Will Climate Change Increase the Occurrence of Very Large Fires in the Northwestern United States?

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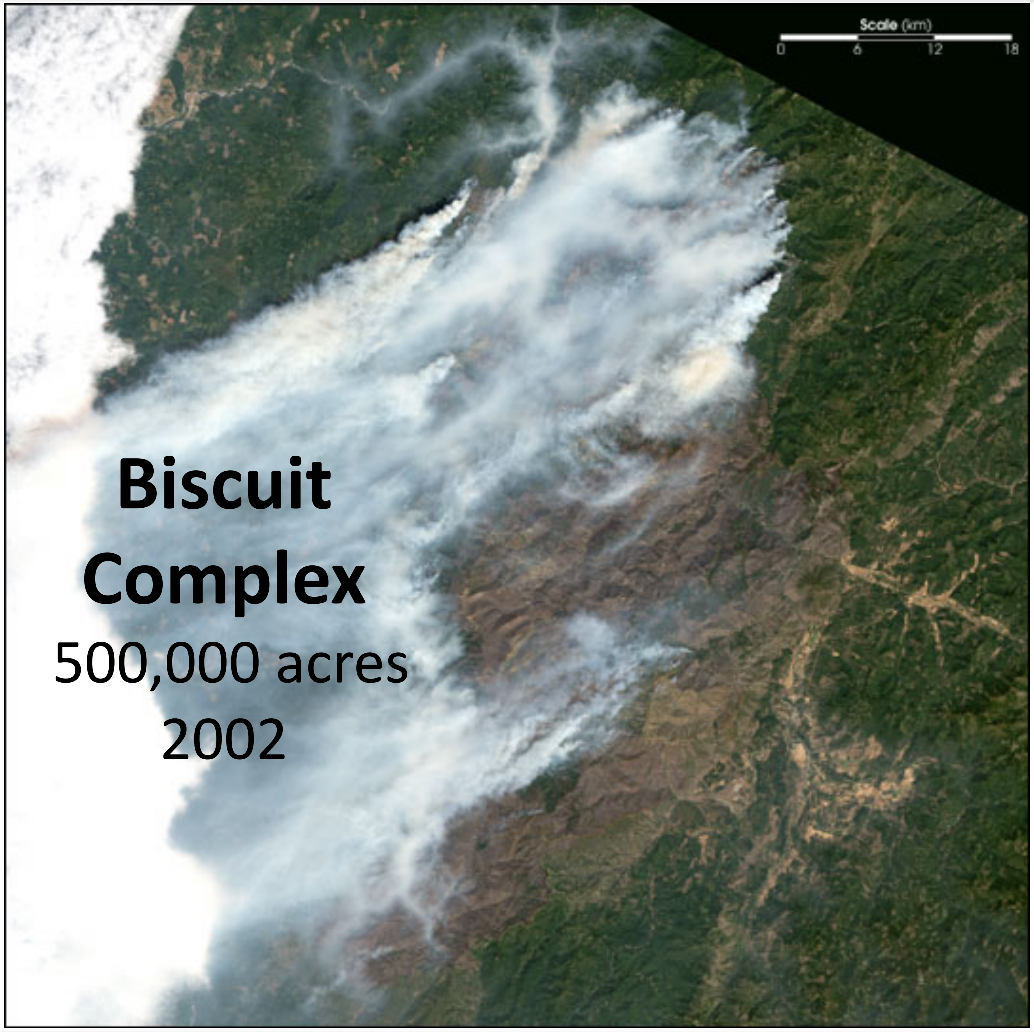
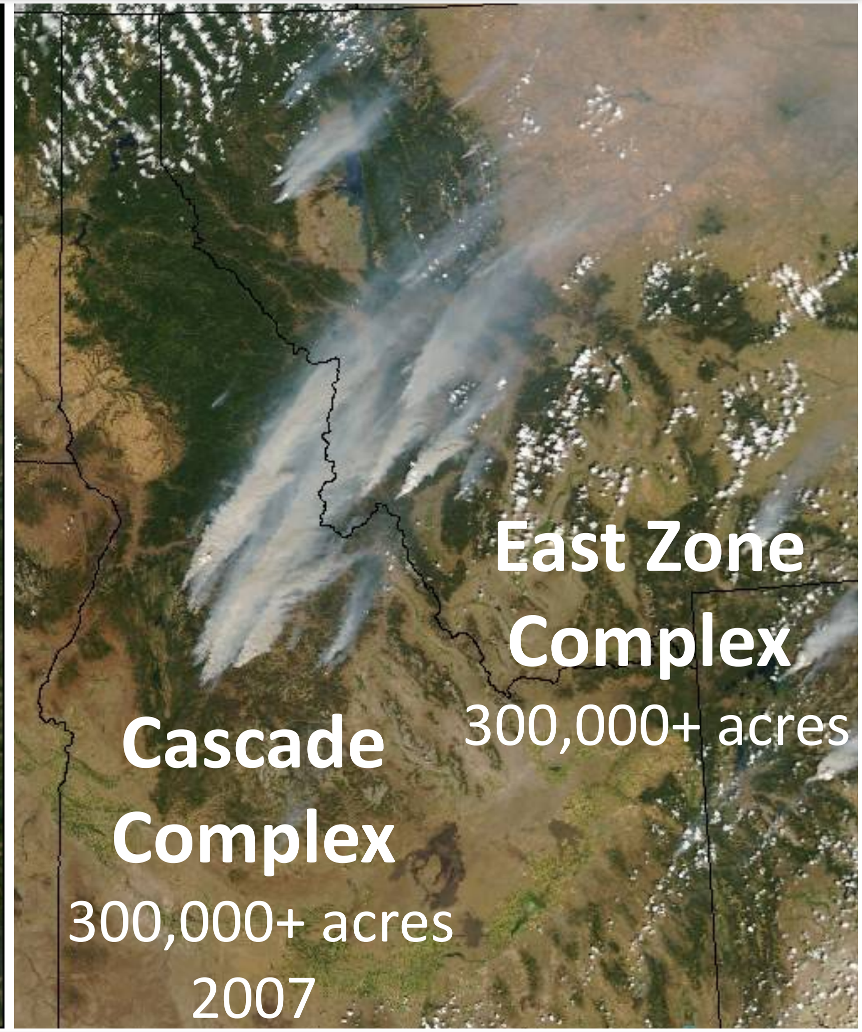
Recent Very Large Wildfires





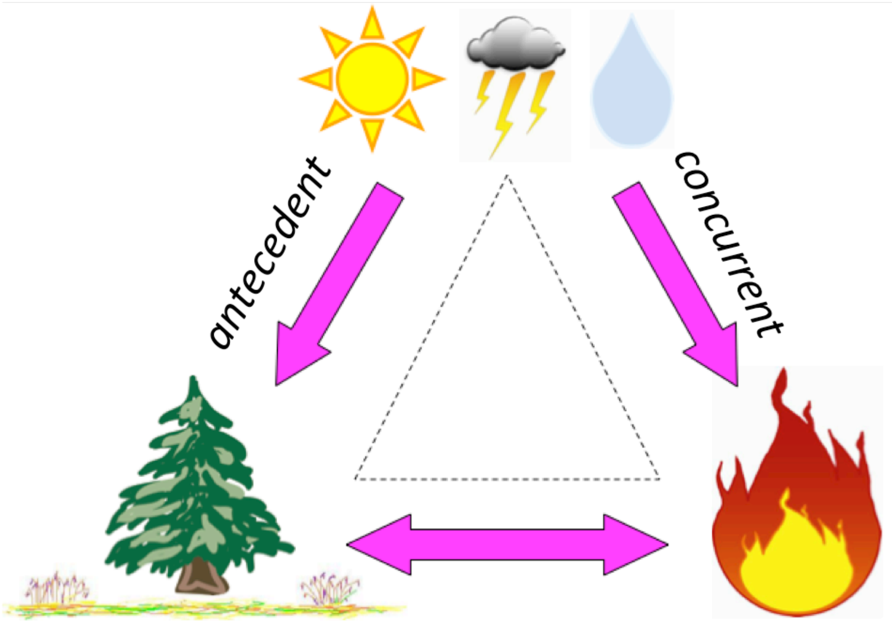
Very Recent Very Large Wildfires July 2014

Today's Focus: Very Large Fire Events

Hypotheses:

Principally enabled and driven by climate and weather

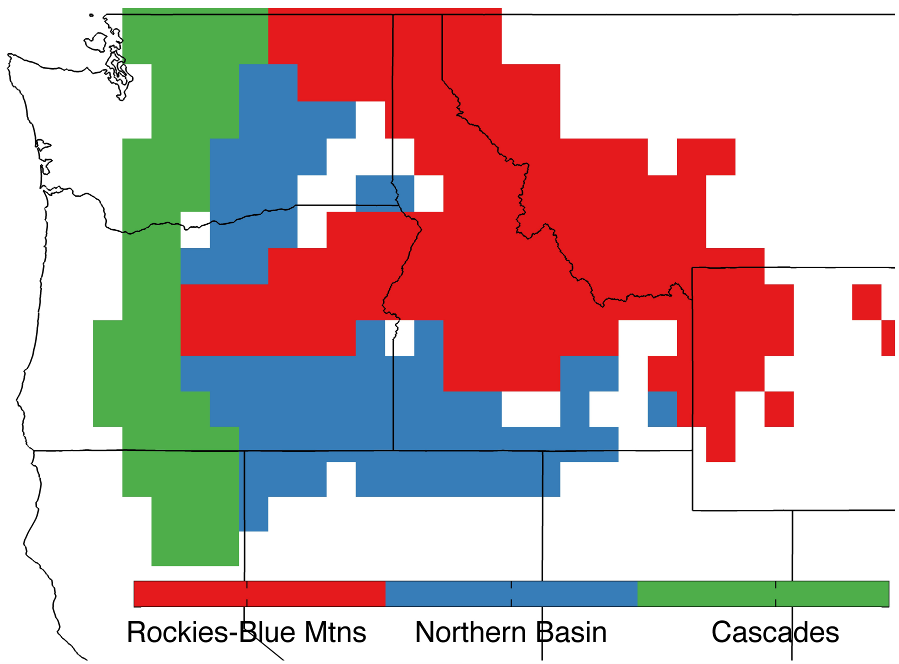
1. Widespread abundant and available fuels
2. Ignition sources
3. Critical fire weather patterns (wind driven) or sustained extreme fire danger (fuel driven)



Defining "MegaFires"

Fire Atlas: MTBS Large Fire (>1000ac) 1984-2012

- >30kac : top 10% of large fires, but >70% of burned area
- Excluded "Unburned to low" burn severity area
- Focused on **top-down drivers** (weather and climate) only



Weather-Climate Data

Climate (PRISM, Daly et al., 1994)

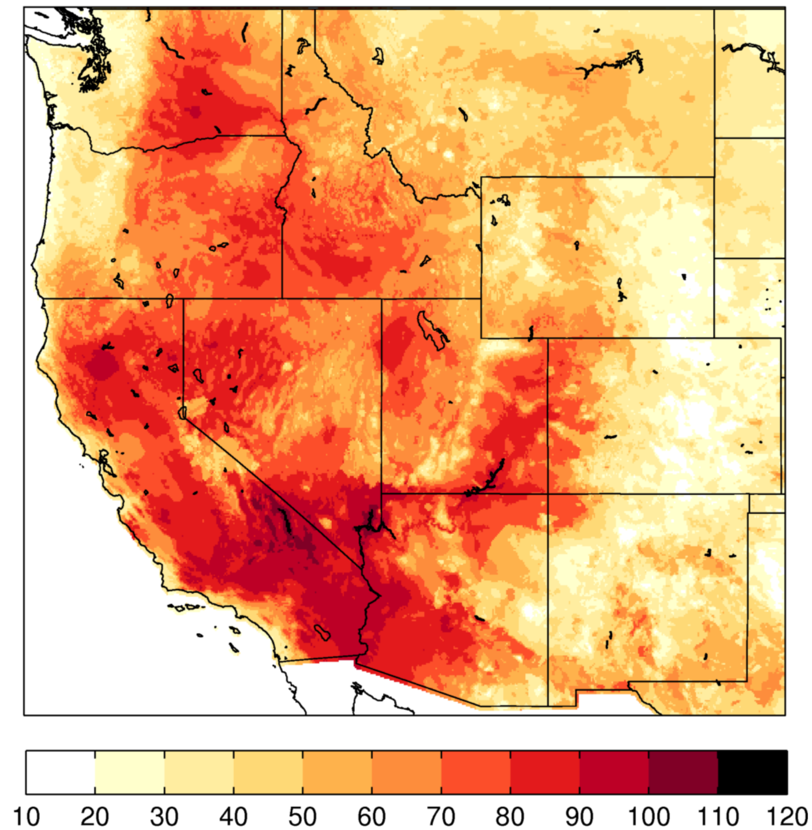
- Monthly: T, PPT, PDSI
- Climatological Water Deficit (CWD), Actual Evapotranspiration

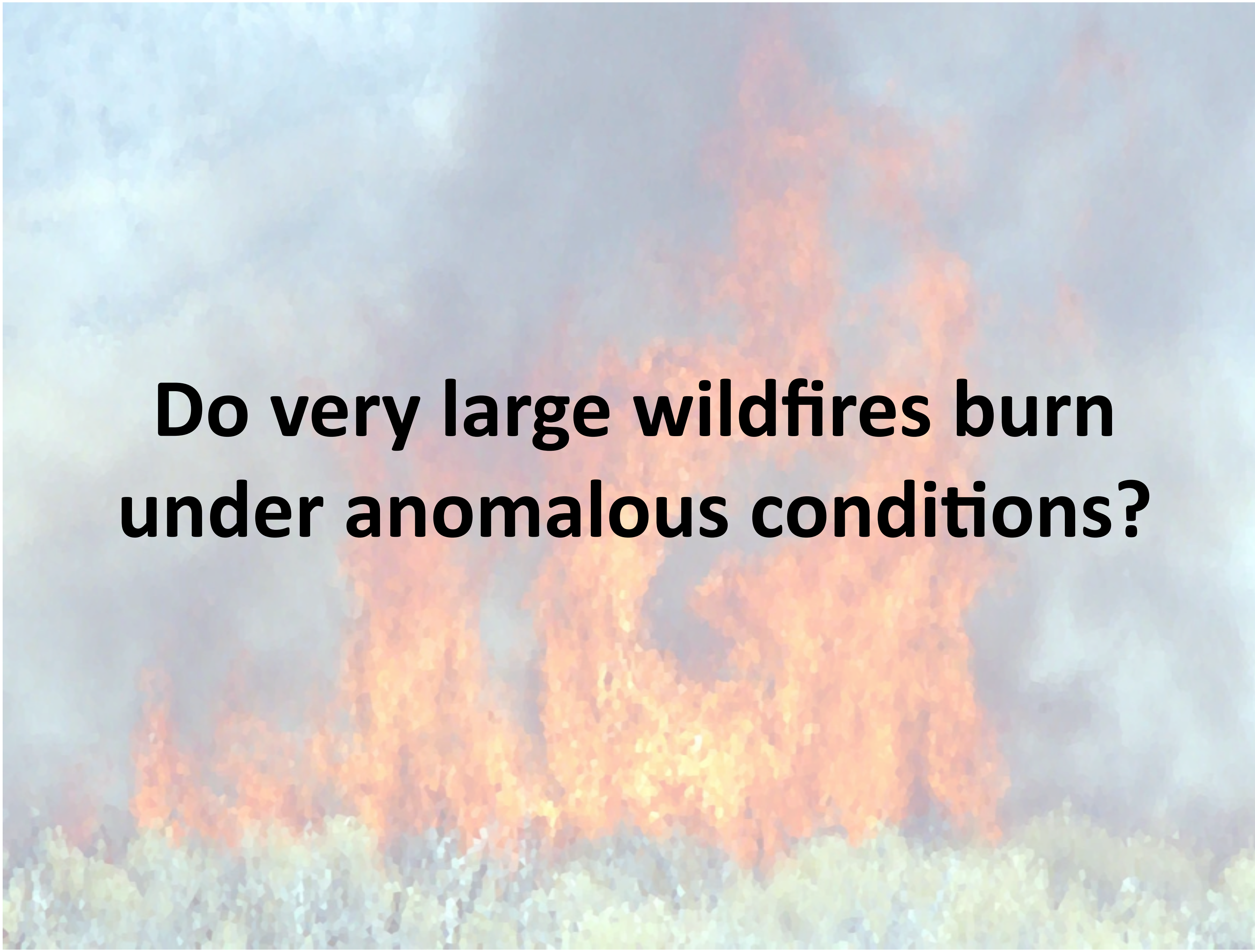
Daily meteorology (Abatzoglou, 2013)

- NFDRS Fire Danger Indices (ERC, BI)
- Canadian Forest Fire Danger Indices

Both data at 4-km scale, aggregated to 50-km scale for computational efficiency

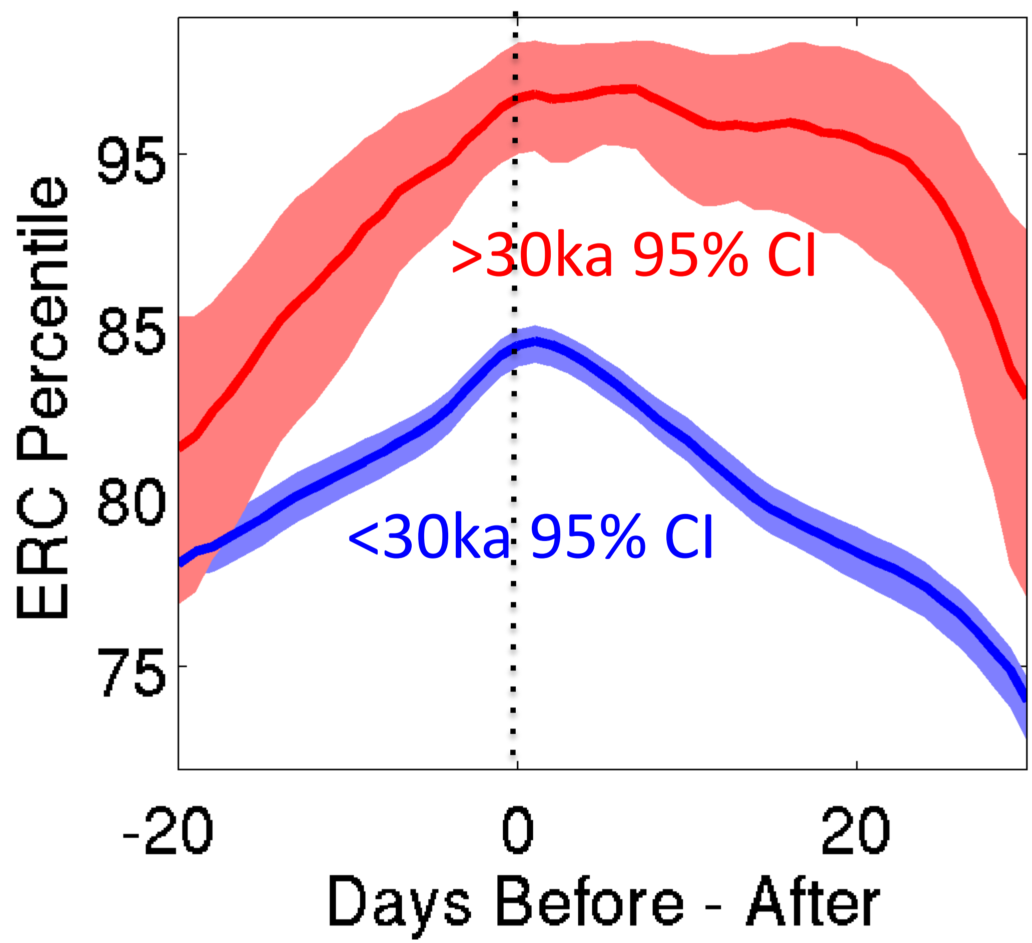
ERC–G 7/17/2014




Do very large wildfires burn
under anomalous conditions?

Commonalities

1. Chronic elevated fire danger
   - pronounced in forests
   - Key “vulnerability windows” of unmanageable fire
2. Dichotomous PDSI signal
   - Forested: **PDSI = -2.3**
   - Rangeland: **PDSI = +1.2**



Stavros et al., 2014 IJWF

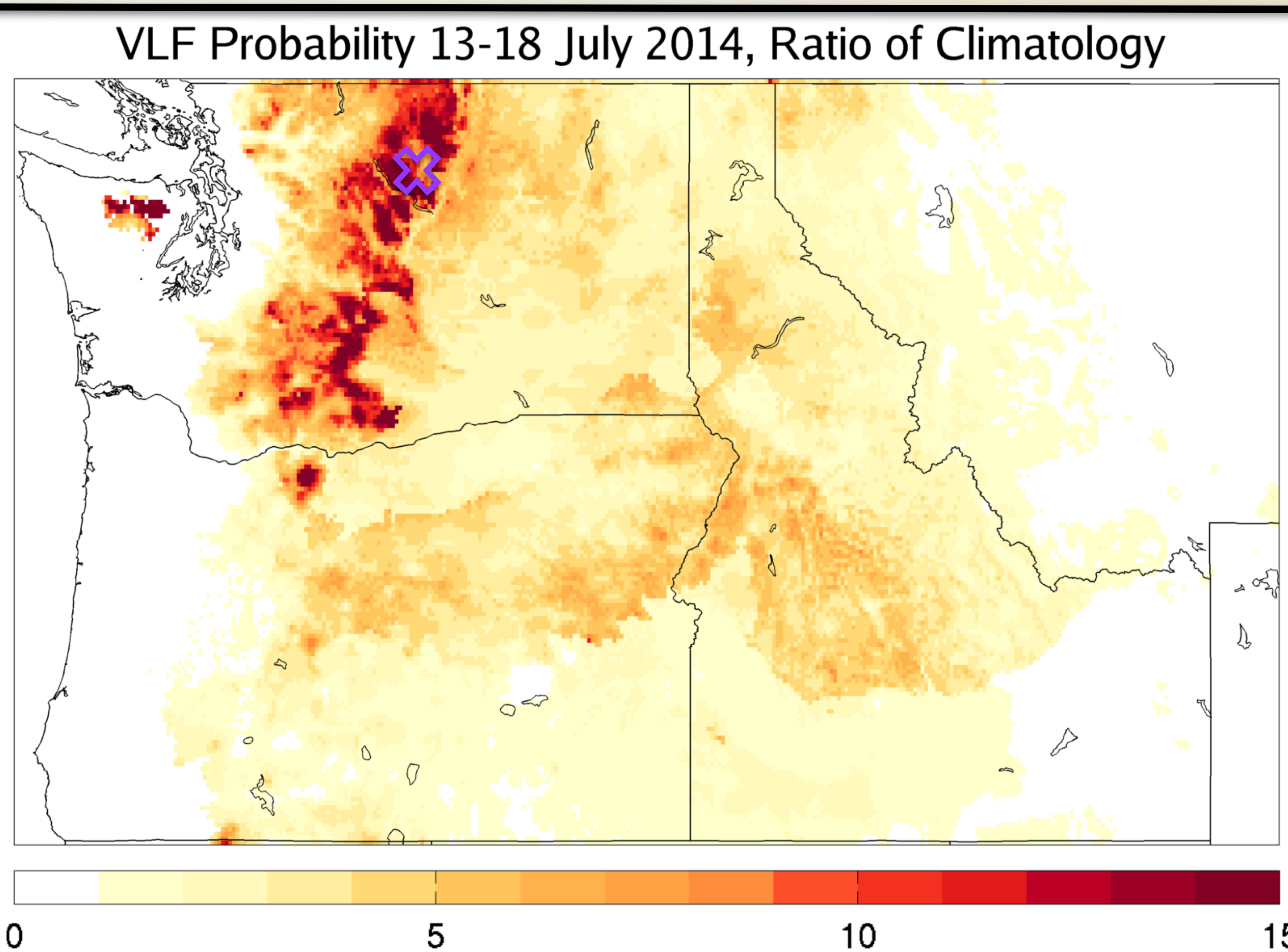
Model Development

Goal: time-space model for VLF likelihood (not explicitly VLF)

- Span all pixels with an ecoregion at a weekly timescale
- Logistic stepwise forward regression, w/resampling
- Models predict 250% increased likelihood for observed VLF

Ecoregions	#VLF weeks	$\boldsymbol{exp(\bar{\beta} - ln(F_0))} / \boldsymbol{1 + \exp(\bar{\beta} - ln(F_0))}$
Northern Basin	80	$\beta = -15.2351 + TEMP \times 0.3370 + BI \times 0.0803 + PDSI - 1 \times 0.1706$
Rockies- Blue Mountains	61	$\beta = -11.3141 + TEMP \times 0.1875 + ERC \times 0.1018 + CWD \times (-0.0070)$
Cascades	16	$\beta = -16.0938 + TEMP \times 0.4969 + ISI \times 0.1482$

Model Application (Carlton Complex, 2014)

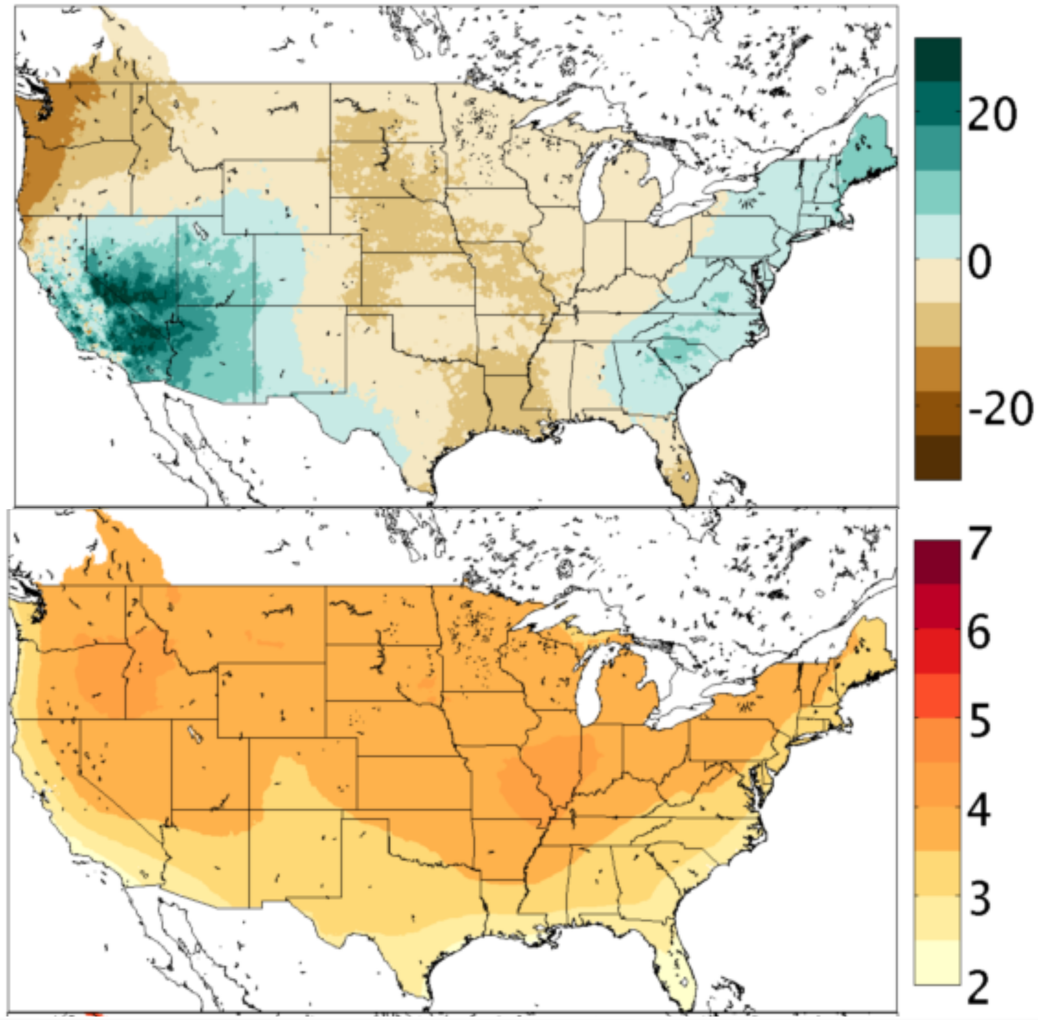


How will climate change alter the likelihood of atmospheric conditions conducive to very large fires?

Projected change in summer (Jun-Aug) climate 2040-2069 (RCP8.5) vs. 1971-2000

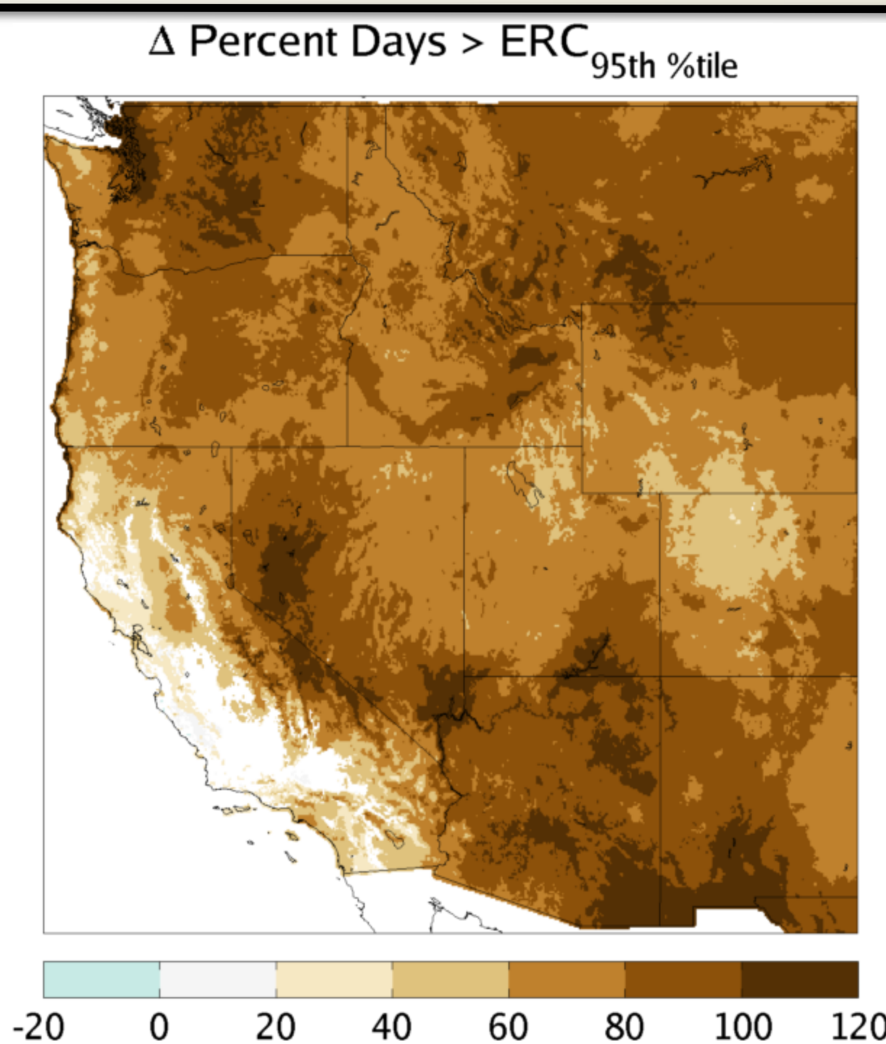
Precipitation

Temperature



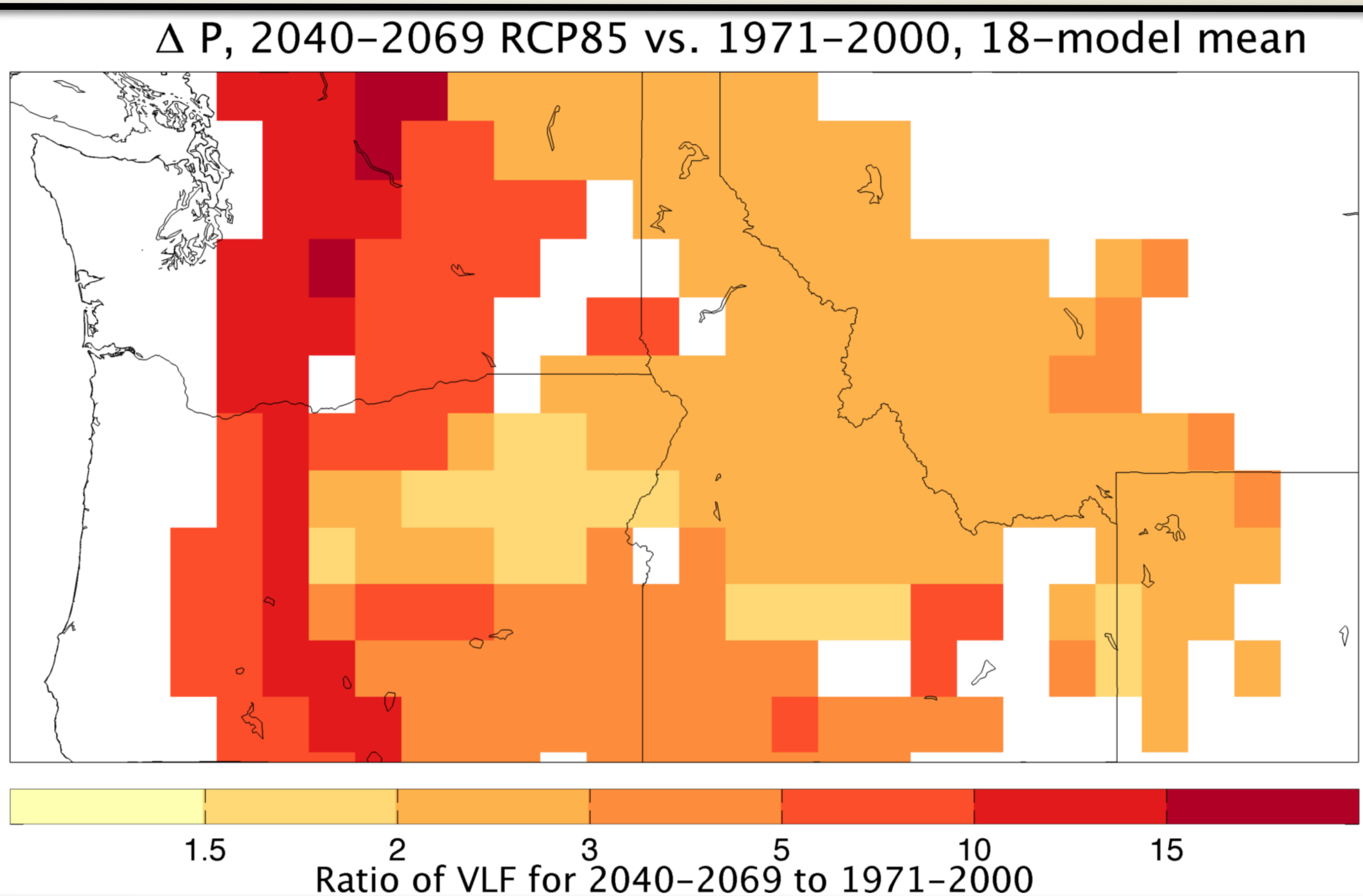
Changes in Extreme Fire Danger

Multimodel Mean (2040-2069 minus 1950-2005; RCP85)



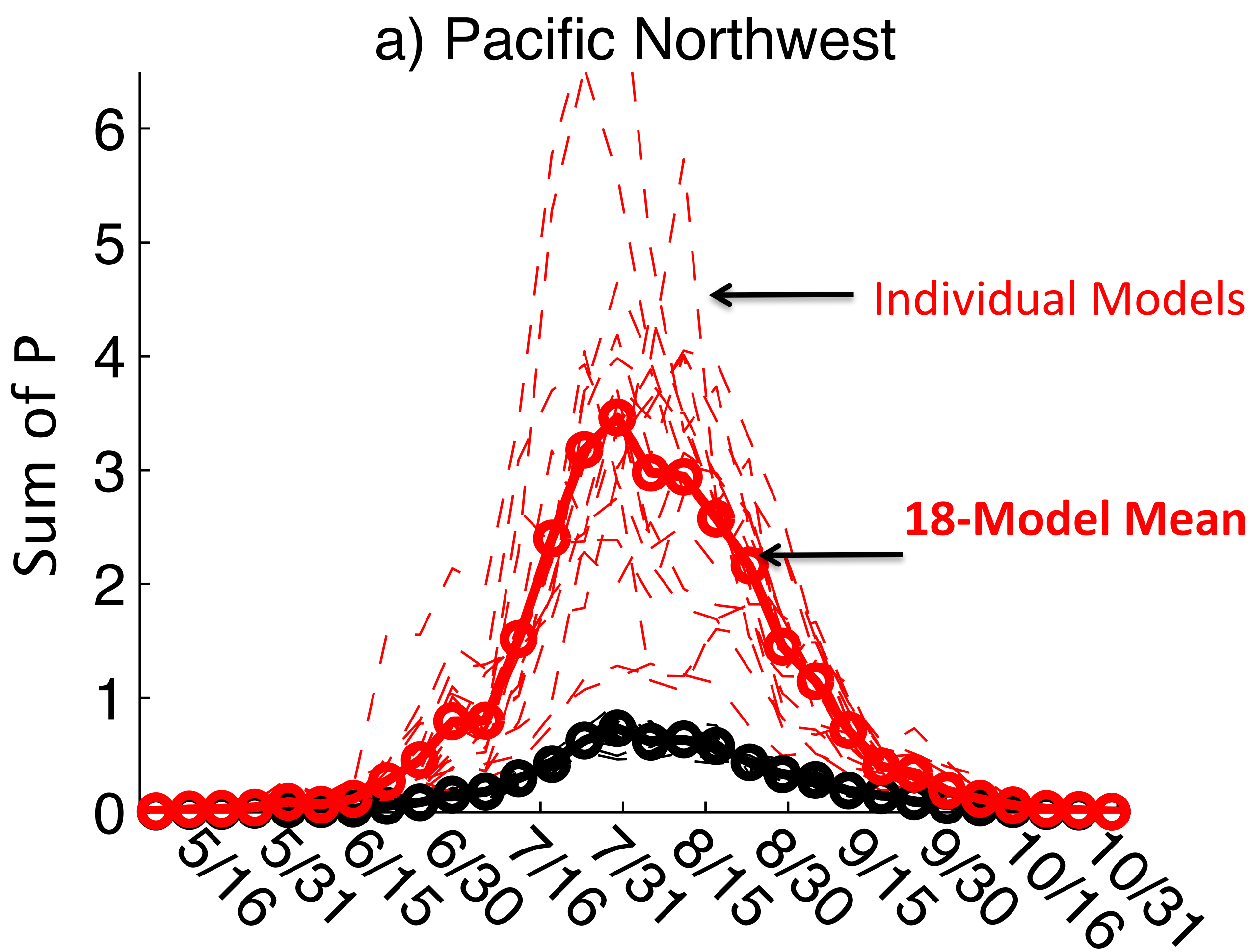
- 60—100% increase in high fire danger days
- Increase of around 3 weeks of core fire season (ERC>90th percentile)

Modeled Changes in VLW Probability

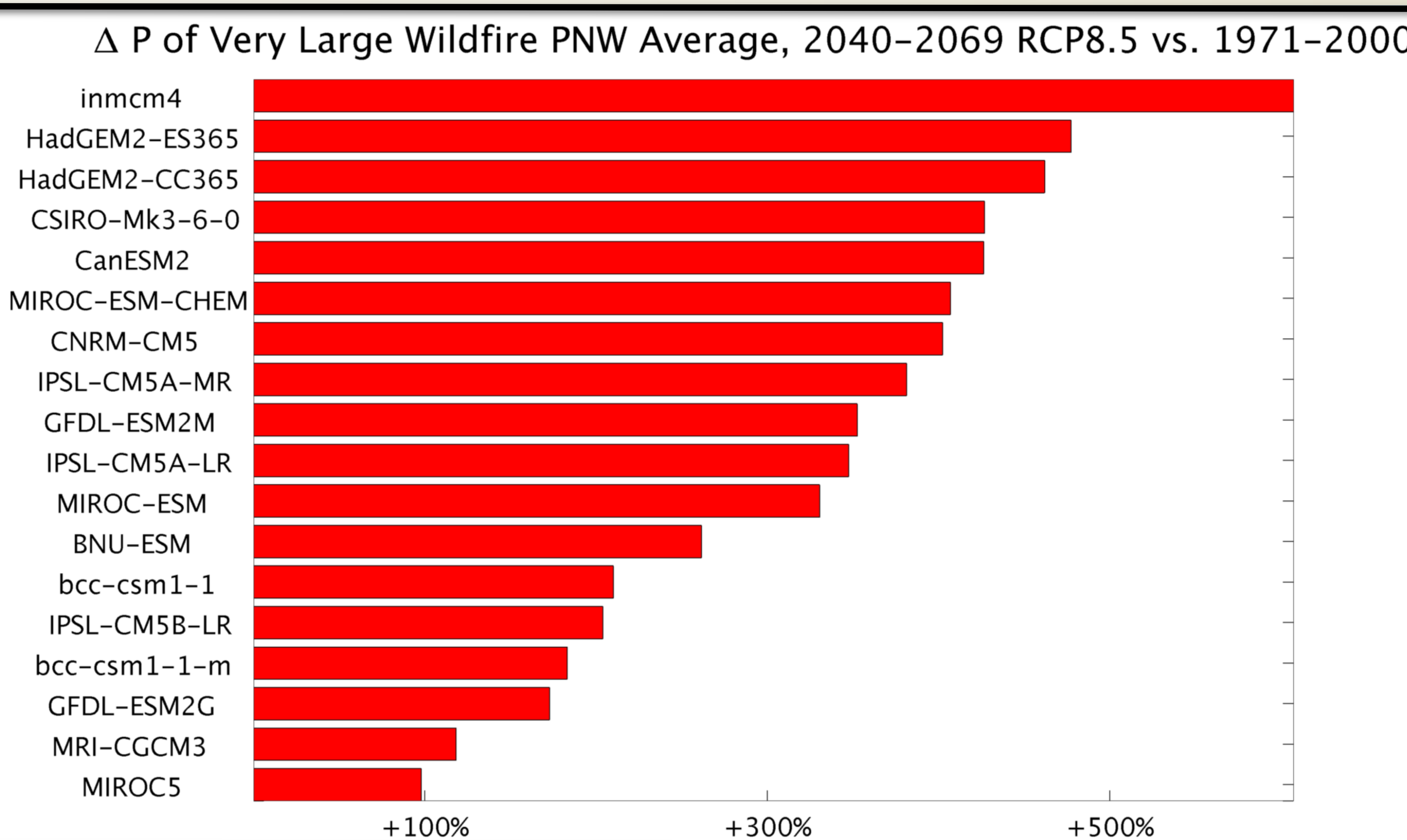


White = ecoregions not modeled or >50% agricultural land

PNW Regional VLF Probability
1971-2000 (black) vs 2040-2069 (red)



Intermodel Variability



Caveats to Statistical Modeling

1. Limited real estate (Westerling et al., 2011)

2. Non-stationarity of fire-climate relationships w/climate change and changing vegetation types (Higuera et al., in review)

3. Changes in fire-weather extremes (lightning, wind extremes, offshore winds)

4. Land management practices

5. Limited large fire activity west of Cascades (1984-2012) restricts model development

Dynamic Global Vegetation Models (e.g., MC2) provide an alternative means of overcoming some of these shortcomings

Conclusions

Very large NW fires occur under:

(a) Prolonged optimal burning conditions (forests)

(b) Extreme fire weather conditions tied to wind events (rangeland)

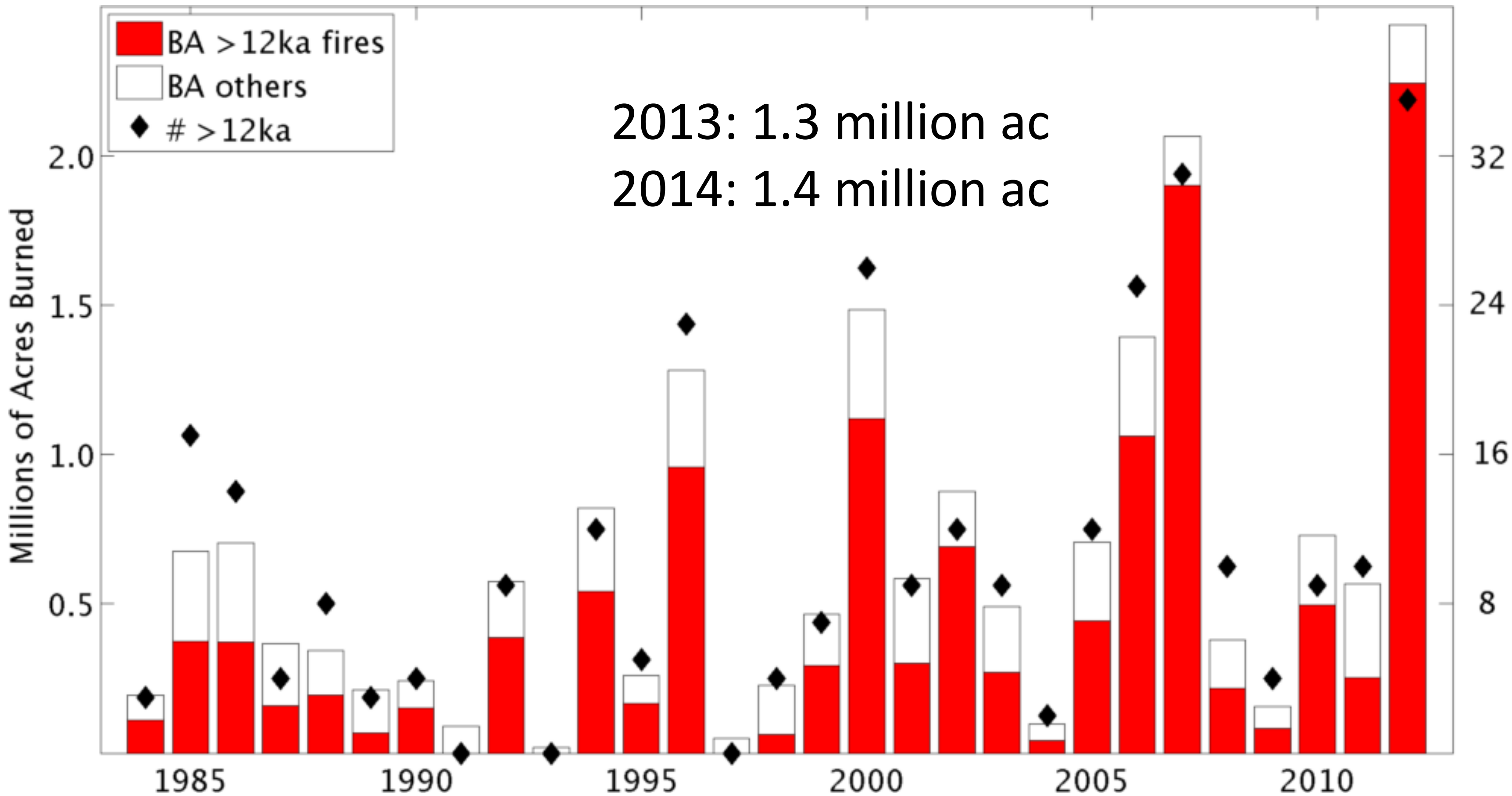
Climate Projections suggest:

- Advance in the onset of fire season by 2+ weeks
- 60-100% increase in high fire danger days
- Three-fold increase in climatic conditions conducive to VLF

CLIMATE IMPACTS RESEARCH CONSORTIUM

Extras

Burned Area and Number of Very Large Fires WA+OR+ID: 1984-2012



Data Source: MTBS