



# Trends in Critical Fire Weather Conditions in the Santa Ynez Mountains in Santa Barbara, CA, Based on 30 Years of High Resolution Downscaling

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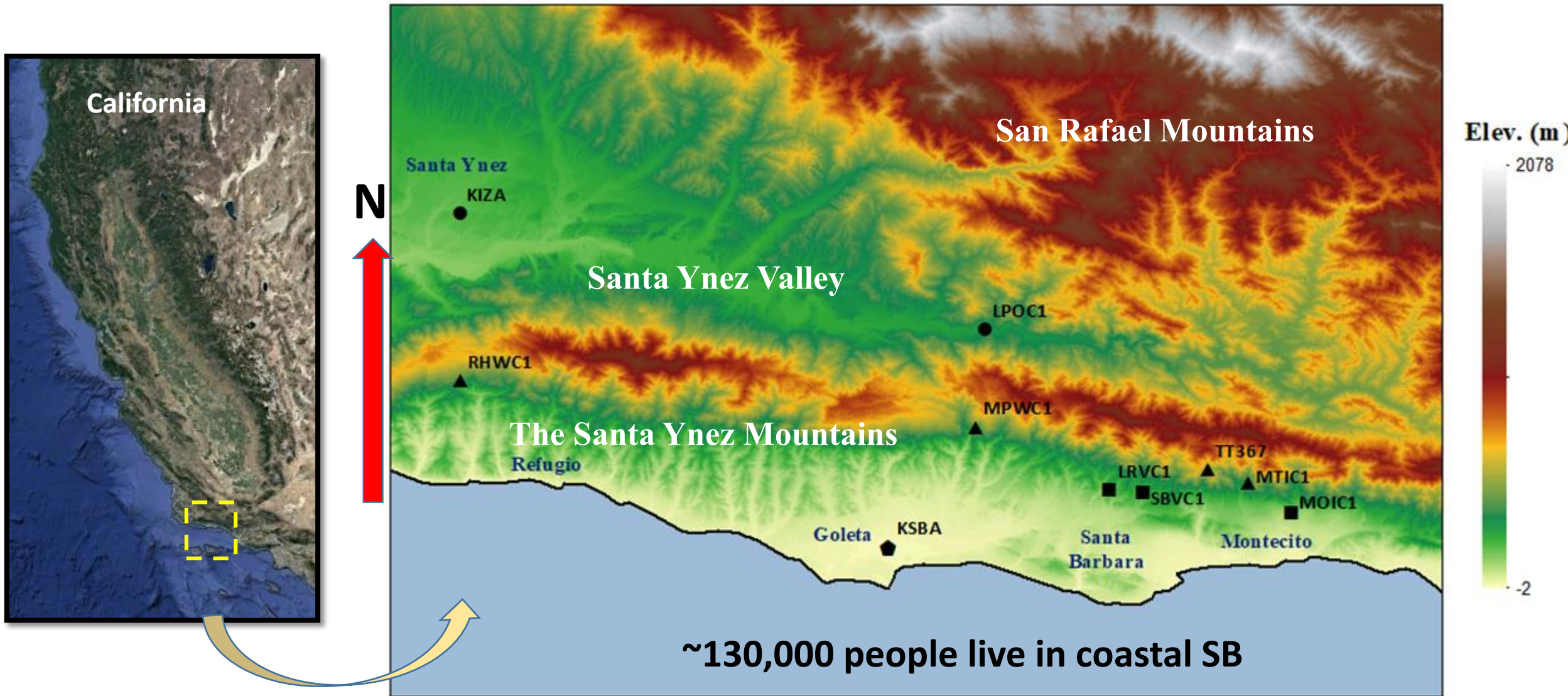
<sup>1</sup>University of California, Santa Barbara

AMS Mountain Meteorology Conference 2020

**NSF –PREEVENTS- ICER – 1664173**



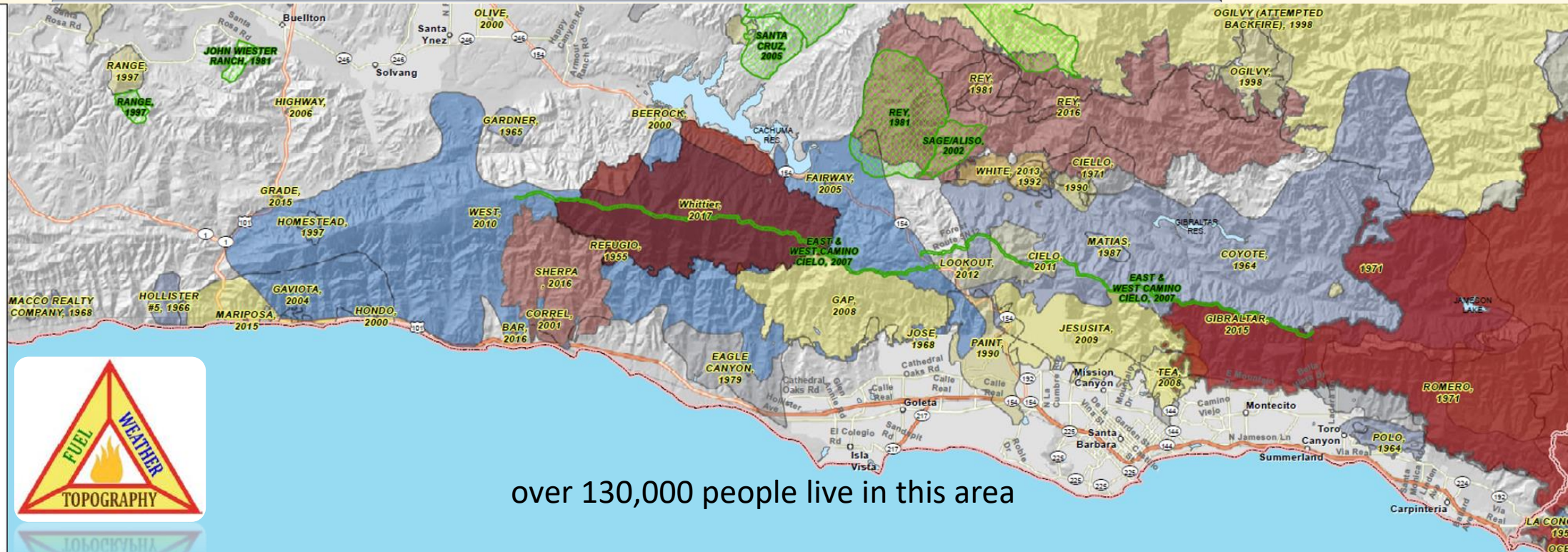
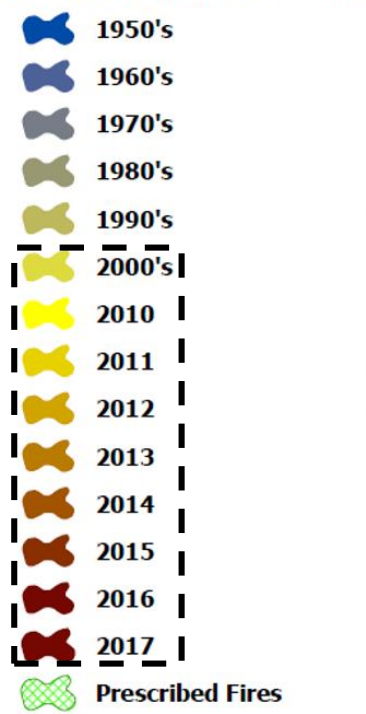
# Santa Barbara Topographic features





# Coastal SB is not new to wildfires

## Fire History from 1950 - 2016



- ✓ All major wildfires affecting coastal SB have been enhanced by strong winds in the southern slopes of the Santa Ynez Mountains: "Sundowner Winds" (or Sundowners)
- ✓ SUNDOWNER IS NOT THE LOCAL NAME FOR THE 'SANTA ANA' WINDS.

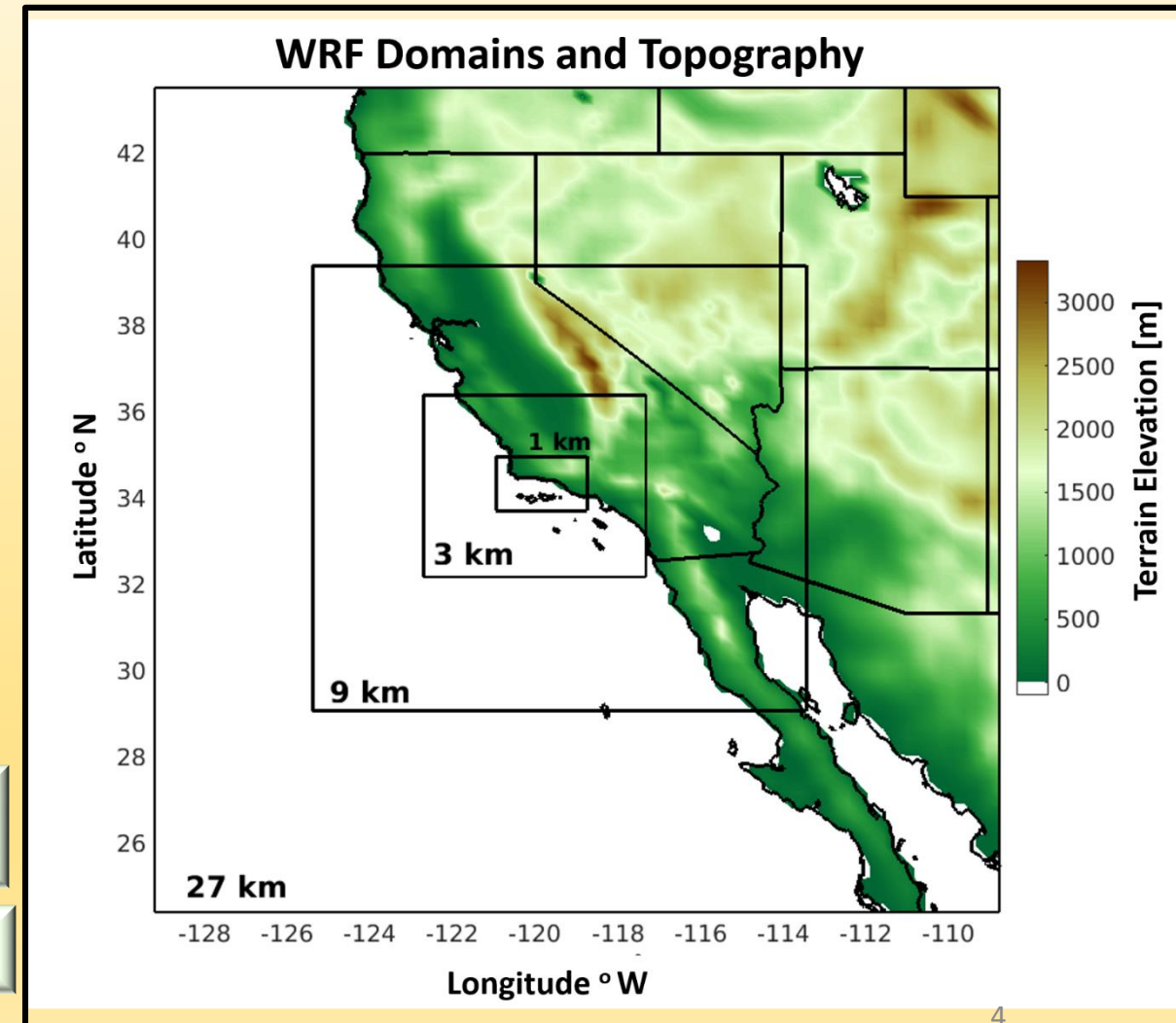
0.13/yr (1955-1999 – 6 events in 45 yr) increased to 0.77 /yr (2000-2017- 13 events in 18yr)  
~6 x more events in the last 18 years compared to before

# Climatology based on 30 yr simulations with the Weather Research and Forecasting Model (WRF) at 1km resolution (hourly data)

- ERAI initial and Boundary Conditions
- 4 nested grids (27km,9km,3km,1km)
- 55 vertical levels
- Parameterizations: <sup>1</sup>Duine et al. (2019)
- 30 yr (1987-2017): Simulations:
  - ✓ 1 July yr1 – 1 Sept yr2
  - ✓ Validations: surface stations (<sup>2</sup>Jones et al. 2020)

<sup>1</sup>Duine, G-J., C. Jones, L. M. V. Carvalho, R. G. Fovell, 2019: Simulating Sundowner Winds in Coastal Santa Barbara: Model Validation and Sensitivity. *Atmosphere*, 10(3), 155; <https://doi.org/10.3390/atmos10030155>

<sup>2</sup>Jones, C. L. M. V. Carvalho, G-J Duine, K. Zigner, 2020: A New Climatology of Sundowner winds based on 30yr WRF downscaling. *Atmospheric Research* (in revision)

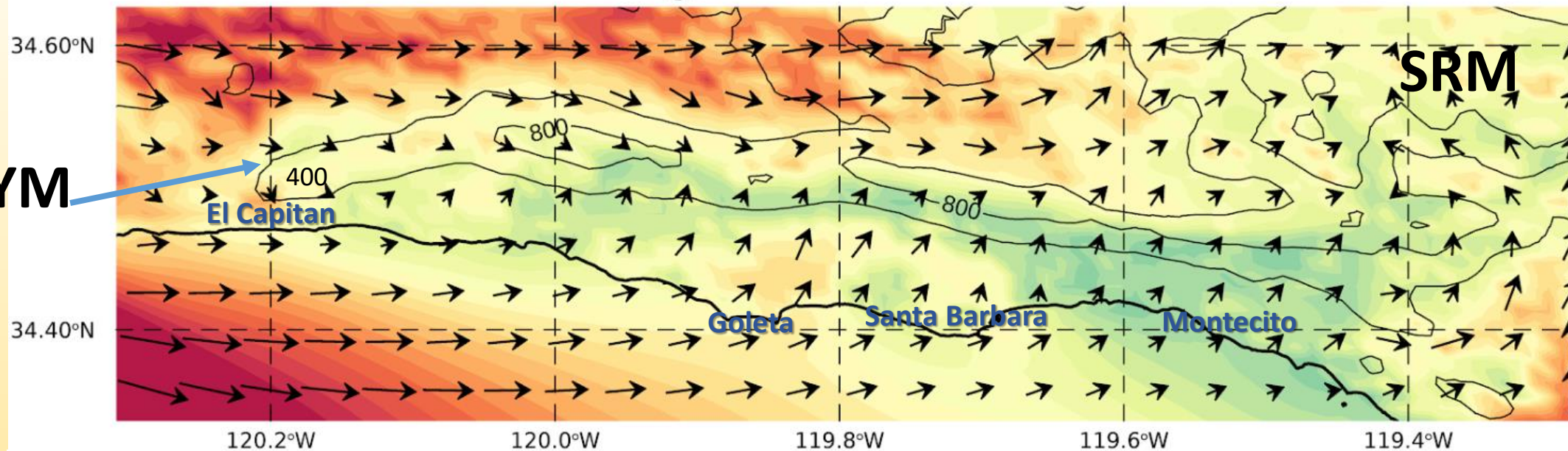


# Winds Climatology : 1987-2017



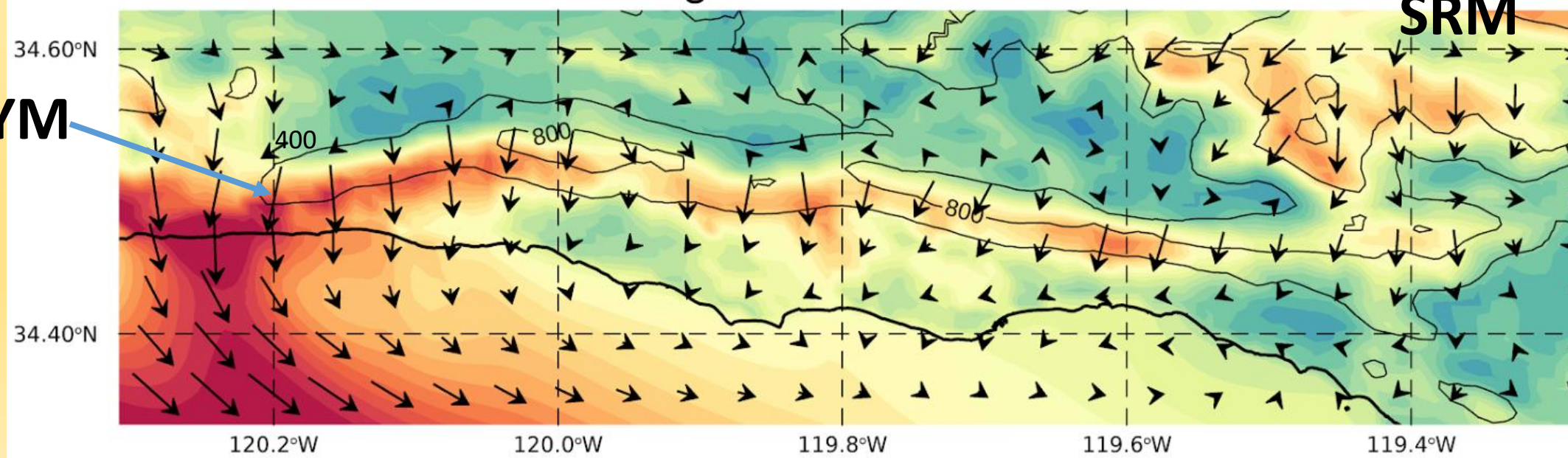
## Average WSPD: 12to15 PST

Wind (m/s)



## Average WSPD: 21to0 PST

Wind (m/s)

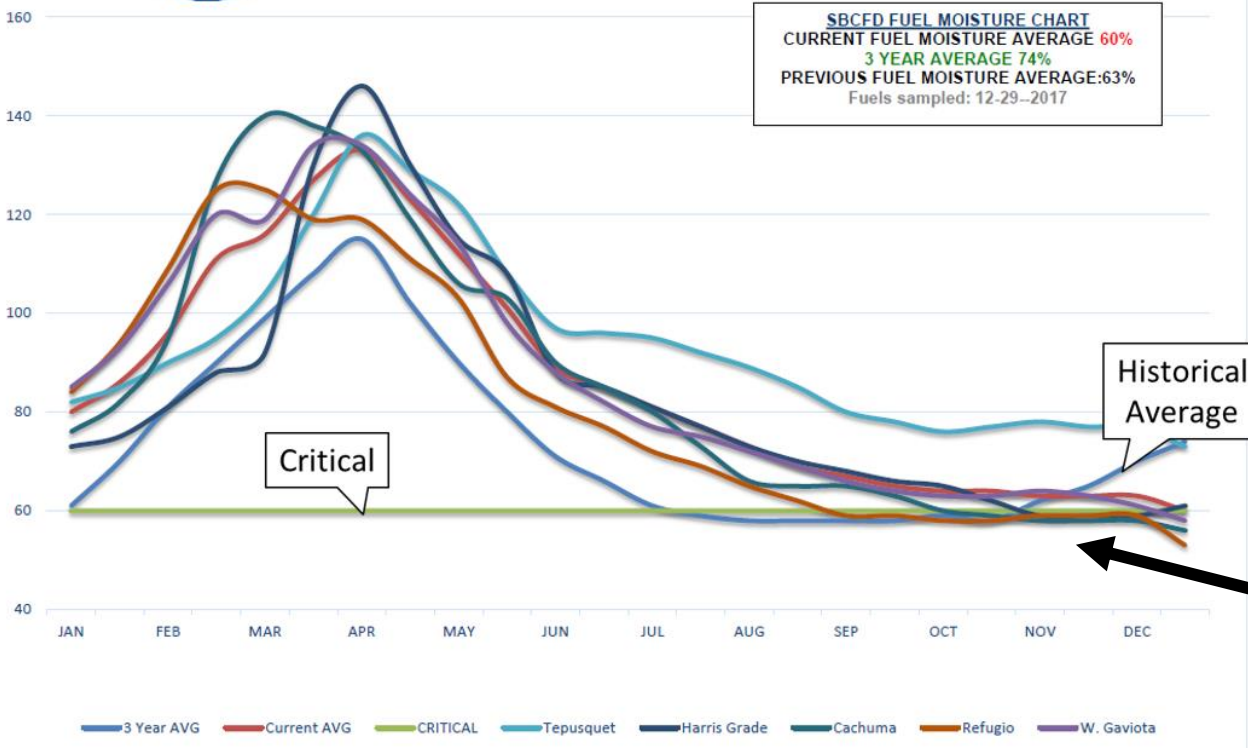




# Climatology: Focus peak of the Fire Season



## SANTA BARBARA COUNTY FIRE DEPARTMENT 2017 LIVE FUEL MOISTURE ALL FUEL BEDS - CHAMISE



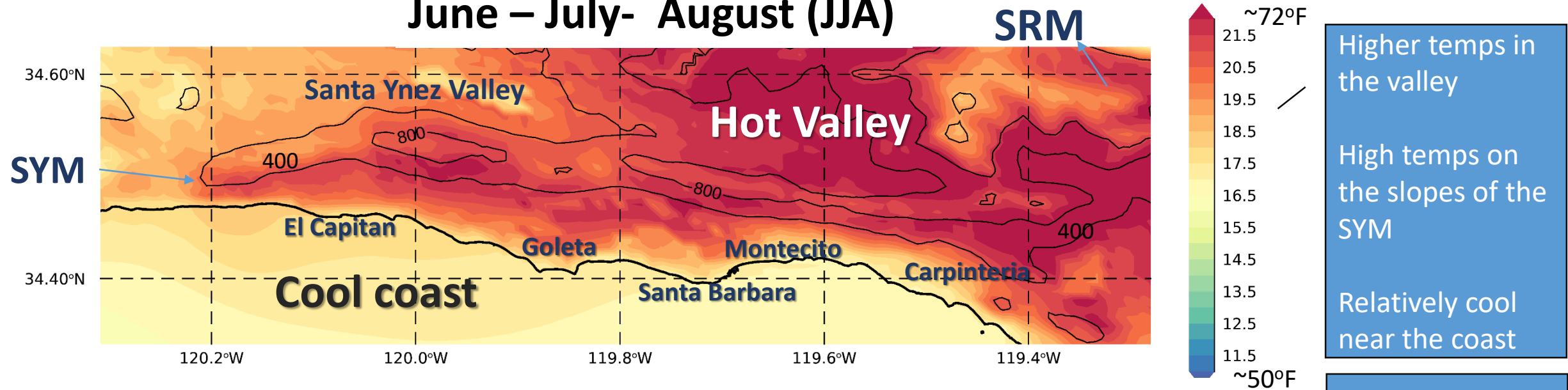
Thomas Fire – December 04/2017



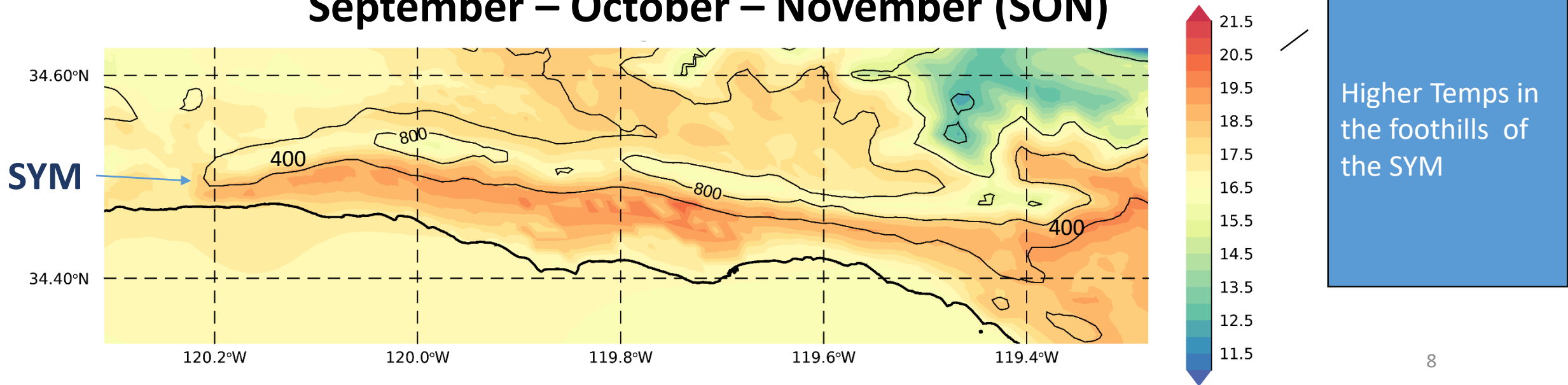
Critical Level in September – November

# Average 2m Temperatures 1988-2016 (all hours)

## June – July- August (JJA)



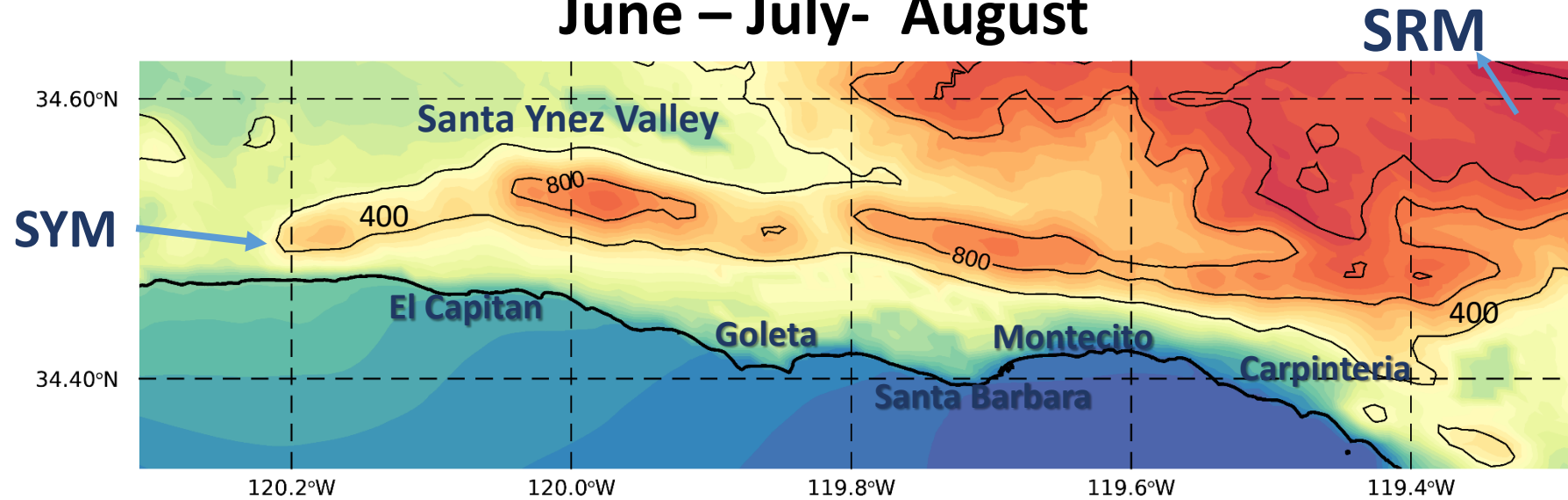
## September – October – November (SON)





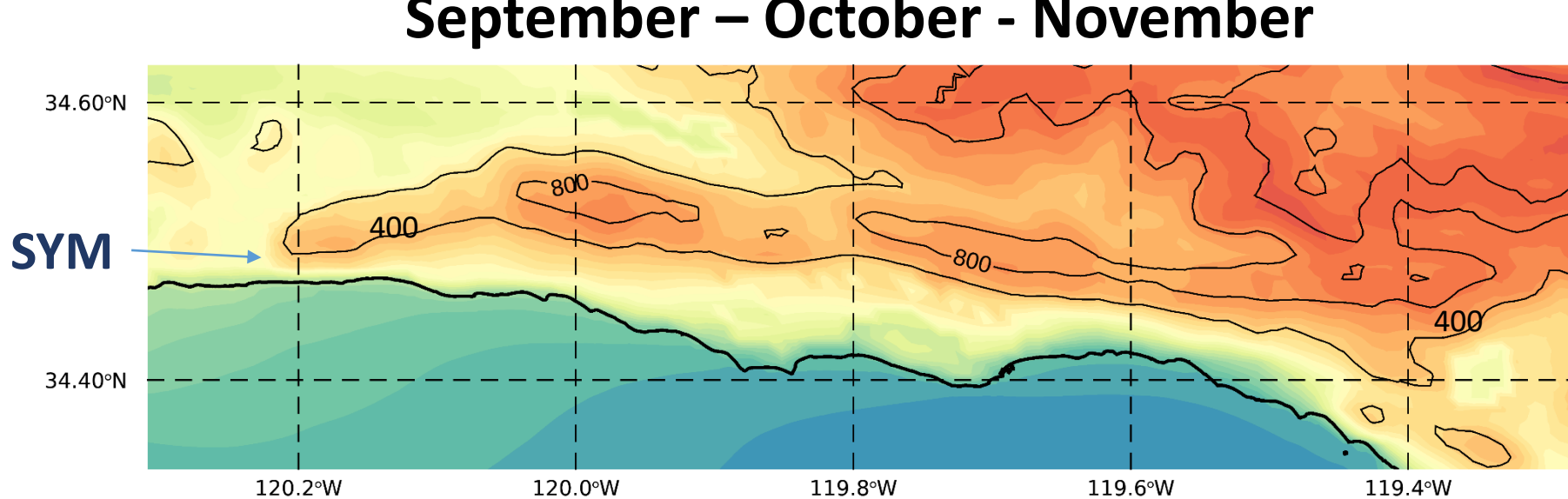
# Average 2m RH 1988-2016 (all hours)

## June – July- August



RH Decreases  
with elevation

## September – October - November

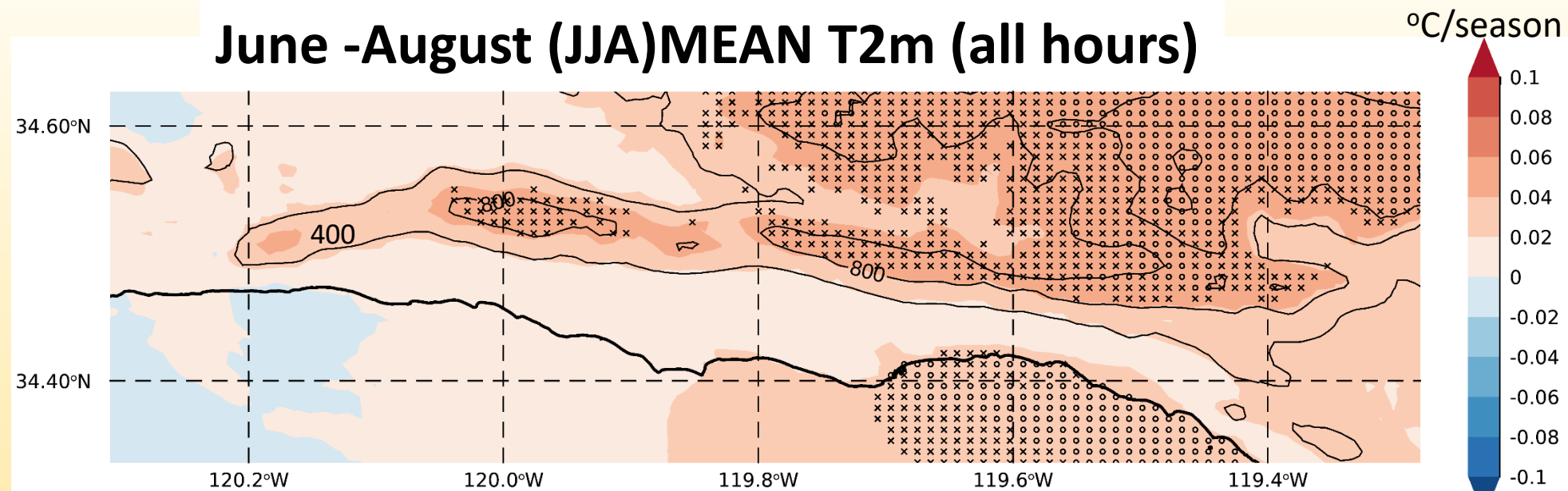


Lower RH in mid-  
slopes of both  
mountains

Trends (Sen' Slope and Mann-Kendall test) :  
1988-2016  
JJA and SON

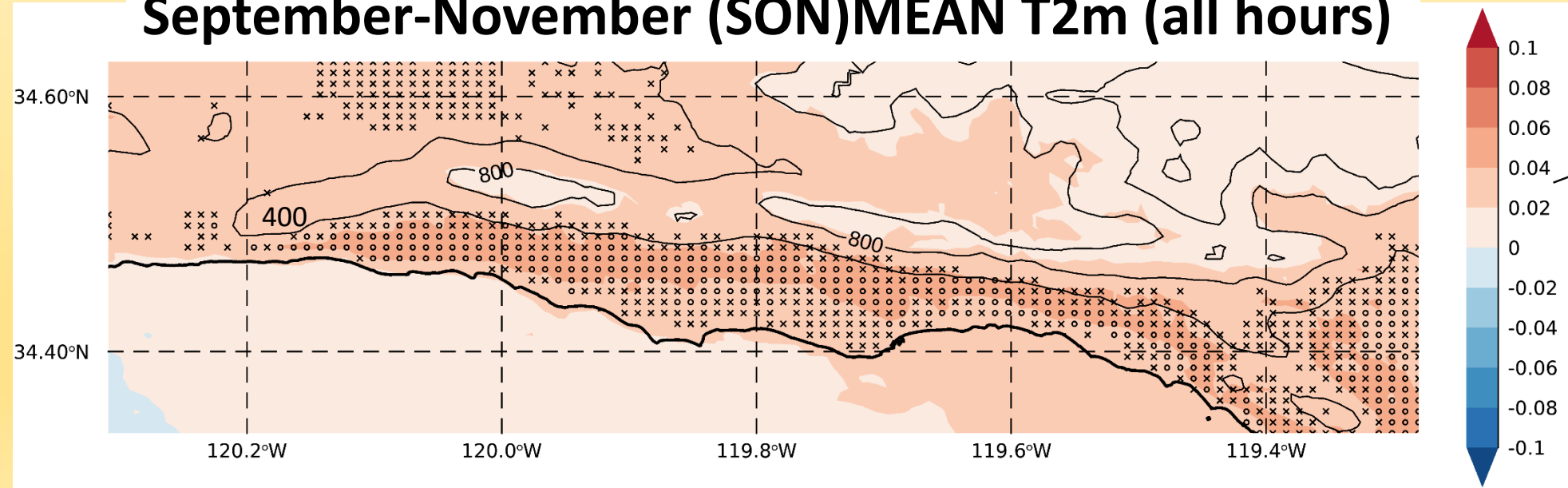


## June -August (JJA)MEAN T2m (all hours)



Increase in T2m in  
high elevations  
In 29 years:  
 $\sim 1.16 \leq T \leq 1.45$

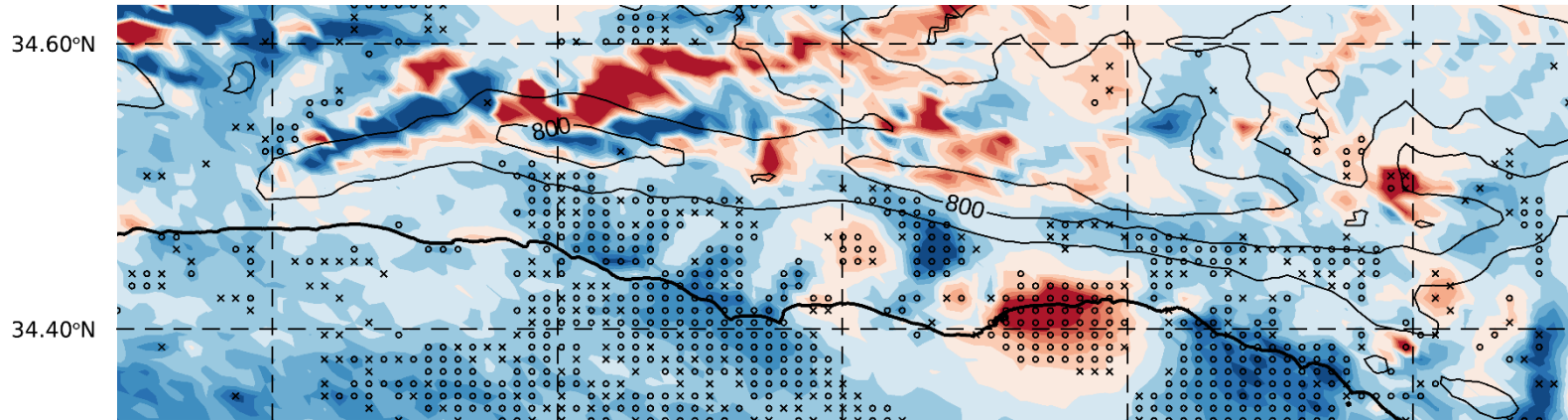
## September-November (SON)MEAN T2m (all hours)



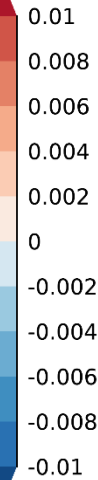
Increase in T2m in  
near foothills in 29  
years:  
 $\sim 1.16 \leq T \leq 1.45$

# Southerly winds (Day time – 13-15 PST)

## June -August (JJA) V10m (only southerly)

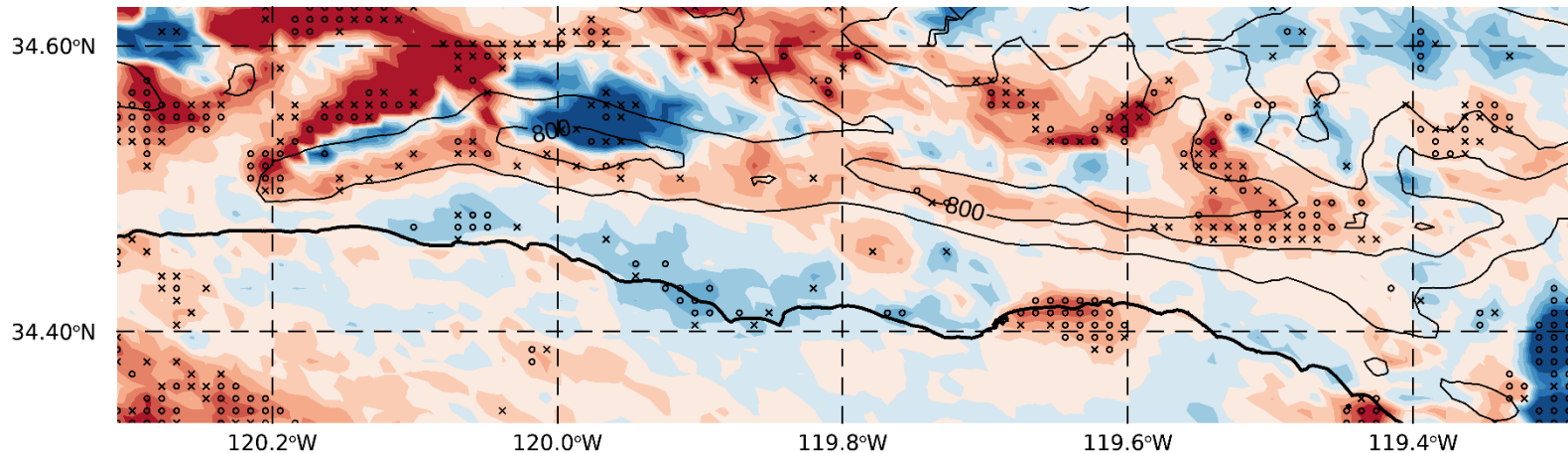


m/s

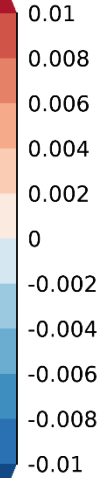


General weakening  
of onshore winds in  
the coast and  
decrease in  
anabatic winds in  
the slopes of SYM

## September-November (SON) V10m (only southerly)



m/s

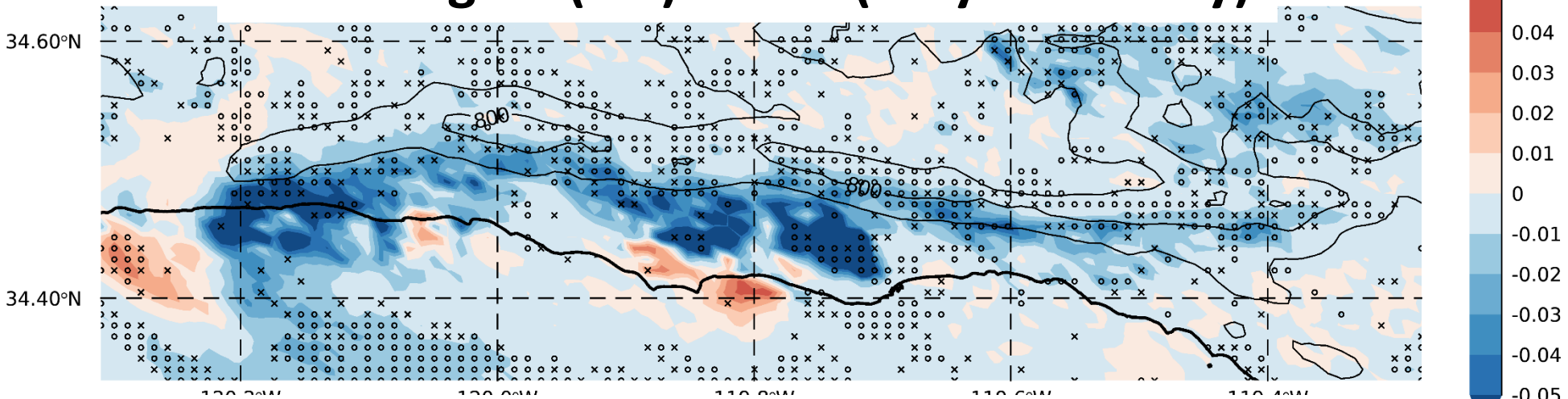


Increase in  
anabatic winds in  
parts of the slopes  
of the SYM and  
SRM



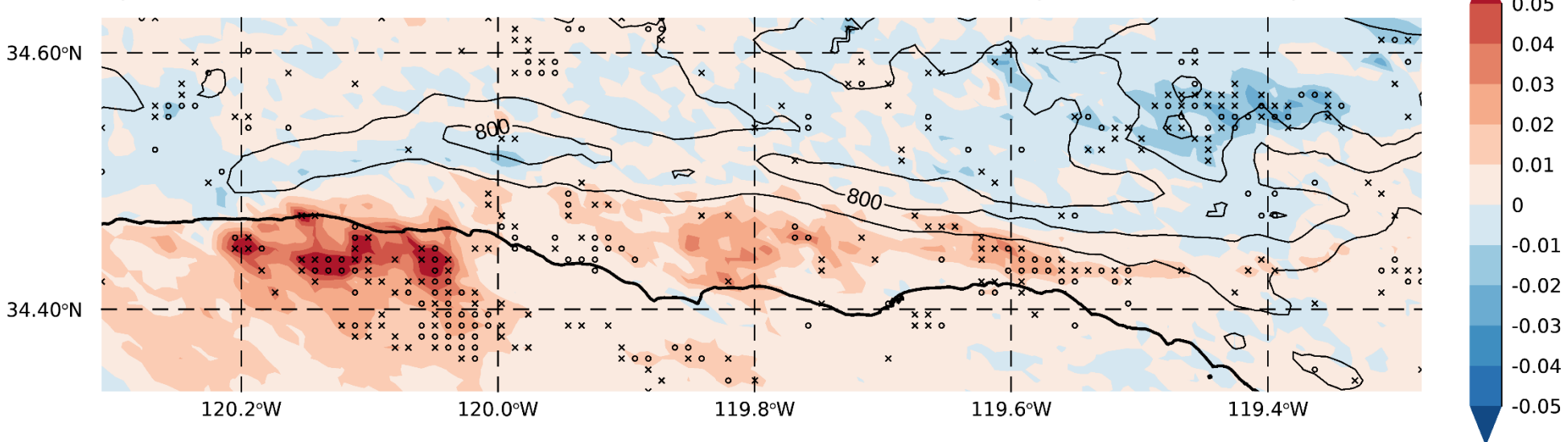
# Northerly winds (Night time– 19-21 PST)

## June -August (JJA) V10m (only Northerly)



General weakening of offshore winds in the coast and decrease in katabatic winds in the SYM and SRM

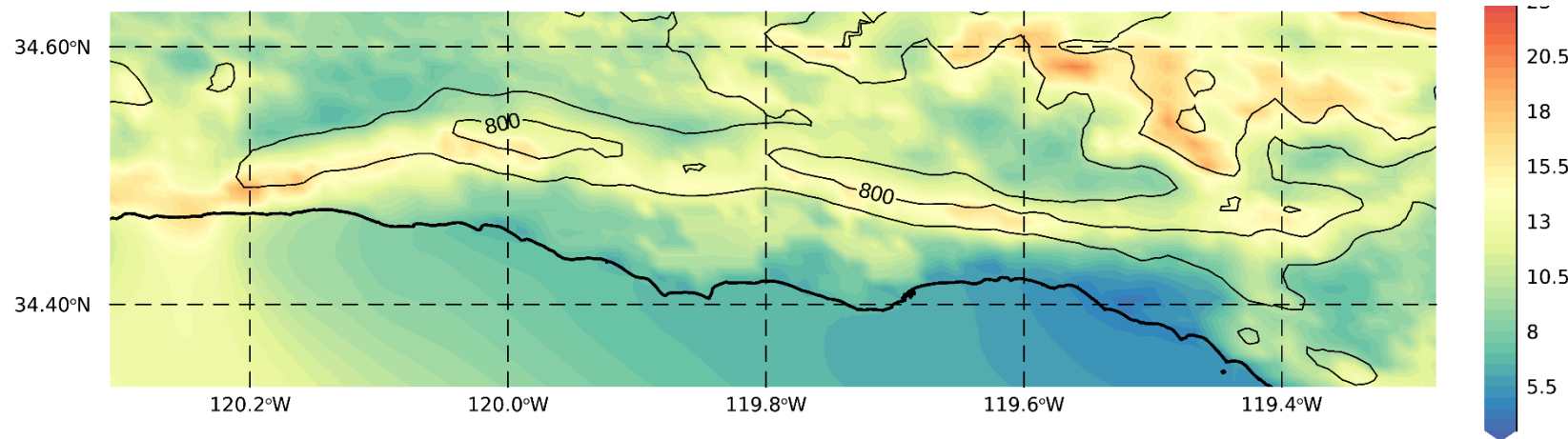
## September-November (SON) V10m (only Northerly)



Decrease in Katabatic winds in the SRM; Increase in offshore winds.

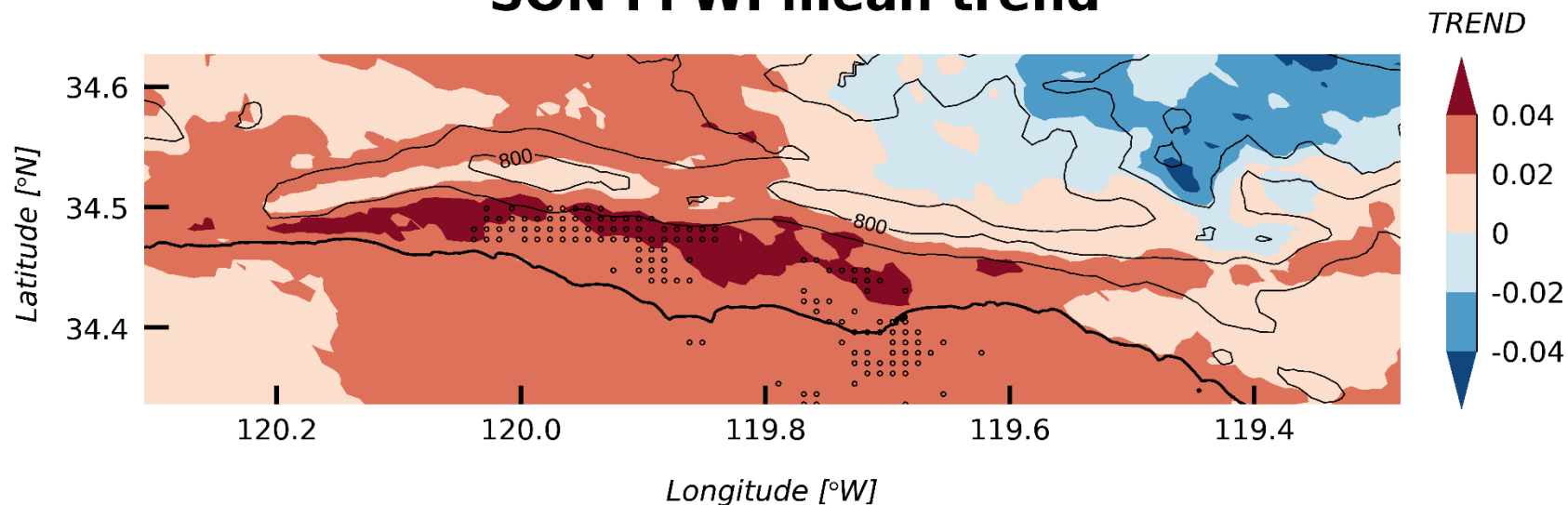
# Fire Weather Index (FFWI – SON)

## September-November(SON) V10m (only Northerly)



Foresberg Fire Weather Index (FFWI: measures the potential influence of weather on a wildfire based on model output of temperature, wind and relative humidity. Represents expected flame length and fuel drying. Large values of the FFWI imply high flame lengths and rapid drying.

## SON FFWI mean trend



Increase in values (up to 3 units in 30 years) in the foothills of the SYM over western SB.



# Main takeaway messages

- 30 yrs of WRF simulations at 1km resolution have shown:

## **Temperature:**

- JJA – warming trends in mountains compared to lower elevations
- SON- warming more pronounced in the foothills of the mountains

## **Circulation:**

- JJA: Weakening of mountain circulation (katabatic and anabatic winds)
- SON: Anabatic and Katabatic winds increasing in the slopes and foothills of the SYM: strengthening of mountain circulation

## **Fire weather index in SON:**

- Increase in temperatures and katabatic winds in SON- increase in fire index in the Western foothills of the SYM
- NO SIGNIFICANT CORRELATION BETWEEN WINDS OR TEMPERATURE AND PDO
- More studies are being conducted to investigate mechanisms related to these trends
- A Field Campaign (Sundowner Winds Experiment – SWEX) in 2021 will help in further understanding local circulations

# Follow up talks on Sundowner Winds in SB:

- **Charles Jones: A New Climatology of Sundowner Winds in Santa Barbara, CA based on 30 years high resolution WRF downscaling;**
- **Gert Jan Duine: Downslope Windstorms in Coastal Santa Barbara from Observations and Numerical Simulations**