Welcome!
Building Climate Resilience in the Rogue Basin

A Workshop for Watershed Managers

July 21, 2010

ABOUT CLI

The Climate Leadership Initiative is a social-science based global climate change research, education, and technical assistance consortium between The Resource Innovation Group, a 501 (c)3 non-profit, and the Institute for a Sustainable Environment at the University of Oregon.

CLI is part of the new Regional Integrated Sciences and Assessments program for the Pacific Northwest (a NOAA program led by the Oregon Climate Change Research Institute and includes universities from Oregon, Washington, and Idaho).

Agenda

- Introduction, purpose of program
- Global climate change and climate projections for the Rogue Basin
- Preparedness principles and methods
- Indicators and guidebook development
- Strategies for building resistance and resiliency
- Climate change communication
- Wrap up/next steps

Preparing for Climate Change in the Rogue Watershed: Global Context and Local Impacts

Climate Leadership Initiative
Institute for a Sustainable Environment
University of Oregon

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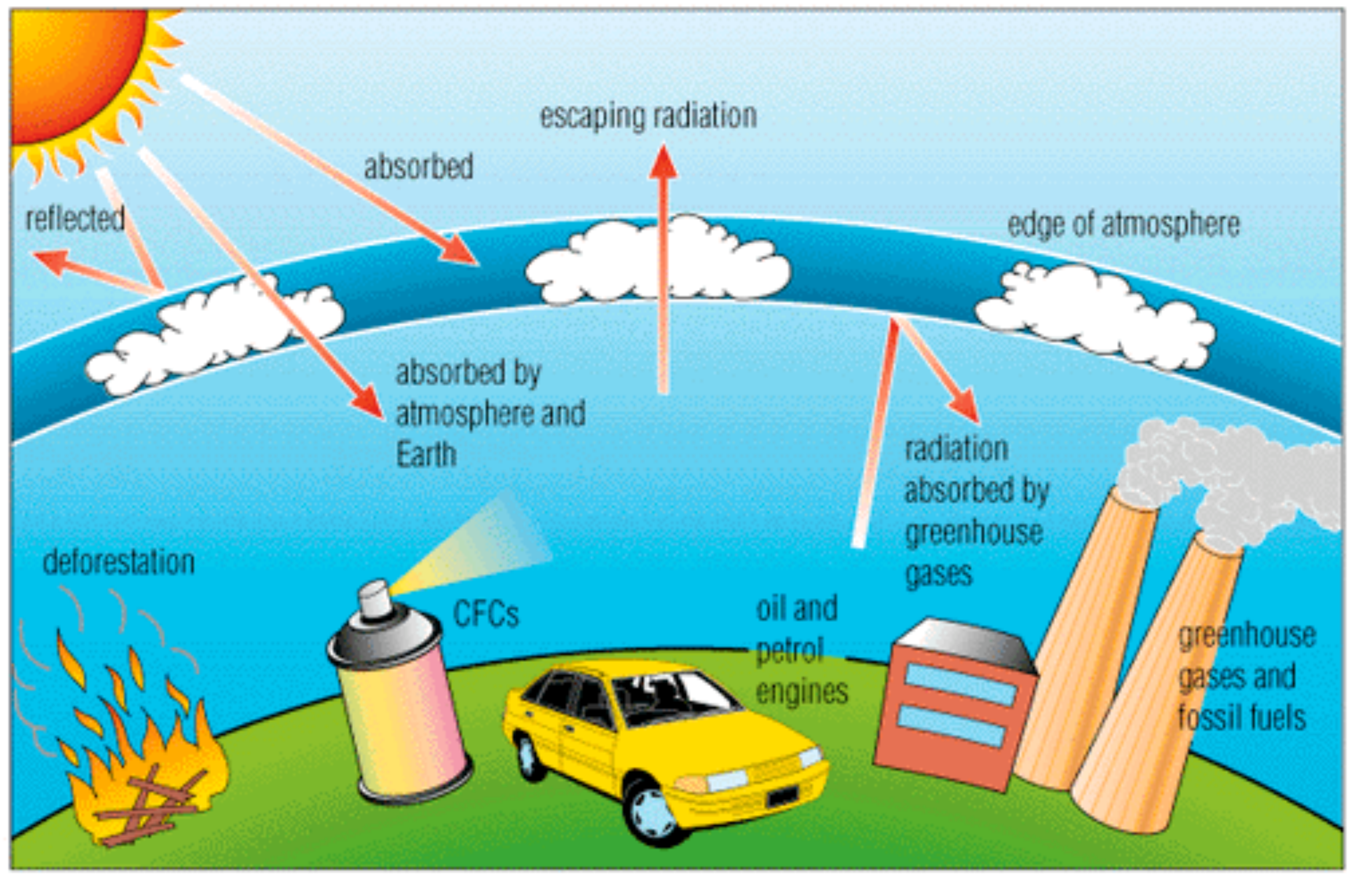
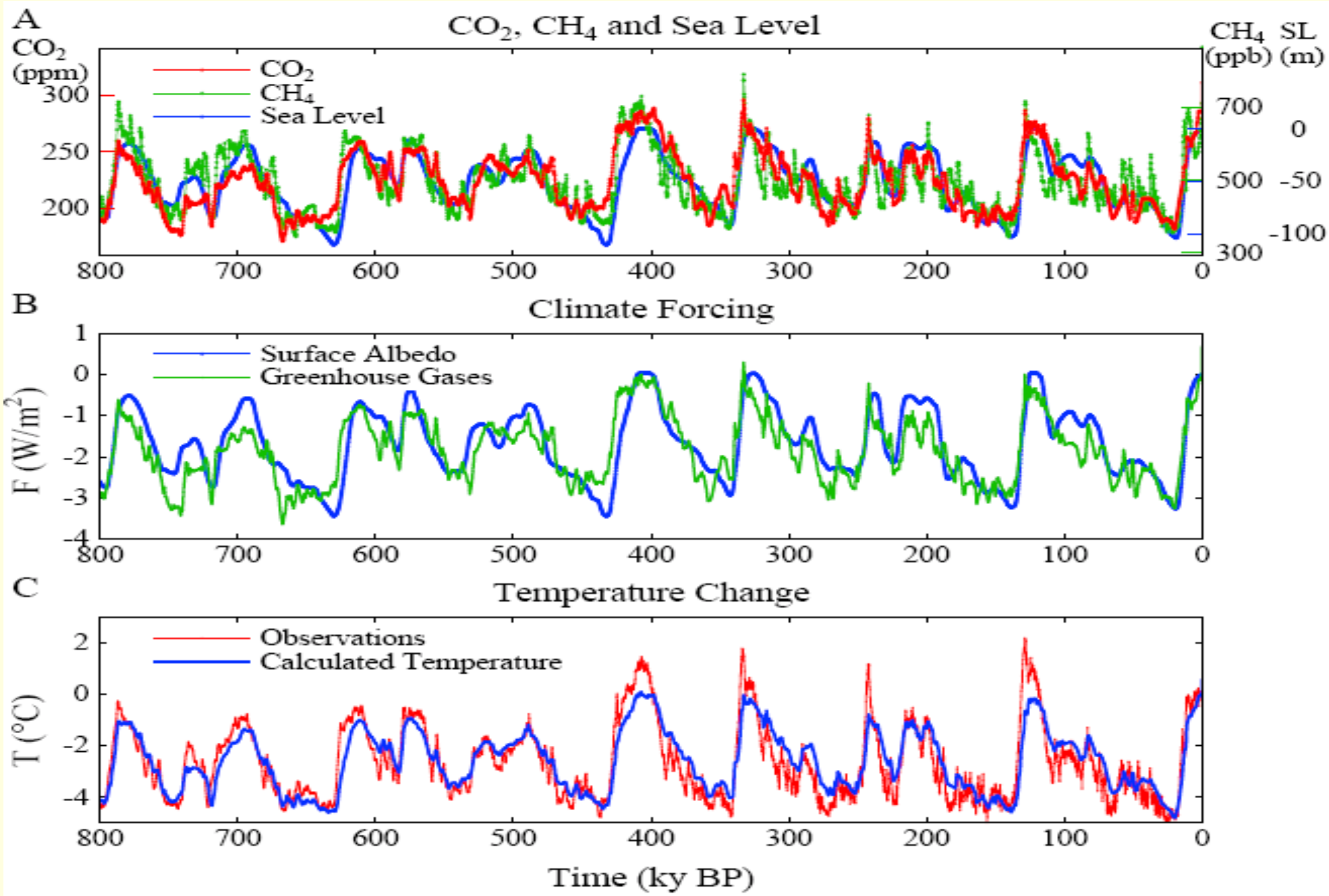
July 21, 2010

The Greenhouse Effect

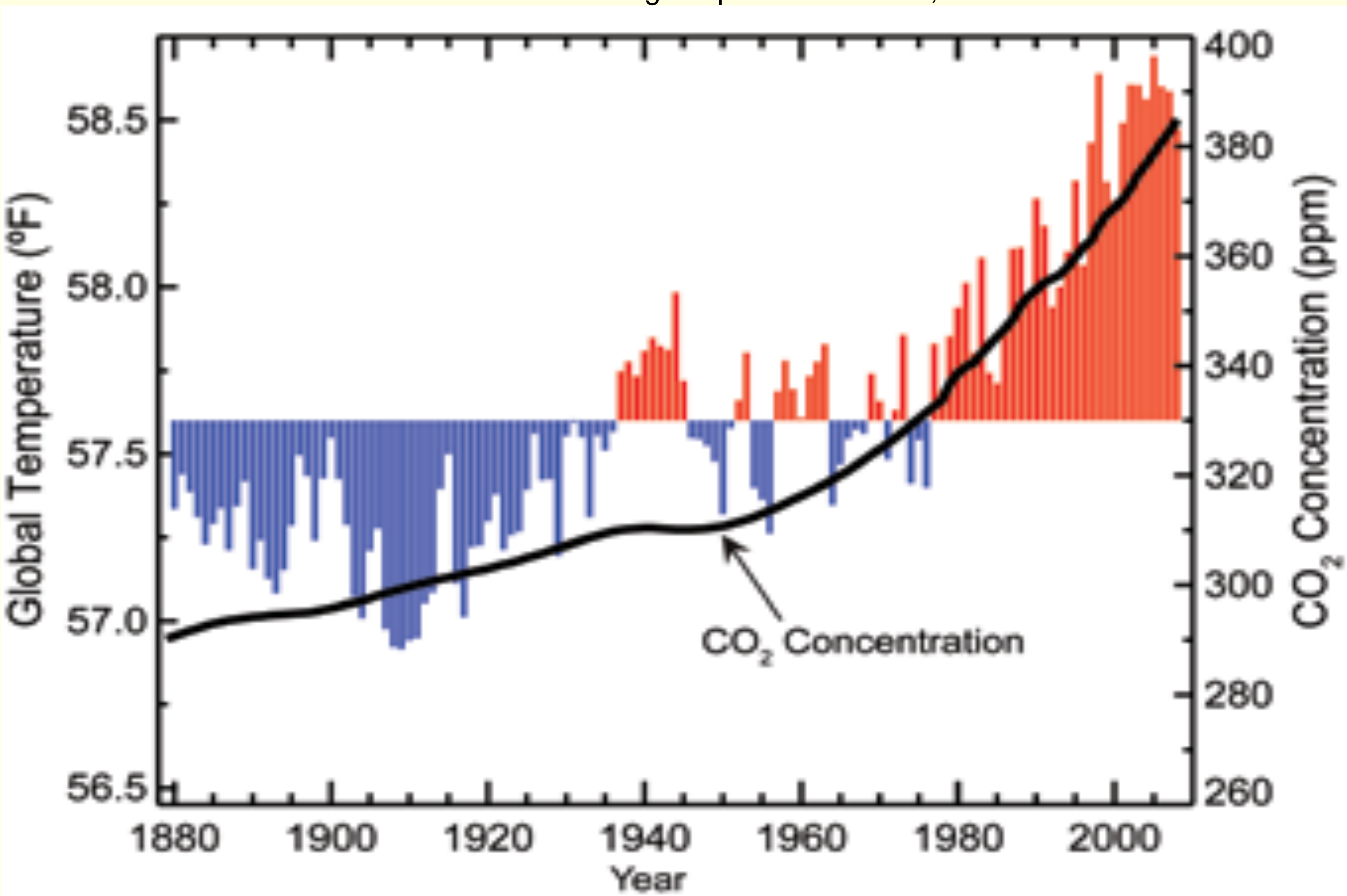


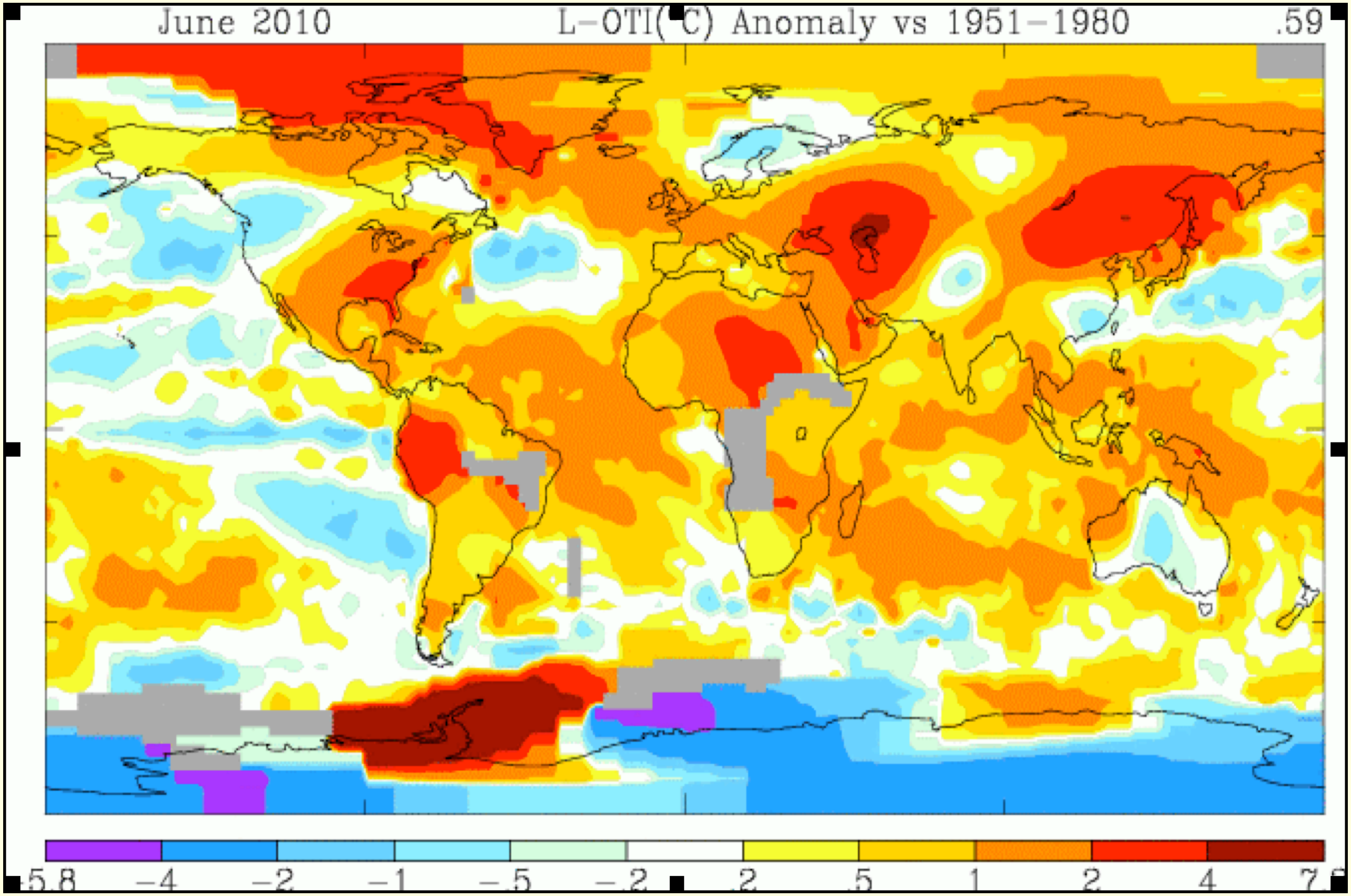
The Problem Based on History of Last 800,000 Years



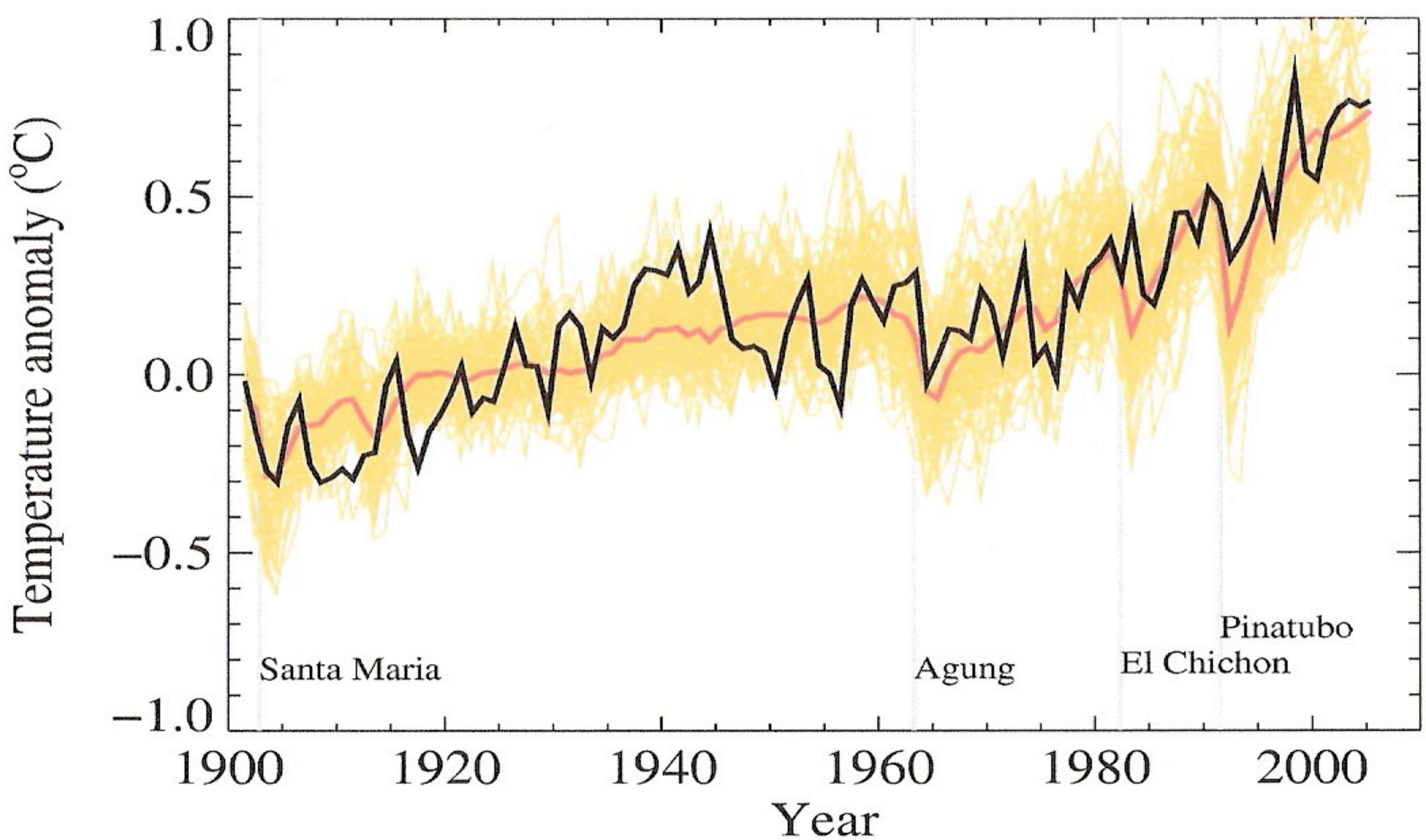
Global Temperature and CO2

Source: Global Climate Change Impacts in the U.S., NOAA 2009

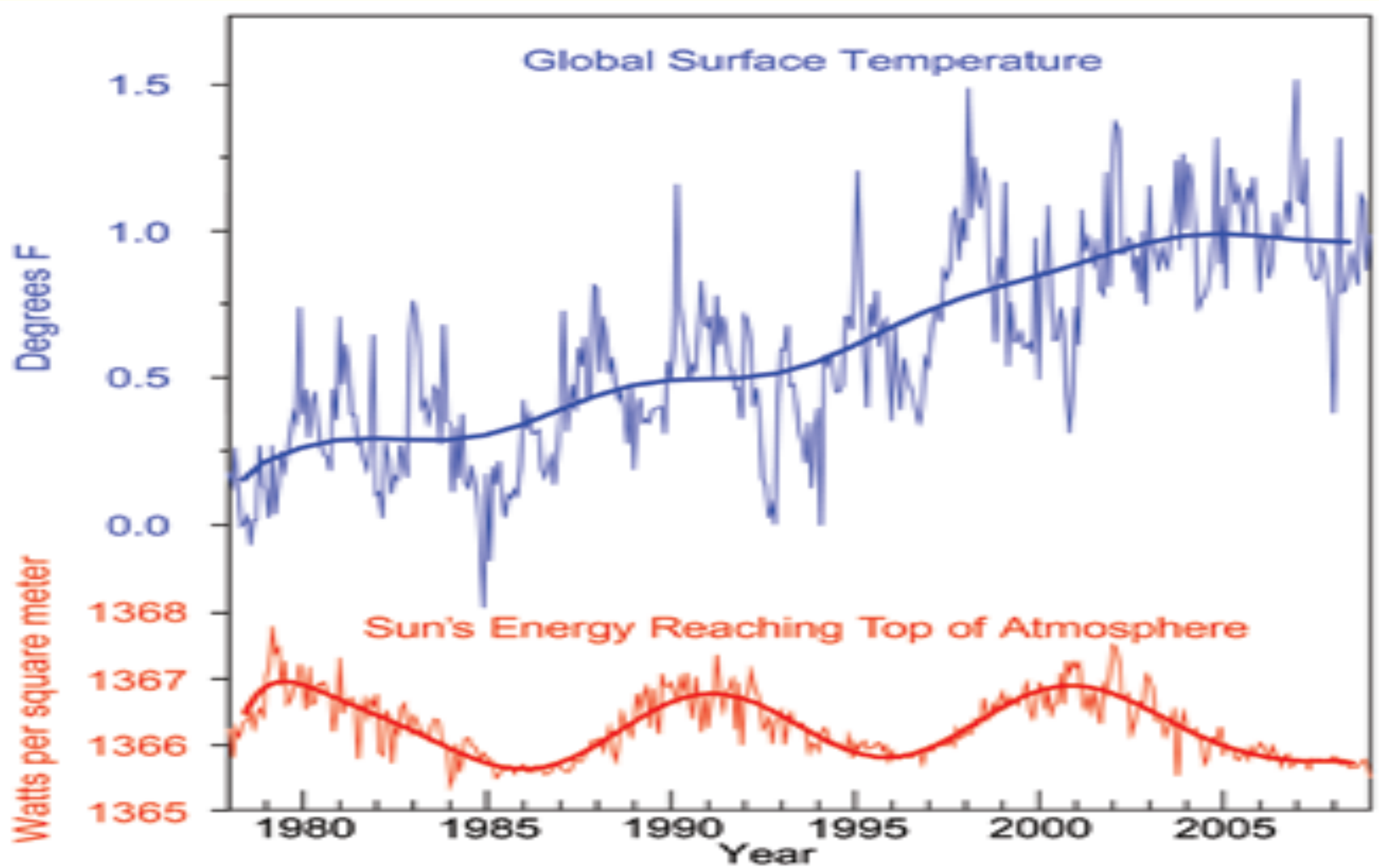



June 2010
L-OTI(°C) Anomaly vs 1951-1980
.59
-5.8 -4 -2 -1 -.5 -.2 .2 .5 1 2 4 7.6

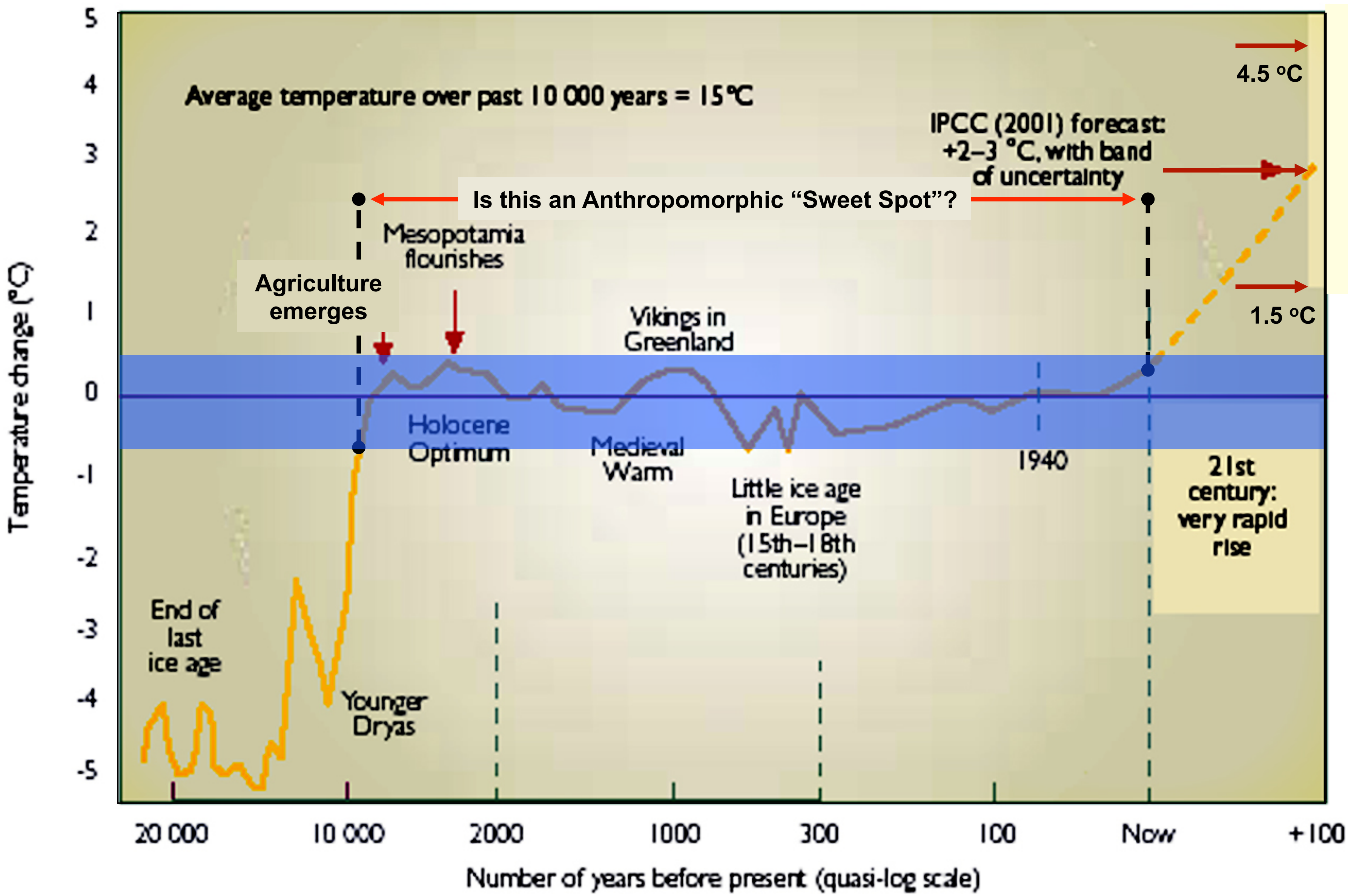
Large Ash Volcanoes Force Cooling in the Short Term (1 to 2 years)

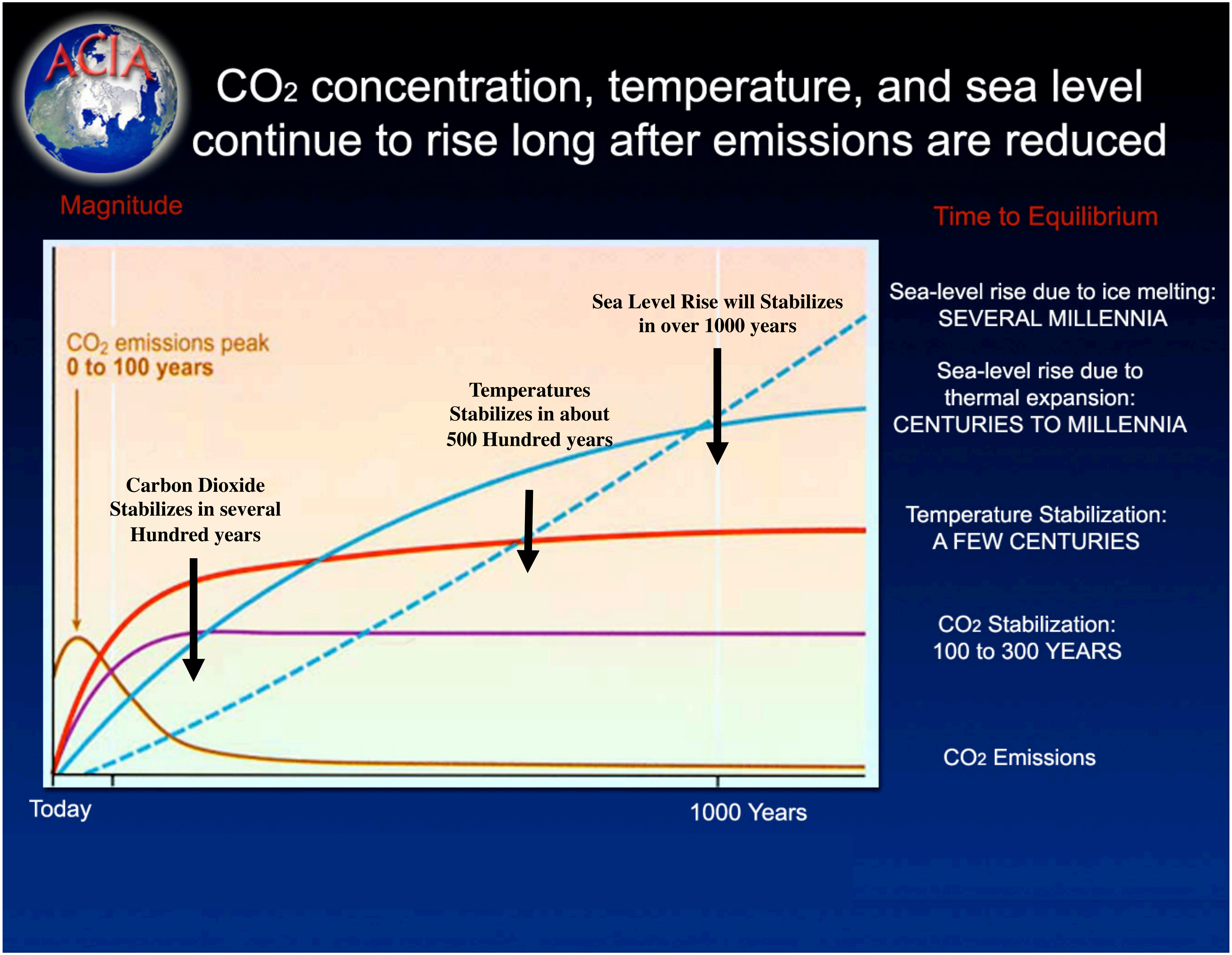


Surface Temperature and Sun's Energy



The Last 20,000 Years seems to have been Ideal for the Development of Human Societies. Is this a Historic “Sweet Spot” that Enabled Humans to Flourish?

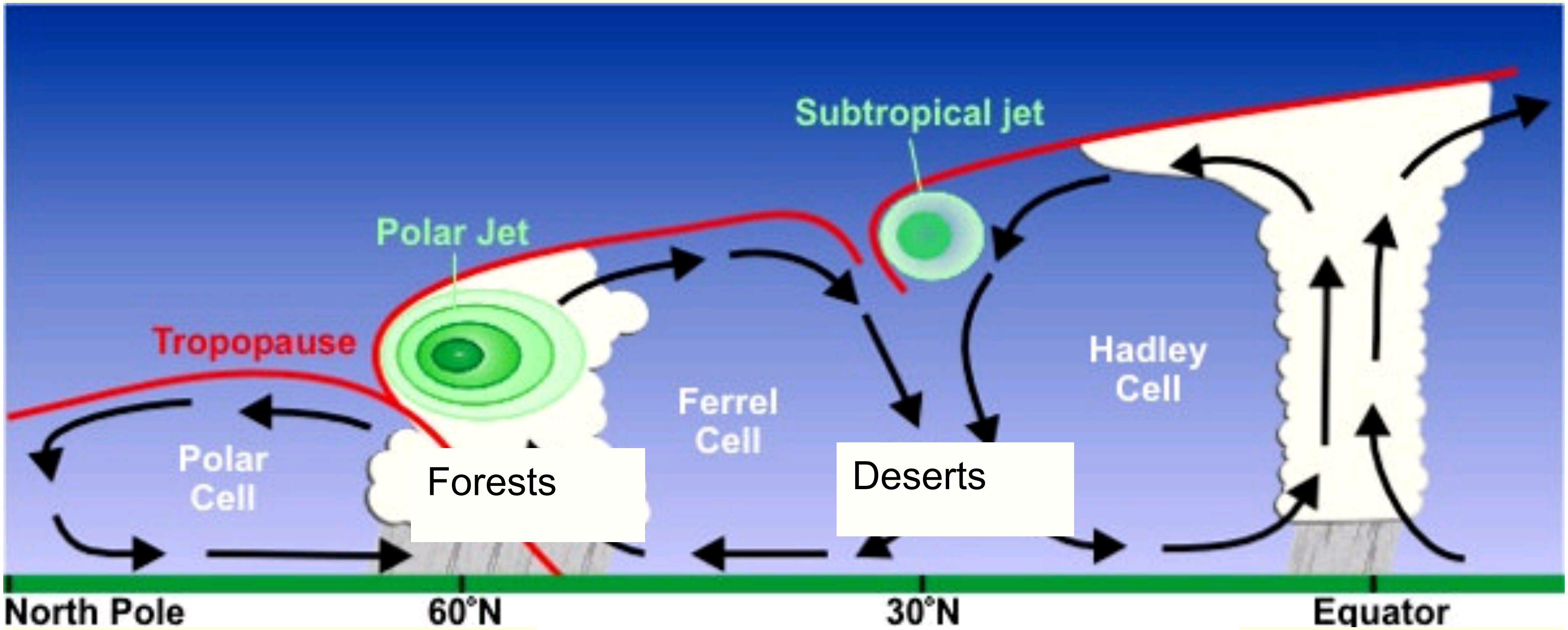


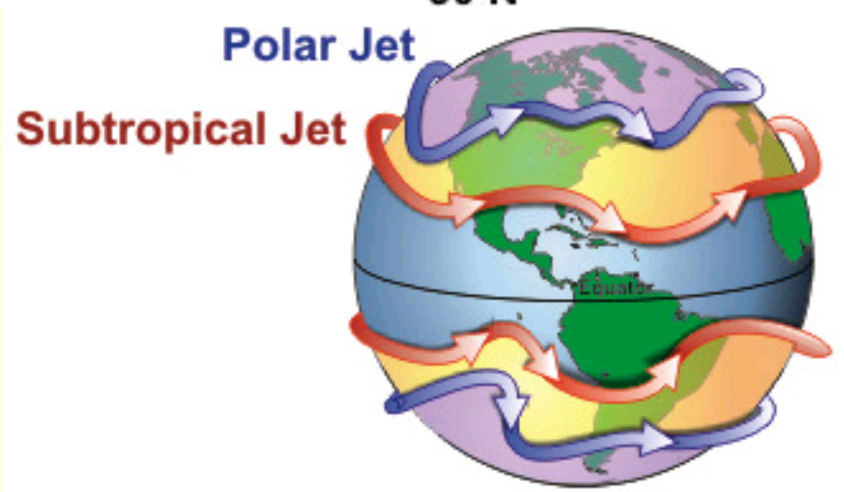


ACIA
CO2 concentration, temperature, and sea level continue to rise long after emissions are reduced
Magnitude
Time to Equilibrium
CO2 emissions peak
0 to 100 years
Sea Level Rise will Stabilizes
in over 1000 years
Temperatures
Stabilizes in about
500 Hundred years
Carbon Dioxide
Stabilizes in several
Hundred years
Sea-level rise due to ice melting:
SEVERAL MILLENNIA
Sea-level rise due to
thermal expansion:
CENTURIES TO MILLENNIA
Temperature Stabilization:
A FEW CENTURIES
CO2 Stabilization:
100 to 300 YEARS
CO2 Emissions
Today
1000 Years

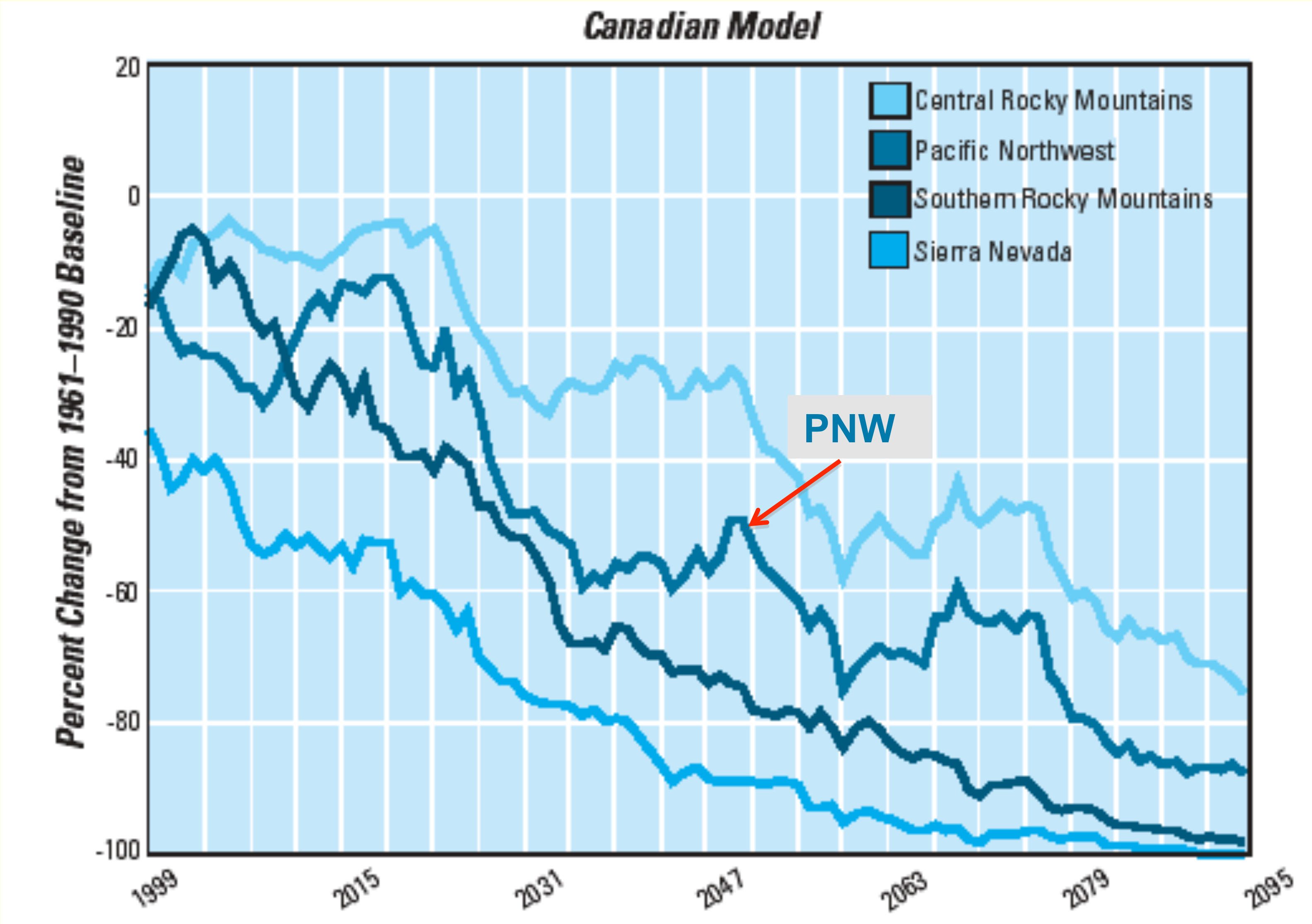
Subtropical Jet Stream Moves North

http://www.srh.noaa.gov/jetstream/global/jet.htm

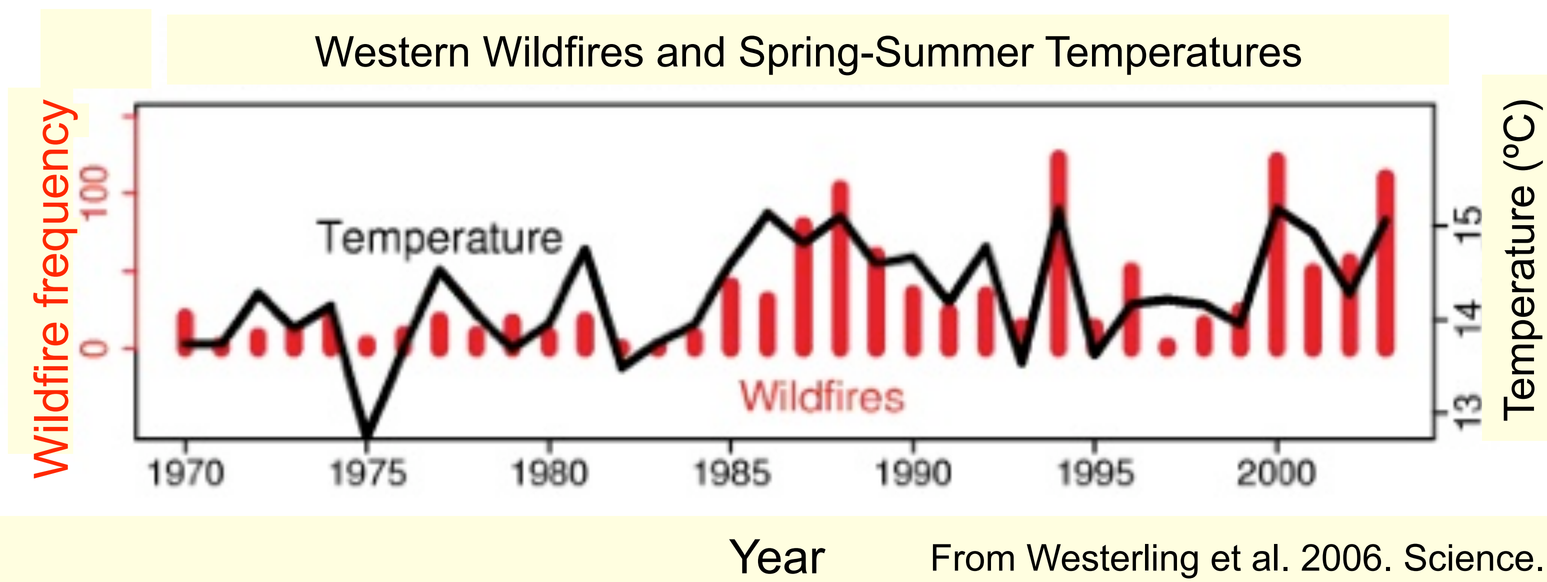




Snowpacks are projected to diminish



Increasing risk of wildfire



From Westerling et al. 2006. Science.

6-fold increase in area burned since 1986

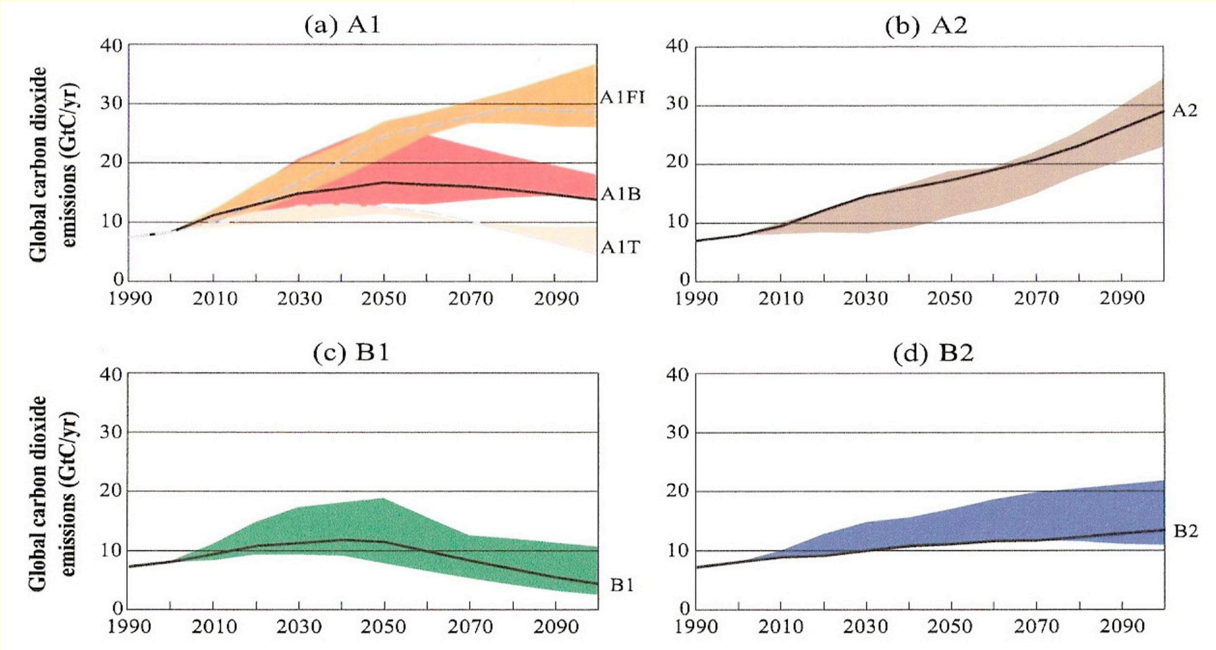
CO_2 concentration increasing at alarming rate

Higher levels of CO_2 stimulate plant growth and drought resistance, but also…

- Tend to favor invasive species and production of allergens
- Ocean has absorbed one-third of all increases in atmospheric CO_2 since beginning of industrial revolution, but also…
- Ocean acidification has increased 30% and threatens formation of calcium carbonate in shellfish and phytoplankton and disruption of marine food chain
- Currently observed particularly corrosive along Pacific coast of North America
- At current emissions trajectory CO_2 acidification will increase 150% by end of century (NOAA 2009)

Emission Scenarios and Climate Modeling

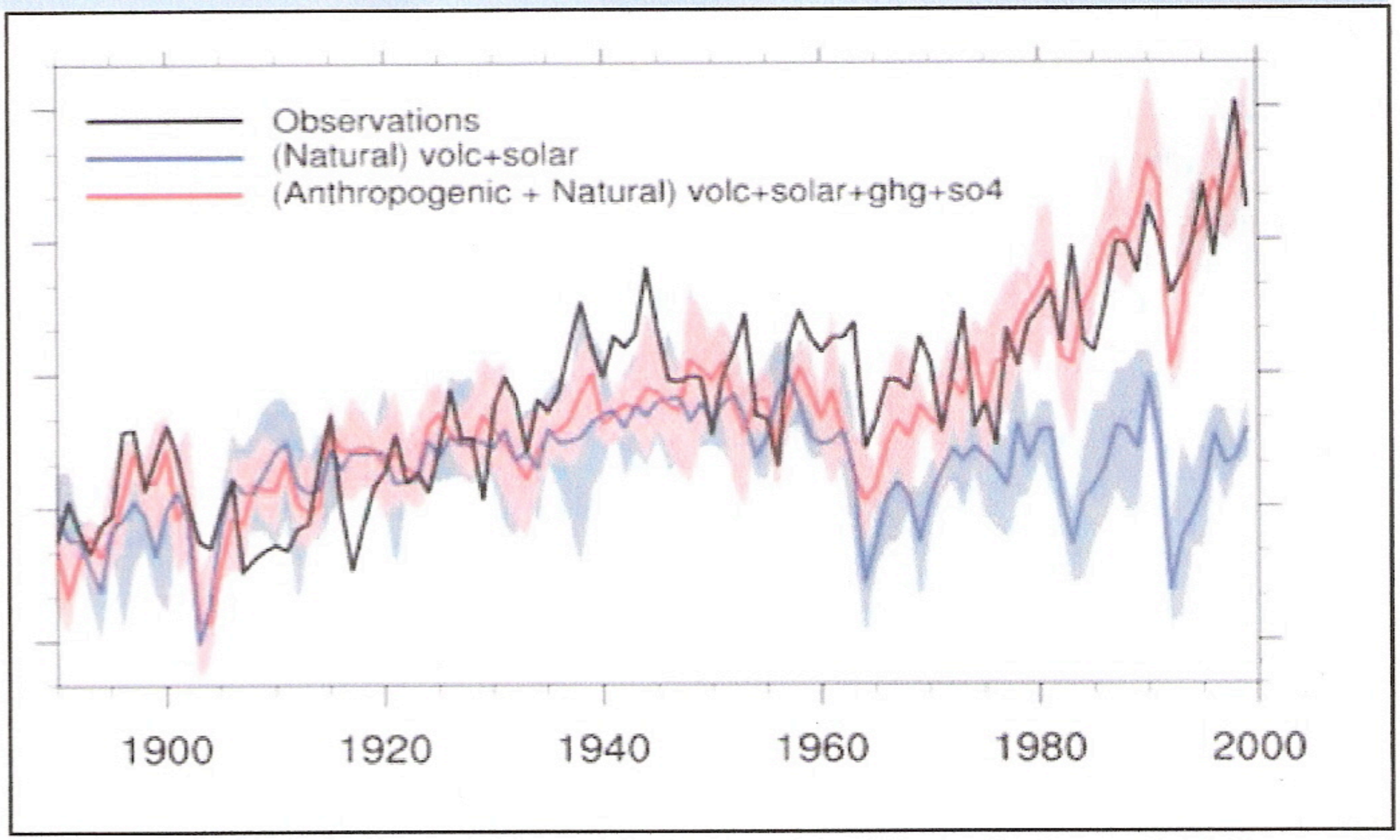
- Models based on inputs from laws of physics
- Couple atmosphere and ocean conditions
- Level of green house gas inputs depend on social, economic, and political assumptions: temperature impacts of B1 half of A2.
- OCCRI models chosen for wide range and vegetation model compatibility



Observed Temperatures Last Century Compared to Natural and Man-Made Simulations

Vertical scale is .5 degrees Fahrenheit

Observed Temperatures and Two Simulations: Natural vs. Anthropogenic Plus Natural[19]



(Figure courtesy of Dr. Gerald Meehl, National Center for Atmospheric Research.)

Rogue Projections

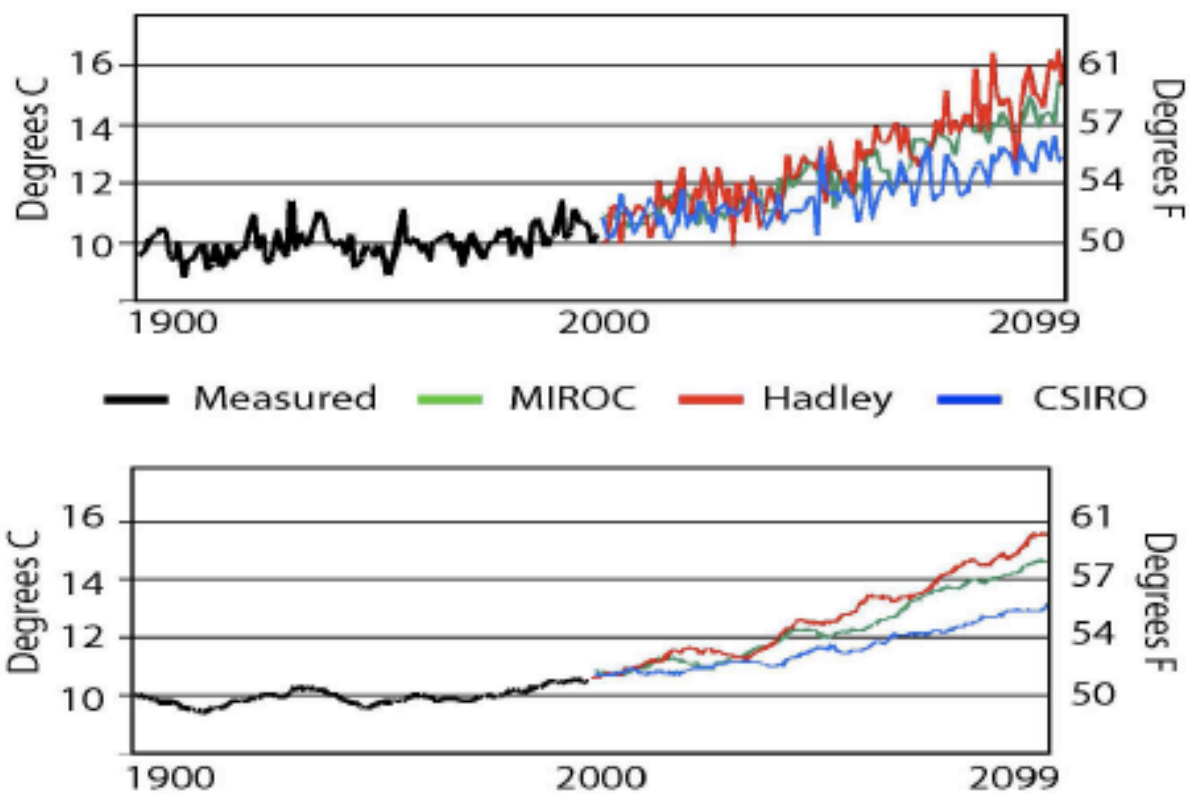
- Temperature
- Precipitation
- Snow Water Equivalent (ie. snowpack)
- Stream Flow Changes
- Vegetation Changes
- Fire: Area Burned and Carbon Consumed

* Please see the Rogue Workshop Report and Appendix C for the full set of projections

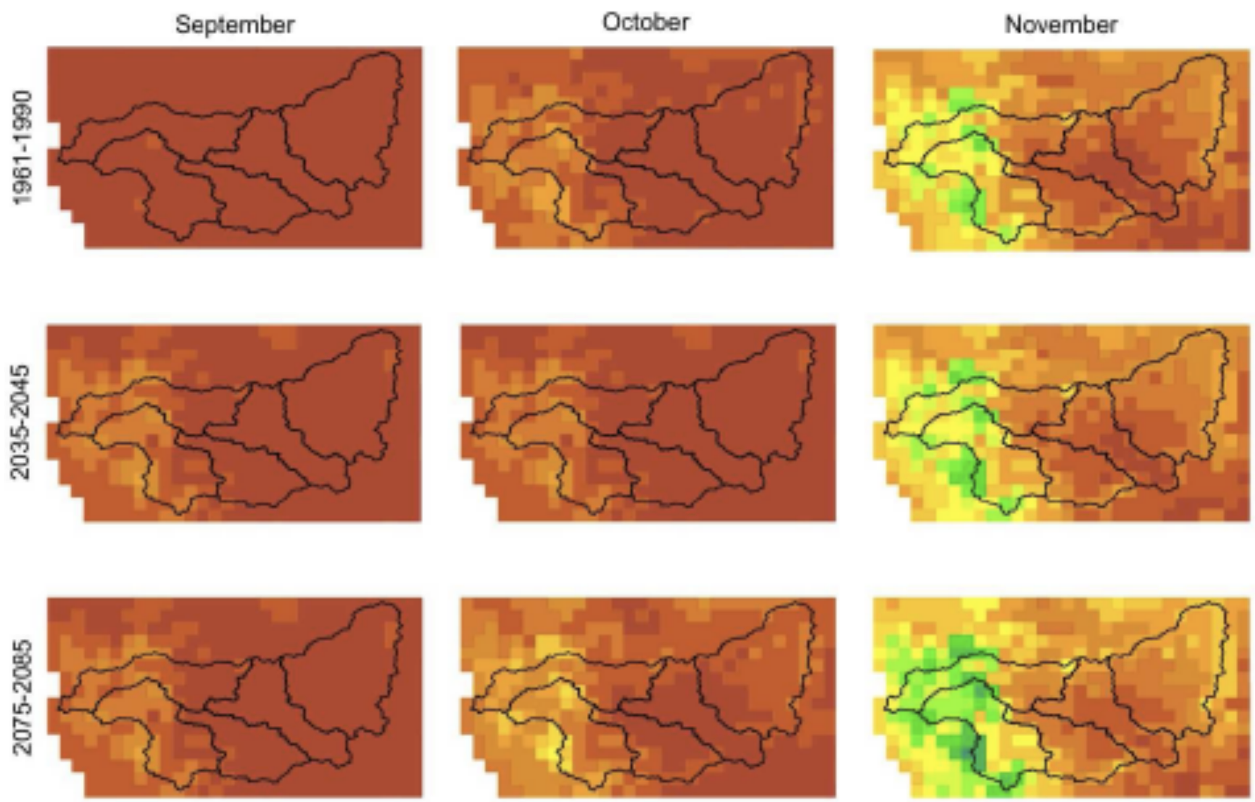
Summary of Climate Projections

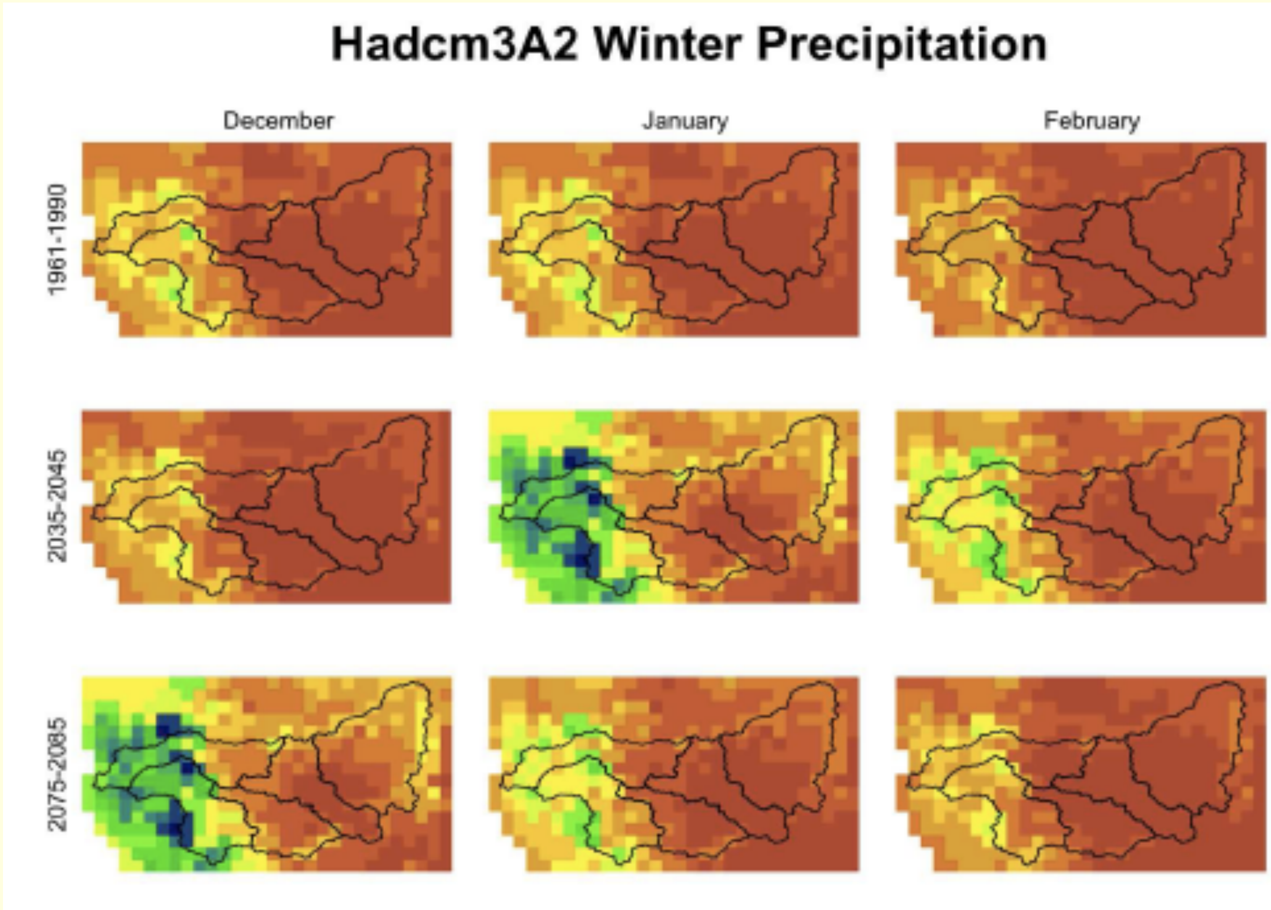
- All models show increase in warming: Average 5 to 12 degrees F in summer
- Average 4 to 5 degrees F warming in winter
- All models show increase in winter precipitation
- Hadley model shows decrease in summer precipitation
- Snow water equivalent declines
- Streamflows higher in winter

APPENDIX C-1. ANNUAL AVERAGE TEMPERATURE ACROSS THE ROGUE BASIN 1900-2099. THE BOTTOM GRAPH SHOWS AN 11-YEAR RUNNING AVERAGE.

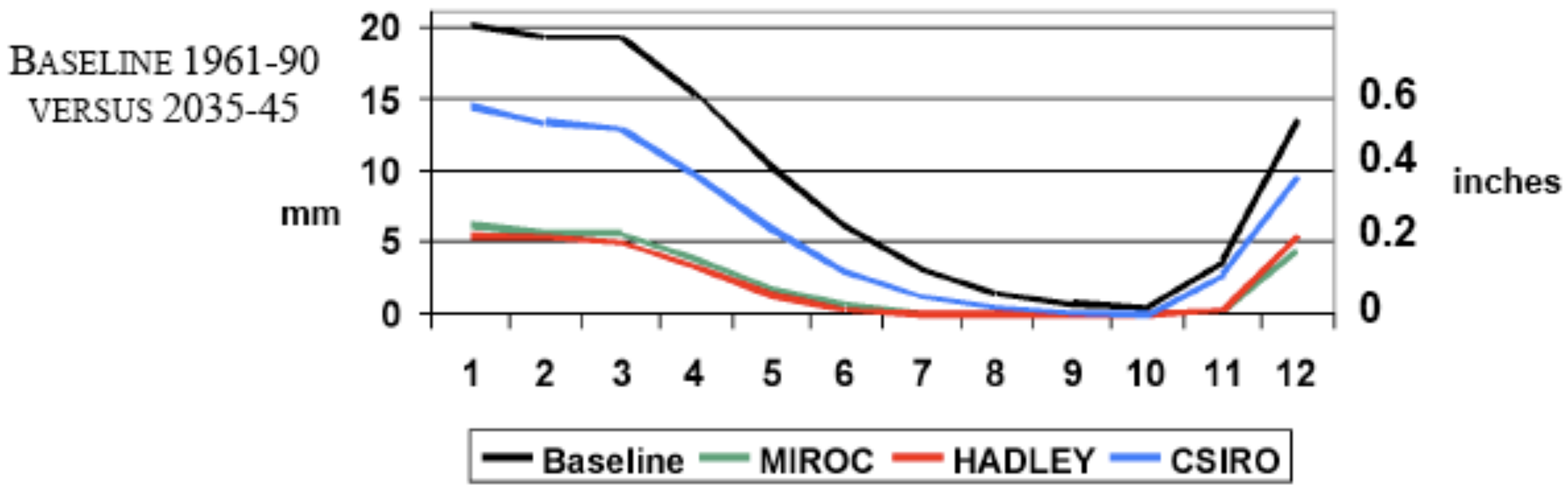


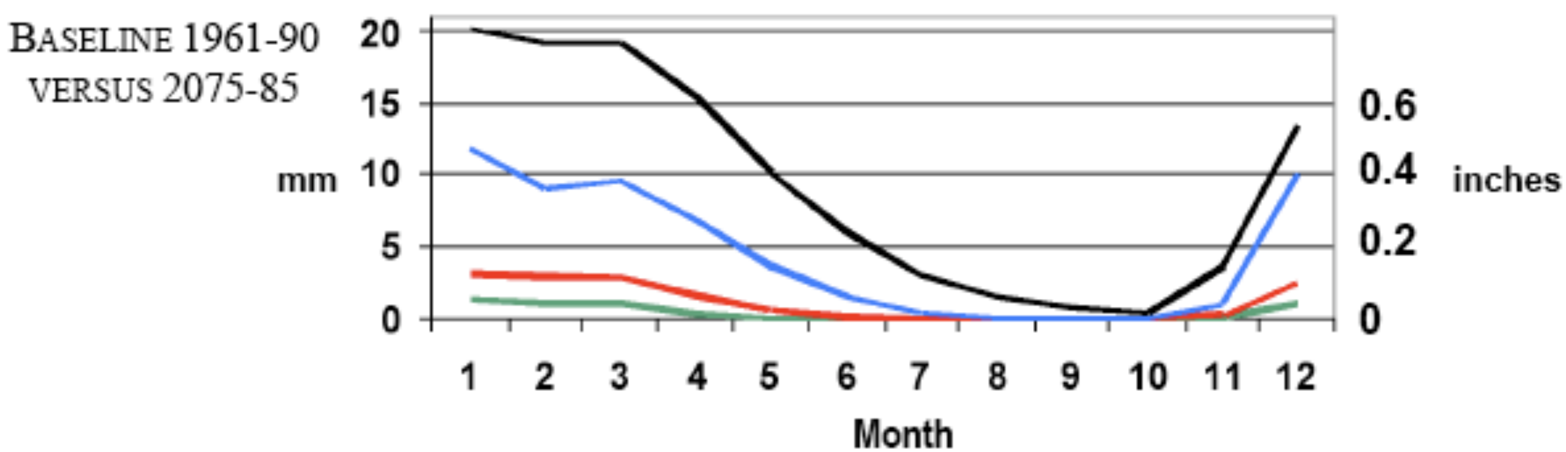
CsiroA2 Fall Precipitation



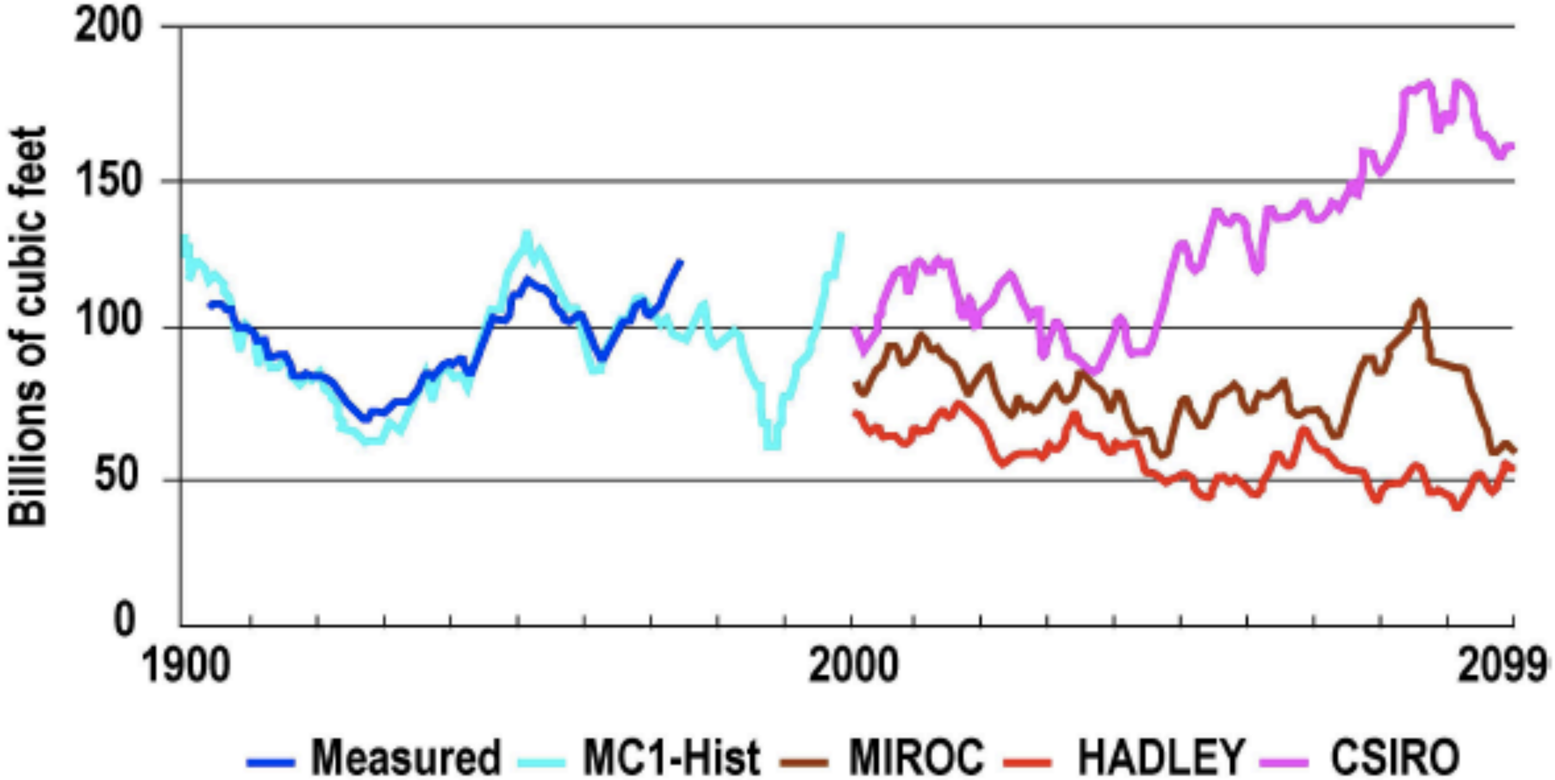

Hadcm3A2 Winter Precipitation
December
January
February
1961-1990
2035-2045
2075-2085

APPENDIX C-5. AVERAGE MONTHLY SNOW ACCUMULATION ACROSS THE ROGUE BASIN: 2035-2045 (TOP) AND 2075-2085 (BOTTOM) VERSUS BASELINE (1961-1990).

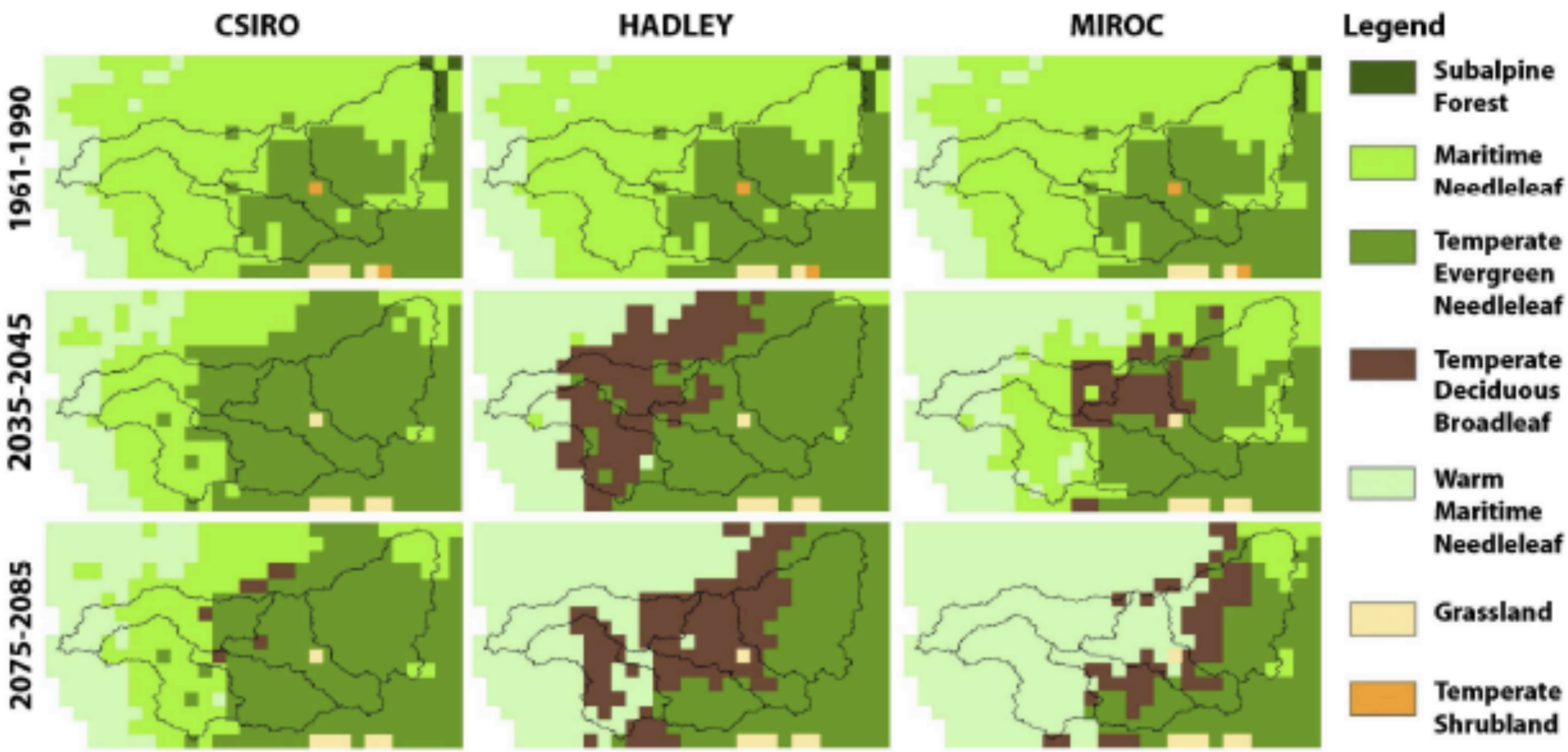




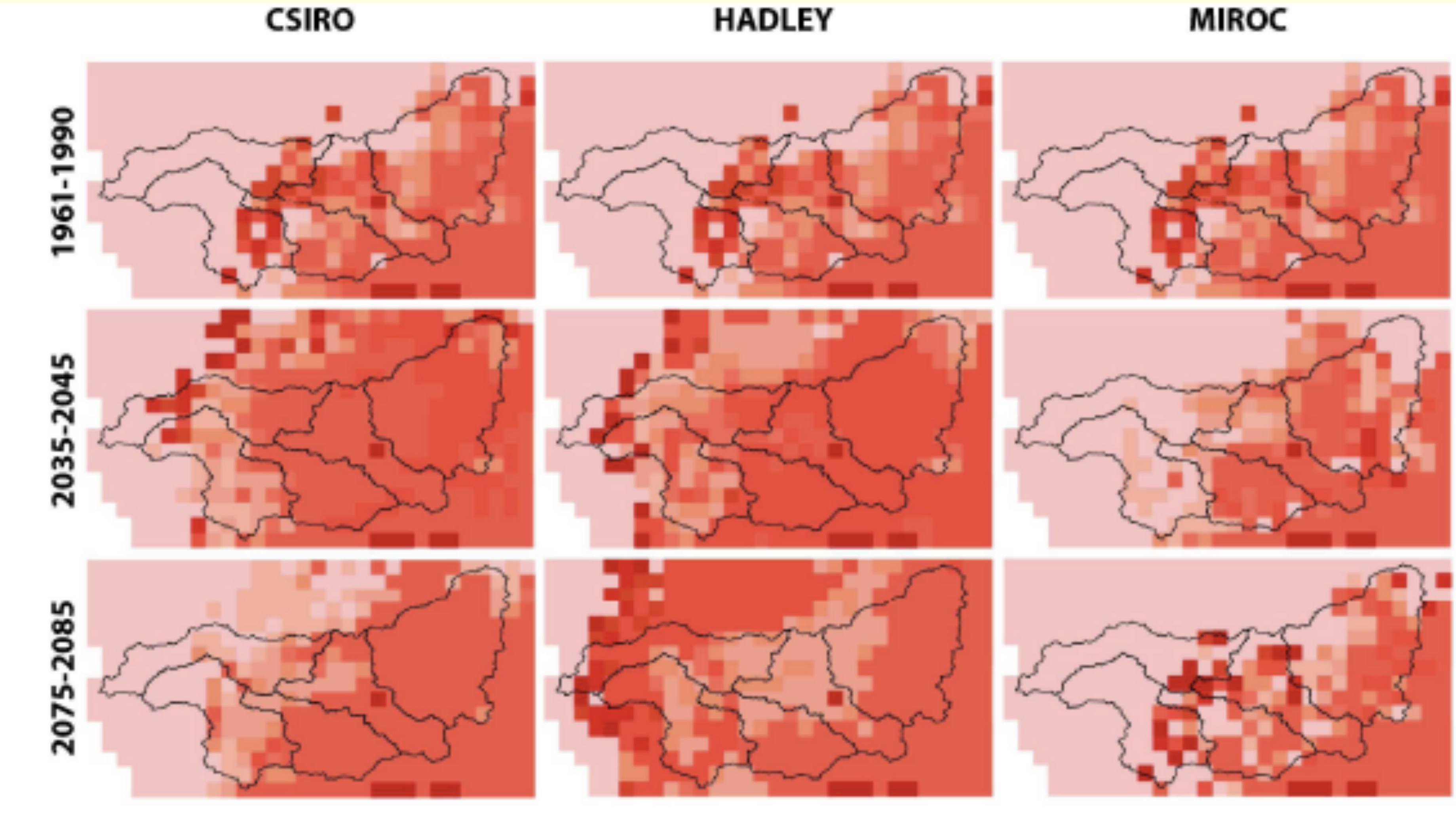
APPENDIX C-7. ANNUAL STREAM FLOW AT THE GOLD REY GAUGE ($FT^3 \times 10^9$): HISTORICAL AND SIMULATED, WITH AN 11-YEAR FILTER.



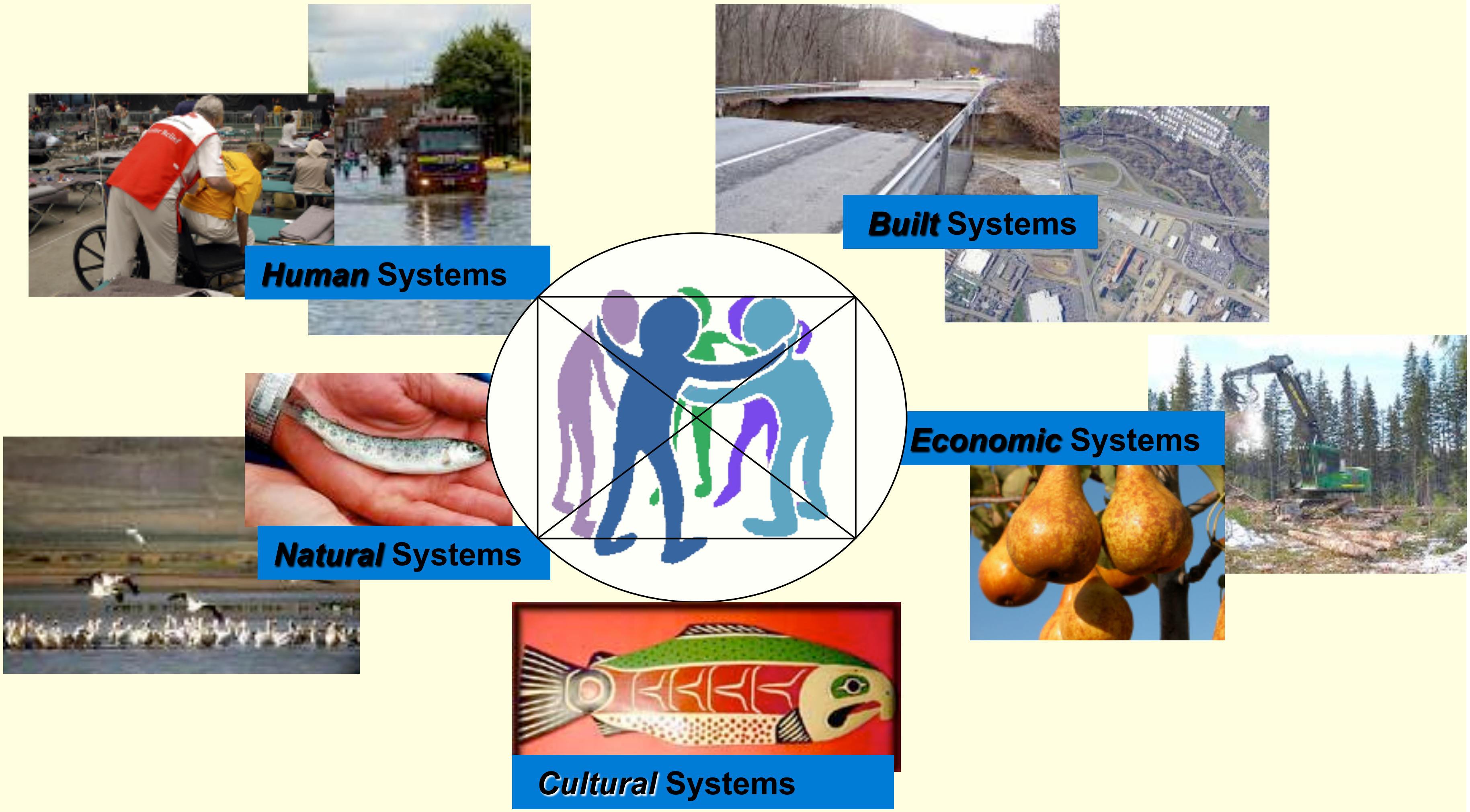
Projected Vegetation Change



Projected Area Burned



FRAMEWORK FOR
CLIMATE CHANGE FUTURES PROJECT



Resulting Impacts
Aquatic Systems

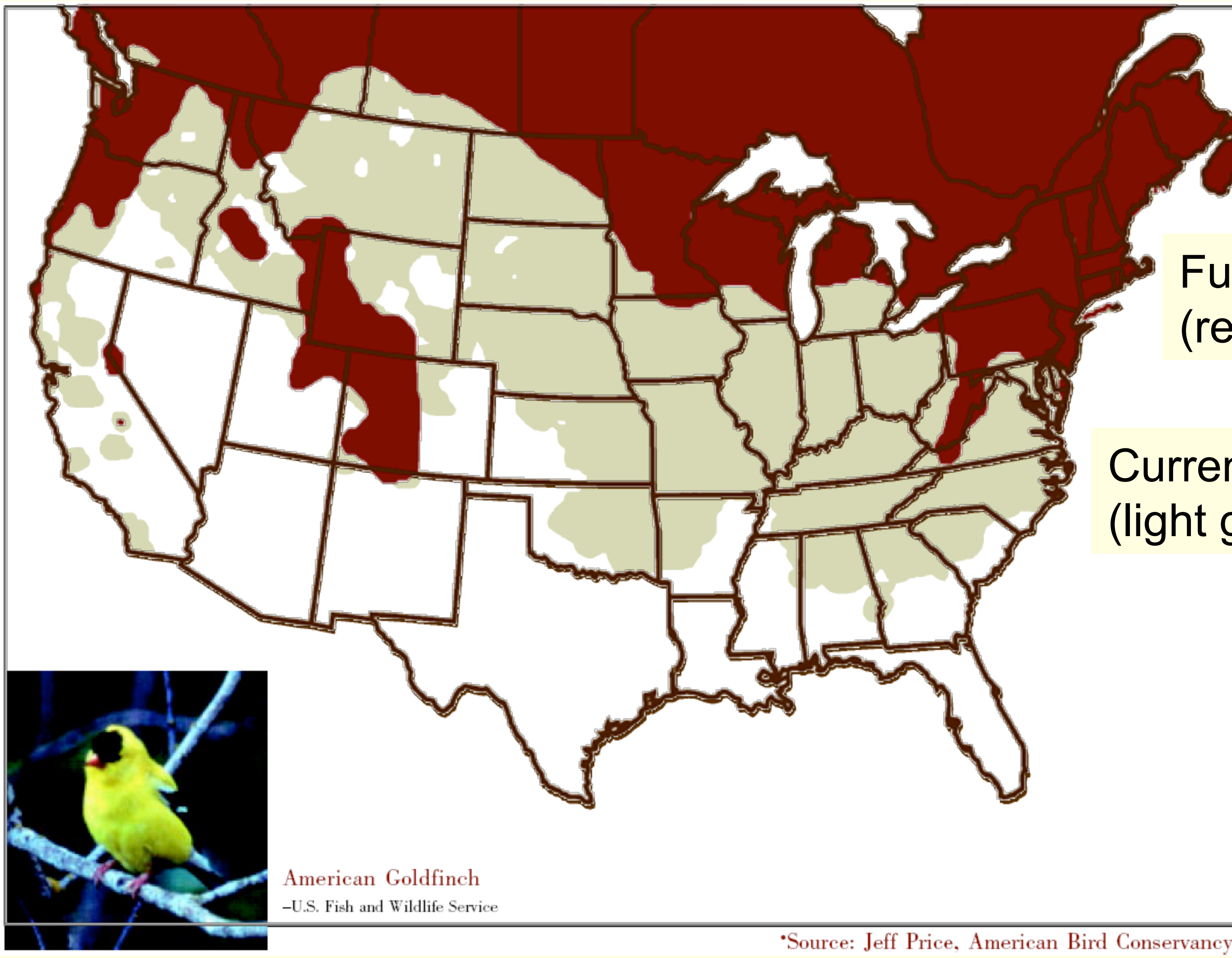



- Altered flow patterns
  - Reduced summer flows
  - Shift in timing of migration cues
  - Thermal tolerance exceeded
- Reduced Suitable Habitat
  - Decreased accessibility
  - Loss/changes in habitat condition
- Compromised water quality
- Increased disturbance from flooding and fire

Resulting Impacts
Terrestrial Systems

- Increased wildfire activity
- Increased forest drought stress and mountain pine beetle infestations
- Earlier runoff and reduced snowpack
- Increase in invasive species
- Loss of habitat and refuges
- Hardwoods and ponderosa pine favored over conifers

Species are expected to shift their ranges…



Future range (red)

Current range (light gray)

Based on doubling of CO_2 in the next 50-100 yrs.

Natural Systems Recommendations

- Aquatic
  - Protect floodplains
  - Increase complexity of streams
  - Protect genetic diversity of fish
- Terrestrial
  - Restore natural fire regime
  - Use landscape scale approach to conservation
  - Expand carbon sequestration efforts
- All
  - Protect high quality habitat
  - Revise species management for both endangered and invasives as result of new climate conditions

-

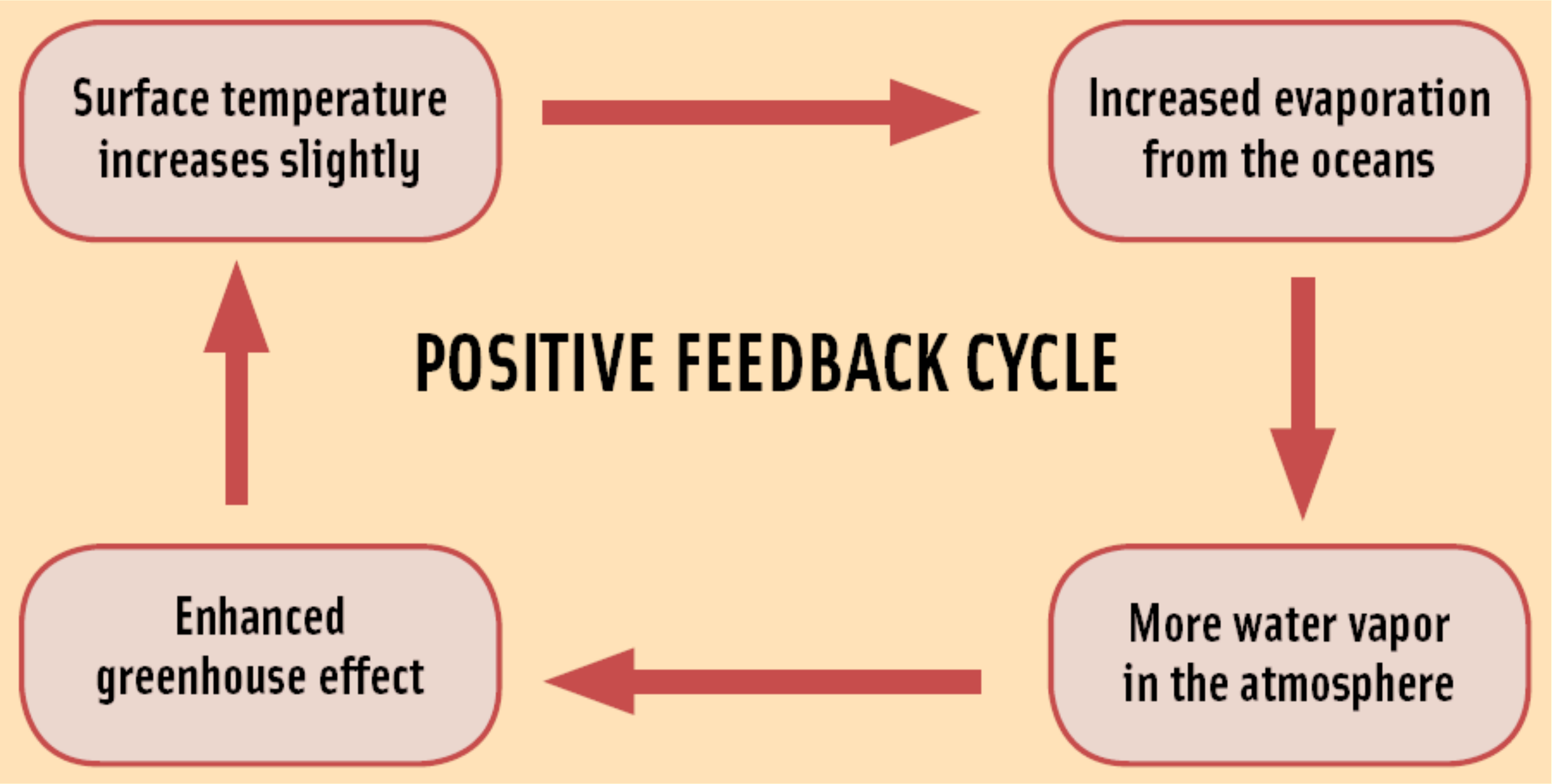
Oregon: Cost of No Action

(CLI and EcoNorthwest, 2009)

Costs ($/year)	2020	2040	2080
Inefficient Energy	$1.5 b	$1.8 b	$2.3 b
Salmon losses	1 b	2 b	5 b
Health Care	.9 b	1.5 b	3.2 b
Lost Recreation	.2 b	.4 b	1 b
Wildfire	.2 b	.4 b	.9 b
Total (inc. energy/water)	4 b	6.7 b	13.7 b
Cost per household	$2340	$3150	$4890

Where will it all end?

ultimate fear of scientists:
“tipping points” (positive-feedback thresholds)



National Academy of Sciences 2008

Preparing Oregon's Watersheds for Climate Change

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DEFINITIONS

Preparing for climate change means *taking proactive steps to anticipate and consciously build resistance and resilience* to the likely range of climate change-induced stresses.

Resistance is the capacity of ecological systems, biodiversity, and humans to *prevent* climate change related impacts from occurring.

Resiliency is the capacity of a system to *adapt to* and *bounce back from* climate-induced stresses *without crossing a threshold into a new 'unwanted' condition.*

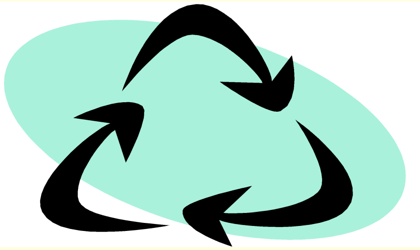
(Adapted from the Resiliency Alliance)

SUSTAINABILITY

• **Watersheds have the capacity to *exist in more than one condition* in which their structure, function and feedbacks are different.**

• **Disturbances—natural or human--can *drive them into a different condition*, often with unwelcome surprises.**

• **A sustainable watershed has the capacity to *absorb disturbance*, *adjust*, but *still retain its essential structures, processes, and feedbacks* without flipping into a new 'unwanted' condition.**



PREPAREDNESS VS. ADAPTATION

• **Adaptation is often used to describe the process of coping with climate change. It describes how <u>organisms respond to change over time</u>. But organisms <u>do not anticipate potential changes</u>.**

• **Humans, however, have the capacity to <u>anticipate</u> the potential consequences & <u>proactively build resistance & resiliency</u> to them.**

• **Adaptation is thus an <u>element of preparedness</u>, but does not capture the full range of processes. It also can <u>create inertia.</u>**

Key Questions in Preparing for Climate Change

1. What are the key variables, core dynamics and disturbances that shape your watershed now?

2. Is your watershed approaching a new threshold?

3. Might climate change alter the key variables and core dynamics and push your system into a new threshold?

4. What management actions can sufficiently build resistance and resiliency to avoid such a change and capture opportunities?

These questions are tough to answer—but continually asking them is key in preparing for climate change.

SIX CORE PRINCIPLES

1. Manage for diversity and redundancy

- **Resilient watersheds are built on *diversity in all forms* such that they can *offset factors* that *'simplify'* watersheds.**

- **Species, populations, habitats, vegetation, social-economic variables.**

- **Resiliency requires *redundancy* (organisms, structures, processes) *that fill the same niches*--the more variations available the better able to cope with shocks.**

- ***Functional* and *response* diversity are key—*Functional*: variety of organisms that support distinct ecosystem functions. *Response*: variety of responses to environmental changes among species that contribute to the same ecosystem function.**

2. <u>Manage for disturbance and change</u>.

• **Many of the problems facing our watersheds are the result of *past efforts to constrain and control ecological variability*—e.g. floods, fire, disease outbreaks.**

• **Unless disturbances are allowed to play out, *climate change may (further) simplify your watershed*---e.g. a forest never allowed to burn will lose its fire-resistant species and burn hotter.**

• **Managing change can help *prevent a disturbance from driving key variables over a threshold* into a new (unwanted) condition.**

3. Promote modularity

• **Modularity:** ***the way and extent to which the key variables within a watershed are interlinked*****. Think of it as *****increased dominance***** of a few key species, processes, or management goals and practices.**

• **Homogenized (simplified) systems often eventually collapse because *****shocks move rapidly into lower and higher scales (*****e.g. a disease can wipe out a single genetic variety of hatchery fish—effecting other organisms also).**

• **In resilient watersheds habitats & processes that *****aren't tightly linked***** keep functioning *****even when major shocks hit the system*****. (e.g. modularity enables some species to avoid a disease, slowing the rate of spread, and giving time for re-organization).**

4. Manage ‘fast’ and ‘slow’ changing variables—but emphasize slow.

• **We tend to manage for factors *that humans depend* which are *readily visible, change quickly, and easy to measure* (e.g. fish return, trees planted, grass cover).**

• **However, *variables that are hard to see or measure because they change slowly* (e.g. soil organic matter, nutrient levels in a lake, depth of water table) *determine the resiliency of a watershed***

This is because they *determine the condition of other variables* (e.g. algal density, soil fertility)—thus are ‘controlling’ variables’ that may have *threshold effects.*

EXAMPLES OF SLOW & FAST VARIABLES

System	Fastest	Slower	Slowest
Forest-pest dynamics	Insects	Foliage	Tree diversity
Forest fire dynamics	Undergrowth	Fuel load	Fire resistant veg Soil organic matter
Deep lakes	Phytoplankton	Zooplankton	Fish biomass Nutrient levels
Freshwater streams	Water quality	Hyporheic zones	Aquifers
Agricultural lands	Crop productivity	Deep rooted trees	Depth of water table

Adapted from *Panarchy*, Gunderson and Holling, Page 69

5. Build effective rapid feedback and learning mechanisms

• Climate-induced *changes in one variable can have important implications* for an entire watershed—even fully reconfigure it.

• Effective feedback systems help respond to these shifts by *detecting changing variables and thresholds before they are crossed*

• Feedback and learning mechanisms should account for *delays*.

6. <u>Manage whole 'social-ecological' systems</u>

• **More than natural disturbances & climate change affect watersheds.** ***Economic & social shocks also have effects*****.**

• **Managing** ***one component of any system in isolation*** **might work in the short run, but** ***inevitably fails*****.**

• ***Fully engage stakeholders and manage the whole system—social, economic and ecological*****, not its individual components.**

SIX CORE PRINCIPLES

1. Manage for diversity and redundancy

2. Prepare & allow for disturbance and change

3. Promote modularity---don't link everything

4. Manage 'fast' & 'slow' changing variables—but emphasize slow.

5. Build effective rapid feedback and learning mechanisms

6. Build capacity to manage social-ecological systems

SESSION ONE

- What are the ‘fast’ variables that your program manages for today?

- What are the ‘slow’ moving variables that control the structure and processes in your watershed?

- What are the key disturbance processes in your watershed?

- What key thresholds have already been crossed?

- What key thresholds might your watershed be approaching?

- Summary: how resilient is your watershed today?

- How resilient are local socio-economic systems?