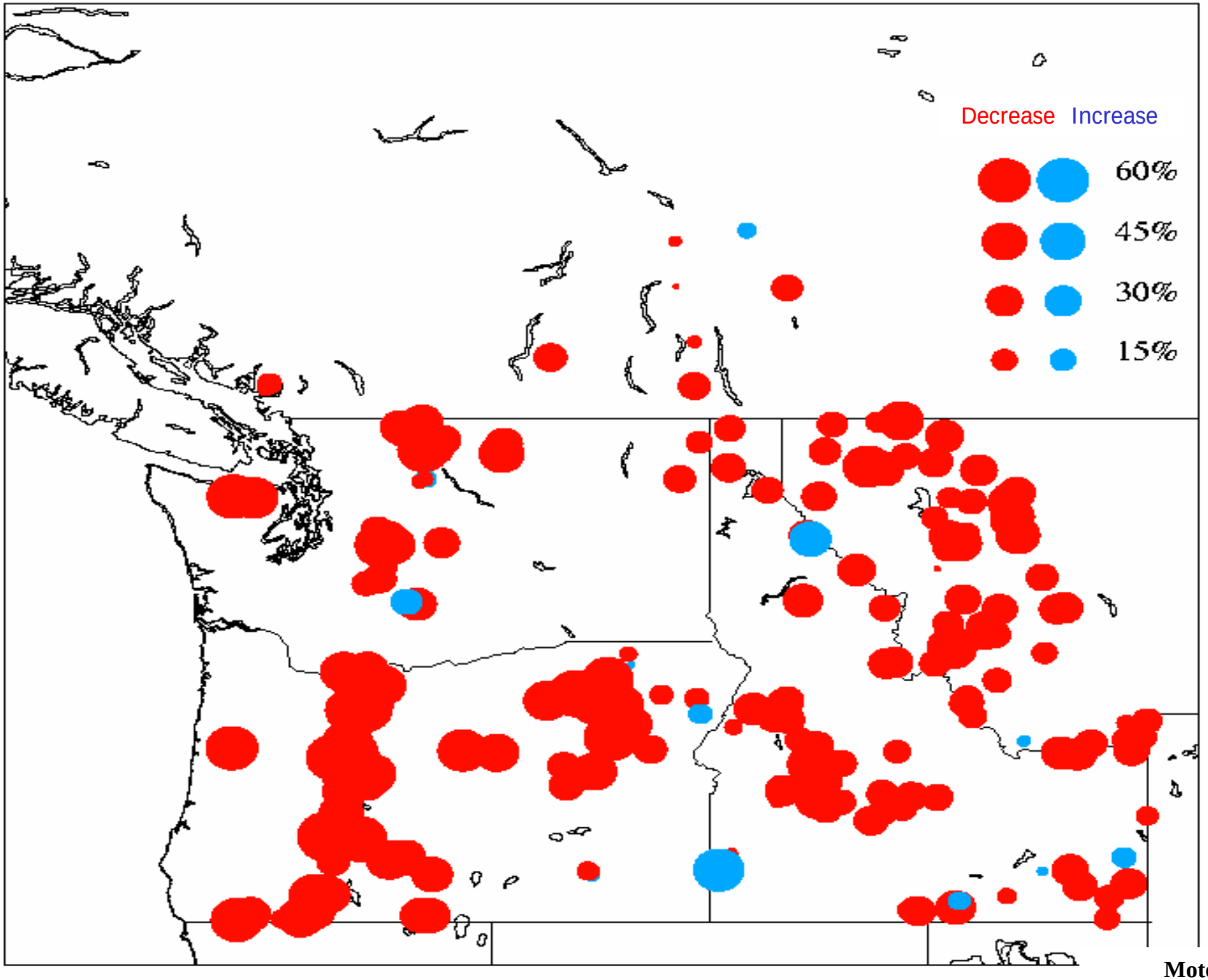


Westerling et al Science 2006, Running, Science 2006


Western US Forest Wildfires and Spring–Summer Temperature
wildfire frequency
0
100
Temperature
Wildfires
13
14
15
T (°C)
1970
1975
1980
1985
1990
1995
2000
Timing of Spring Snowmelt
days (anomaly)
−15
−5
5
15
Late
Early
Fire Season Length
day of year
0
100
300
1: First Discovery
2: Last Discovery
3: Last Control
1
2
3


WILDLAND ACRES BURNED 2006
November 10, 2006
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
ACRES
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
DATE
Legend
2000
2005
2006
10 Year Av

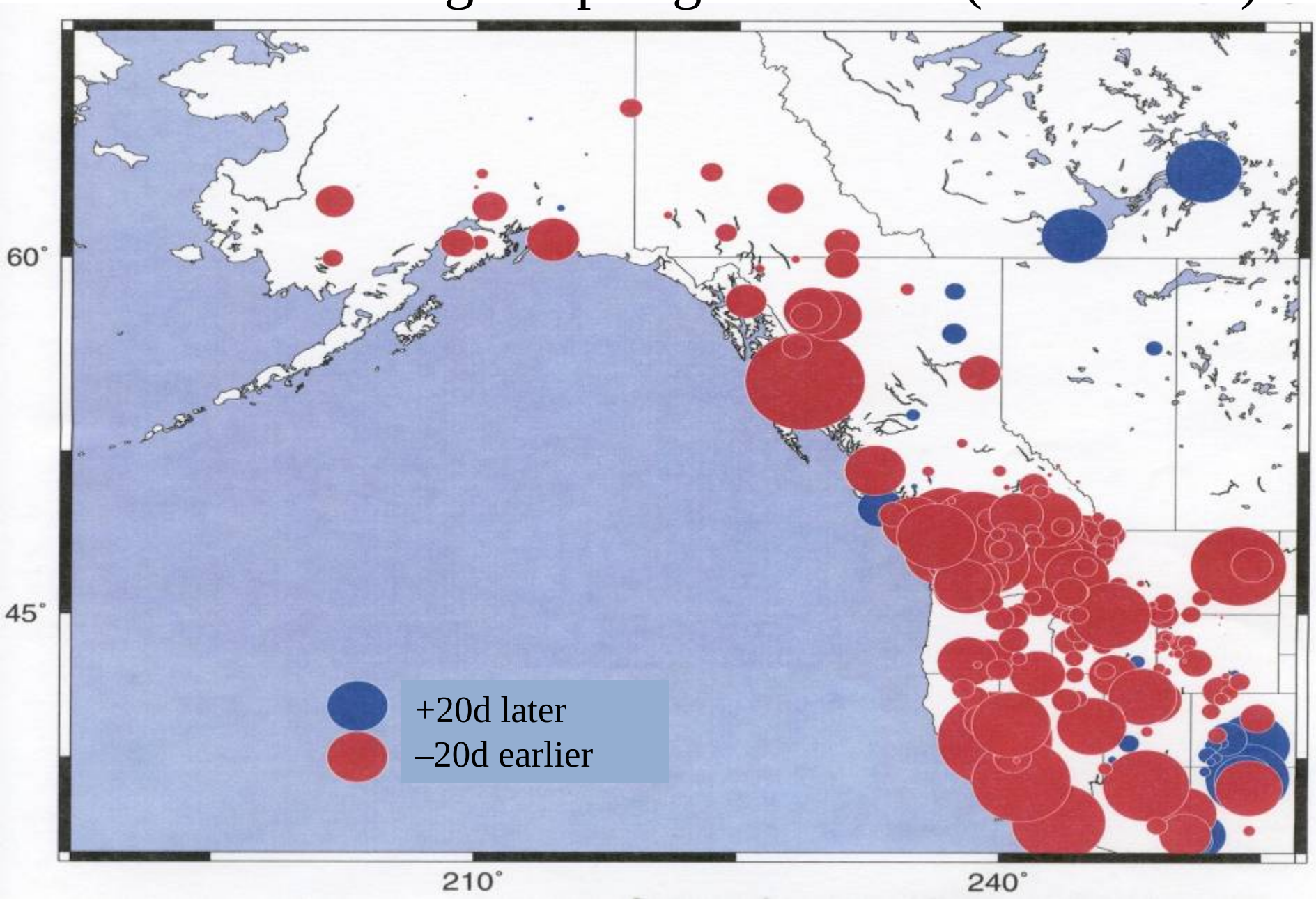
Relative trend in Apr 1 snow water equivalent, 1950-2000



Climate Science in the Public Interest

Mote 2003(b)

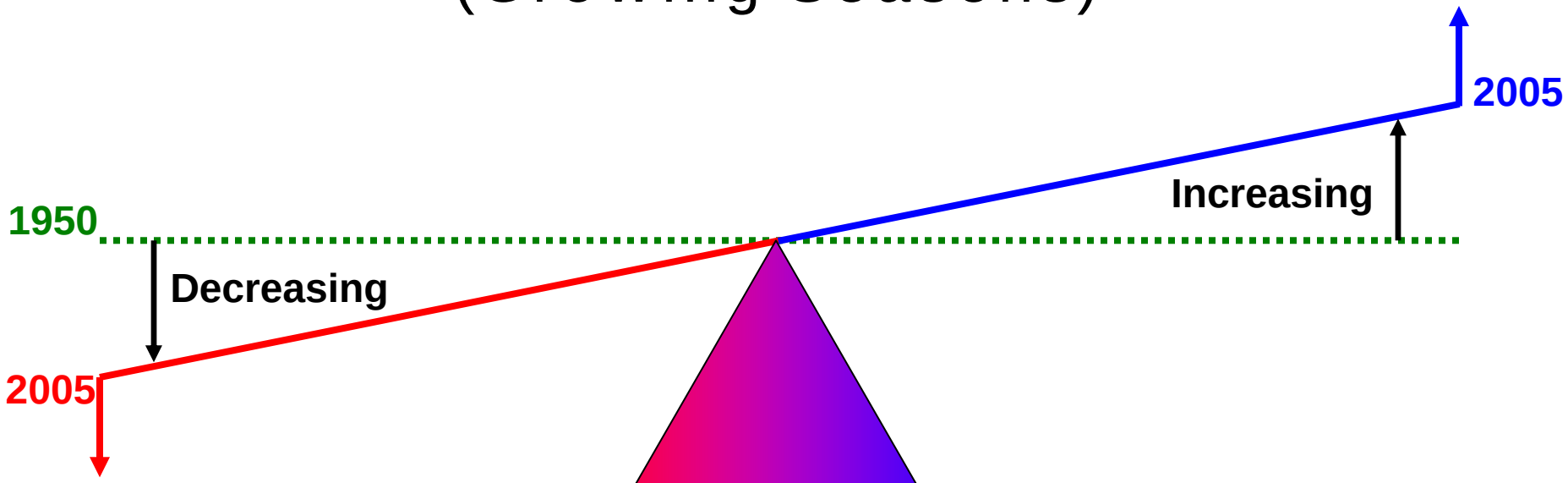
Trends in timing of spring snowmelt (1948-2000)



Courtesy of Mike Dettinger, Iris Stewart, Dan Cayan

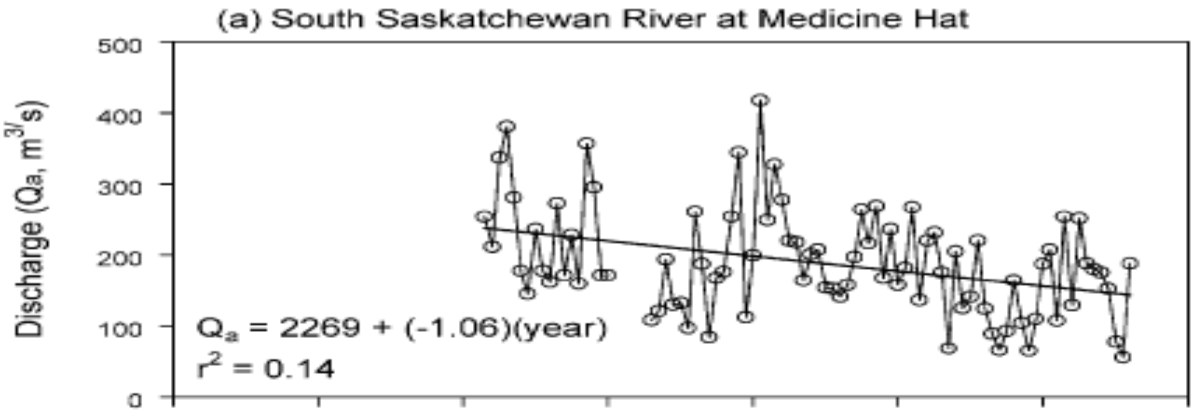
Land Water Balance Tipping Points

(Growing Seasons)



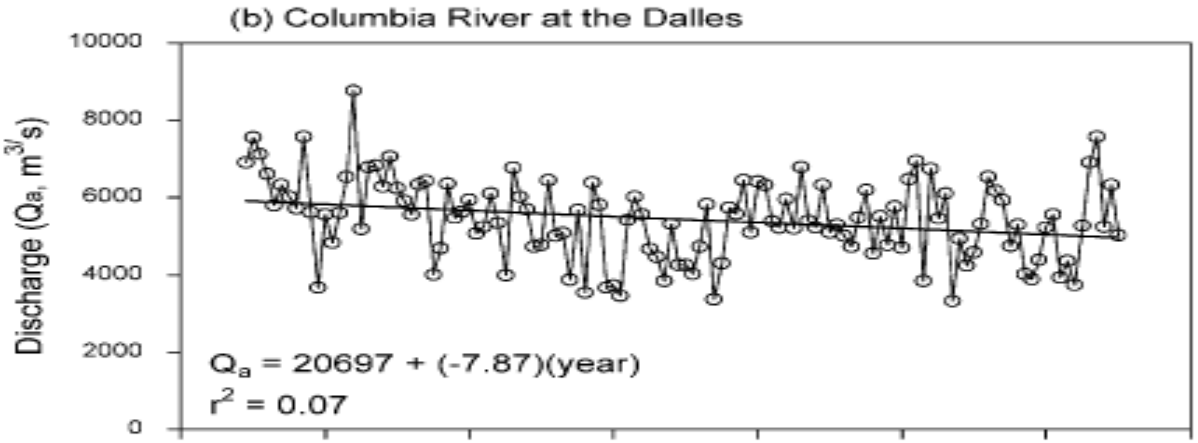
Pest Epidemics
Wildfire
Forest Mortality
Low Streamflows
Reduced Nutrient Cycling
Lower NPP
Biodiversity?
Invasives?

Higher LAI, ET, NPP
Higher Streamflows
Streambank Erosion
Insect-borne diseases
Human Health
Improved wildlife habitat?
Biodiversity?

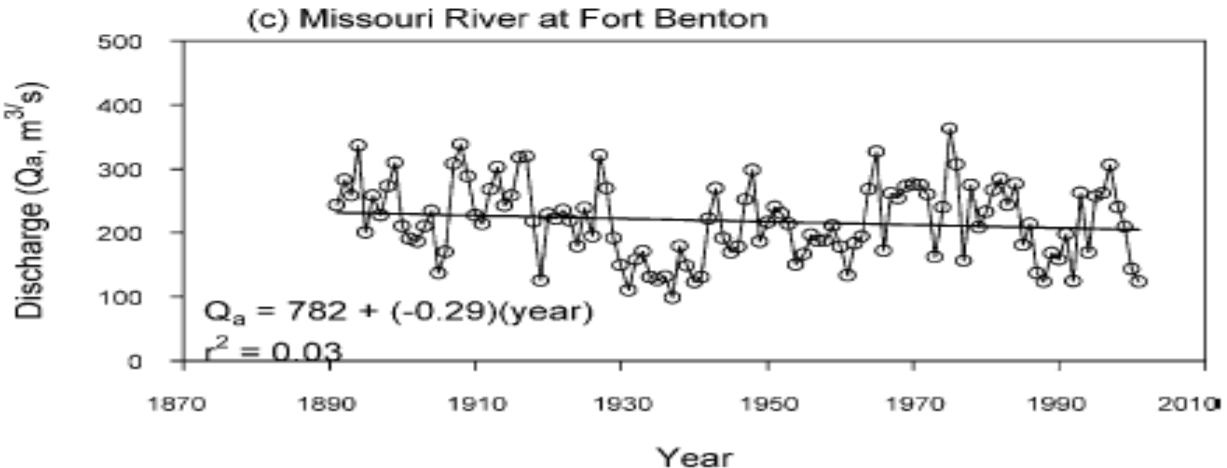


Flows North to Arctic O.

DECLINING RIVER FLOWS
Columbia and Missouri Basins



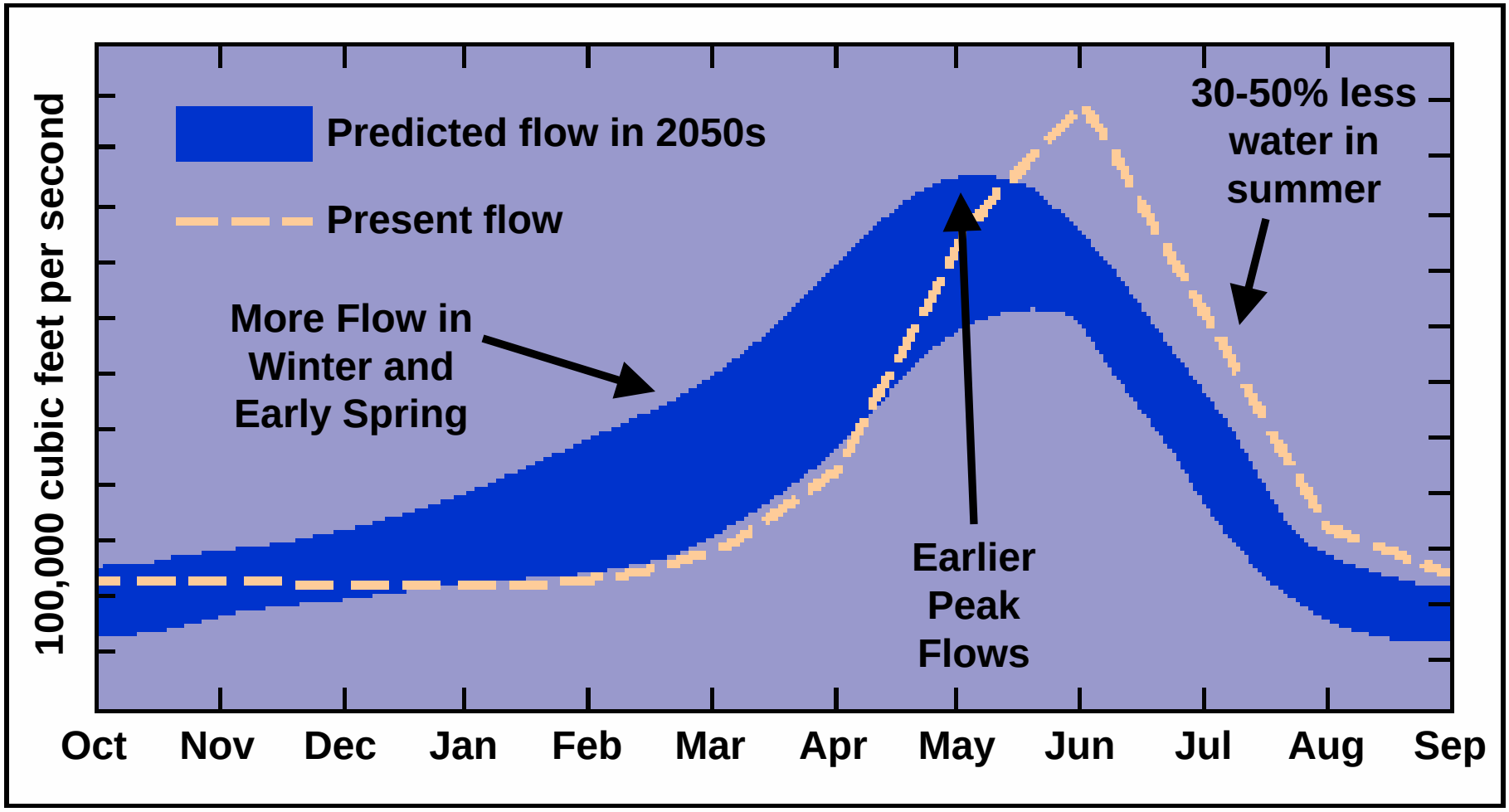
Flows West to Pacific O.



Flows SE to Gulf

Rood et al. J.Hydrology 2005

Naturalized Columbia River Streamflow, The Dalles, OR



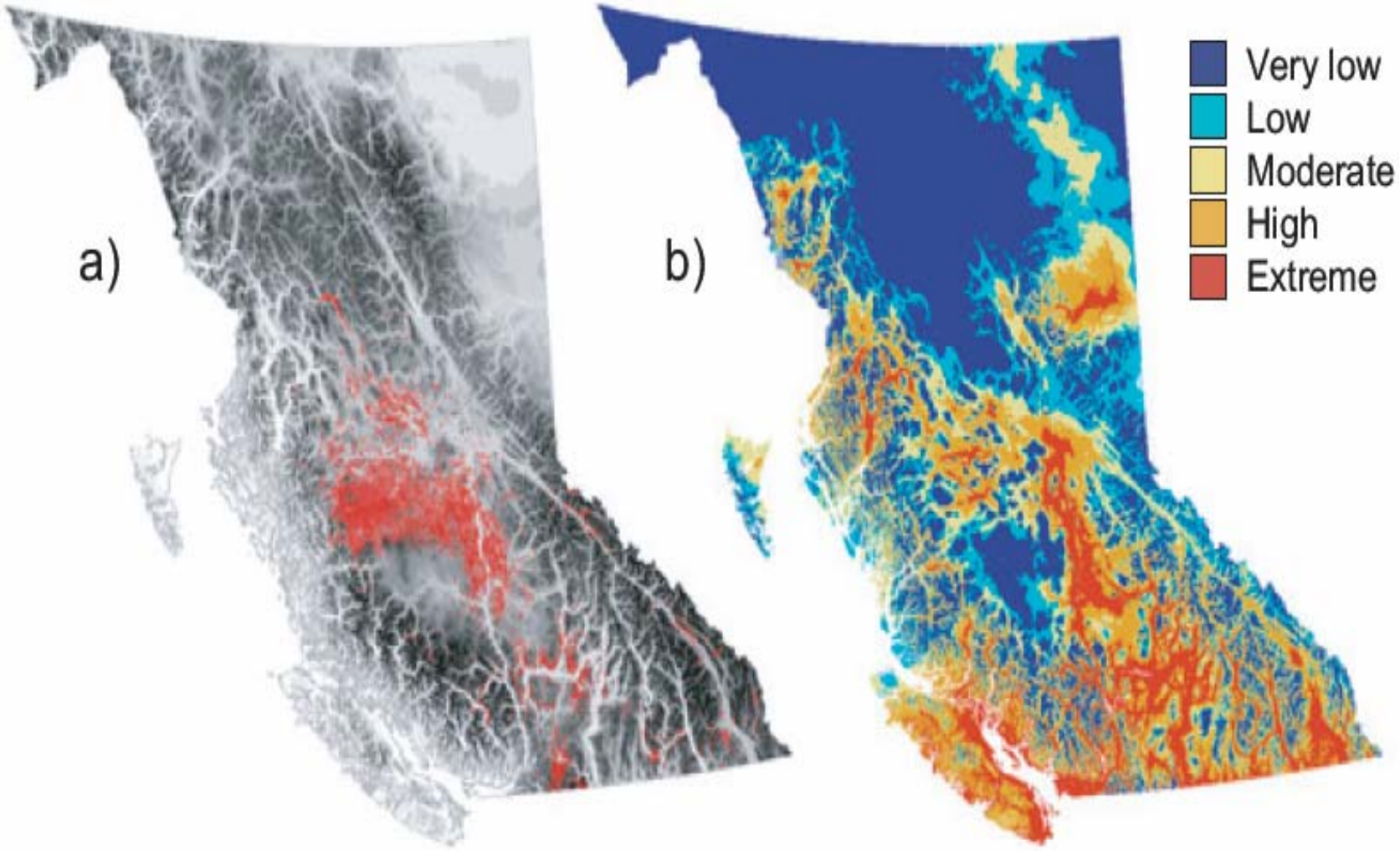
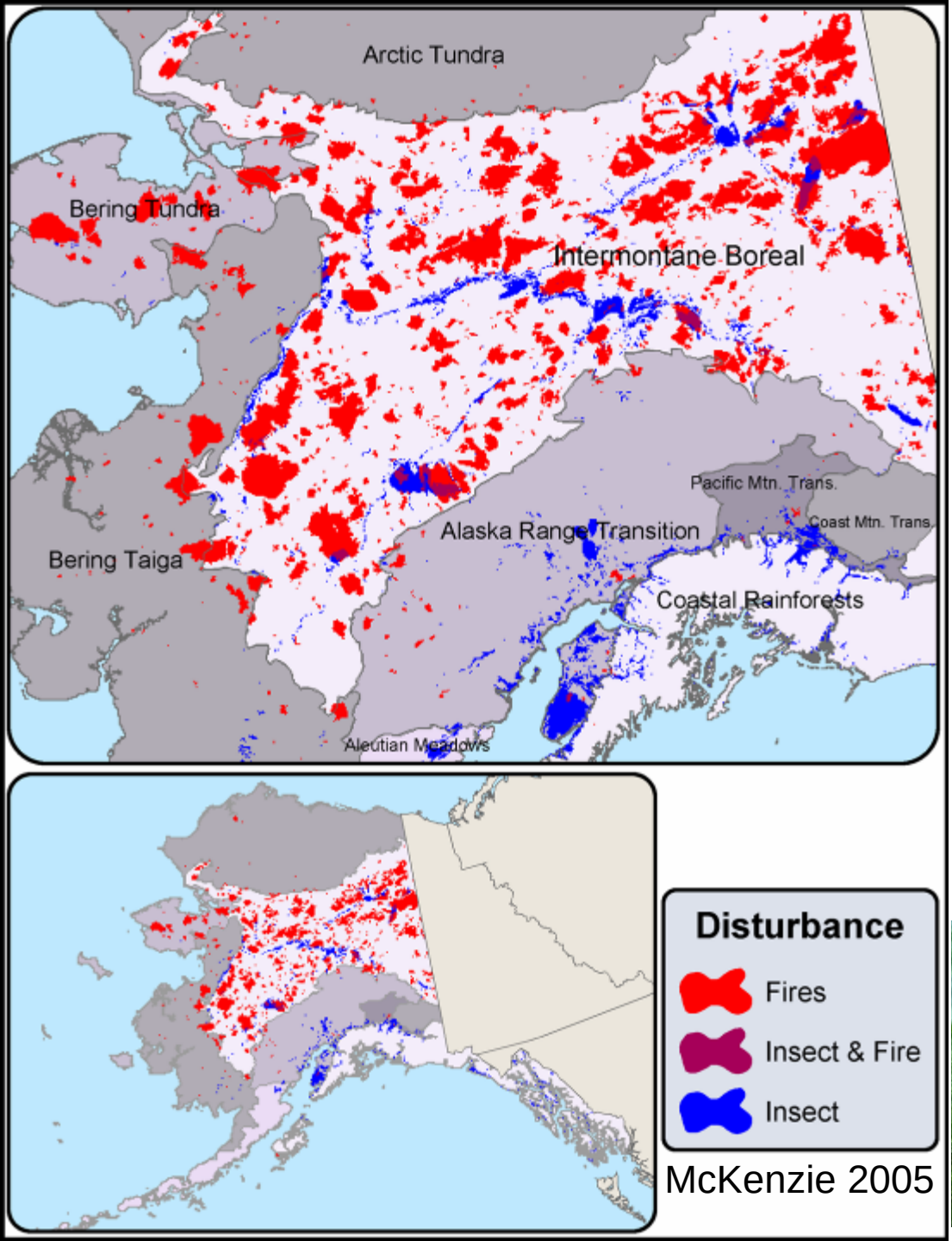


Figure 2. Mountain pine beetle infestations (all severity classes) from 1998 to 2002 (a), and the distribution of climatic suitability classes derived from 1971-2000 climate normals [30-year monthly means and extreme minima and maxima (b)] for the mountain pine beetle in BC. "Very low" CSCs are habitats with climatic conditions unsuitable for mountain pine beetle, whereas "extreme" CSCs are those considered climatically optimal.

Carroll et al 2004

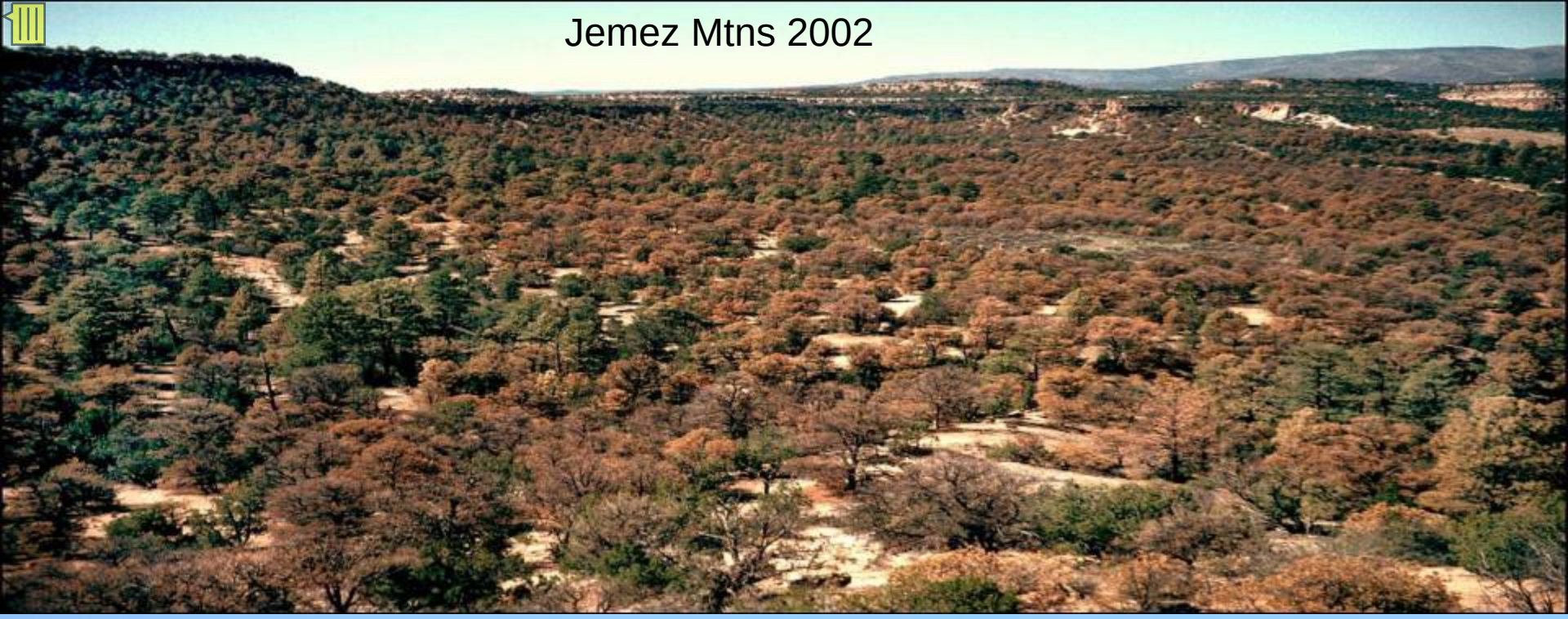


McKenzie 2005

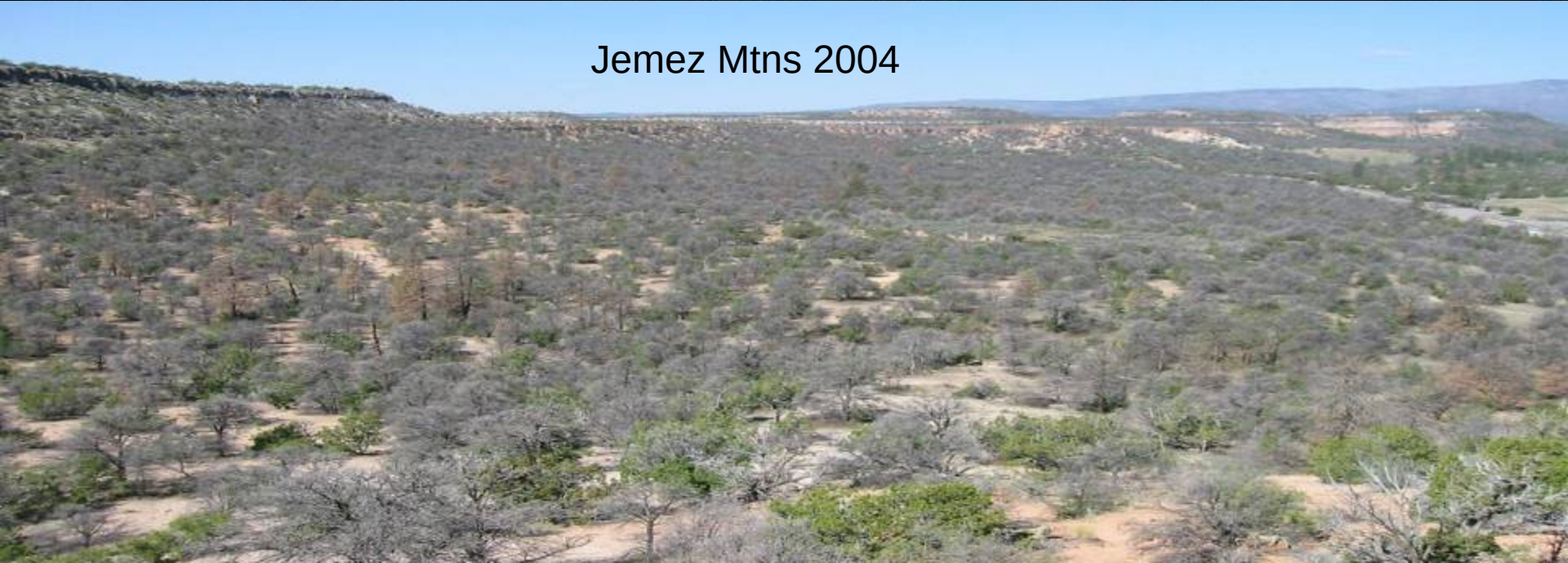
Spruce forest (S. Alaska)
Extended warm period, insects, spruce die, fuels accumulate, large fires, species conversion?

Yellow cedar (SE Alaska)
Extended warm period, insects, yellow cedar stressed or die.

Jemez Mtns 2002



Jemez Mtns 2004

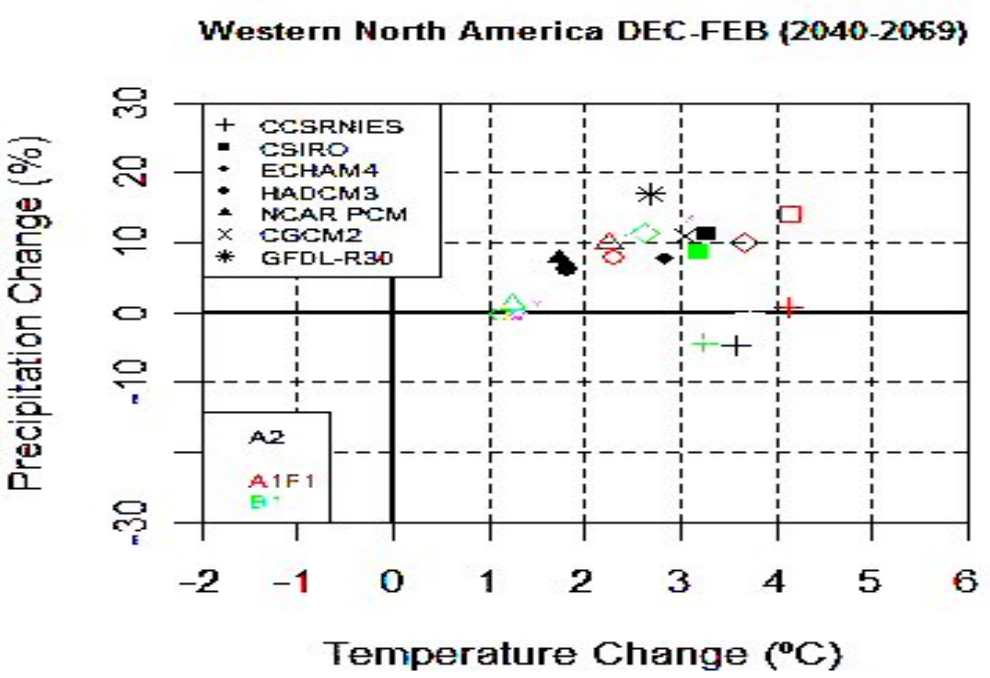


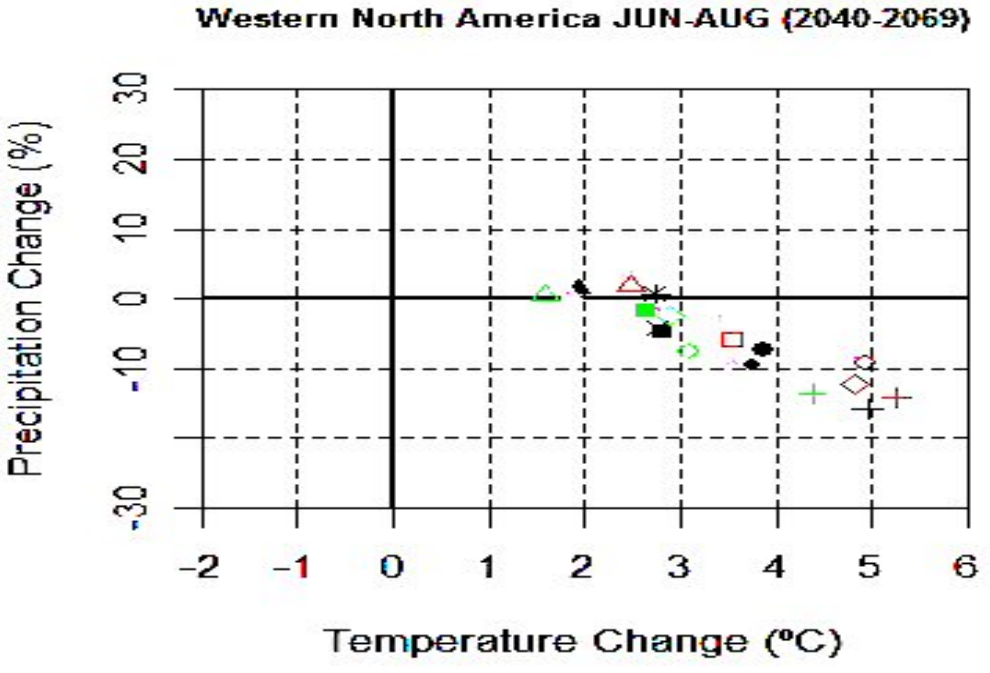
Both Seasons
3°C warmer, *BUT*

Winter – wetter

Summer – drier

IPCC AR4 GCMs





THE S.W. RUNNING CRYSTAL BALL

Northern Rocky Mountains: THE NEXT 50 YEARS

EXPECTED CLIMATE TRENDS

- Shorter, milder winters
- Earlier snowmelt
- Longer growing seasons
- Decreasing summer streamflows
- More drought and fire danger
- Precipitation???