

Climate Change and Conflict: A Provocative Assessment.

Jonathan Overpeck, The University of Arizona



Outline of talk:

- (1) Update on global climate change
- (2) Special focus on potential climate change conflict hotspots
- (3) Aggressive focus on climate change **adaptation** and **mitigation** probably wise



ECR2008



The Norwegian Nobel Committee

THE NOBEL PEACE PRIZE FOR 2007

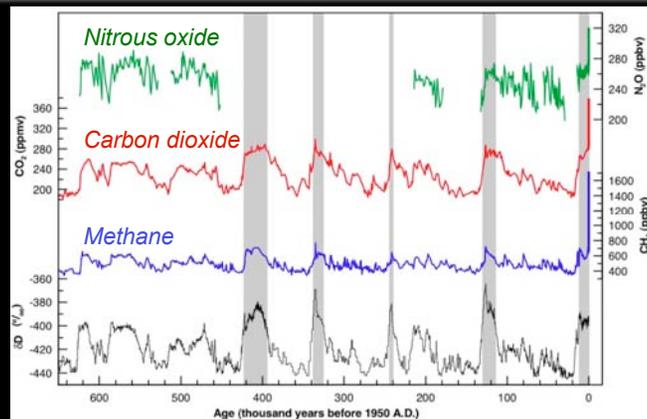
What does climate change have to do with peace?

IPCC Intergovernmental Panel on Climate Change
The Nobel Peace Prize 2007

Photo Gallery



Current greenhouse gas concentrations **far** above natural



IPCC, 2007

IPCC, 2007

Global Warming is *unequivocal*

Since 1970, rise in:

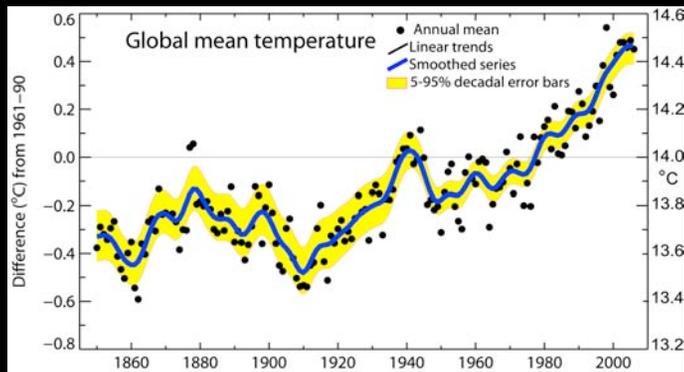
- Global surface temperatures
- Extreme high temperatures
- Heat waves
- Lower atmosphere temperatures
- Global sea-surface temperatures
- Ocean heat content
- Water vapor
- Extratropical precipitation
- Rainfall intensity
- Drought
- Hurricane intensity
- Global sea level

Decrease in:

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

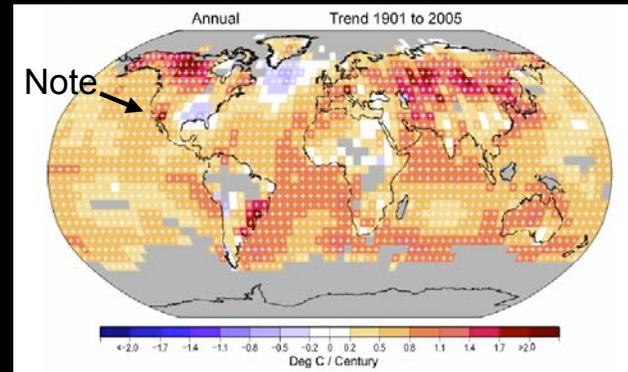


Global mean temperatures are rising faster with time



IPCC, 2007

The Earth has warmed almost everywhere - very likely (90% sure) due to humans

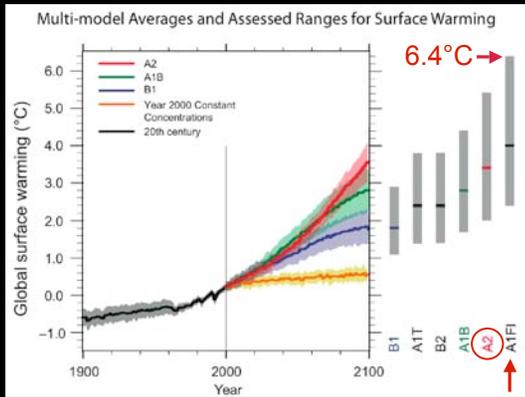


Temperature trend from 1901 to 2005

IPCC, 2007

IPCC, 2007

Projected future global warming

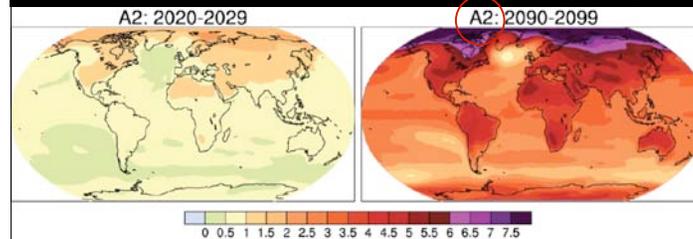


Likely warming depends on emissions scenario

Presently increasing than on the fast-track A2 scenario

Bottom line... A2 scenario and average of all models yields 3.5°C global average warming

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



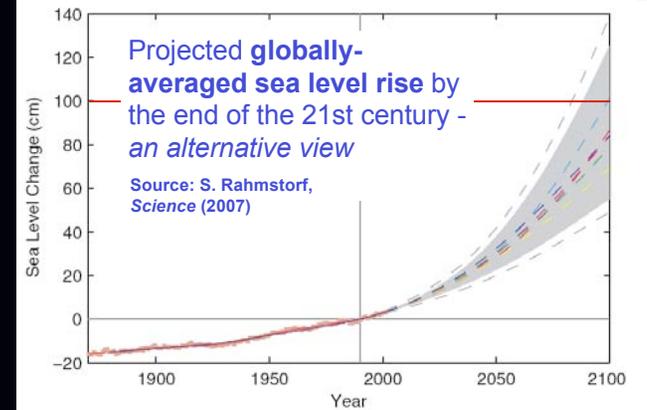
(Differences relative to 1980-99)

NOTE: A global average warming of up to 6.4°C is possible by 2100 if carbon emissions are not curbed

IPCC, 2007

Sea level change

Could it could be worse than widely believed ?



2008 *Nature Geoscience* Rohling et al., confirms 1+m per century is possible

More from the new IPCC report...

Current models suggest ice ... mass balance becomes negative at a **global average warming (relative to pre-industrial values) in excess of 1.9 to 4.6°C**. **If a negative surface mass balance were sustained for millennia, that would lead to ... sea level rise of about 7 m [23 feet]**.

Source: IPCC *Summary for Policy Makers*, February 2007

What about the last time the Arctic was 3 to 4°C warmer than today?

129,000 to 116,000 years ago

(due to changes in the Earth's orbit rather than increases in greenhouse gases)

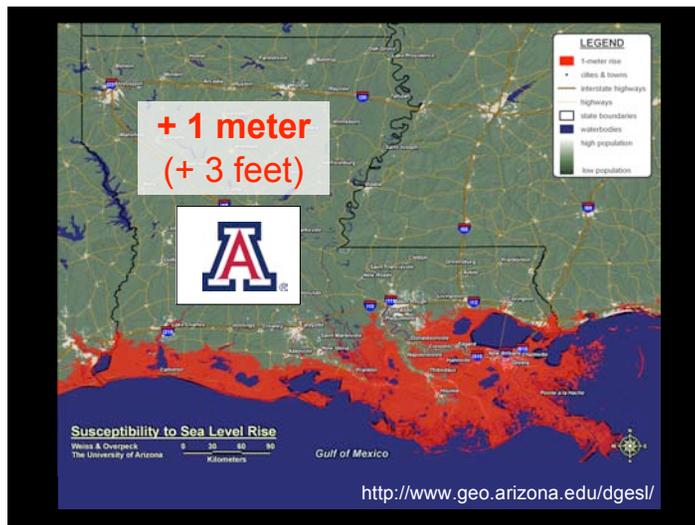
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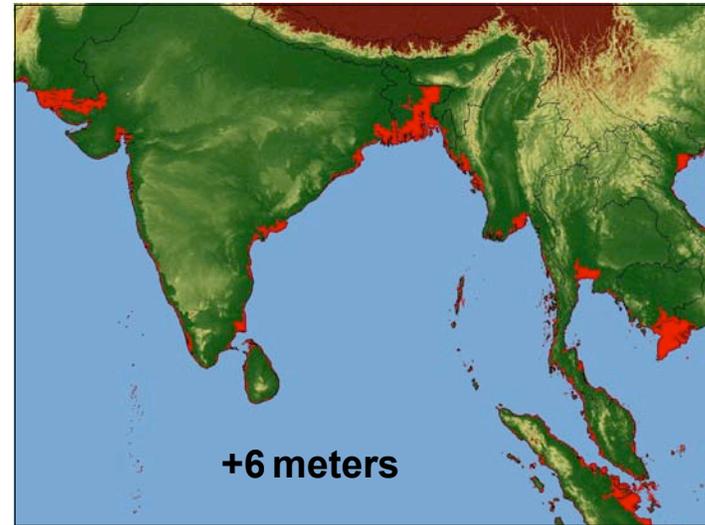
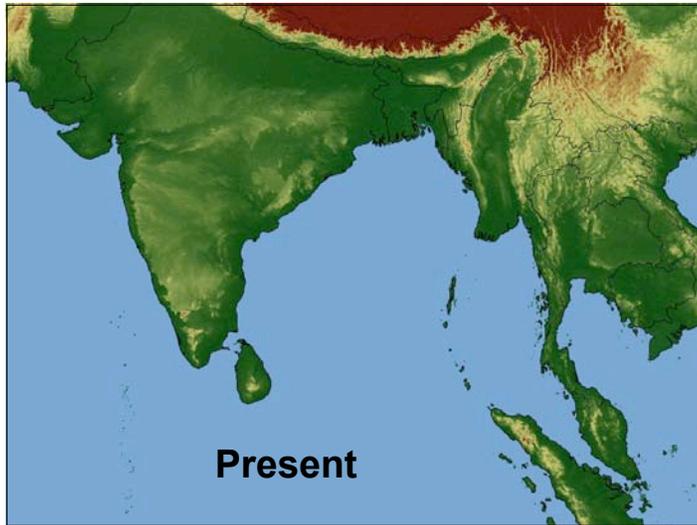
129,000 to 116,000 years ago

*(due to changes in the Earth's orbit rather
than increases in greenhouse gases)*

Sea level was 4 to 9m above present

So what ???





"There is no comprehensive global assessment of the number of people who would be displaced by a 1-meter sea level rise, but it's thought that roughly 1 billion live at sea level or just a few meters above it."

Hinrichsen, 2000



Sovereign nations destroyed by possible future sea level rise

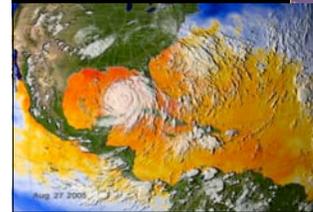
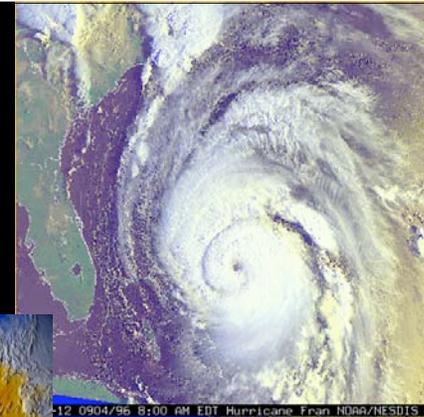
	<u>Rise Required</u>	<u>Population</u>
Indian Ocean		
Maldives	1 meter	291,000
Pacific Ocean		
Marshall Islands	3 meters	51,000
Tuvalu	6 meters	10,000
Kiribati	1 meter (95%)	96,000
Tonga	1 meter (75%)	106,000



And, as if likely sea level rise is not enough...

And - don't forget the likely one-two punch...

Increase in hurricane peak **wind intensities** likely
(IPCC Summary for Policy Makers, February 2007)

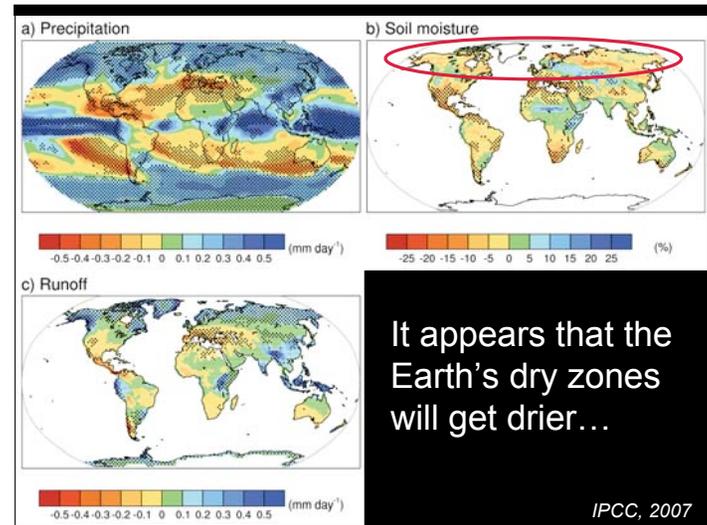
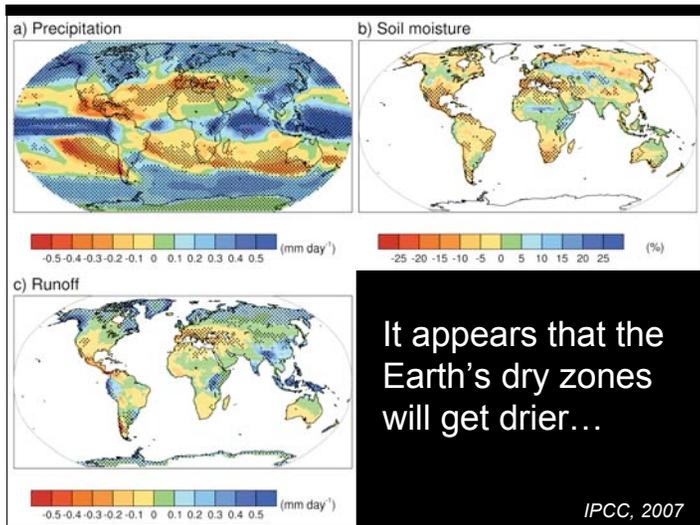
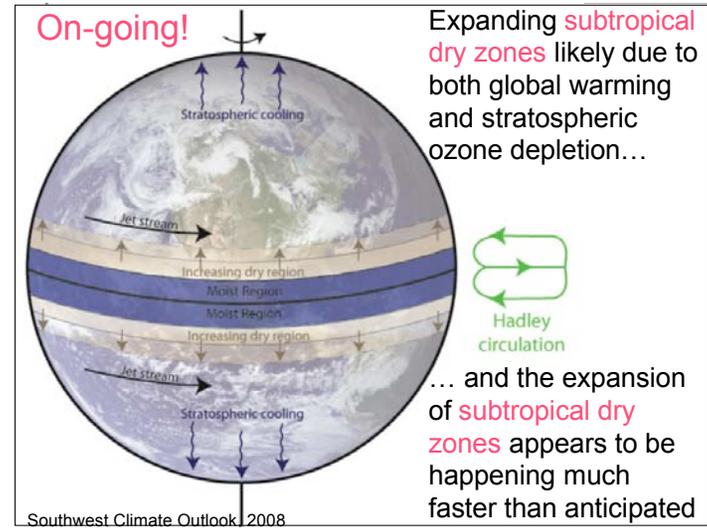
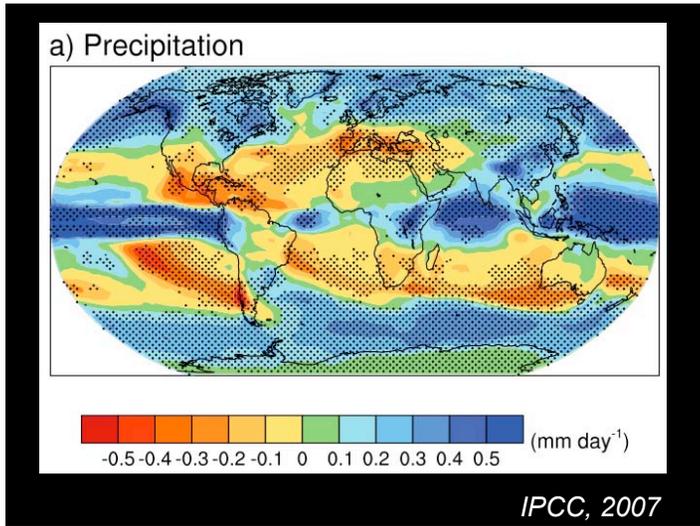


12 0904/96 8:00 AM EDT Hurricane Fran NOAA/NESDIS

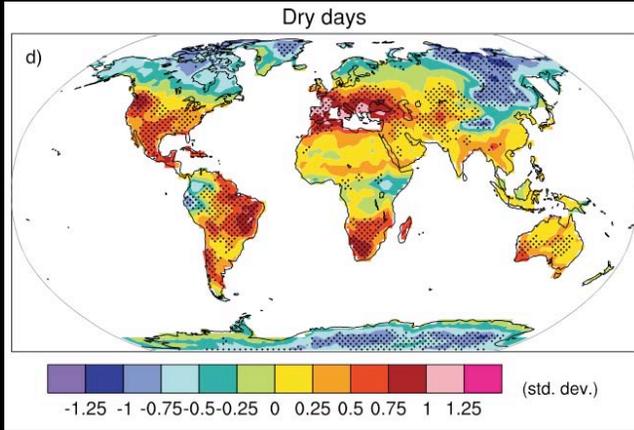
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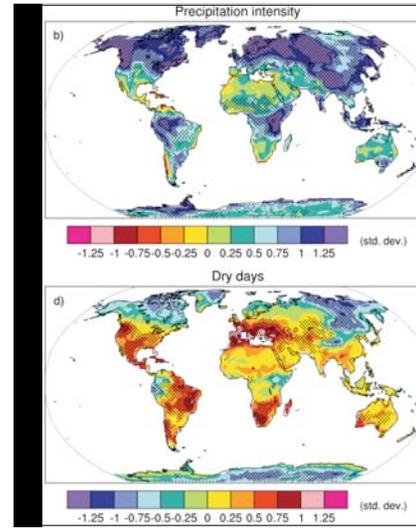
And hydrologic change could create many losers...



Dry zones will also see more drought too



IPCC, 2007

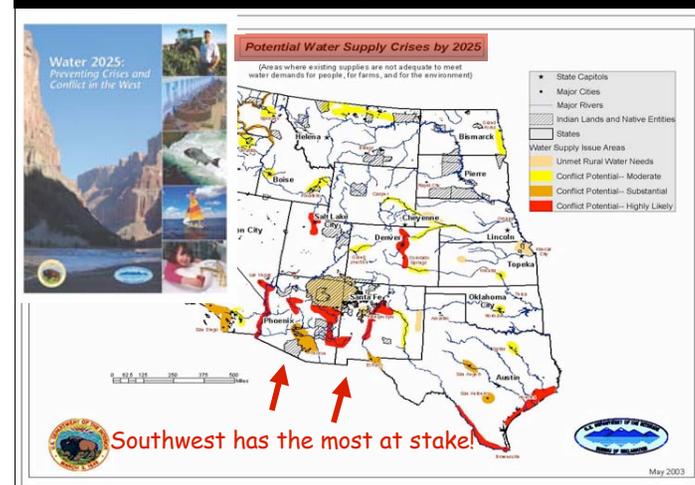


A warmer, more accelerated hydrologic cycle also means more frequent floods

IPCC, 2007

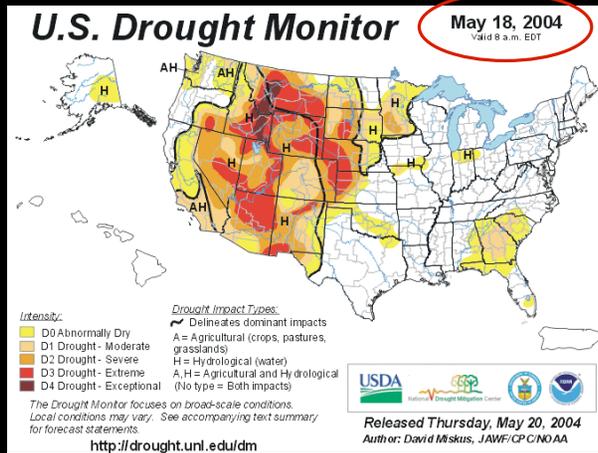
And what about our own backyard?

A recent federal water warning seems on target...

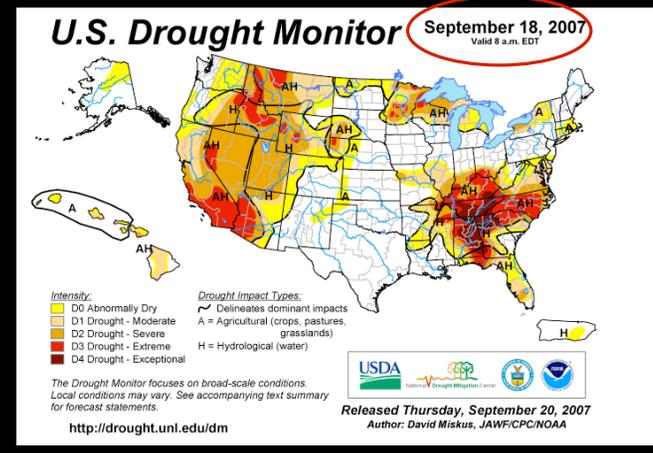


Southwest has the most at stake!

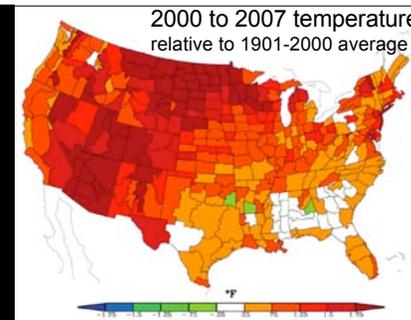
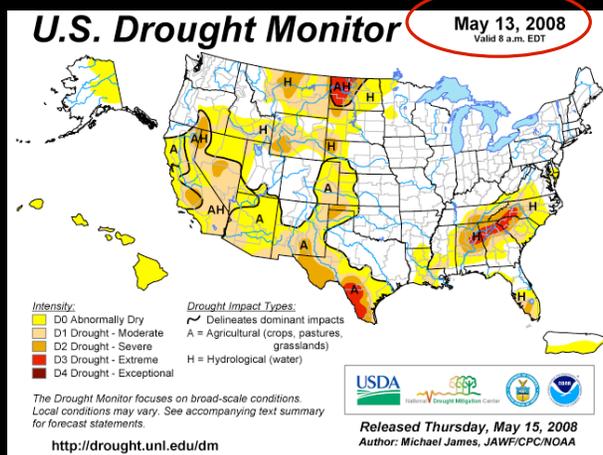
The current western drought began in 1999...



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



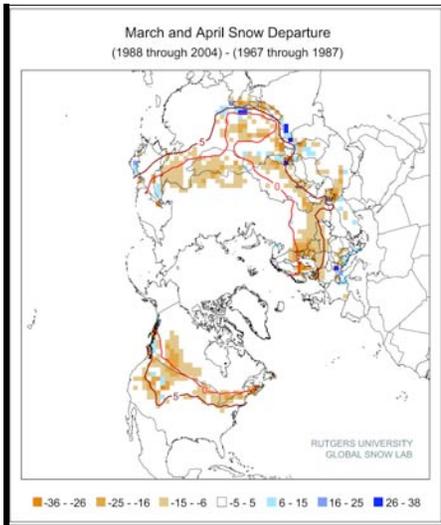
And even with our "wet" winter, the drought persists...



Key observation:
The West is warming!

Parts of the West have already warmed more than 2°F relative to average 20th century temperatures

(map from M. Hoerling, NOAA)



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)

Just in..... warmer, drier West likely driven by greenhouse gas emissions

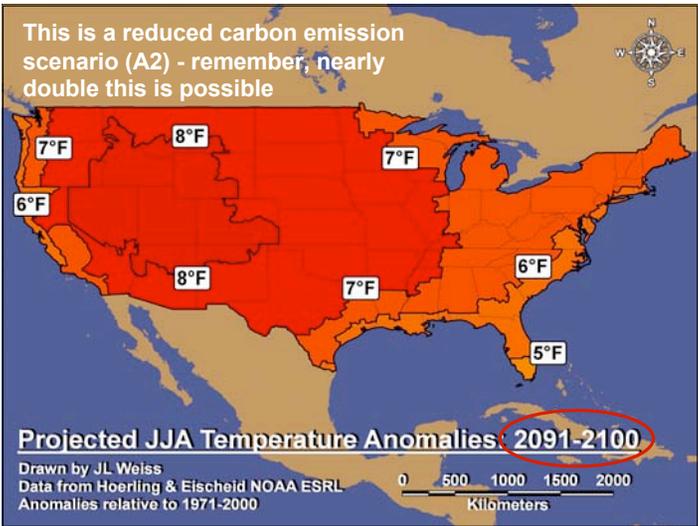
“up to 60% of the climate related trends of river flow, winter air temperature and snow pack between 1950-1999 are human-induced

...They portend, in conjunction with previous work, a coming crisis in water supply for the western United States.”

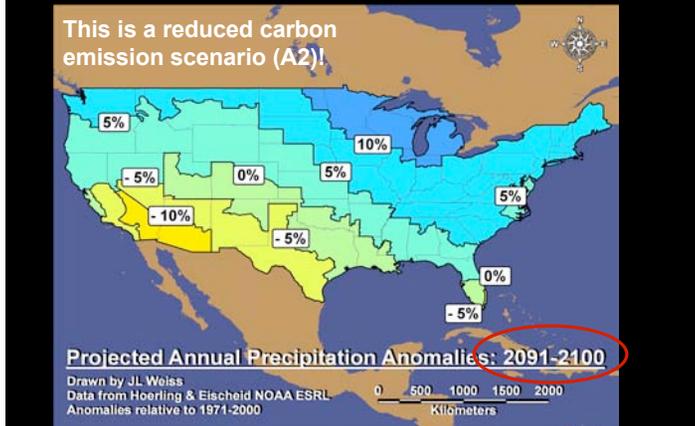


Barnett et al., *Science* 2008

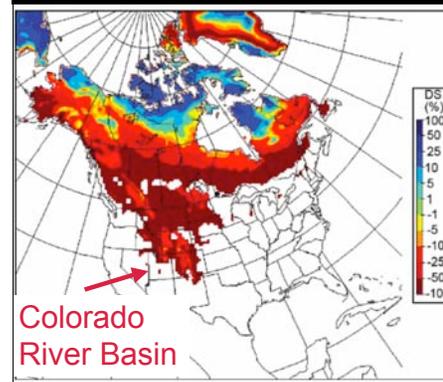
Now, what about the future?



Nearly all IPCC Projections indicate winter drying in the Southwest by 2100



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

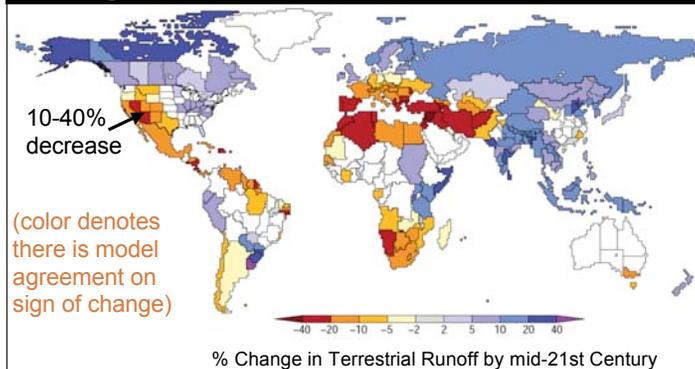


Projected percent change in March snow depth by mid-21st century

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

Source: IPCC Working Group I Report (2007)

Colorado River Flow Likely to Decrease even given the A1B reduced-emission scenario



Milly et al., 2008

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 (e.g., sea level and drought!) is a sure bet - *we must develop adaptation capability*

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Colorado population projected to increase 55% (2.6M) by 2030

Arizona population (5M) projected to double by 2030

Enough water?

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

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A major landscape transformation has already begun in the West



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- **Biggest (= dangerous) 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 a good start*

but how?

*Technological Solutions - not one silver bullet,
but many...*

- **Conservation and increased efficiency**
- **Carbon-free electricity** - coal with carbon capture, wind, solar, hydropower, geothermal
- **Carbon-free fuels** - biofuels, hydrogen generated with carbon-free electricity
- **Natural carbon sinks** - forestry and agricultural soils
- **Nuclear?** - problems with waste problems with NIMBY, and... problems with proliferation



Photo: J. Overpeck



Photo: J. Overpeck