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

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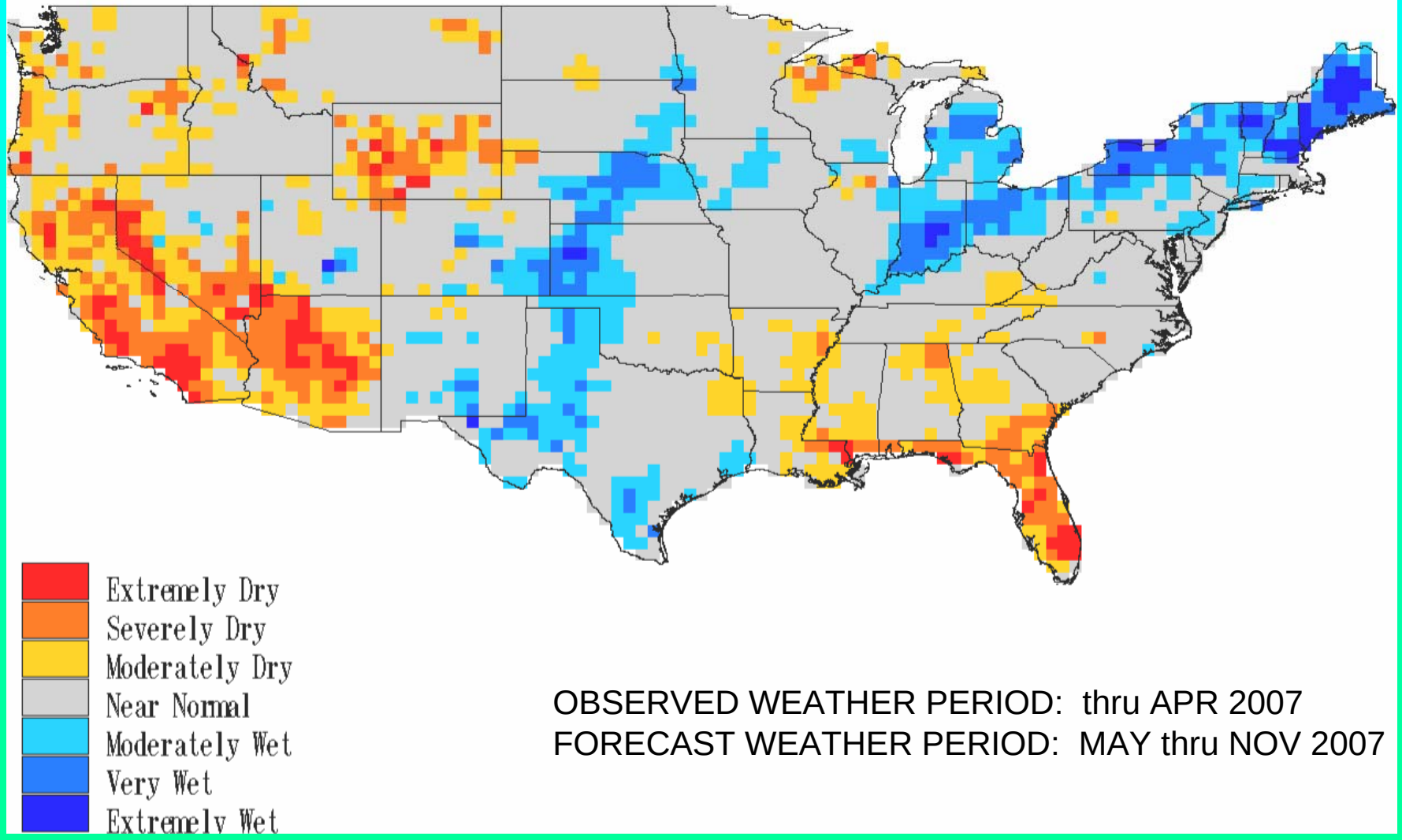
PALMER DROUGHT SEVERITY INDEX FORECAST
JULY-SEPTEMBER 2007

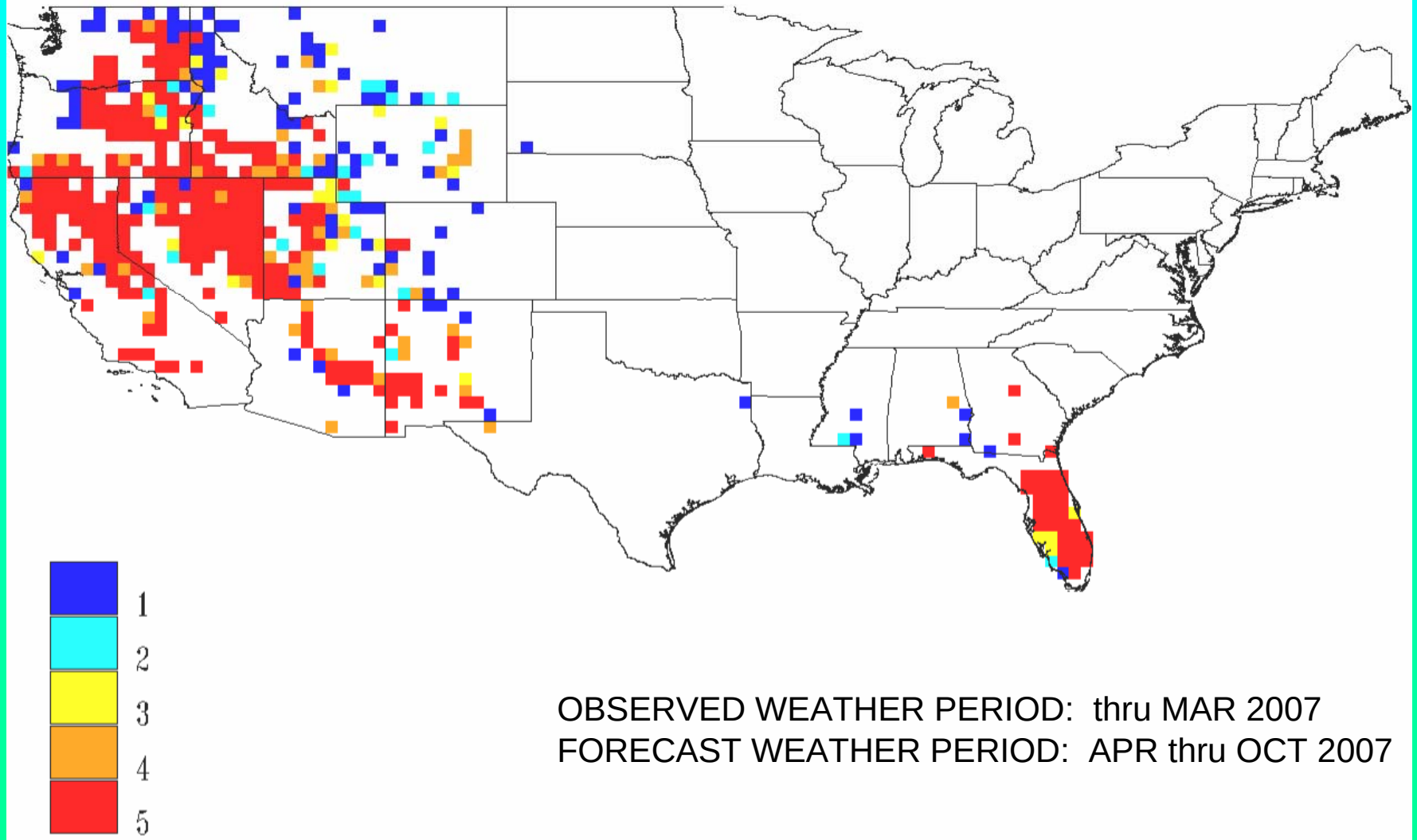
AVERAGED ACROSS ALL FIVE WEATHER FORECASTS



OBSERVED WEATHER PERIOD: thru APR 2007
FORECAST WEATHER PERIOD: MAY thru NOV 2007

MC1 DGVM FIRE RISK CONSENSUS FORECAST
JANUARY-OCTOBER 2007

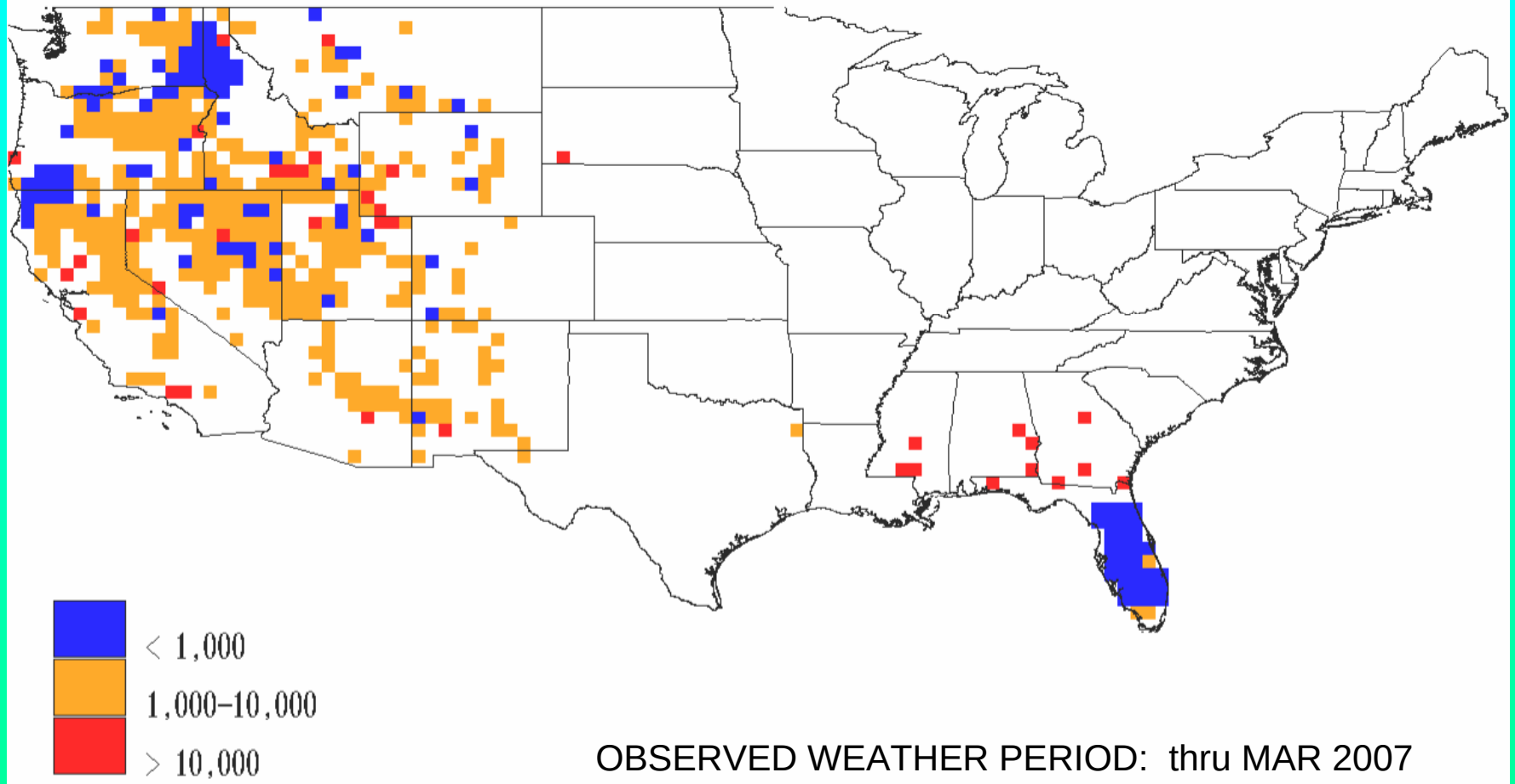
NUMBER OF WEATHER FORECASTS RESULTING IN FIRE OCCURRENCE



OBSERVED WEATHER PERIOD: thru MAR 2007
FORECAST WEATHER PERIOD: APR thru OCT 2007

MC1 DGVM FIRE RISK CONSENSUS FORECAST
JANUARY-OCTOBER 2007

ACRES BURNED



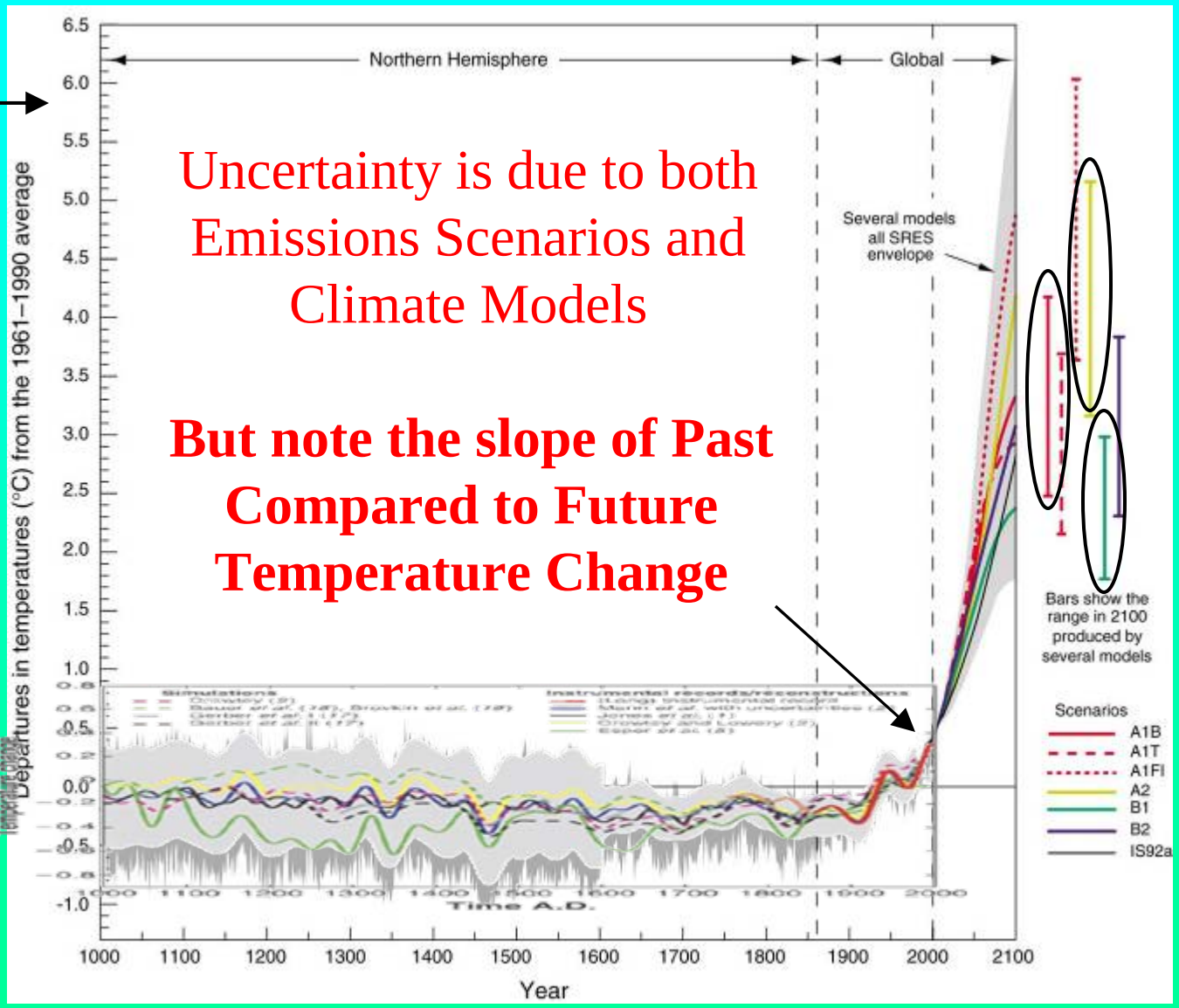
OBSERVED WEATHER PERIOD: thru MAR 2007
FORECAST WEATHER PERIOD: APR thru OCT 2007
TOTAL ACRES BURNED: 1,940,458 ACRES

Future Climate Managing for Change with Uncertainty

- Multi-Scale Assessment (Persistent, Ongoing)
  - 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
  - **What –** Biodiversity – Vegetation Type and Species Distribution
  - **Function --** Global Carbon Balance – Sources and Sinks, Forest Productivity
  - **How Change? –** Catastrophic Disturbance, e.g. Fire and Infestation
- Management *Of* Change, per se
  - Perpetual Uncertainty
  - Toolbox for Managers

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

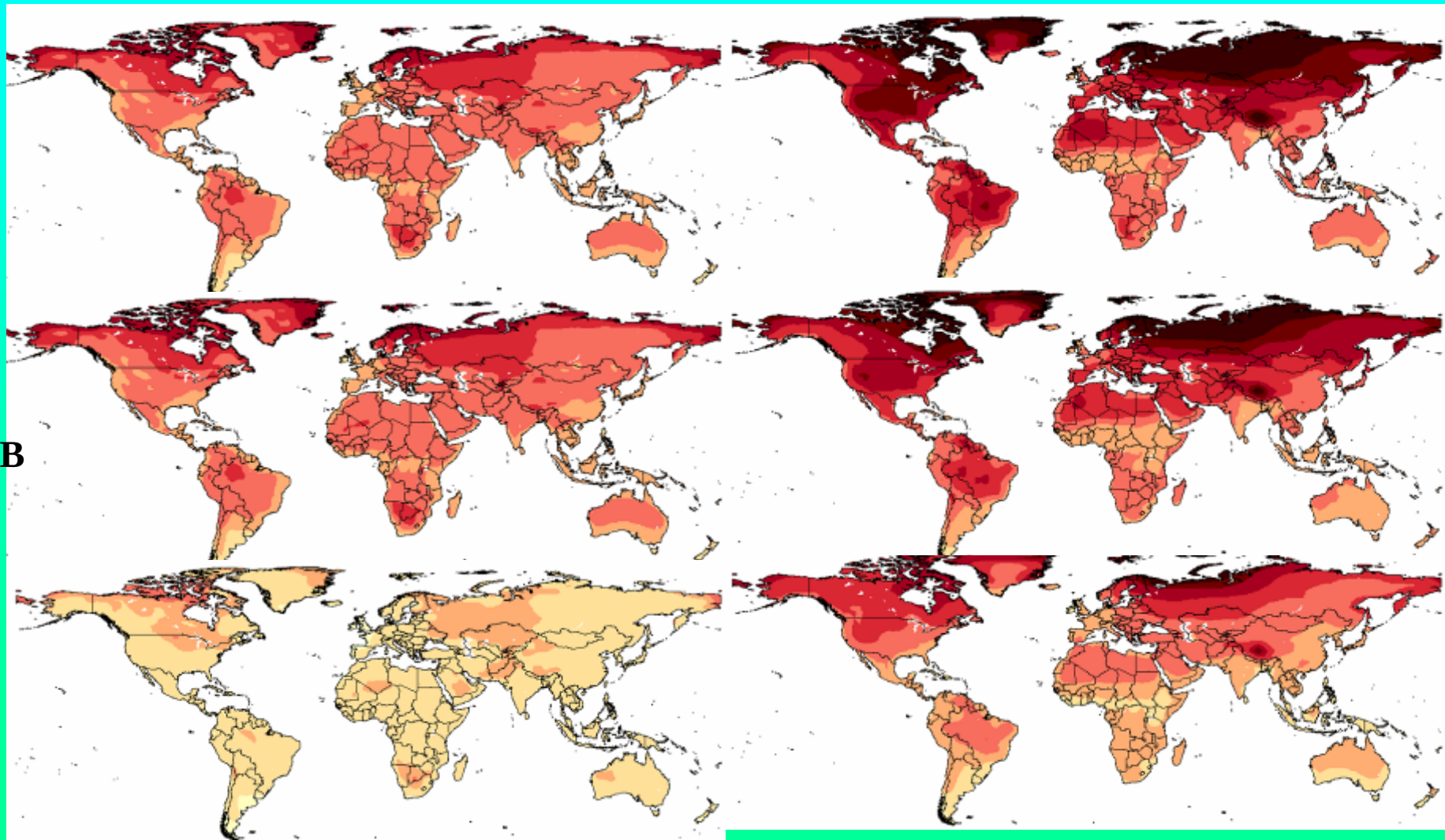
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
> 7

CSIRO MK3 | **MIROC MEDRES**

A2

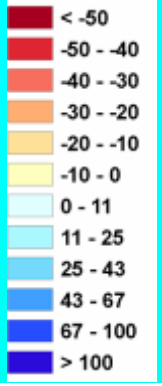
A1B

B1



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

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



CSIRO MK3 | **MIROC MEDRES**

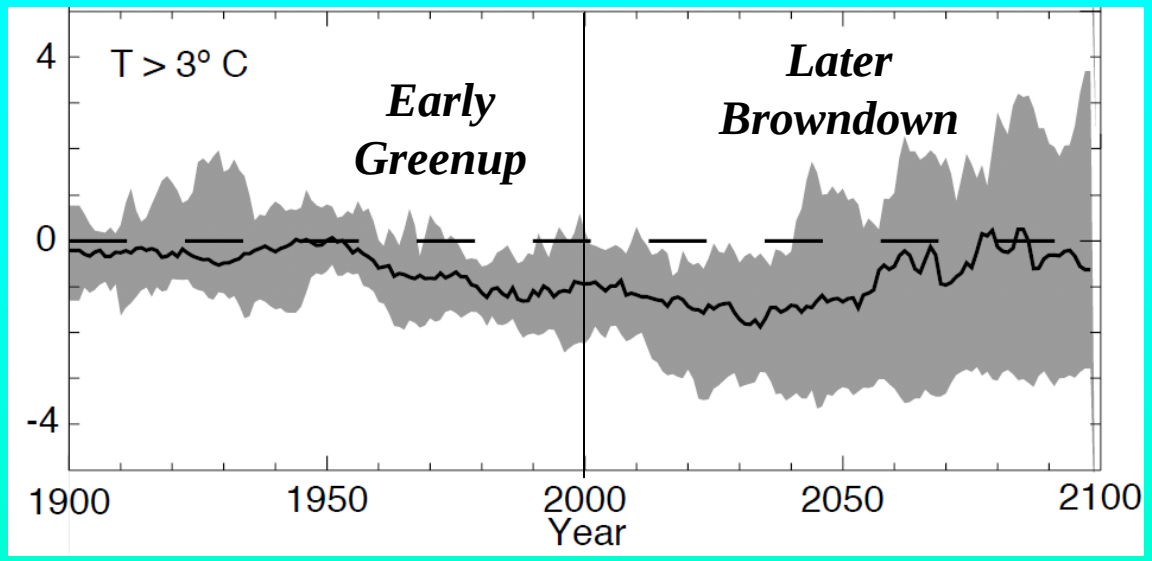
A2

A1B

B1

A climate change risk analysis for world ecosystems

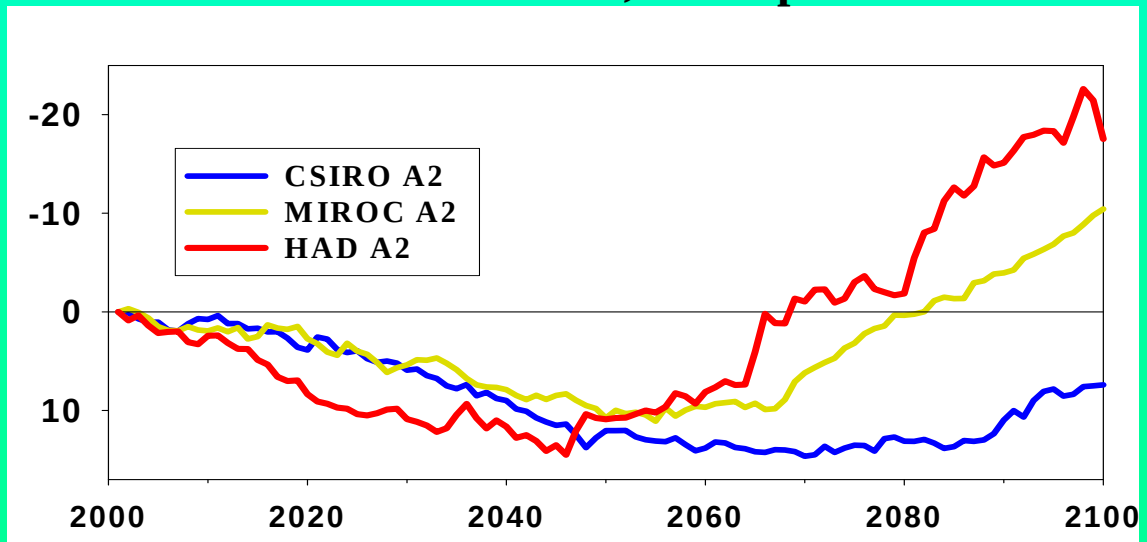
Scholze et al. 2006. Proc. Natl. Acad. Sci.



LPJ DGVM
16 Climate Scenarios

Global Simulated Ecosystem Carbon Change (Pg)

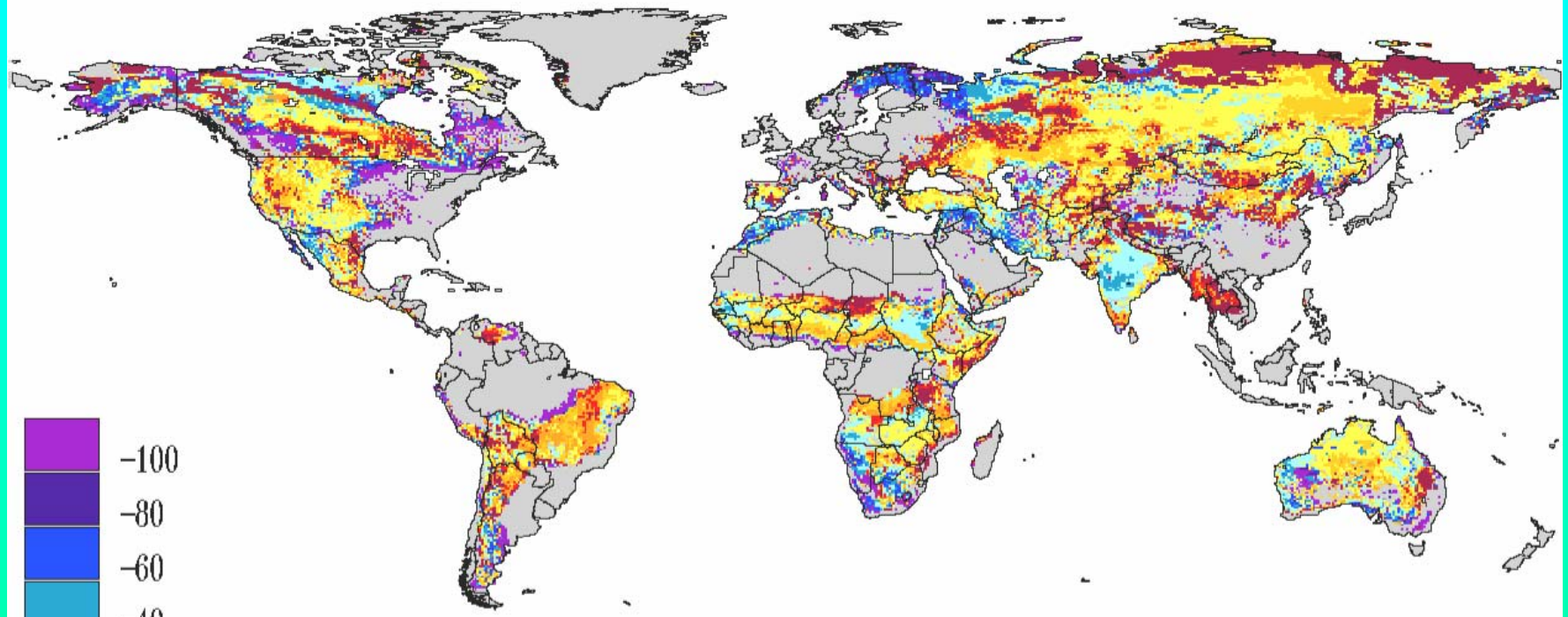
MAPSS Team, In Prep.

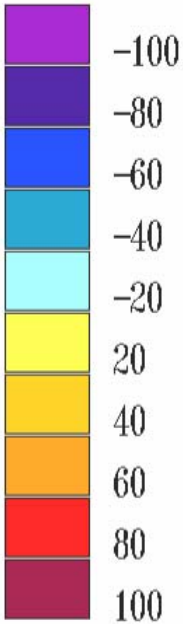


MC1 DGVM
3 Climate Scenarios

Percent Change in Biomass Burned

MAPSS Team, In Prep.
CSIRO_MK3 A2



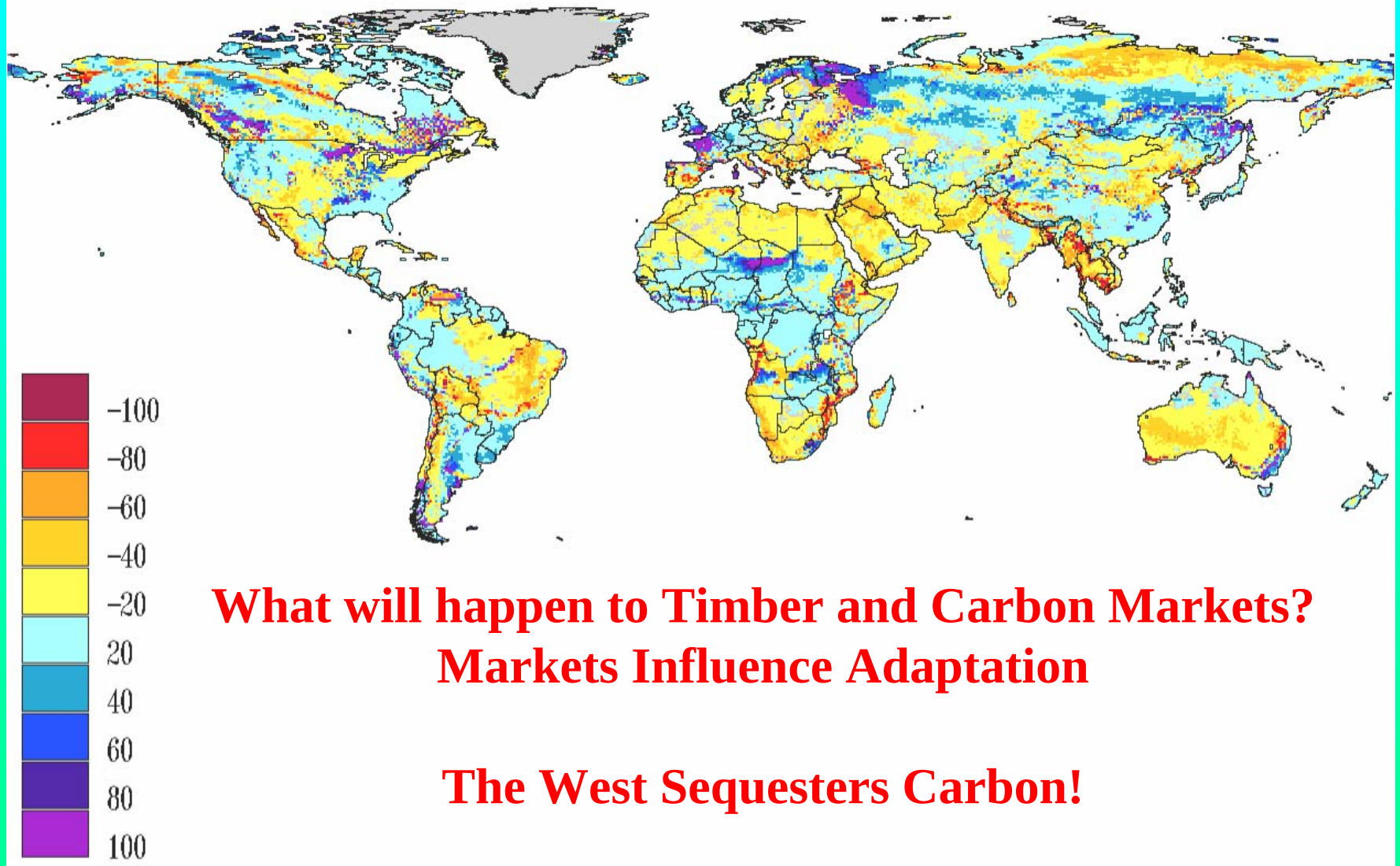


Fire Increases Across the Western U.S.

But, Look at the Boreal Forest

Percent Change in Total Ecosystem Carbon

MAPSS Team, In Prep.
CSIRO_MK3 A2

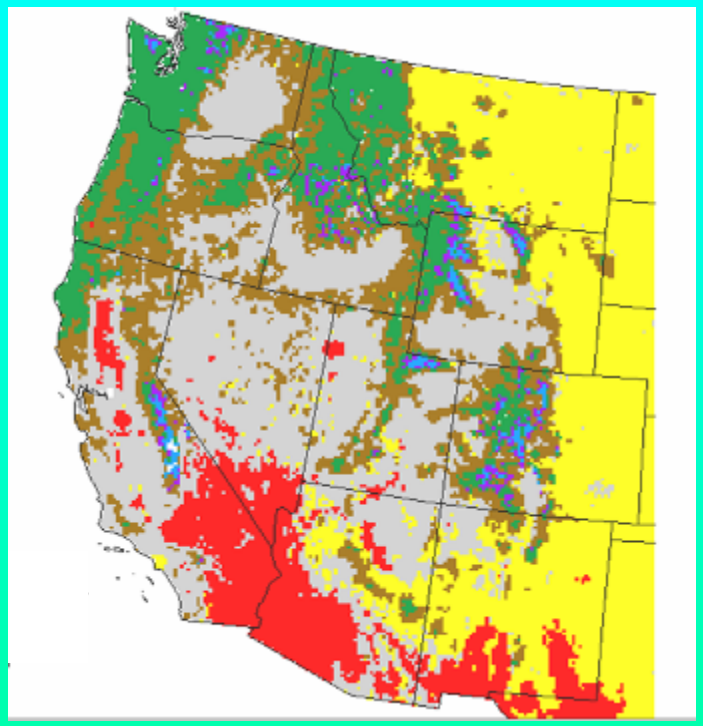


What will happen to Timber and Carbon Markets?
Markets Influence Adaptation

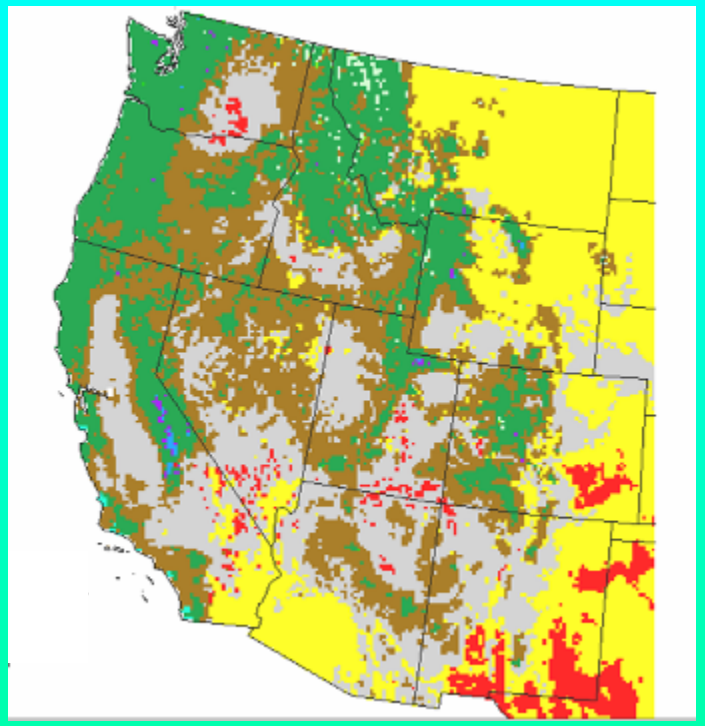
The West Sequesters Carbon!

MAPSS Simulated Vegetation Distribution

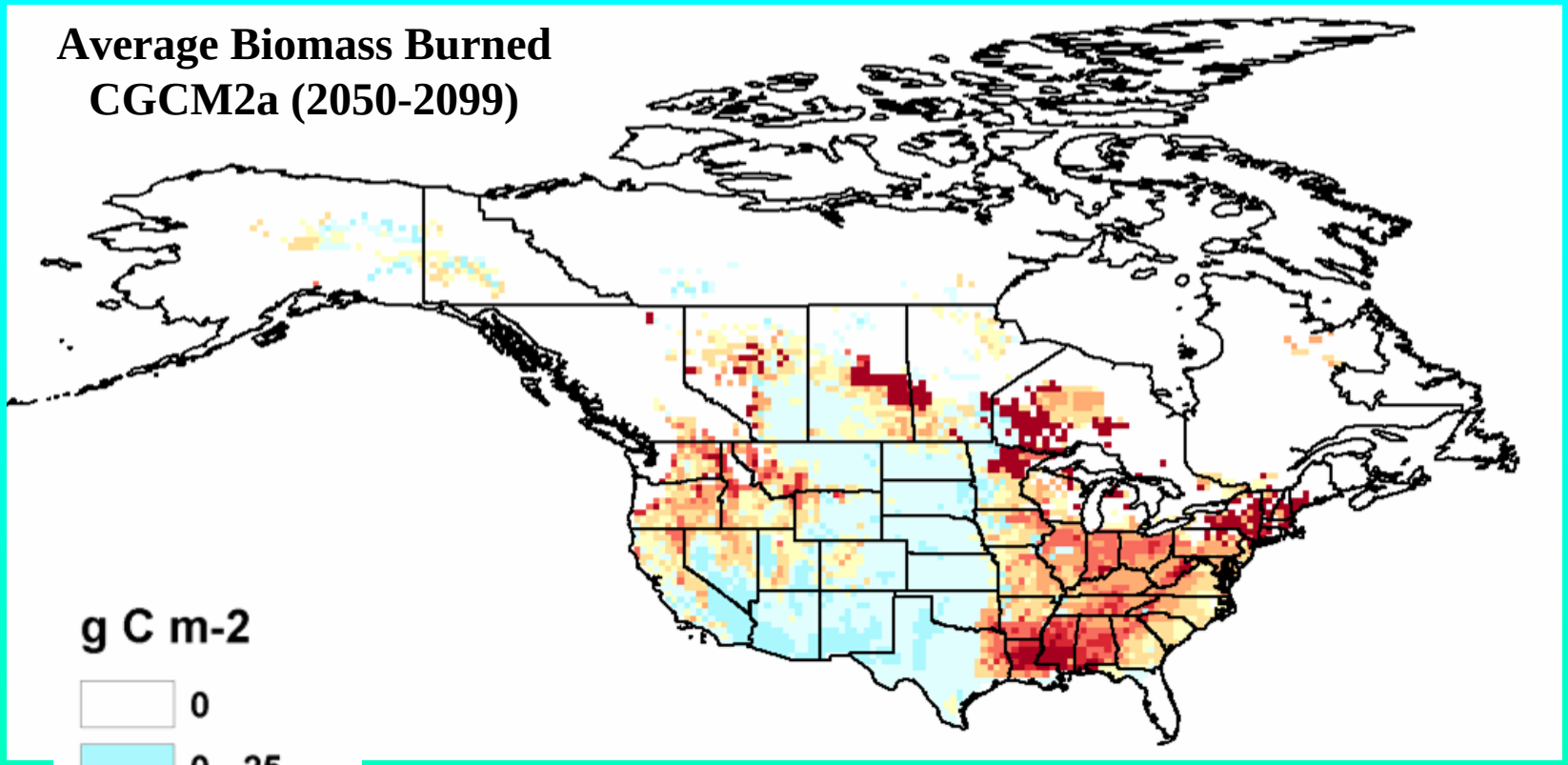
Current Climate



Future Climate
(CGCM1)



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

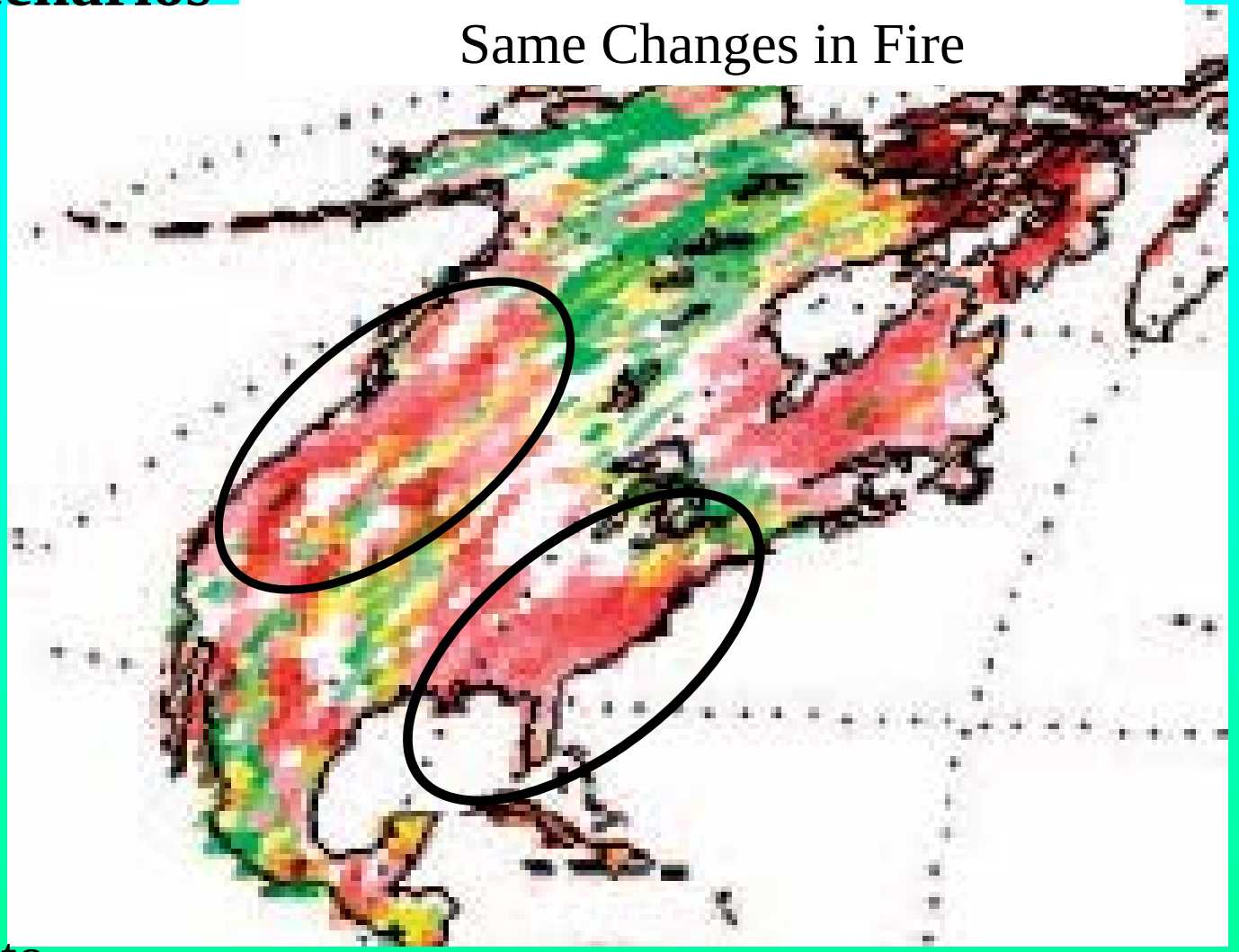


In the Future
The West gets Woodier, and
It burns a lot more!...
But, look at the East!

LPJ DGVM
16 Climate Scenarios

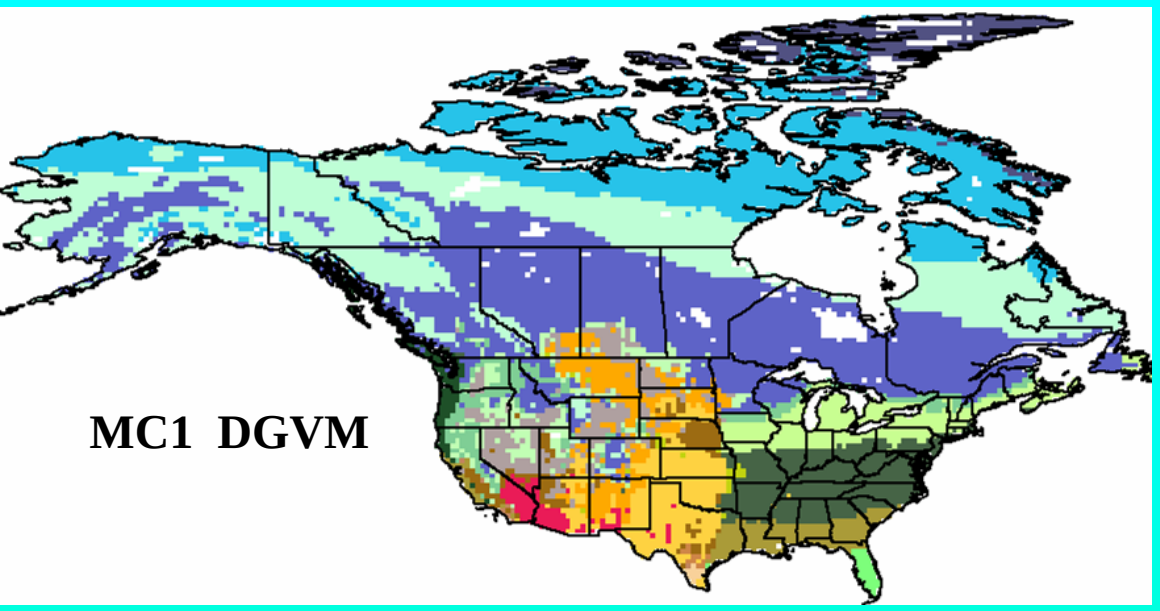
Different Ecological Model
Different Climate Scenarios
Same Changes in Fire

Red = + Fire
Green = - Fire



Changes relative to
Base Period 1961 – 1990

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



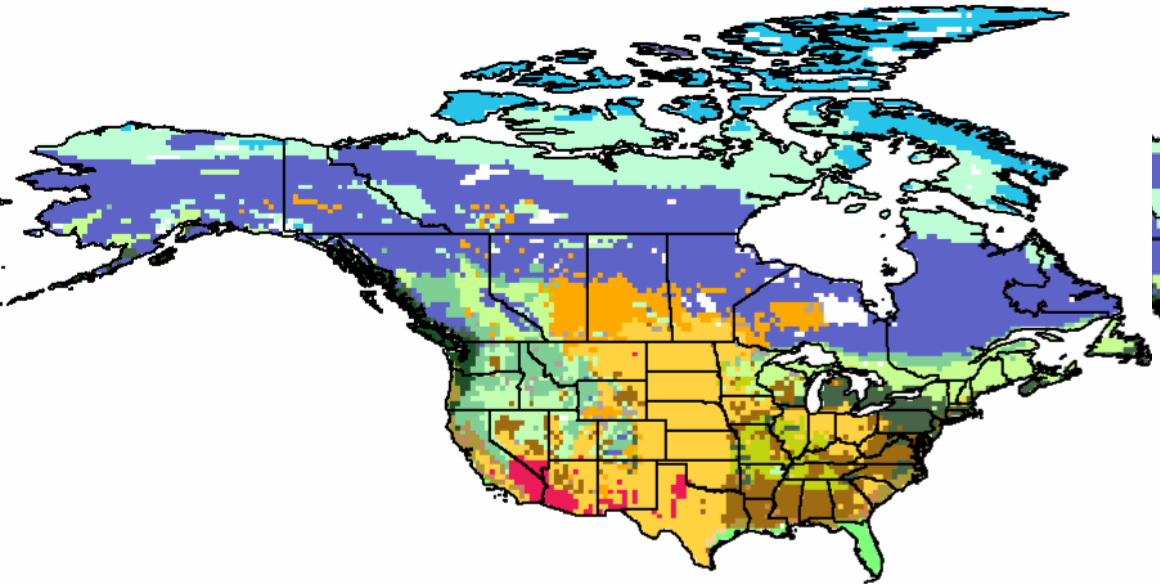
MC1 DGVM

Current Vegetation (1961-1990)
Suppressed Fire

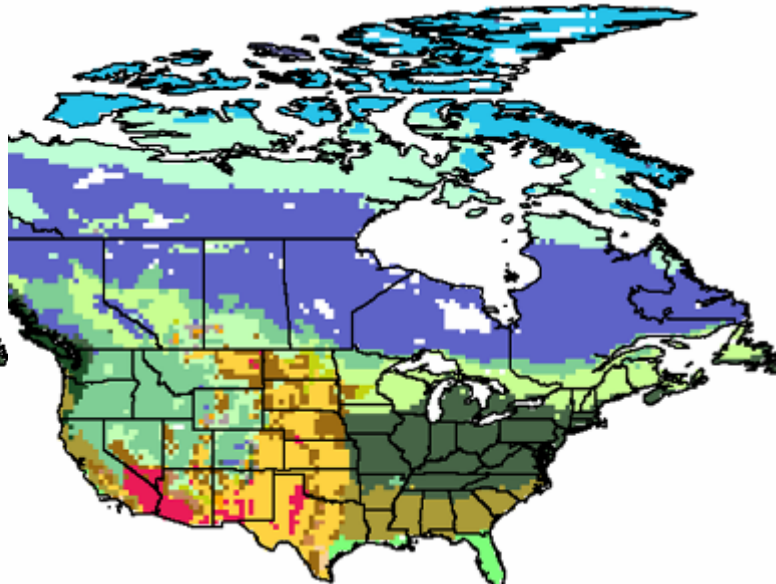
MAPSS Team, In Prep.

CGCM2-A2 Scenario

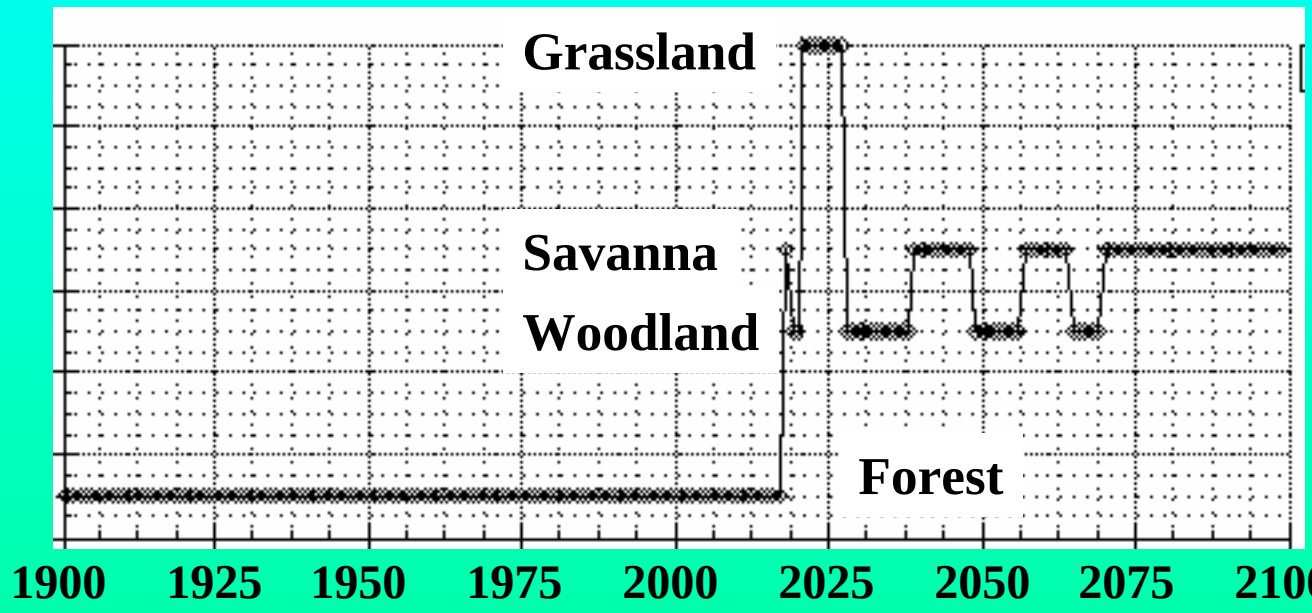
With Fire



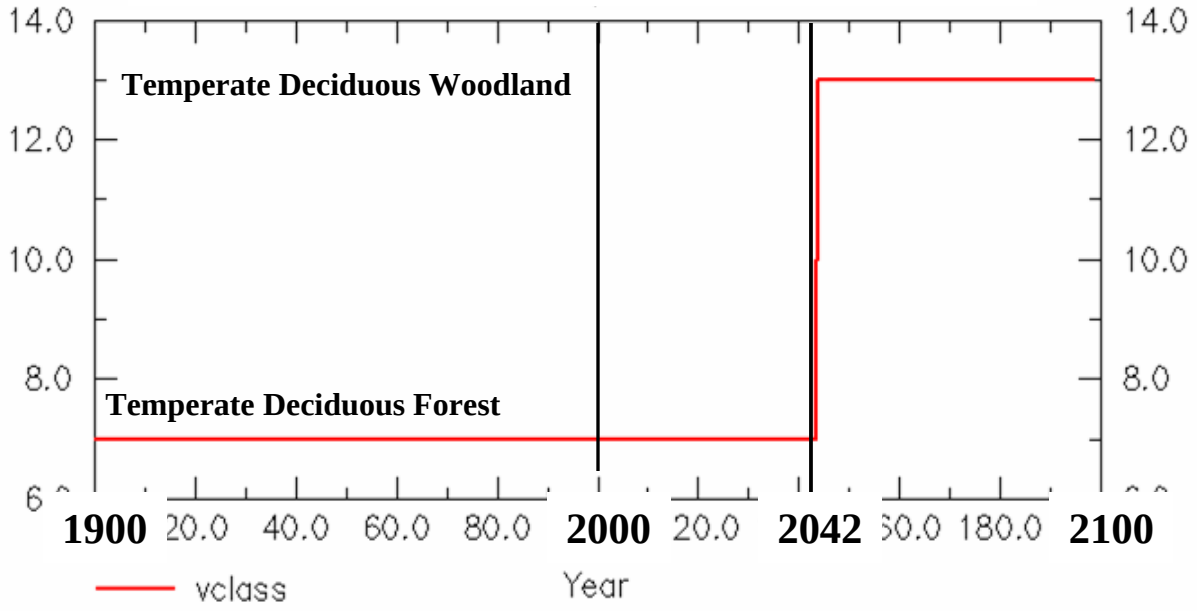
Suppressed Fire



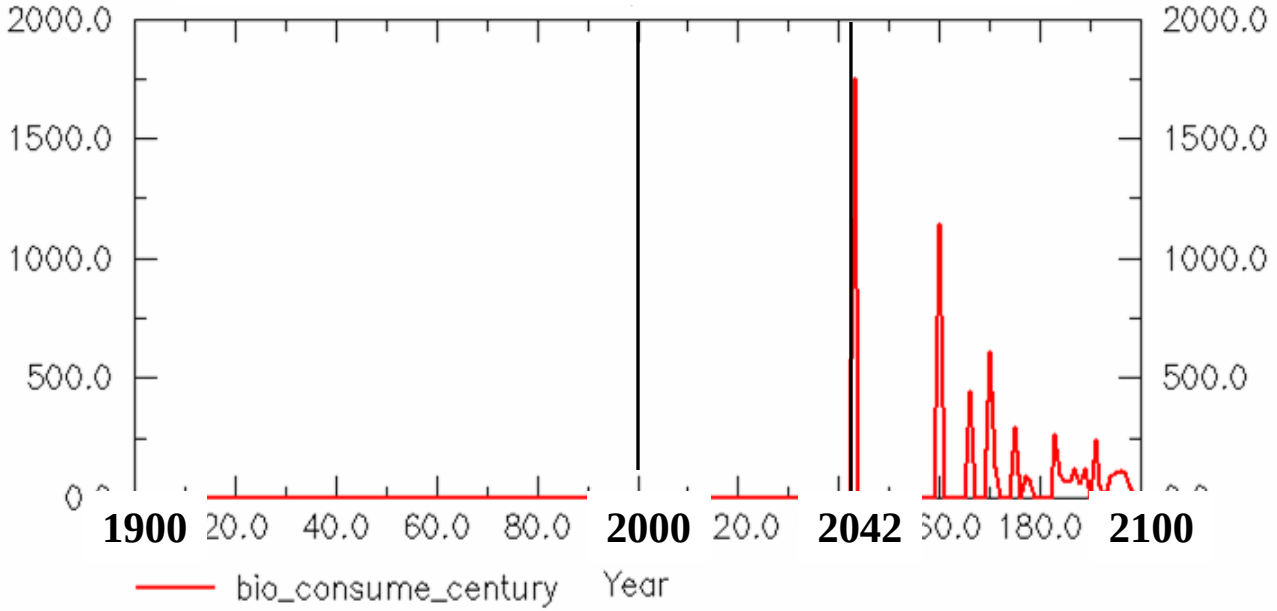
VINCERA HADCM3-A2
Eastern Deciduous Forest Region



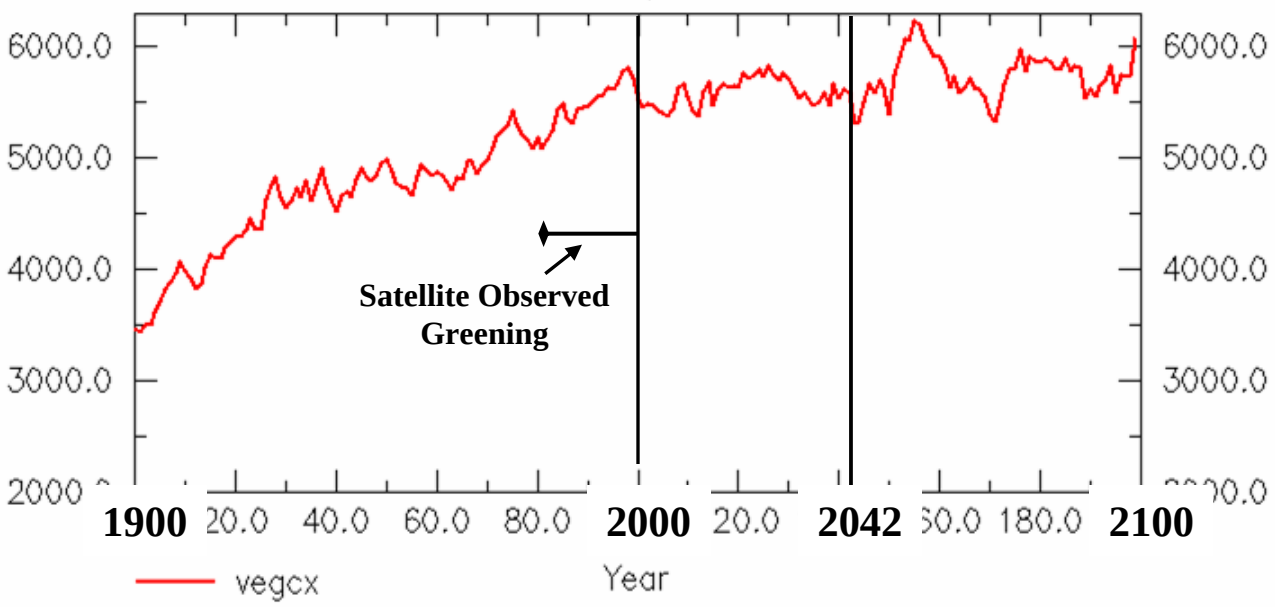
Vegetation Classification
High CO_2 Sensitivity, No Fire Suppression



Biomass Consumed By Fire (g C/m^2)
Low CO_2 Sensitivity, No Fire Suppression

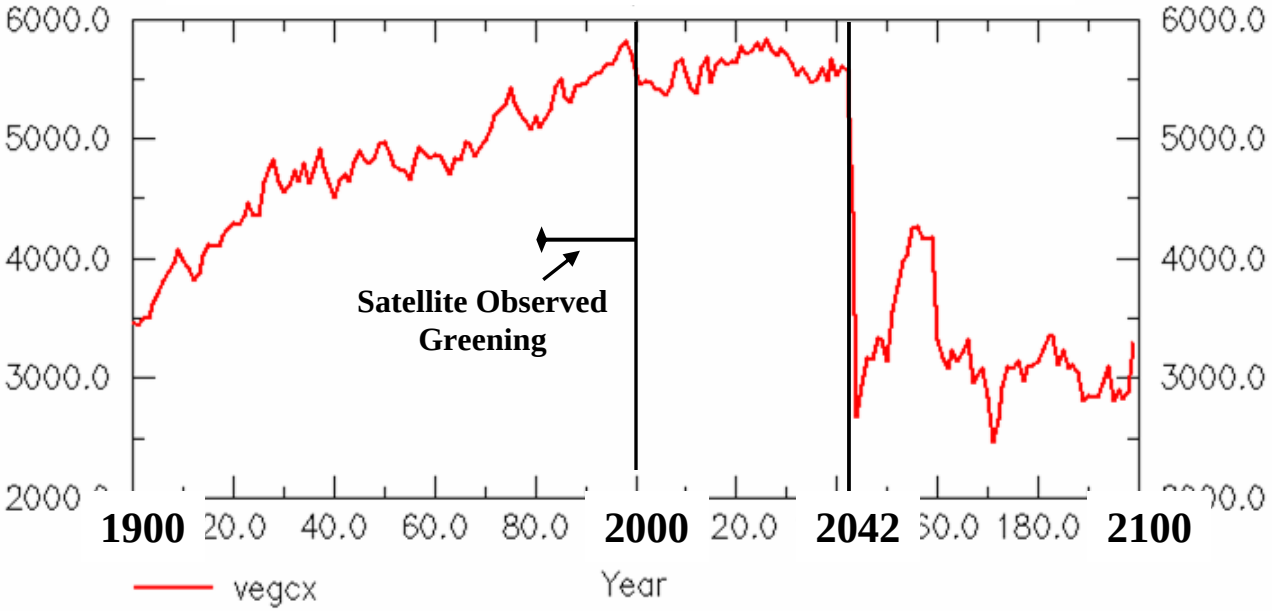


Total Live Vegetation Carbon (g C/m^2)
High CO_2 Sensitivity, With Fire Suppression



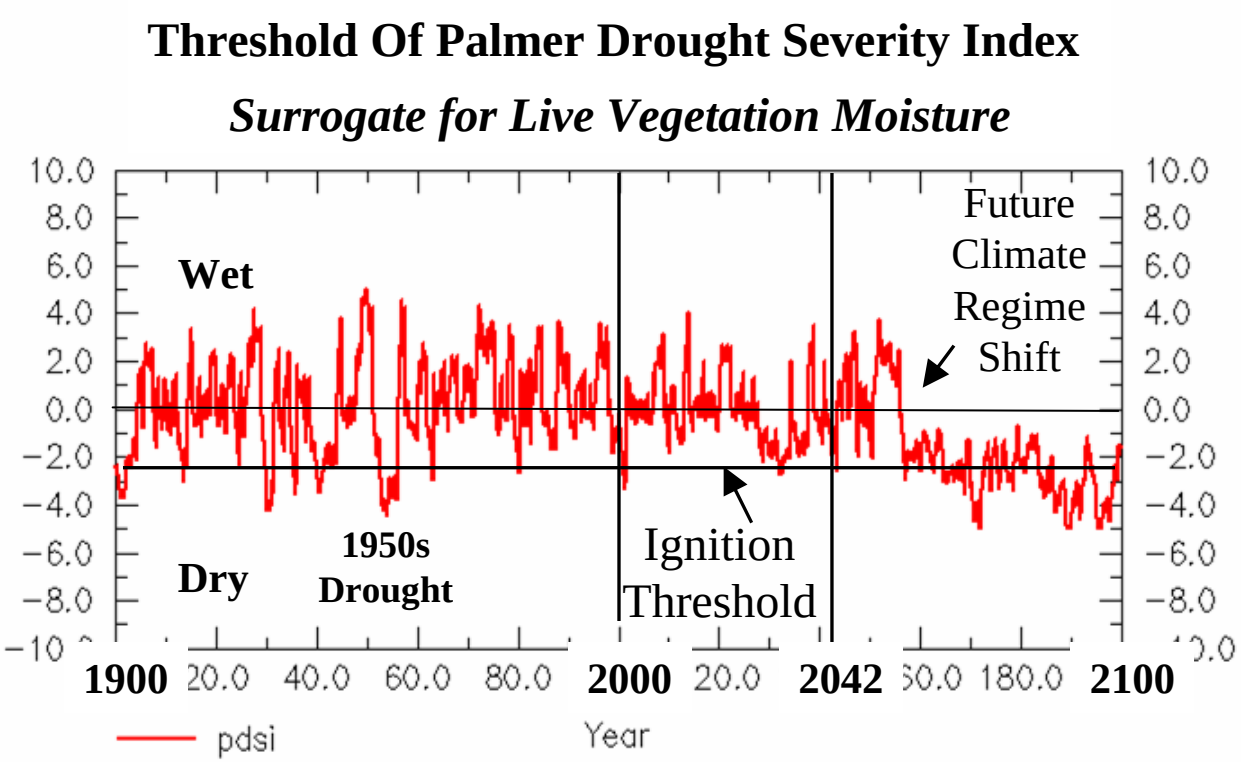
‘Greening’ Processes Become Saturated

Total Live Vegetation Carbon (g C/m^2)
High CO_2 Sensitivity, No Fire Suppression



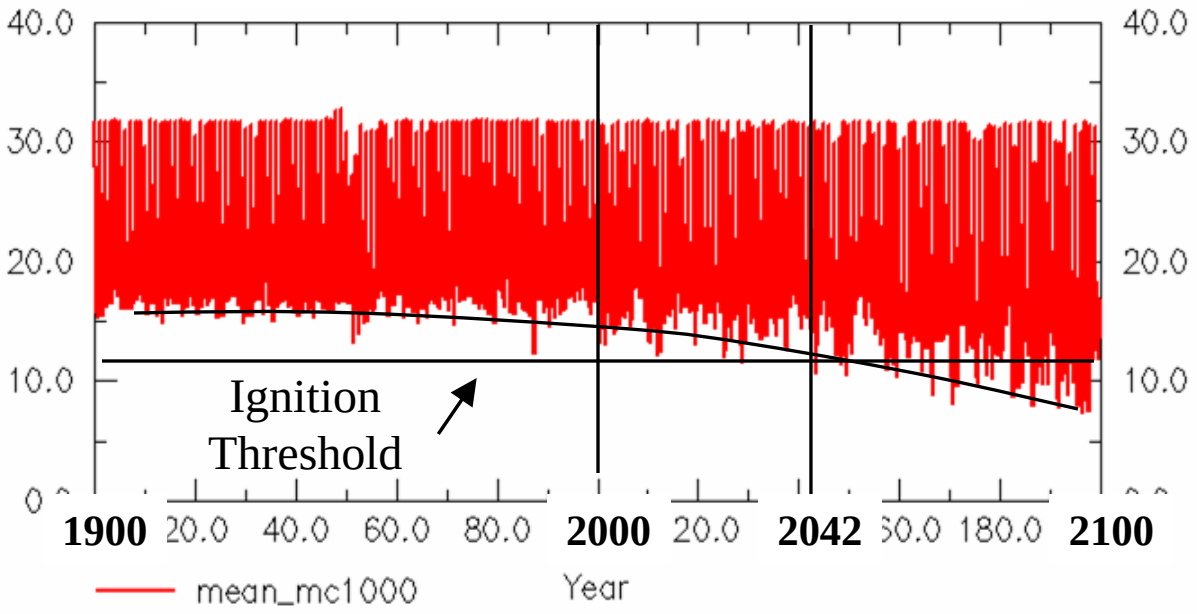
Persistent fire maintains young ecosystems,
But changes vegetation to a different, quasi-stable state.

Fire Ignition Trigger



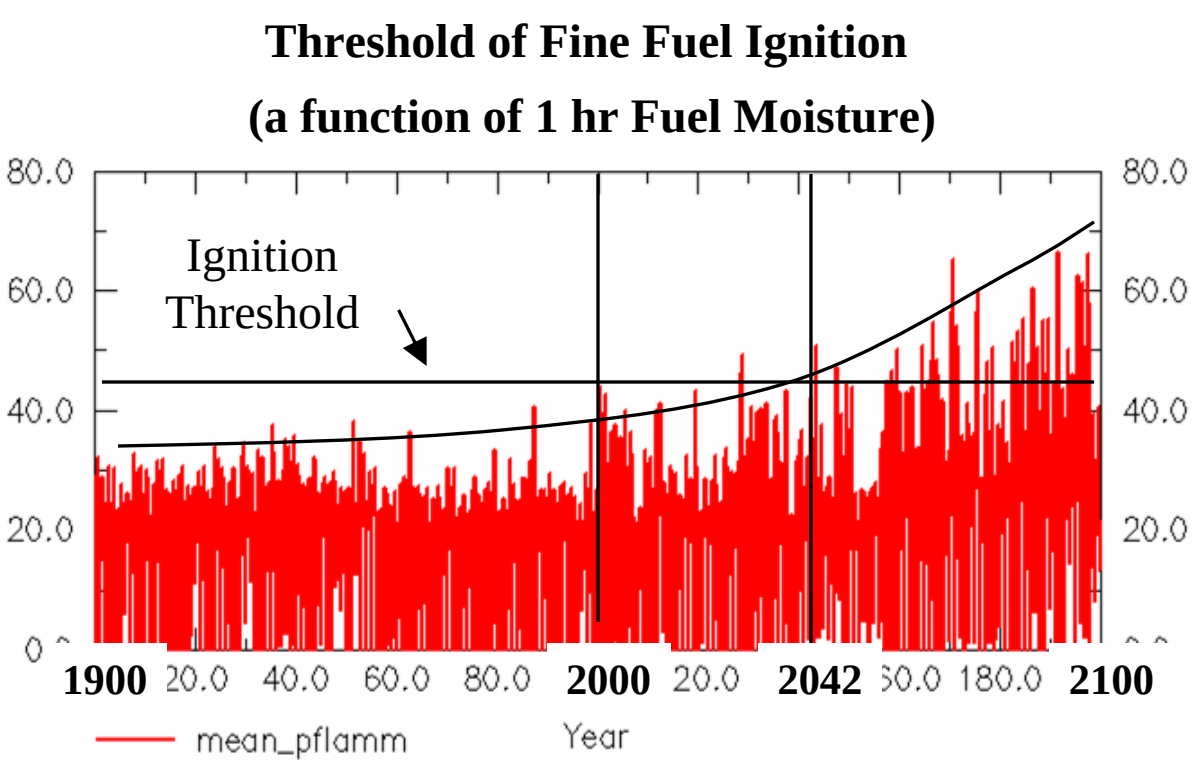
Fire Ignition Trigger

Threshold Of 1000-hr Moisture Content



Evaporative Demand Increases Exponentially With Temperature

Fire Ignition Trigger



Evaporative Demand Increases Exponentially With Temperature

Management Toolbox

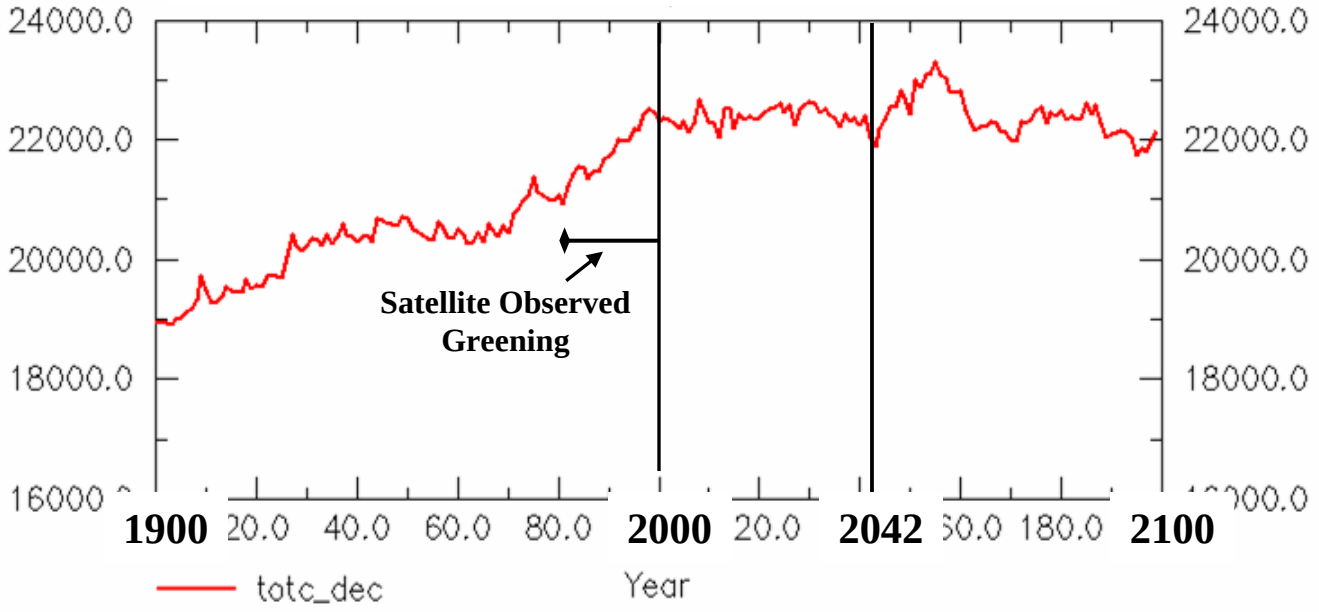
- **Current management strategies presume the *'status quo'***
  - **the past is a good predictor of the future.**
- Most Current modeling tools, e.g. FVS, TELSA and VDDT, cannot use climate.
- **Re-build tools to be 'climate smart', yet to retain their 'look and feel'.**
- Reframe management strategies for a changing climate
  - add new field experiments
  - identify underlying assumptions
  - Re-examine regeneration, restoration techniques

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
- Possible strategies
  - Keep forest density below water-limited carrying capacity
  - Plant diversity as opposed to homogeneous monocultures
  - Use Plants as an Energy Source
- Fire, carbon, water and other policies may be at cross-purposes, demanding creative management of change

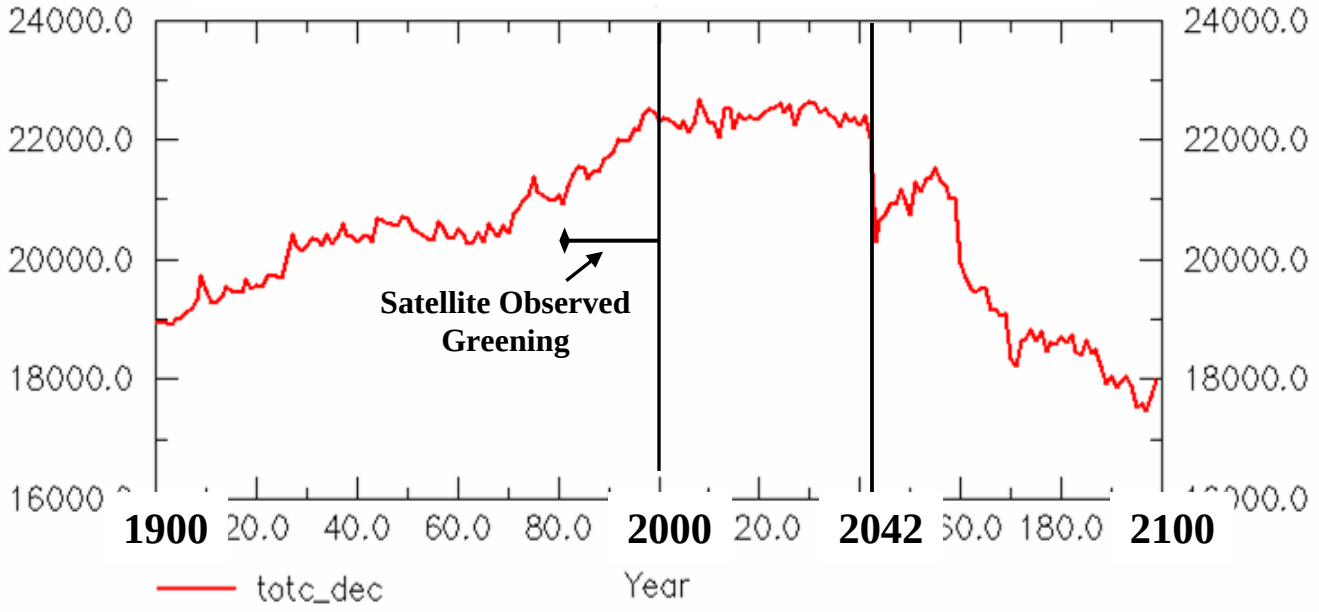
Total Ecosystem Carbon (g C/m^2)
High CO_2 Sensitivity, With Fire Suppression



‘Greening’ Processes Become Saturated

Early Greenup – Later Browndown

Total Ecosystem Carbon (g C/m^2)
High CO_2 Sensitivity, No Fire Suppression



Persistent fire maintains young ecosystems,
But gradually reduces soil carbon.