

A decorative graphic featuring a stylized globe in the upper right corner. The globe is composed of several curved segments, with the top-right segment showing a satellite-style image of California in red, orange, and yellow, set against a blue background. The rest of the globe is a solid dark blue. The background of the entire slide is a dark blue with a subtle, repeating pattern of small, light blue leaves.

# California Drought Implications: Analyzing AVIRIS Relative Fraction of Alive Vegetation Cover and Climatic Trends

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Kelsey Foster, Ariana Nickmeyer

# NASA DEVELOP



- NASA Applied Sciences Program
- Addresses environmental and public policy issues
- Builds capacity in participants and partner organizations
- 10 week project

# The Problem

- **Oak woodlands** and other biologically important plant communities in the **Santa Monica Mountains (SMM)** have experienced dieback during the recent drought
- Adverse effects of **oak loss** include:
  - Loss of **ecosystem services**
  - Decreased real estate value, recreation use, and aesthetic appeal
  - Negative effect on associated species



Image source: Emil Chang

# Our Partners

- Resource Conservation District of Santa Monica Mountains
- National Park Service – Santa Monica Mountains National Recreation Area
- California Department of Parks and Recreation – Los Angeles District
- California Department of Forestry and Fire Protection (CAL FIRE)
- LA County Department of Forestry and Fire Protection



Image source: Emil Chang

# Objectives

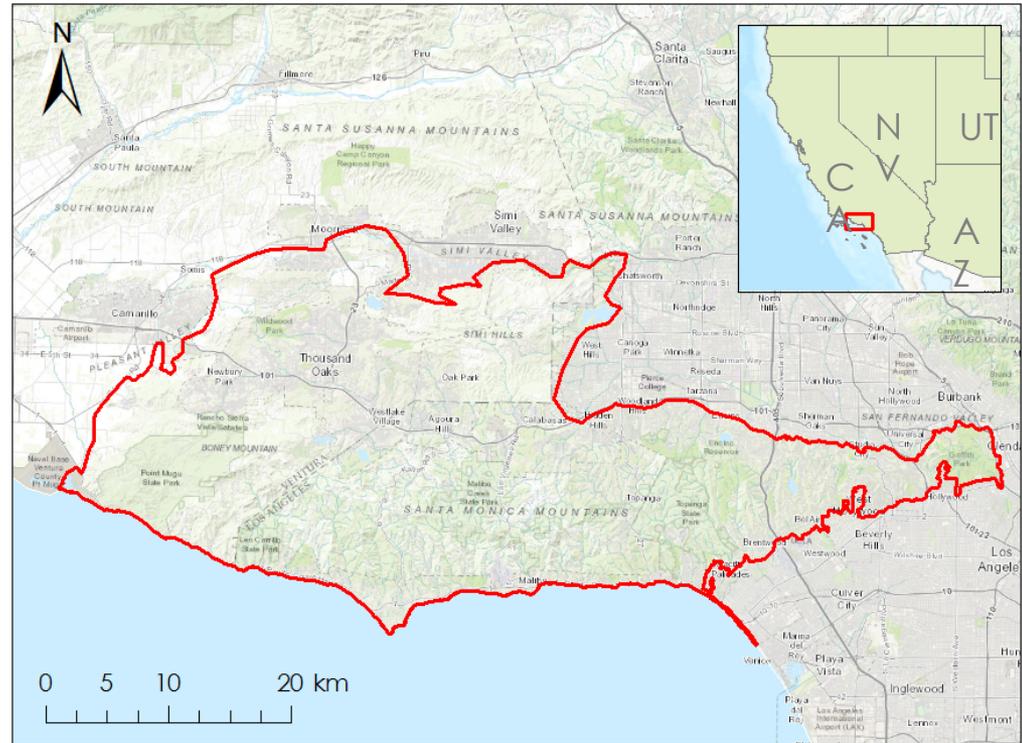
- **Map** annual changes in relative fraction of alive vegetation cover
- **Identify** vegetation dieback hotspots
- **Provide** better understanding to project partners of spatial dynamics of oak woodland dieback



Image source: Emil Chang

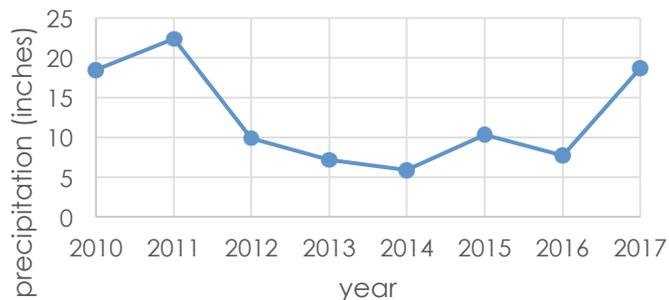
# Study Area & Time Period

- Ecological Monitoring Zone in SMM used by Resource Conservation District of SMM and NPS
- Time period: 2013 - 2016



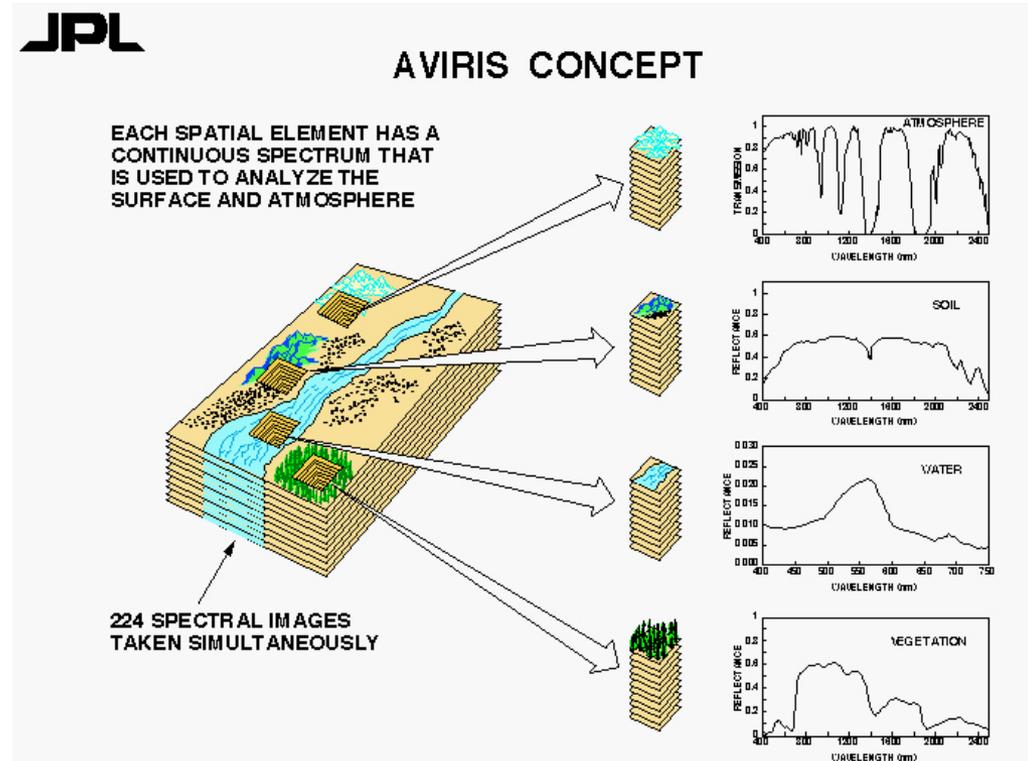
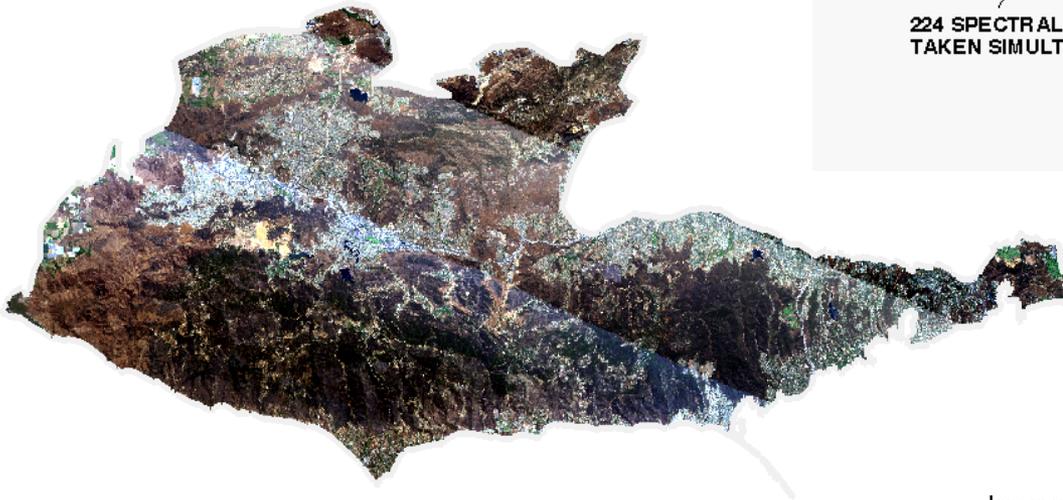
 Study Area

Cumulative Precipitation  
(water year)



# Why AVIRIS?

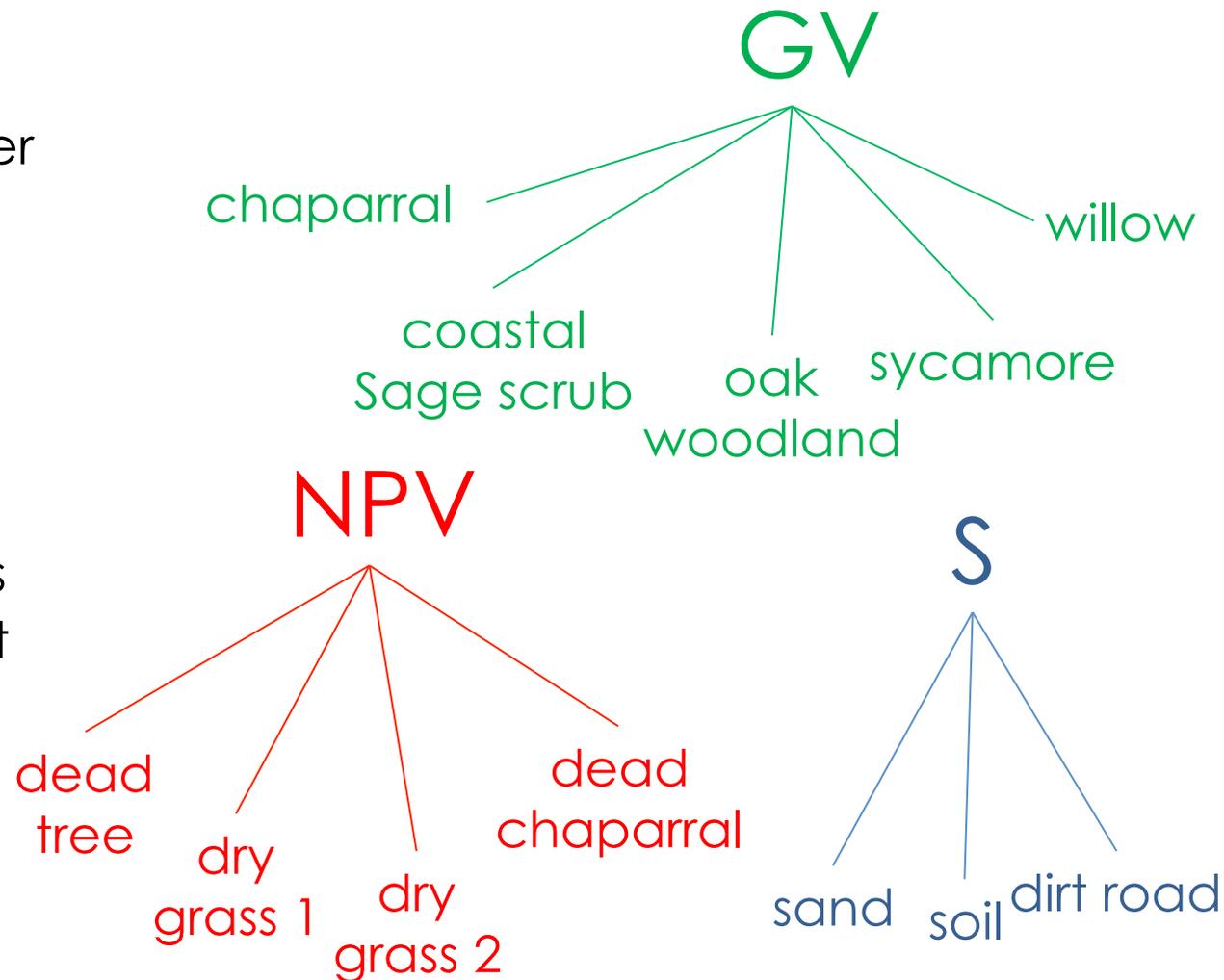
- Ability to differentiate non-photosynthetic vegetation from soil (cannot be done with NDVI)



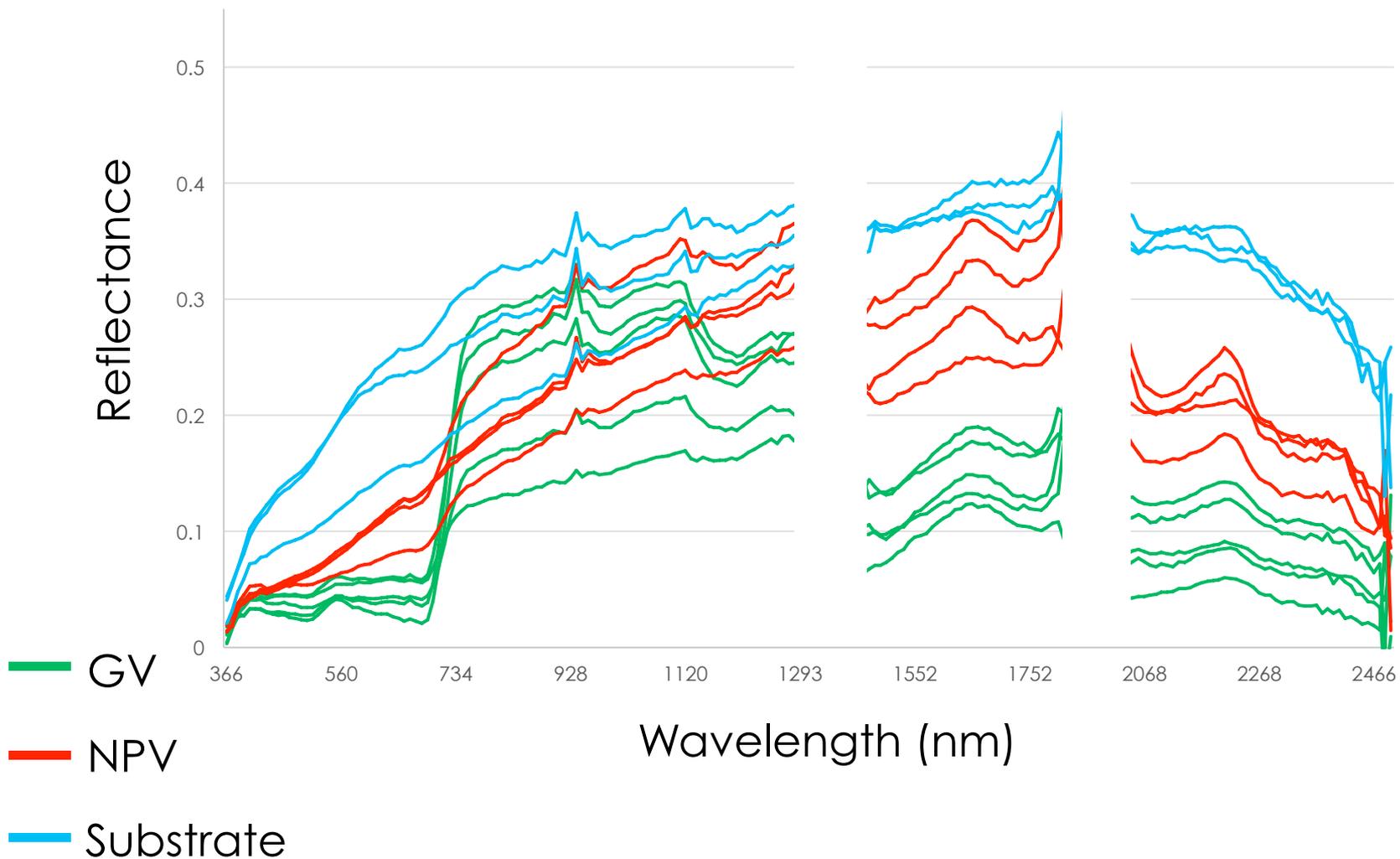
# Multiple Endmember Spectral Mixture Analysis (MESMA)

- **M**ultiple **E**ndmember **S**pectral **M**ixture **A**nalysis (MESMA)  
pure spectra to classify an image

- Method: Viper Tools  
(out of VIPER Lab at UCSB)



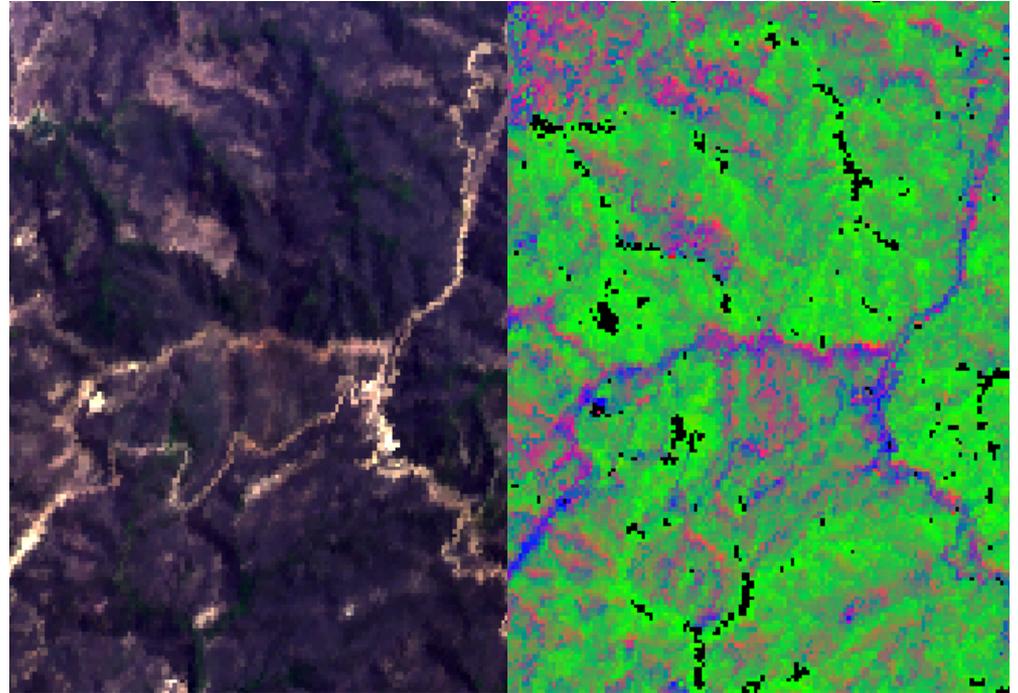
# Spectral Library



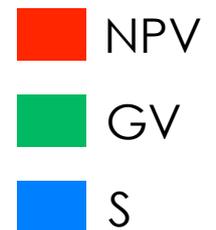
# MESMA Output

AVIRIS Reflectance Image MESMA Output

- MESMA outputs fractional cover of the chosen classes: Green Vegetation, Non-Photosynthetic Vegetation, and Substrate



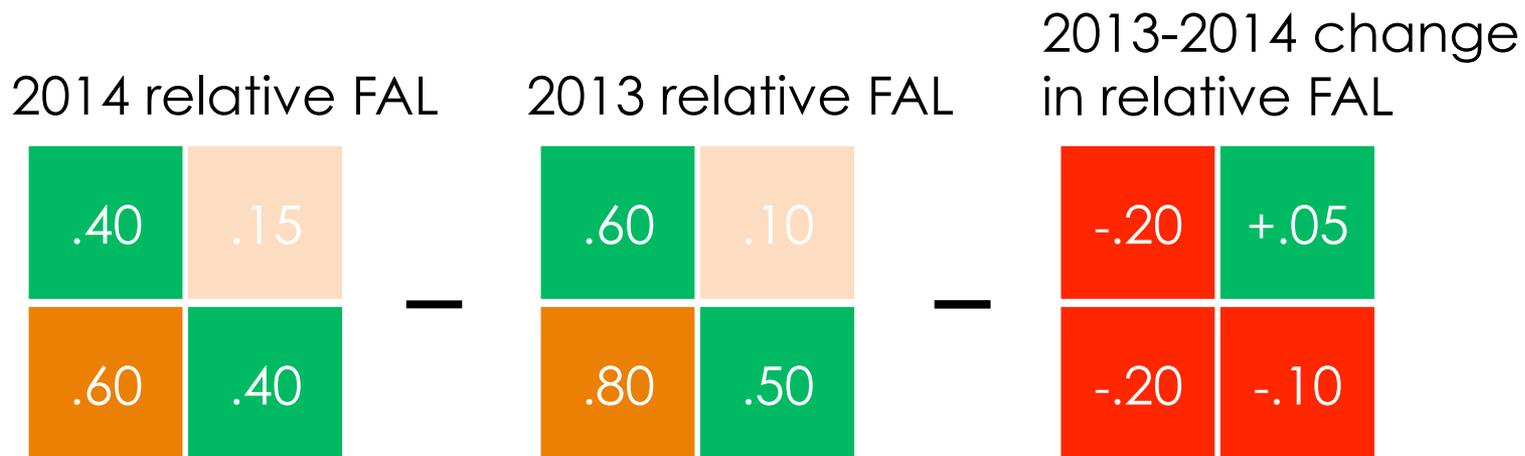
RGB display



# Relative Fraction of Alive cover (FAL)

$$\text{FAL} = \frac{\text{GV}}{\text{GV} + \text{NPV}}$$

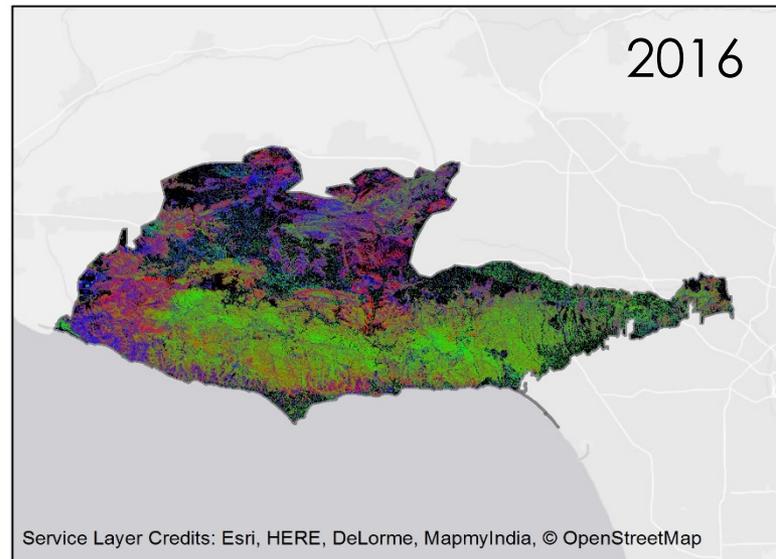
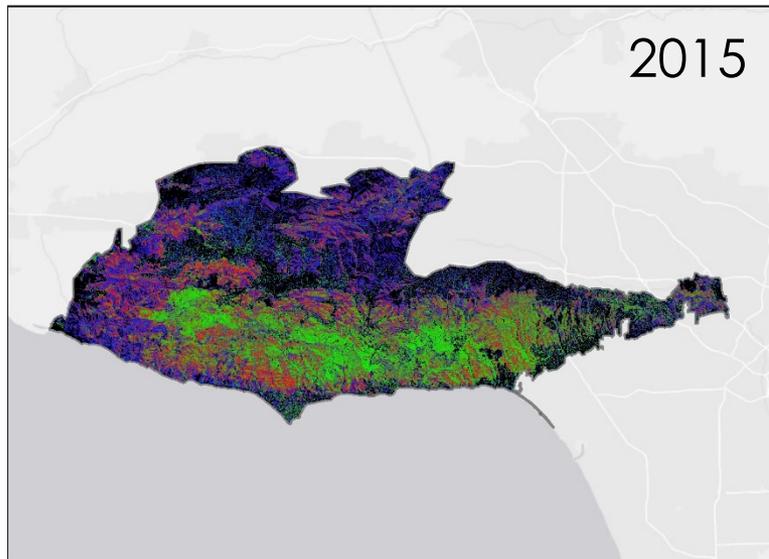
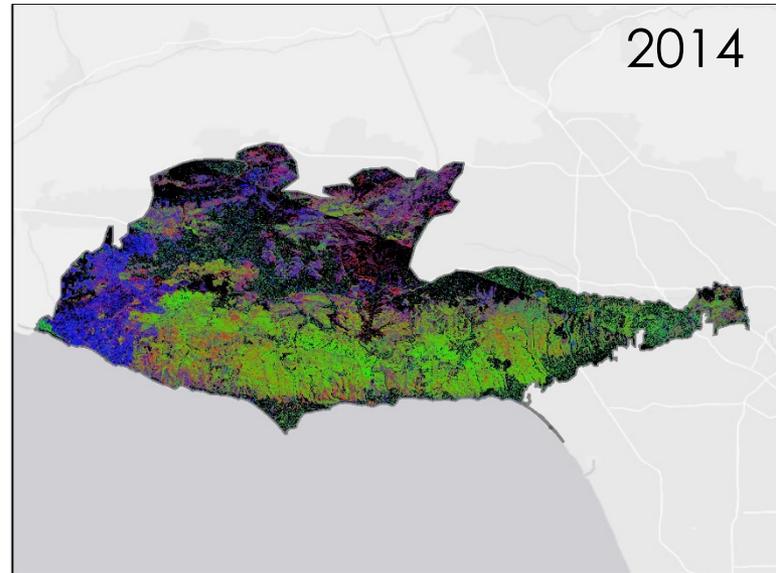
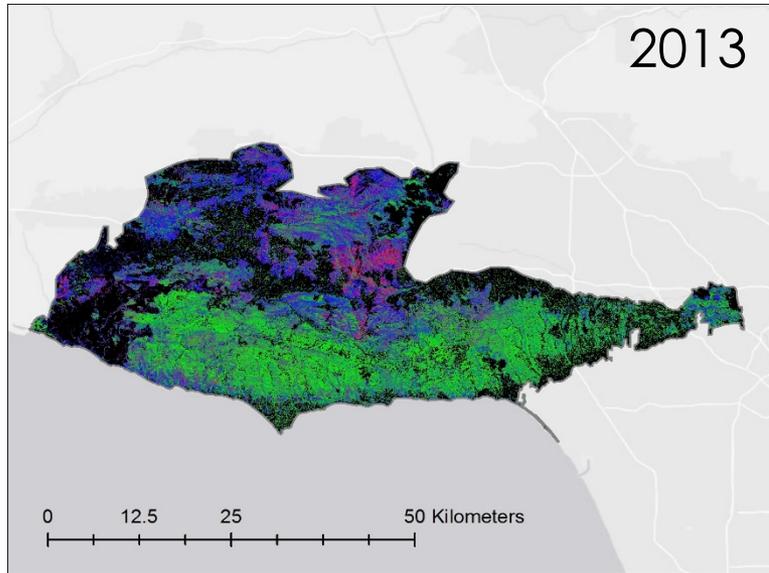
- Change in FAL shows how the fraction of alive vegetation has changed over the study period





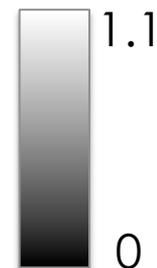
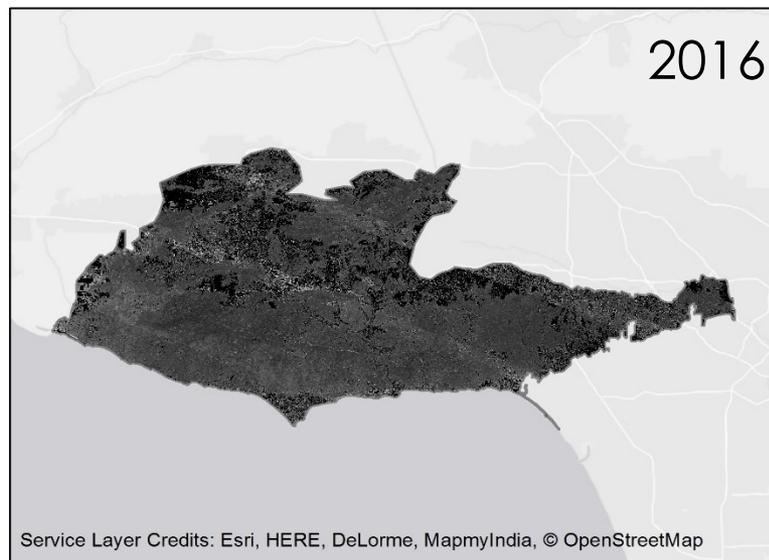
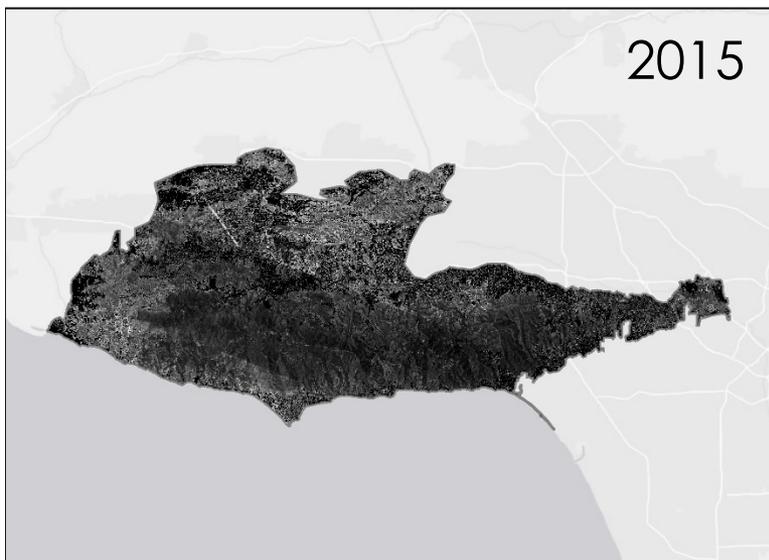
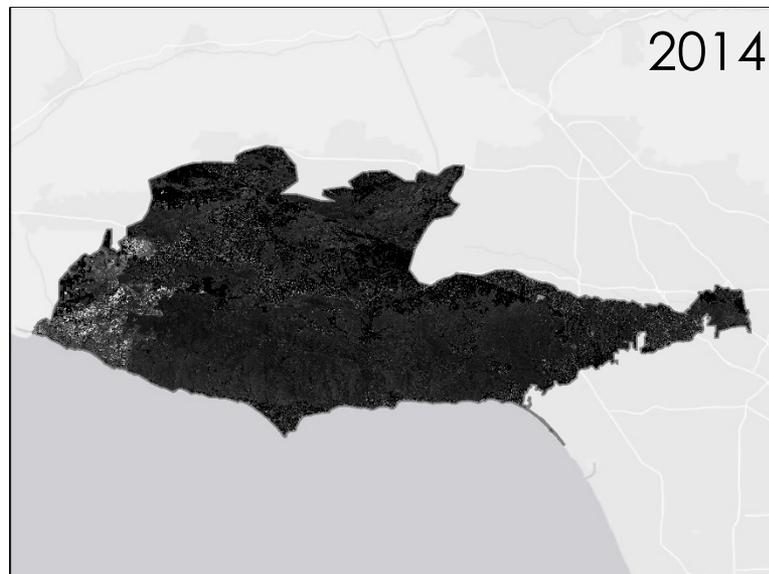
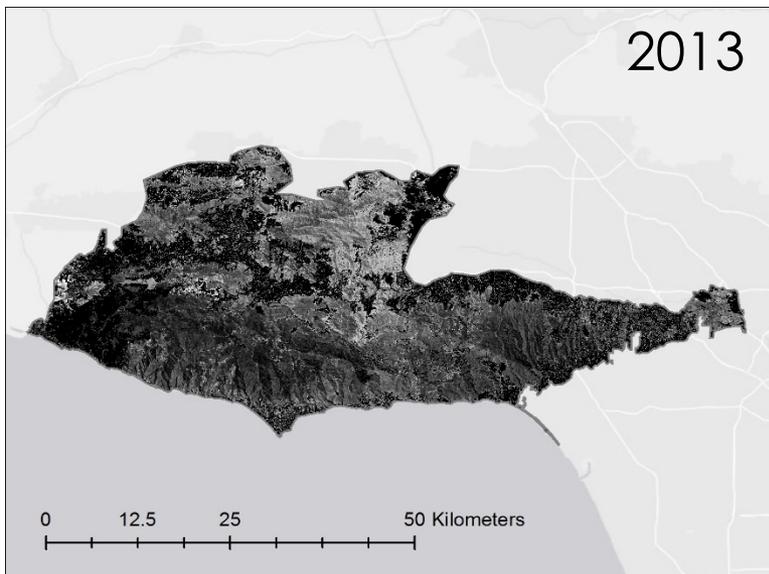
# RESULTS

# MESMA results

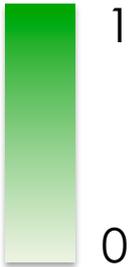
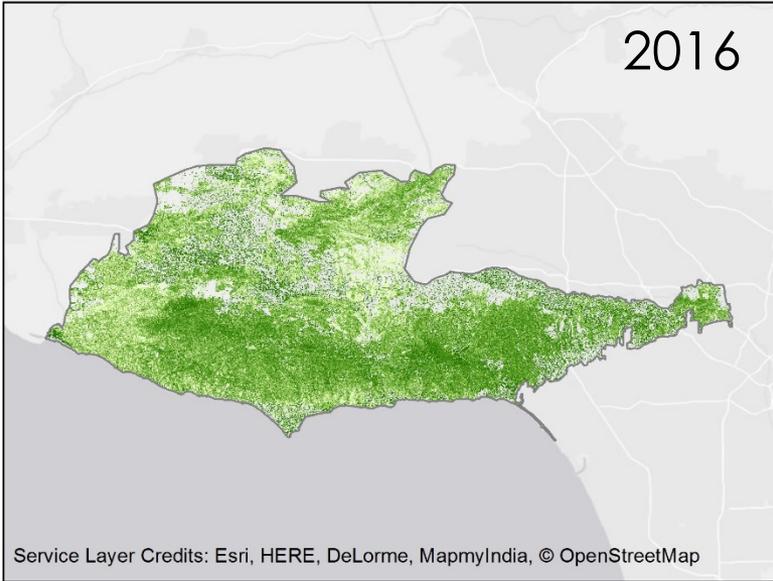
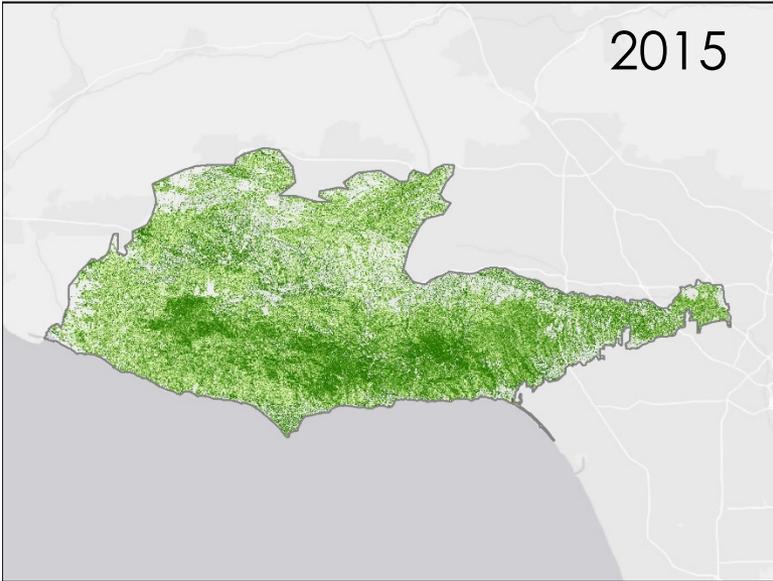
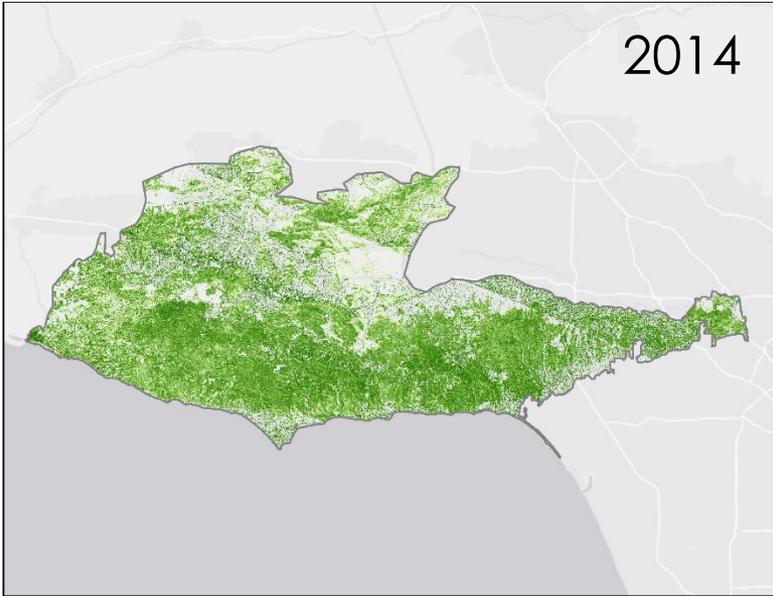
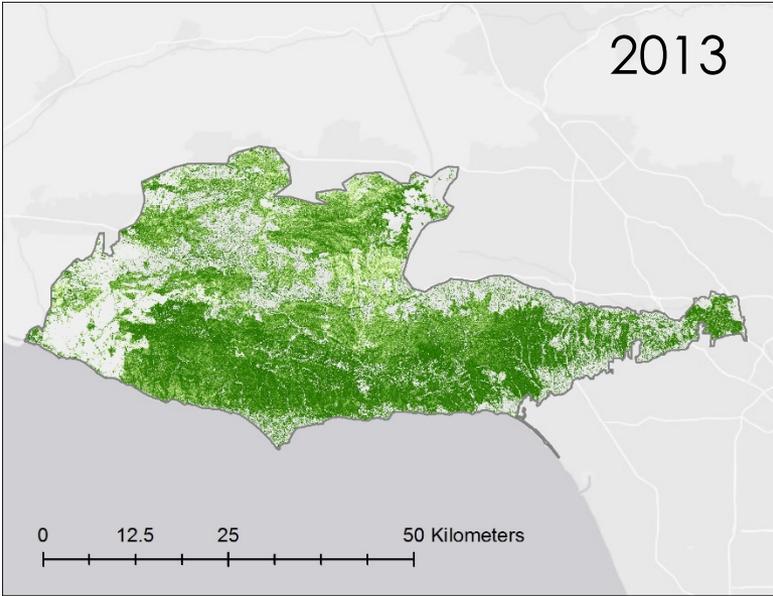


 NPV  GV  S  Unclassified

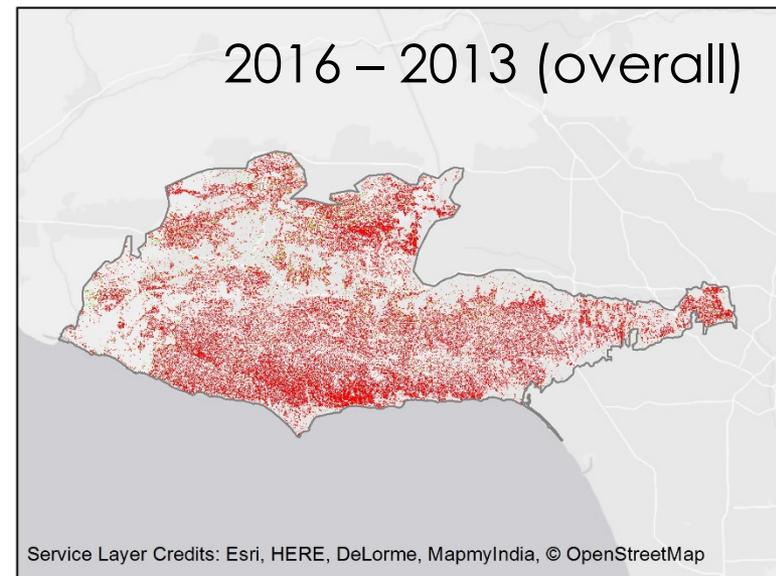
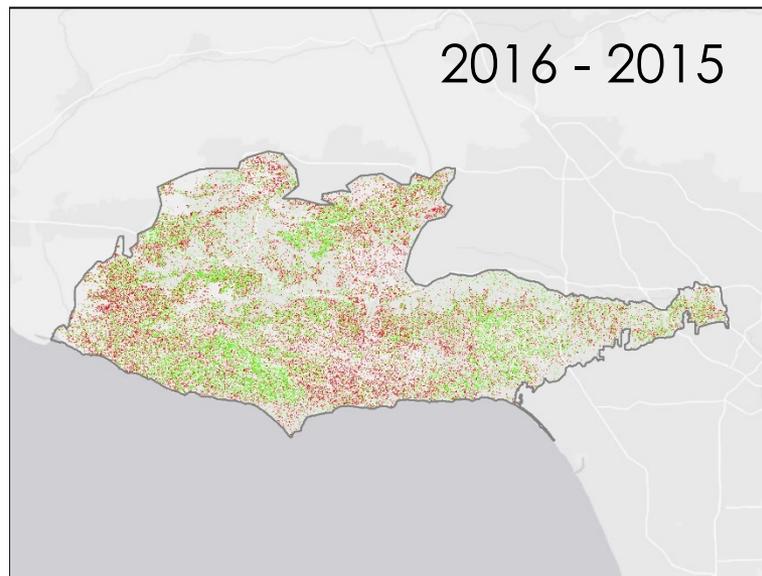
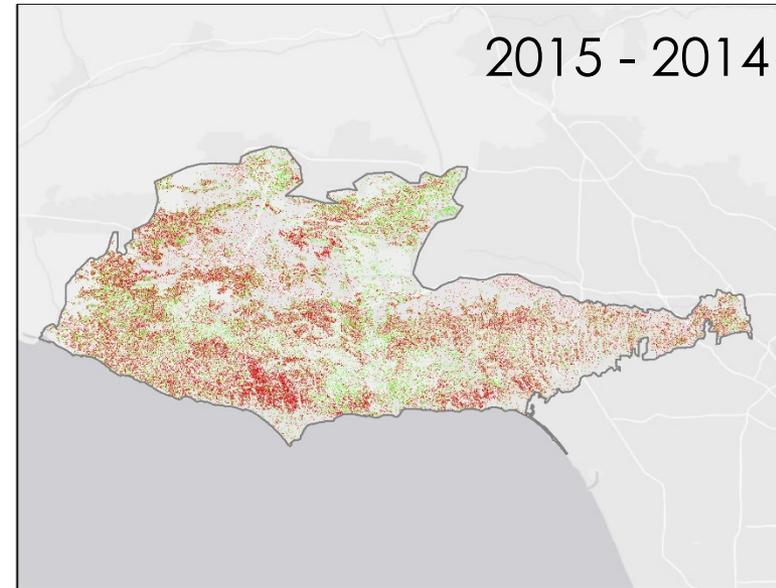
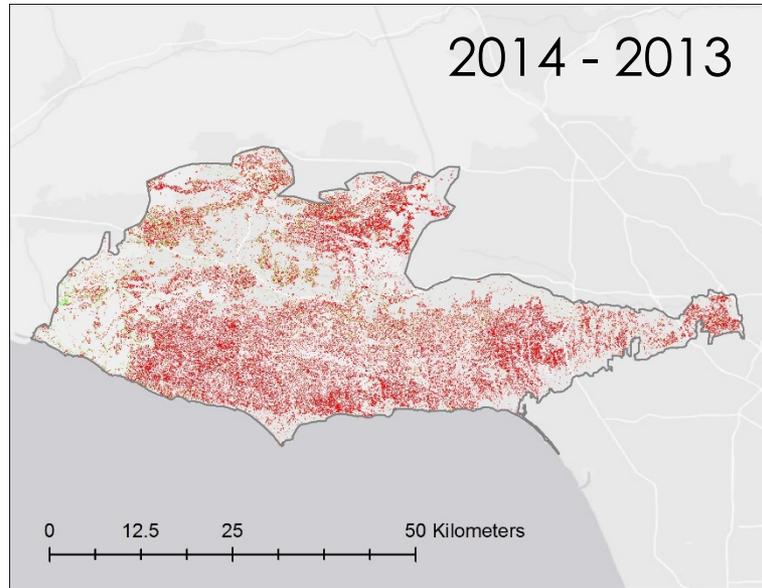
# MESMA RMSE



# Relative Fraction of Alive Cover



# Change in Relative Fraction of Alive Cover

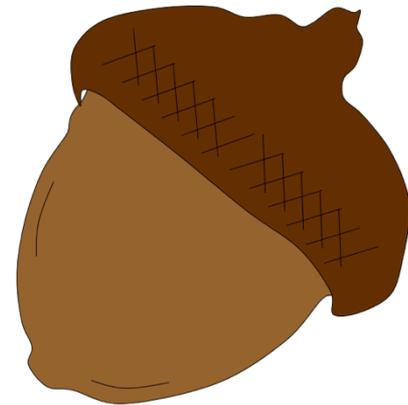


 Decrease relative FAL ( $< -0.3$ )

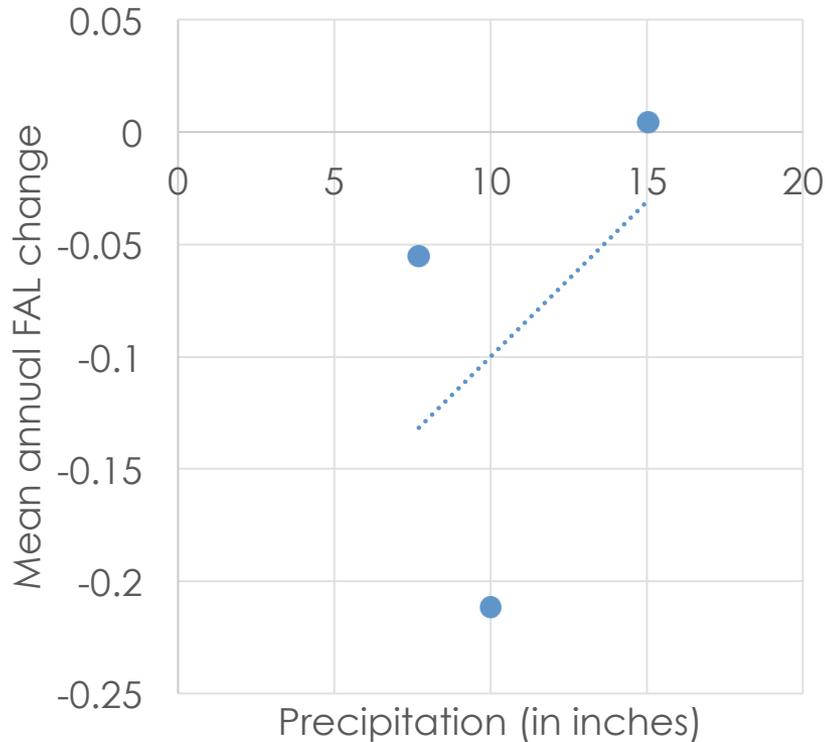
 Increase relative FAL ( $> 0.3$ )

# Exploratory Regressions

- How does relative FAL change relate to certain climate variables?
  - Temperature
  - Extreme heat days
  - Precipitation
  - Dewpoint temperature
  - Vapor pressure deficit



### FAL change vs **Cumulative Precipitation**

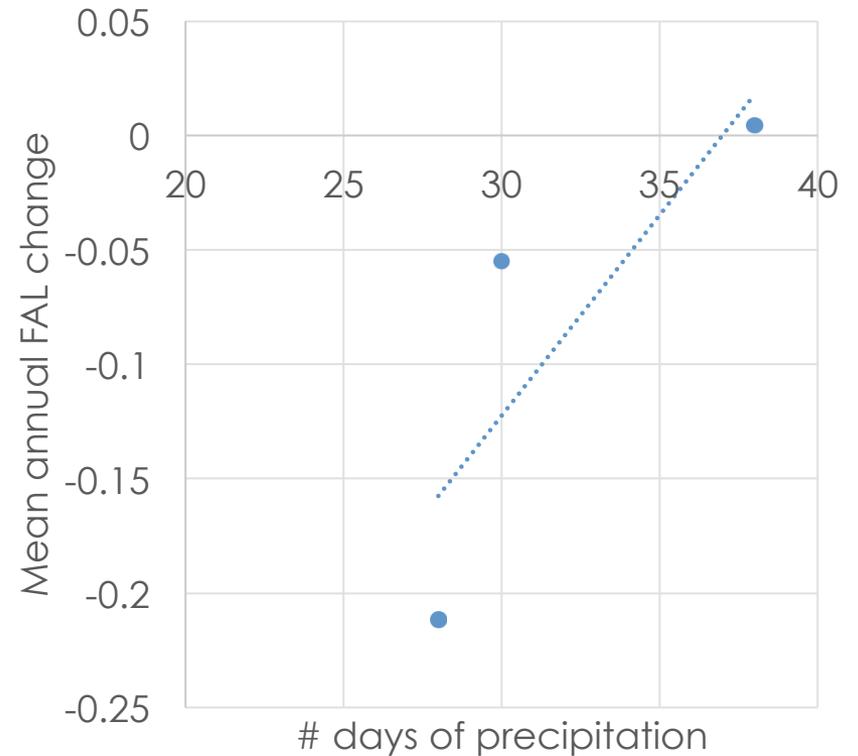


$$y = 0.0138x - 0.238$$

$$R^2 = 0.216$$

$$RMSE=0.081$$

### FAL change vs **Days of Precipitation**

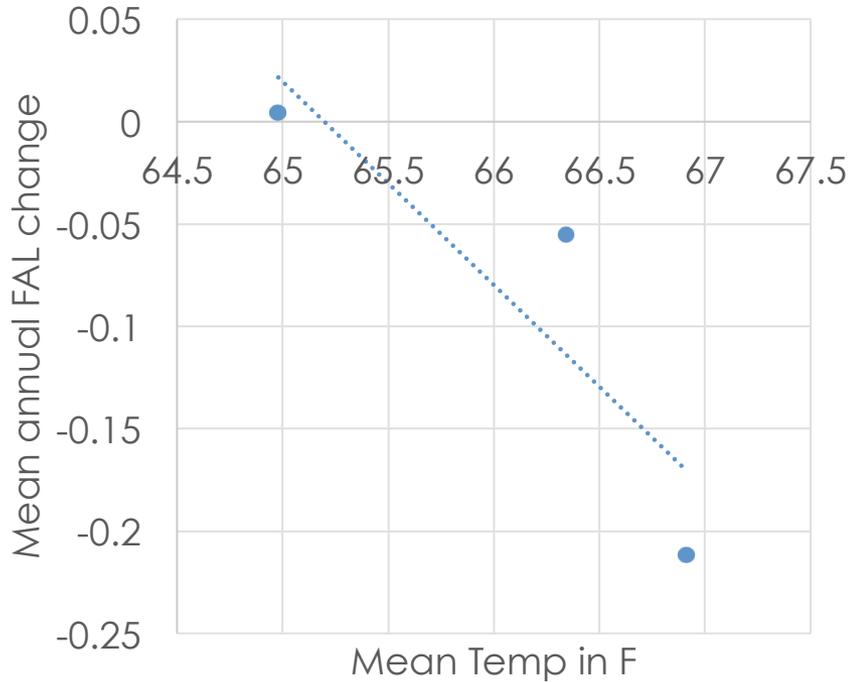


$$y = 0.0175x - 0.6485$$

$$R^2 = 0.693$$

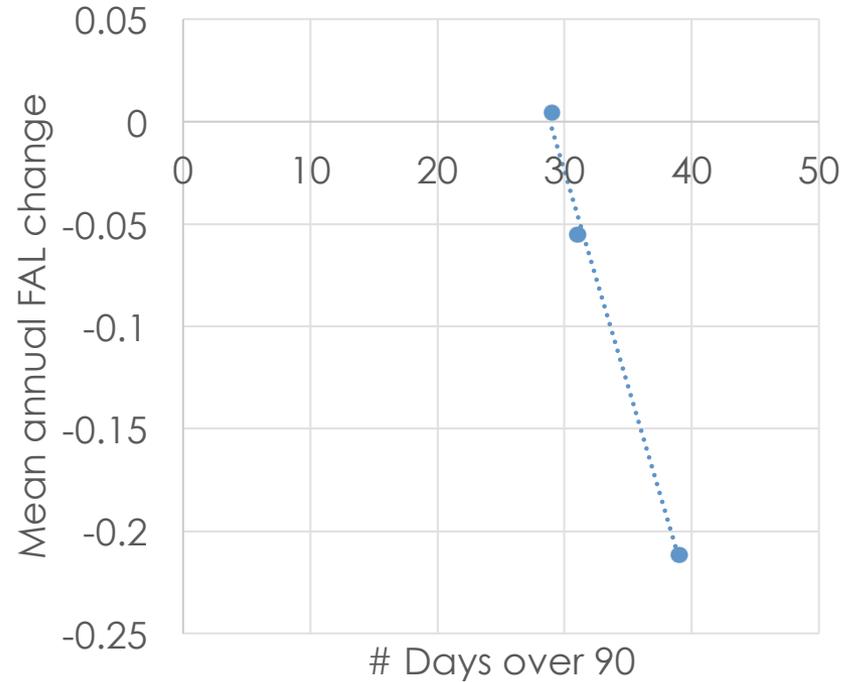
$$RMSE= 0.050$$

### FAL change vs **Mean Temperature**



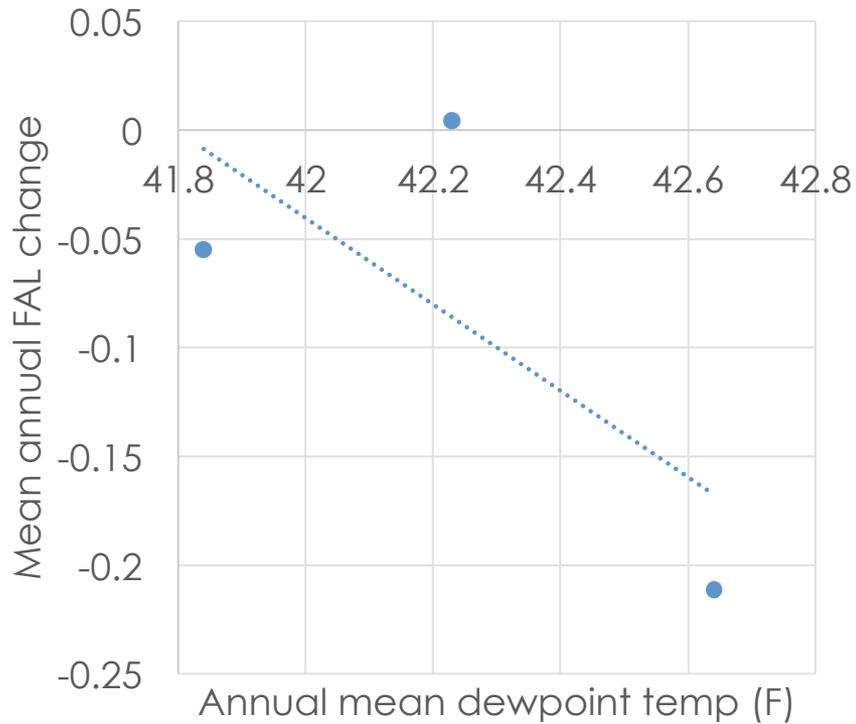
$y = -0.0994x + 6.4804$   
 **$R^2 = 0.782$**   
**RMSE=0.043**

### FAL change vs **Days over 90F**



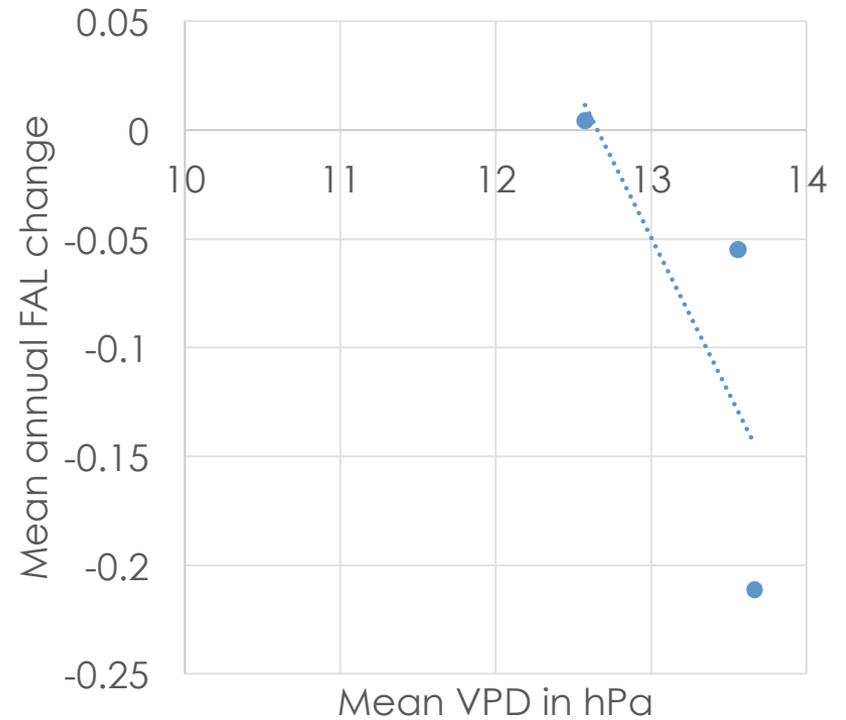
$y = -0.021x + 0.6057$   
 **$R^2 = 0.994$**   
**RMSE=0.007**

### FAL vs Mean Dewpoint Temperature

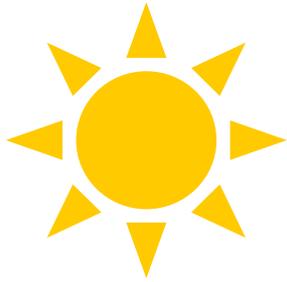


$y = -0.1984x + 8.2936$   
 **$R^2 = 0.507$**   
**RMSE= 0.064**

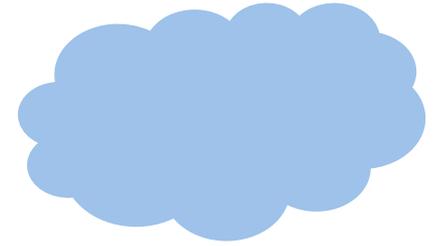
### FAL vs Mean Vapor Pressure Deficit



$y = -0.1429x + 1.809$   
 **$R^2 = 0.594$**   
**RMSE= 0.0580**



# Conclusions



- We saw an overwhelming loss of relative fraction of alive cover across the study period
- The exploratory regression analysis suggested the annual change in relative FAL was highly correlated with **mean temperature** and number of **days over 90F**
- Change in relative FAL was also moderately correlated with number of **days of precipitation** and **mean vapor pressure deficit**

# Uncertainties

- Time period limited to AVIRIS surface reflectance coverage
- Chosen AVIRIS dates may be subject to seasonal changes
- Exploratory regression used very few data points



Image source:  
Emil Chang

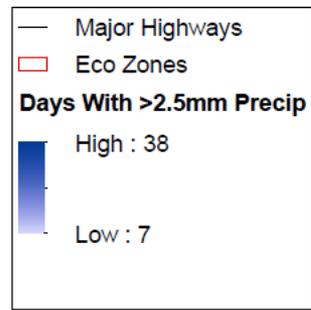
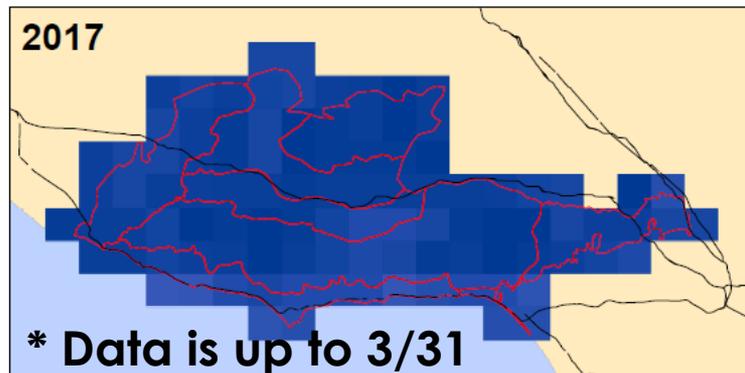
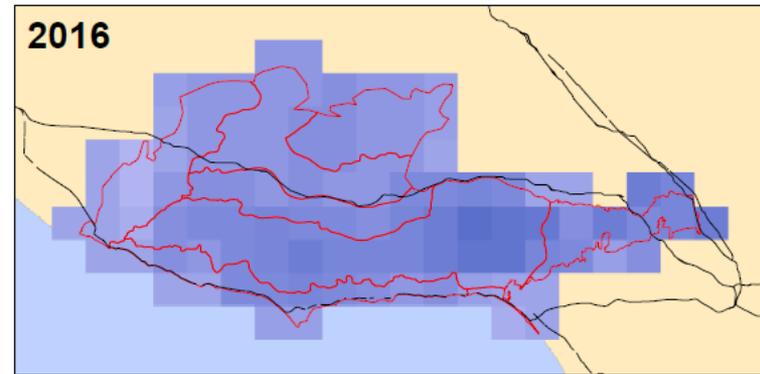
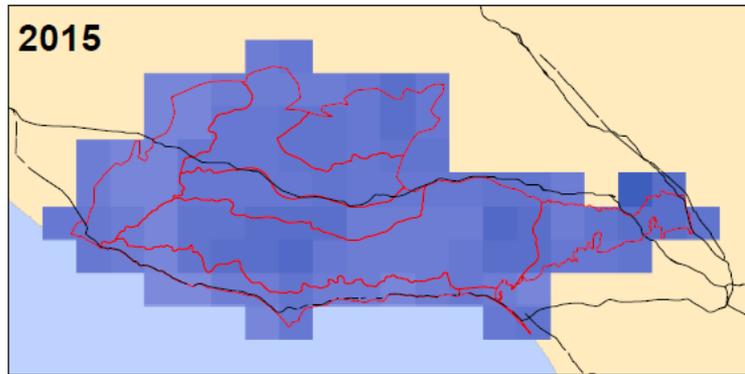
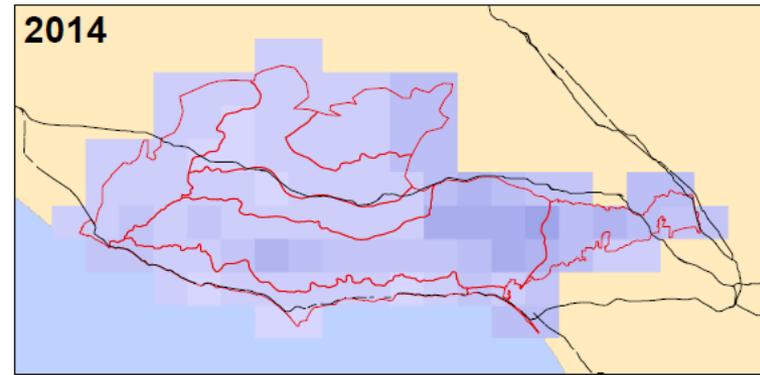
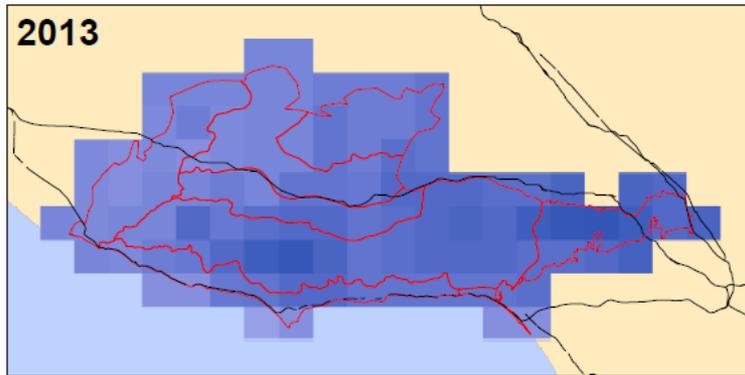
# Next steps

- The partners wanted us to continue!
- **Process PRISM for entire landscape**
- Test different thresholds in relative FAL – what makes a “dead” pixel?



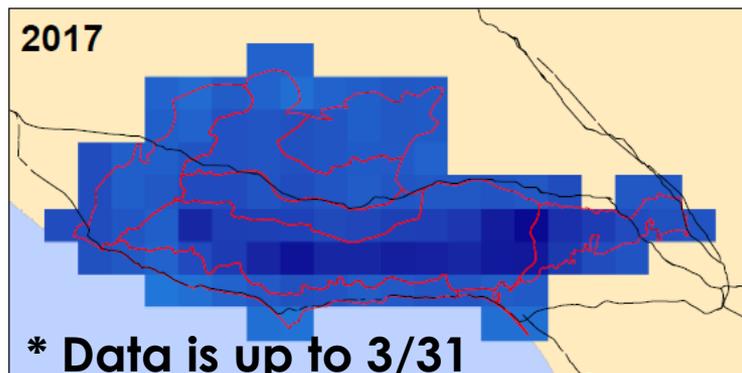
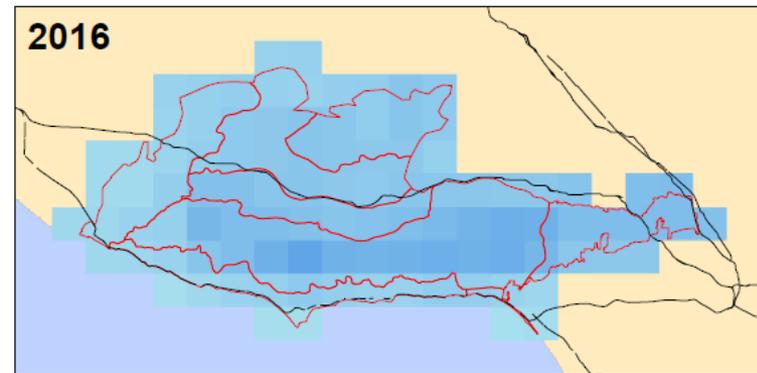
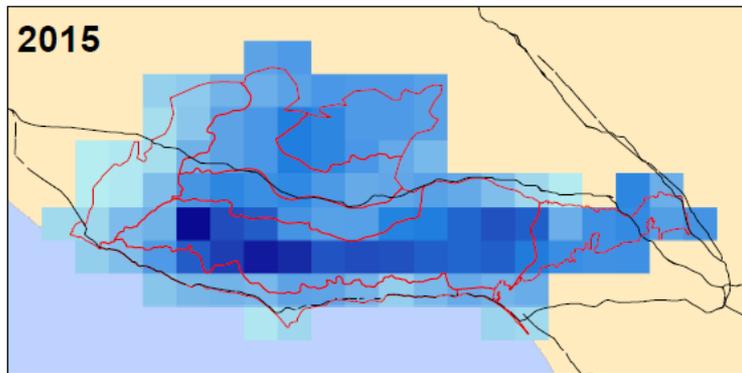
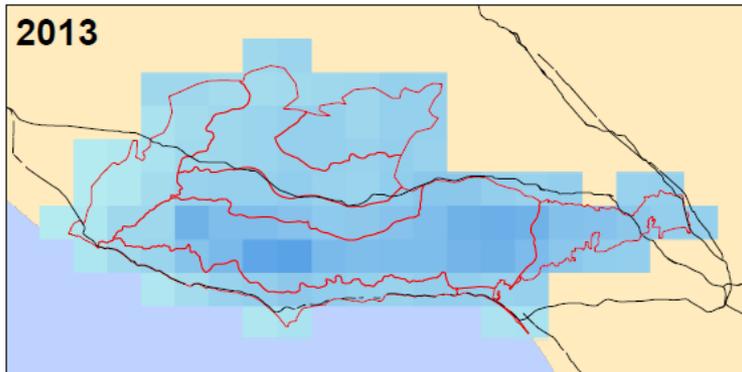
Image source: Ariana Nickmeyer

# Annual # days precipitation

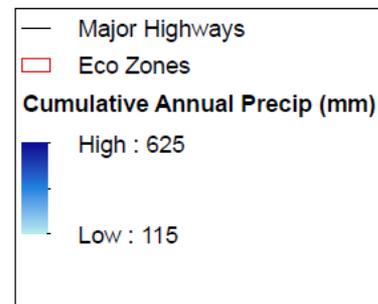


Data Source: PRISM  
Pixel size: 4km

# Annual cumulative precipitation

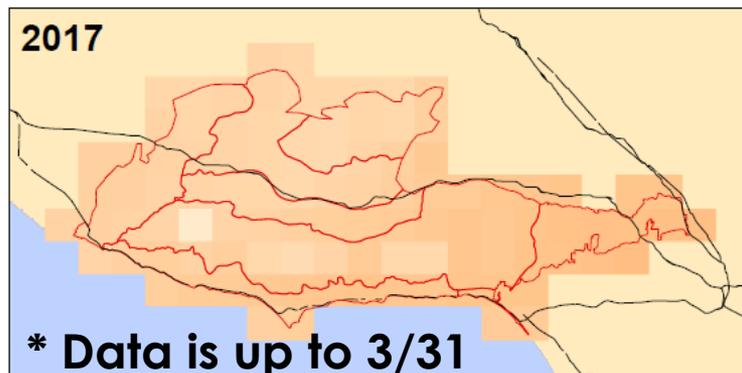
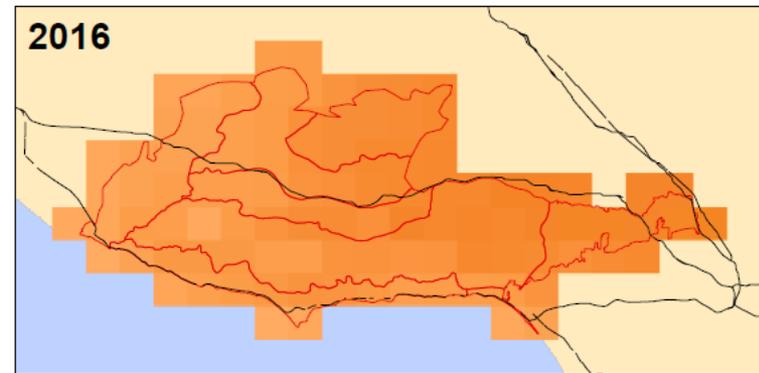
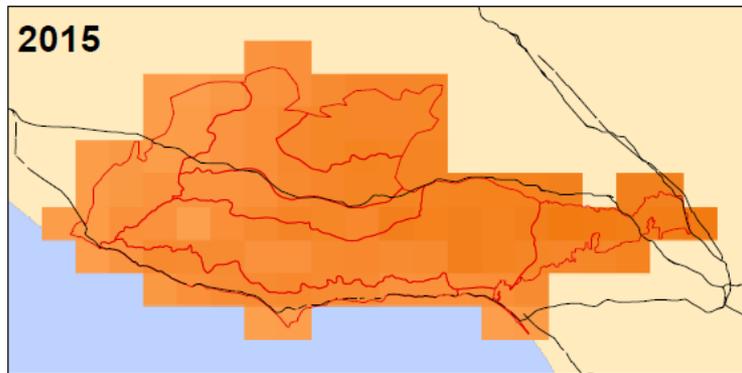
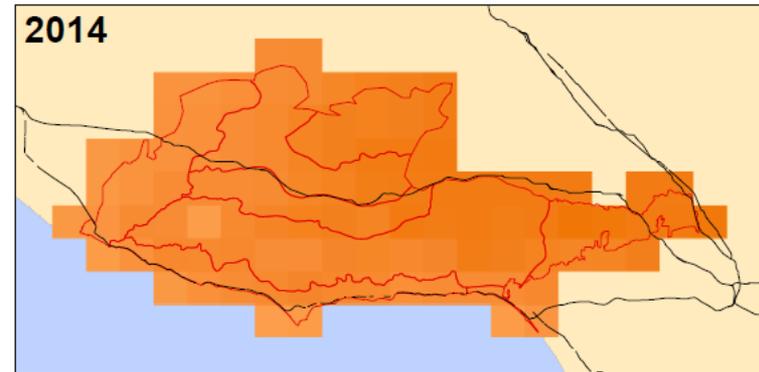
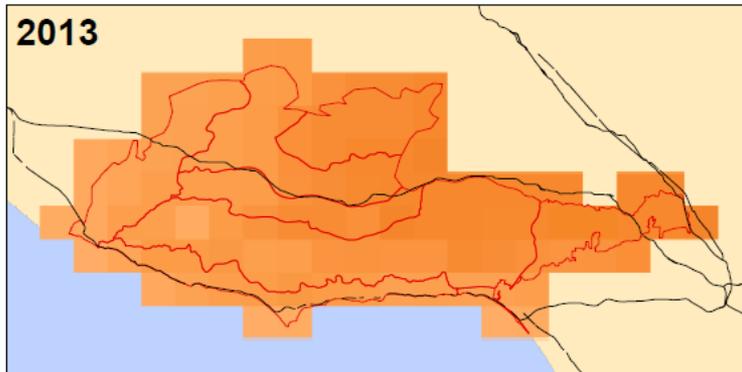


0 12.5 25 50 Miles

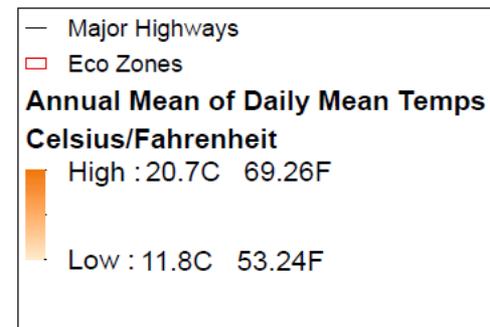


Data Source: PRISM  
Pixel size: 4km

# Annual mean temperature

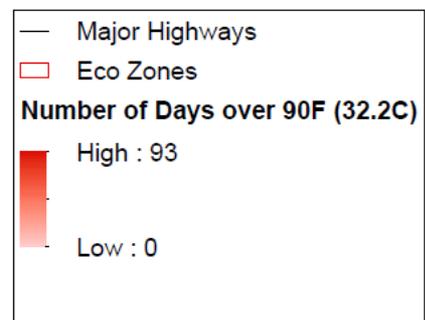
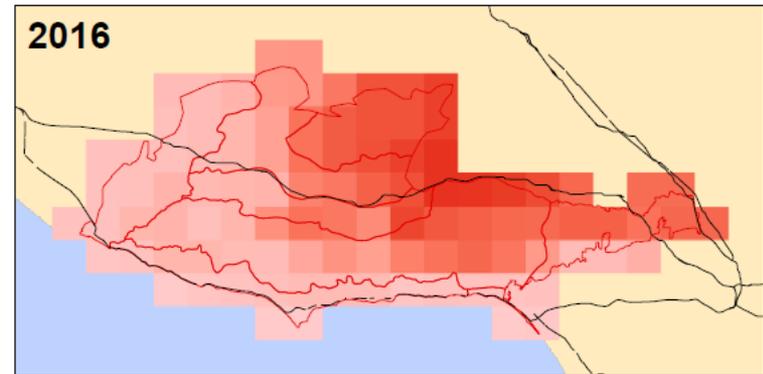
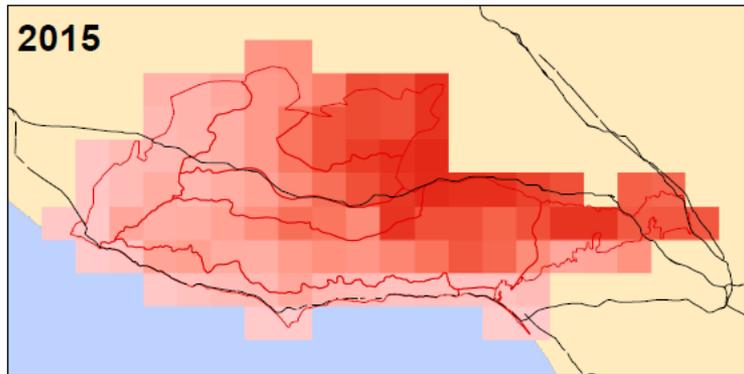
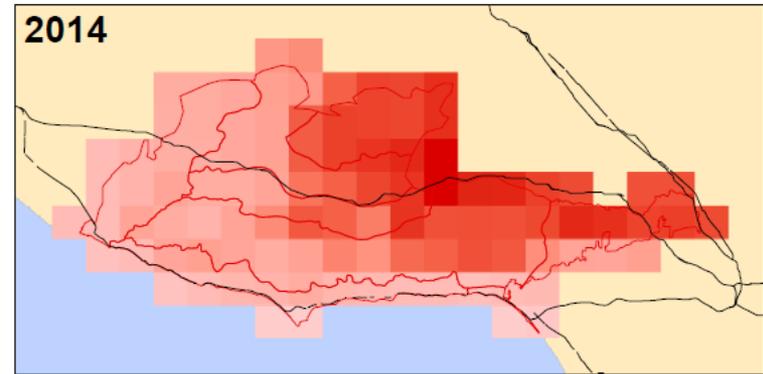
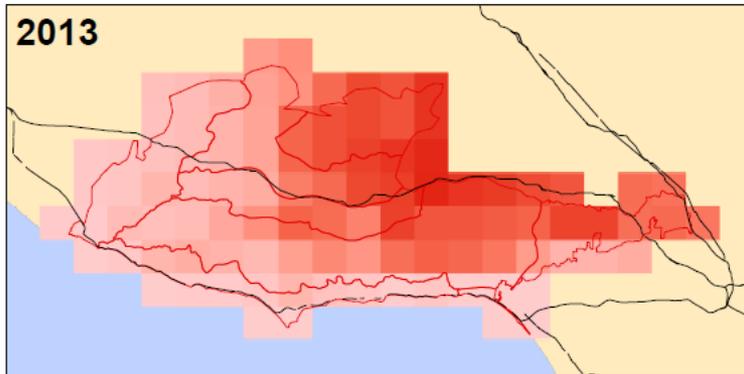


0 12.5 25 50 Miles



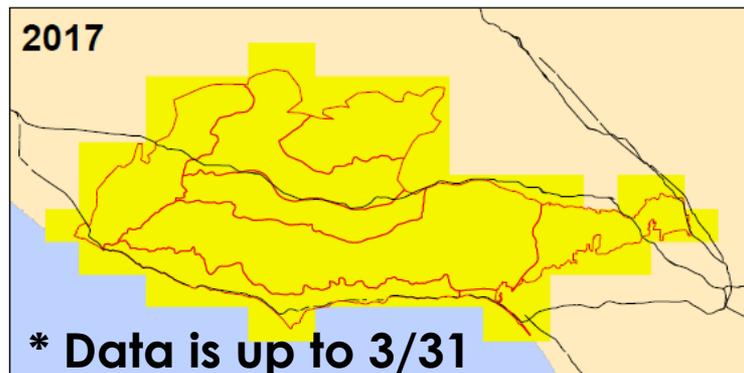
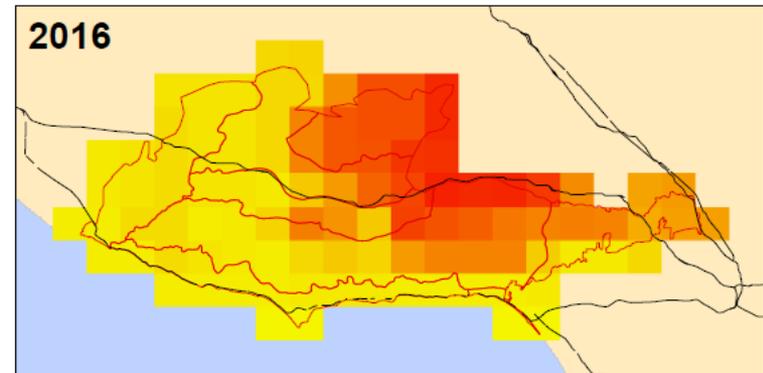
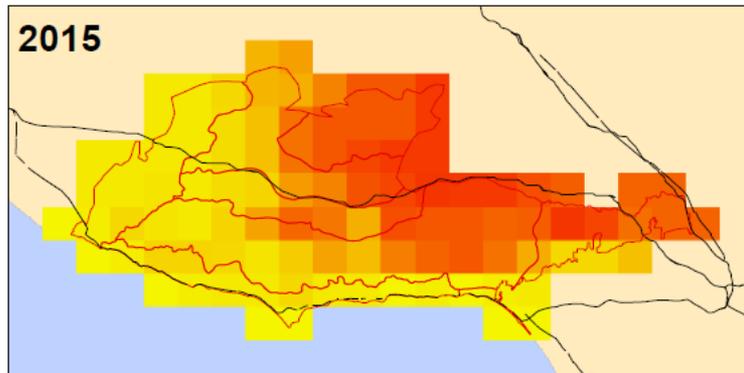
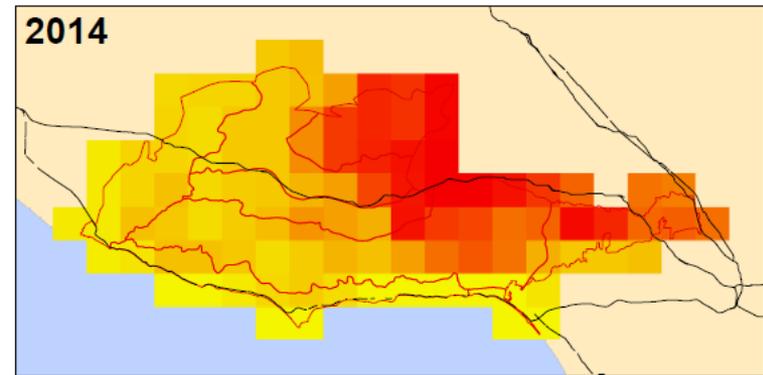
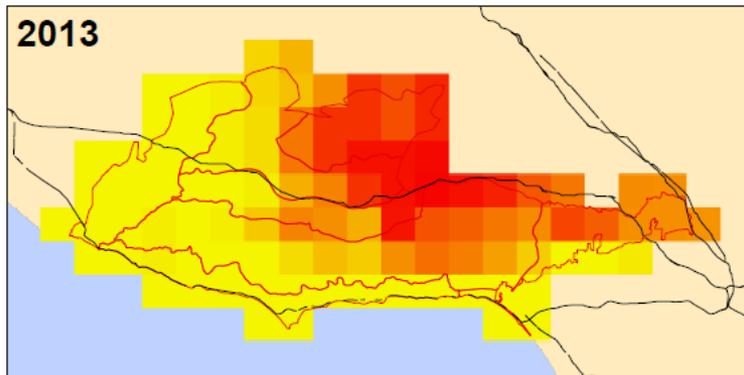
Data Source: PRISM  
Pixel size: 4km

# Annual # days over 90°F

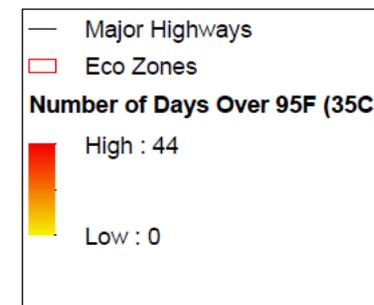


Data Source: PRISM  
Pixel size: 4km

# Annual # days over 95°F



0 12.5 25 50 Miles



Data Source: PRISM  
Pixel size: 4km

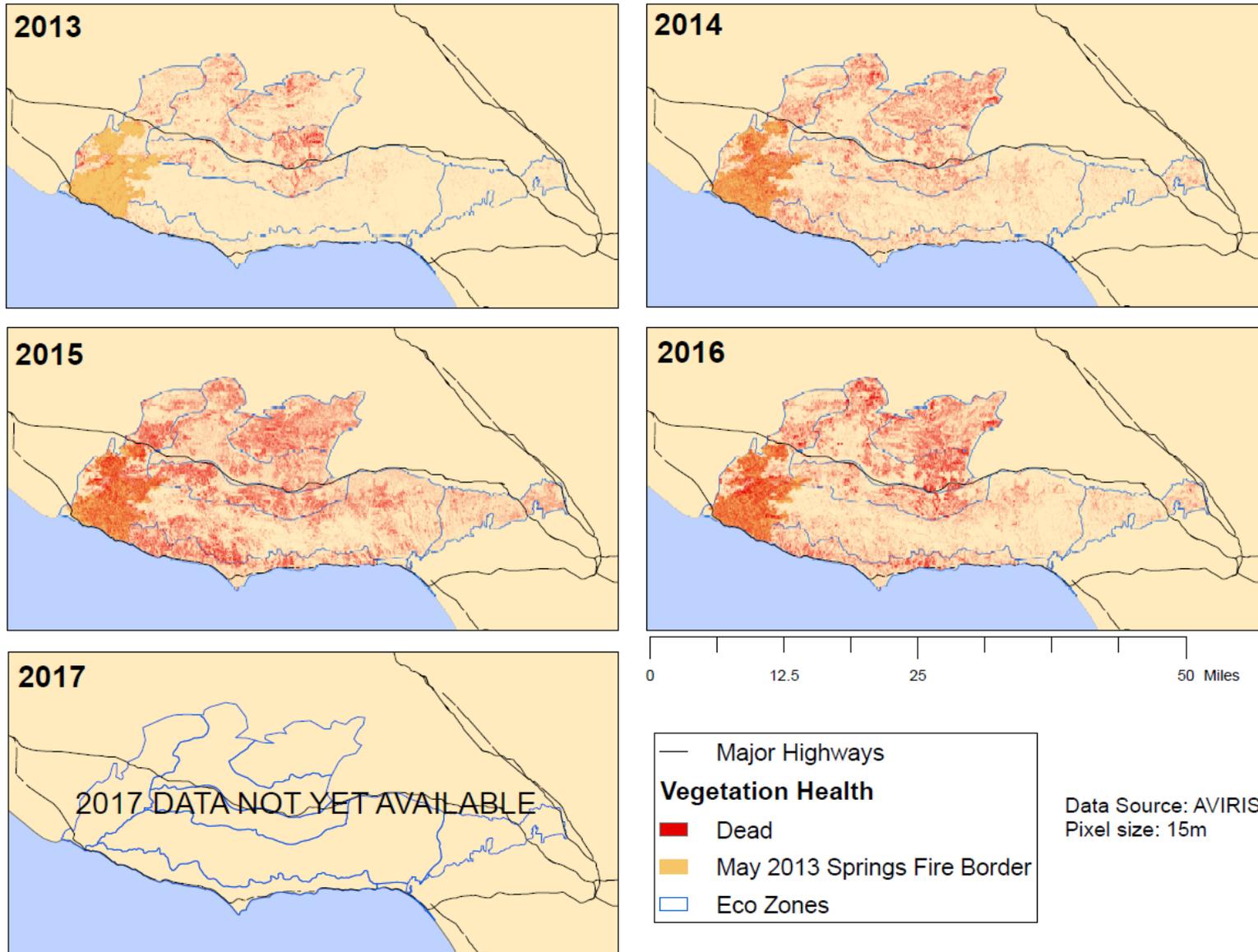
# Next steps

- The partners wanted us to continue!
- Process PRISM for entire landscape
- **Test different thresholds in relative FAL – what makes a “dead” pixel?**



Image source: Ariana Nickmeyer

# Finding relative FAL threshold



# In the coming weeks...

- Incorporate field vegetation plots and locations of harmful beetle presence
- Address how dieback has varied among major vegetation types
- Assess topographical effects: slope, aspect, and elevation



Image source: Ariana Nickmeyer

# Acknowledgements

- Dr. Natasha Stavros, Jet Propulsion Laboratory, California Institute of Technology
- Benjamin Holt, Jet Propulsion Laboratory, California Institute of Technology



For more about DEVELOP visit <https://develop.larc.nasa.gov>