

# **CLIMATE CHANGE IMPACTS ON THE BIOSPHERE: What should we look for?**

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# PROGRESSION OF U.S. CLIMATE CHANGE POLICY QUESTIONS

**First, is the Earth warming? *YES***

**Second, is human activity causing warming *YES***

**Third, is the warming “dangerous” *???***

**1992 Framework Convention on Climate Change, key language:**

**DANGEROUS ANTHROPOGENIC INTERFERENCE IN THE GLOBAL CLIMATE SYSTEM**

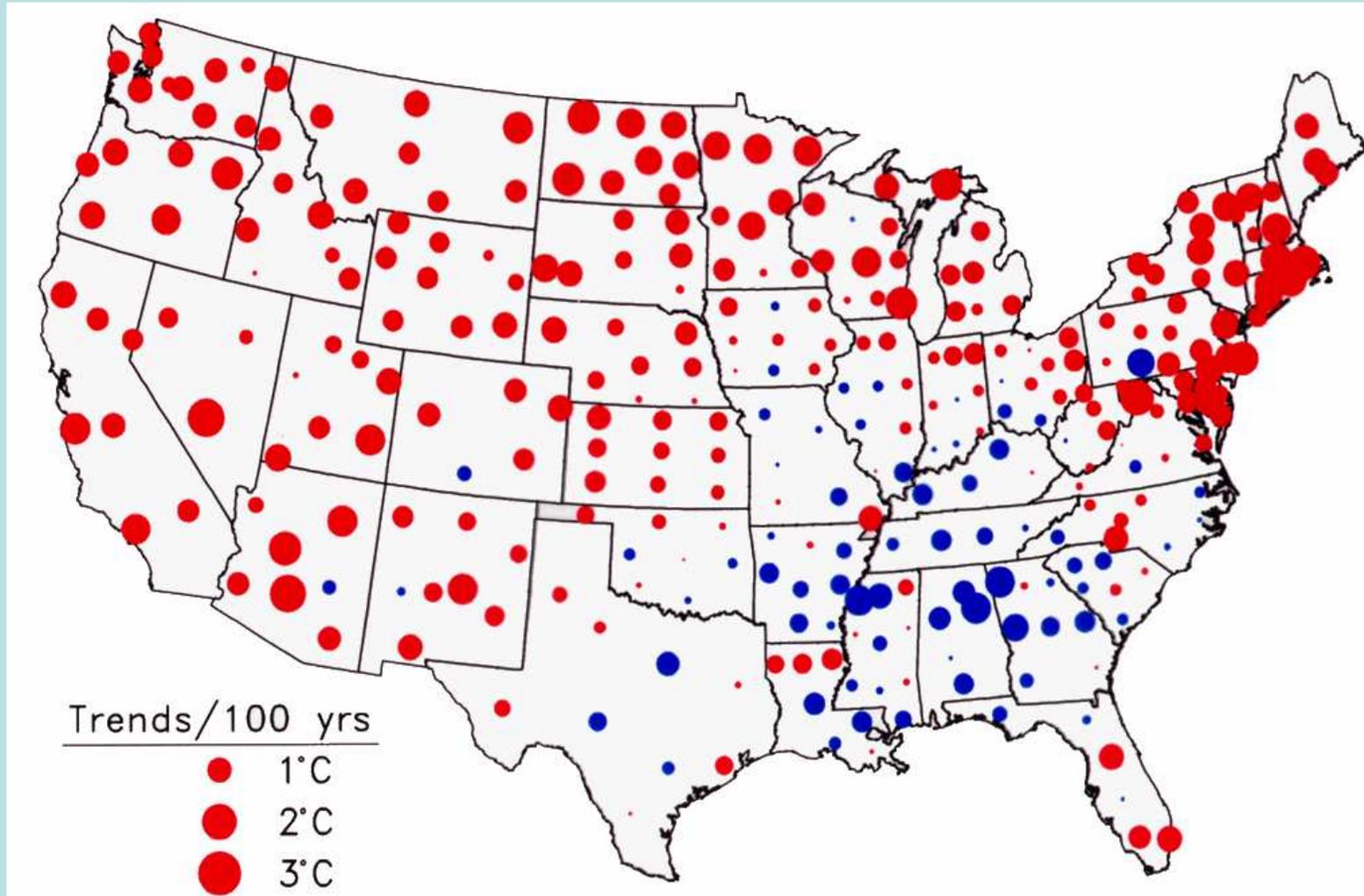
**Jim Hansen at GISS has chosen**

***SEA LEVEL RISE***

**as the most clearly illustratable “dangerous impact” of climate change to build public awareness.**

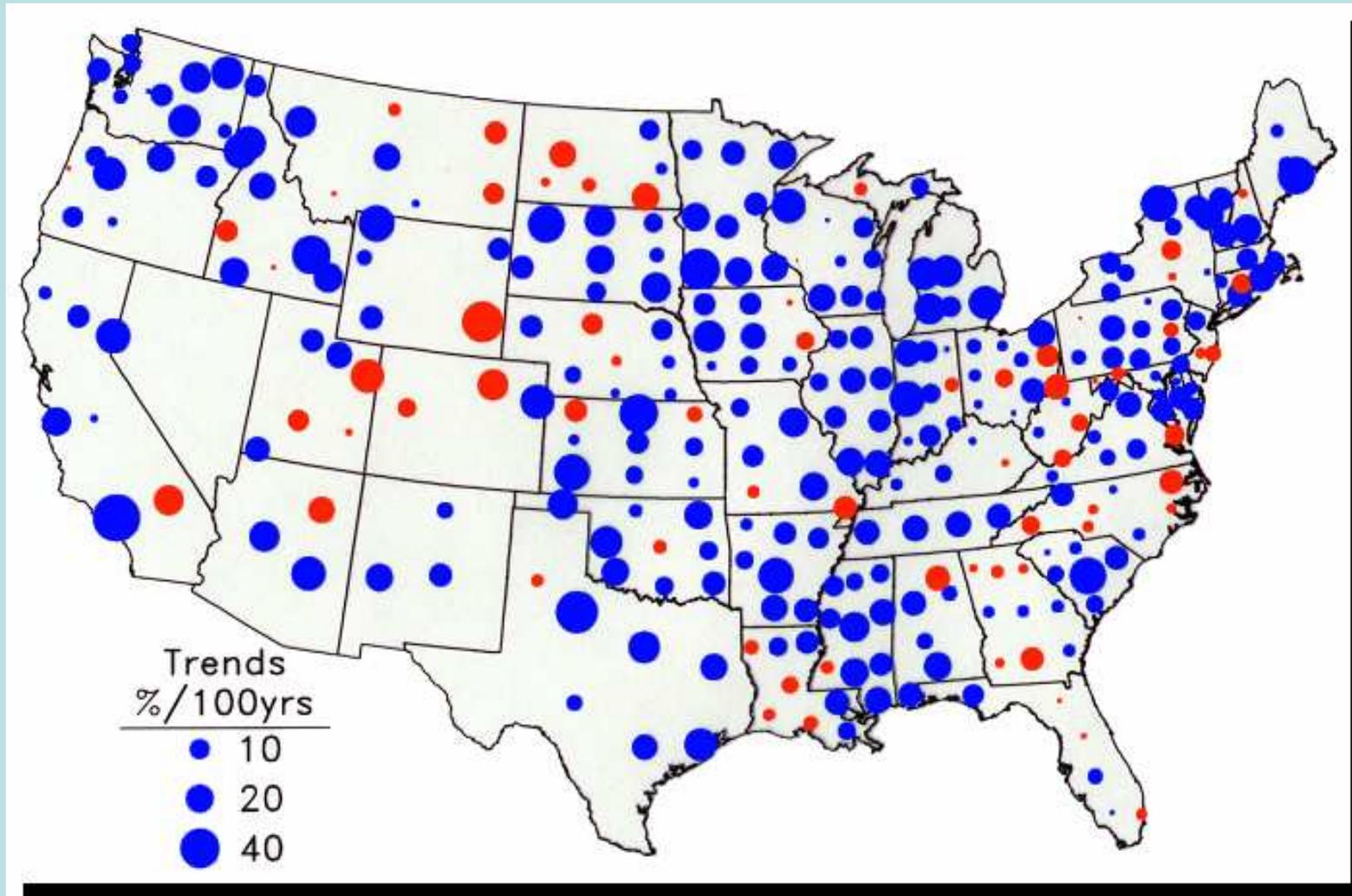
***I want to focus on Terrestrial Ecosystems***

# Temperature Trends: 1901 to 1998



Red circles reflect warming; Blue circles reflect cooling  
All Stations/Trends displayed regardless of statistical significance.  
Source: National Climatic Data Center/NESDIS/NOAA

# Precipitation Trends: 1901 to 1998

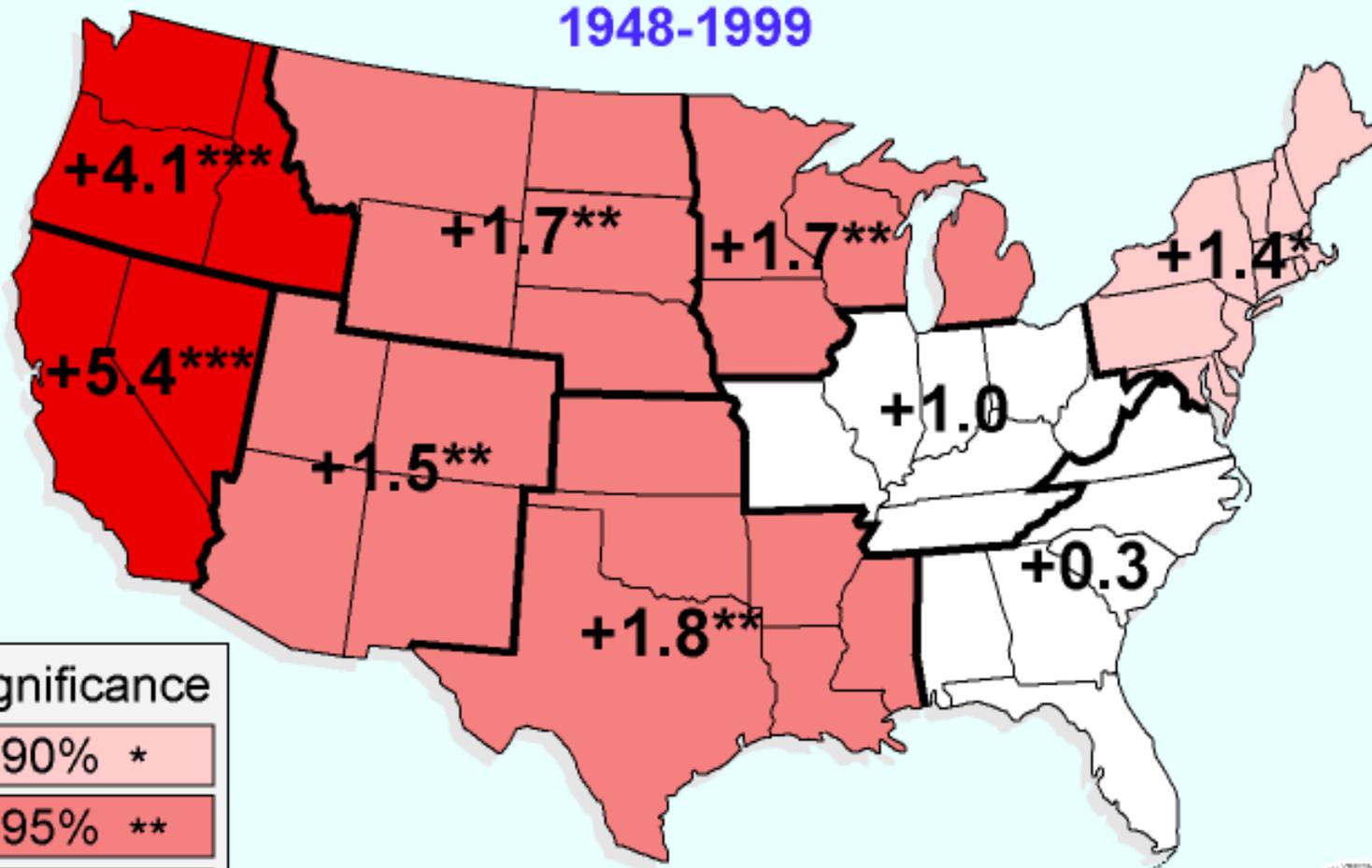


Blue circles reflect increasing precipitation; Red circles reflect decreasing precipitation

All Stations/Trends displayed regardless of statistical significance.

Source: National Climatic Data Center/NESDIS/NOAA

# CHANGE IN FROST-FREE LENGTH DAYS PER DECADE 1948-1999



## Significance

> 90% \*

> 95% \*\*

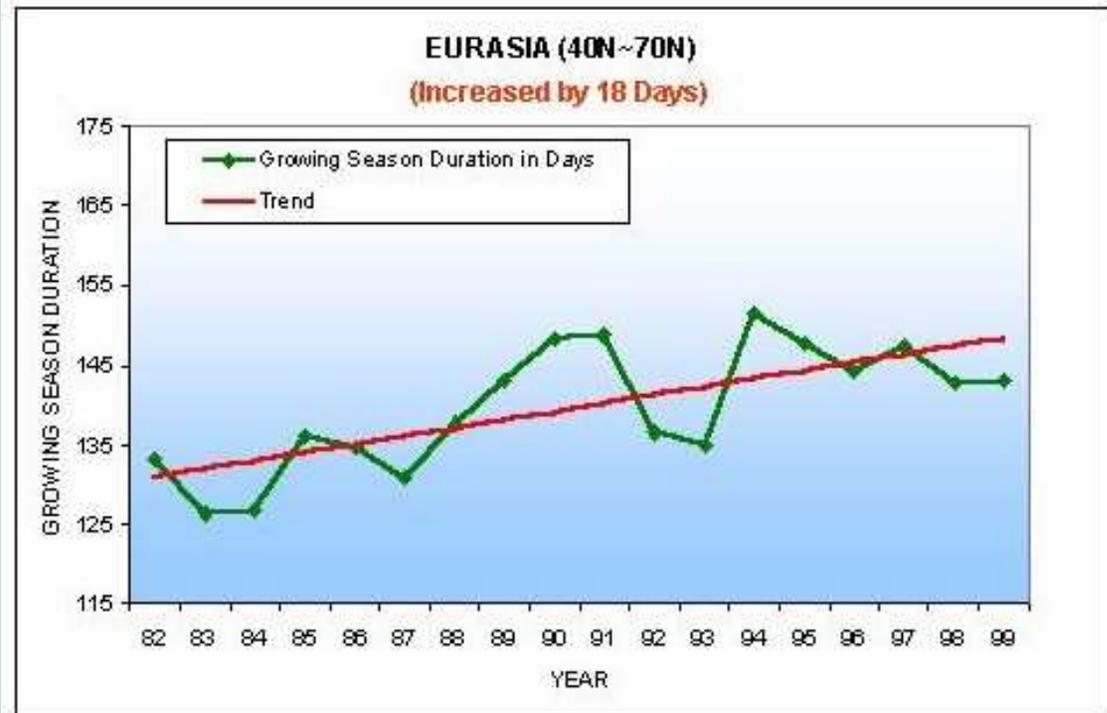
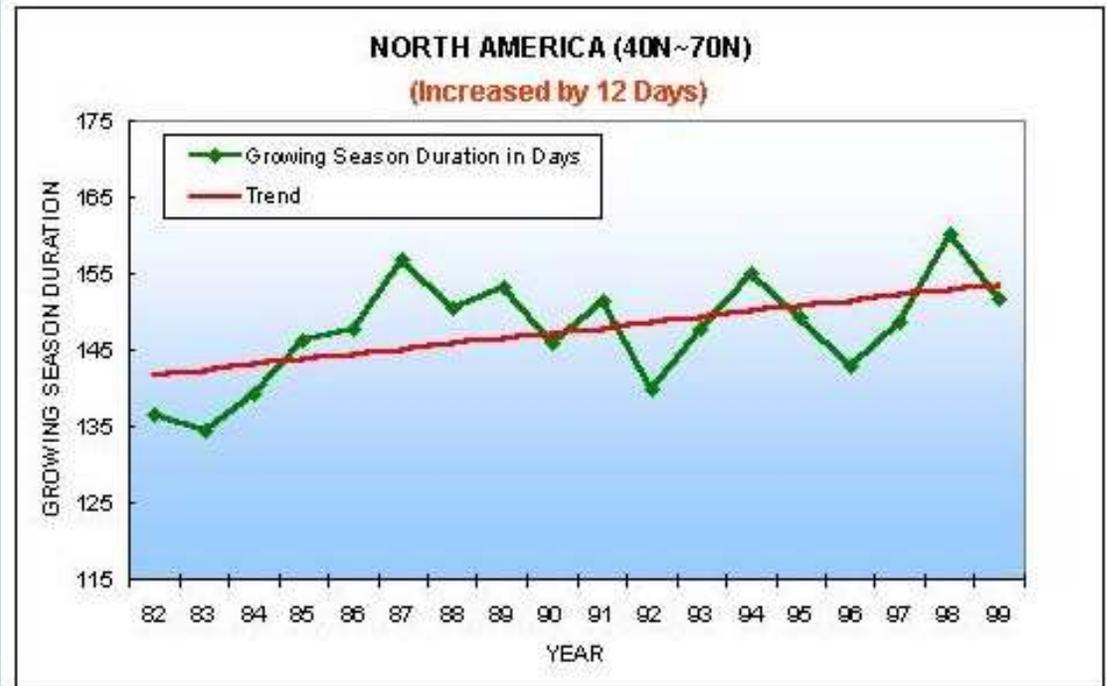
> 99% \*\*\*

Not Significant

All U.S. = +2.0 \*\*\*

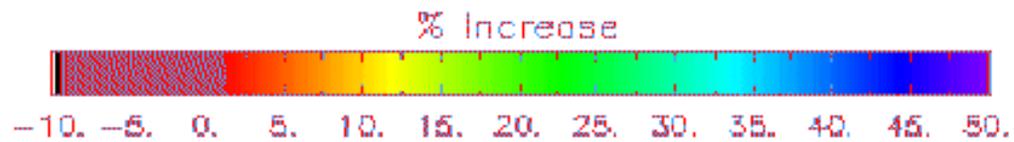
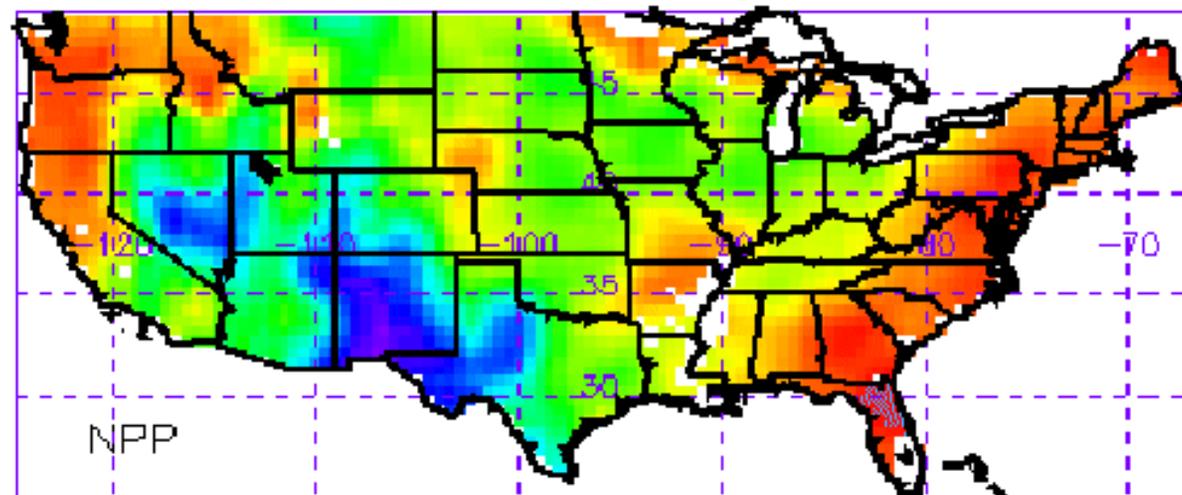
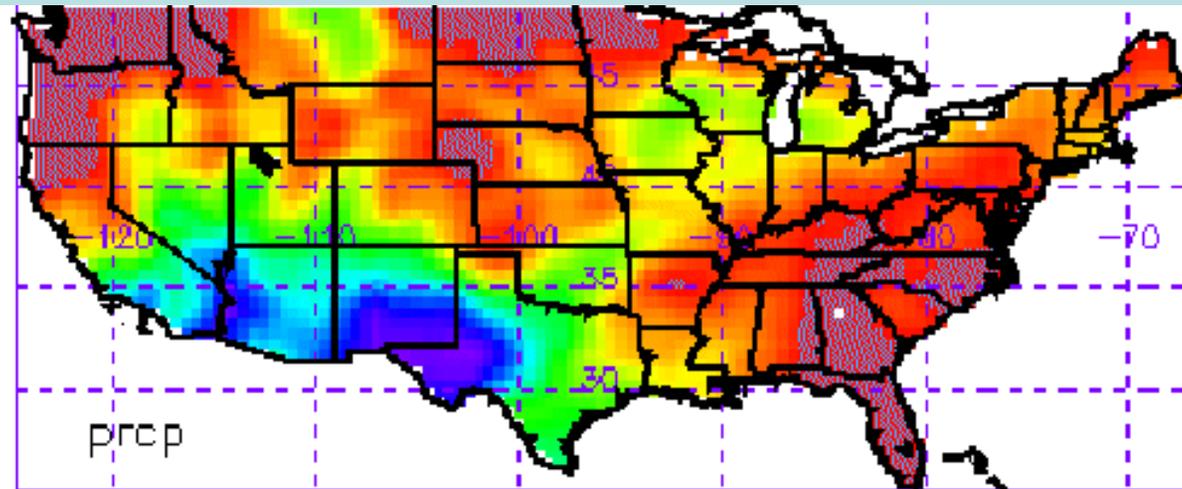


# NDVI DEFINED GROWING SEASON 1982 - 1999

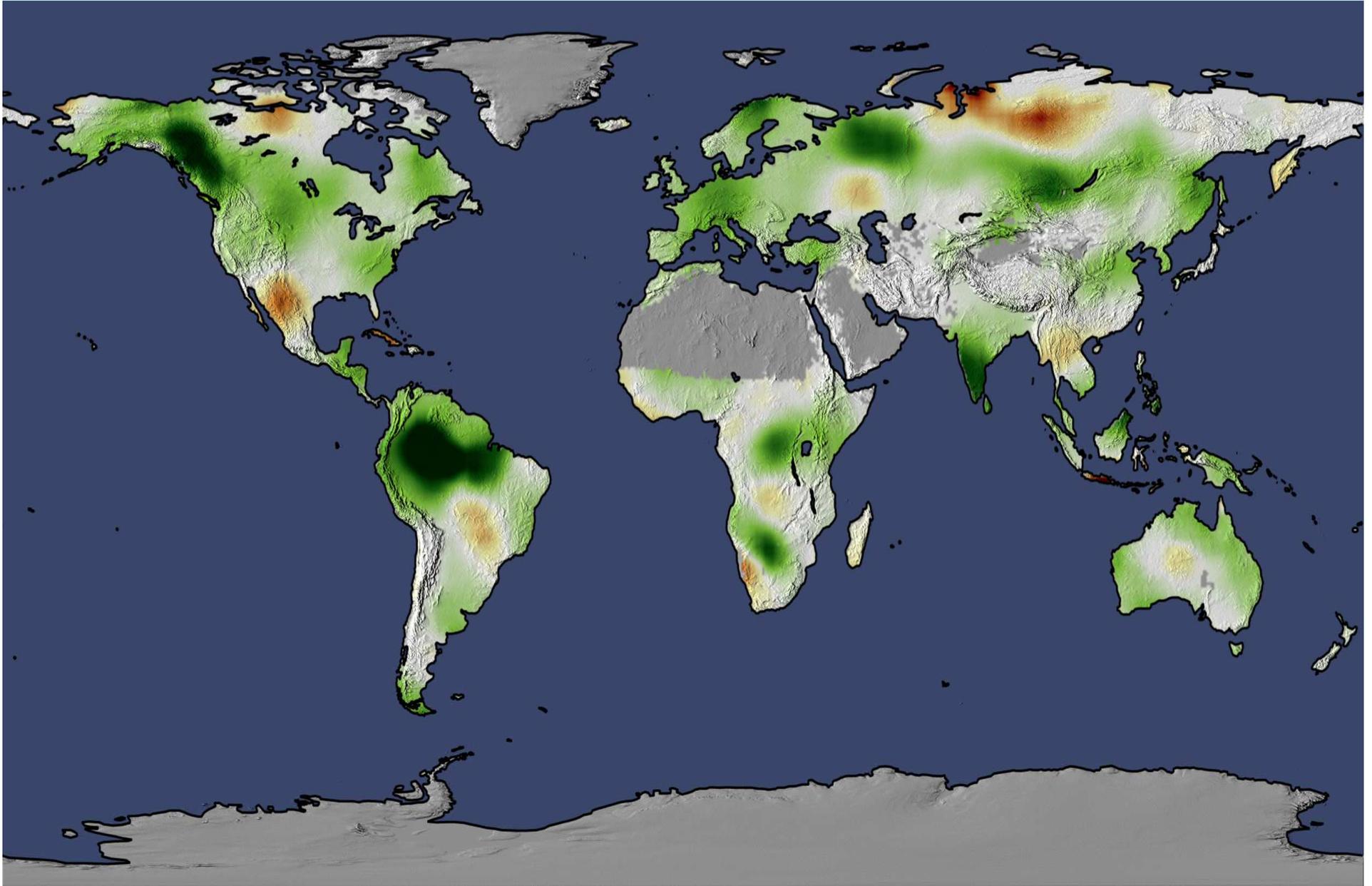


From Myneni et al 2001 JGR

# Geographic Trends in Precipitation and NPP 1944-1993

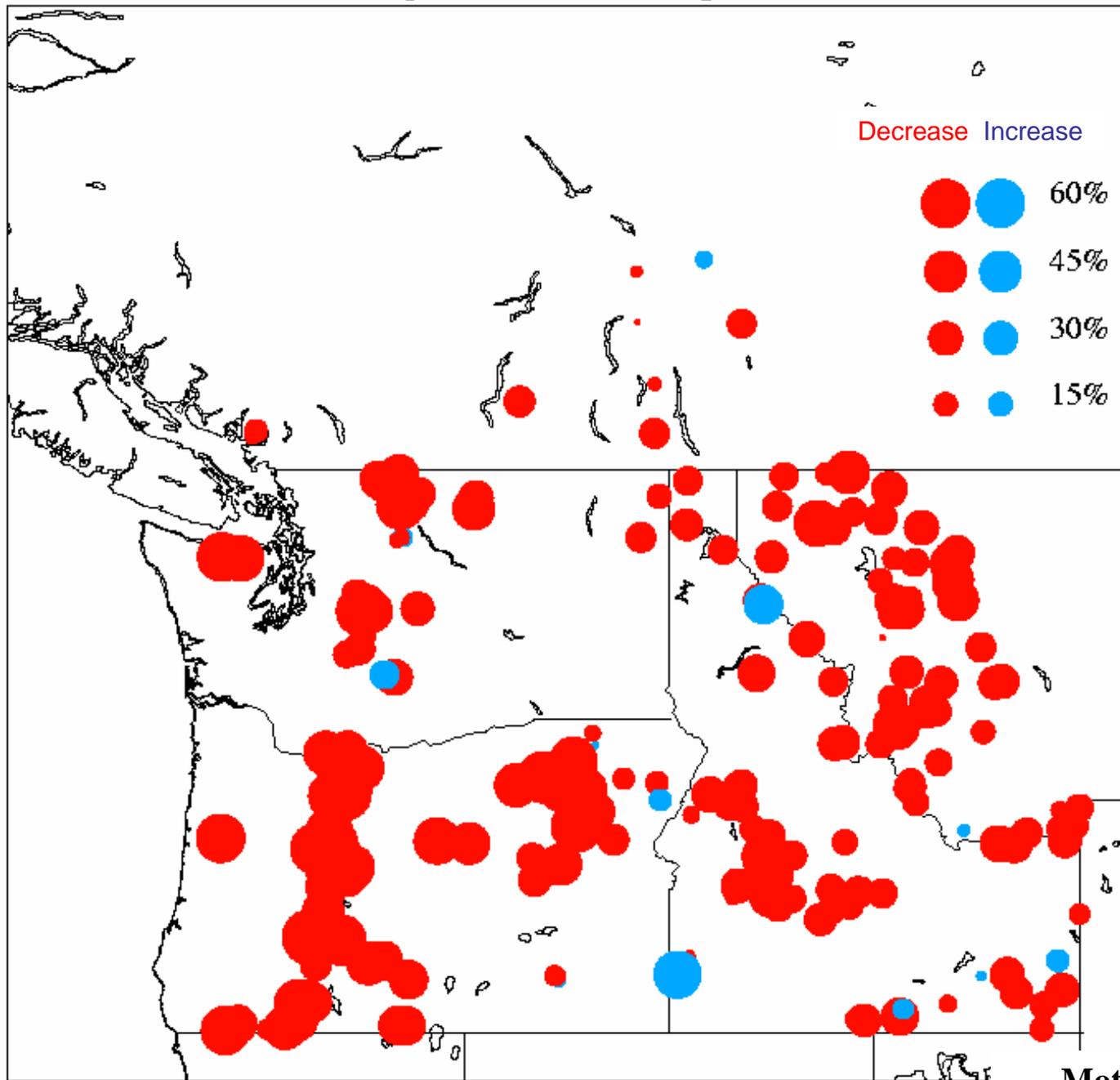


## Change in Terrestrial NPP from 1982 to 1999.



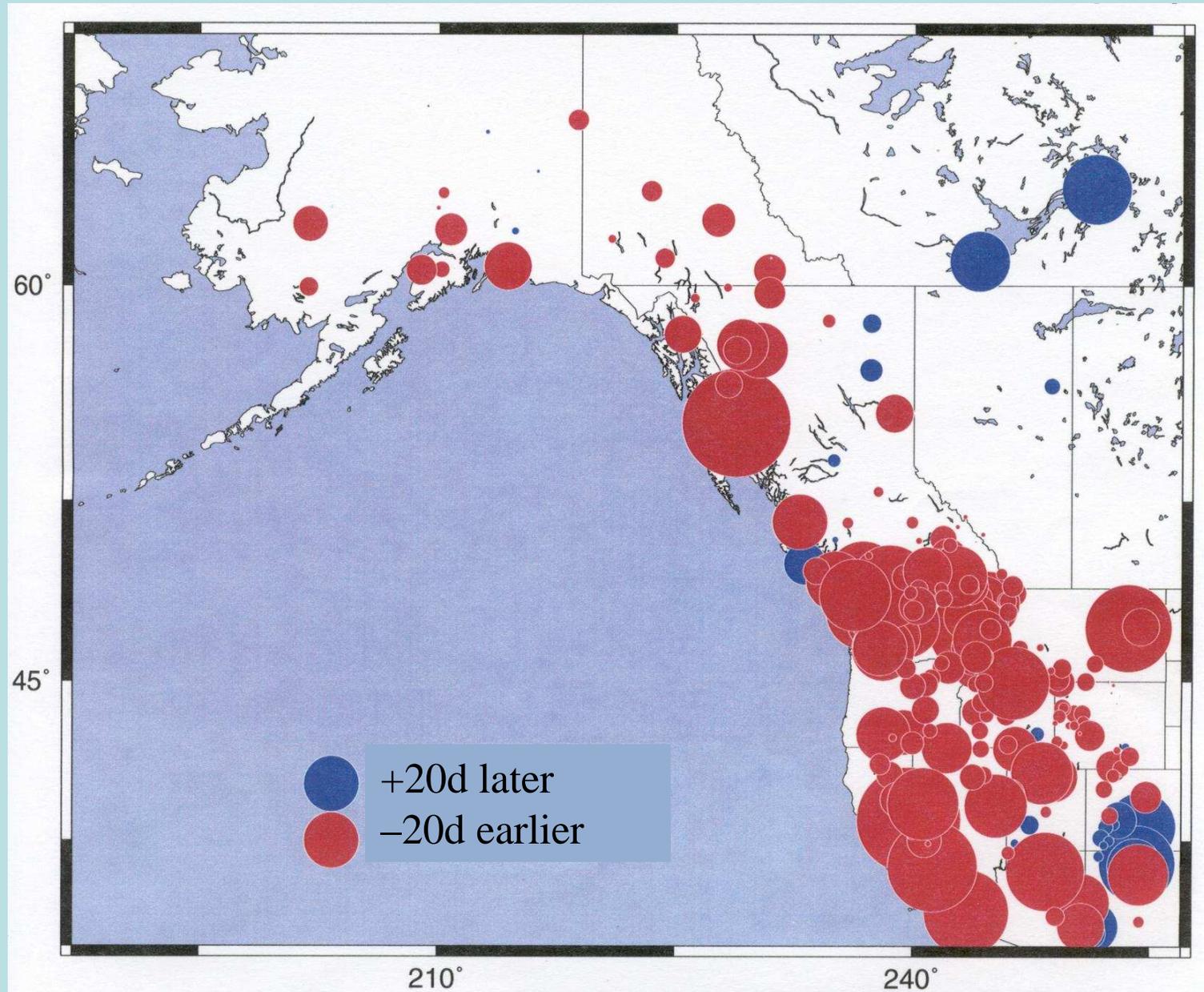
Nemani et al., Science June 6<sup>th</sup> 2003

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

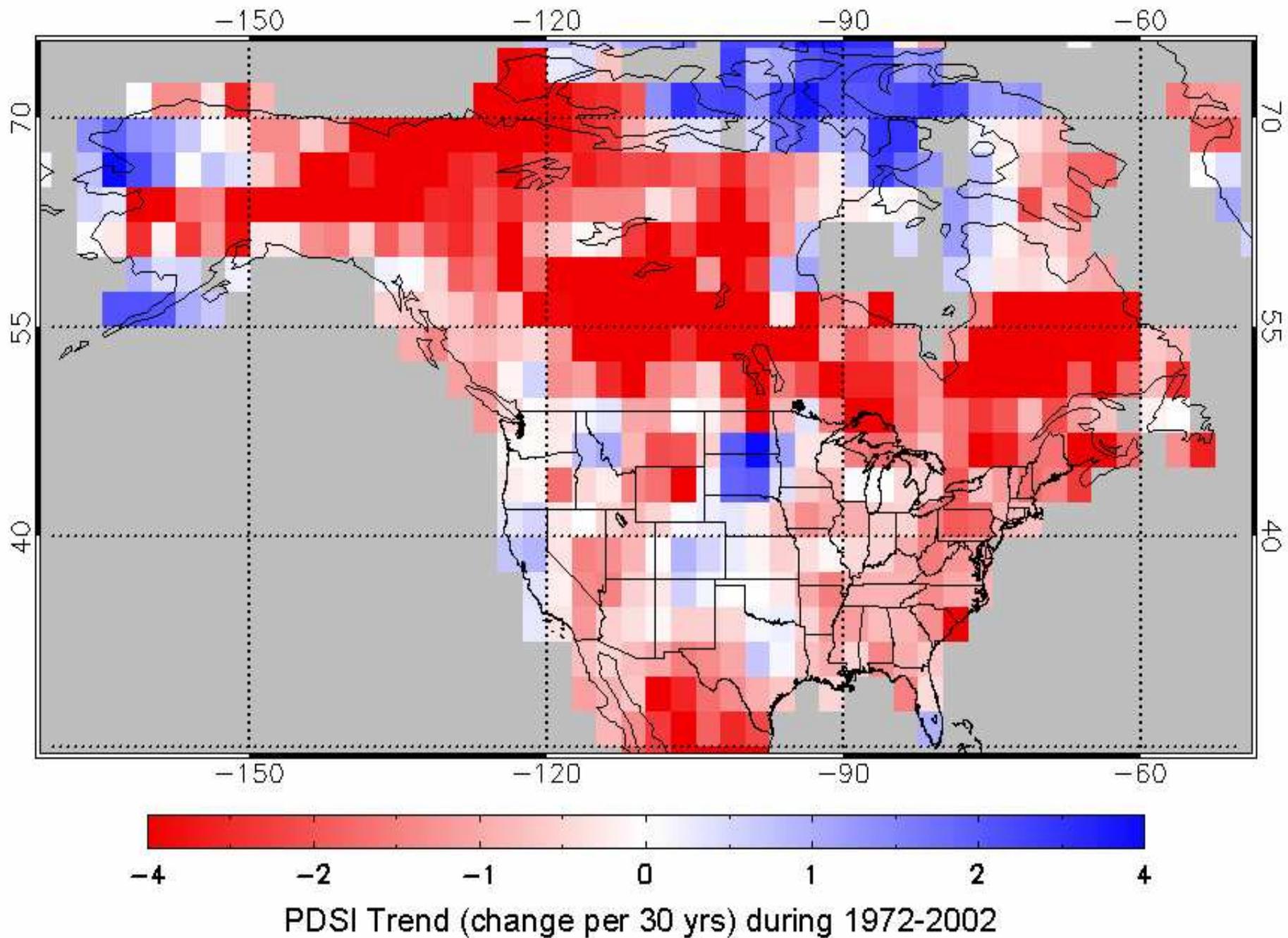


Mote 2003(b)

# Trends in timing of spring snowmelt (1948-2000)



Courtesy of Mike Dettinger, Iris Stewart, Dan Cayan

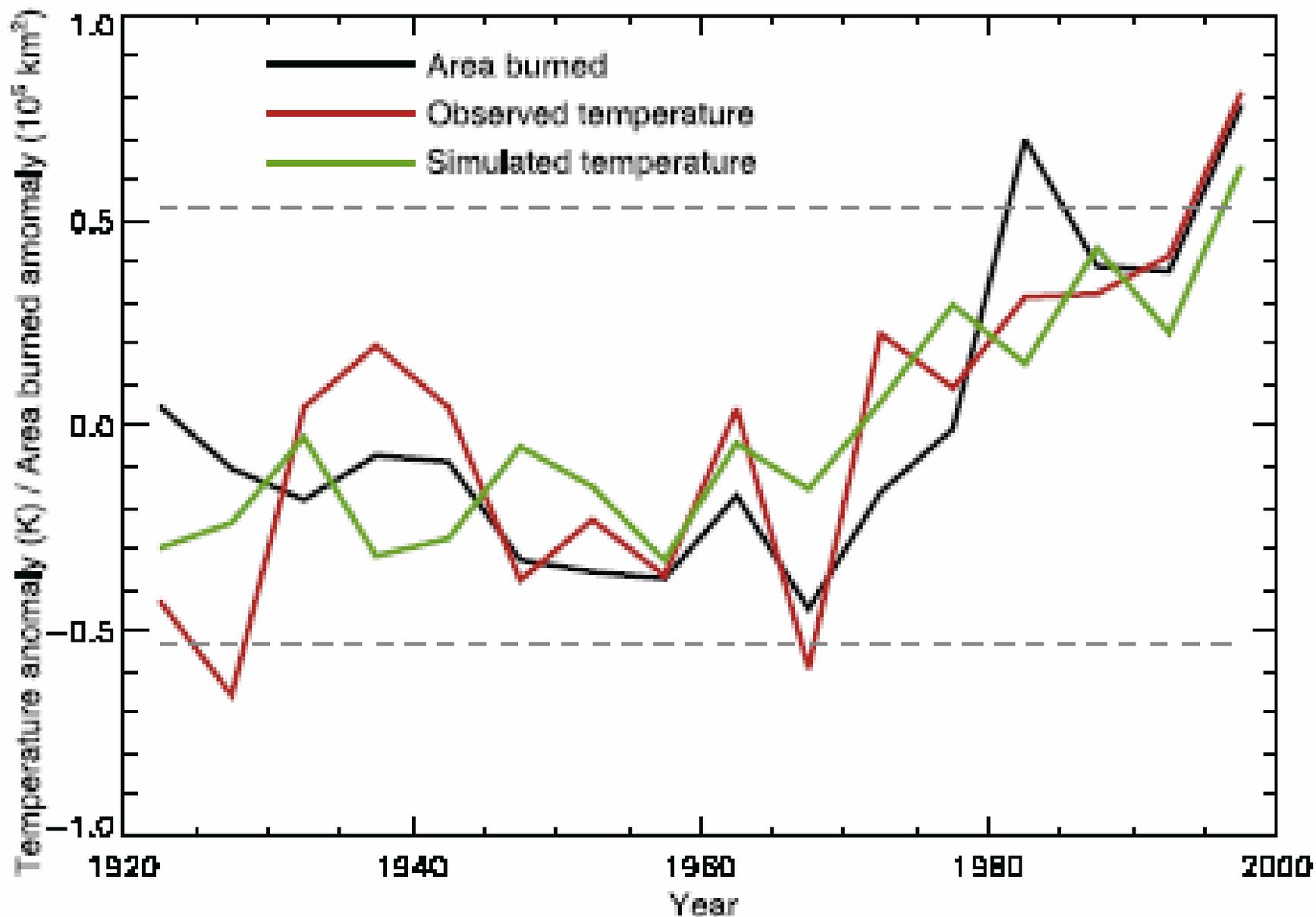


Dai et al. J. Hydromet (2004)

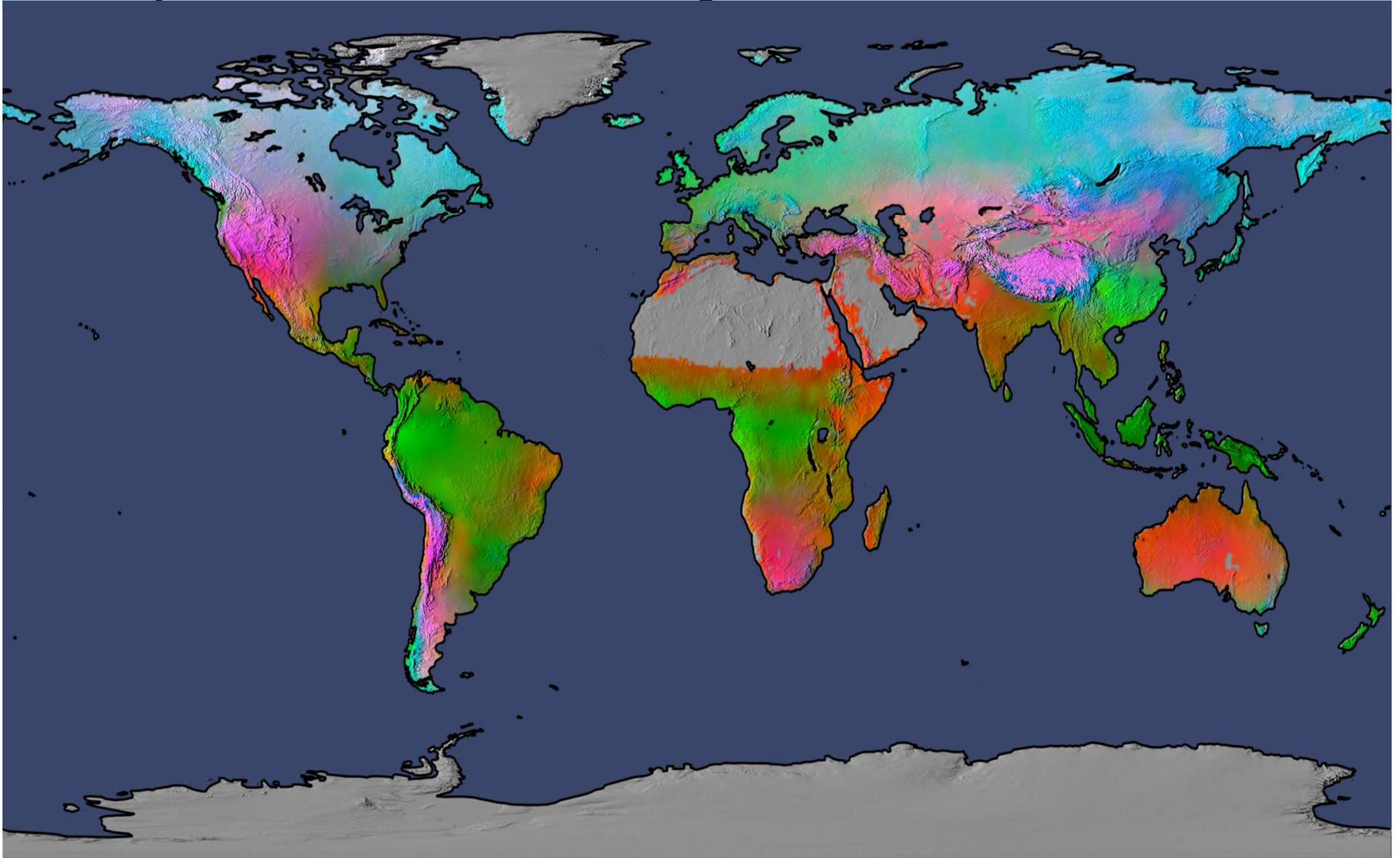
Fires in Montana/Idaho in August 2000  
monitored from the EOS/MODIS satellite



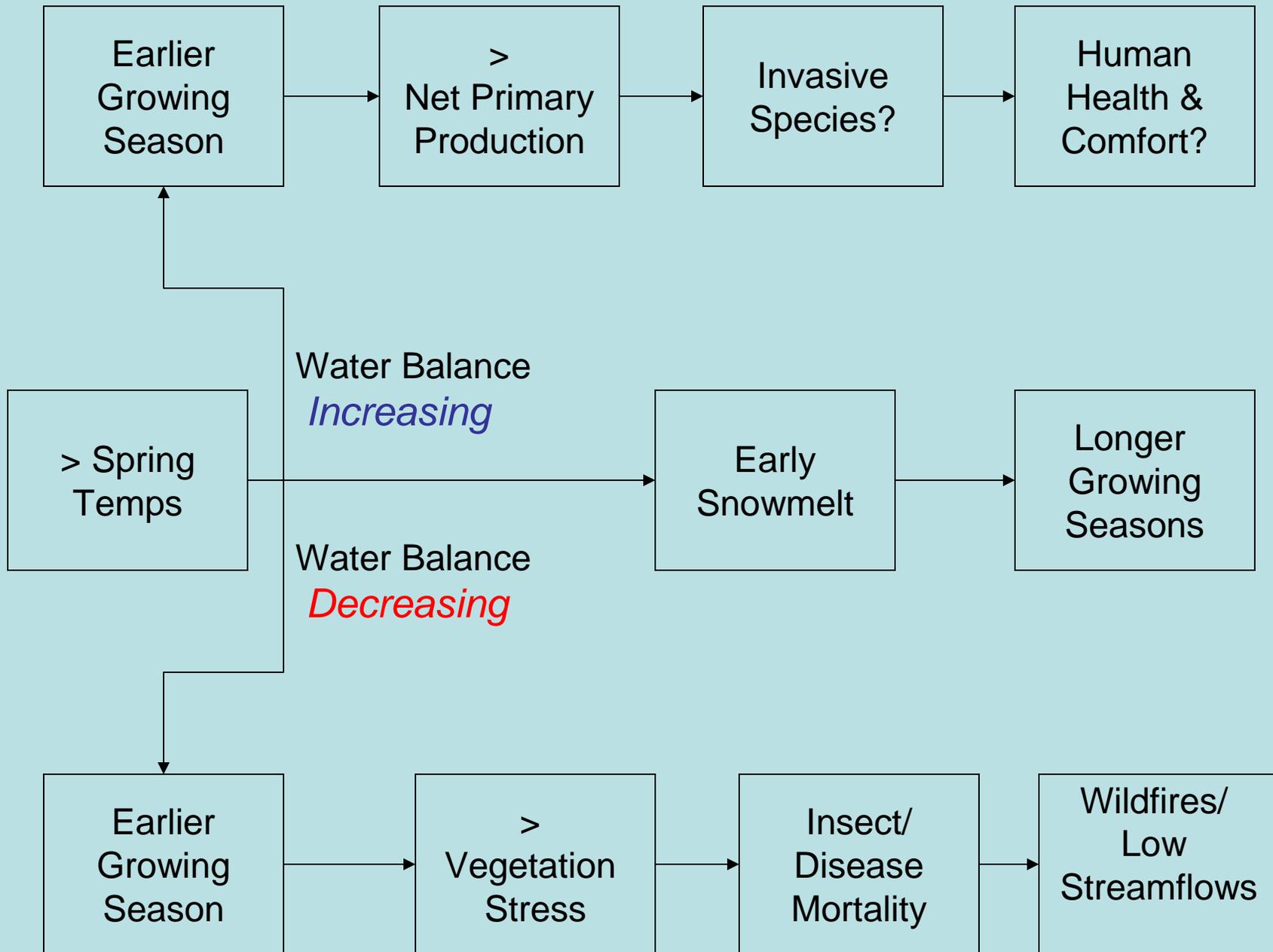
# CANADIAN FOREST FIRE TREND



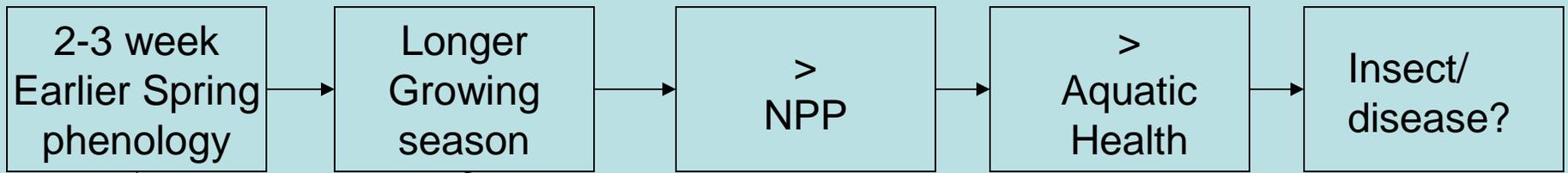
**Potential climate limits to plant growth derived from long-term monthly statistics of minimum temperature, cloud cover and rainfall.**



**Nemani et al., Science June 6<sup>th</sup> 2003**



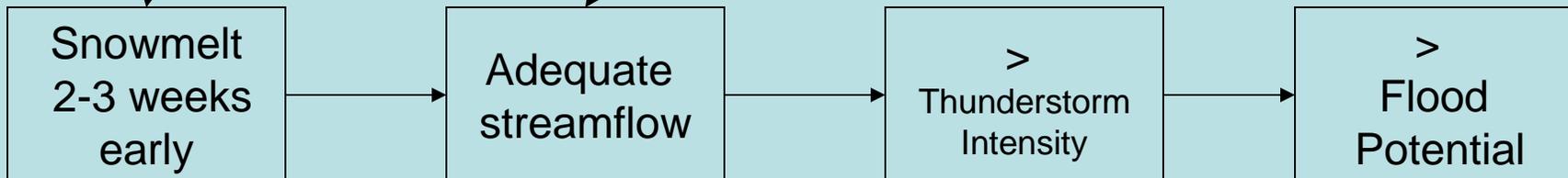
## ECOLOGY



## METEOROLOGY



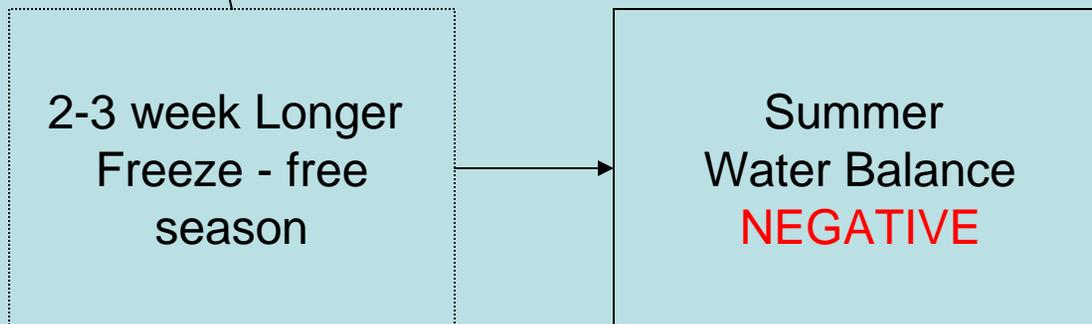
## HYDROLOGY



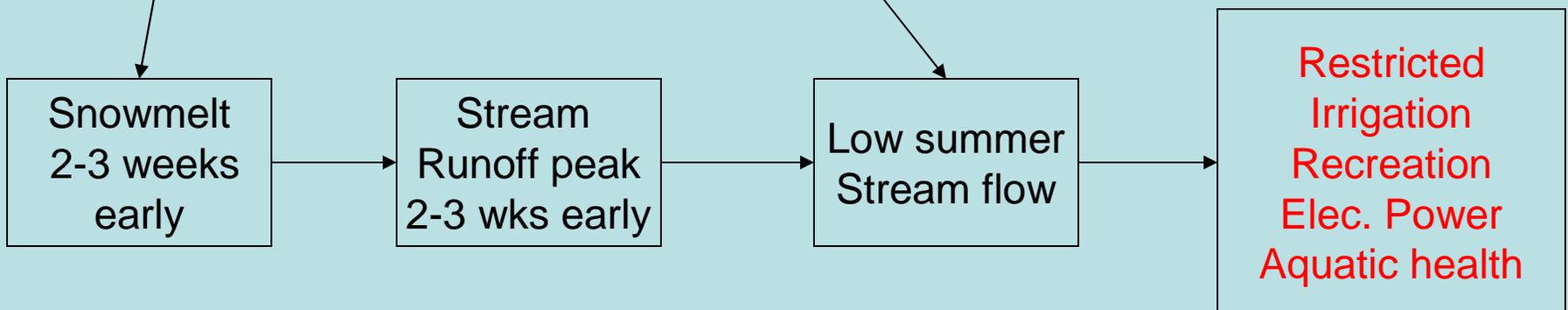
## ECOLOGY



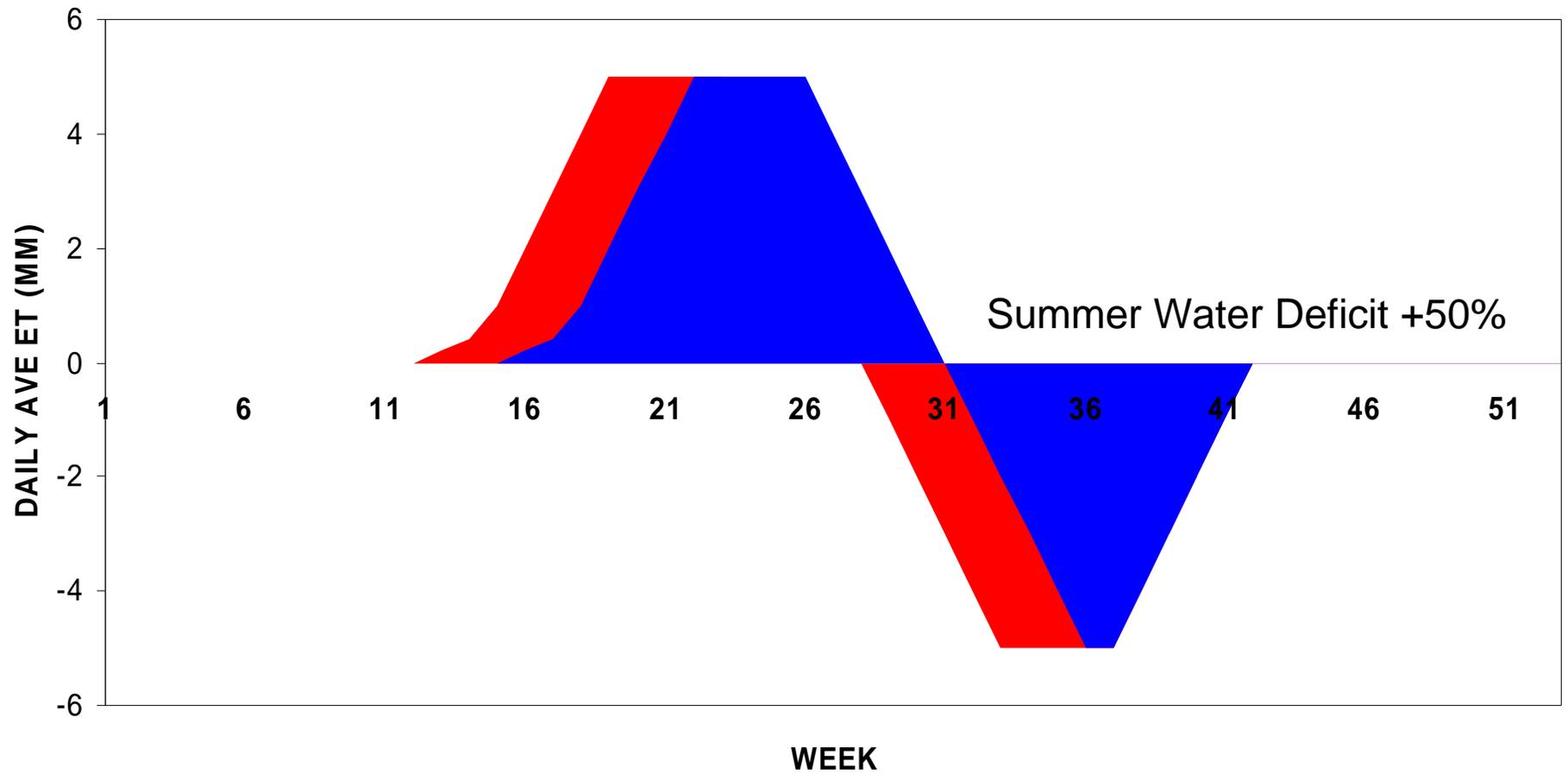
## METEOROLOGY

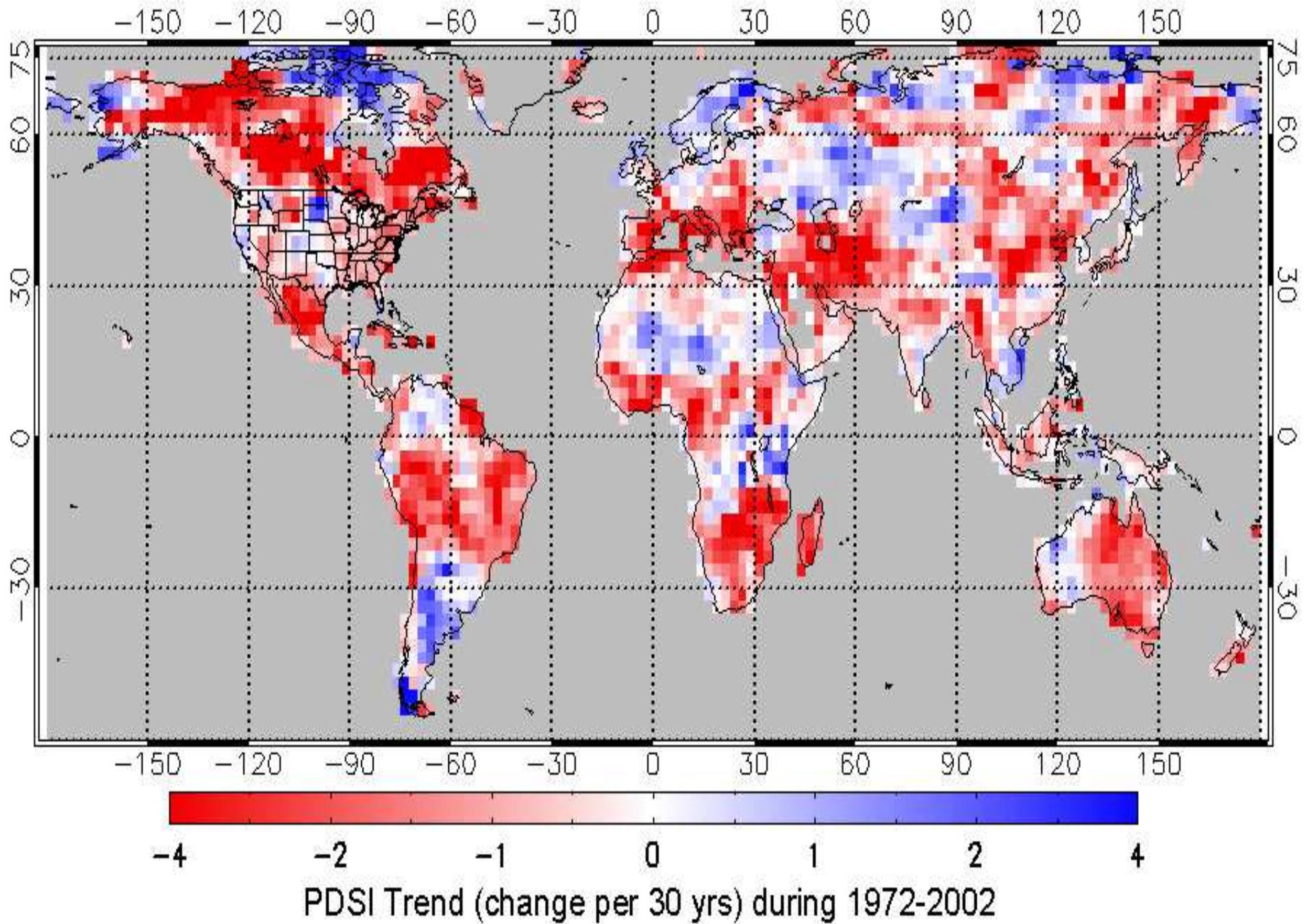


## HYDROLOGY



## CHANGING SEASONAL WATER BALANCE

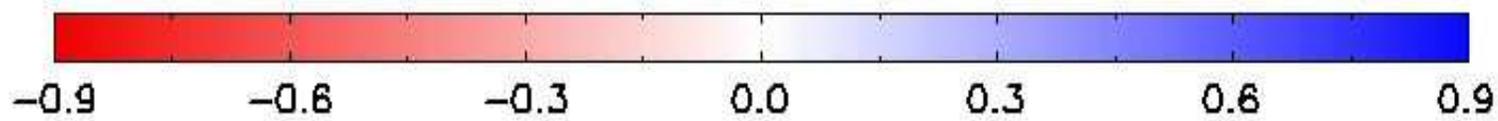
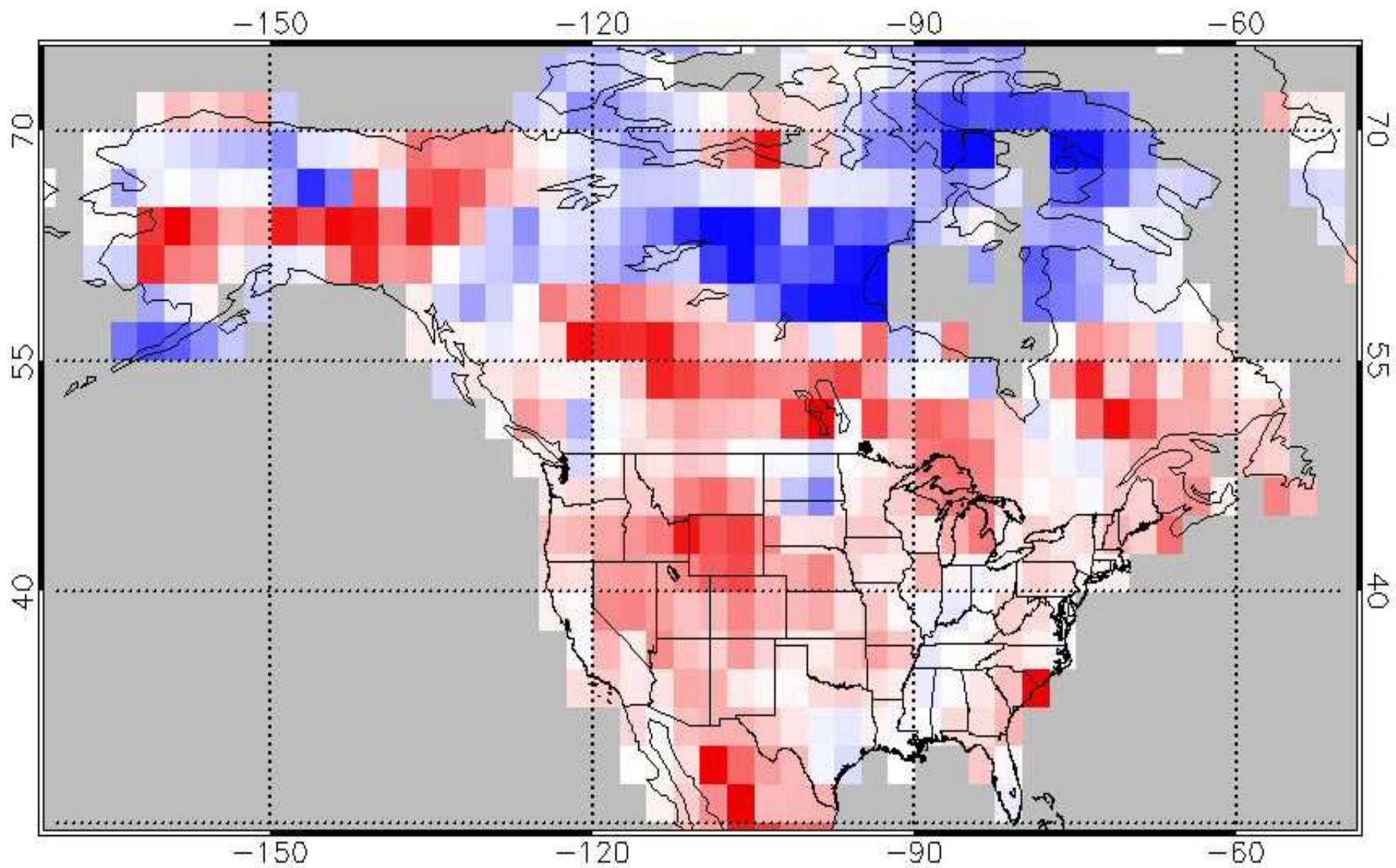




Dai et al. J. Hydromet (2004)



- Might the dry season of tropical ecosystems be getting longer, even if annual precipitation is stable or increasing?



PDSI Trend (change per 10 yrs) during 1994-2003

Dai et al. J. Hydromet (2004)

## DATA SETS NEEDED FOR AN ACCURATE GLOBAL COMPUTATION OF LAND-SURFACE WATER BALANCE TRENDS

- REQs: Time period [1950 – present], daily
- Air temperature – widely available
- Precipitation – widely available
- Solar radiation – sparse
- Specific humidity – very sparse
- Then run a Penman-Monteith model of daily water balance

