Outline for *Climate Impacts on Burn Severity in Three Forest Ecoregions of the U.S.* – Carl Key, USGS NOROCK.

Slides

1. Introduce Co-Pi's
2. – 4. Introduce Carl Key. Continuity taking burn severity/remote sensing research into applications and National operations.
5. – 6. Introduce active burning, awesome force of wildfire, high media and public interest, these burns we will see on fieldtrip, recent fires from Glacier and my property in the Flathead Valley.
7. Media and public attention fades quickly, but fire effects persist for decades shaping ecosystems and management.
8. – 10. Three factors important to ecosystem response and burned area evaluation; severity, time, mosaic/pattern. These factors not currently recognized in wildfire-climate work.
11. Yet climate and weather closely link to most aspects of active wildfire and post-fire response. Covers extensive topics, highlight only a few: Fuel dynamics may be most complex, loading and structure governed by past climate, moisture a seasonal climate response. Active fire intensity governed by going weather. All such burning conditions feed directly into post-fire effects and responses. Under climate change ecological communities that succeed after fire may be different from those that existed prior to fire, having evolved under the climate that prevailed after previous burns. Second-order effects. Post-fire responses feed back to set the stage and potential for future fuel and fire potential.
12. Summary statement on wildfire significance, and relationship to climate and ecosystems, including the atmosphere.
13. Back to our project, pictures of our small happy group
14. General goals and objectives, and how project addresses new elements of climate-wildfire science: burn severity and pattern in three regions that differ by climatic drivers, vegetation and fuels, and form a <u>continental</u> north-south gradient.
15. – 19. Yukon-Charlie: Variable terrain and vegetation; driest climate in AK and most wildfire; some larger trees; black spruce and tundra; fire seasonality not that different from Glacier. History includes fire in the 1950's-1960's as well as recent 1990's-2000's. Area burned not related to number of ignitions; fuel and going weather important determining factors.
20. Glacier: various climatic influences, terrain, vegetation, and fire season. History shows strong pulse of recent burning after 1984, but that is not unique, earlier similar periods occurred (1844-1889; 1910-1936). Hiatus evident after 1936 until mid-1980's, very little '50's-60's burning. Good long-term burn data record.
21. – 22. Yosemite. Also ecologically variable; climatic influences; similar burn history to Glacier.
23. – 25. Introduce the key fire, climate, and teleconnection variables we intend to study. Several fire variables are different from what has been done in the past. Most of this data is readily available, though Yukon-Charlie has less continuity; we will have surrogates there for some variables. Show some of my new models and statistical approaches for continuous burn data. Contrast main teleconnection features, periodicity, region of influence.
26. Key analyses and hypothesis testing. Trends within regions, and comparisons between regions, looking for rationales of synchrony, asynchrony, or lack of trend.
27. Outcomes. New statistical approaches and modeling of continuous severity data related to spatial fire dynamics and climatic influences; better understanding of factors enhancing or decreasing wildfire frequency, size, severity or pattern. Two examples from Jim Lutz showing such relationships.
28. Closing slide. Reminder, many of these images are available from my web sites.....

Climate Impacts on Burn Severity in Three Forest Ecoregions of the U.S.

Carl Key
Glacier Field Station
USGS NOROCK
carl_key@usgs.gov

Crystal Kolden
SCEP PhD Student
USGS Alaska Science Center
crystal_kolden@usgs.gov

Jim Lutz
Post Doc
University of Washington
jlutz@u.washington.edu

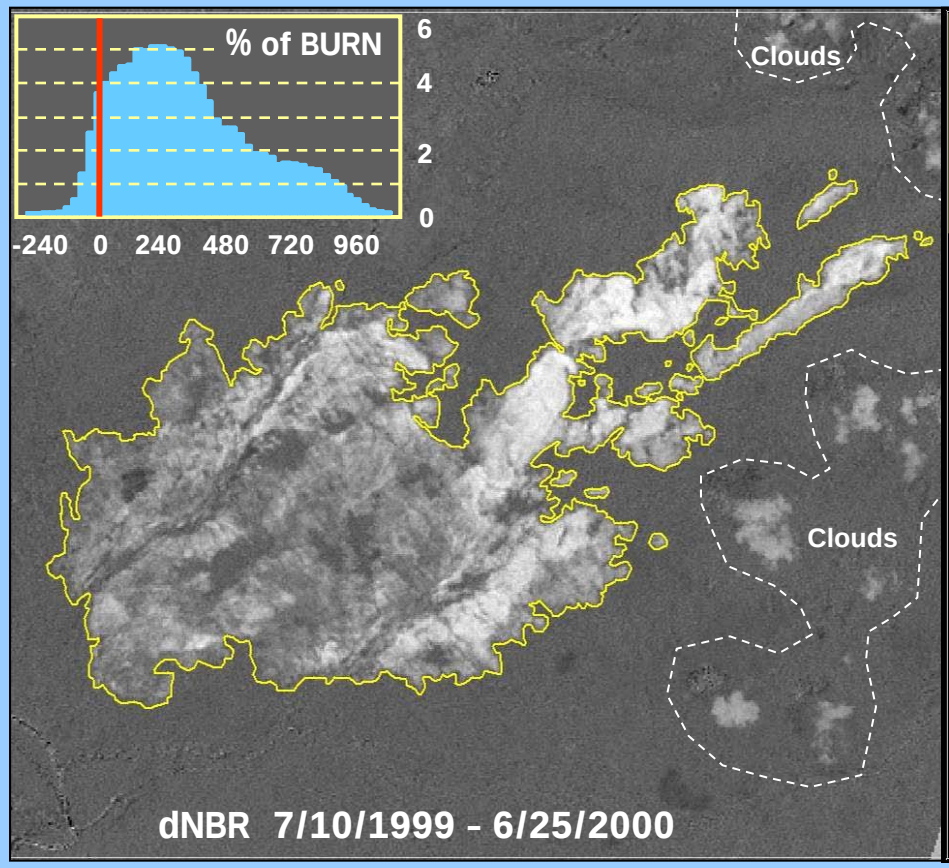
Jan vanWagtendonk
Emeritus Yosemite Field Station
USGS WERC
jan_van_wagtendonk@usgs.gov

2003 Rampage Burn, Upper Park Creek

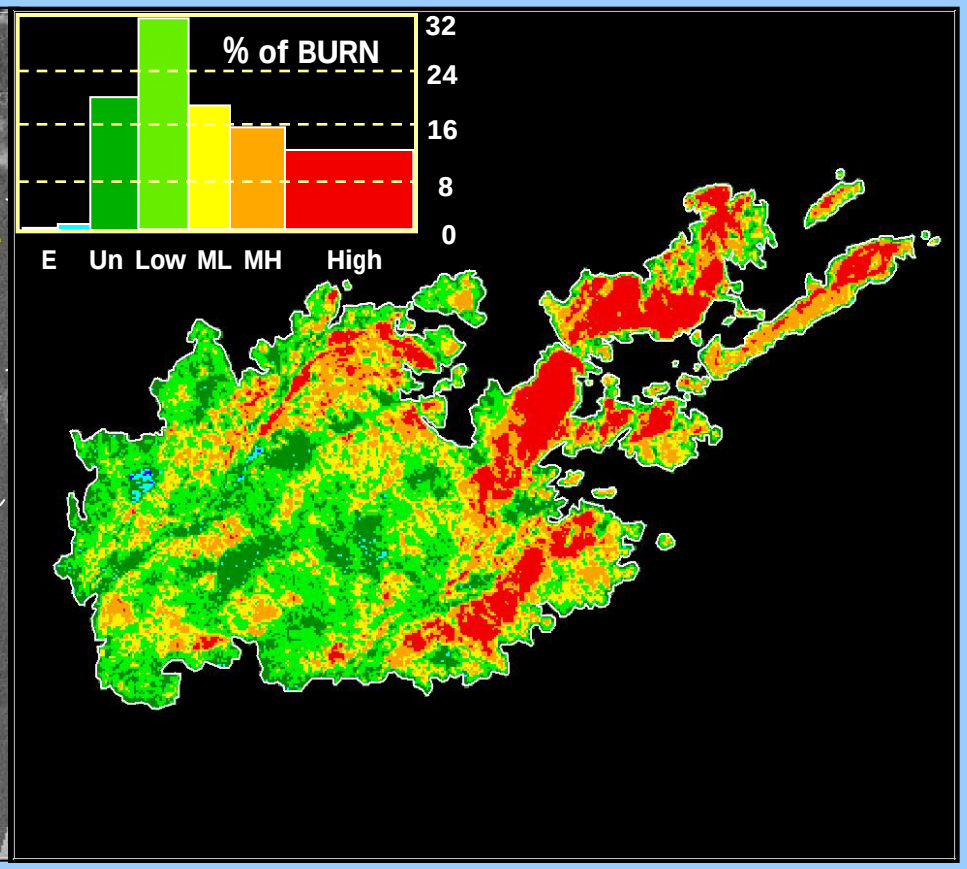
Whole-Burn Spatial Characteristics of Severity

The dNBR, a Remote Sensing Index Very Responsive to Fire Effects

dNBR Continuous Measure of Change
Burn Perimeter Mapped



Burn Severity Levels or Classes
Data Extracted within Perimeter



August 1999 Anaconda Fire 4,220 ha

Post-fire Assessment of Landscape Fire Effects: dNBR – CBI Timeline

88 92 94 96 98 00 02 04 06 08

88 Red Bench Fire Glacier White et al. B7 reflectance

94 GLAC fires, dNBR CBI, 95 Nate Benson

USGS-NPS POBS Study

JFSP Study 83 new fires

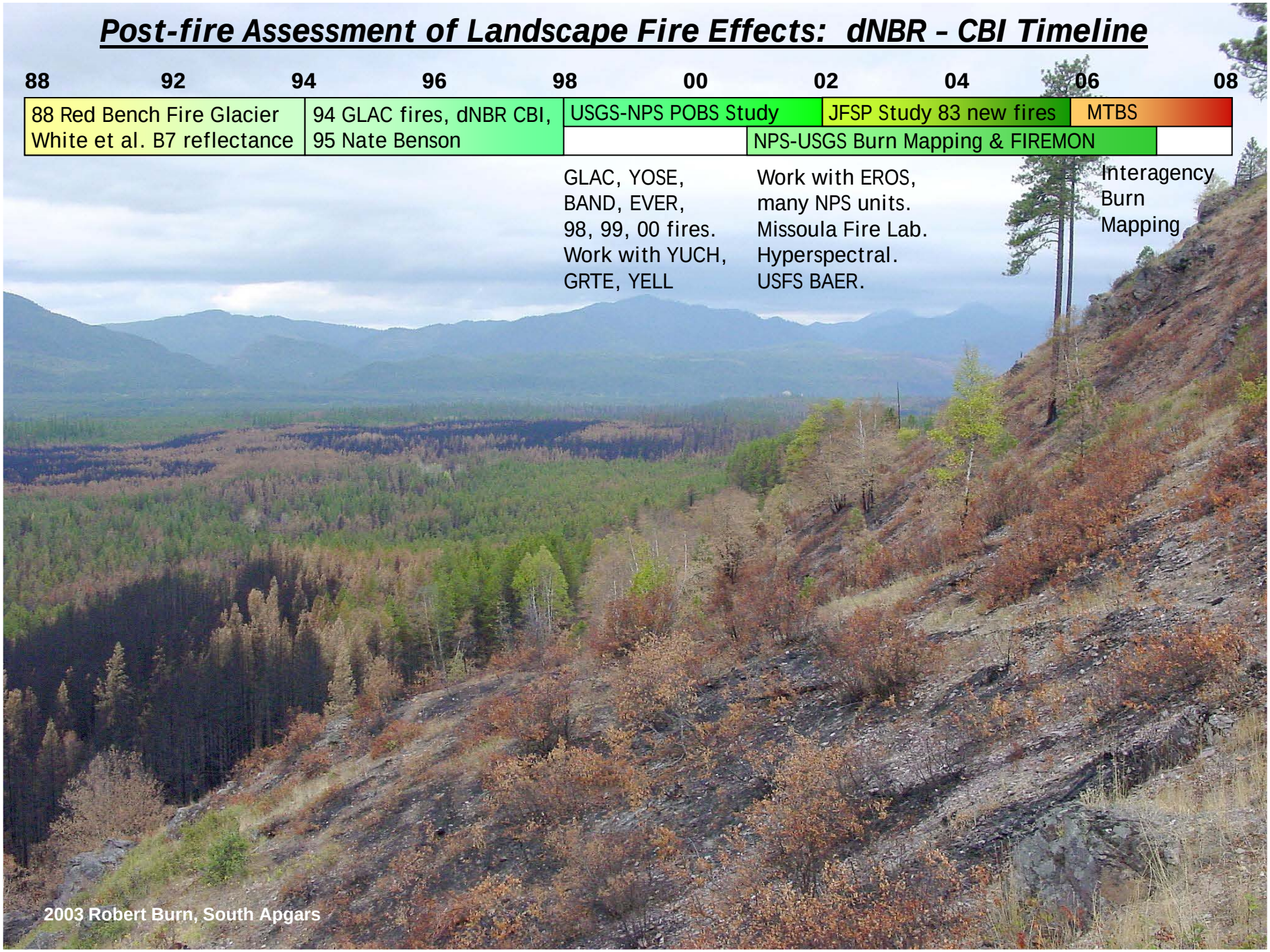
MTBS

NPS-USGS Burn Mapping & FIREMON

GLAC, YOSE, BAND, EVER, 98, 99, 00 fires. Work with YUCH, GRTE, YELL

Work with EROS, many NPS units. Missoula Fire Lab. Hyperspectral. USFS BAER.

Interagency Burn Mapping



2003 Robert Burn, South Apgars

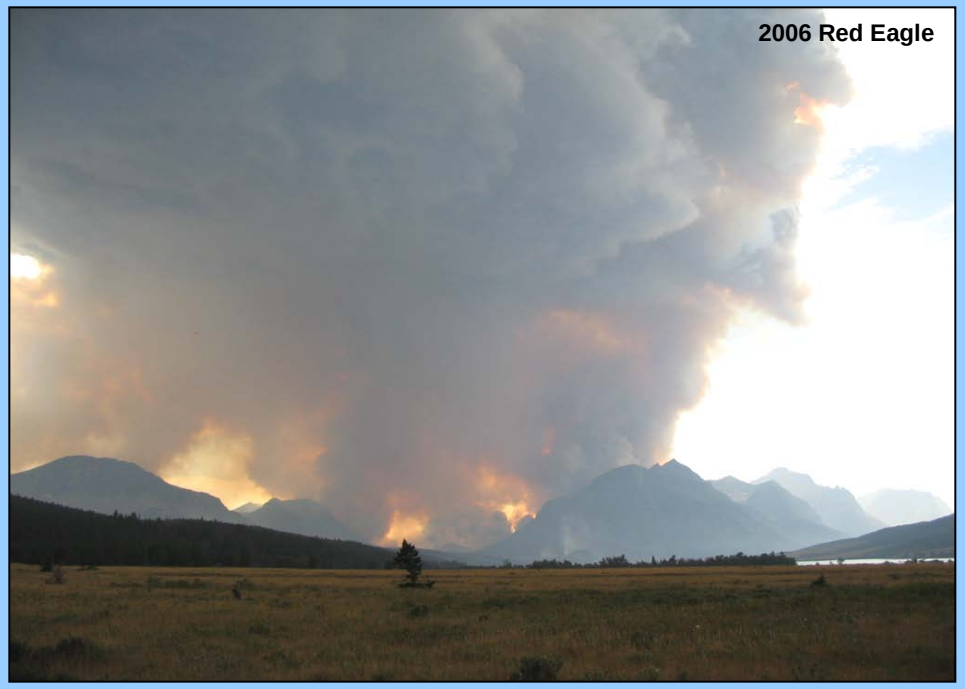
NPS-USGS National Burn Severity Mapping

http://burnseverity.cr.usgs.gov

MTBS- Monitoring Trends in Burn Severity

http://www.mtbs.gov

Some Cool Pictures of Active Burning



2007 Chippy Creek
2007 Brush Creek

1999 Anaconda
9/22/1999

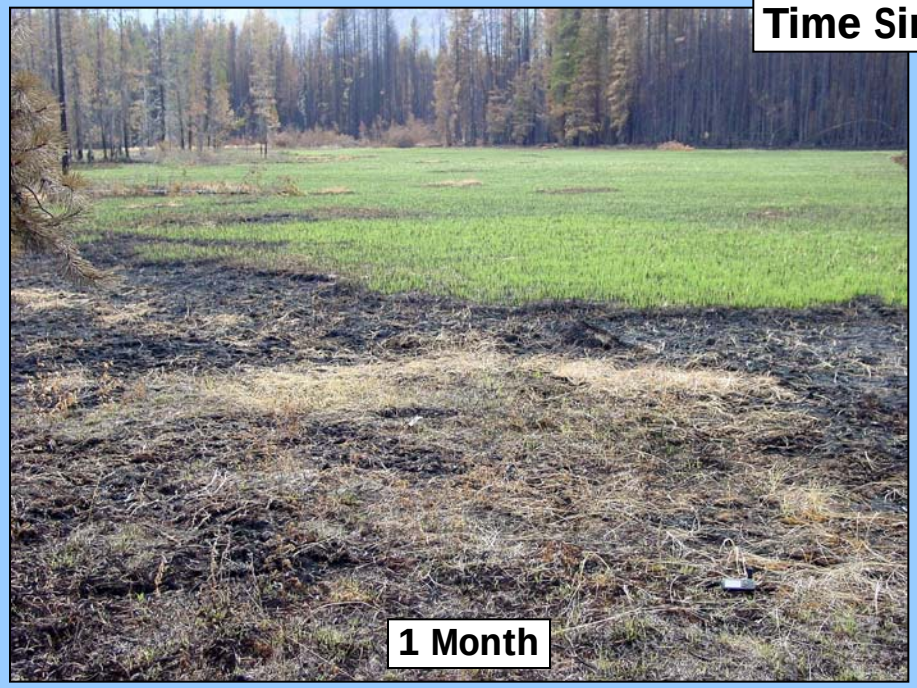
2001 Moose

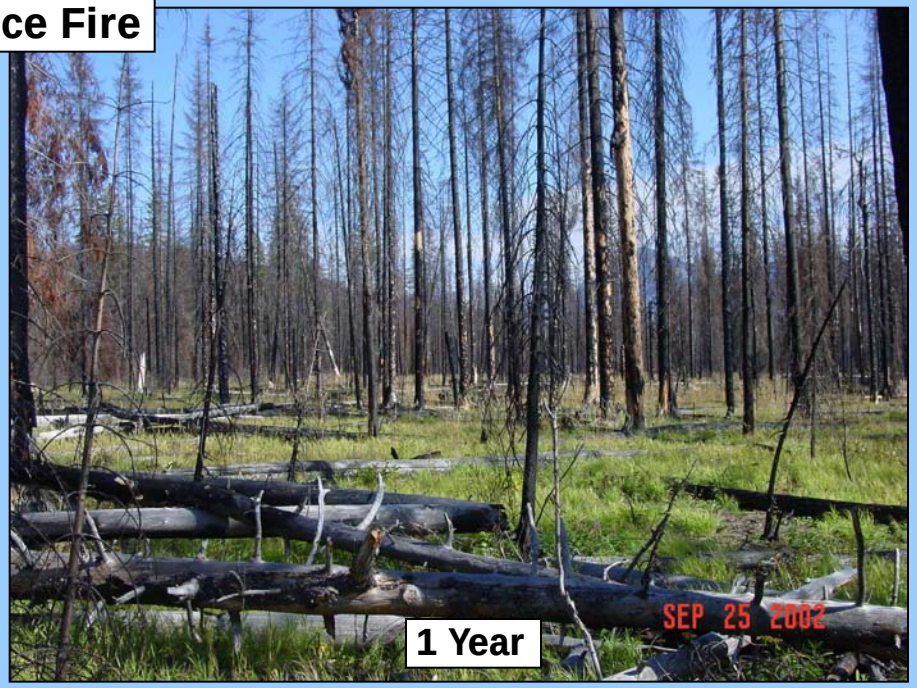
1988 Redbench

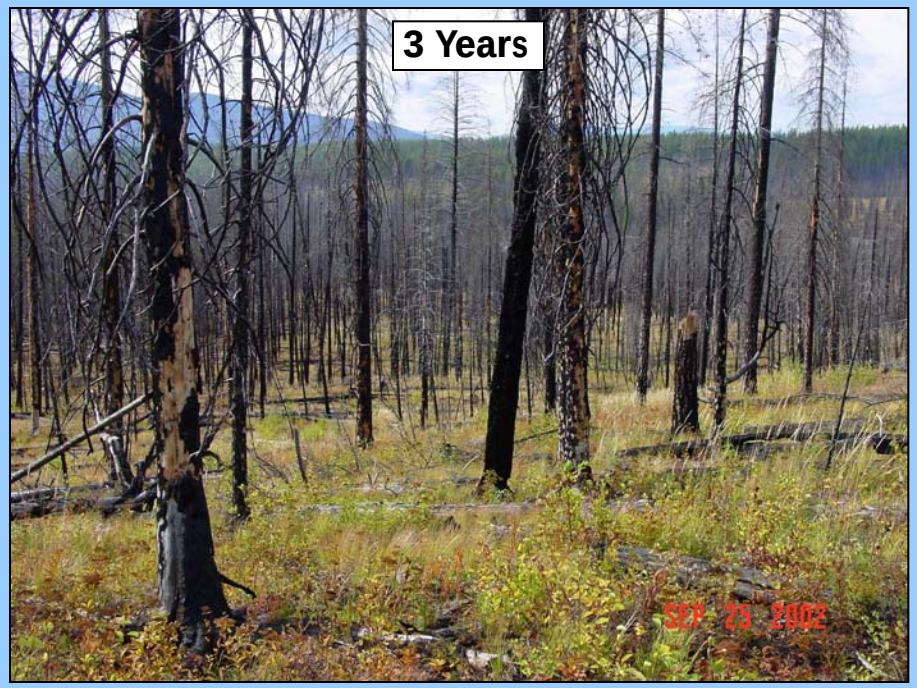
2003 Trapper Creek

Burn Severity

Time Since Fire







Burn Size, Mosaic and Pattern

Fire Frequency, Extent, Pattern, Severity, and Recovery All link to climate and weather.

What do fires need to burn?

1) Fuel
   a) Quantity
   b) Distribution
   c) Structure
   d) Moisture Content

2) Ignition

3) Oxygen – Fire Weather
   a) Wind
   b) Relative Humidity
   c) Temperature

What governs post-fire responses?

1) Burn Severity
   a) Survivorship
   b) Biomass consumption
   c) Changes to soil

2) Patchiness and pattern
   a) Available seed sources
   b) Refugia, biodiversity

3) Subsequent Weather/Climate
   a) Species selection
   b) Productivity, growth
   c) Erosion, infestation, etc.

AS WELL AS BEING A RESPONSE TO CLIMATE CHANGE,

WILDFIRE ALSO IS THE FASTEST, MOST RADICAL AND DIRECT DRIVER OF ECOSYSTEM CHANGE*.

POTENTIALLY OF GREATEST SIGNIFICANCE* BY SEVERAL CRITERIA:

- SIZE OF AREA AFFECTED
- DEGREE OF CHANGE TO PRE-FIRE SYSTEMS
- VARIETY OF ECOSYSTEM COMPONENTS AFFECTED

* IN U.S., AT LEAST IN MANY SYSTEMS OF THE WEST, INCLUDING THE NORTH ROCKIES, PORTIONS OF ALASKA, AND THE SOUTHEAST.

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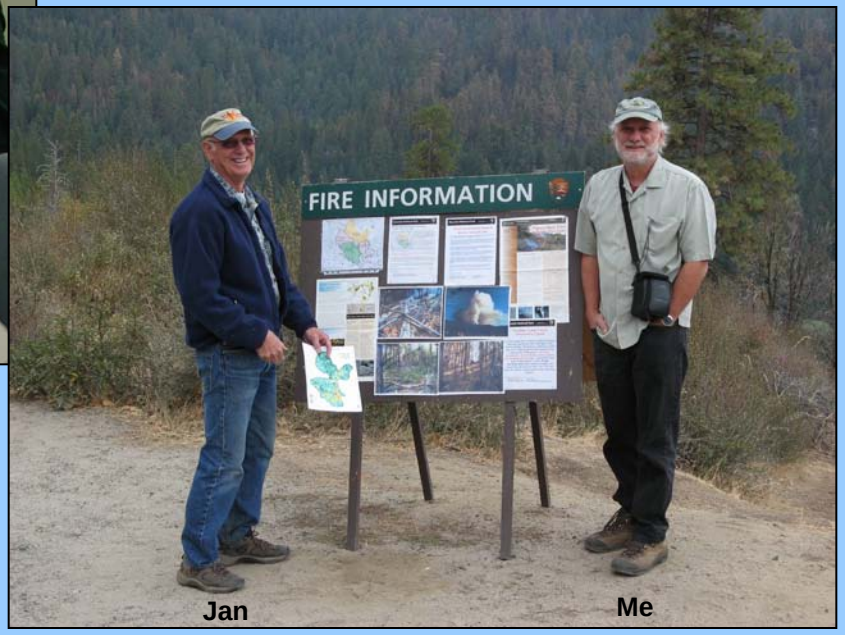
Carl Key
Glacier Field Station
USGS NOROCK
carl_key@usgs.gov

Crystal Kolden
SCEP PhD Student
USGS Alaska Science Center
crystal_kolden@usgs.gov

Jim Lutz
Post Doc
University of Washington
jlutz@u.washington.edu

Jan vanWagtendonk
Emeritus Yosemite Field Station
USGS WERC
jan_van_wagtendonk@usgs.gov



Selected September 30, 2008
Funding Allocated May 22, 2009
All Contracting Documents Submitted
Still waiting on final contracts and agreements. . . . . .

Assess the role that climate has played in wildfire burn severity across three distinct biomes of the United States.

Compare and Contrast the Regions Surrounding Yukon-Charlie, Glacier, and Yosemite National Park Units

1. How is climate variability (i.e. seasonality, temperature and precipitation) spatiotemporally manifested in large area patterns of burn severity?

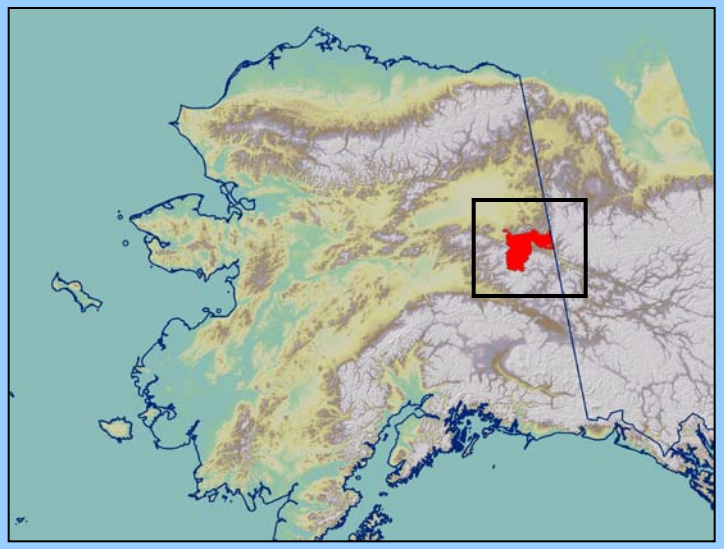
2. How are climate teleconnections spatiotemporally manifested in large area patterns of burn severity?

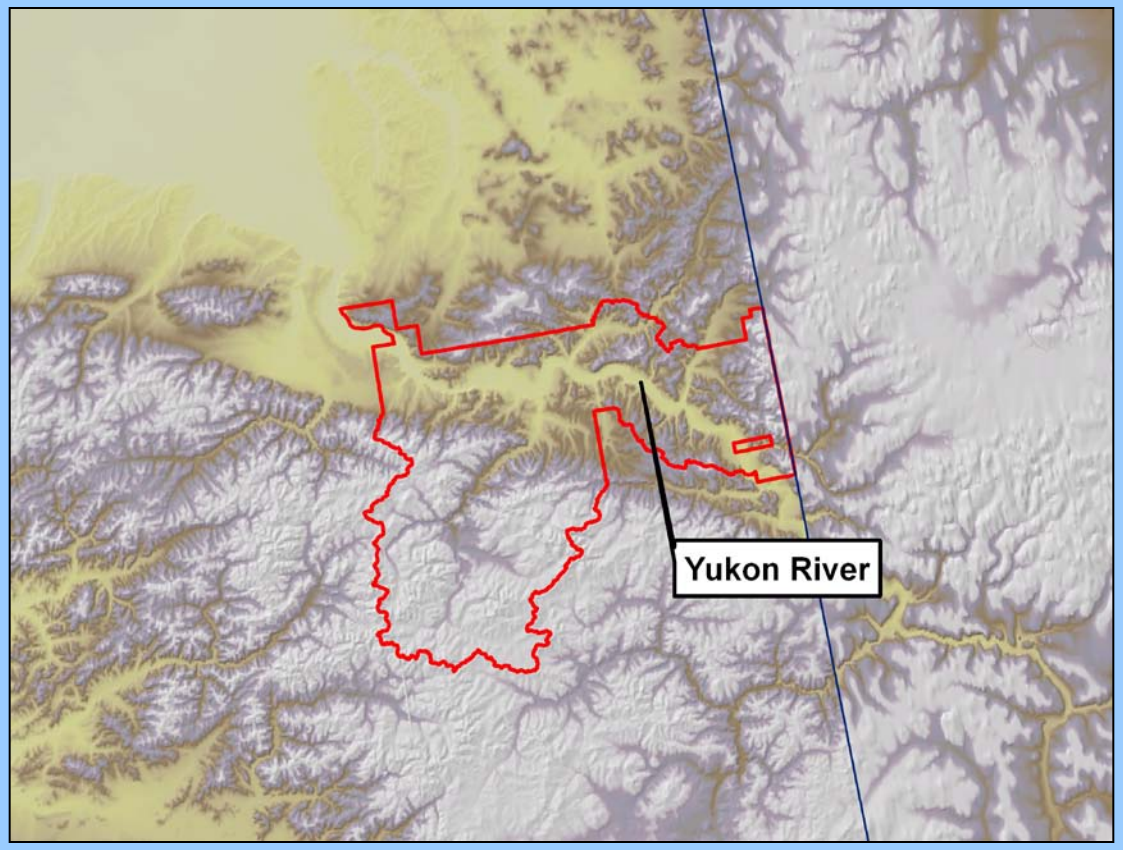
3. To what extent can we generalize *impacts on* and *trends in* burn severity across three ecoregions in the western U.S.; how are they similar, how do they differ?

Monthly and annual burn summaries will be related to monthly and annual climate variables.

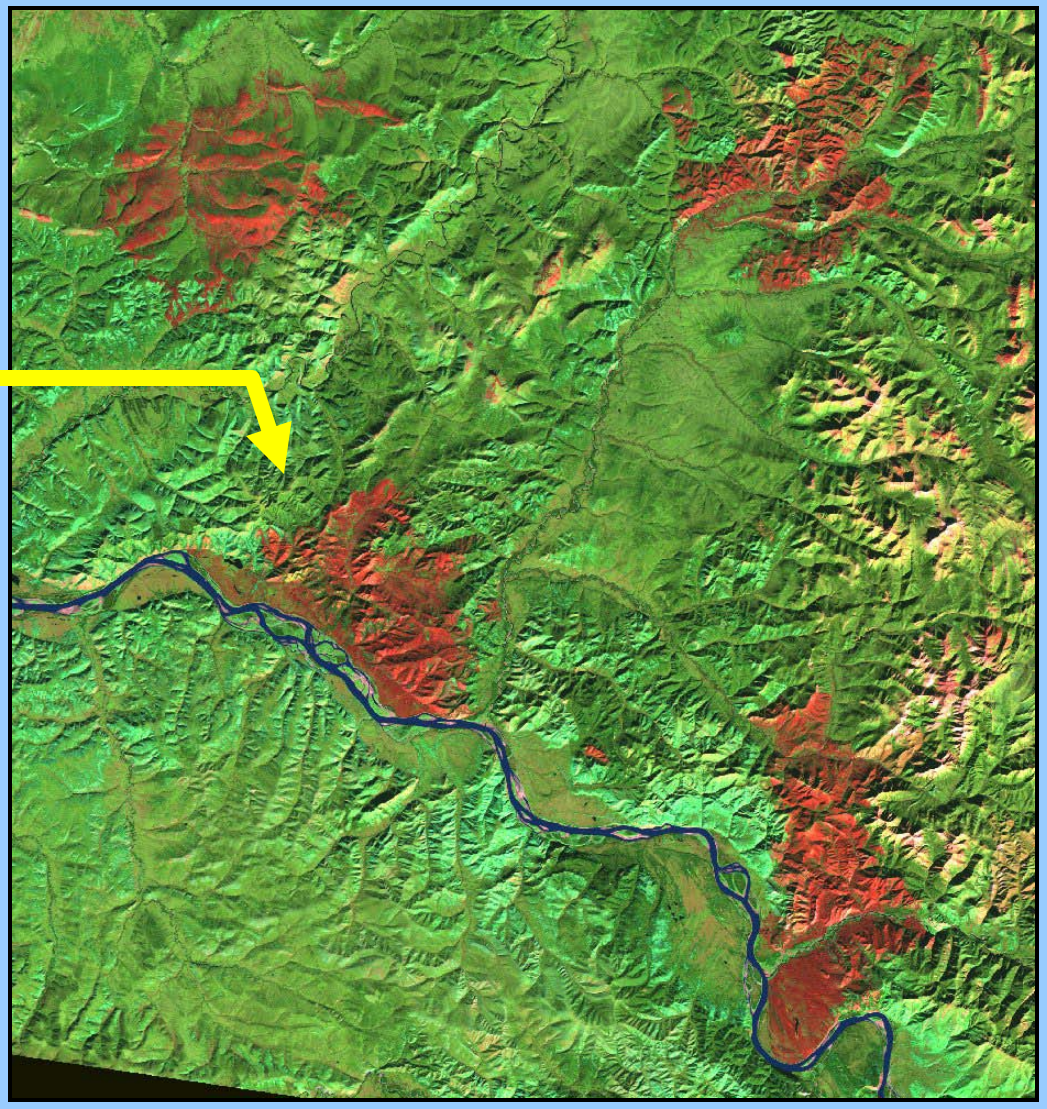
Yukon Charlie Rivers National Preserve

- 1 million hectare park in heart of Alaska interior
- Bisected by the Upper Yukon River,
- Represents the range of boreal ecotypes and fire regimes throughout Yukon River Basin





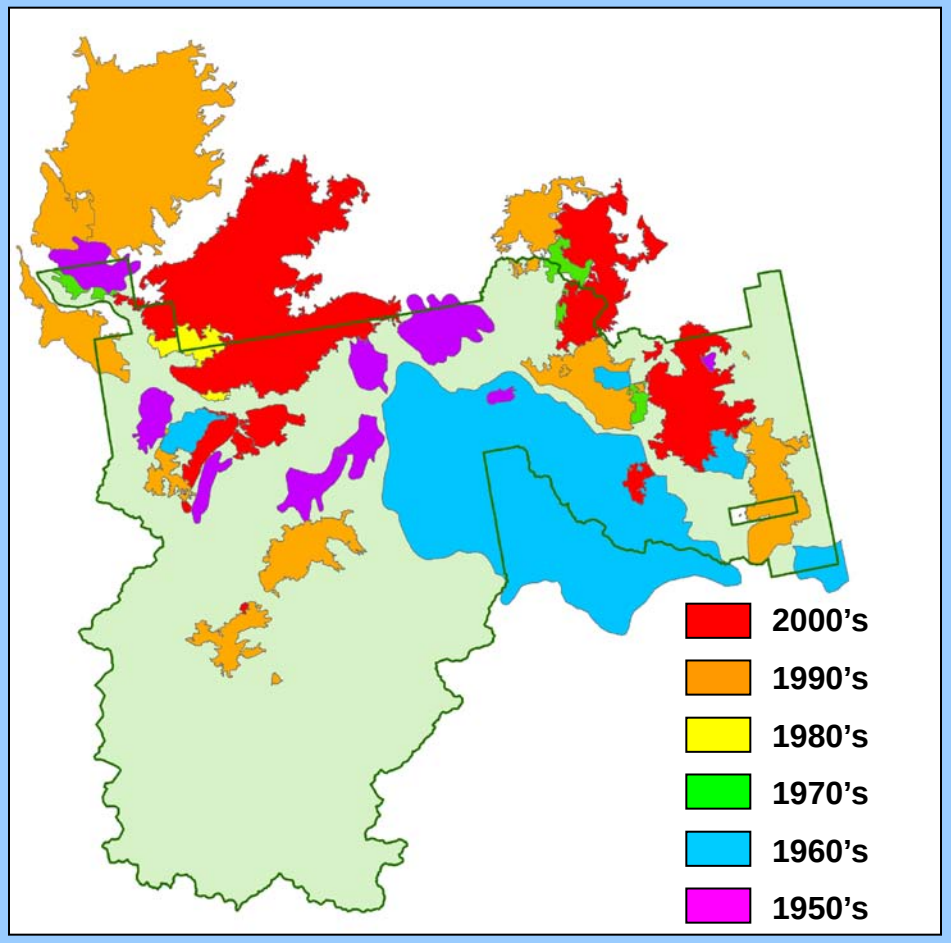
Landsat Image 9-12-1999



<u>Yukon Charlie</u>
Low to High Elevation Gradient.

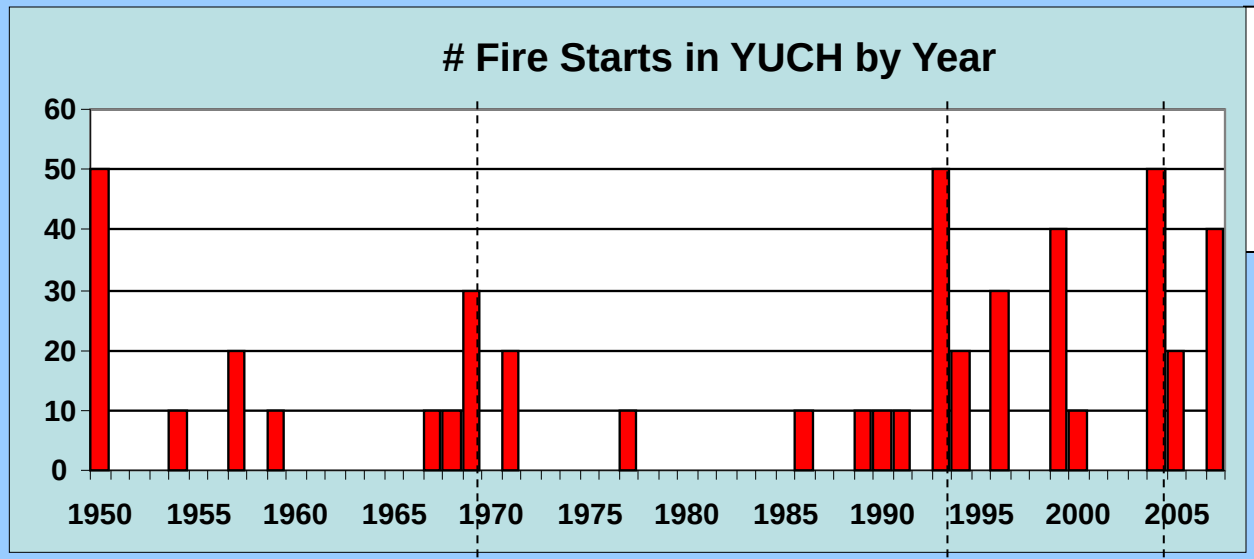
Variety of Vegetation and Fuel Types.

Yukon Charlie NPS Fire Monitors Sampling Burn Severity with the Composite Burn Index (CBI).



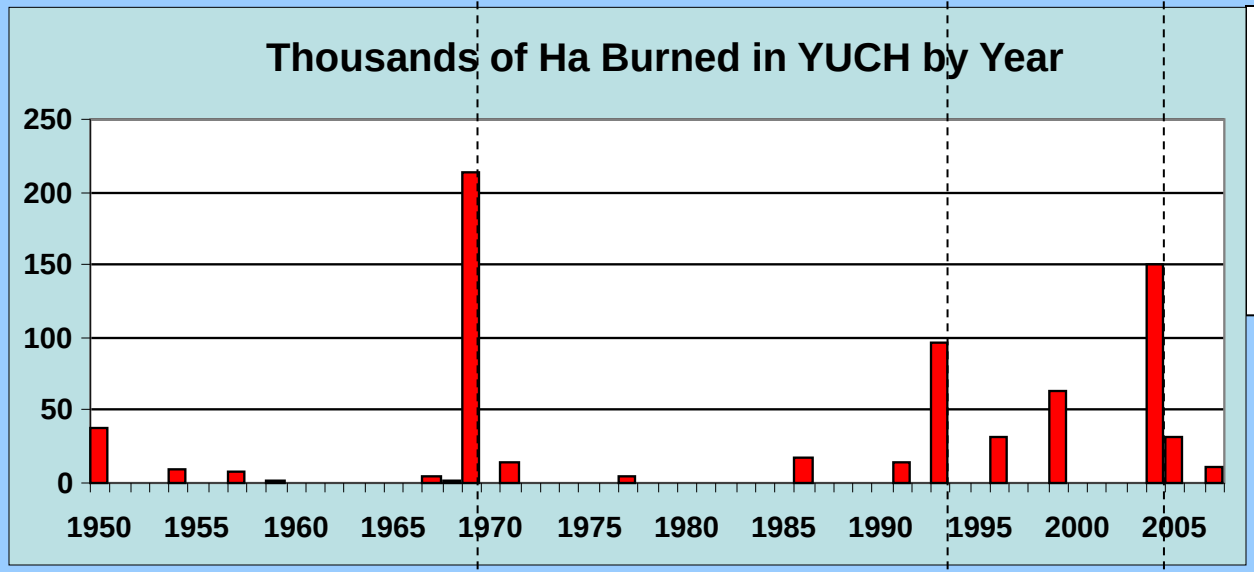
47 known fires 1950-2007

Largest: 200K ha (1969)



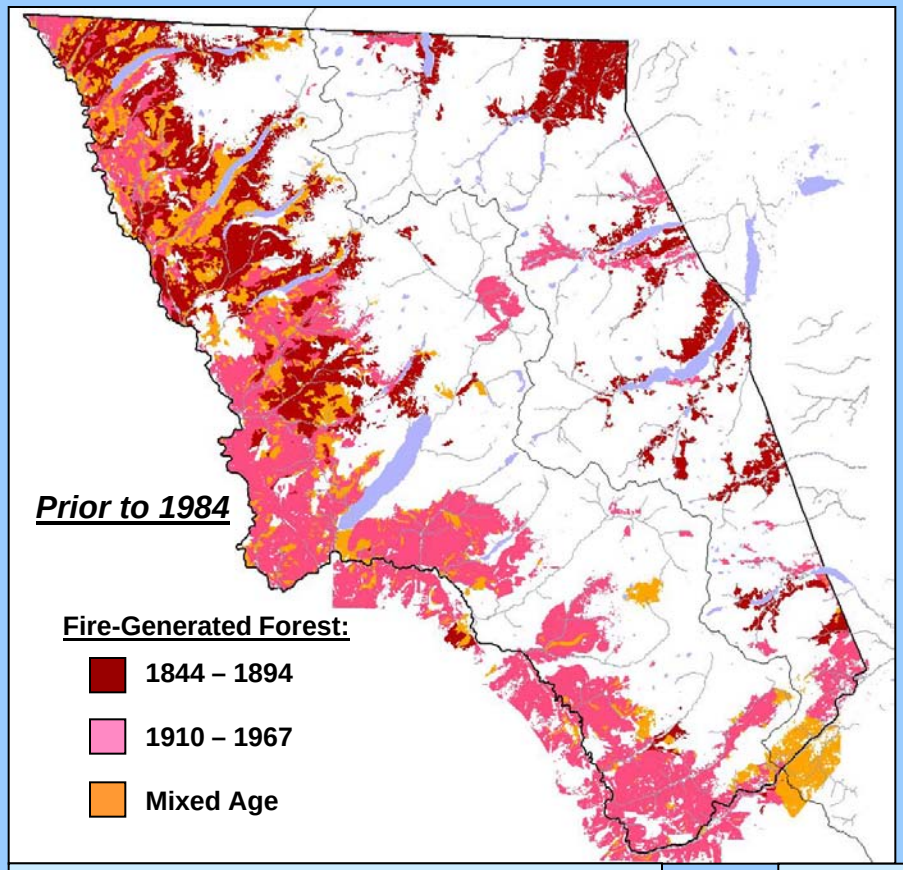
Many years with fires

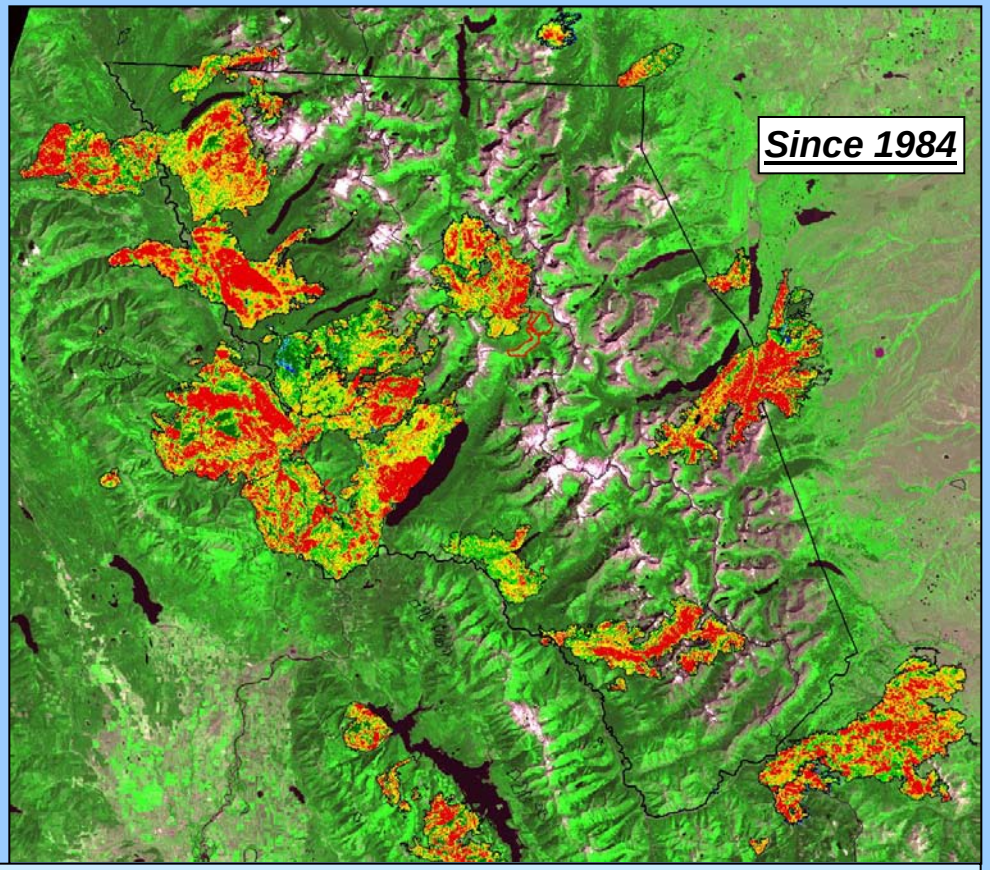
Largely Not Suppressed



Only a few years with large area burned:

1950, 1969, 1993, 1996, 1999, 2004, 2005





Minimum Stand Replacement Burn Area

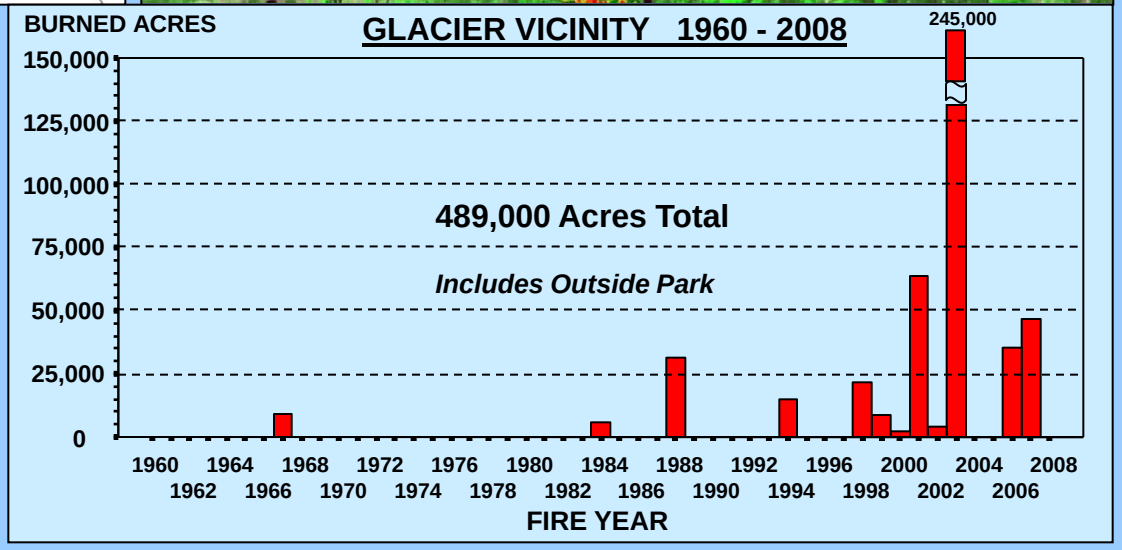
Mostly In Park Only.

Pre-1844 = 198,000 Ac.

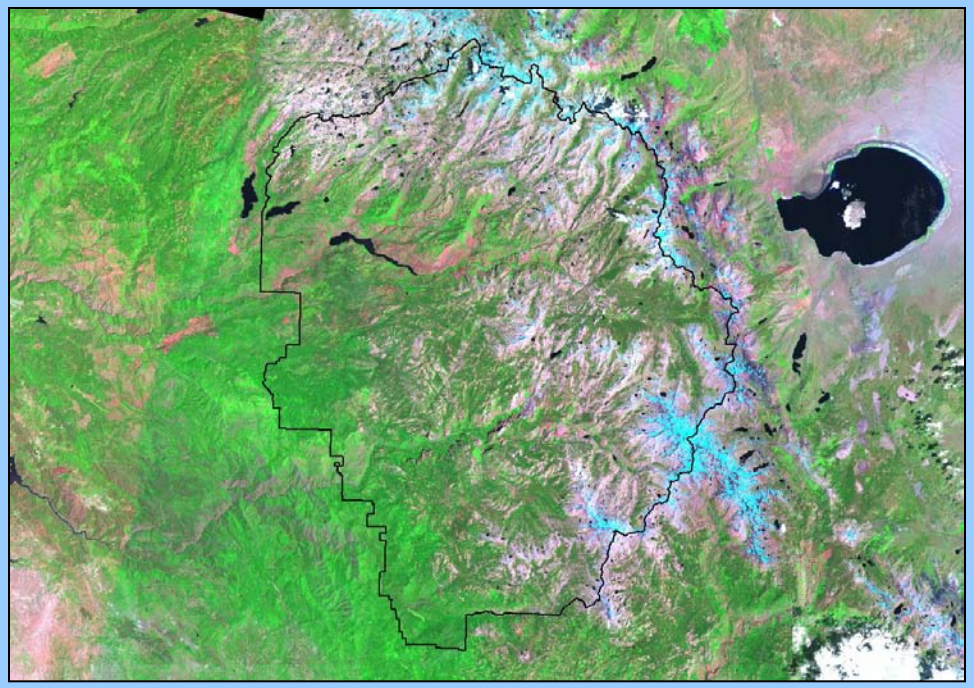
1844 – 1894 = 179,000 Ac.[1]

1910 – 1967 = 242,000 Ac.[2]

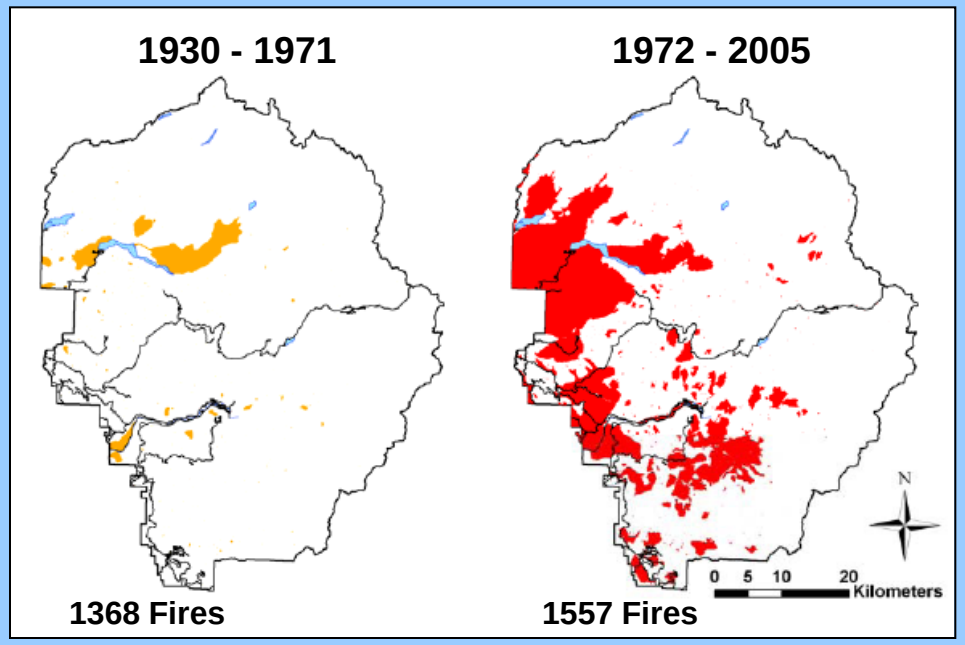
[1] Vast Majority 1844-1889
[2] Vast Majority 1910-1936



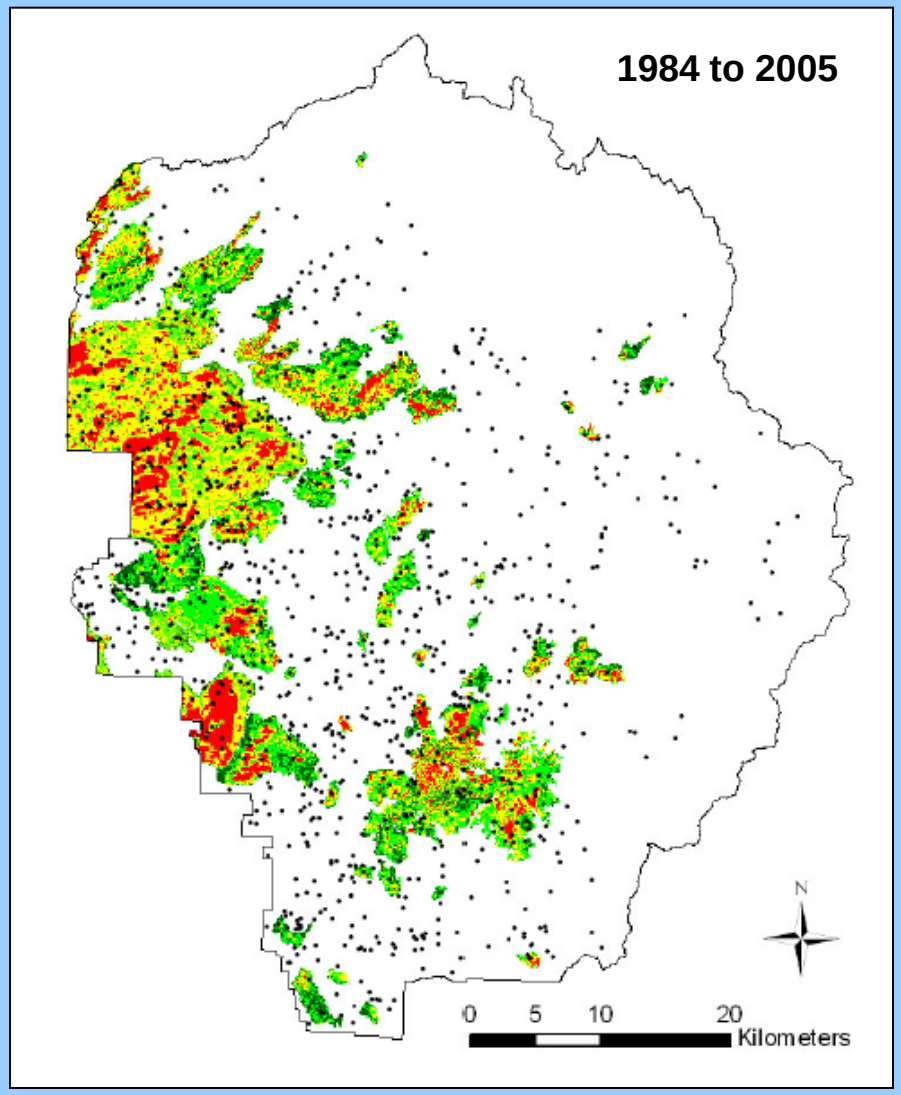
Yosemite National Park



Burn Perimeter Area



Ignitions and Fire Severity



Key Fire Variables:

Ignition Frequency & Periodicity

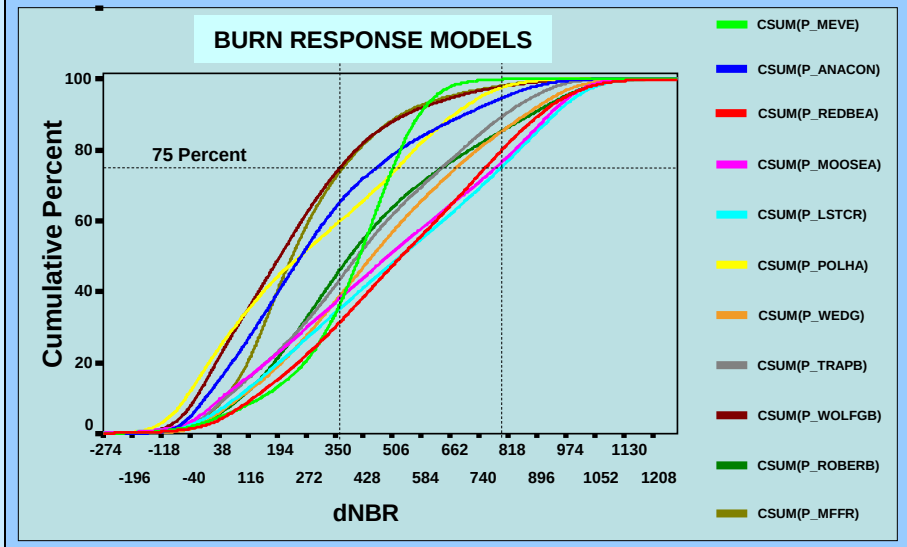
Burn Area & Duration

Severity Frequency

- Continuous and categorical data

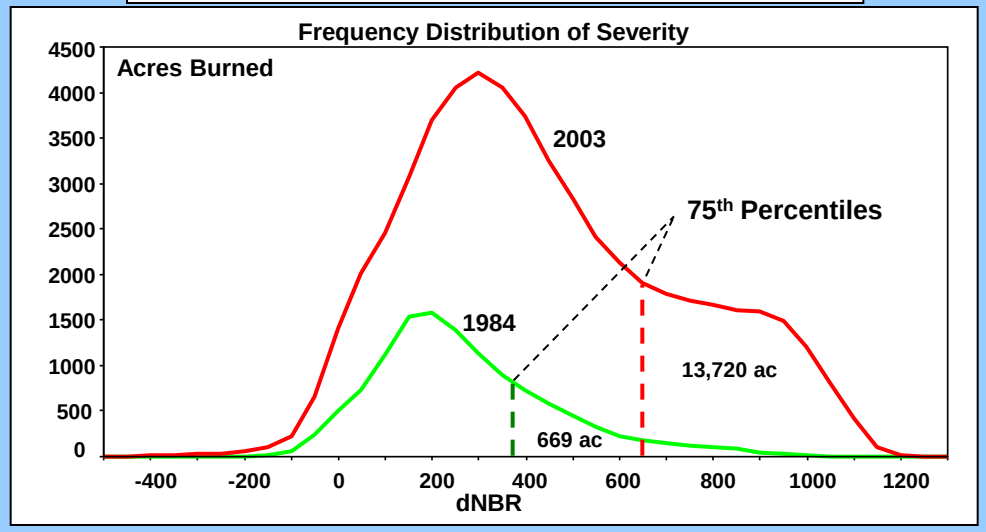
Burn pattern, heterogeneity, and patch dimensions

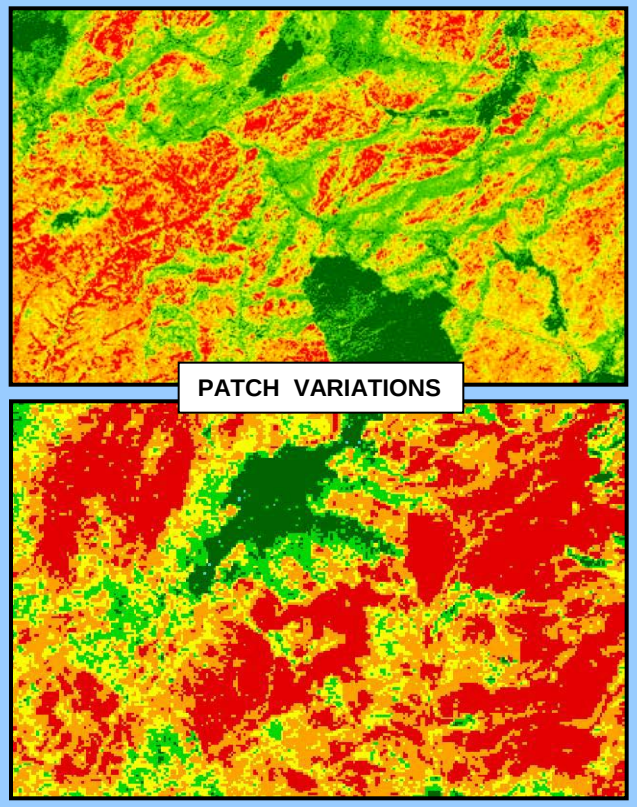
Summarized annually, monthly and by burn



Comparative Severity "Population" Statistics

	AC	dNBR Mean	dNBR 75th Pct.	∑100km²
2003 Fires	54,750	640	439	974
1984 Fires	12,223	372	270	134





Key Climate Variables:

Annual and monthly temperature and precipitation summaries

mean, max and min, growing degree days, and potential evapotranspiration

Indices of Seasonality

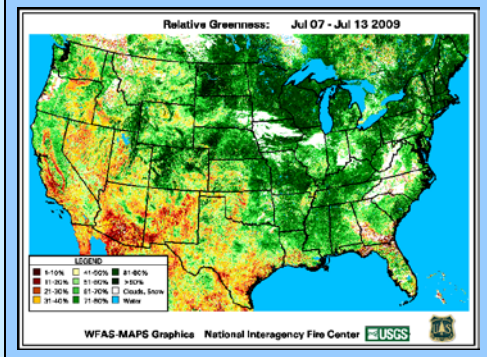
Phenology and Drought Indices and Trends

NDVI Composite Index, Palmer Drought Severity Index, Palmer Z Index, Standardized Precipitation Index, Snow Water Equivalent, Runoff/Stream-flow data

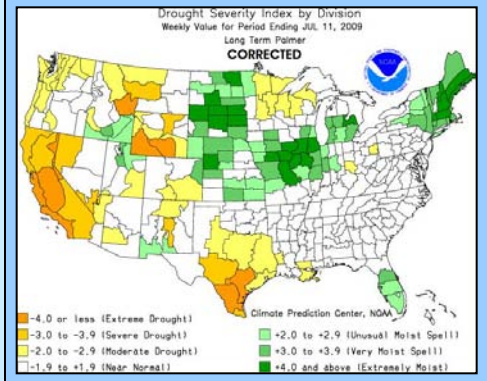
National Fire Danger Rating System (NFDRS), and Wildland Fire Assessment System -- Haines Index & Fuel Moisture

National and North American Lightning Detection Network data

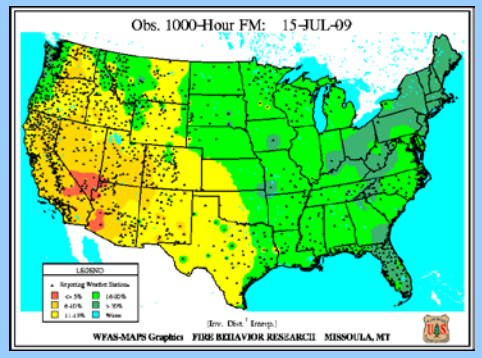
NDVI Composite Index



Palmer Drought Severity



Fuel Moisture



Possible Teleconnection Linkages:

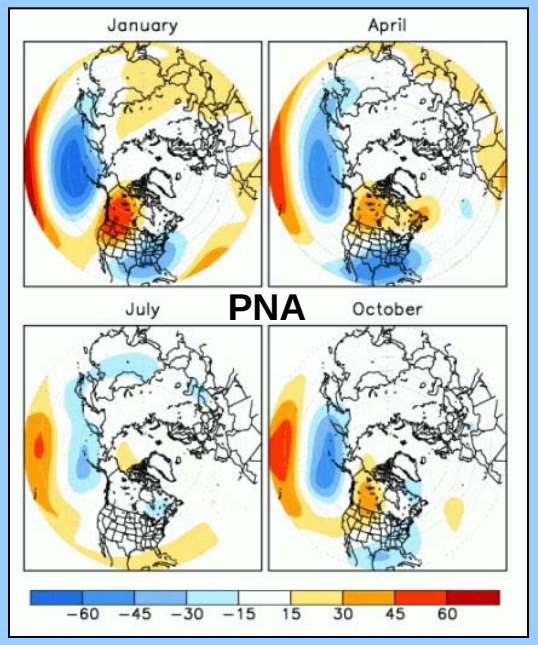
	NPI	PNA	PDO	ENSO
Yukon-Charlie	X	XX	X	
Glacier	x	X	X	x
Yosemite		X	X	XX

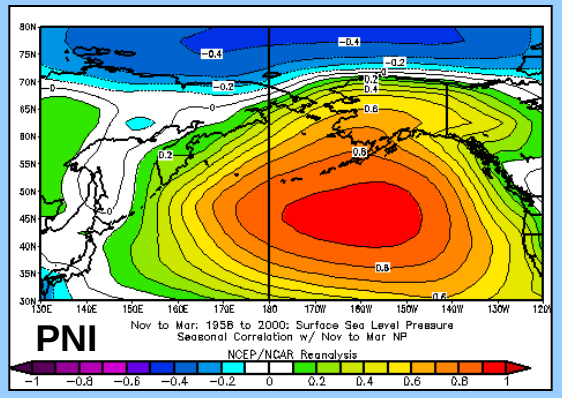
NPI – North Pacific Index, correlated to Aleutian Low Pressure Index (ALPI)

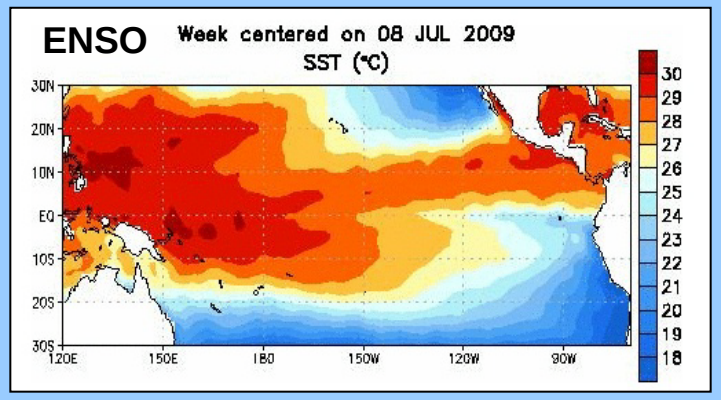
PNA – Pacific / North American teleconnection pattern

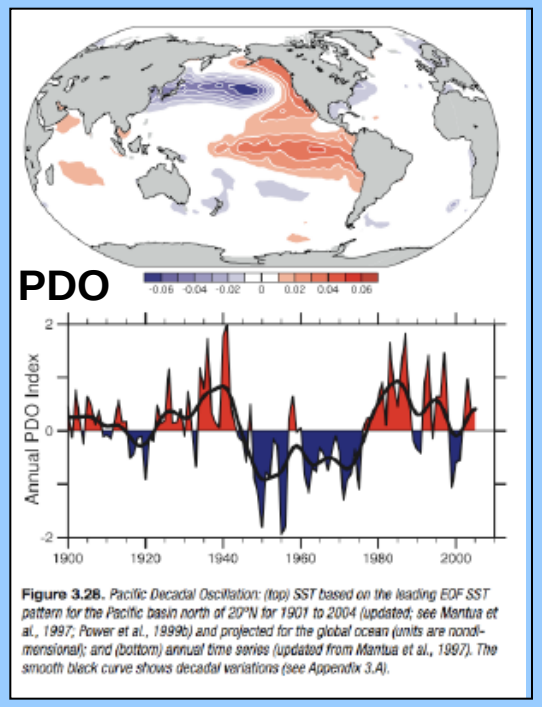
PDO – Pacific Decadal Oscillation

ENSO – El Niño-Southern Oscillation









Key Analyses:

Correlation and Trend analysis over the time series of fire and climate variables

Describe the variation in variables and test for temporal trends within regions

Include characteristics and trends in landscape metrics (heterogeneity) of burn severity

Test whether burn size, periodicity, or composition differ across regions and time intervals

Test hypotheses to understand what climate factors, if any, have influenced burn severity over time, and

Compare these climate and fire associations between regions, looking for rationales of synchrony, asynchrony, or lack of trend.

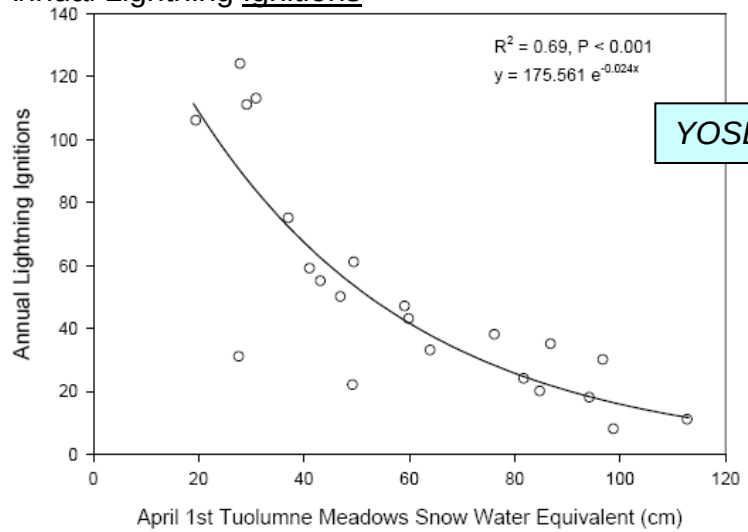
Outcomes:

New statistical approaches and modeling of continuous severity data, as it relates to spatial fire dynamics and climatic influences

Better understanding of factors that may enhance wildfire frequency, size or severity , e.g. drought and seasonal changes. As well as factors that may decrease wildfires, e.g. increased moisture, or structural alterations and cumulative fuel consumption from past fires.

This understanding, then, can lead to better projections of future burning potential, and conditions expected from future climate forecasts.

Annual Lightning Ignitions



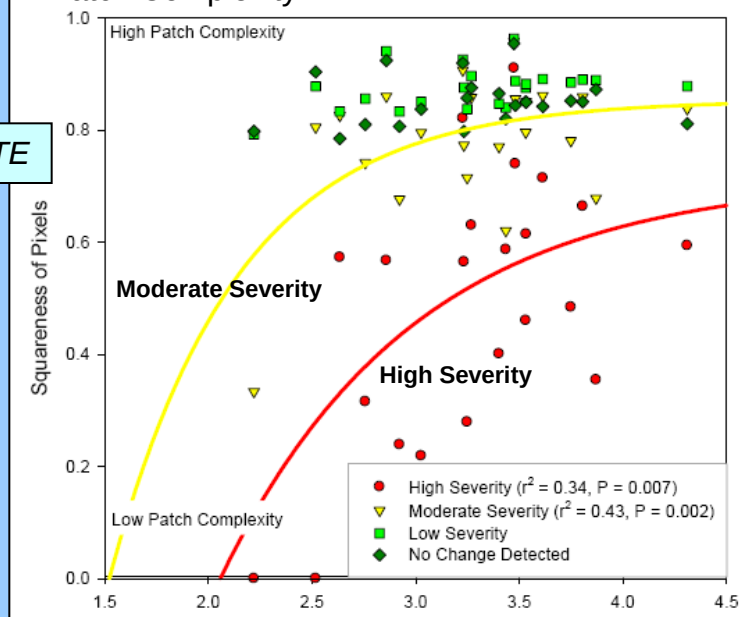
April 1st Snow Water Equivalent

Fig. 17. Lightning ignitions and April 1st snow water equivalent. The number of lightning ignitions of all sizes for each year from 1984 to 2005 and the April 1st snow water equivalent for that year are shown.

Lutz 2008

YOSEMITE

Patch Complexity



Log10 Total Annual Area Burned

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The End

http://nrmsc.usgs.gov ...../science/fire/CBI ...../image/tid/76 (Image Gallery Fire Science)