

Climate change in the southwestern US: mechanisms, evidence and projections.

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Outline of talk:

- (1) Update on global climate change and the U.S.
- (2) Special focus on the Southwest
- (3) Global warming *plus decadal megadrought* could be biggest threat
- (4) Aggressive focus on both climate change **adaptation** and **mitigation** probably wise



IPCC, 2007

Global Warming is *unequivocal*

Since 1970, rise in:

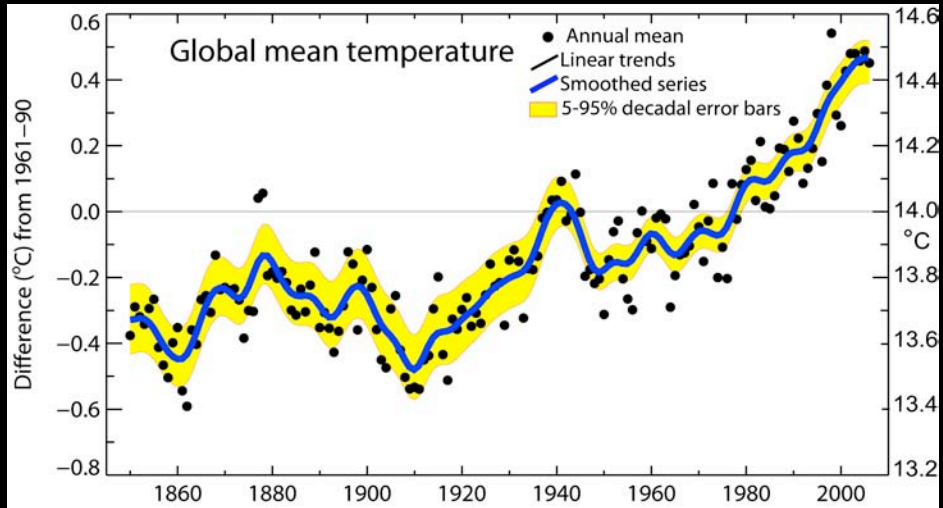
- Global surface temperatures
- Lower atmosphere temperatures
- Global sea-surface temperatures
- Ocean heat content
- Water vapor
- Rainfall intensity
- Extratropical precipitation
- Hurricane intensity
- Global sea level
- Drought
- Extreme high temperatures
- Heat waves

Decrease in:

- NH Snow extent
- Arctic sea ice
- Glaciers
- Cold temperatures

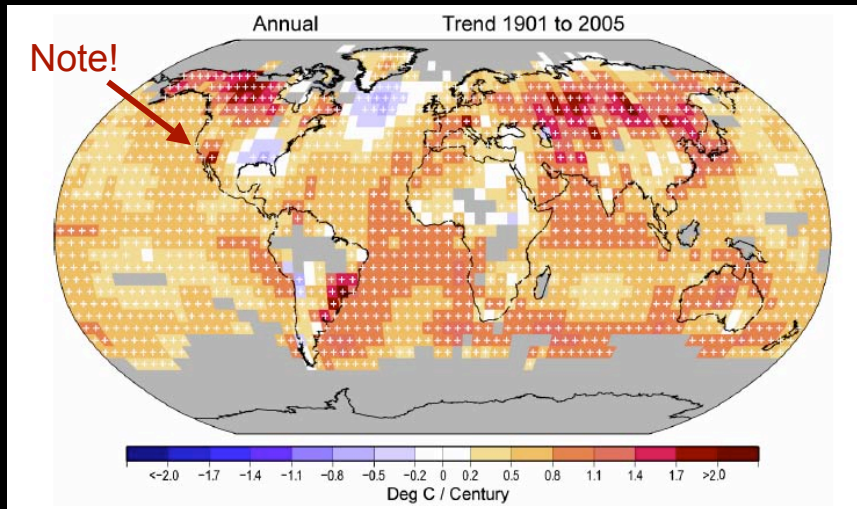


Global mean temperatures are rising faster with time



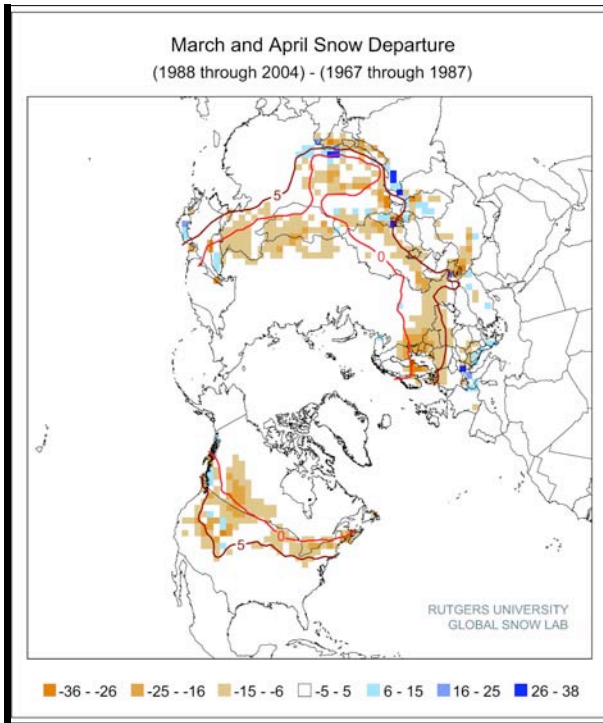
Source: IPCC Working Group I Report (2007)

The Earth has warmed almost everywhere Very likely due to humans



Temperature trend from 1901 to 2005

IPCC, 2007



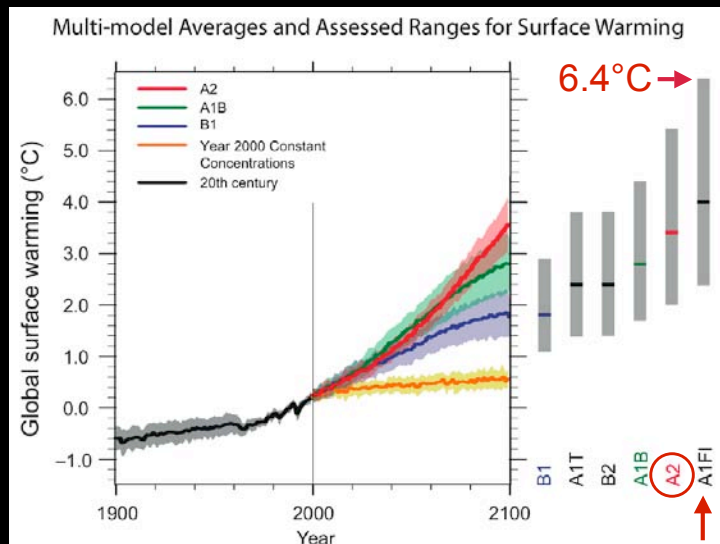
Recent Changes in March and April Percent Snow Coverage

Red lines show recent 0° and 5°C isotherms

Source: IPCC Working Group I Report (2007)

IPCC, 2007

Projected future global warming



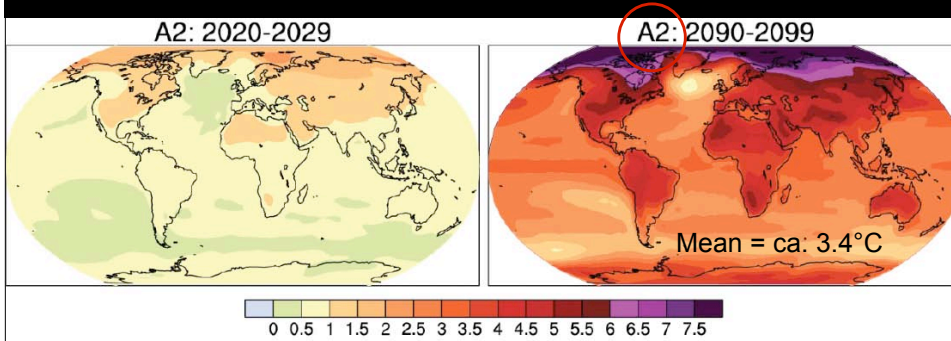
Likely warming depends on emissions scenario

Presently on the fast-track

Bottom lines...

A **global average warming of up to 6.4°C (11.5°F)** is possible by 2100 if carbon emissions are not curbed

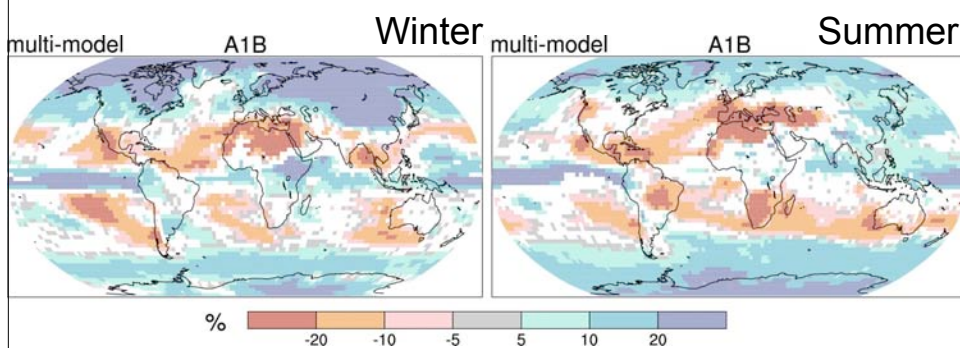
Warming will be **more over land, and at higher latitudes** (i.e., in the U.S. and the poles)



(Differences relative to 1980-99)

Source: IPCC Summary for Policy Makers, February 2007

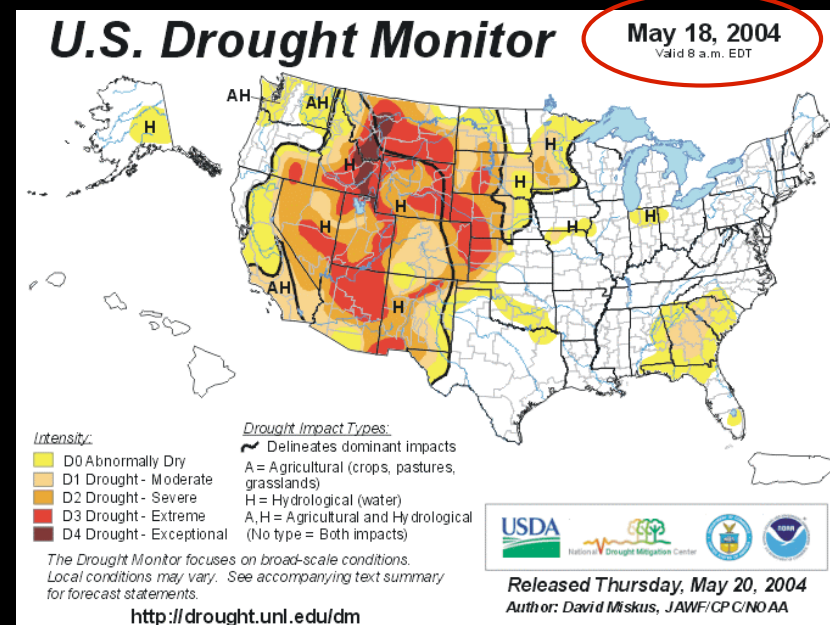
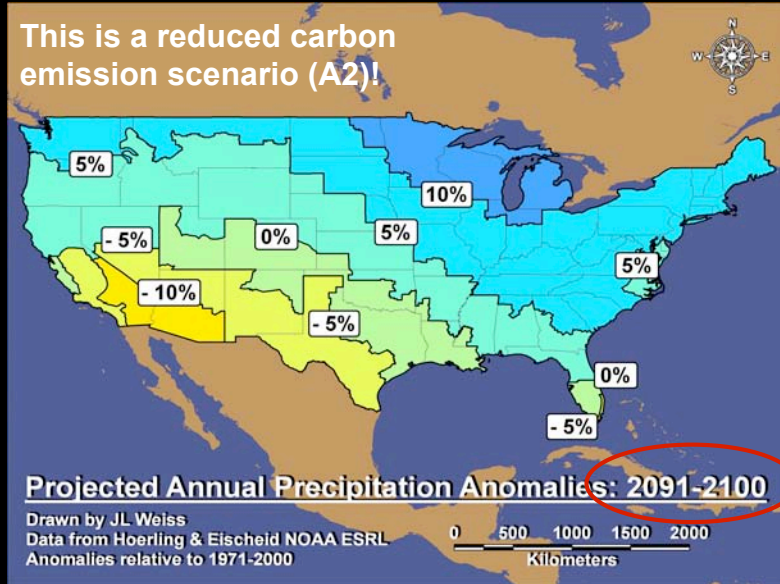
Projected changes in precipitation over the 21st century



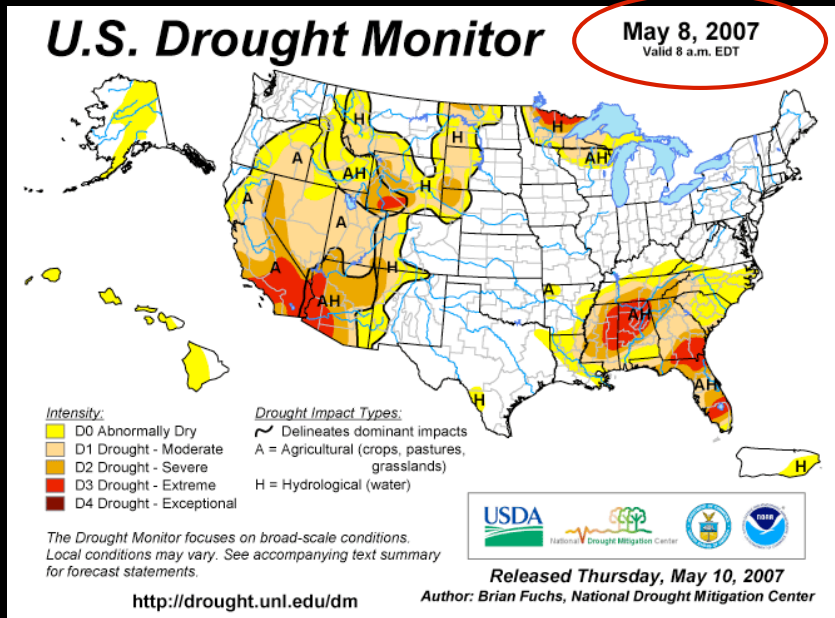
White areas are where less than two thirds of the models agree in the sign of the change

Source: IPCC Working Group I Report (in press)

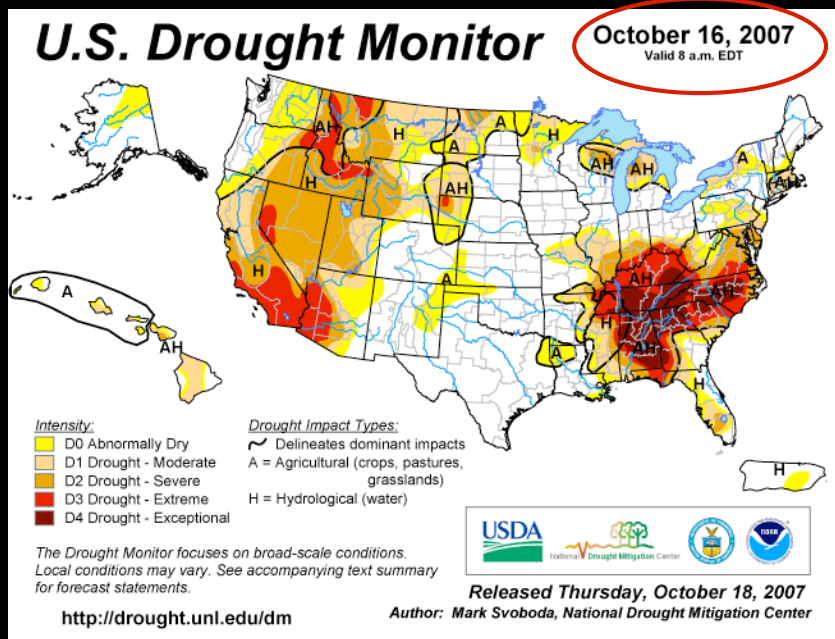
Nearly all IPCC Projections indicate winter drying in the Southwest



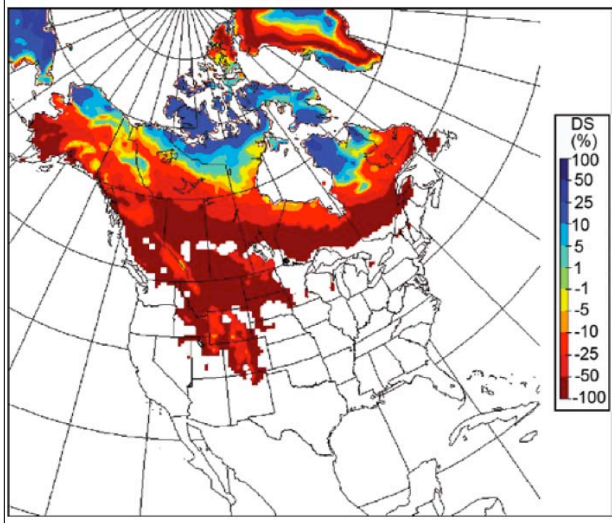
As we entered summer 2007, the drought still persisted...



As we exit summer 2007, the drought still persists...



March snowpack will be rare by mid-century...



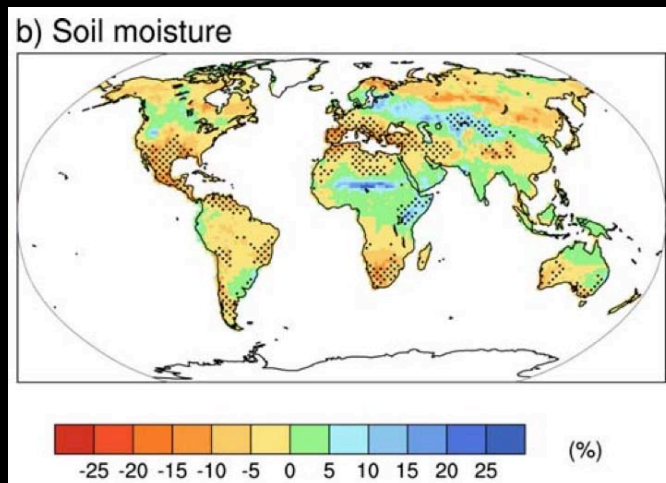
Source: IPCC Working Group I Report (2007)

Projected percent change in March snow depth by mid-21st century

(as simulated by the Canadian Regional Climate Model - change only plotted where there is currently at least 5mm of average snow depth in March)

The Southwest will be hit hard

Increased temperatures, decreased precipitation and increased probability of drought are all likely

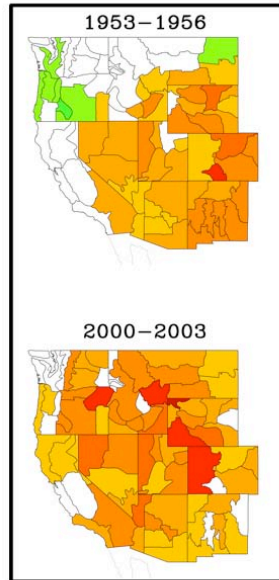


Source: IPCC Working Group I Report (in press)

M. Hoerling and
J. Eischeid
(*Southwest
Hydrology*, 2007)

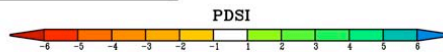


Historical



Palmer Drought
Severity Index
(PDSI)

WHITE color
means no
drought

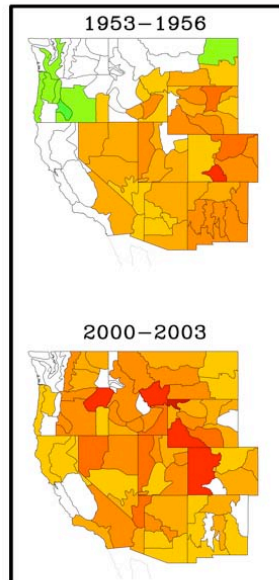


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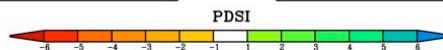
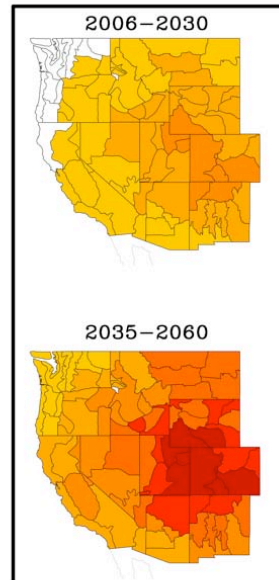


The U.S.
West is
destined to
become
more
drought-like
on average

Historical



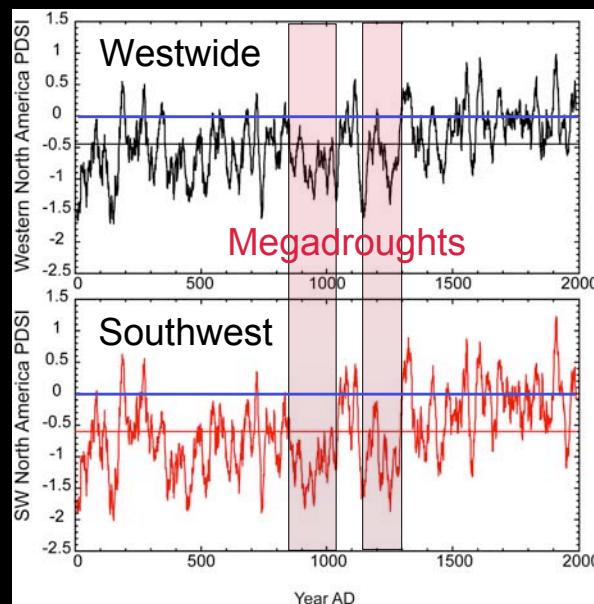
Future



*Increased temperature will
drive a more arid west...*

*...but don't forget the ability of
the climate system to deprive
the West of moisture for
decades at a time...*

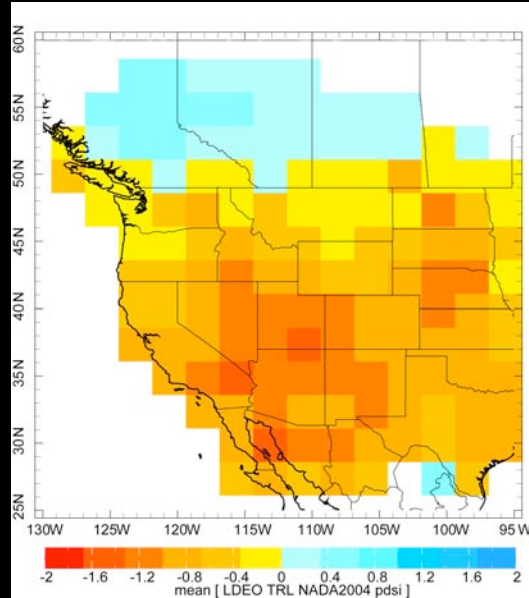
Tree-ring reconstructed hydrologic balance, 1
1 to 2003 AD



*After Cook et al.,
Science, 2004*

Mean PDSI, 1130-1300 Megadrought

170 years
of drought



After Cook et al.,
Science, 2004

Conclusions (1 of 2)

- Global warming (etc.) is very real - and impacting the Southwest (and the West more generally!)
- Humans are causing the problem - little doubt
- More climate change (and drought!) is a sure bet - ***we must develop adaptation capability***

Arizona population
(5M) projected to
double by 2030

California
population to go
up 37% (up 12M)
by 2030

Conclusions (2 of 2)

- **Biggest changes are avoidable** if action is taken to start soon to dramatically reduce carbon emissions to the atmosphere
- *California's goal of reducing emissions to 80% below 1990 levels by 2050 probably on target*



Photo: J. Overpeck