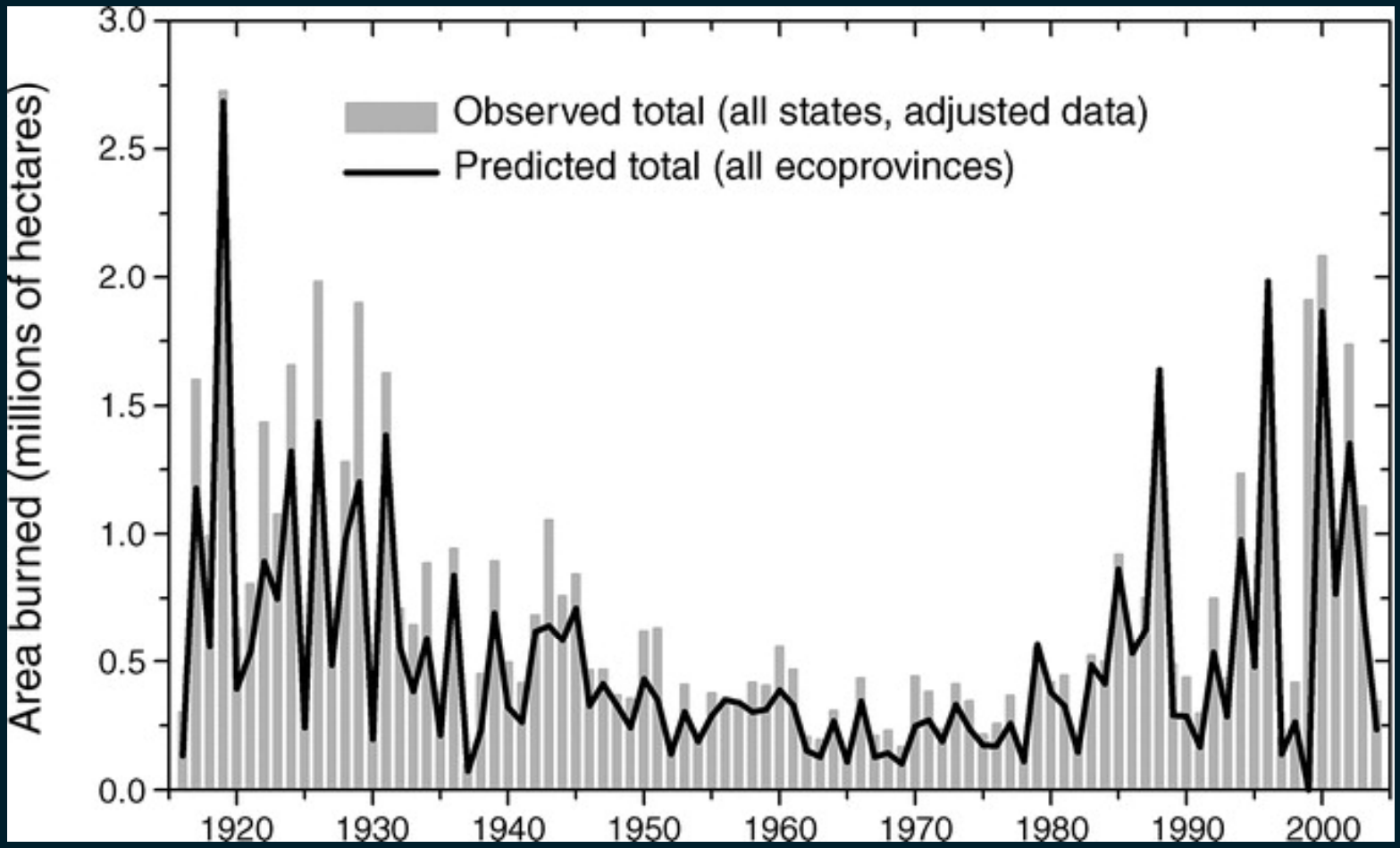
Observed Changes in Fire Danger Across the Western United States

Dr. John Abatzoglou
University of Idaho
Department of Geography

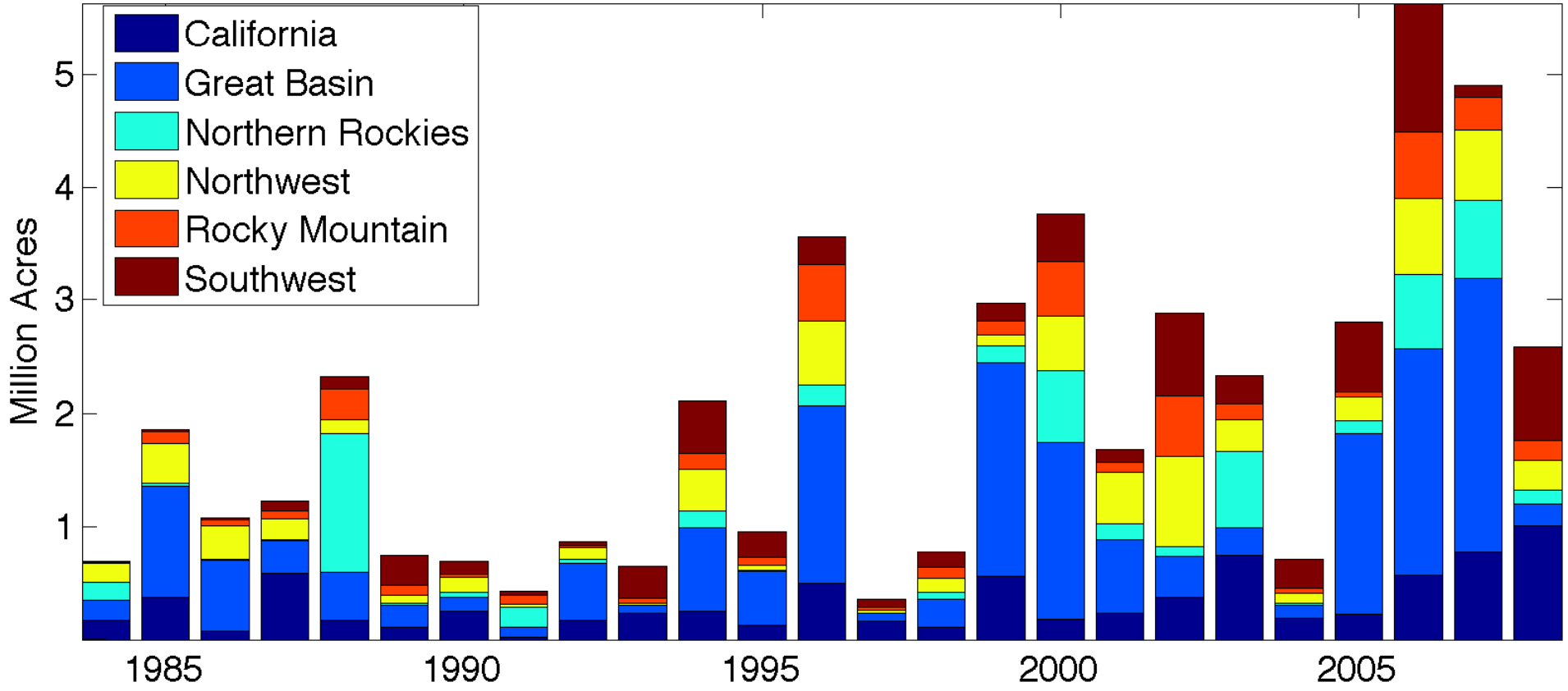
27 July 2006
MODIS composite

Western United States Area Burned (1916-2003)



Littell et al. (2009)

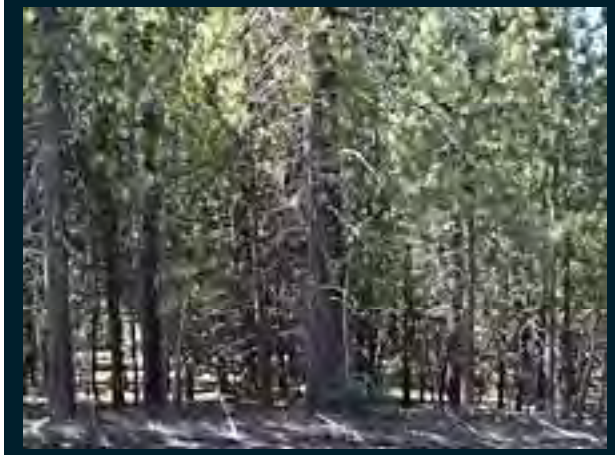
Western United States Area Burned (1984-2008)



Fire Atlas: MTBS Large Fire (>1000ac) 1984-2008

Hypotheses for Changes in Western Wildfire

Fire Suppression and Fuel Buildup



…accumulation of dead fuel and overstocked forests …

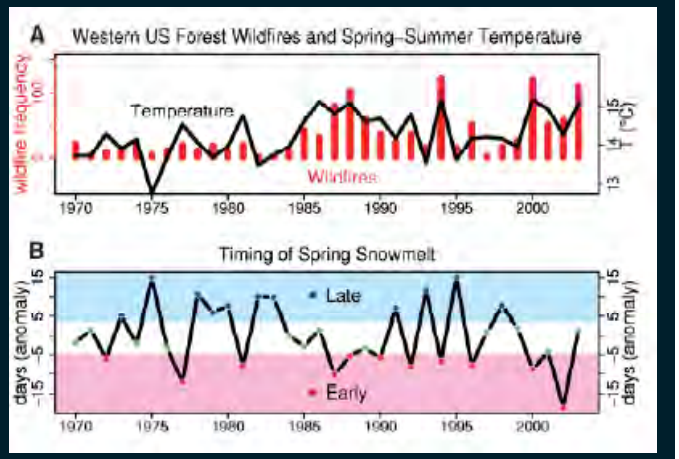
Covington and Moore, 1994

Fire Management Practices

…increased fire use and back-burning…

Kolden and Weisberg, 2007
Kolden and Brown, forthcoming

Climate

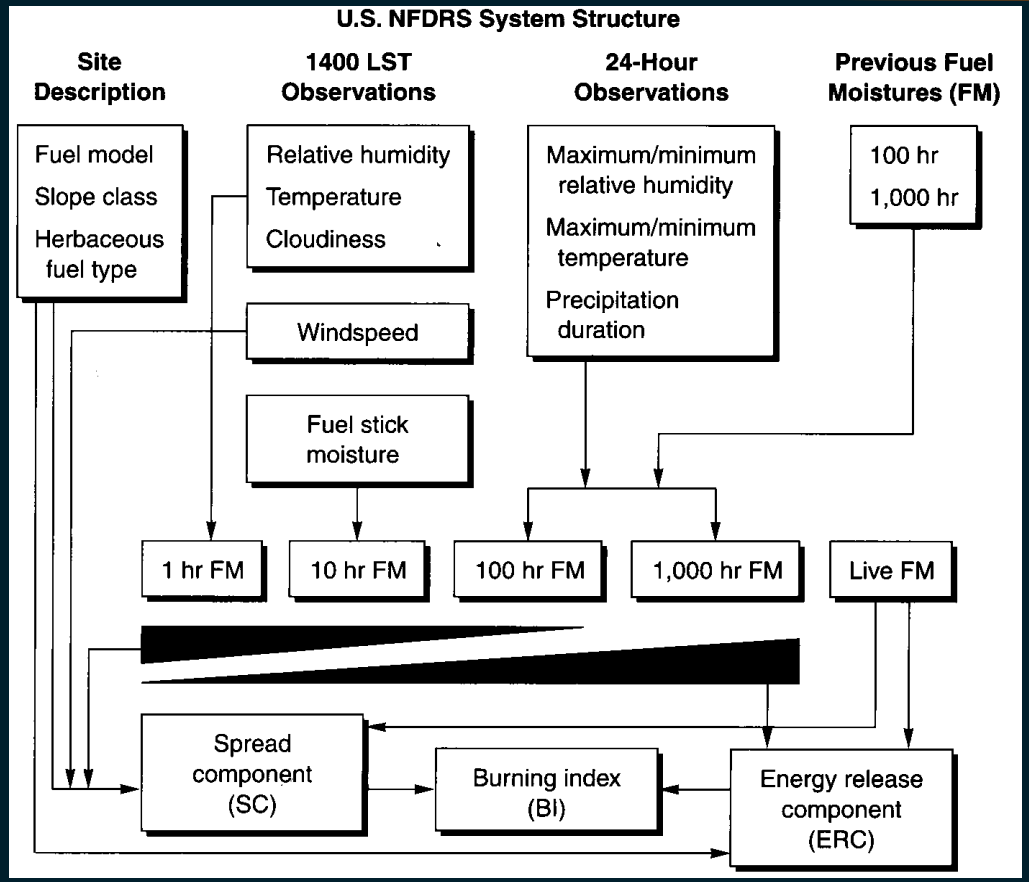


*…increased spring-summer **temperature** and earlier snowmelt…*

Westerling et al., 2006

Fire Danger

NFDRS: Objective Fire Danger Indices used in the U.S.



Input Variables

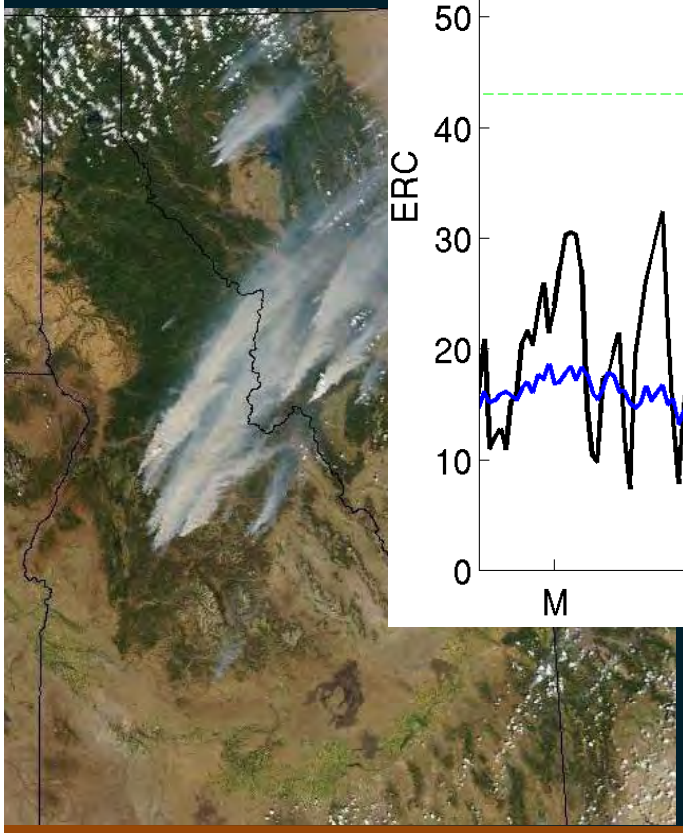
Fuel Model Matrix

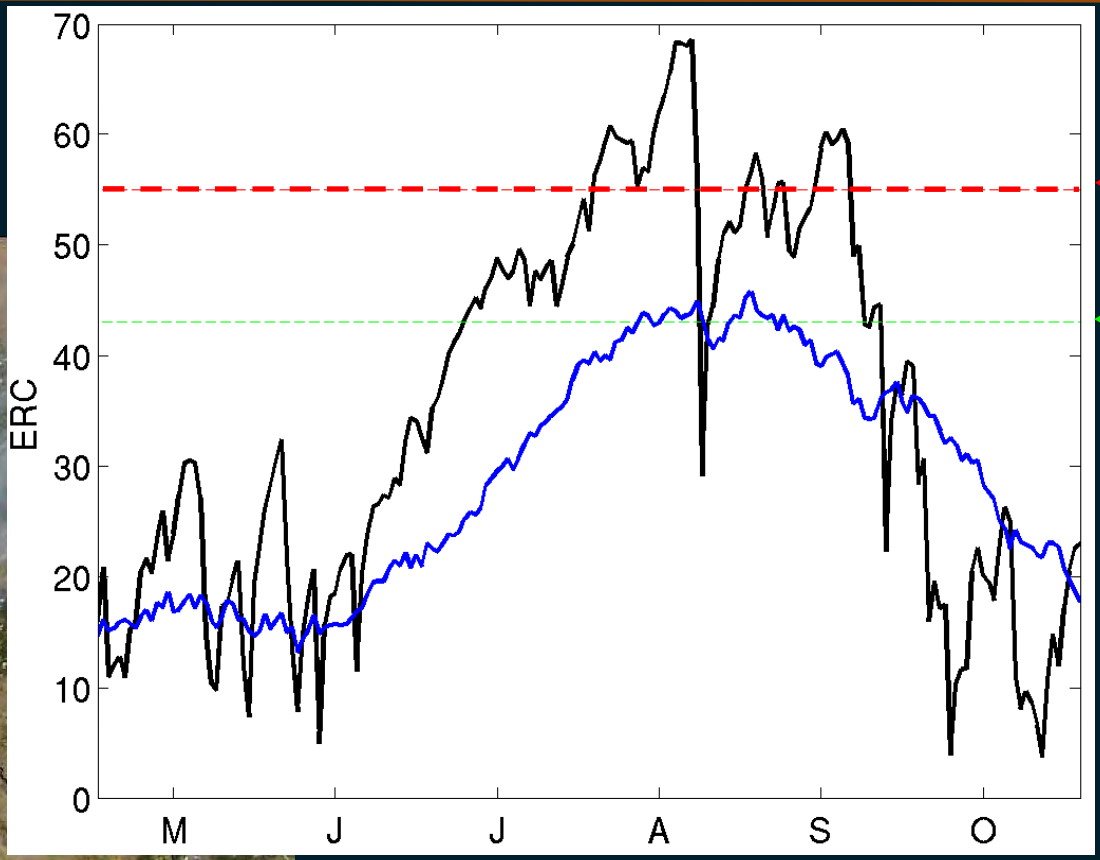
Fire Danger Indices

Energy Release Component (ERC: BTU/m^2 of flaming front)

Hybrid climate-weather build-up index: fuel moisture/fire intensity proxy

Payette NF, 2007



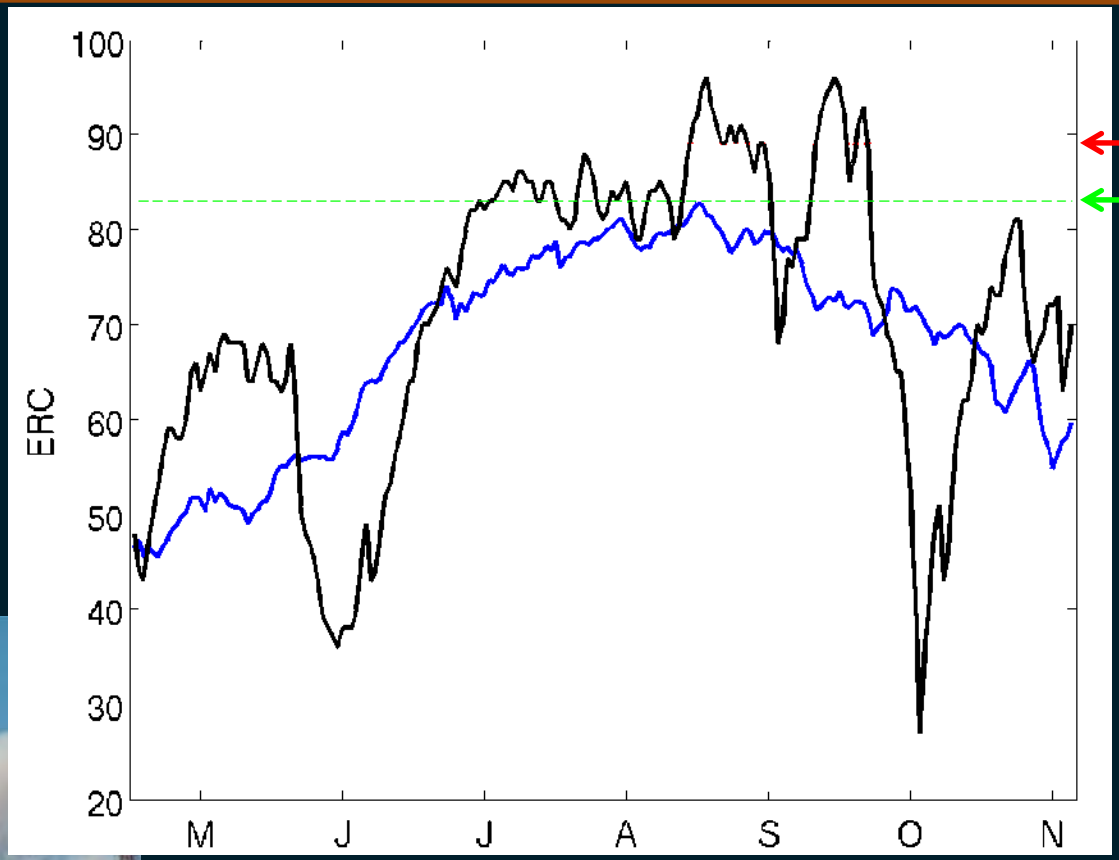


Extreme (97th)

High(90th)

Black: 2007
Blue: Climatology

Angeles NF, 2009

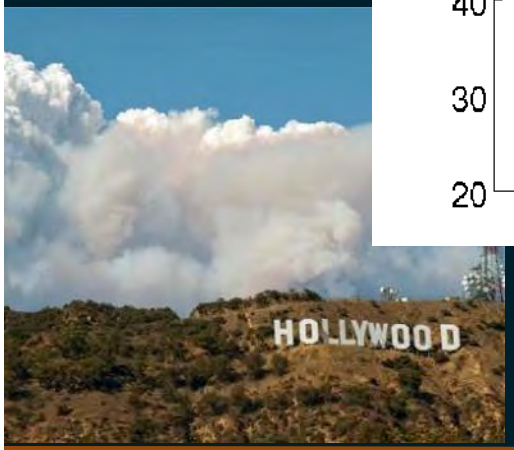


Extreme (97th)

High(90th)

Black: 2009

Blue: Climatology



Primary Research Questions

Driving Question: Has fire danger and the potential for large fires increased over the past three decades?

- What "added-value" do fire danger metrics contribute to regional climate-fire relationships?
- Can we attribute observed changes in fire danger to anthropogenic forcing?

Daily Gridded Meteorology

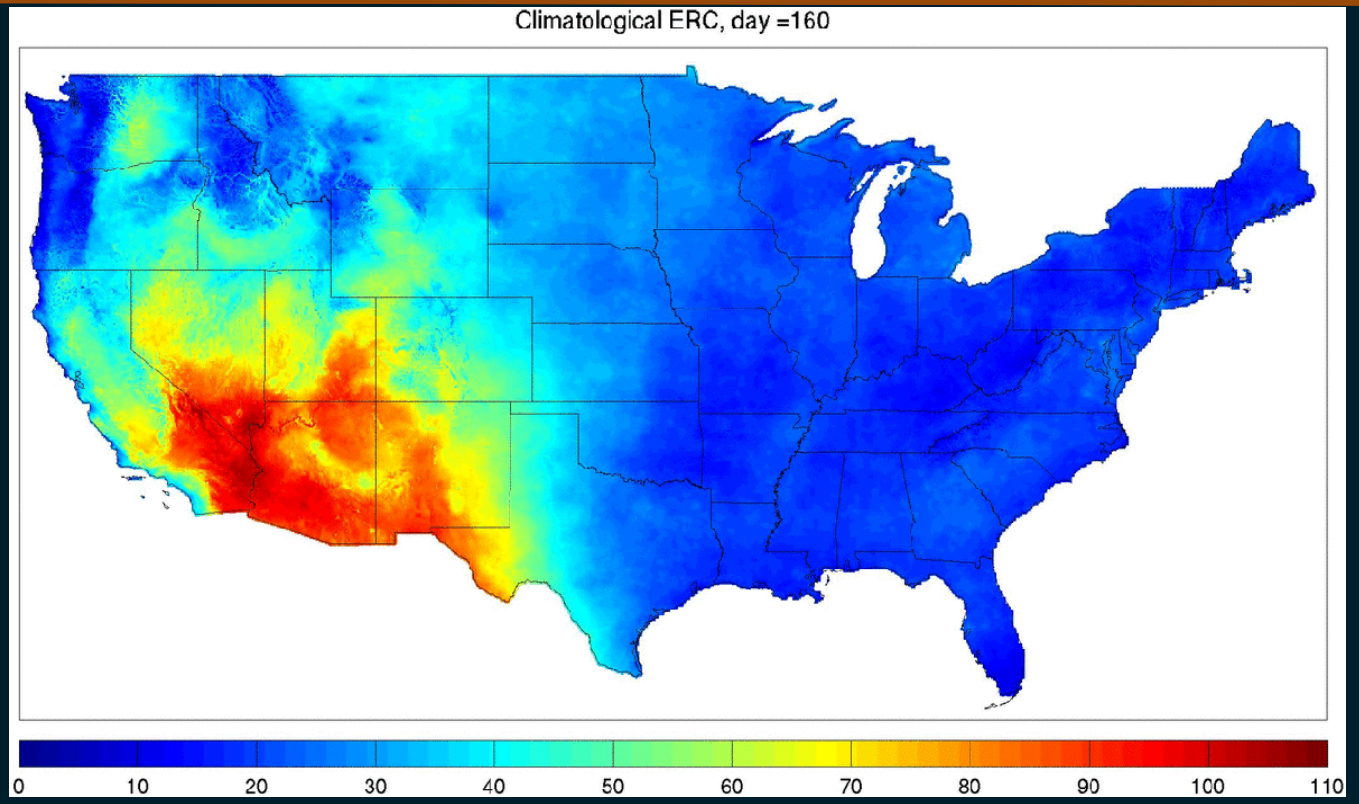
Motivation

- Lack of long-term high-quality dense observational network across most of the western United States
- Data quality and siting problems of existing network
- Existing gridded meteorological datasets lack key variables
- Mesoscale reanalyses too coarse (30km) and contain biases

Solution

- NLDAS-2 gridded 1/8th degree meteorological data
- Bias correct temperature and precipitation w/4-km res PRISM
- Relative humidity adjusted (q & temperature)

Daily Gridded Meteorology
4-km Daily 1979-2010



Products

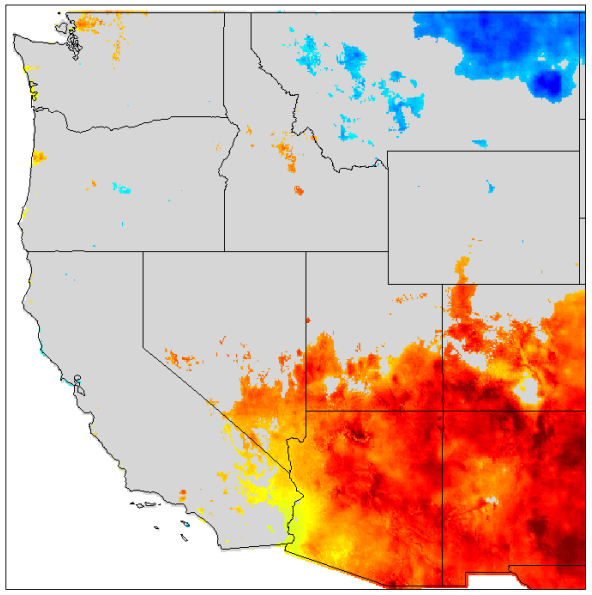
Variables: TMAX/TMIN RHMAX/MIN, PPT, PPT DURATION, INSOLATION, WIND VELOCITY

Validation (USHCN)

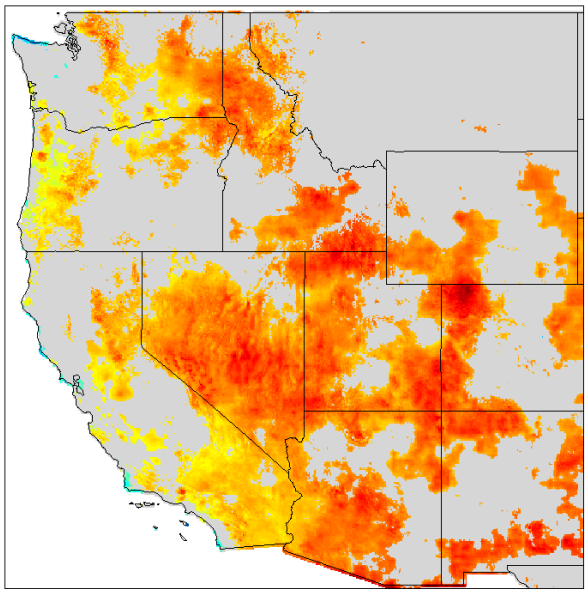
- Daily TMAX/TMIN (r = .967)
- Daily Precipitation (r=.765)

Linear Trends in Seasonal ERC (1979-2010 per decade)

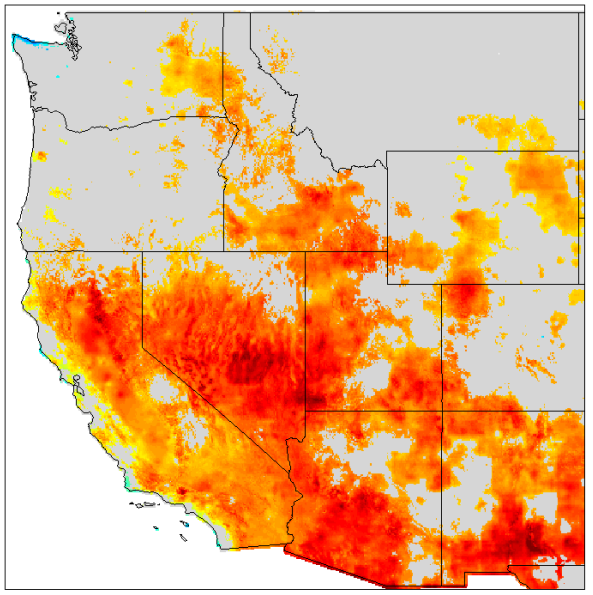
Linear Trend 1979-2010 in May-June ERC

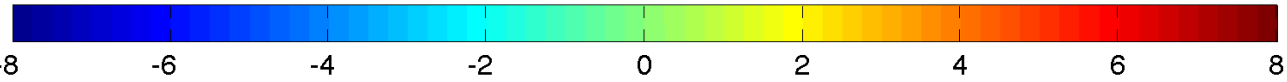


Linear Trend 1979-2010 in Jul-Aug ERC

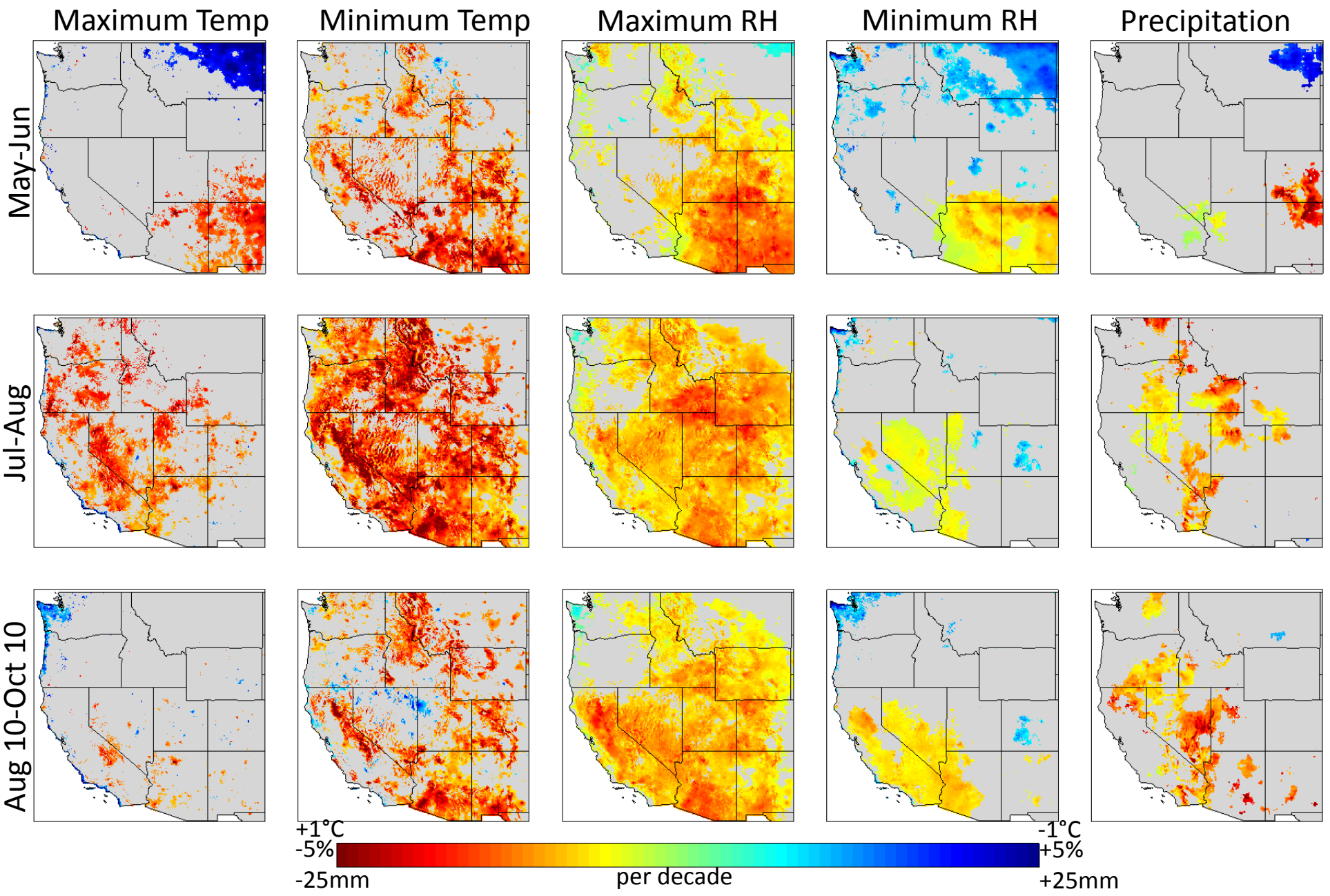


Linear Trend 1979-2010 in Aug-10 Oct ERC





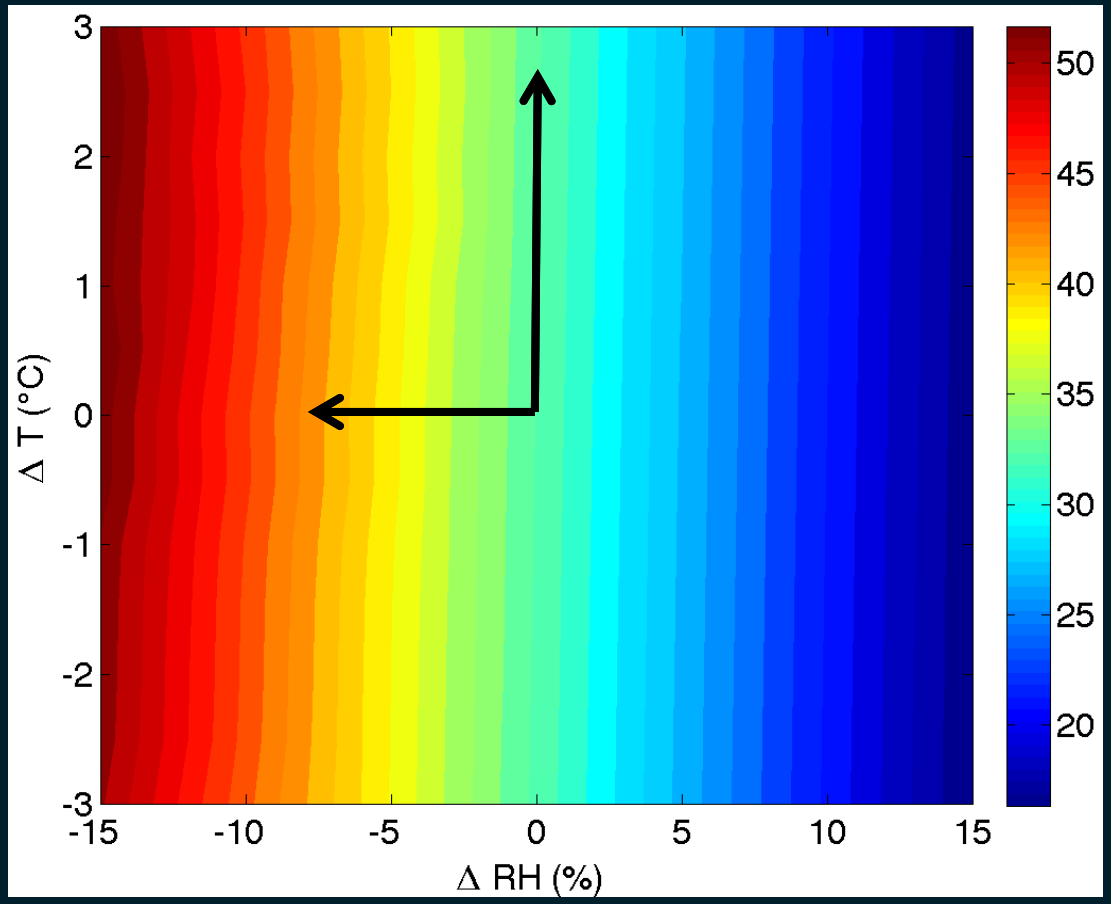
Shaded = Statistical Significant Trend at 95 % C.I.


Maximum Temp
Minimum Temp
Maximum RH
Minimum RH
Precipitation
May-Jun
Jul-Aug
Aug 10-Oct 10
+1°C
-5%
-25mm
per decade
-1°C
+5%
+25mm

Sensitivity of Fuel Moisture to Meteorology

Jul 20-Aug 15 ERC Nez Perce NF, Idaho, 1650m

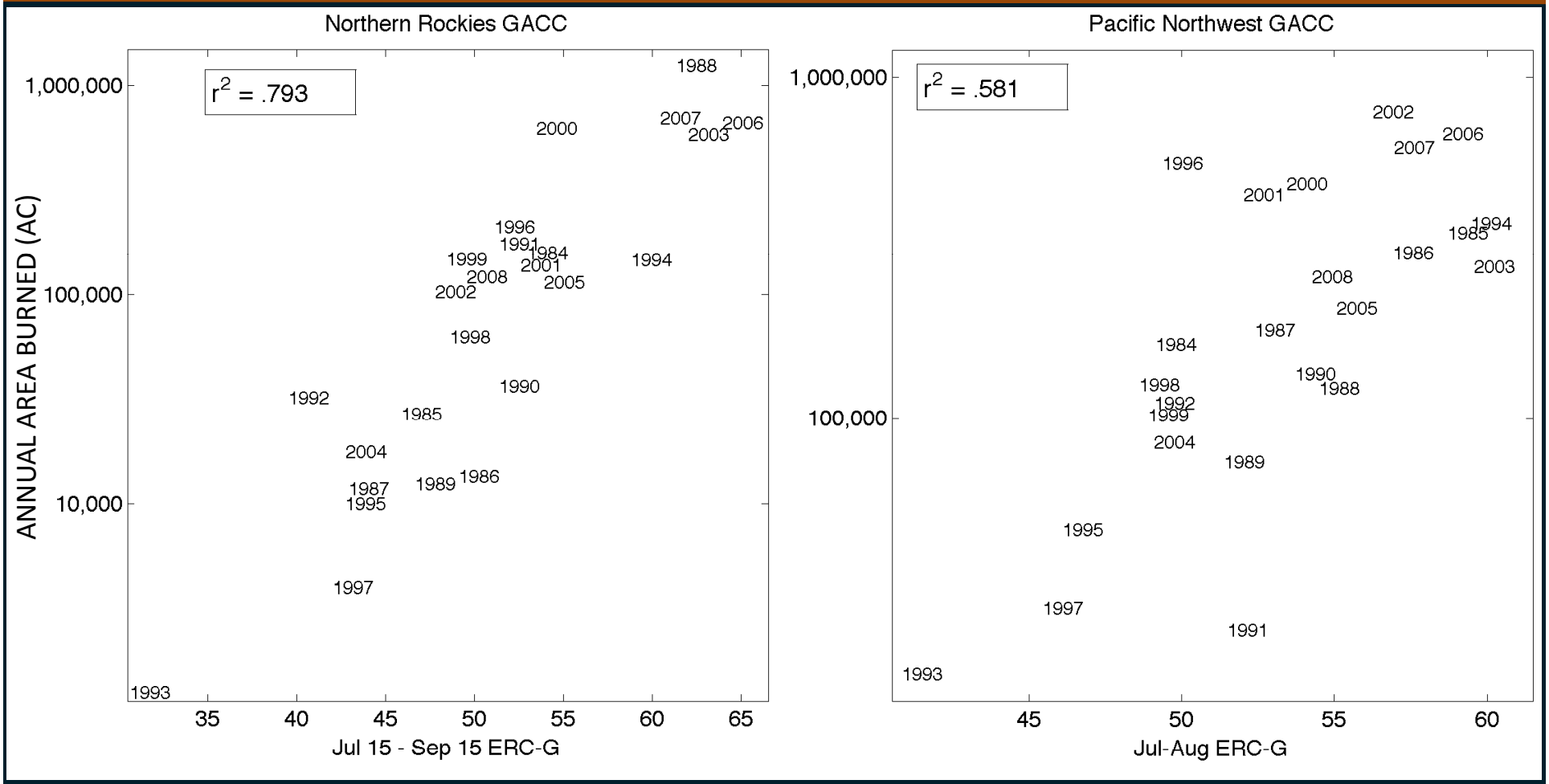
Strong Sensitivity to RH



Nominal Sensitivity to Temperature

Limited overnight relative humidity recover enables nighttime burning and further depletes fuel moisture to enhance fire activity during the subsequent day.

Value Added for Fire Danger Indices
ERC-Area Burned Relationship



Westwide Area Burned r^2 = .522

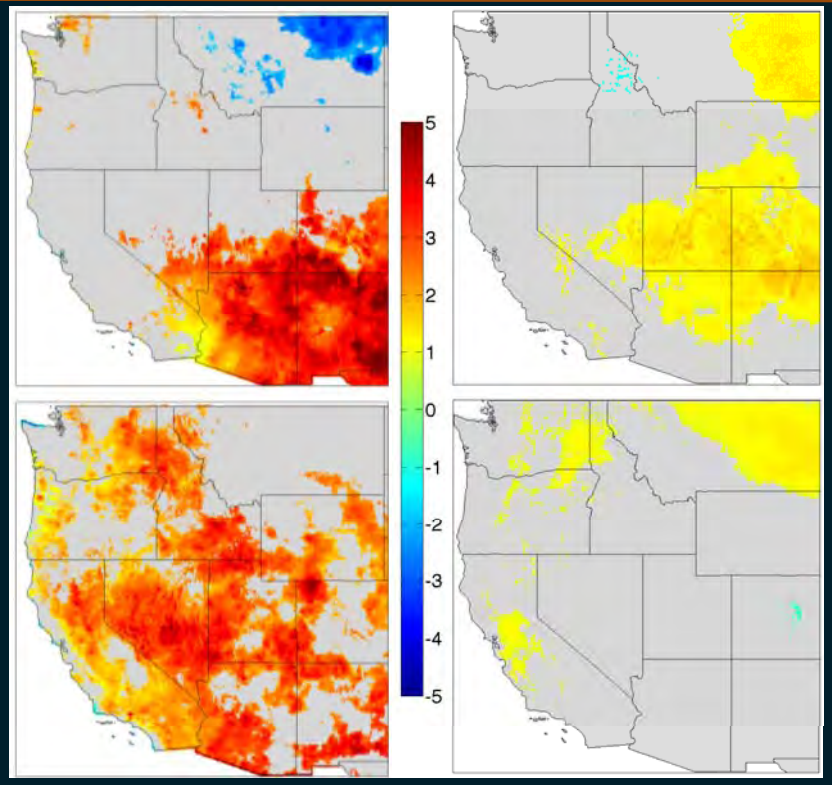
Detection and Attribution

Comparing Observed and Modeled Changes

Observed Trends 1979-2010

ERC/decade

Shaded areas where observations show trend significant at 95th confidence level



Ensemble Mean Trend 1970-1999

Shaded areas where >50% of GCMs show trend significant at 90th confidence level

Similar to observed trends in direction of change/seasonality

- Observed pace of change exceeds model predictions (esp. in SW)
- Observed trends in NW and Northern Rockies close to what is modeled

Summary Points

Widespread increases in fire danger have been observed

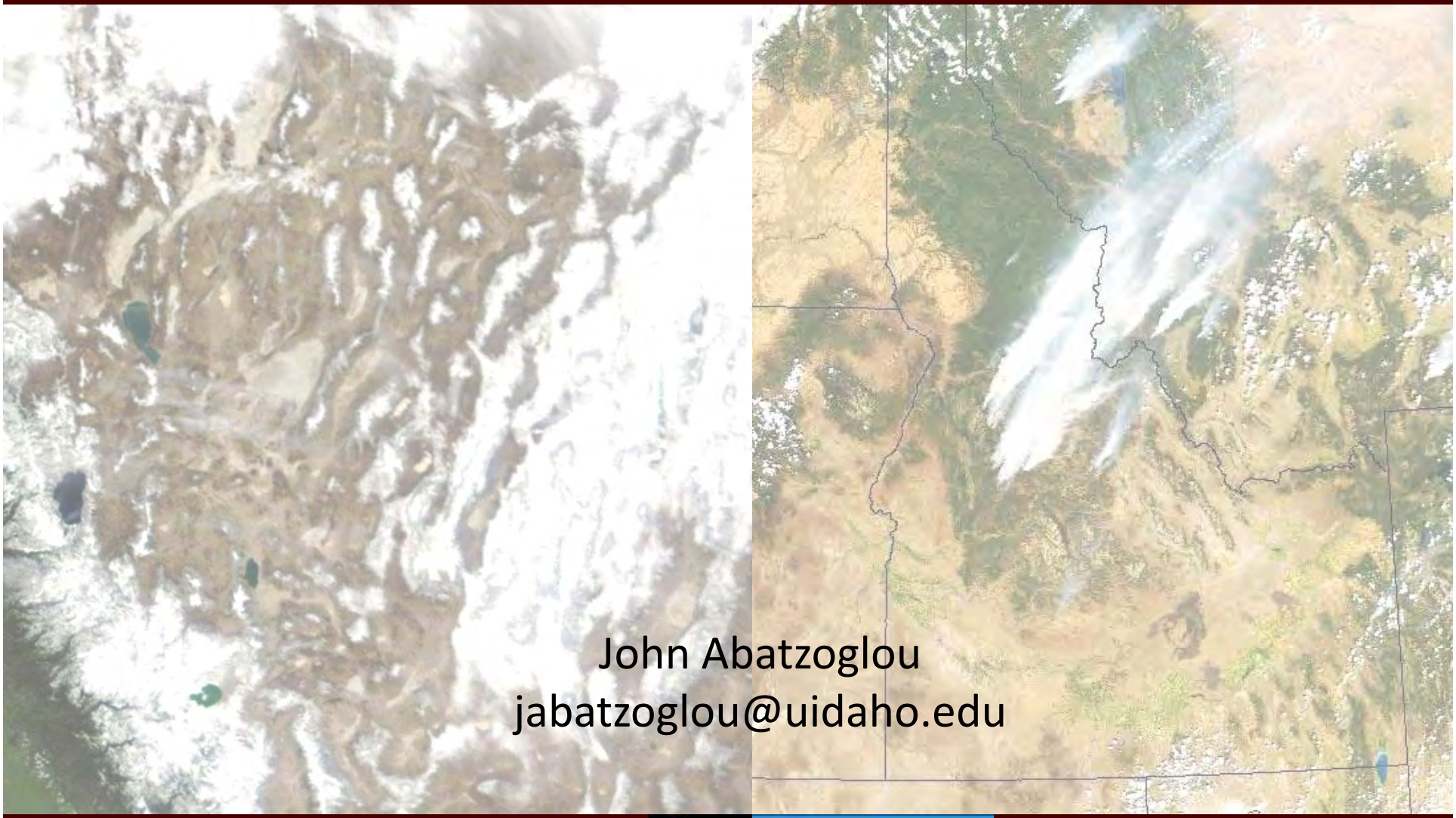
- Particularly pronounced in desert SW (Weiss et al., 2009)
- Lack of overnight relative humidity recovery associated with warming/drying implicated (increased VPD)

Strong relationships between fire danger and area burned

- Processed-based understanding of climate-fire relationships
- Alternative means to contextualize the role of temperature

Trends are broadly consistent with anthropogenic forcing

- Implicates role of climate change in increased western wildfire
- Rate of change in the SW suggests alignment of anthropogenic and natural variability



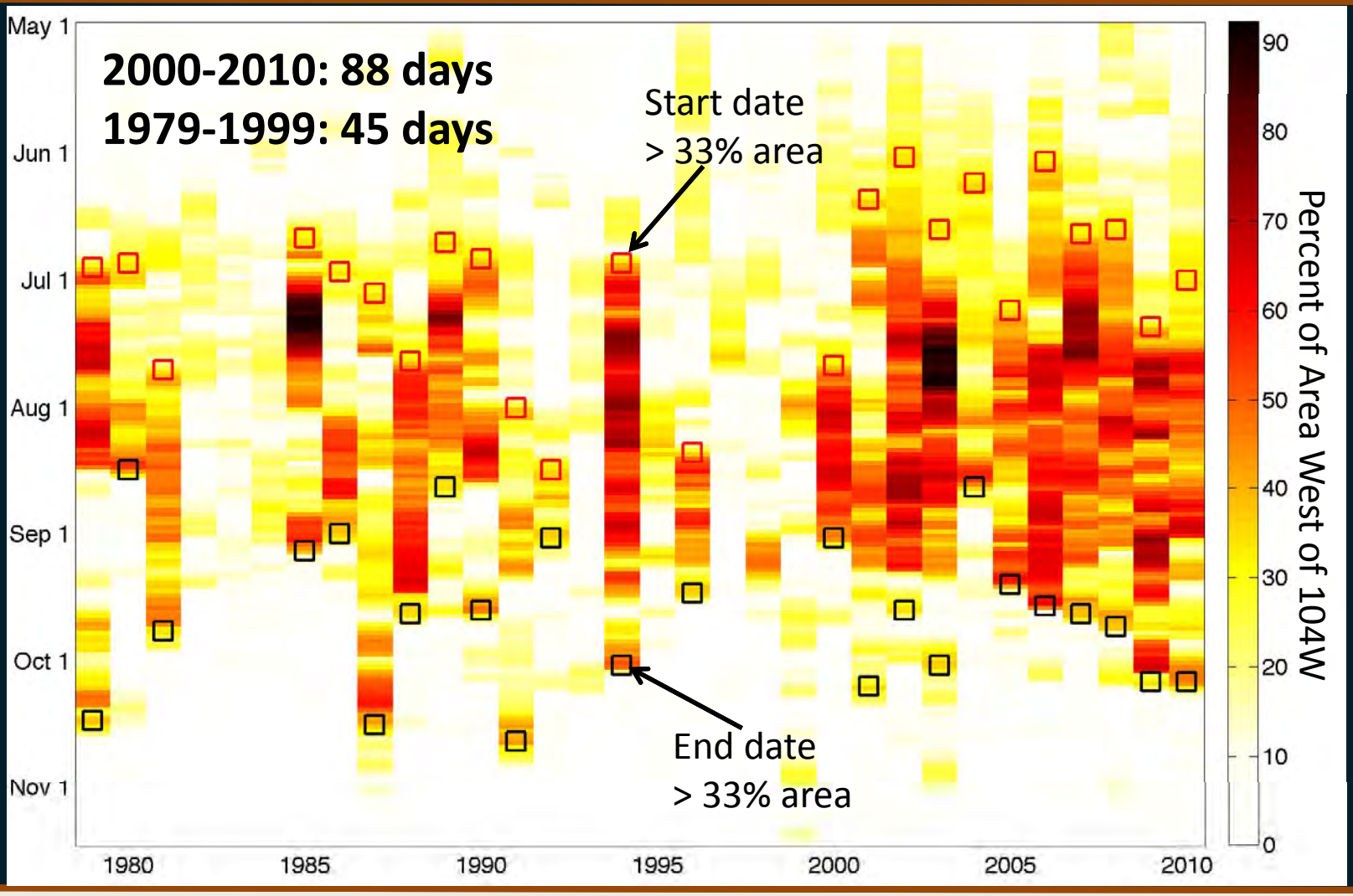
John Abatzoglou
jabatzoglou@uidaho.edu

University of Idaho

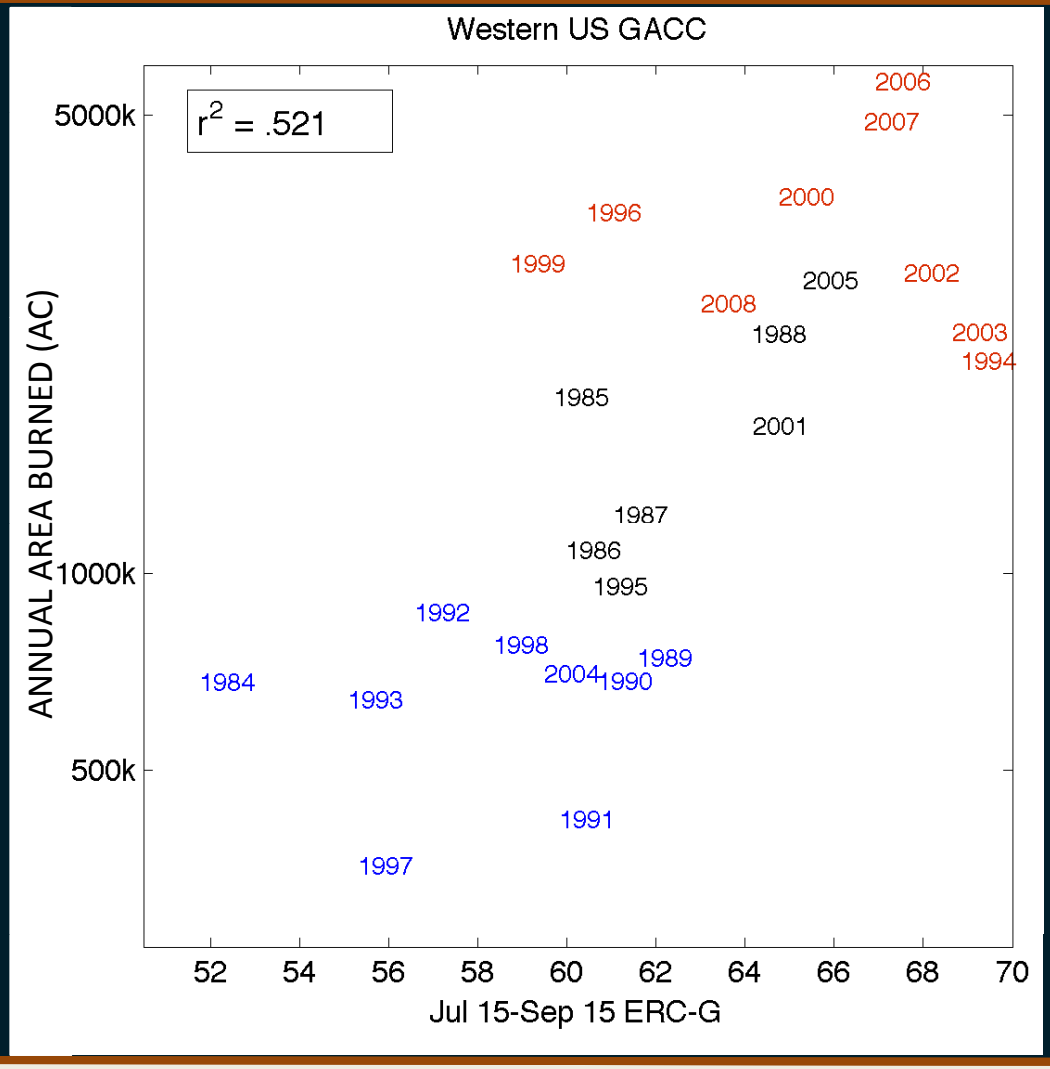
Joint Fire Science Program

NSF EPSCoR IN IDAHO

Western US Large-Fire Potential Area



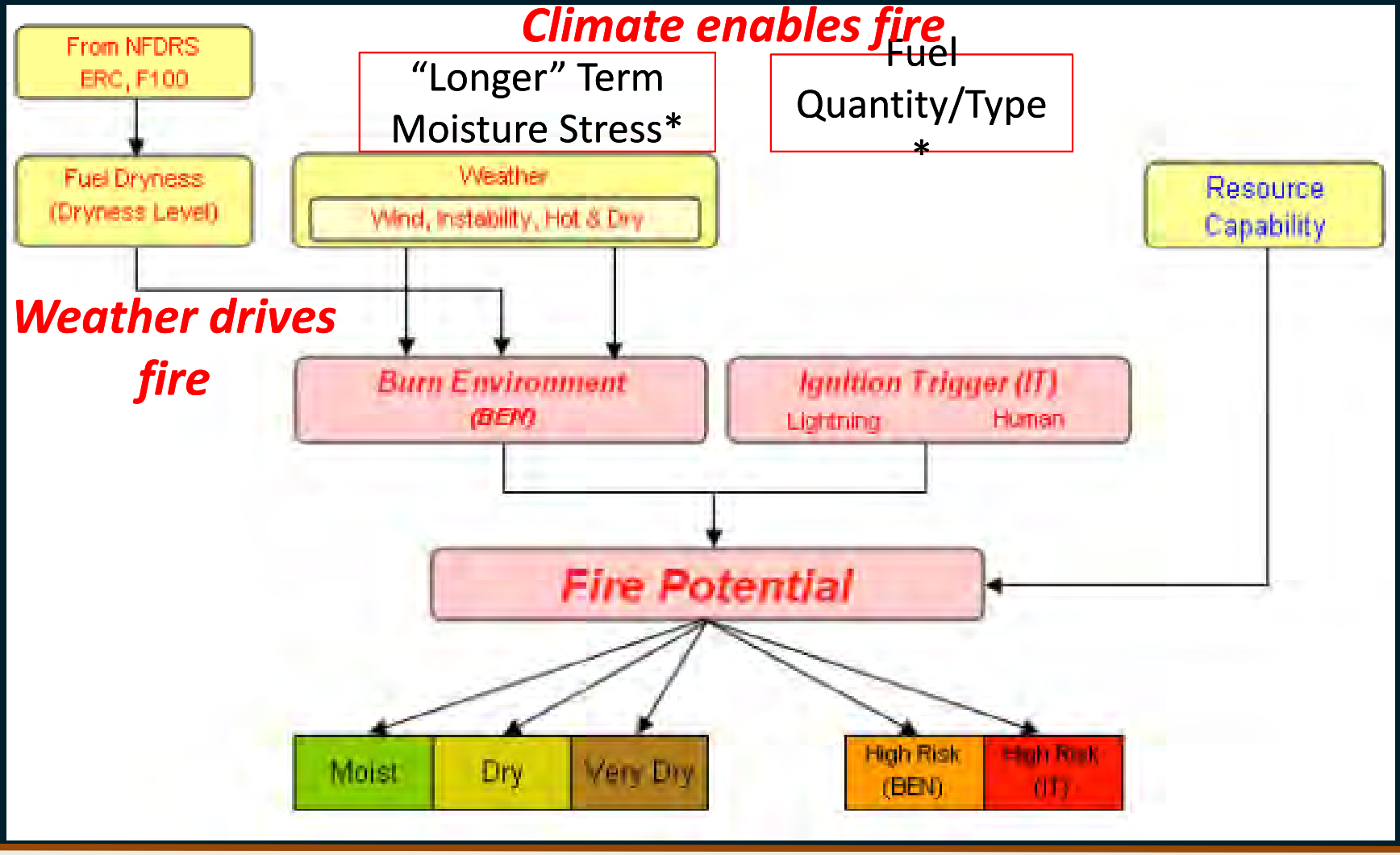
ERC-Area Burned Relationship



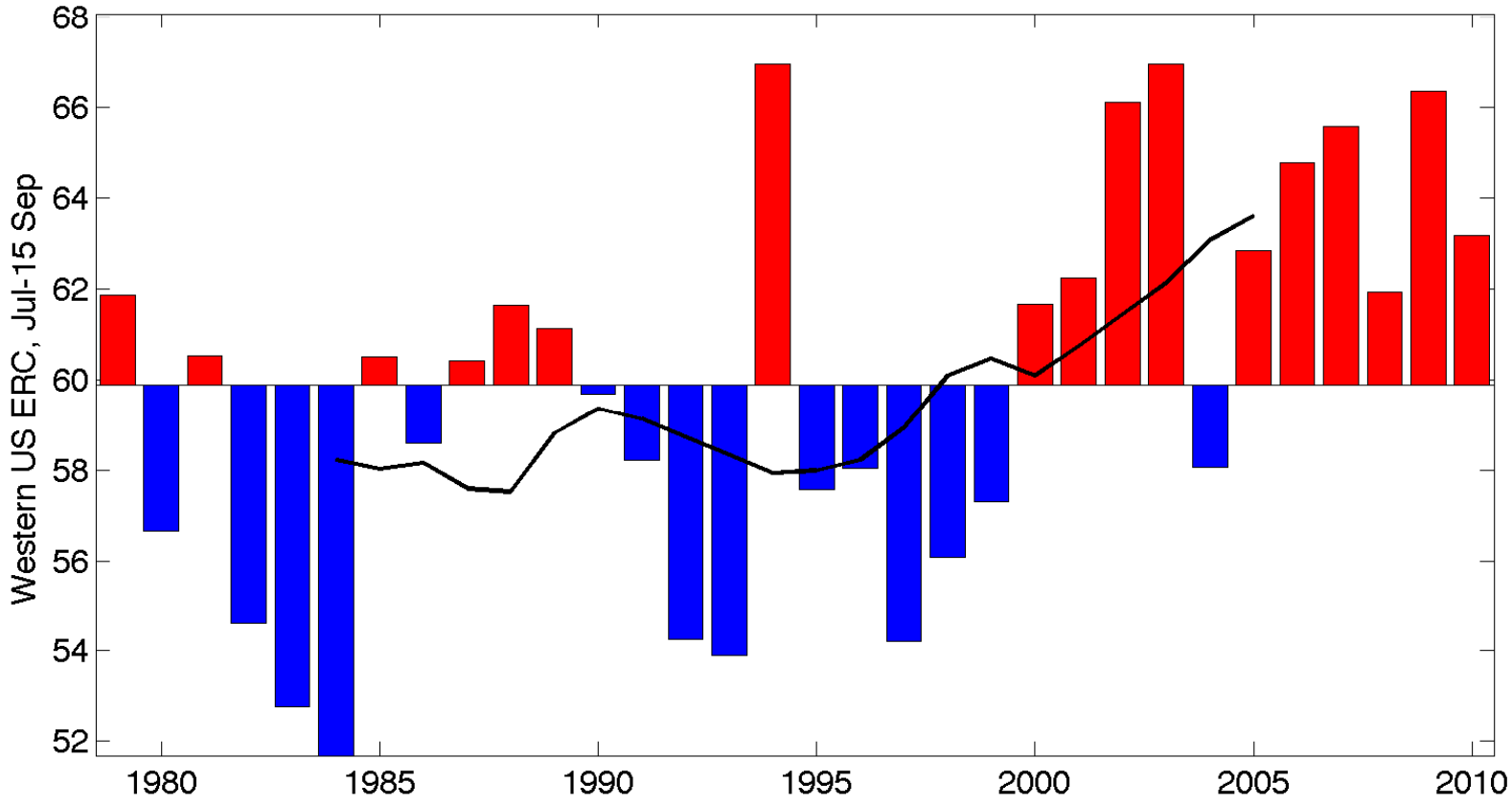
RED: At least 5 of the 6 GACC reported above normal fire activity (burned area)

BLUE: At least 5 of the 6 GACC reported below normal fire activity

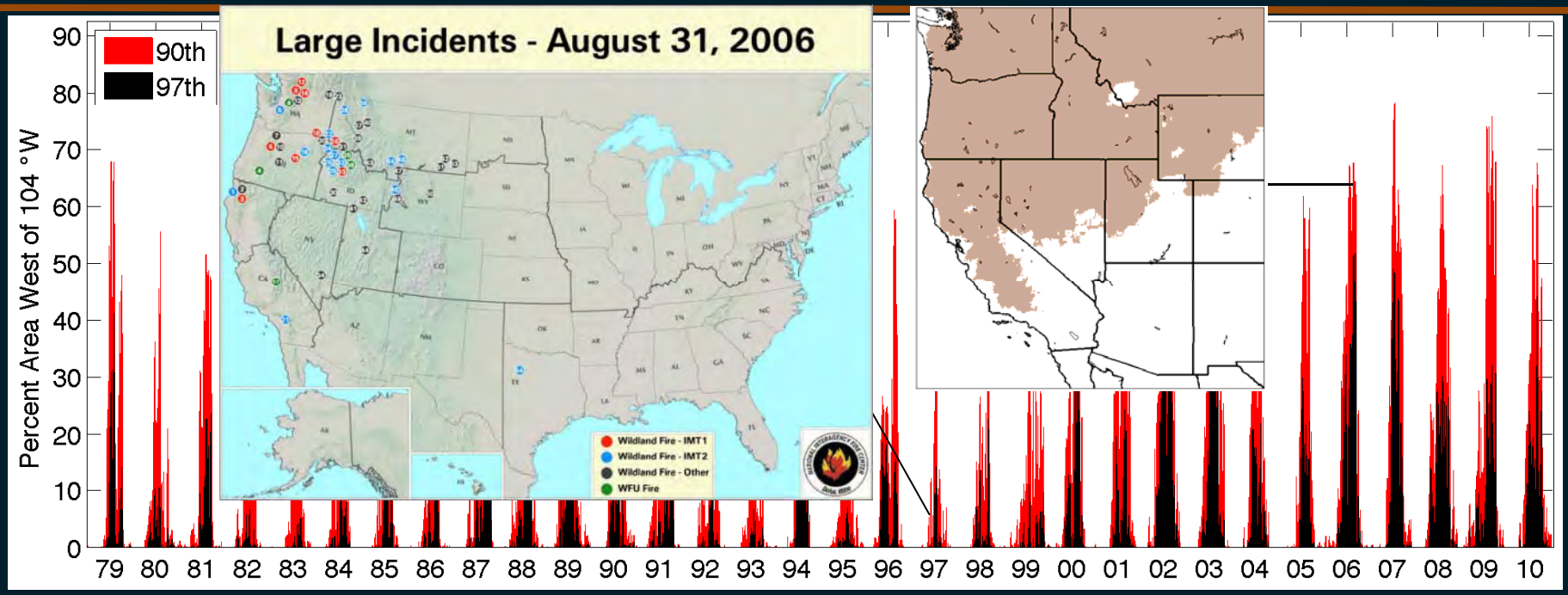
Predictive Services: Significant Fire Potential Model



Western US ERC
Jul 1 to Sep 15



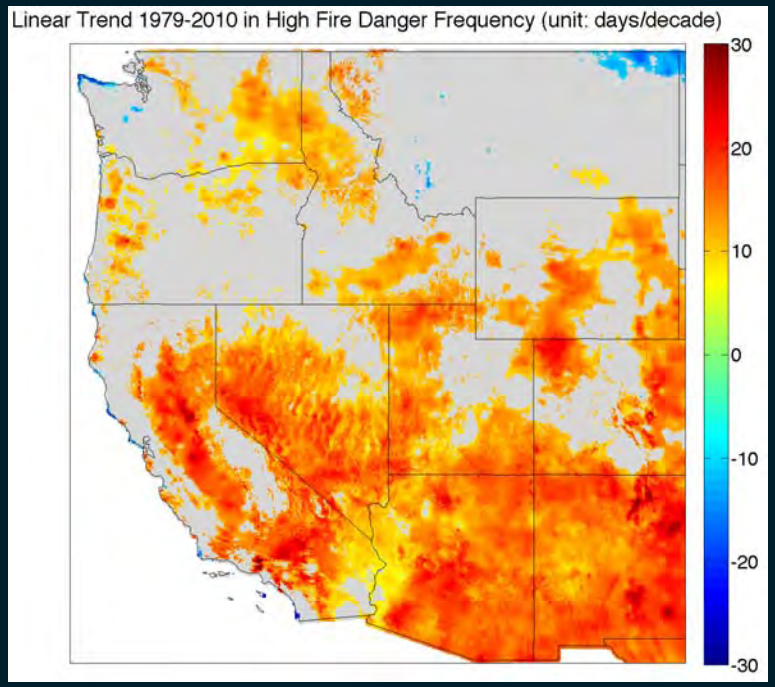
Synchronous Fire Danger



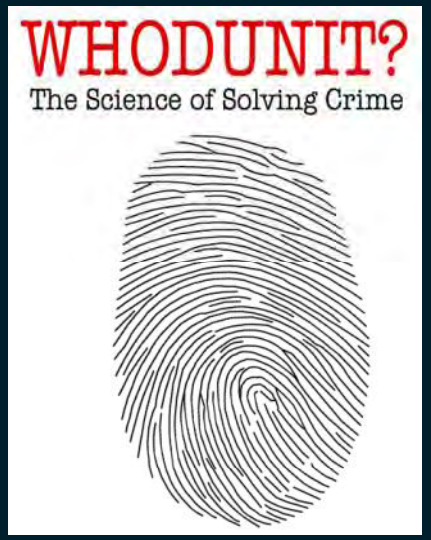
- Synchronous risk from a suppression perspective
  -Isolated/local risk = more successful suppression
  -Synchronous/west-wide risk = less successful
- Increase in synchronous risk across the West since 2000

Changes and its Causes

Detection: demonstrating that a signal is statistically significant from background climate variability.



Attribution: demonstrating a signal is consistent with a given forcing mechanisms.



- *Full D/A Study requires null runs, etc.*
- *Signal: Statistically significant trends*
- *Noise: Interannual climate variability*