

# Pacific Institute for Climate Solutions



THE UNIVERSITY OF BRITISH COLUMBIA



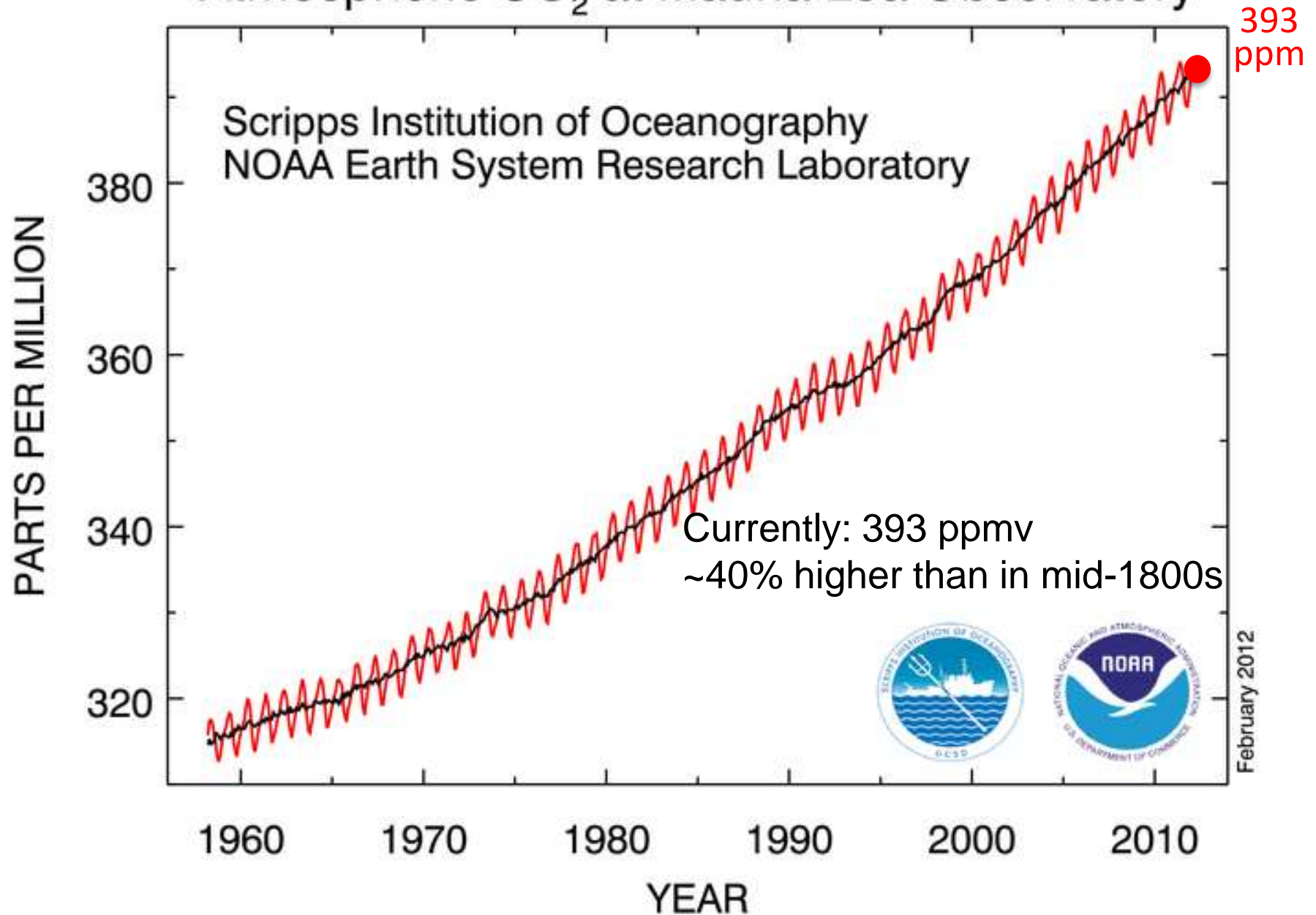
SIMON FRASER UNIVERSITY  
THINKING OF THE WORLD

## *Global Warming and Water: Some Side-Effects*

Tom Pedersen,  
Executive Director, PICS  
University of Victoria

# The “Keeling Curve”

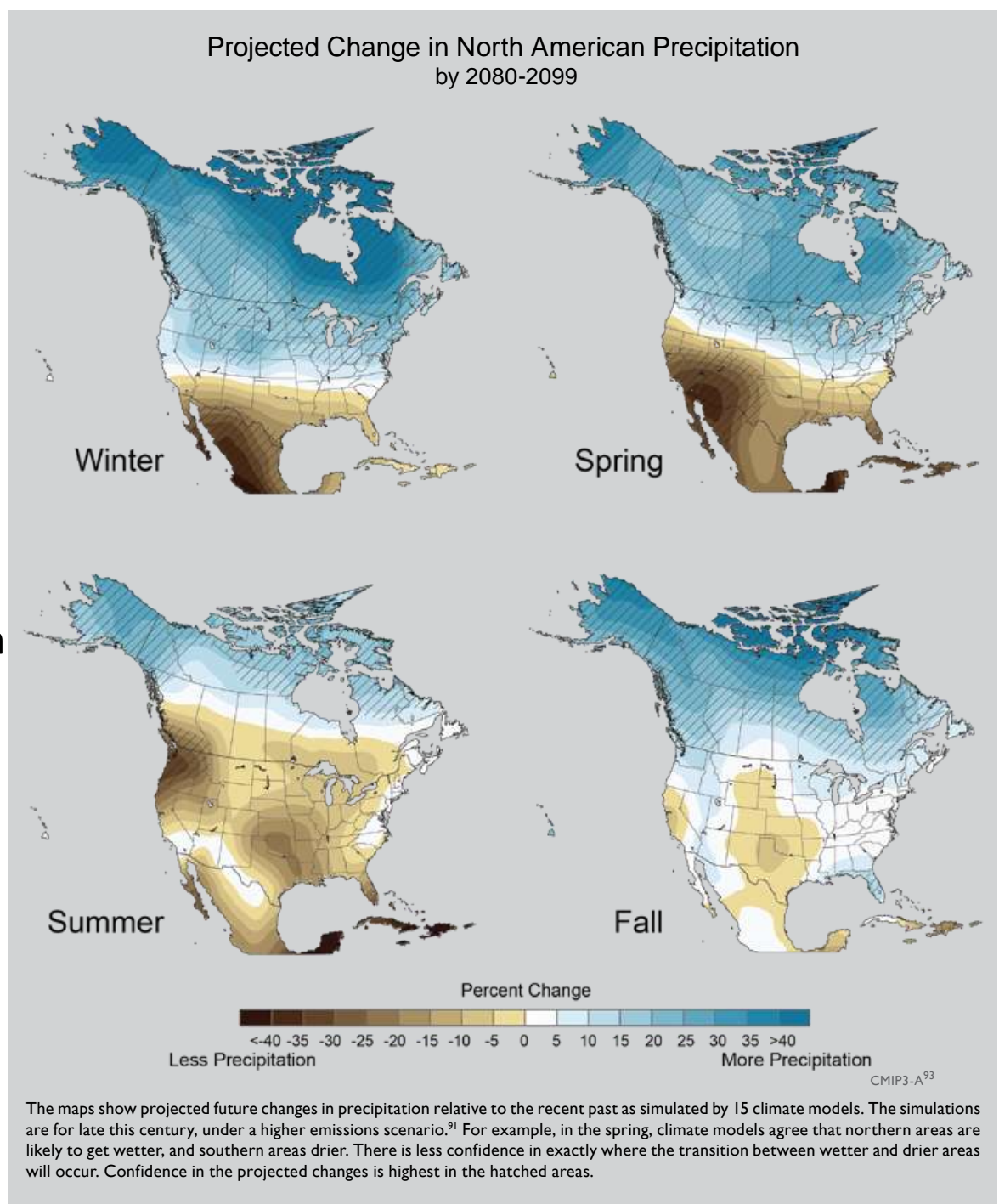
## Atmospheric CO<sub>2</sub> at Mauna Loa Observatory



*We can expect  
a **wetter north**  
and a **drier south**...on  
average*

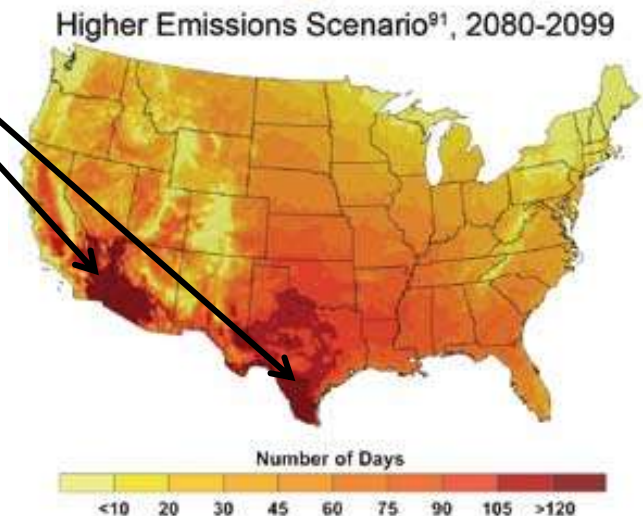
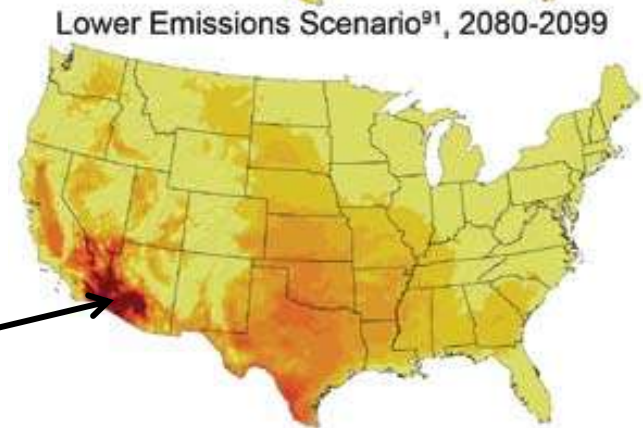
Projections for the change in  
precipitation **by 2080-2099**,  
relative to now

Source: 'Global Climate Change  
Impacts in the United States', US  
Global Change Research Program  
Report, 2009



***The drier areas will get hotter:  
Projected number of days per  
year by the end of this century  
with daytime highs above 37.7  
°C (100 °F)***

>120 days/year  
above 37.7 °C



Source: 'Global Climate Change  
Impacts in the United States', US  
Global Change Research Program  
Report, 2009



## June to August, Avg. Temperature (°C)

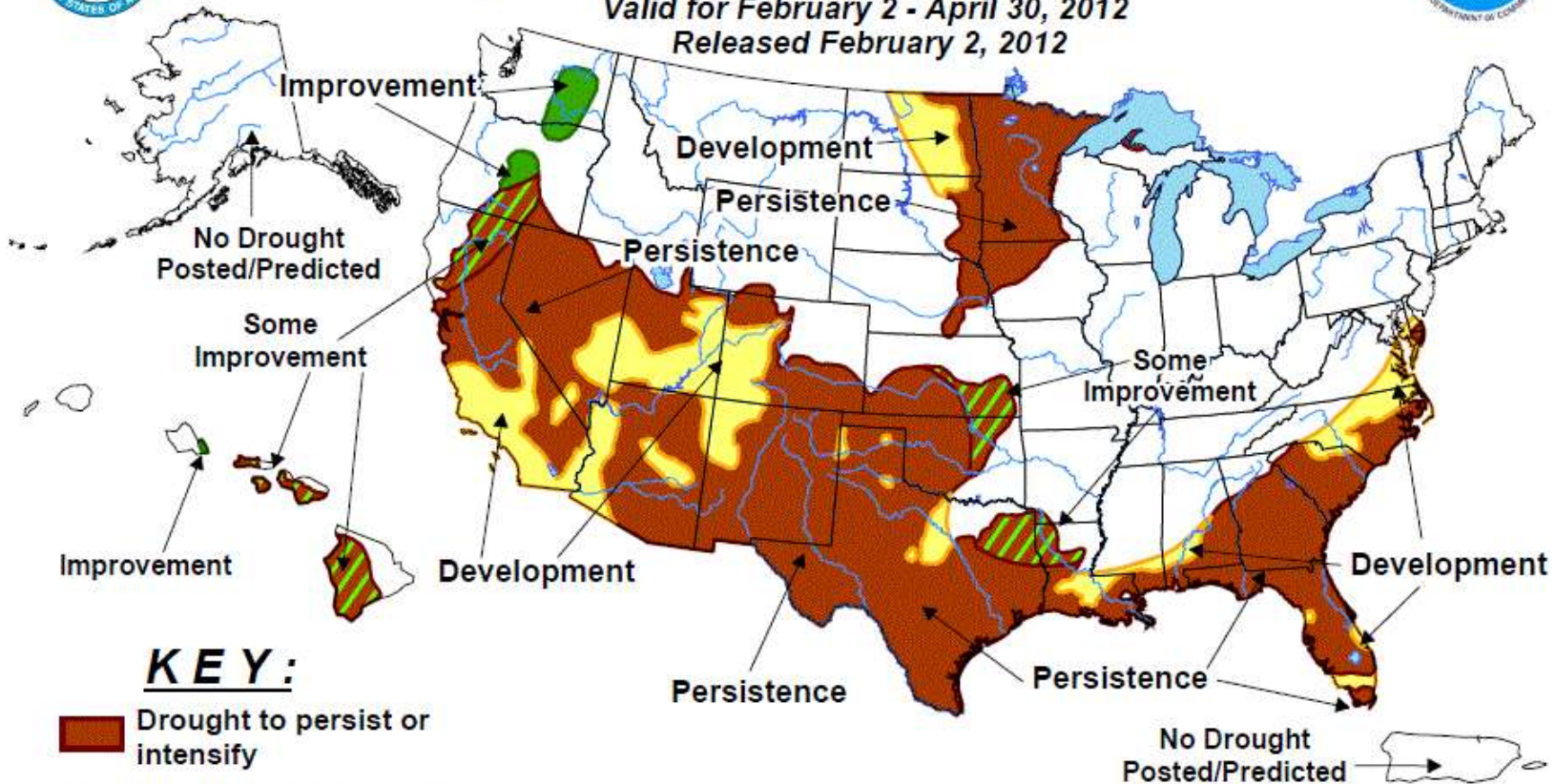


Based on original chart prepared by Dr. John Nielsen-Gammon, Texas State Climatologist;  
Units converted from Farenheit and inches

# U.S. Drought Forecast to April 30, 2012



## U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period Valid for February 2 - April 30, 2012 Released February 2, 2012



### KEY:

- Drought to persist or intensify
- Drought ongoing, some improvement
- Drought likely to improve, impacts ease
- Drought development likely

Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

*From: "2012 Water for Texas", Texas Water Development Board,  
January 2012, p. 174*



# Quick Facts

In the event of severe drought conditions, with the current drought conditions showing a representative example, the state faces an immediate need for additional water supplies of 3.6 million acre-feet per year.

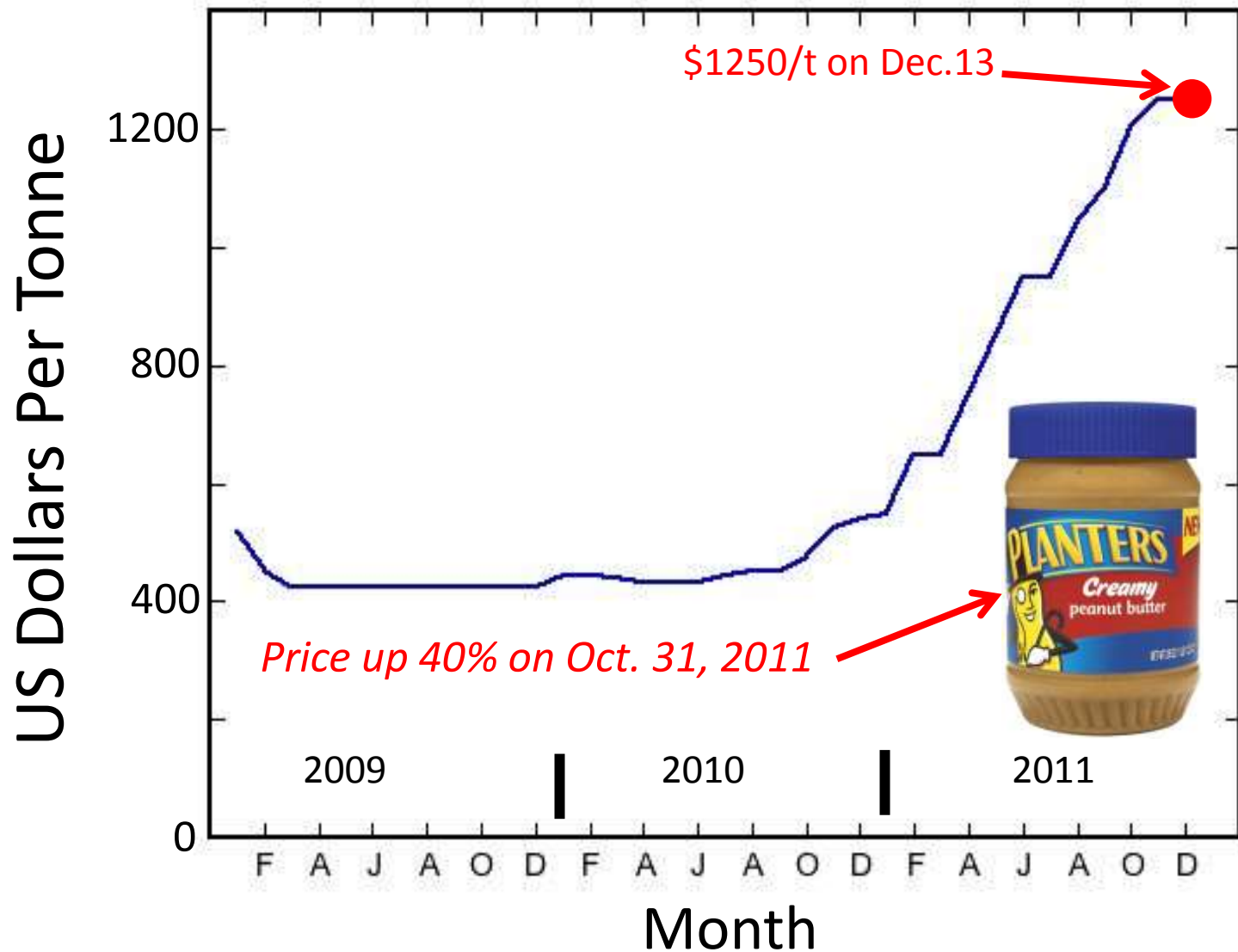
If Texas does not implement new water supply projects or management strategies, then homes, businesses, and agricultural enterprises throughout the state are projected to need 8.3 million acre-feet of additional water supply by 2060.

Planning groups were unable to find economically feasible strategies to meet over 2 million acre-feet of annual needs, with the vast majority of the unmet needs in irrigation.

Annual economic losses from not meeting water supply needs could result in a reduction in income of approximately \$11.9 billion annually if current drought conditions approach the drought of record, and as much as \$115.7 billion annually by 2060, with over a million lost jobs.



## Runner Peanut Prices, USA, 2009-2011



Data: Farm Service Agency, USDA



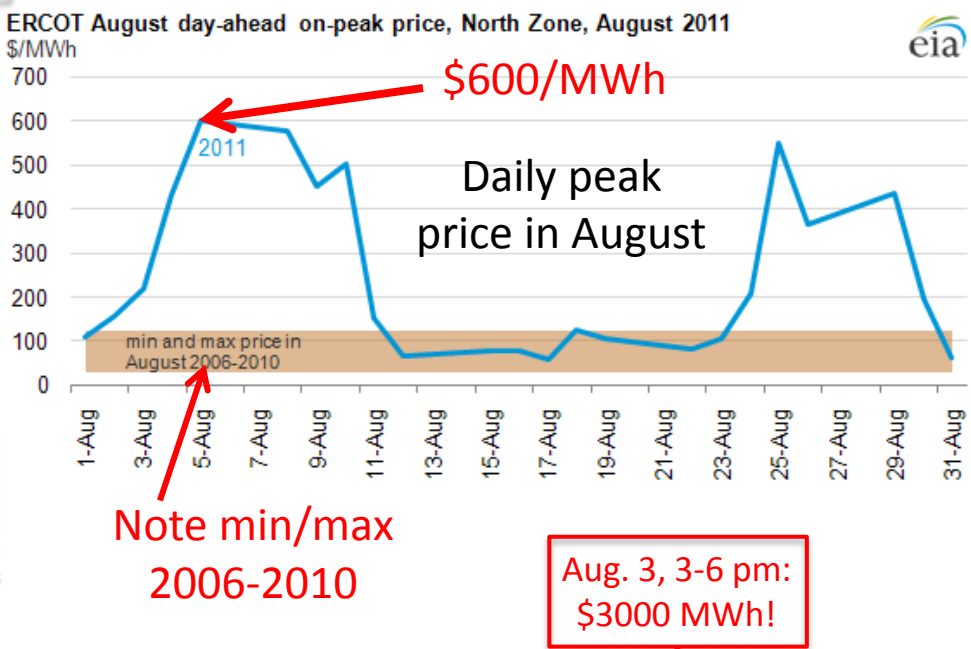
July 24 to September 3, 2011 Calendar:  
 Record electricity demand days in **dark rose**.  
 Numbers in black are the day-ahead **off-peak** price.

Texas August heat wave and electric power issues (click to enlarge)

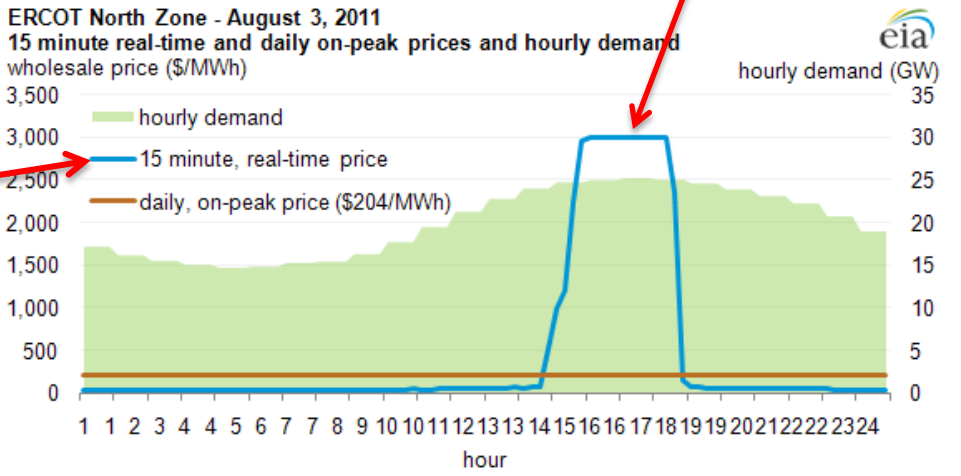
SUN	MON	TUE	WED	THUR	FRI	SAT
July 24 Temp: 104 Load: 61,185 Power Price: 44.17 Gas Price: 4.49	July 25 Temp: 106 Load: 65,196 Power Price: 87.25 Gas Price: 4.49	July 26 Temp: 105 Load: 65,196 Power Price: 102.93 Gas Price: 4.41	July 27 Temp: 104 Load: 65,317 Power Price: 117.00 Gas Price: 4.41	July 28 Temp: 104 Load: 63,788 Power Price: 80.33 Gas Price: 4.39	July 29 Temp: 101 Load: 60,563 Power Price: 55.50 Gas Price: 4.41	July 30 Temp: 101 Load: 60,563 Power Price: 41.05 Gas Price: 4.38
July 31 Temp: 103 Load: 61,832 Power Price: 44.79 Gas Price: 4.38	Aug 1 Temp: 107 Load: 65,877 Power Price: 67.93 Gas Price: 4.39	Aug 2 Temp: 107 Load: 67,29 Power Price: 127.29 Gas Price: 4.39	Aug 3 Temp: 110 Load: 68,115 Power Price: 204.10 Gas Price: 4.29	Aug 4 Temp: 109 Load: 68,115 Power Price: 488.00 Gas Price: 4.21	Aug 5 Temp: 108 Load: 68,115 Power Price: 643.00 Gas Price: 4.21	Aug 6 Temp: 107 Load: 68,115 Power Price: 155.00 Gas Price: 4.23
Aug 7 Temp: 105 Load: 62,715 Power Price: 193.19 Gas Price: 4.23	Aug 8 Temp: 106 Load: 65,196 Power Price: 515.00 Gas Price: 4.23	Aug 9 Temp: 107 Load: 67,29 Power Price: 592.00 Gas Price: 4.23	Aug 10 Temp: 107 Load: 65,805 Power Price: 204.00 Gas Price: 4.01	Aug 11 Temp: 104 Load: 63,454 Power Price: 100.32 Gas Price: 4.00	Aug 12 Temp: 103 Load: 60,563 Power Price: 56.00 Gas Price: 4.04	Aug 13 Temp: 103 Load: 60,563 Power Price: 42.00 Gas Price: 4.01
Aug 14 Temp: 99 Load: 59,003 Power Price: 41.56 Gas Price: 4.01	Aug 15 Temp: 103 Load: 65,437 Power Price: 56.00 Gas Price: 4.01	Aug 16 Temp: 104 Load: 65,437 Power Price: 56.00 Gas Price: 4.14	Aug 17 Temp: 104 Load: 65,437 Power Price: 56.00 Gas Price: 4.00	Aug 18 Temp: 106 Load: 67,775 Power Price: 134.00 Gas Price: 4.03	Aug 19 Temp: 107 Load: 67,498 Power Price: 37.88 Gas Price: 3.90	Aug 20 Temp: 107 Load: 64,149 Power Price: 44.30 Gas Price: 3.97
Aug 21 Temp: 107 Load: 62,432 Power Price: 43.58 Gas Price: 3.97	Aug 22 Temp: 107 Load: 62,432 Power Price: 108.00 Gas Price: 3.97	Aug 23 Temp: 104 Load: 65,437 Power Price: 219.00 Gas Price: 4.04	Aug 24 Temp: 106 Load: 65,437 Power Price: 204.00 Gas Price: 3.99	Aug 25 Temp: 106 Load: 65,437 Power Price: 475.00 Gas Price: 4.01	Aug 26 Temp: 104 Load: 64,842 Power Price: 358.24 Gas Price: 4.08	Aug 27 Temp: 107 Load: 64,842 Power Price: 116.00 Gas Price: 3.98
Aug 28 Temp: 108 Load: 65,139 Power Price: 195.23 Gas Price: 3.98	Aug 29 Temp: 102 Load: 65,139 Power Price: 488.58 Gas Price: 3.98	Aug 30 Temp: 107 Load: 65,139 Power Price: 144.00 Gas Price: 3.98	Aug 31 Temp: 99 Load: 64,474 Power Price: 56.20 Gas Price: 3.92	Sept 1 Temp: 104 Load: 63,888 Power Price: 50.00 Gas Price: 3.89	Sept 2 Temp: 101 Load: 63,136 Power Price: 40.80 Gas Price: 3.92	Sept 3 Temp: 101 Load: 63,136 Power Price: 42.00 Gas Price: 4.11

■ Daily peak load above forecasted summer 2011 peak (63,531 MW) □ Daily peak load < 63,531 MW  
 ■ Daily peak load above previous all-time peak (65,776 MW)  
 □ Interruptible load shed  
 Power Prices: Italic > \$100/MWh, Bold > \$200/MWh, Italic & Bold > \$500/MWh  
 Load is ERCOT Daily Peak Load in MW, Power Price is Day-Ahead On-Peak Price for weekdays and Day-Ahead Off-Peak Price for weekends at ERCOT North Zone in \$/MWh, Temperature is Daily High at Dallas/Forth Worth Airport in Degrees Fahrenheit, Gas Price is Houston Ship Channel Day-Ahead Spot Natural Gas price in \$/MMBtu for delivery

Energy Reliability Council of Texas  
 August day-ahead **on-peak** price,  
 Dallas-Fort Worth region, August 2011



Aug. 3, 2011: Dallas-Fort Worth Airport, 110° F (43° C)

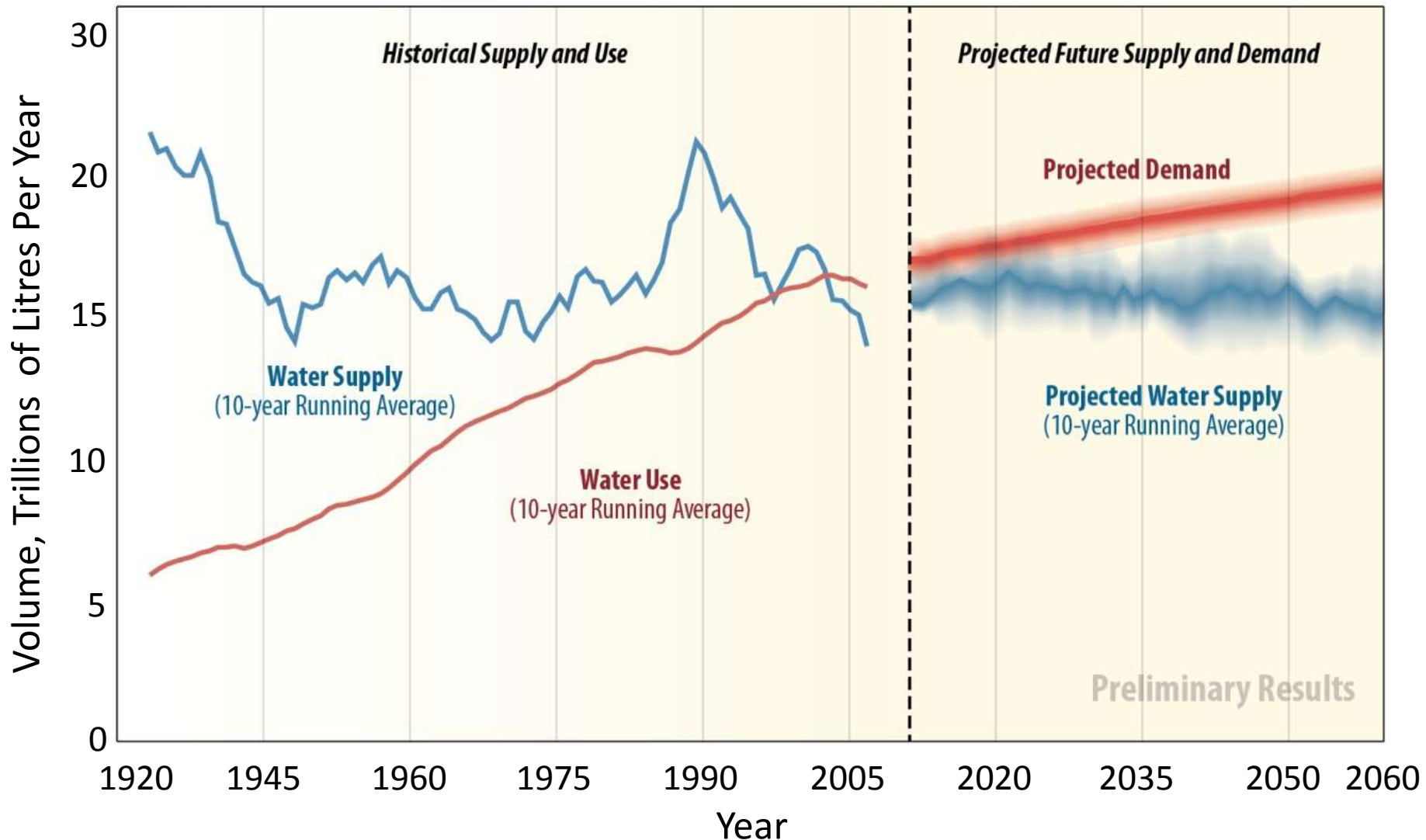




## *Colorado River Watershed (shaded)*

M.J. Cohen, Municipal Deliveries of Colorado River Basin Water, Pacific Institute, 2011

# *Projected Future Colorado River Basin Water Supply and Demand*

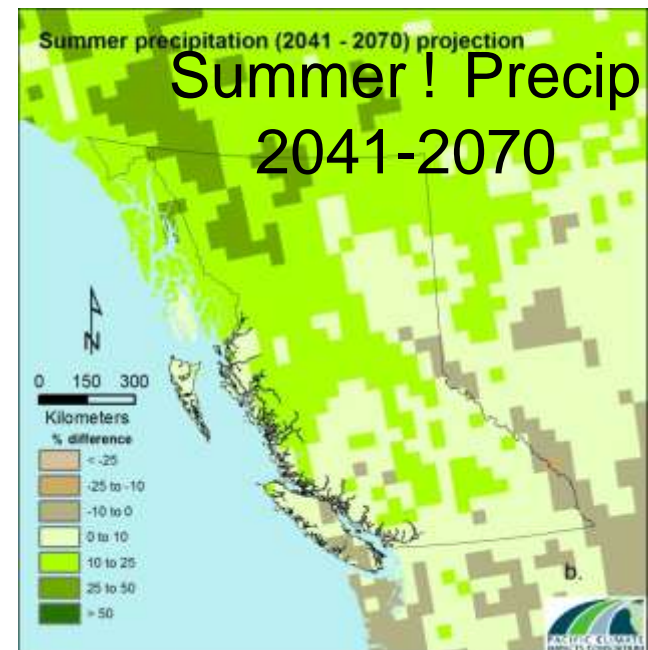
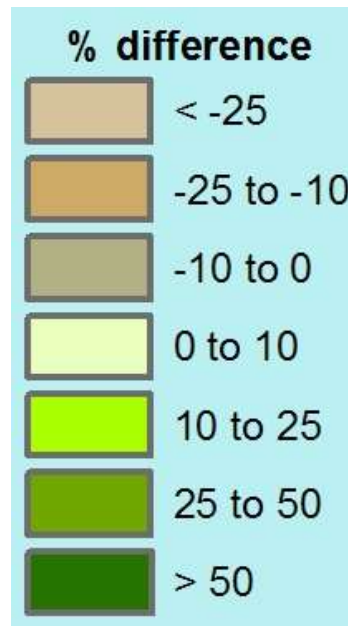
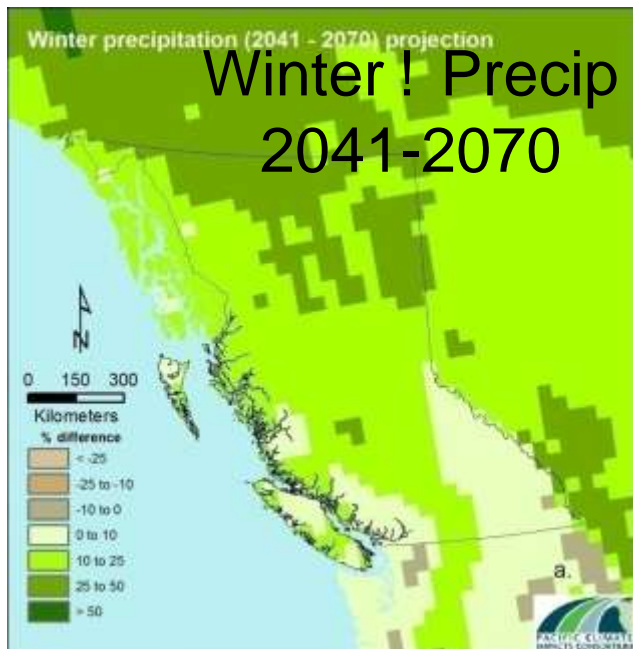
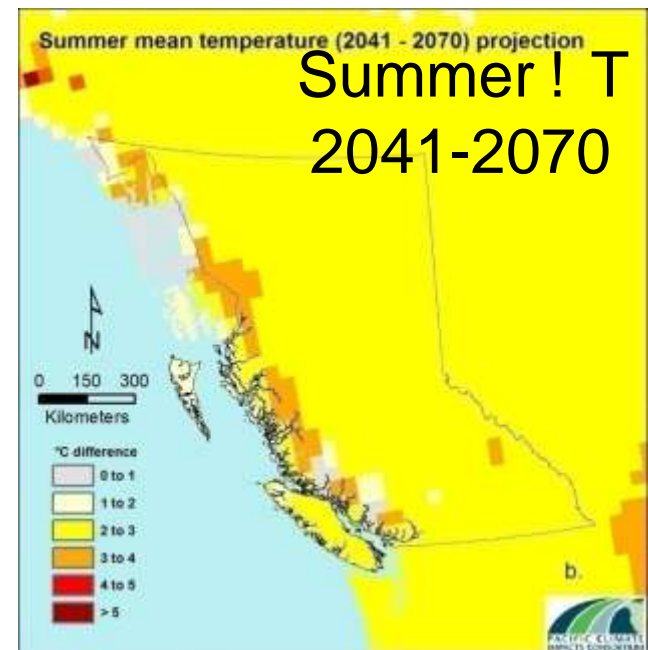
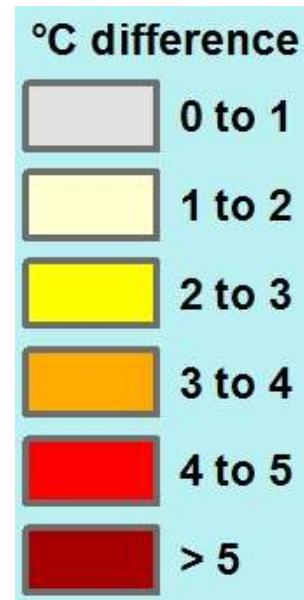
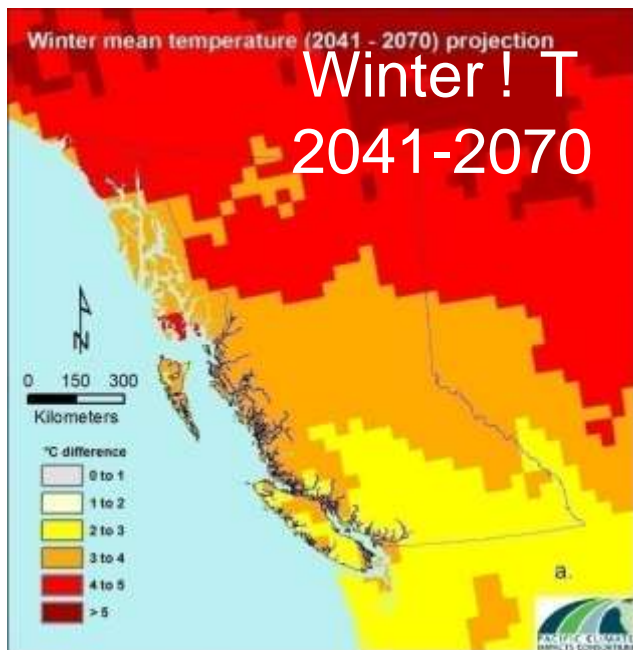




## *Implications for the future:*

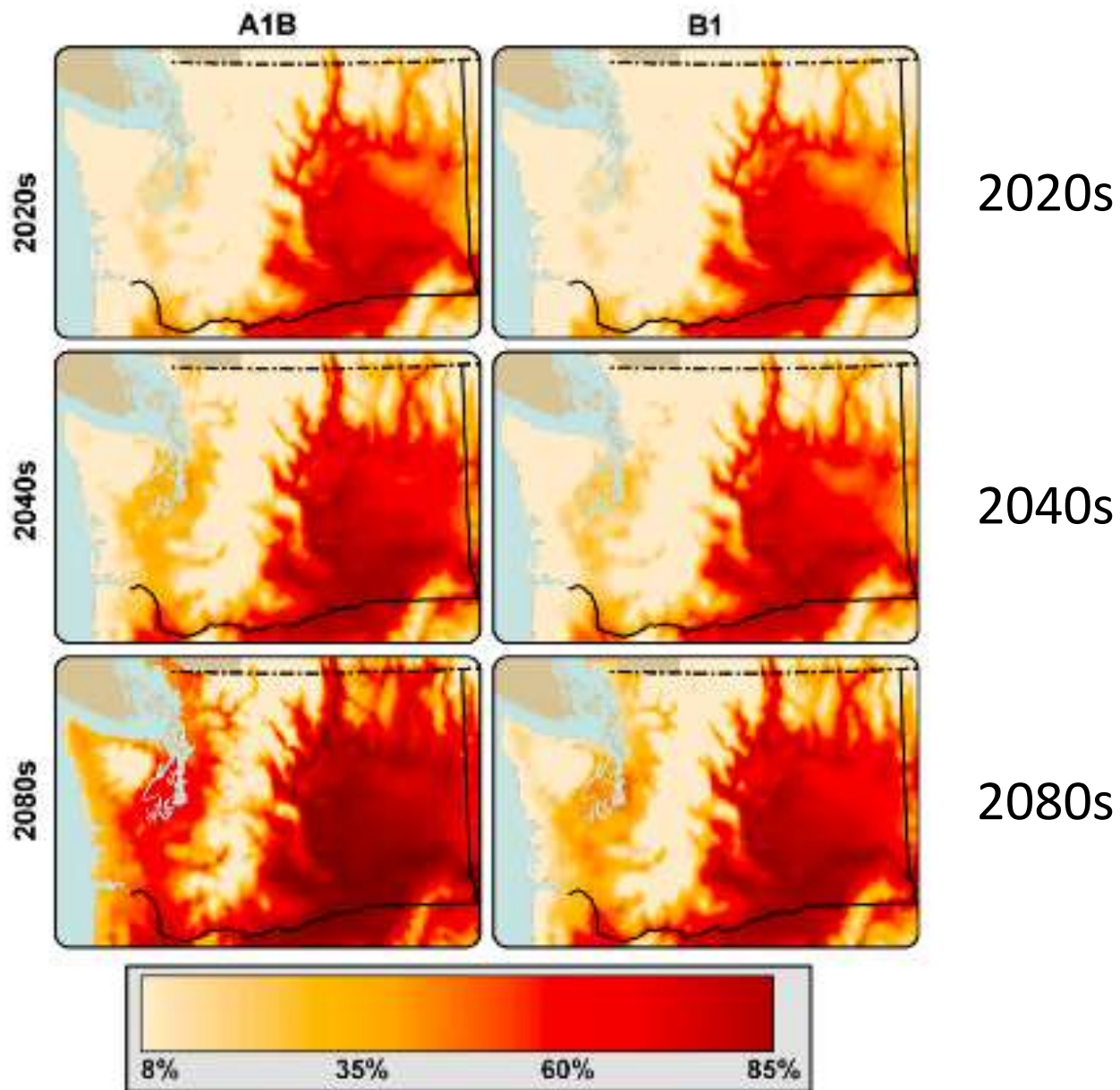
- Colorado River supplies 100% of the irrigation water for the Imperial Valley, southern California, the source of much of the fruits and vegetables consumed in North America in winter.
- Growing tension between urban/residential and agricultural users of diminishing water.
- Growing tension among bordering states.
- The Hoover Dam on the Colorado River (Lake Mead) generates 2 GW of electricity (1/6 of BC's total capacity) when the reservoir is at full volume...it hasn't been near full for the last 13 years, and electricity production is down ~30%.

# PCIC Results



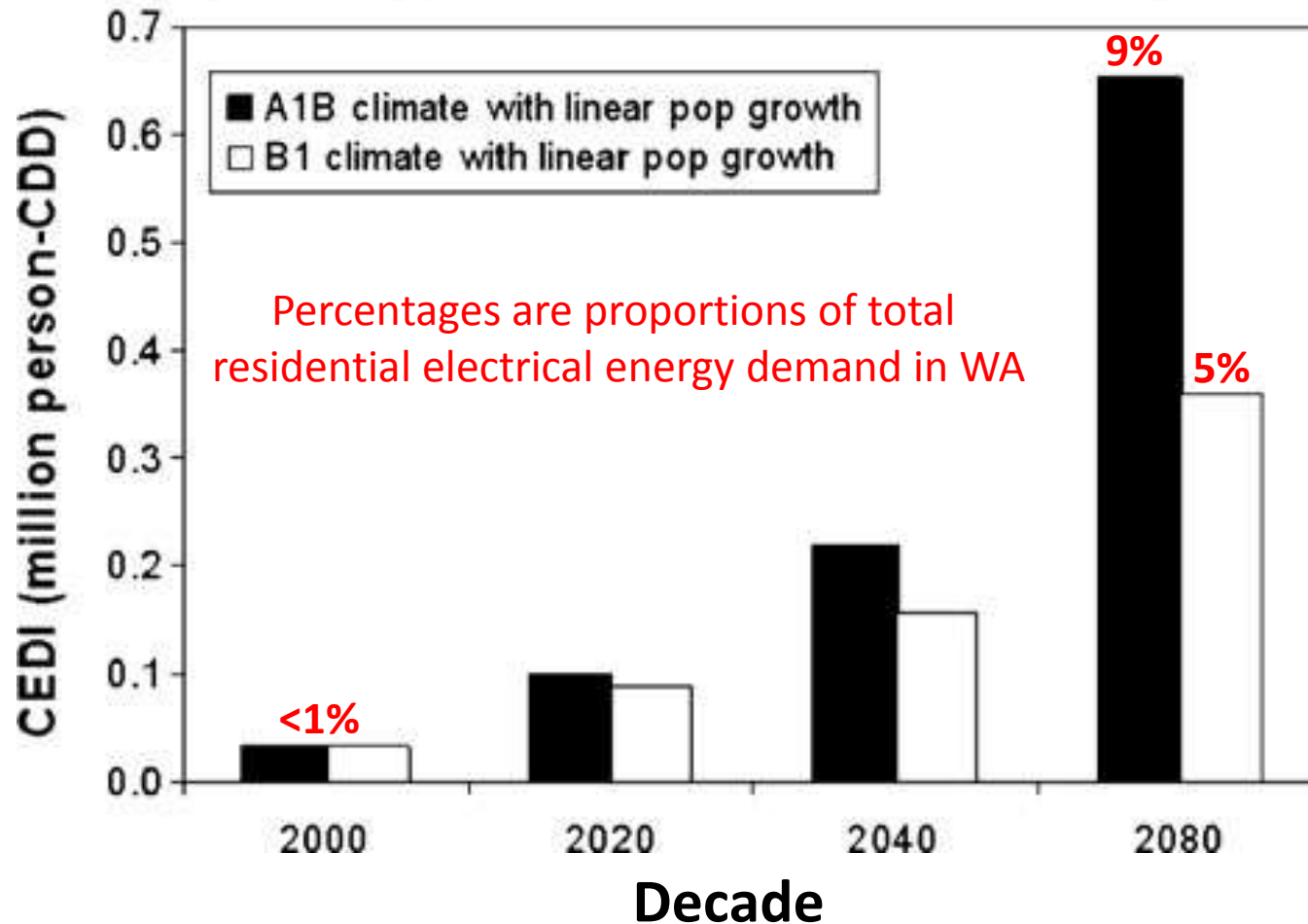
Courtesy Trevor Murdock

## Projected Air Conditioning Market Penetration, Washington State





## Cooling Energy Demand Index, Washington State



“By the 2080s hydropower production [in the Columbia River Basin] is projected to...**decrease** by about 17.1–20.8% in summer...”

# *Summary*

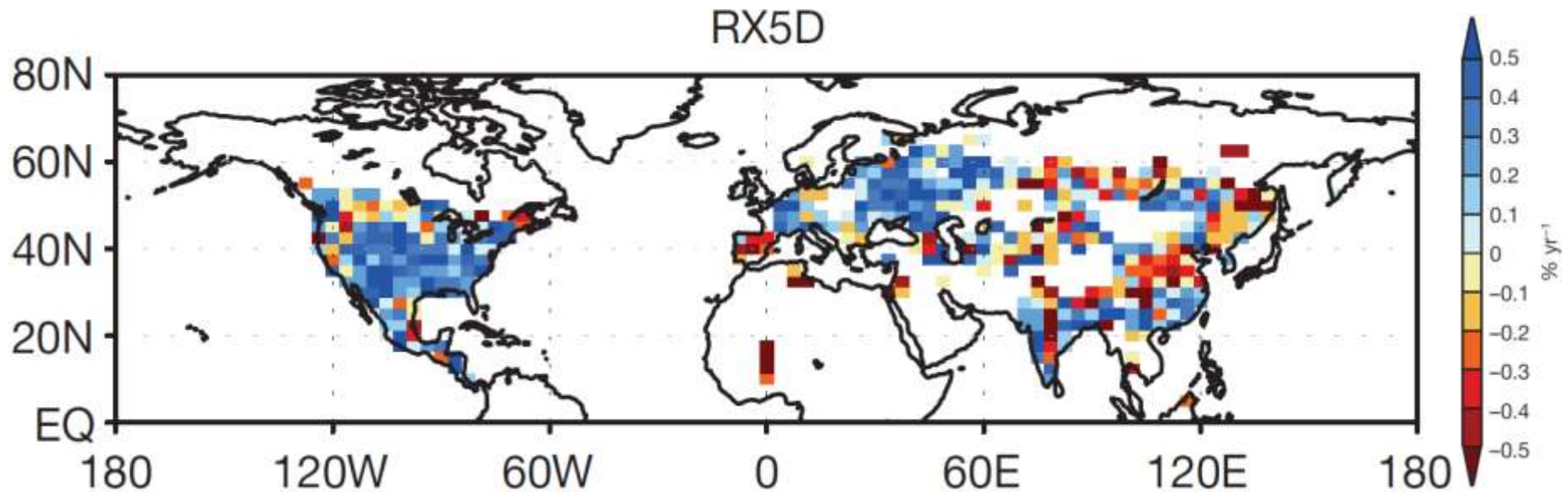
- the northern half of Canada will likely be wetter on average in future decades.
- southwestern Canada will likely see drier, warmer summers in future decades.
- farther south, increased warming and drying will affect electricity demand (impacting BC hydropower trade) and have negative impacts on food production (thus, higher food costs in Canada)





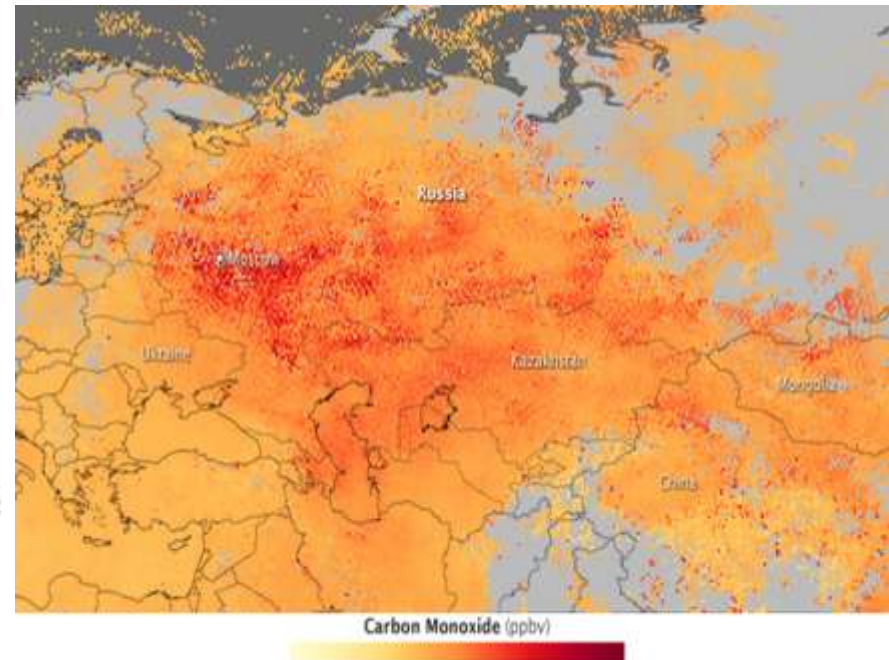
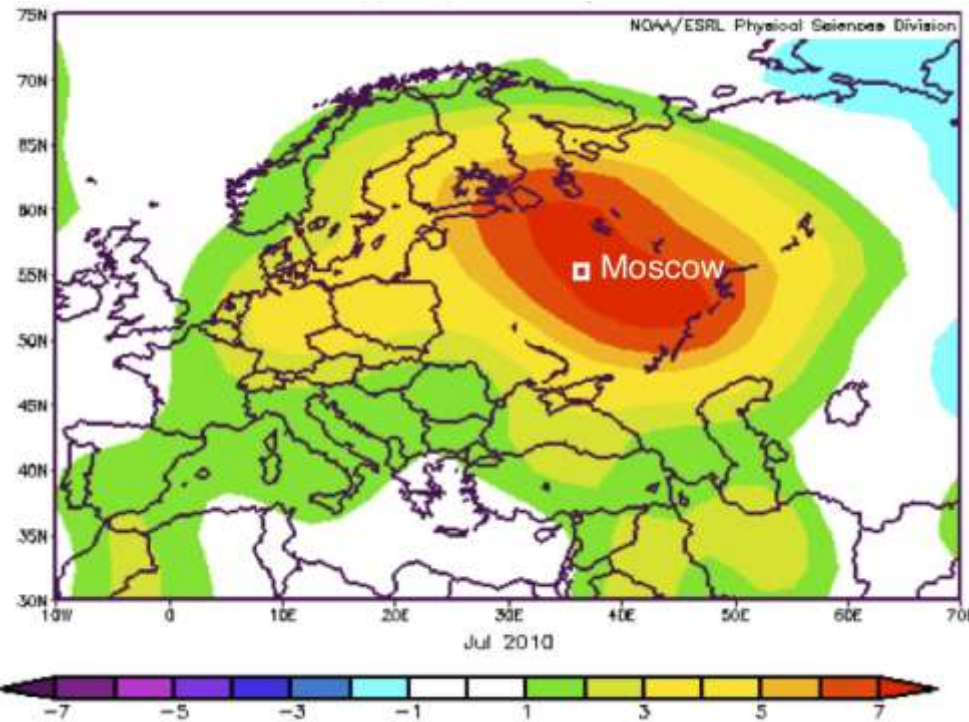


# *Trends in Extreme Precipitation Indices, 5-day events, Northern Hemisphere, 1951-1999*



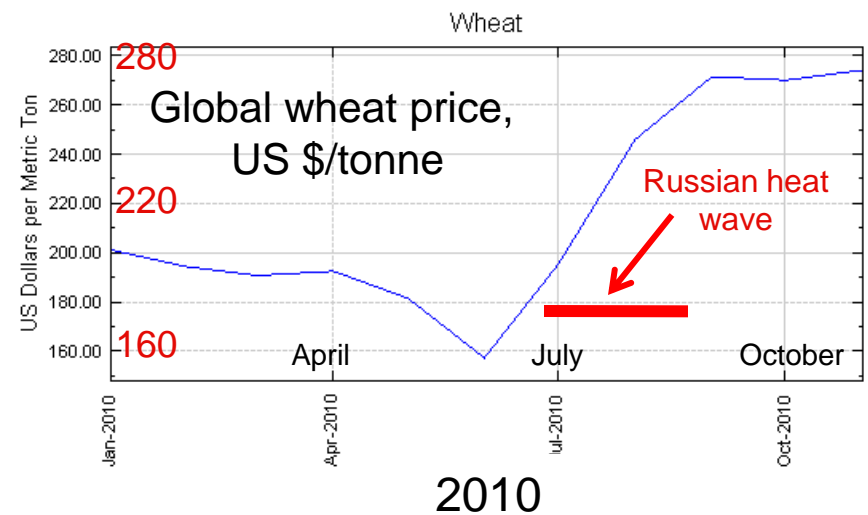
From: Min, Zhang, Zwiers and Hegerl, Nature, February 17, 2011, "Human contribution to more-intense precipitation extremes"

## Russian heat wave, July-August, 2010



- 10,935 “excess” deaths (a 60% increase) in Moscow in July and August, 2010, attributed to heat, smog or smoke.
- ~25% of Russian grain crop lost (economic loss roughly \$7-15 billion)

Source: AFP, Moscow



Source: Index Mundi

*We can also expect **more-extreme warm events**...*

European Summer Land Temperature Anomalies,  
1500-2010 C.E.

