Climate Change, Uncertainty and Forecasts of Global to Landscape Ecosystem Dynamics

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Climate Change, Uncertainty and Forecasts of Global to Landscape Ecosystem Dynamics

Contributions From:

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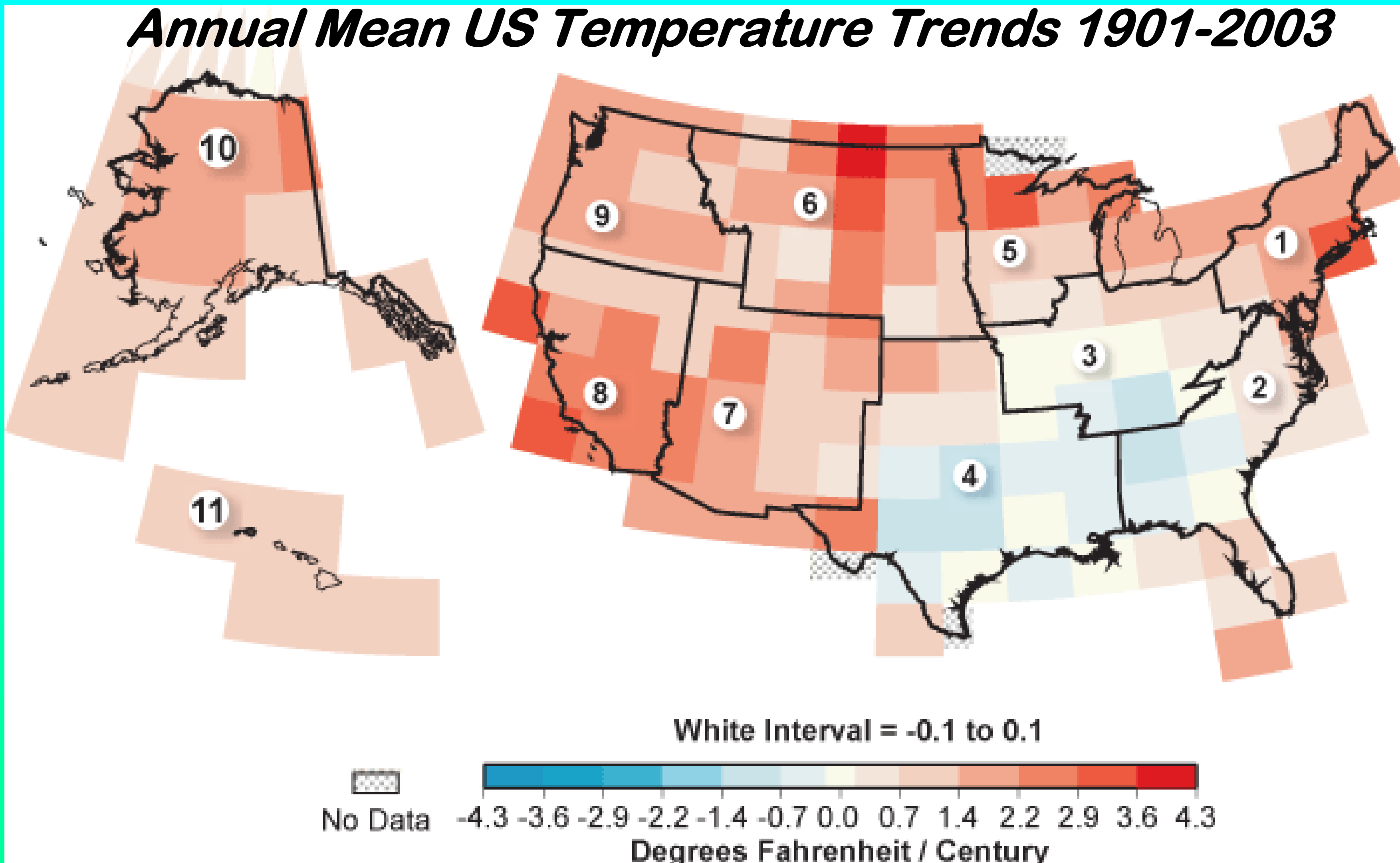
Future Climate
Managing for Change with Uncertainty

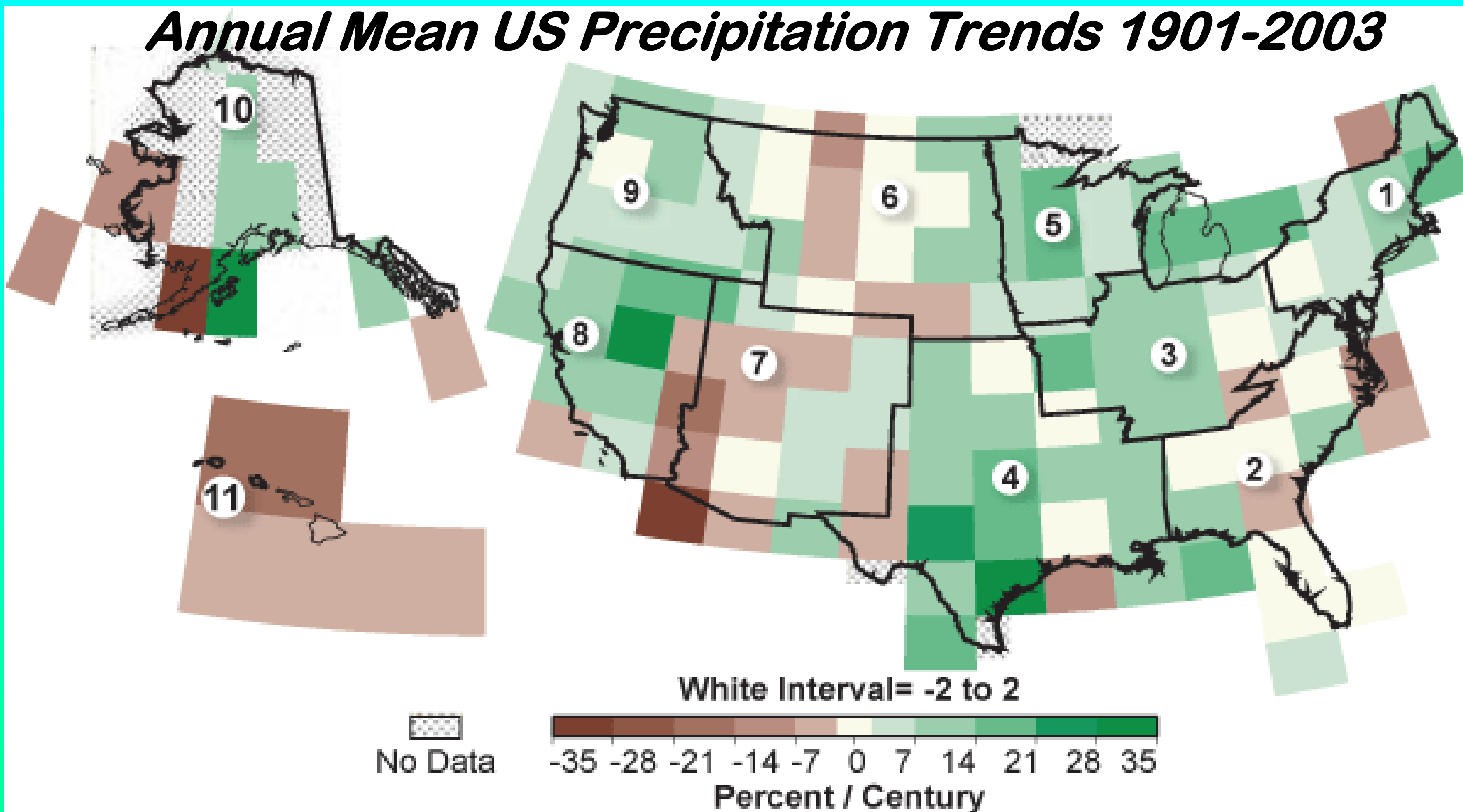
- Hierarchical Assessment
  - Global to Local Scales
  - Near to Long Term Scales
    - Natural Climate Variability – Near term Variability vs. Long term trends
    - Historical Management Legacy – e.g., Fire Suppression
- Natural Resources and Issues of Concern
  - Biodiversity – Vegetation Type and Species Distribution
  - Global Carbon Balance – Sources and Sinks, Forest Productivity
  - Catastrophic Disturbance, e.g. Fire and Infestation
- Management *Of* Change, per se
  - Perpetual Uncertainty
  - Toolbox for Managers

Warming Trend Observed in Most of US



Data from NOAA/NCDC; See: http://www.epa.gov/climatechange/science/recenttc.html

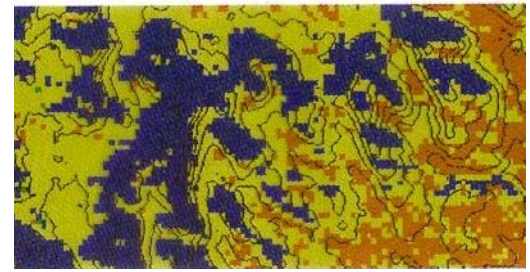
Precipitation Increases & Decreases depending on Region



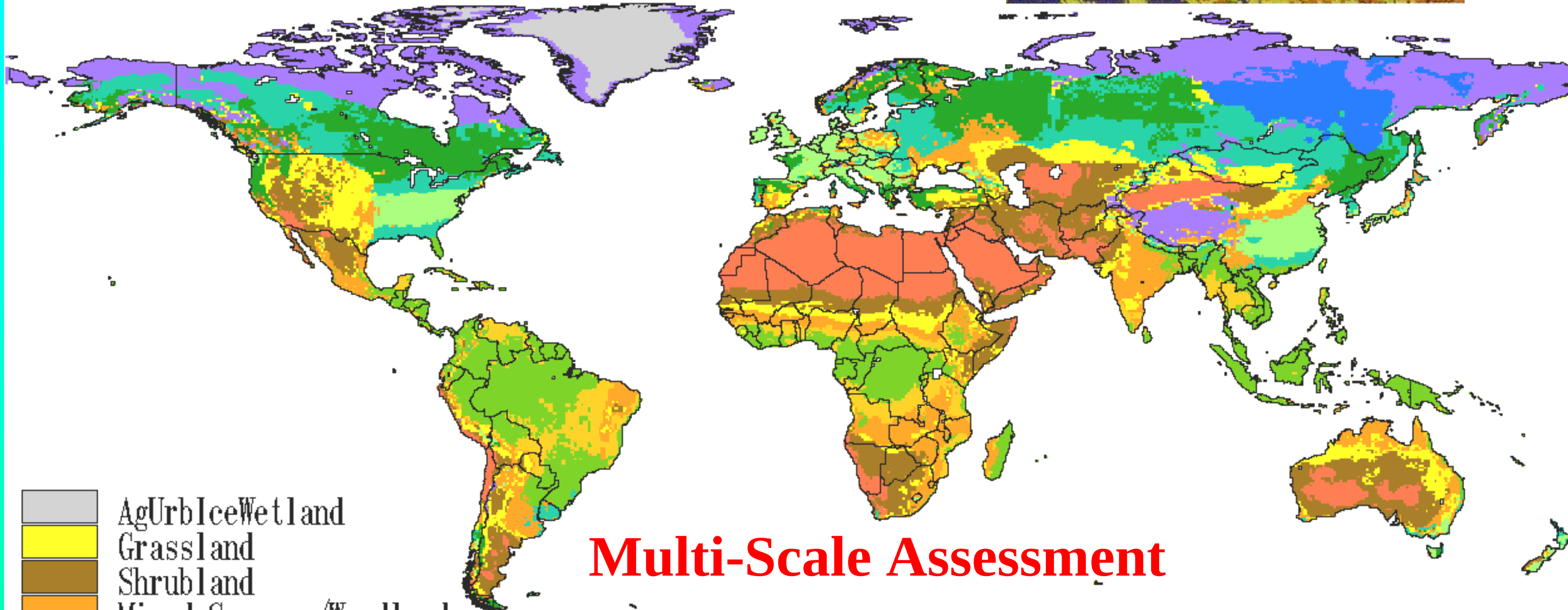
Data from NOAA/NCDC; See: http://www.epa.gov/climatechange/science/recentpsc_precipanom.ht

Simulated Historical Vegetation
MC1 (MAPSS-CENTURY, v.1)

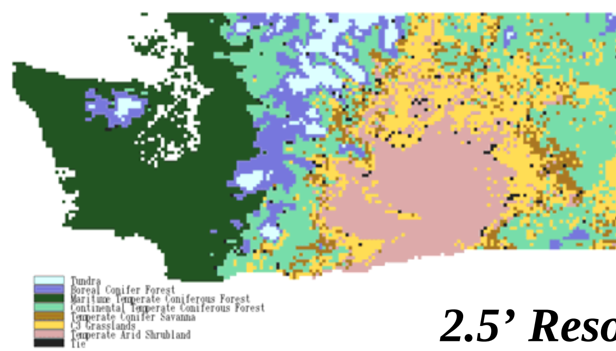
50m Resolution



0.5^o Resolution



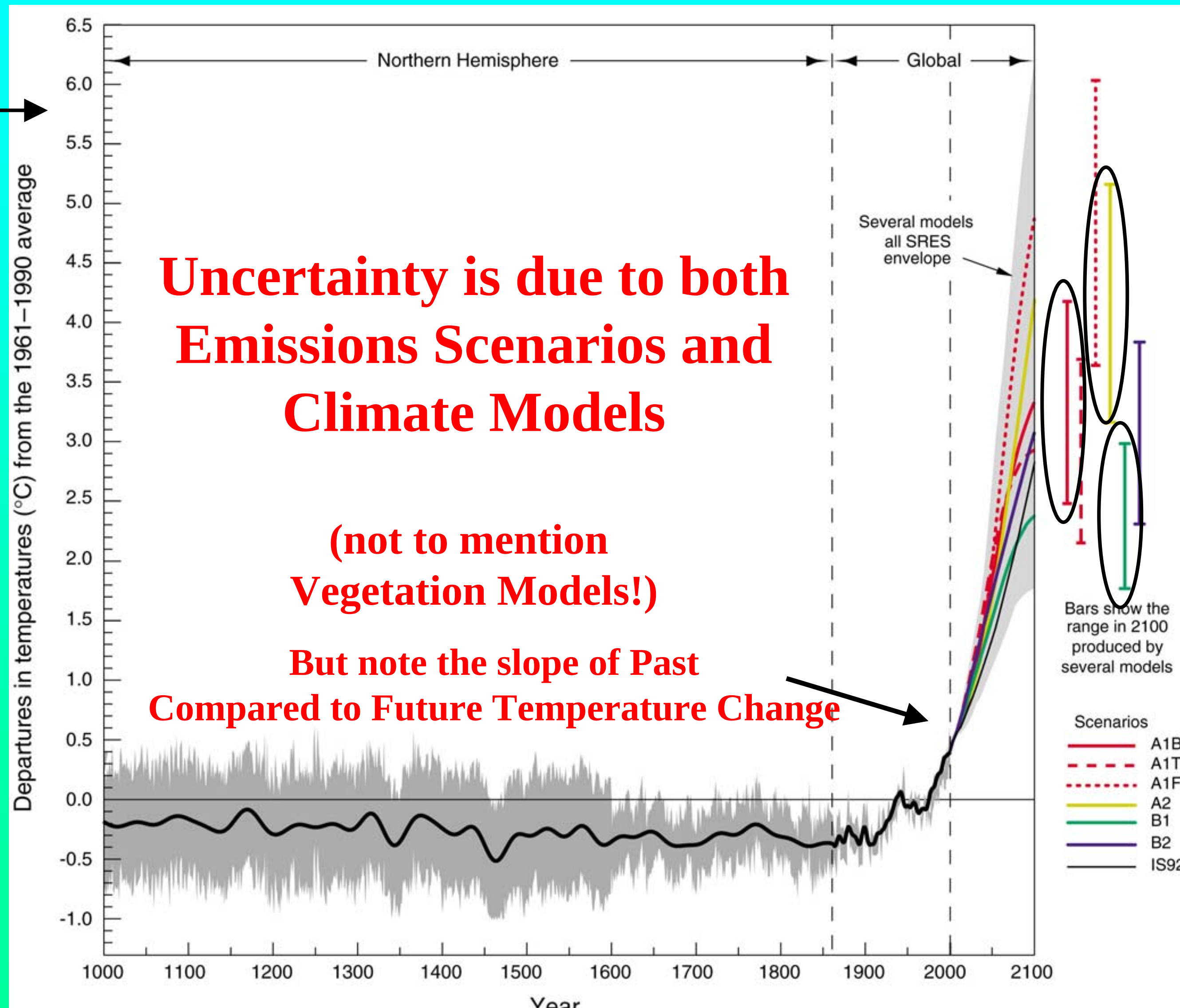
Multi-Scale Assessment



2.5’ Resolution

Variations of the Earth's Surface Temperature: 1000 to 2100

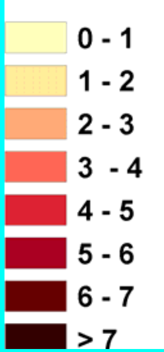
Similar to Glacial – Interglacial Temperature Change



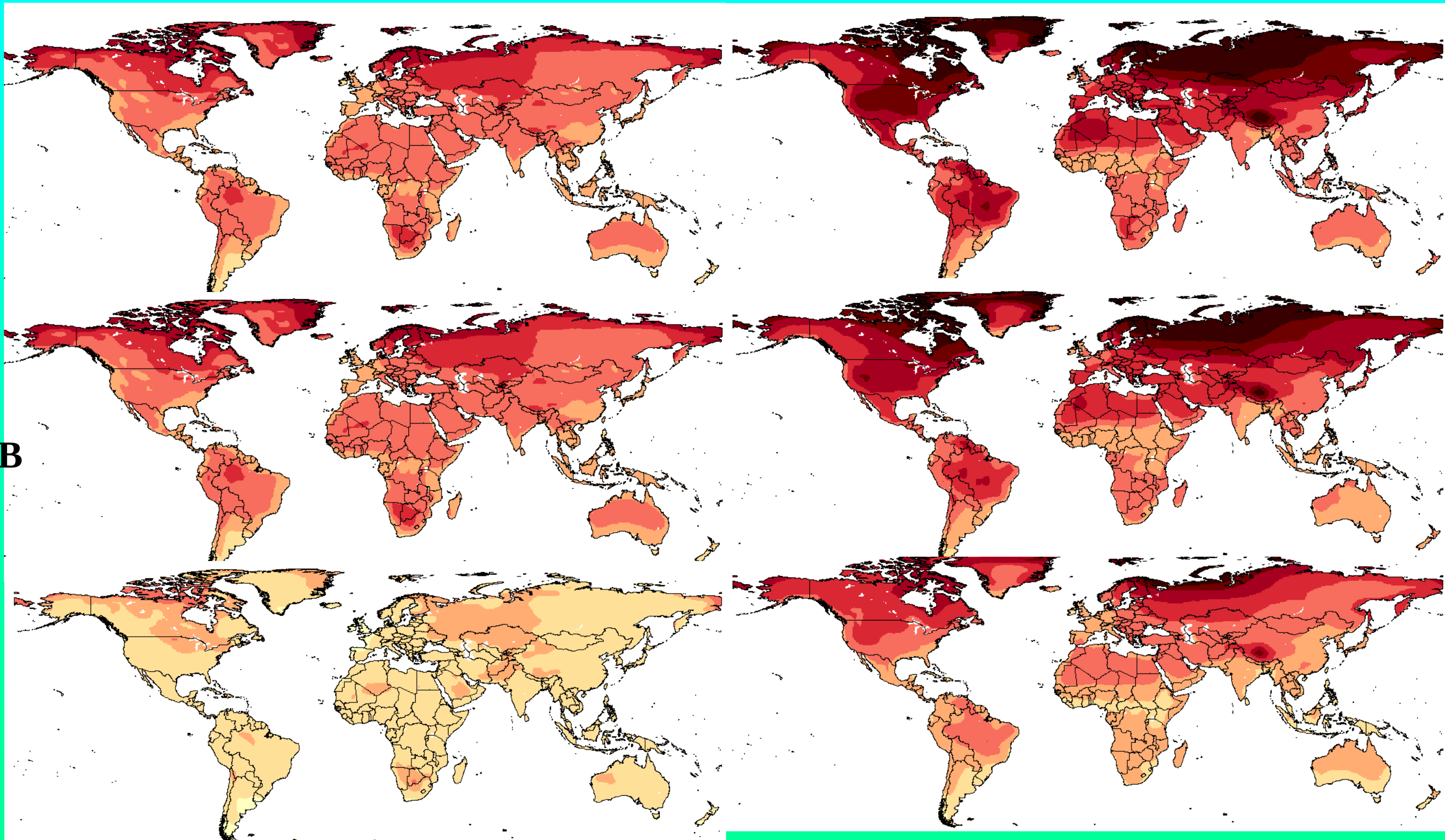
- **1000 to 1861, N. Hemisphere, proxy data;**
- **1861 to 2000 Global, Instrumental;**
- **2000 to 2100, SRES projections**

The Low End of Some Models Is as High as The High End of Other Models

Temperature difference: 2070-2099 vs. 1961-1990



CSIRO MK3 | **MIROC MEDRES**



A2

A1B

B1

The Uncertainties are Often Greater Between Climate Models Than between Emissions Scenarios!

Percent Change Precipitation: 2070-2099 vs. 1961-1990

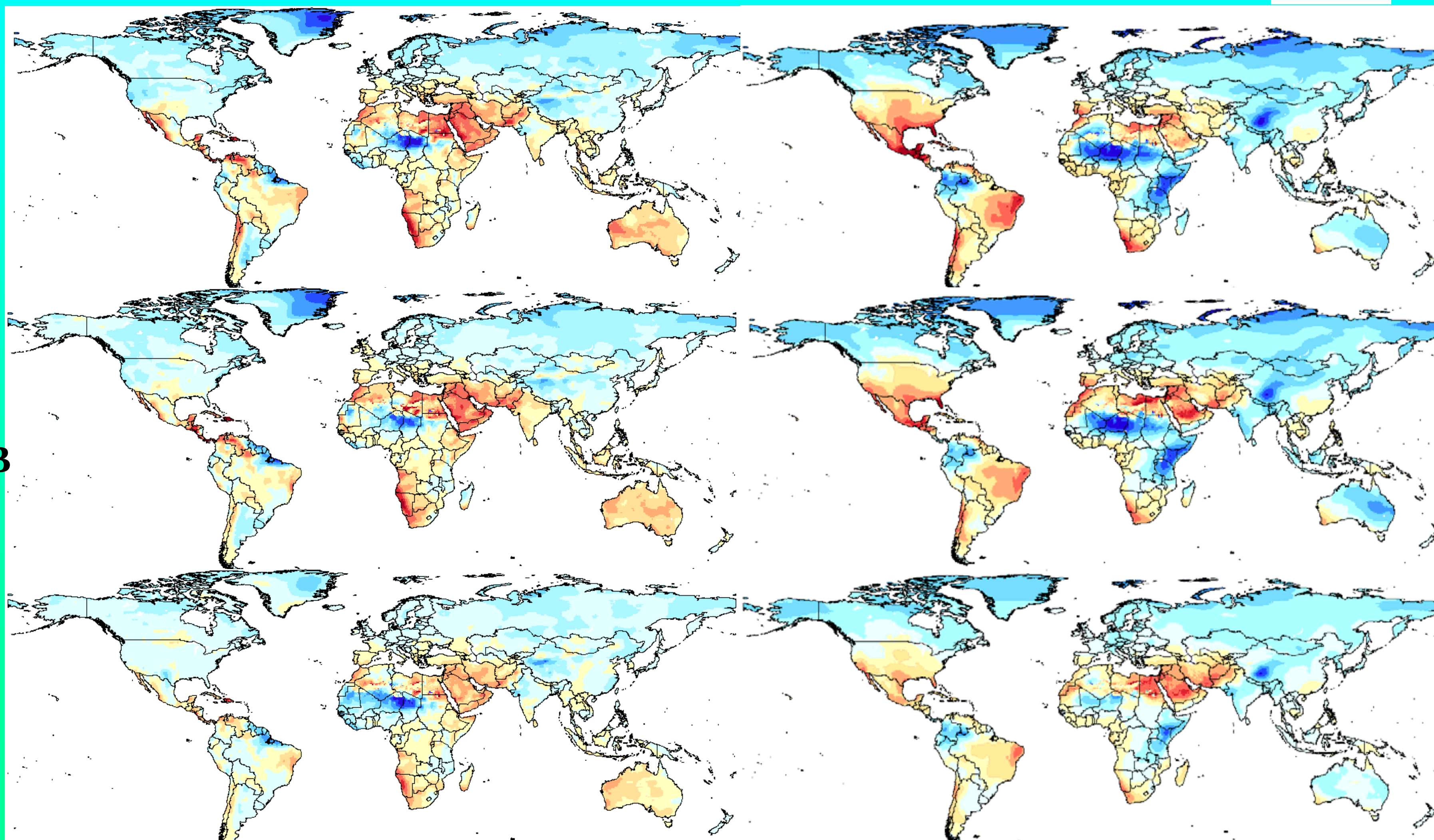
< -50
-50 - -40
-40 - -30
-30 - -20
-20 - -10
-10 - 0
0 - 11
11 - 25
25 - 43
43 - 67
67 - 100
> 100

CSIRO MK3 | **MIROC MEDRES**

A2

A1B

B1

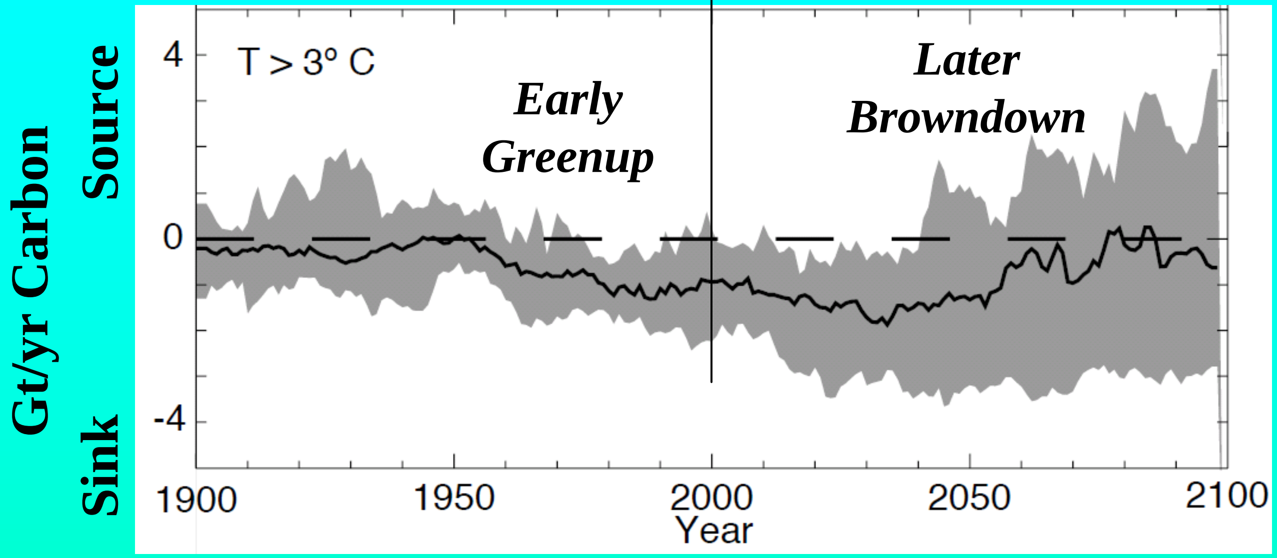


Future Climate
Managing for Change with Uncertainty

Global Assessments

A climate change risk analysis for world ecosystems

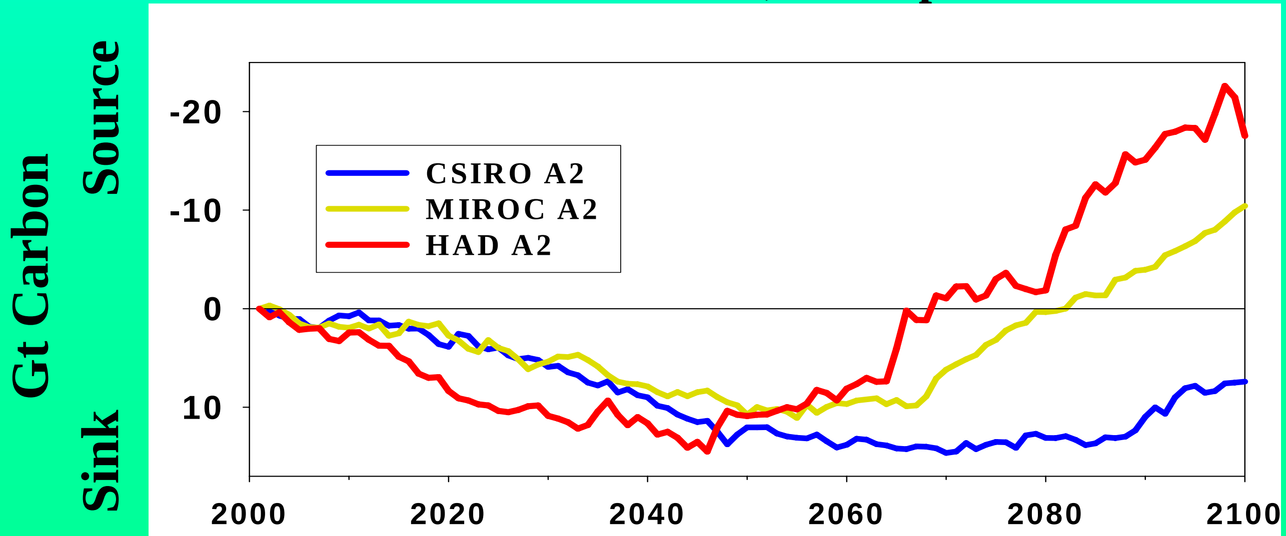
Scholze et al. 2006. Proc. Natl. Acad. Sci.



LPJ DGVM
16 Climate Scenarios

Global Simulated Ecosystem Carbon Change (Pg)

MAPSS Team, In Prep.

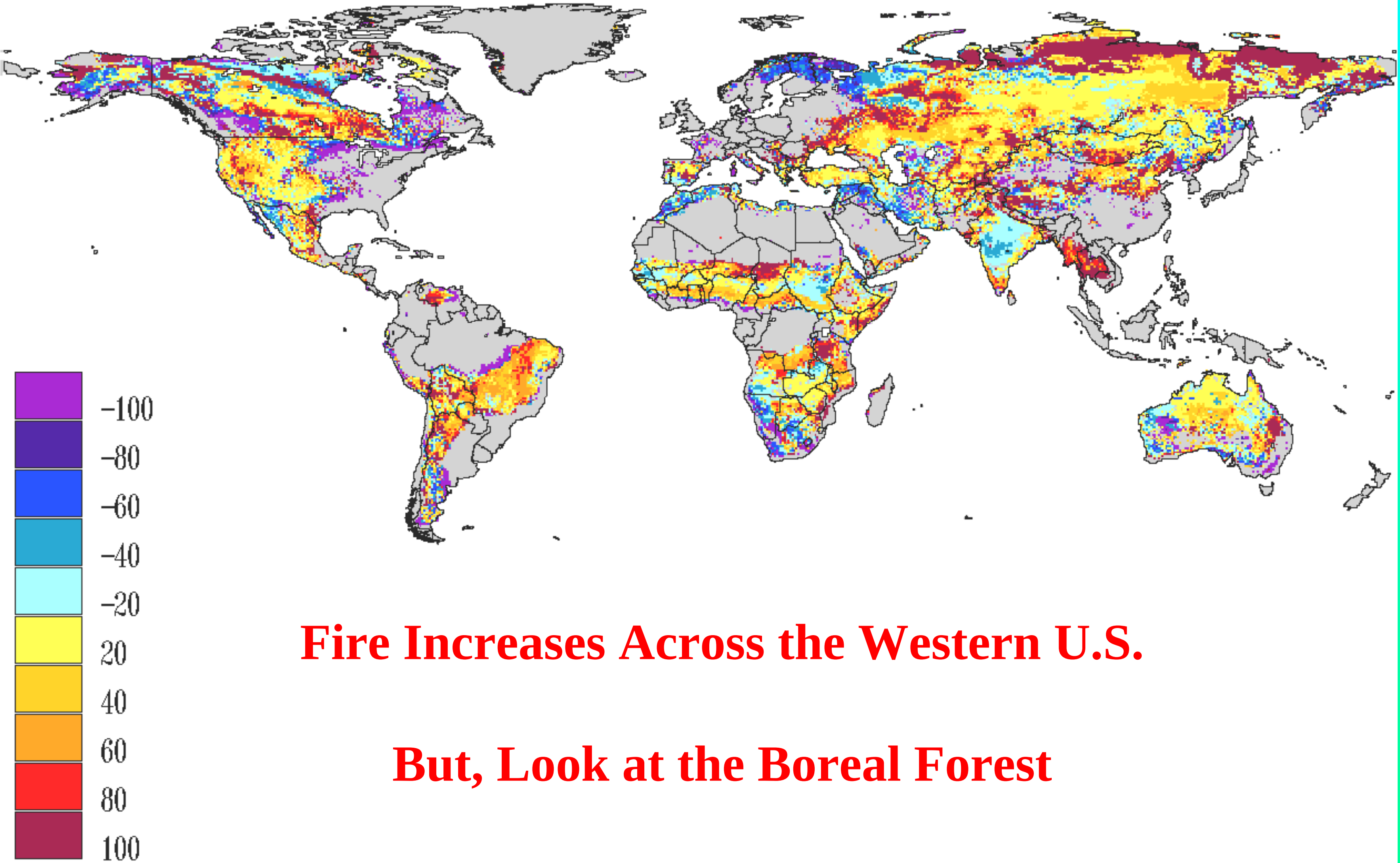


MC1 DGVM
3 Climate Scenarios

Percent Change in Biomass Burned

MAPSS Team, In Prep.

CSIRO_MK3 A2



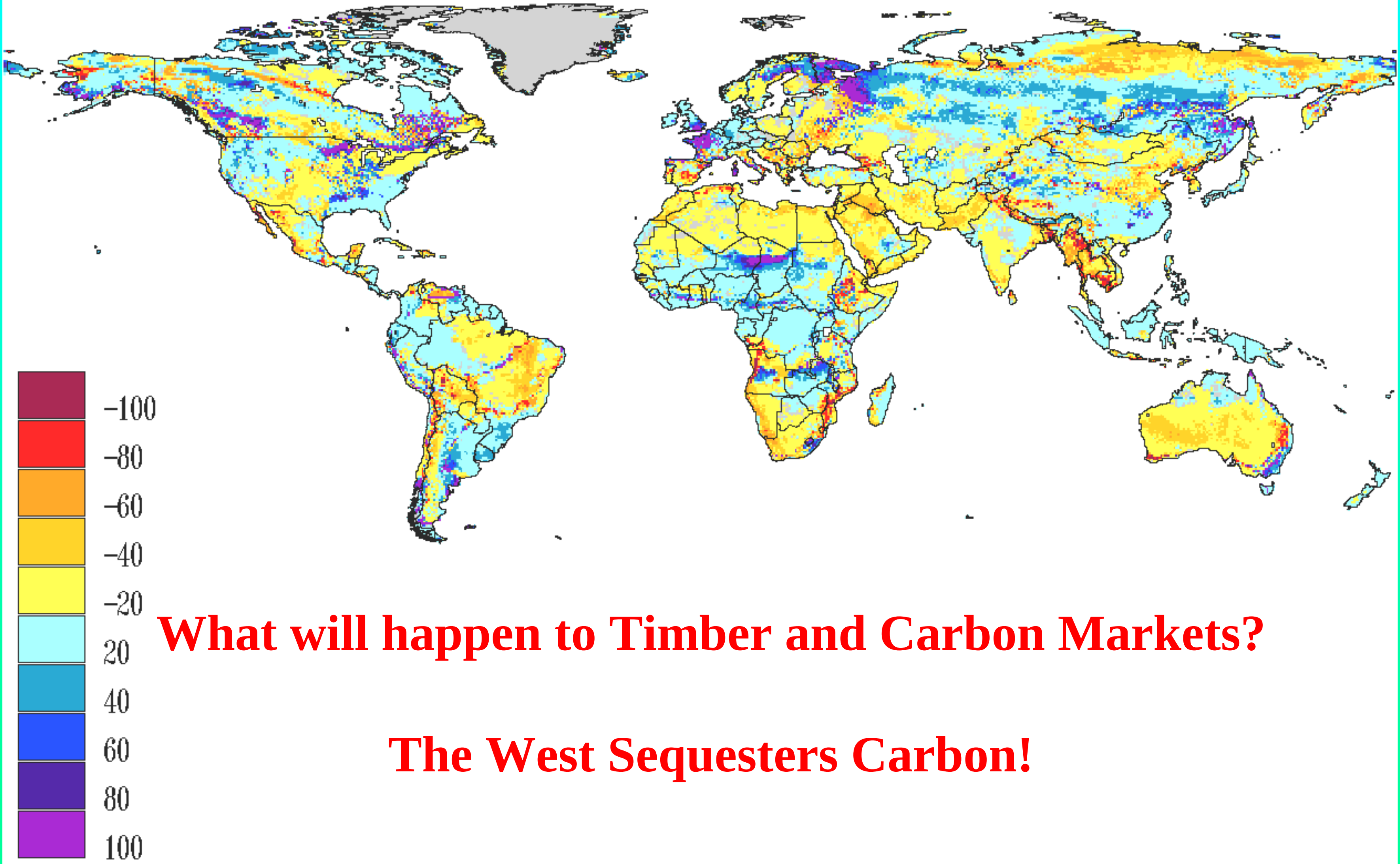
Fire Increases Across the Western U.S.

But, Look at the Boreal Forest

Percent Change in Total Ecosystem Carbon

MAPSS Team, In Prep.

CSIRO_MK3 A2

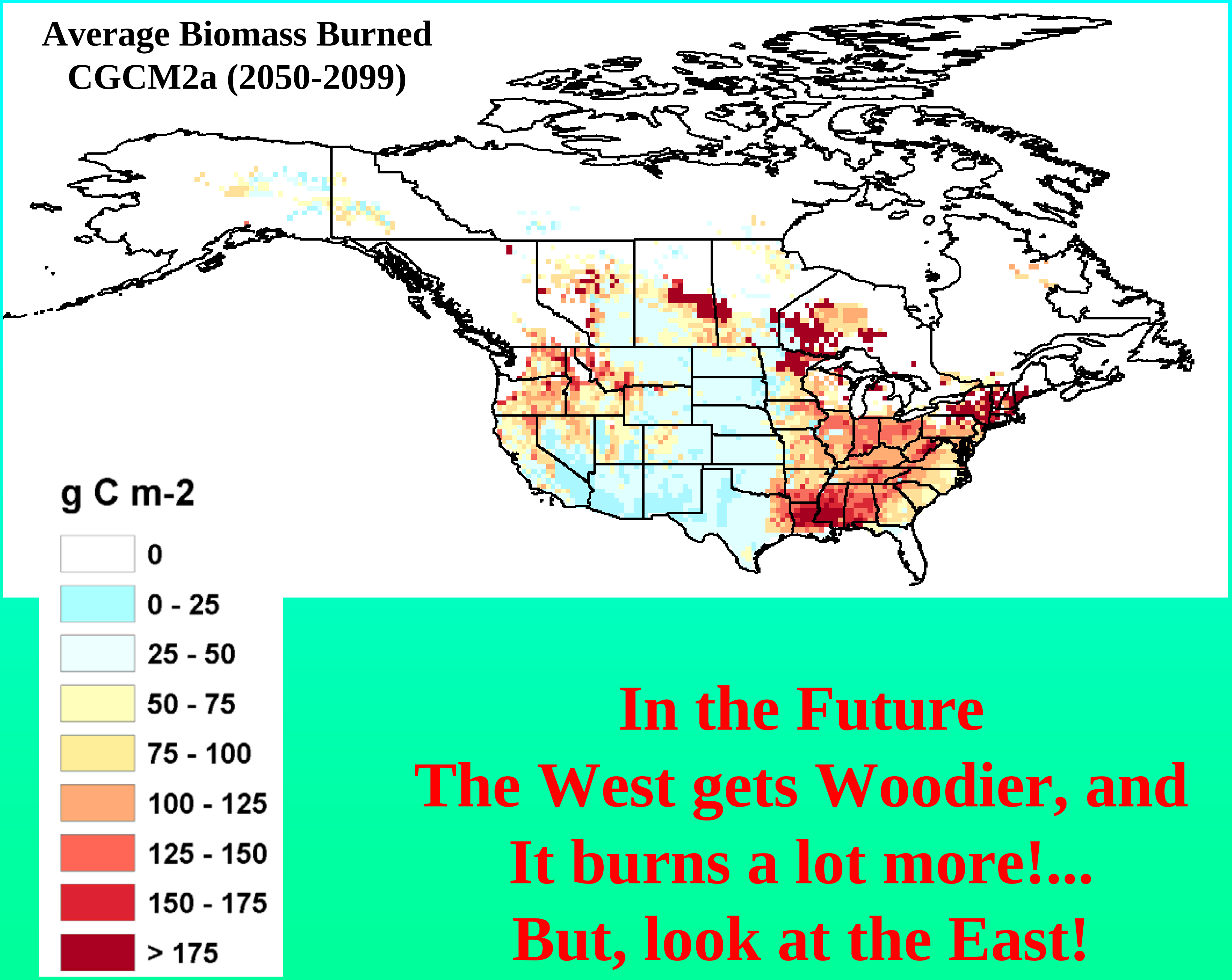


What will happen to Timber and Carbon Markets?

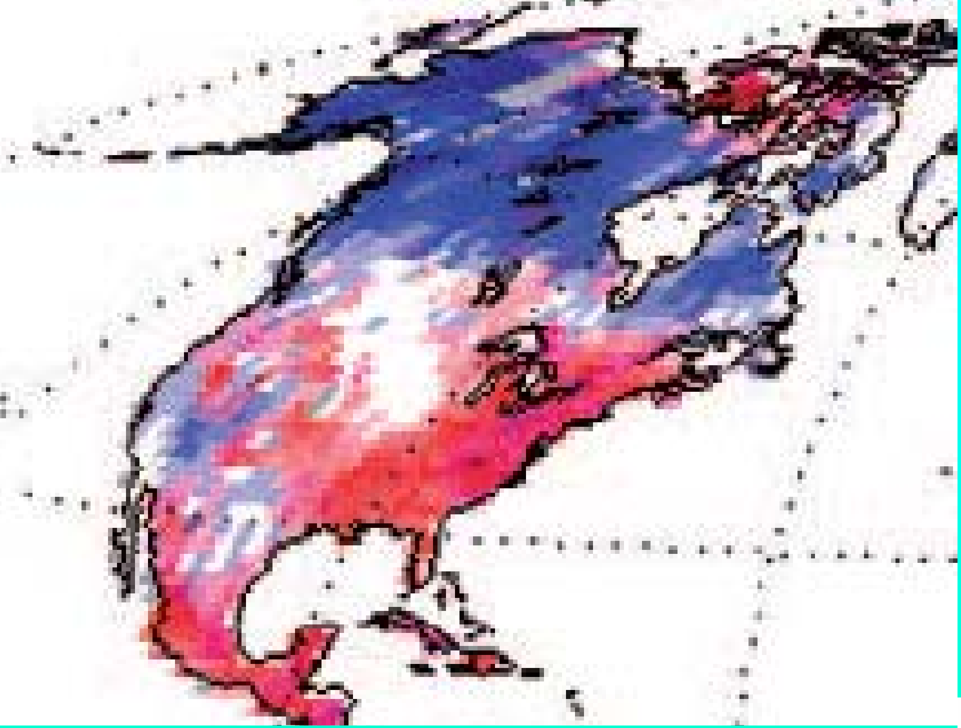
The West Sequesters Carbon!

Future Climate
Managing for Change with Uncertainty

Regional Assessments



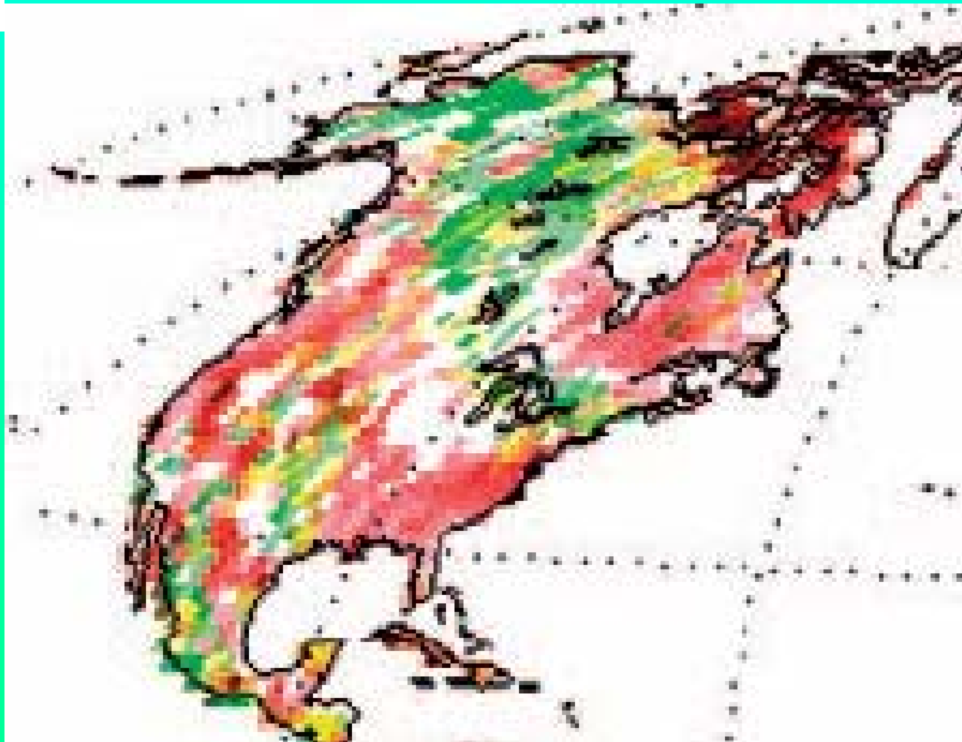
In the Future
The West gets Woodier, and
It burns a lot more!...
But, look at the East!



LPJ DGVM
16 Climate Scenarios

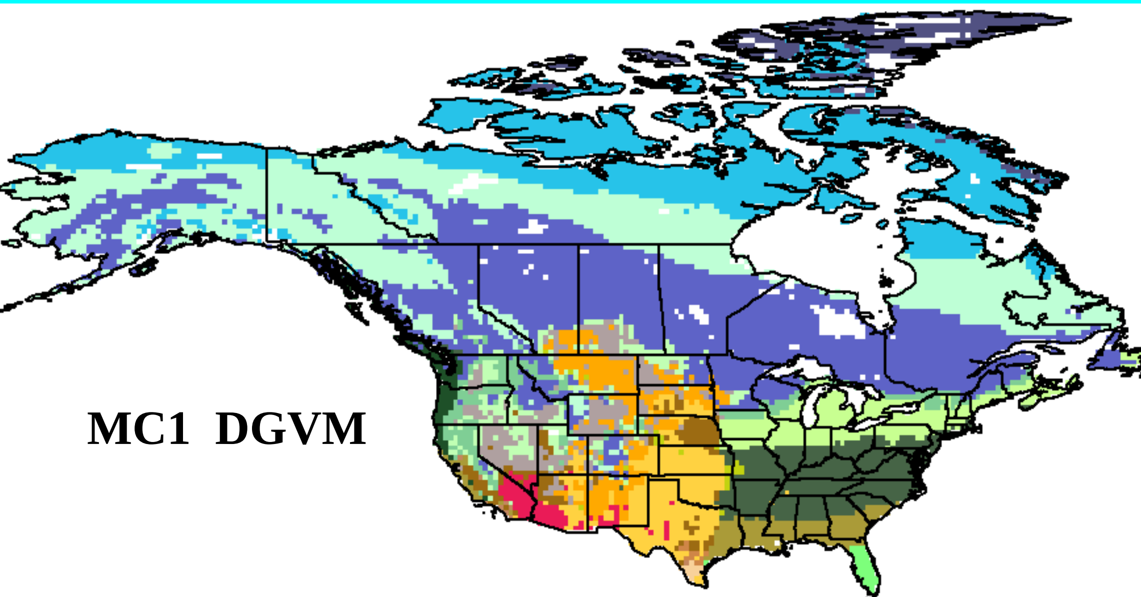
Areas that Exceed One Standard Deviation of 1961 – 1990

Red = - Runoff
Green = + Runoff



Red = + Fire
Green = - Fire

Scholze et al. 2006.
Proc. Natl. Acad. Sci.

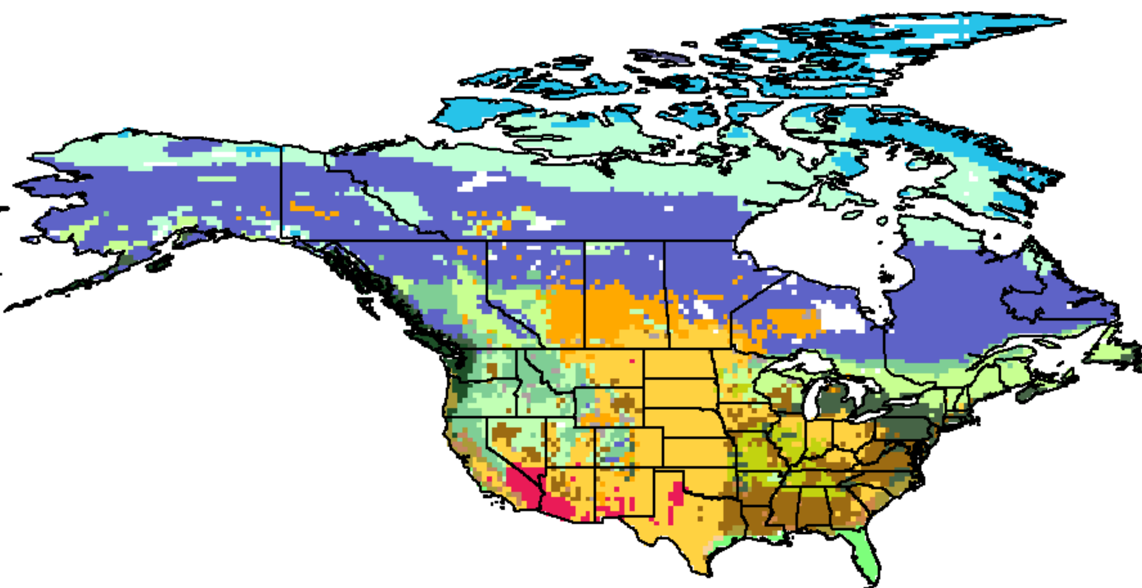


Current Vegetation (1961-1990)
Suppressed Fire

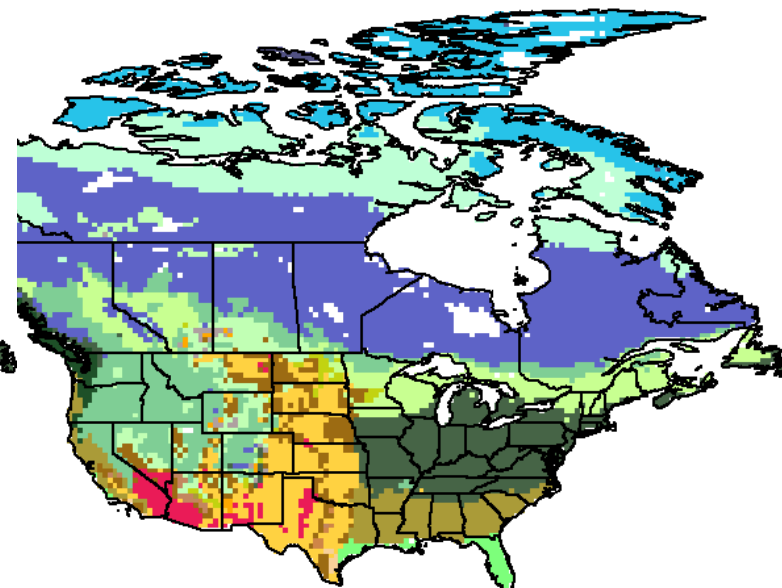
MAPSS Team, In Prep.

CGCM2-A2 Scenario

With Fire

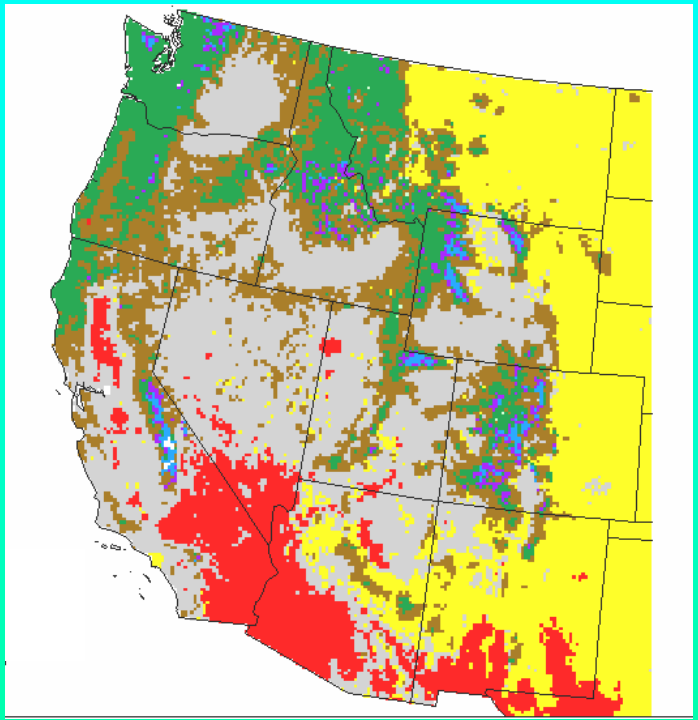


Suppressed Fire

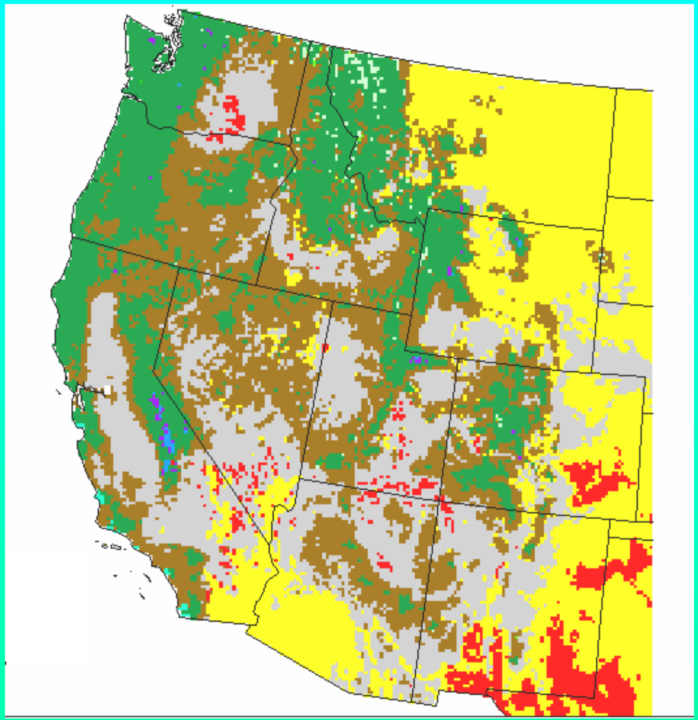


MAPSS Simulated Vegetation Distribution

Current Climate



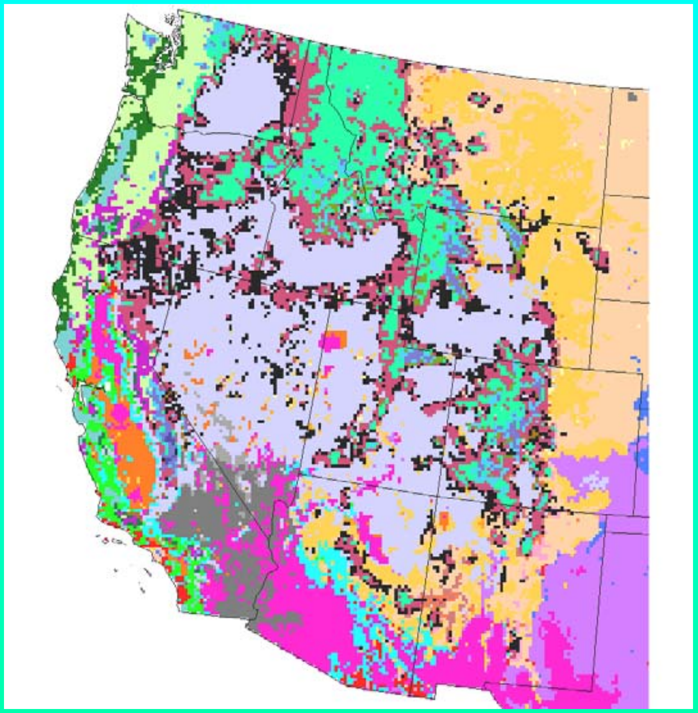
Future Climate
(CGCM1)



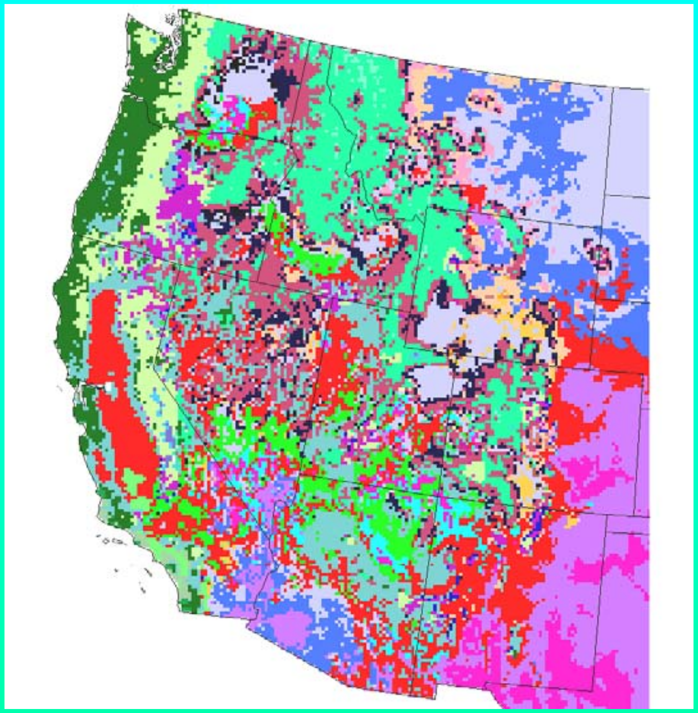
**Future Woody and Grass Expansion in the West
Enhance Carbon Storage, and
Catastrophic Wildfire, But…**

Changing Vegetation Community Diversity

Current Climate



Future Climate
(CGCM1)



Threshold Change – Migration Lags

Future Climate
Managing for Change with Uncertainty

Local Assessments

THE RESPONSE OF VEGETATION DISTRIBUTION, ECOSYSTEM PRODUCTIVITY, AND FIRE IN CALIFORNIA TO FUTURE CLIMATE SCENARIOS SIMULATED BY THE MC1 DYNAMIC VEGETATION MODEL

A California Assessment Requested by the Governor

A Report From:
California Climate Change Center

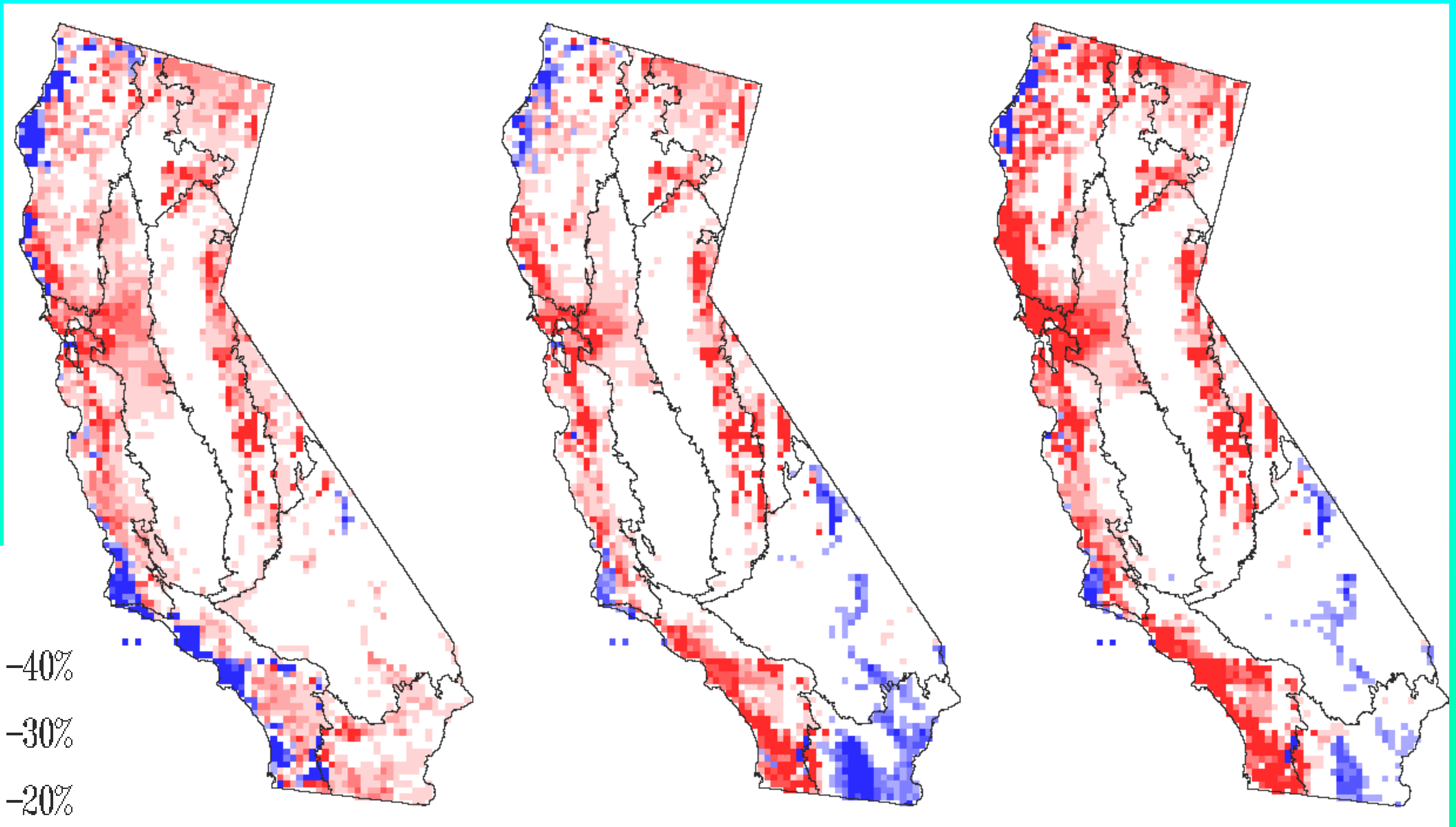
Prepared By:
James M. Lenihan, Dominique Bachelet, Raymond Drapek, and Ronald P. Neilson

WHITE PAPER

Arnold Schwarzenegger, *Governor*

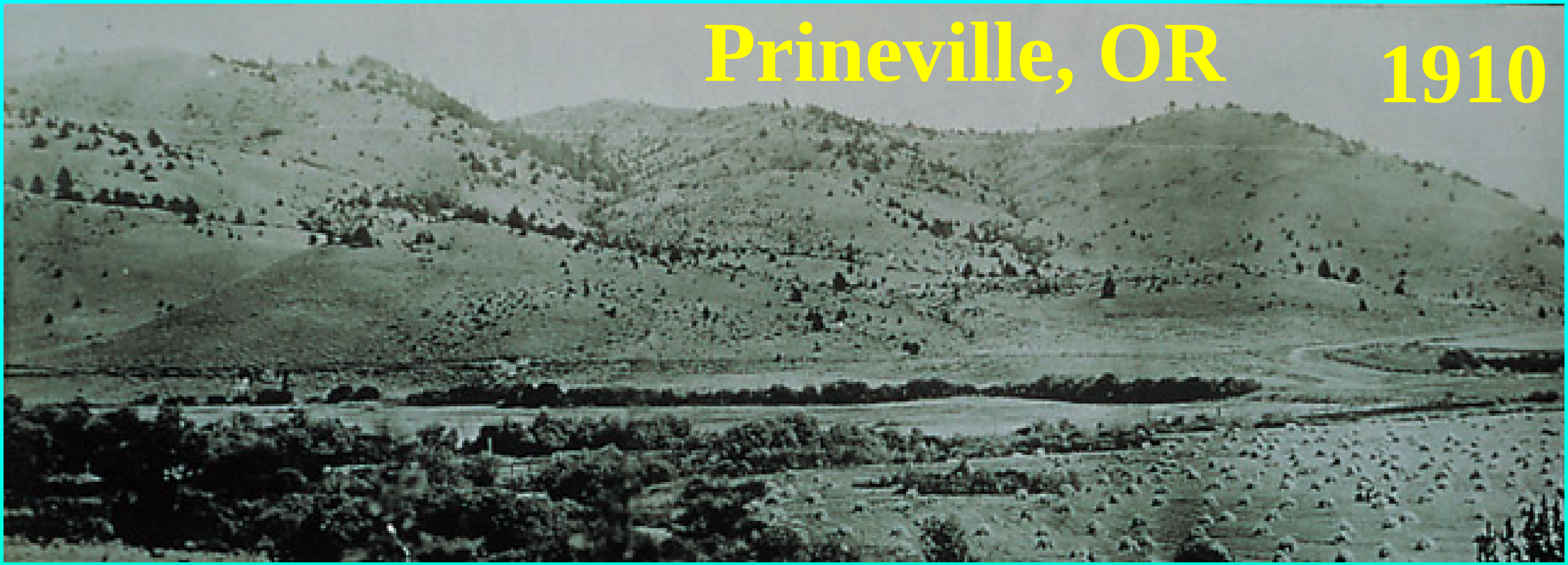
February 2006
CEC-500-2005-191-SF

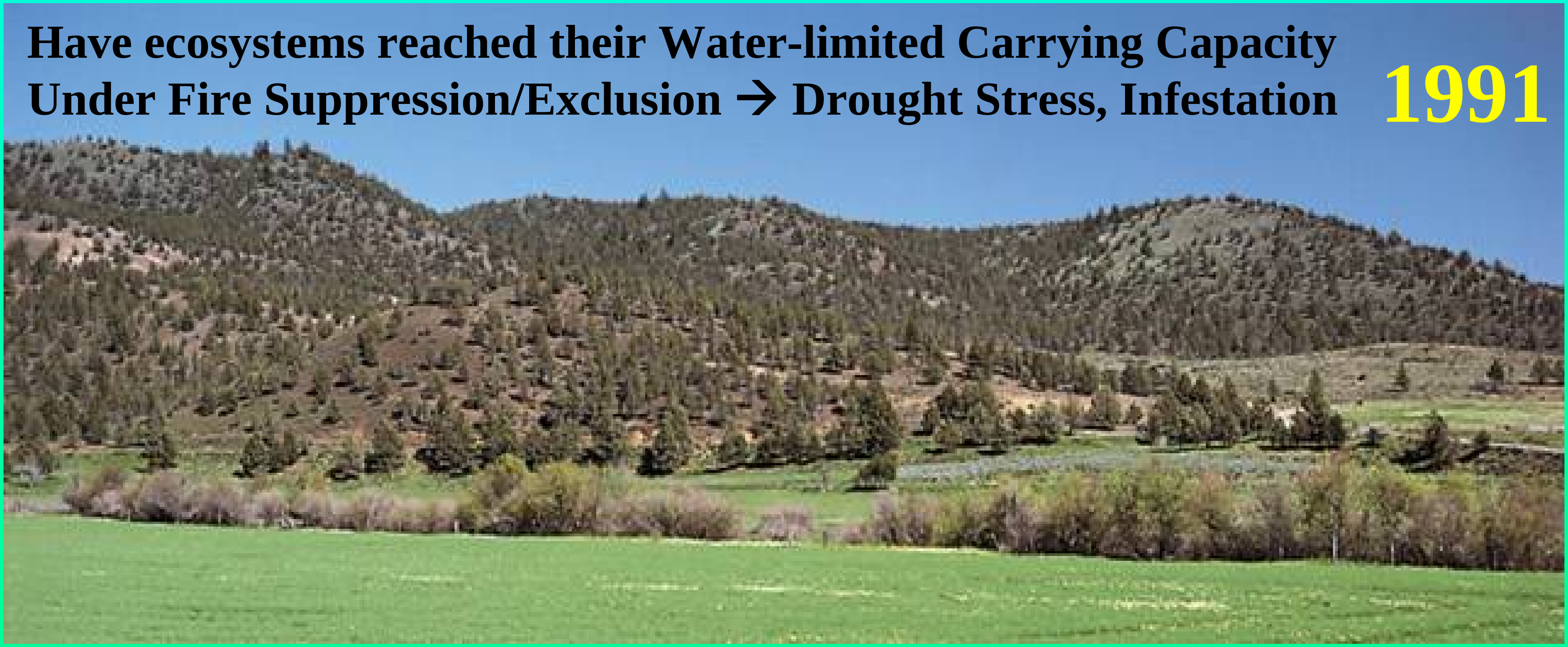
Percent Change In Annual Area Burned (2050-2099), Compared To The 20th Century



PCM-A2 GFDL-B1 GFDL-A2

Even Across Models, there Appear to be Intrinsic Regional Sensitivities


Prineville, OR
1910


Have ecosystems reached their Water-limited Carrying Capacity
Under Fire Suppression/Exclusion → Drought Stress, Infestation
1991

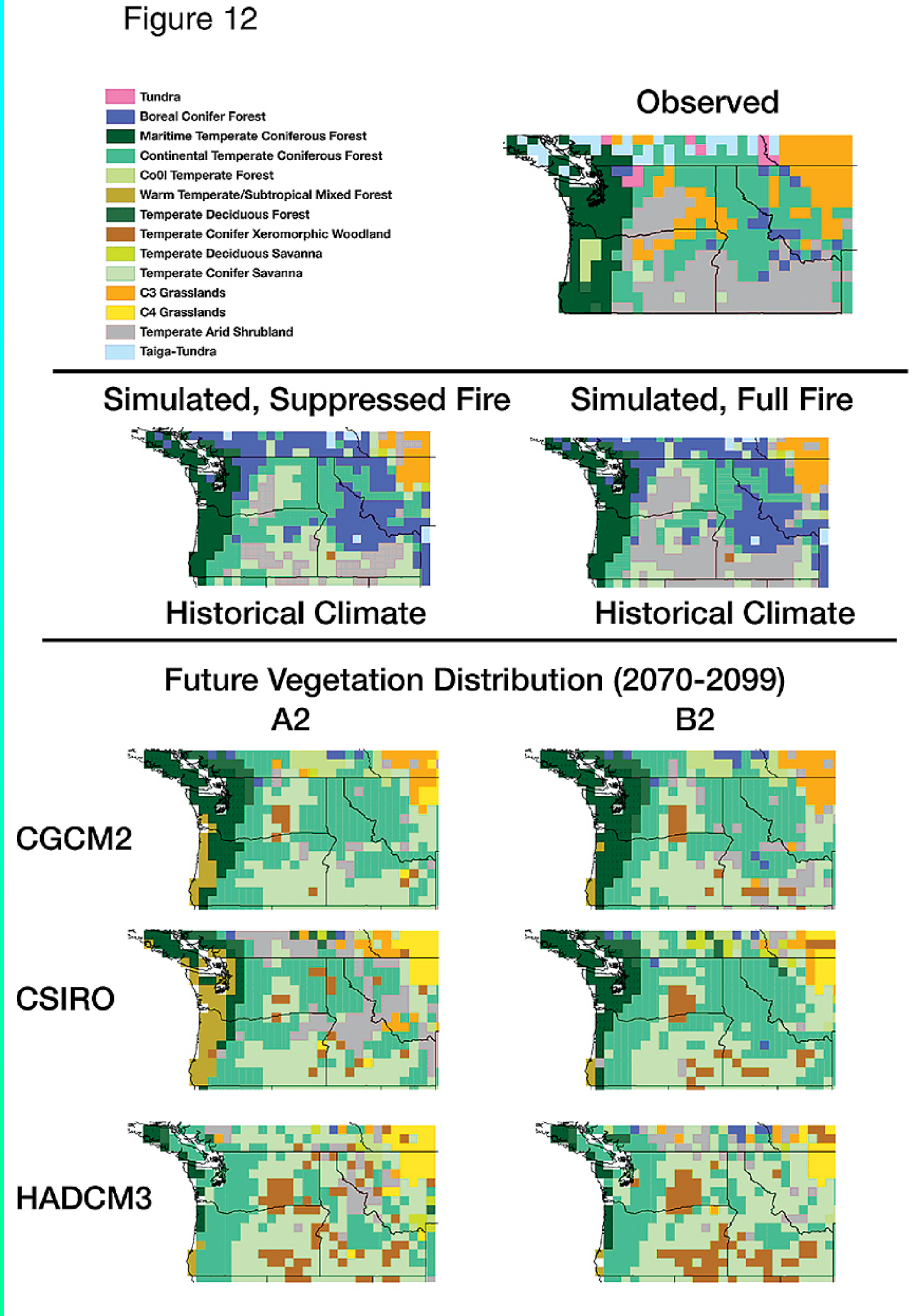
San Francisco Peaks, AZ – May 17, 2003
(courtesy of Neil Cobb)

San Francisco Peaks, AZ – 4 Months Later

(courtesy of Neil Cobb)

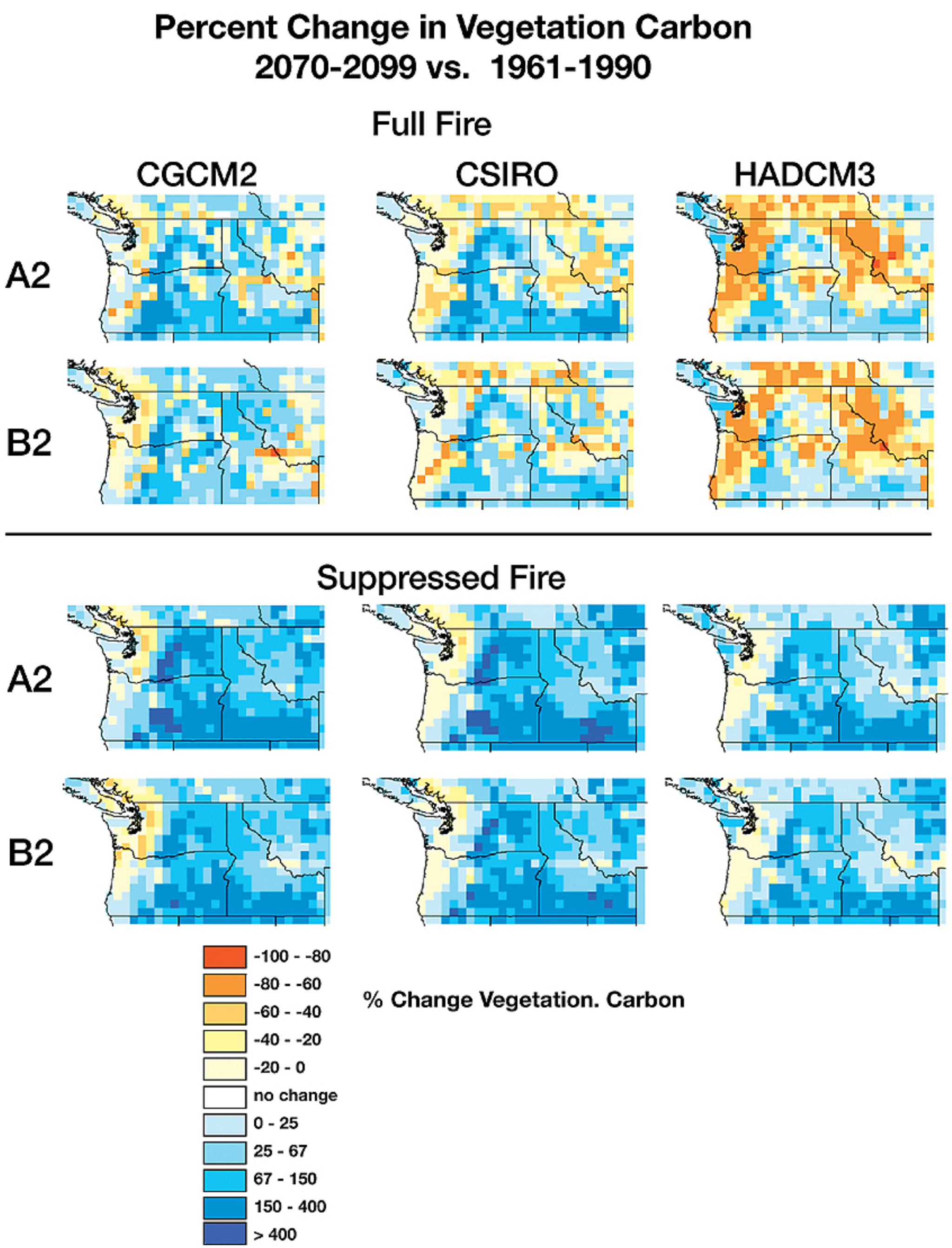
Threshold Change – Drought → Infestation → Dieback

Vegetation Distribution Change

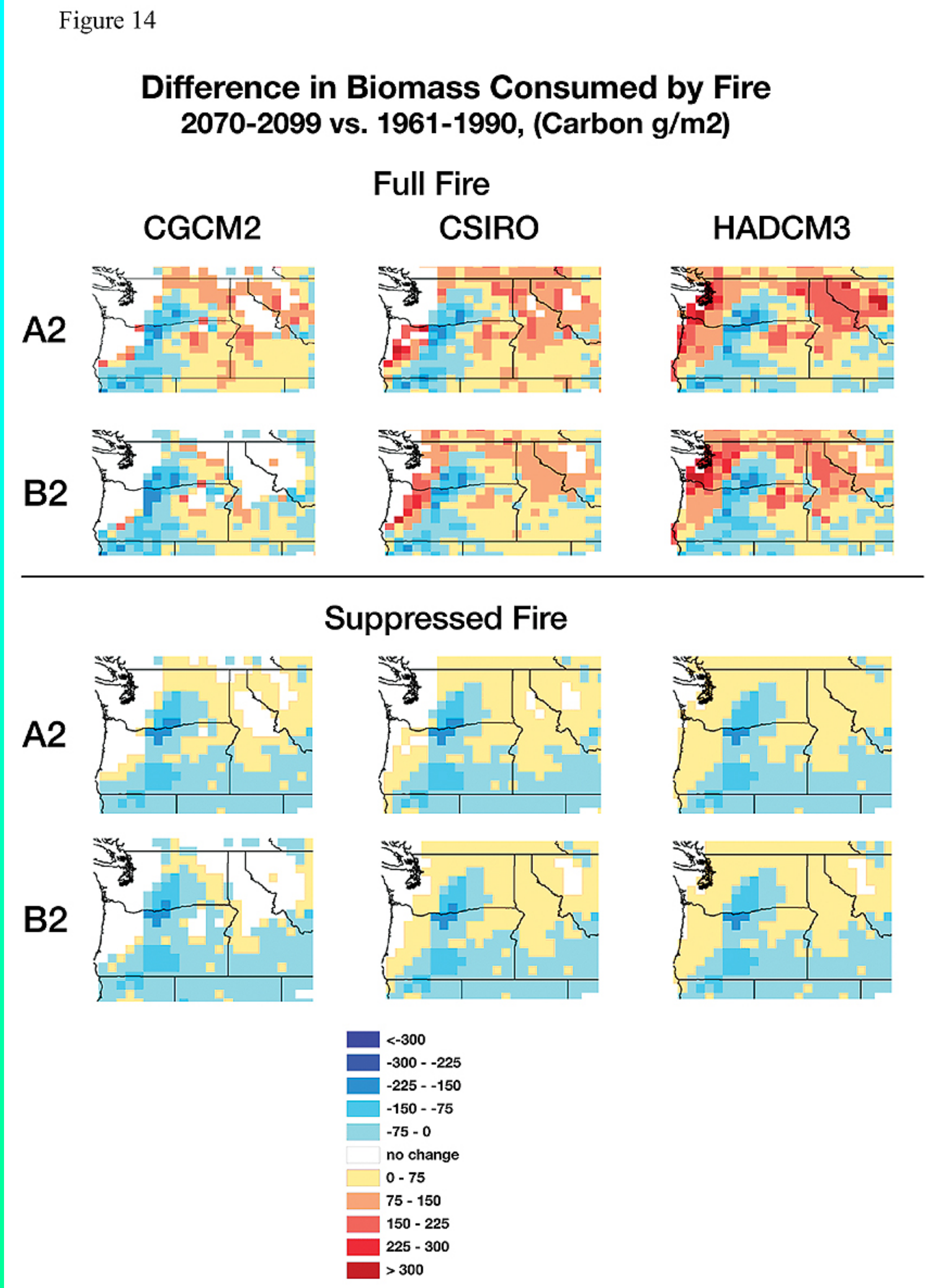


Ecosystem Carbon Change

Figure 15

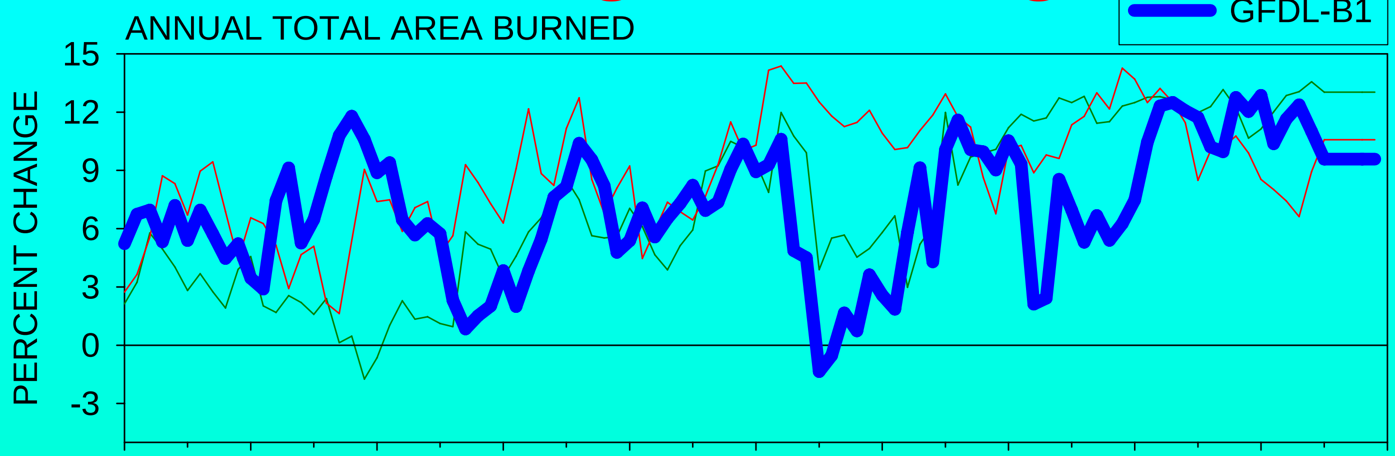


Biomass Burned Change



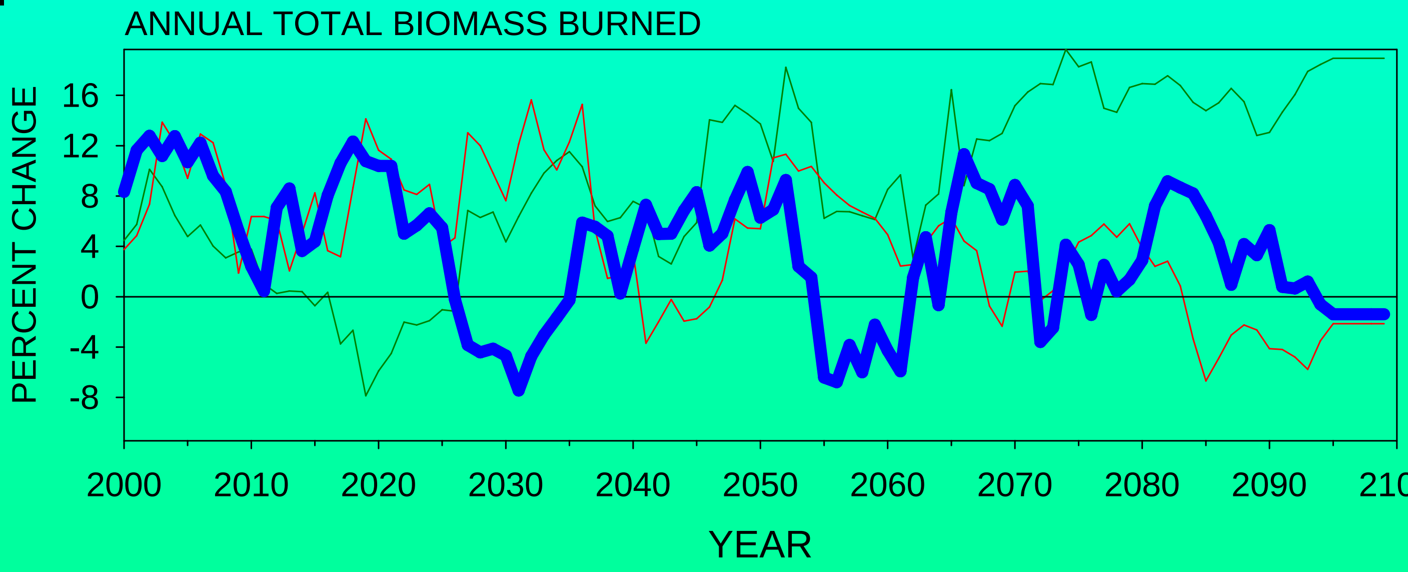
Interdecadal Climate Variability Can Obscure the Long Term Change

A.

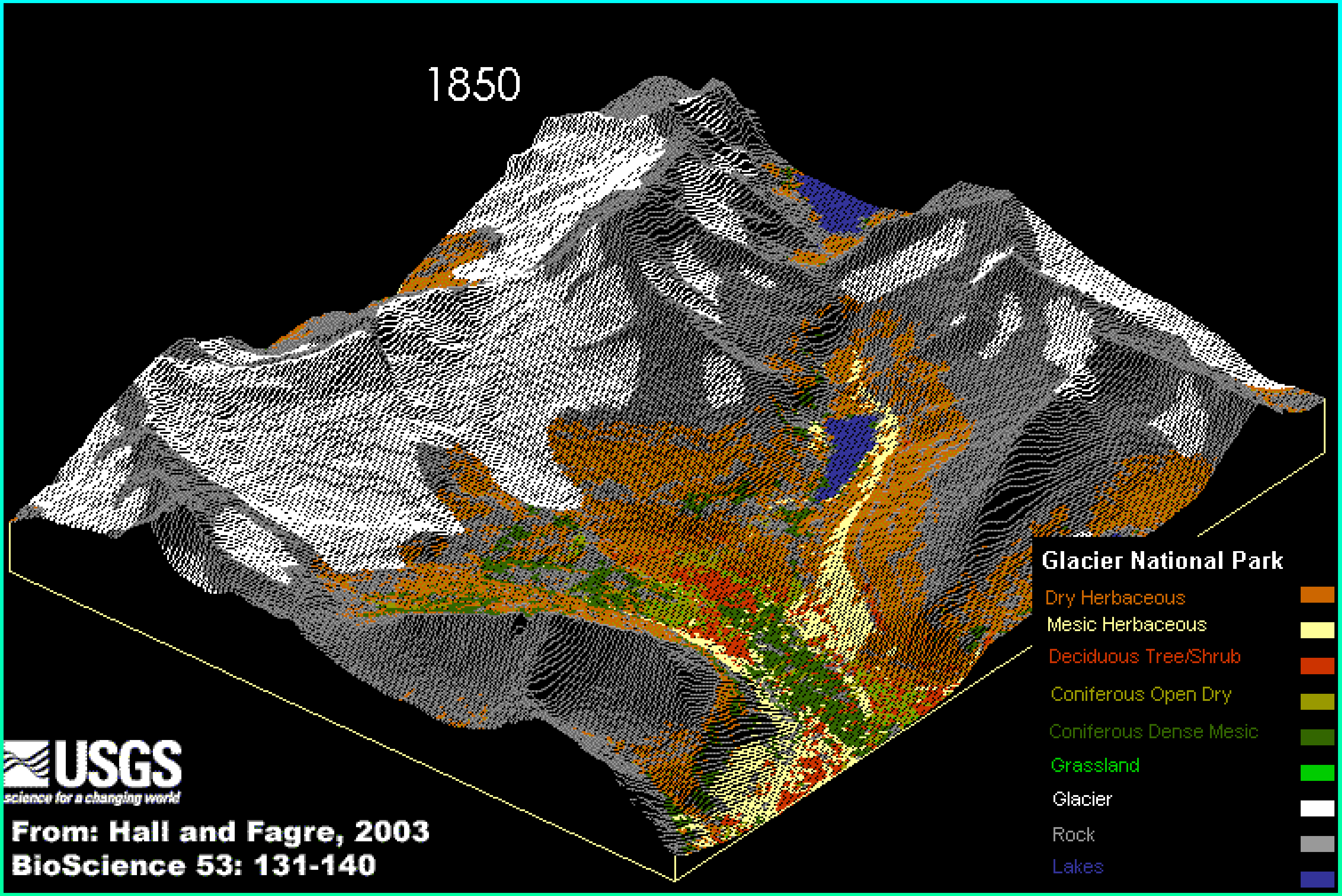


Multiple Scenarios can help 'Bound' the Uncertainties

B.



Glacier National Park



USFS Strengths

- **Observers of the Natural World – Data!**
- **Management Activities**
  - Discussions, education, monitoring, assessments, management, mitigation, policy and planning, research
- **Climate Change Assessments**
  - Synthesis of Knowledge
  - Future changes
- **Options for Adaptation to a Changing Climate**
  - Unplanned
  - Respond to Disturbances
  - Proactive

Management Options

- Adaptation options
  - ***Resist*** change (paddling upstream)
  - Promote ***Resilience*** (reduce stresses, minimize catastrophic transitions)
  - ***Respond*** to change (consider "bet-hedging" approaches)
  - ***Realign*** to conditions that are far out of NRV
- Mitigation options
  - ***Reduce*** GHG emissions (e.g. carbon sequestration)
  - Carbon **Pump** vs. Carbon **Bank**

Management Toolbox

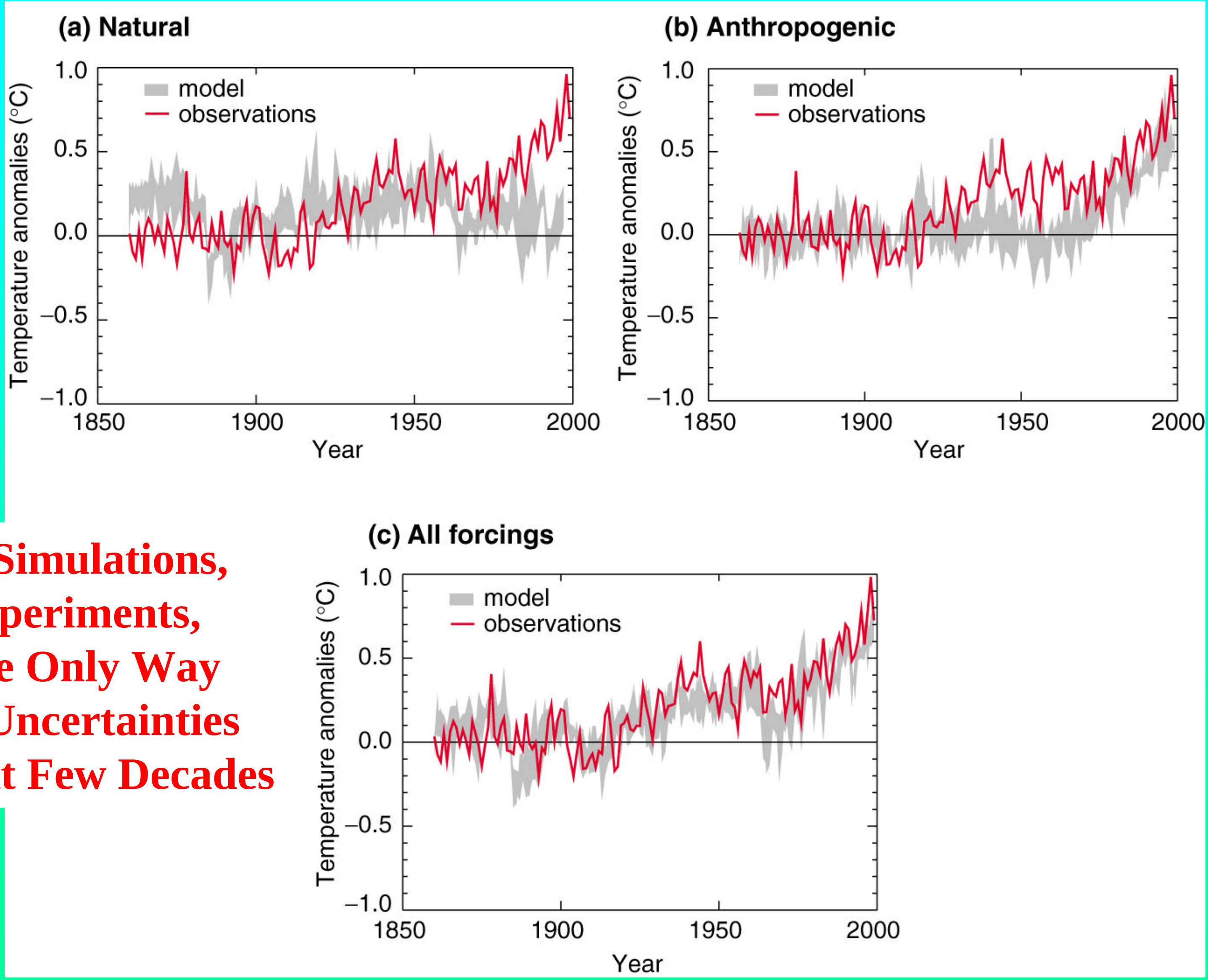
- Most planning tools, such as FVS, TELSA and VDDT, cannot use climate.
- Re-build tools to be ‘climate smart’, yet to retain their ‘look and feel’.
- Workshops between scientists and managers to design and refine these tools.
- Socio-economic factors must be included.

Management Implications

(personal musings)

- Management Goals face an *uncertain* Future
  - The Future will NOT echo the Past
- Instead,… Manage *Change*, *per se*
  - Desired *function* may supercede ‘Desired future *condition*’
- Improve resilience of ecosystems to rapid change, e.g.
  - Keep forest density below water-limited carrying capacity
  - Plant diversity rather than homogeneous monocultures
- Fire, Carbon and other policies may be at cross-purposes demanding creative management of change

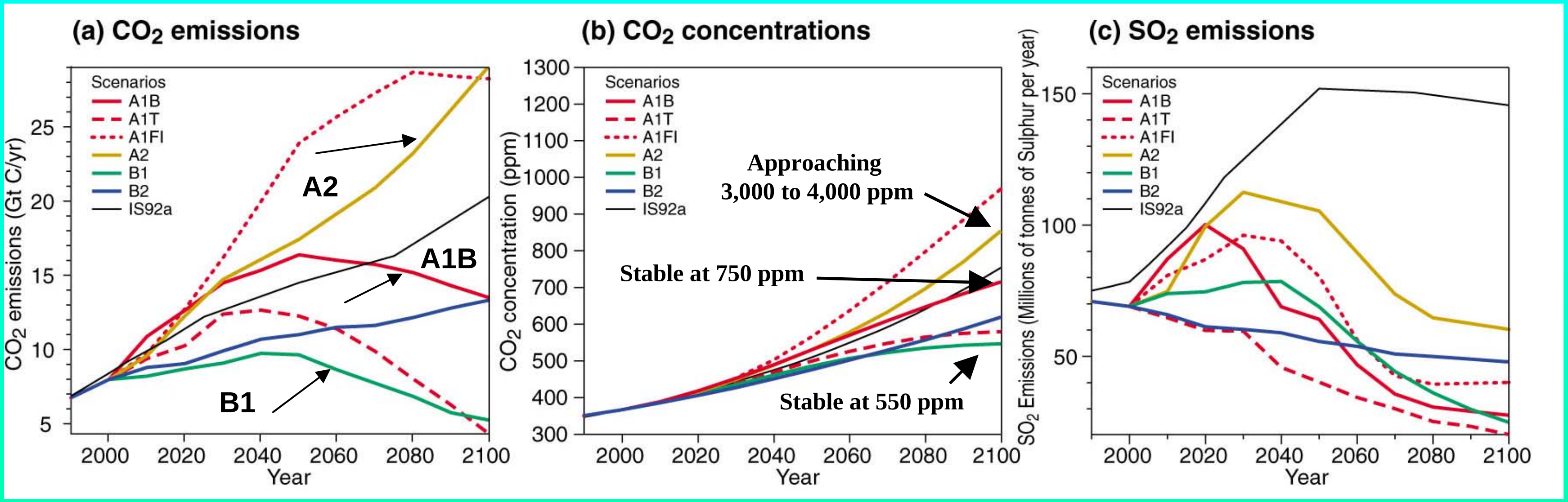
Simulated Annual Global Mean Surface Temperatures



Ensemble Simulations,
Doing Experiments,
May be the Only Way
To Bound Uncertainties
Over the Next Few Decades

Assessments of Future Climate Change Begin with Uncertainty

CO_2 and SO_2 in the 21st Century

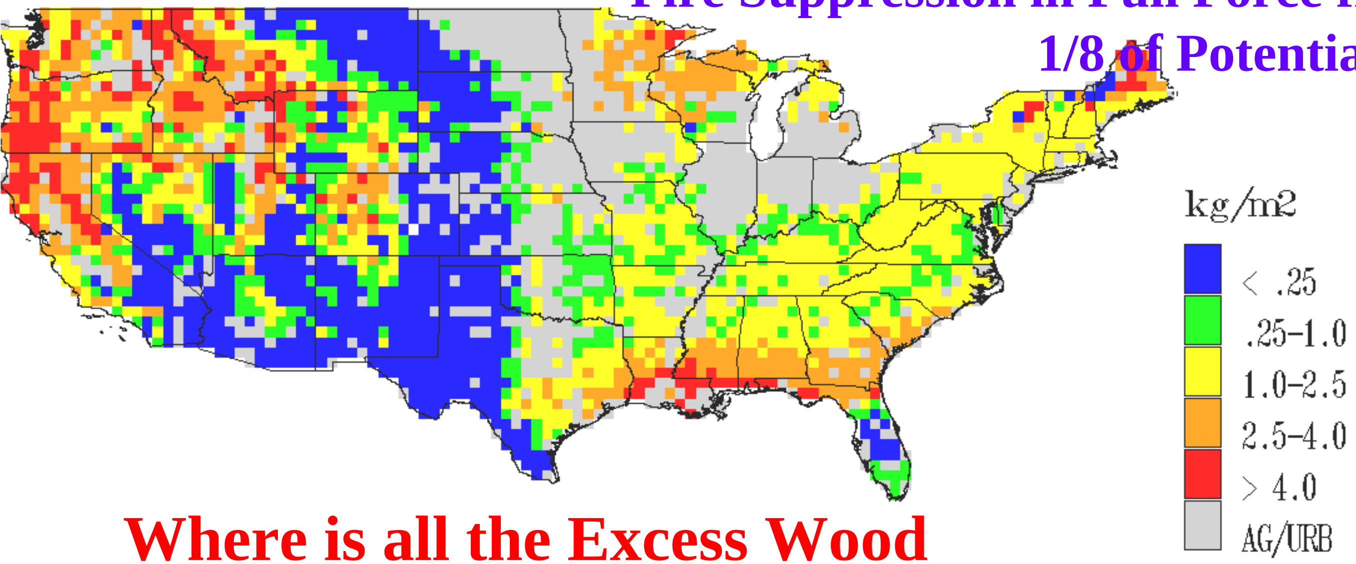


Future Scenarios are Based on Socio-Economic 'Storylines'

This Presents a Paradigm for All Future Management Considerations

Source: IPCC TAR 2001

Fire Suppression in Full Force from 1950 to the Present
1/8 of Potential Area Allowed to Burn



Absolute Change (Kg/m^2)

Where is all the Excess Wood

From Fire Suppression / Exclusion?

Percent Change

MC1 Simulation of Fire Suppression