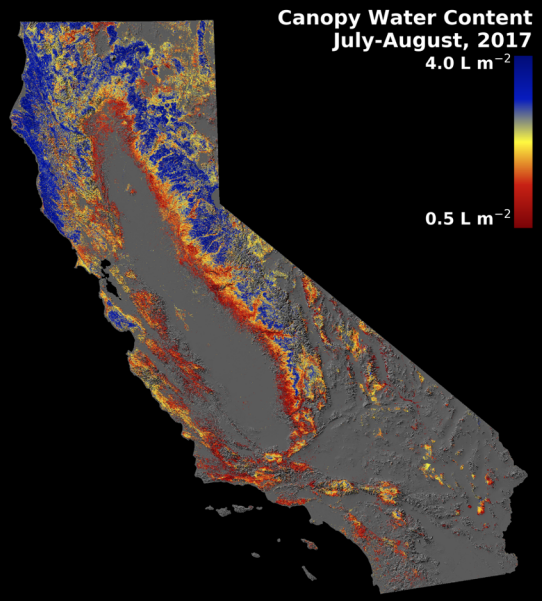
Vulnerability and Resistance to Drought in California Forests

Sponsorship to present this work at the 2019 AGU Fall Meeting was provided by Jet Propulsion Laboratory, California Institute of Technology, under contract to NASA. This work was done as a private venture and not in the author's capacity as an employee of the Jet Propulsion Laboratory, California Institute of Technology.

ASU Center for Global Discovery and Conservation Science

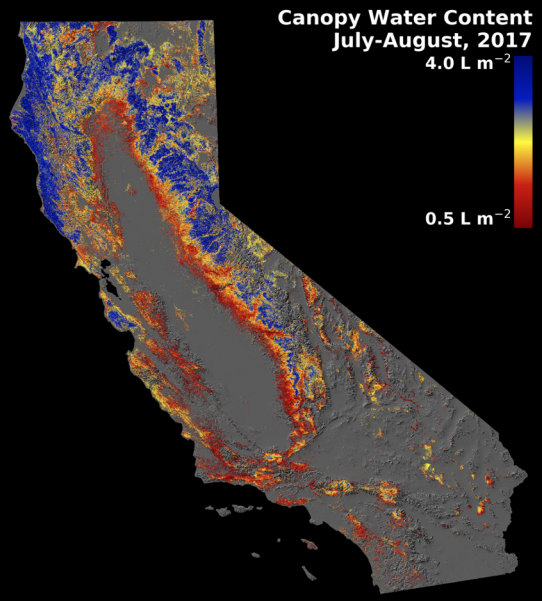
Bridging Field and Satellite Observations

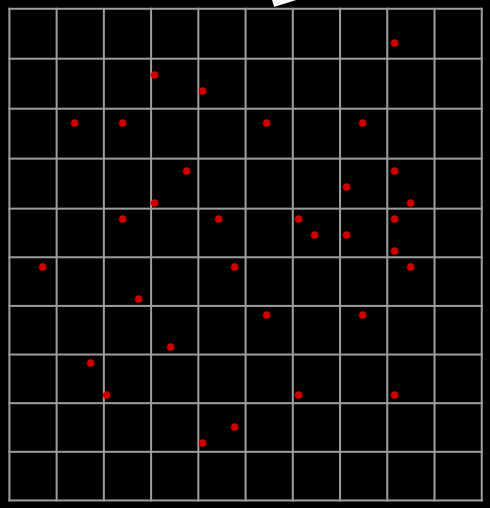
Scale Mismatch

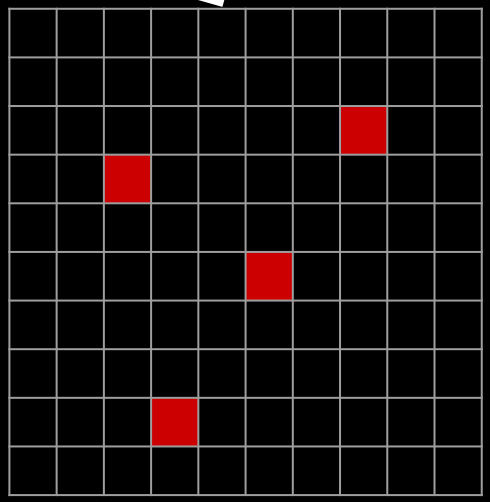


Bridging Field and Satellite Observations

Scale Mismatch

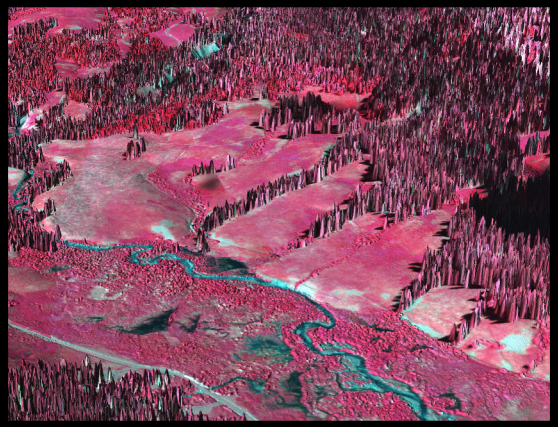




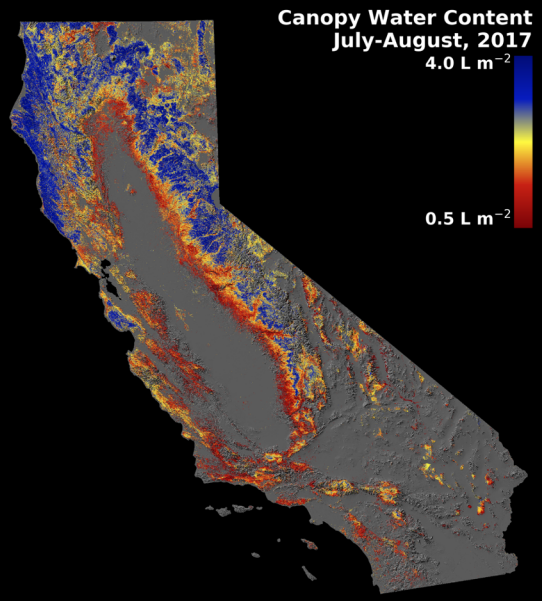


Bridging Field and Satellite Observations

Field



Airborne Imaging Spectroscopy



Satelite

Small n
Big p

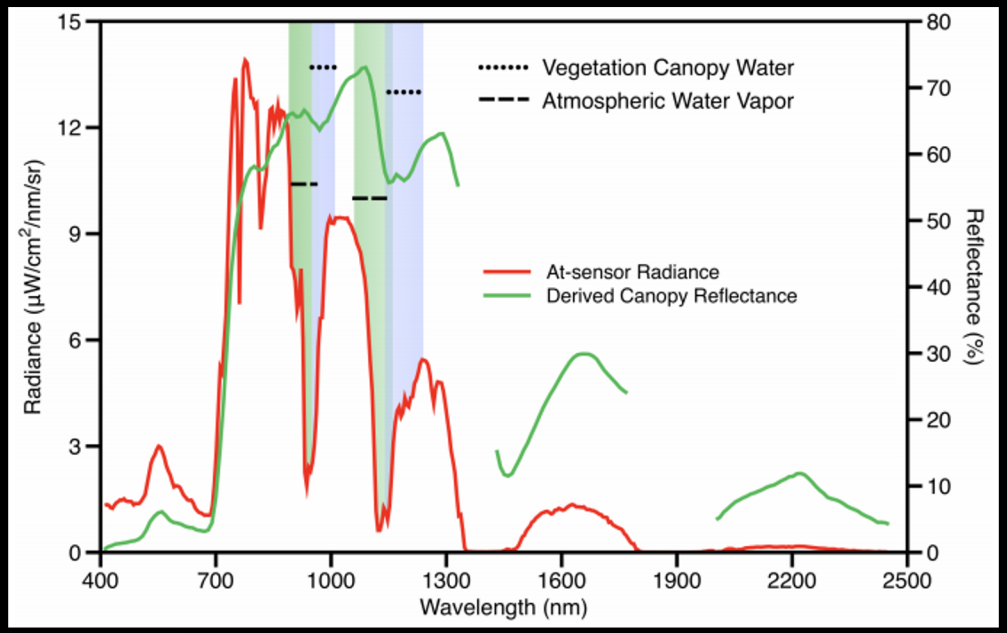
Big n
Small p

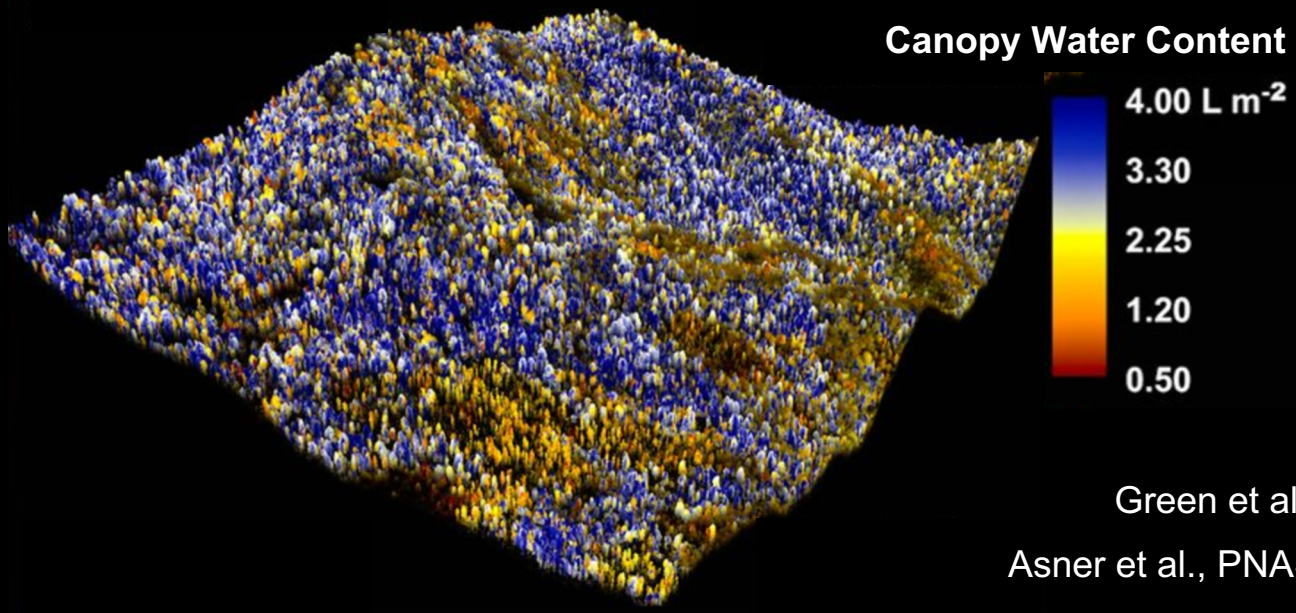
2012-2015 California Drought

Justin Sullivan/Getty Images

Widespread Tree Mortality

Global Airborne Observatory (GAO)

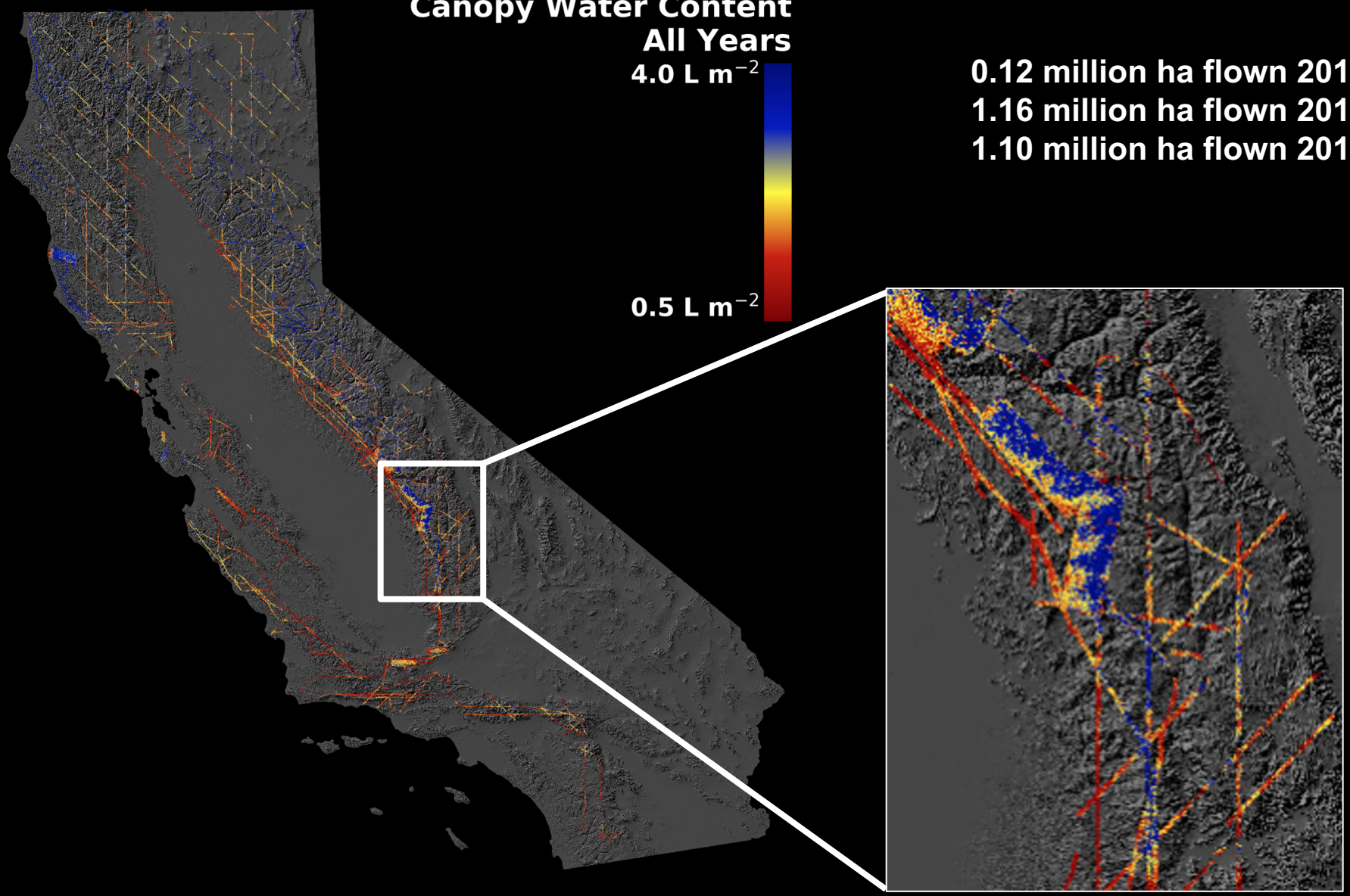




Green et al., 1993

Asner et al., PNAS 2016

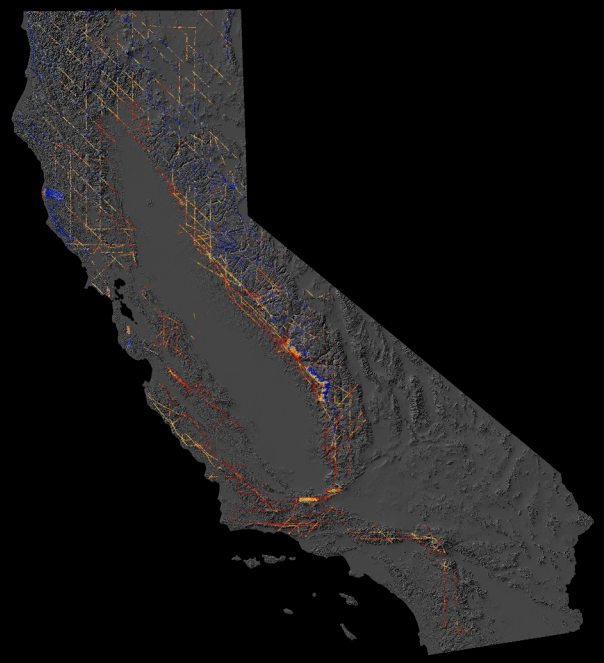
2015, 2016, and 2017 Data Collection Campaigns



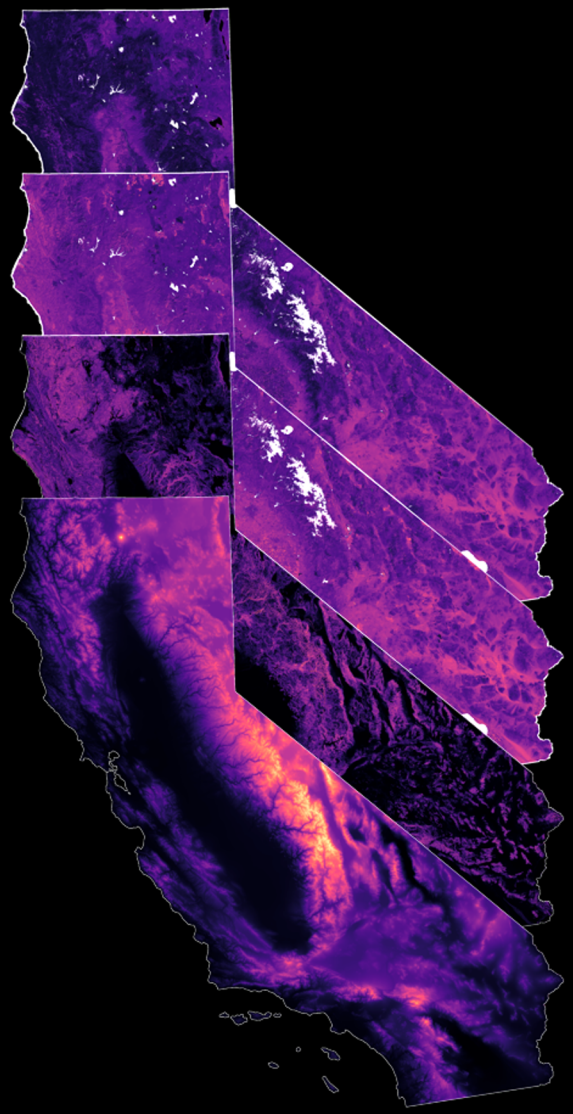
0.12 million ha flown 2017
1.16 million ha flown 2016
1.10 million ha flown 2015

Upscaling for Statewide Mapping

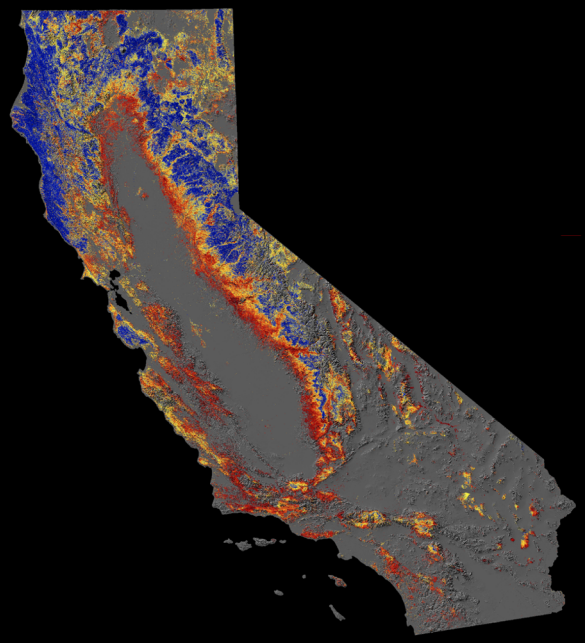
Sparse Flight Observations



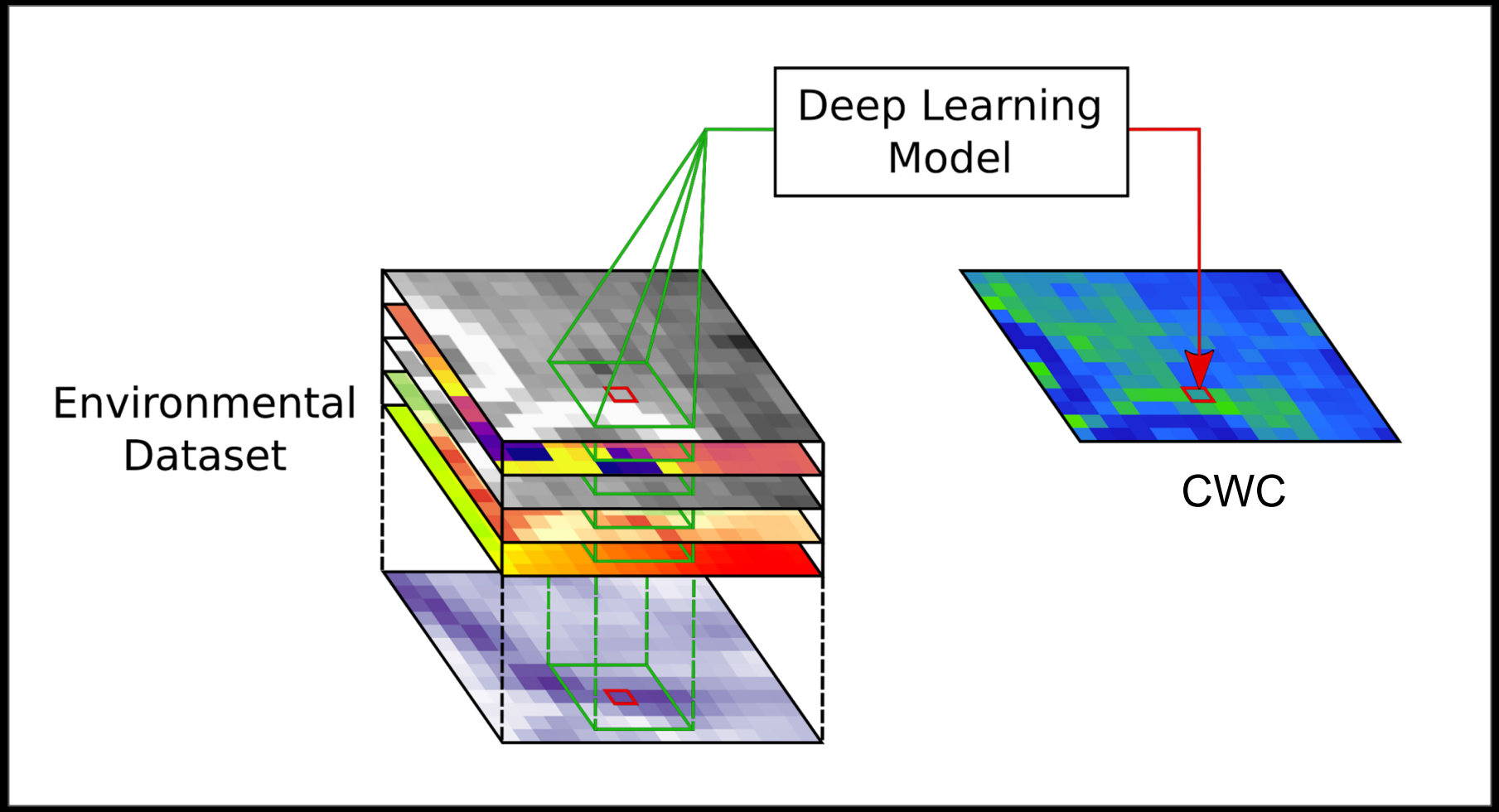
Wall-to-wall Satellite Data



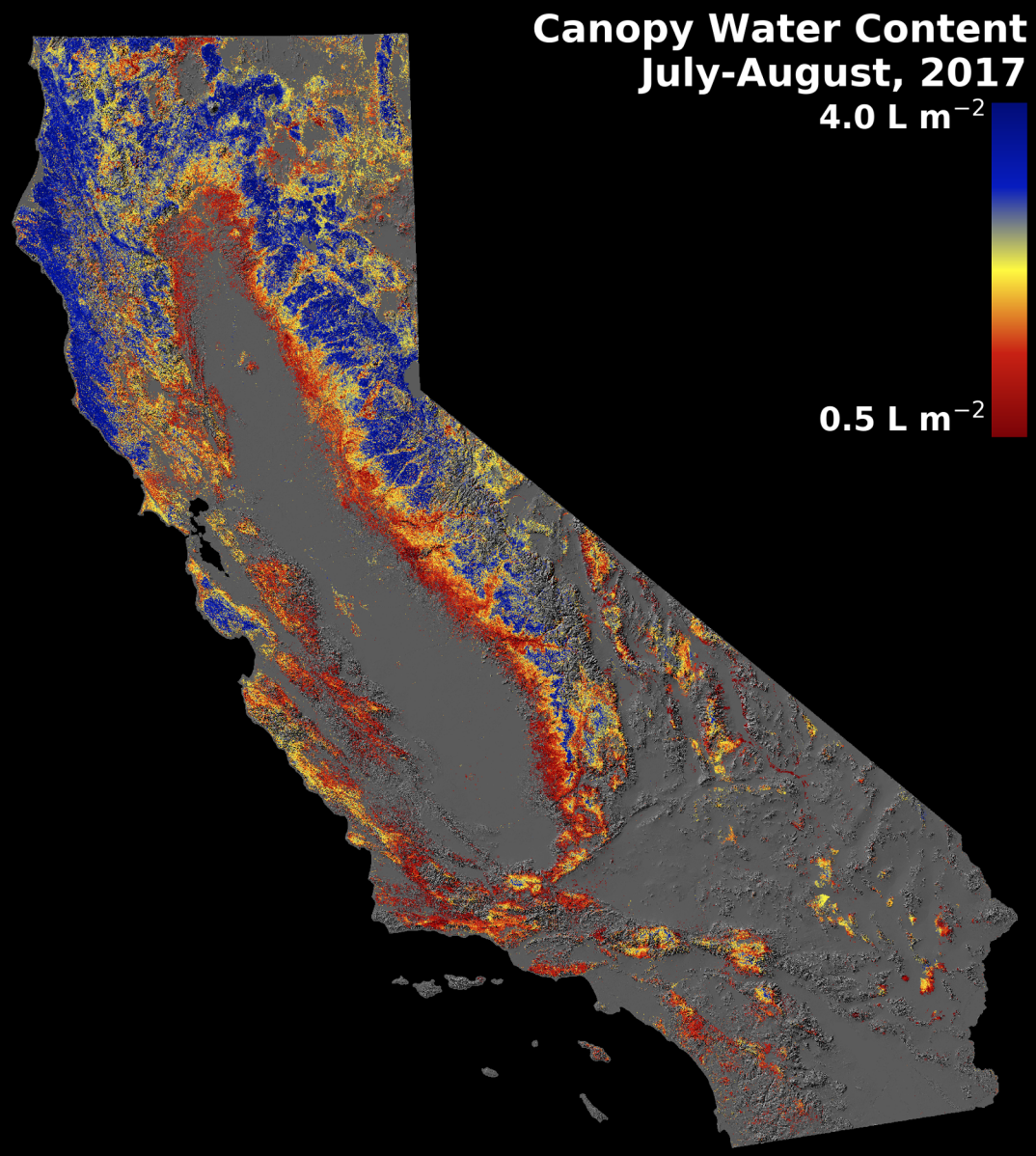
Wall-to-all Canopy Water Content

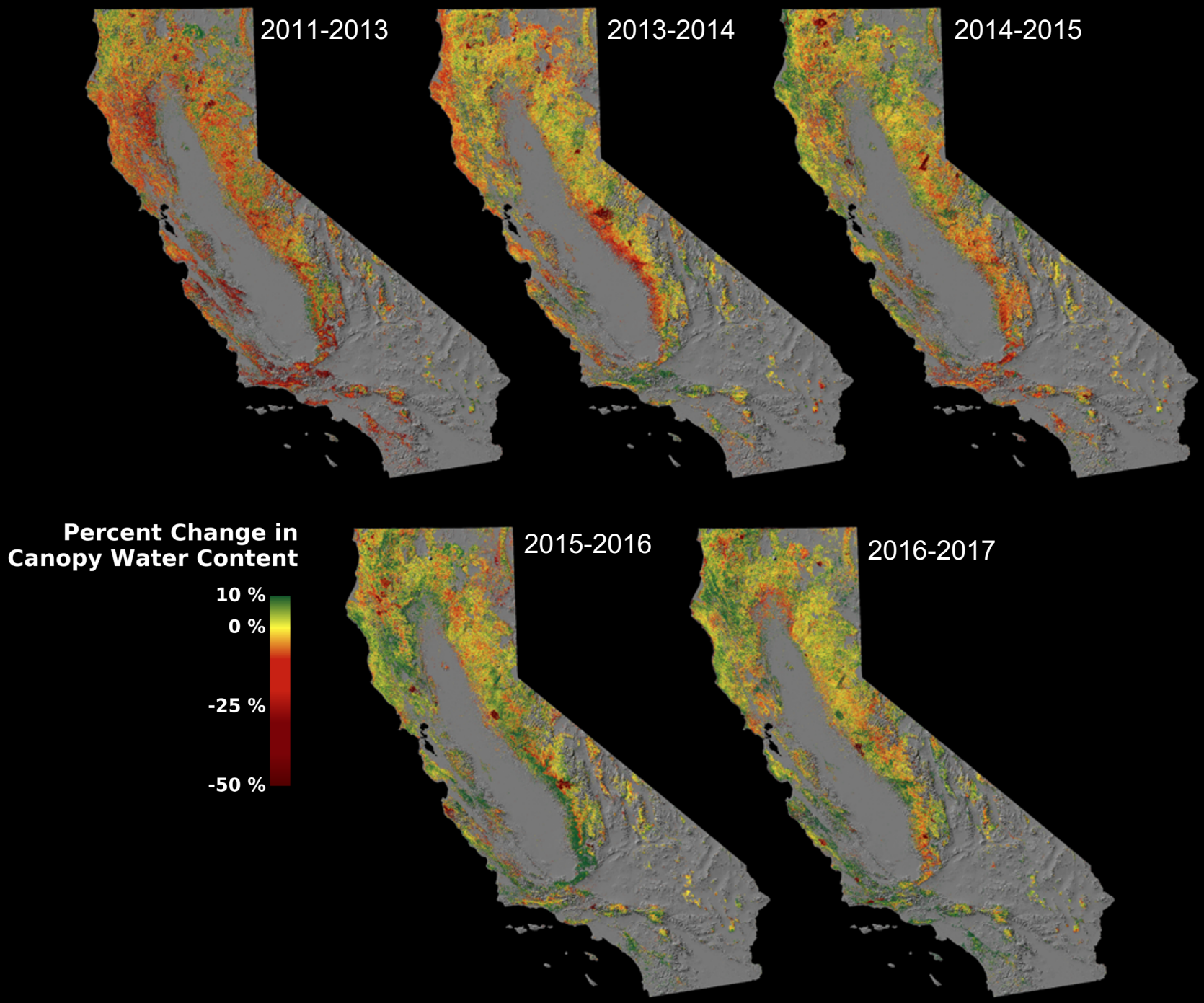


Upscaling for Statewide Mapping

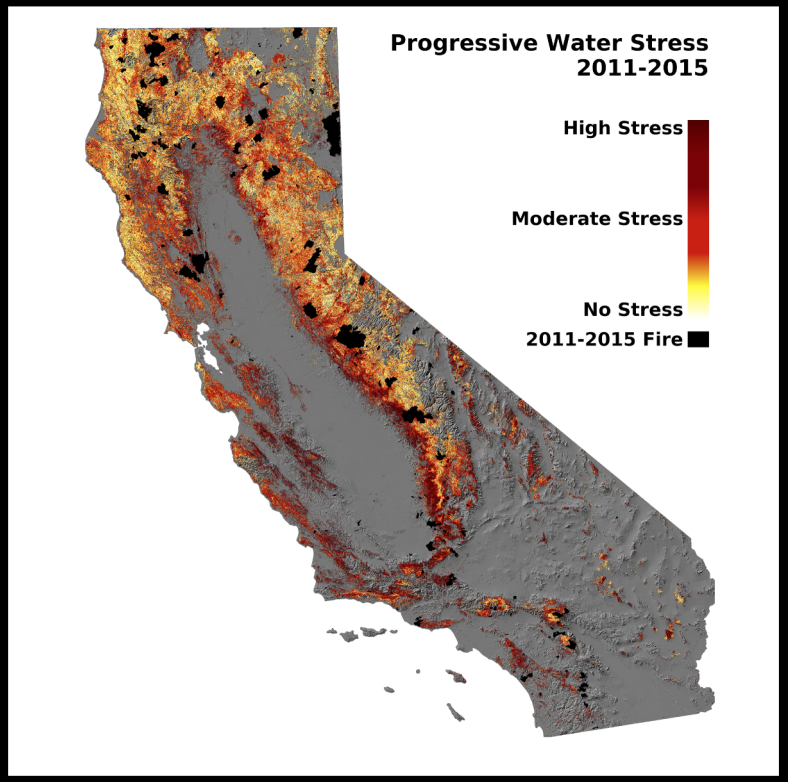


2017 Canopy Water Content (CWC) Mapping

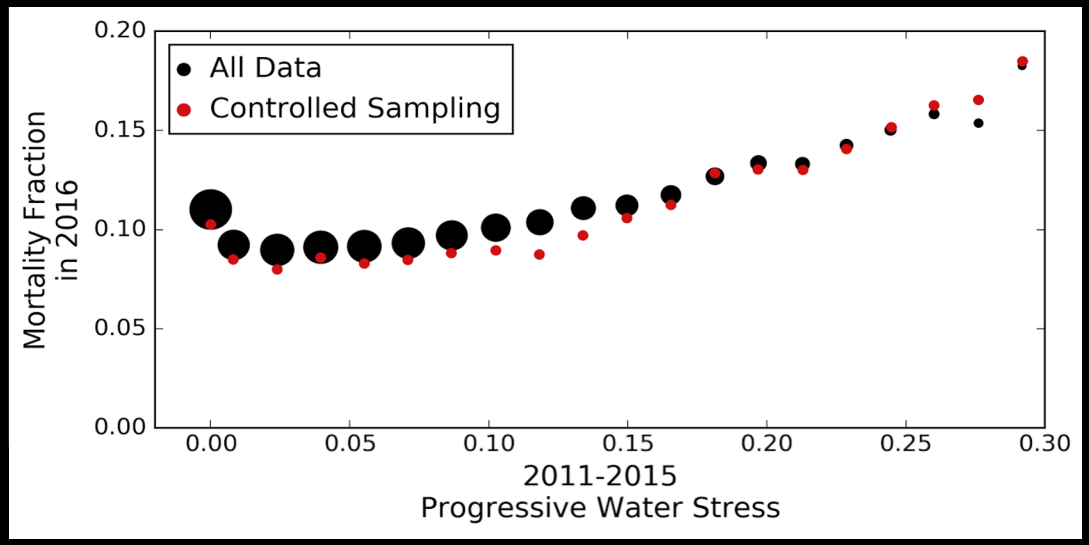



2011-2013
2013-2014
2014-2015
Percent Change in
Canopy Water Content
10 %
0 %
-25 %
-50 %
2015-2016
2016-2017

Using Percent CWC Change to Predict Mortality Increase

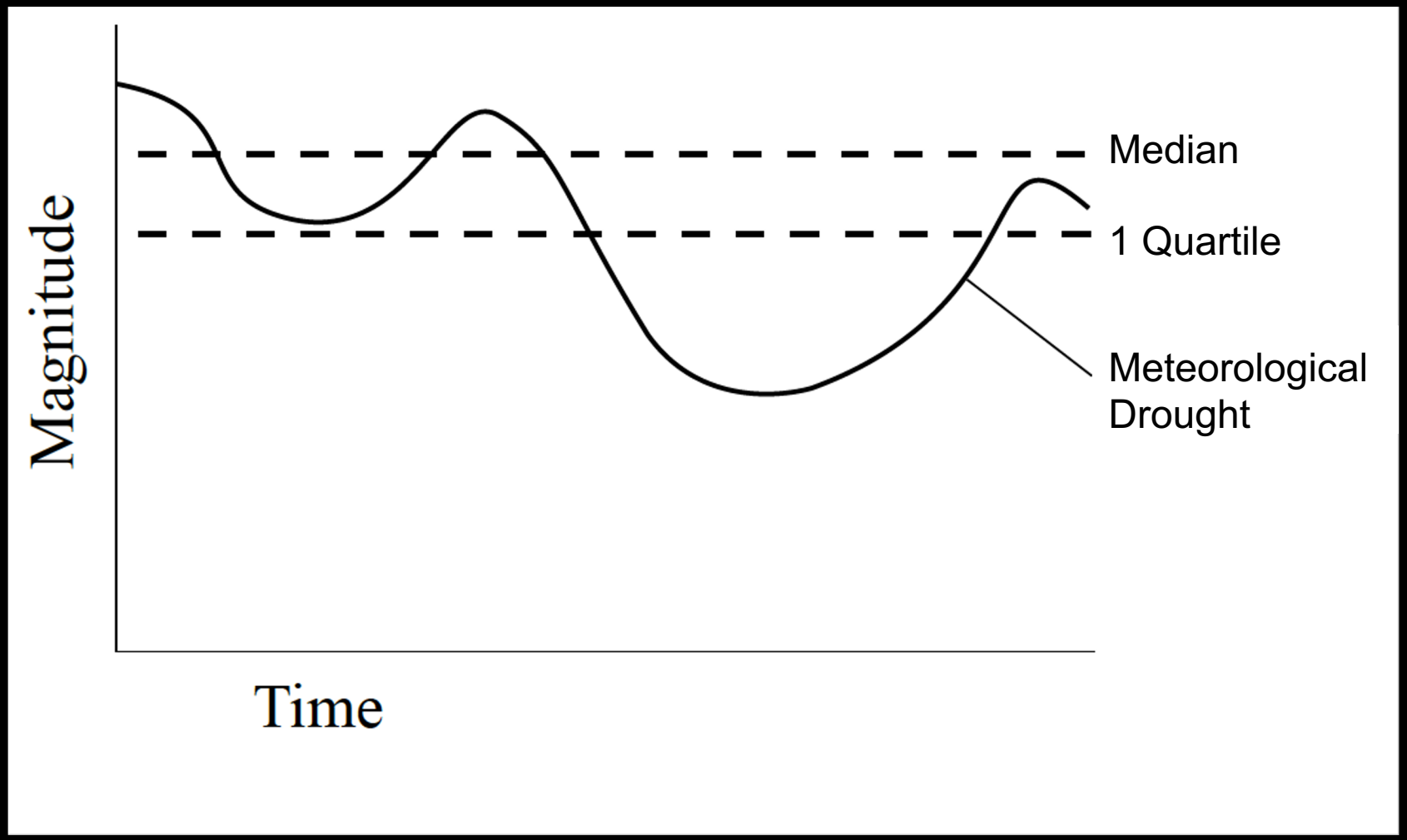


Asner et al., PNAS 2016



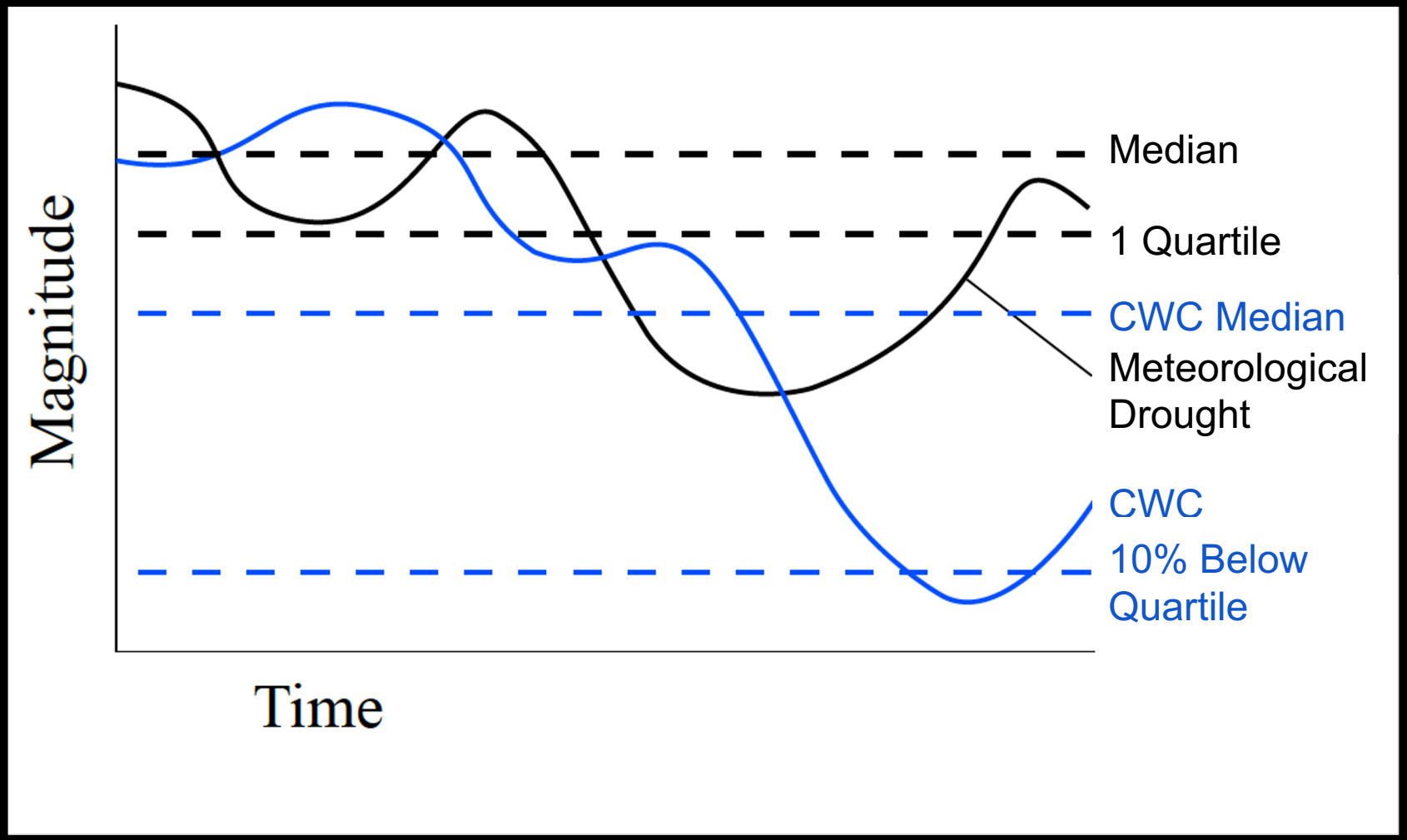
Brodrick and Asner, ERL 2017

Drought Resistance



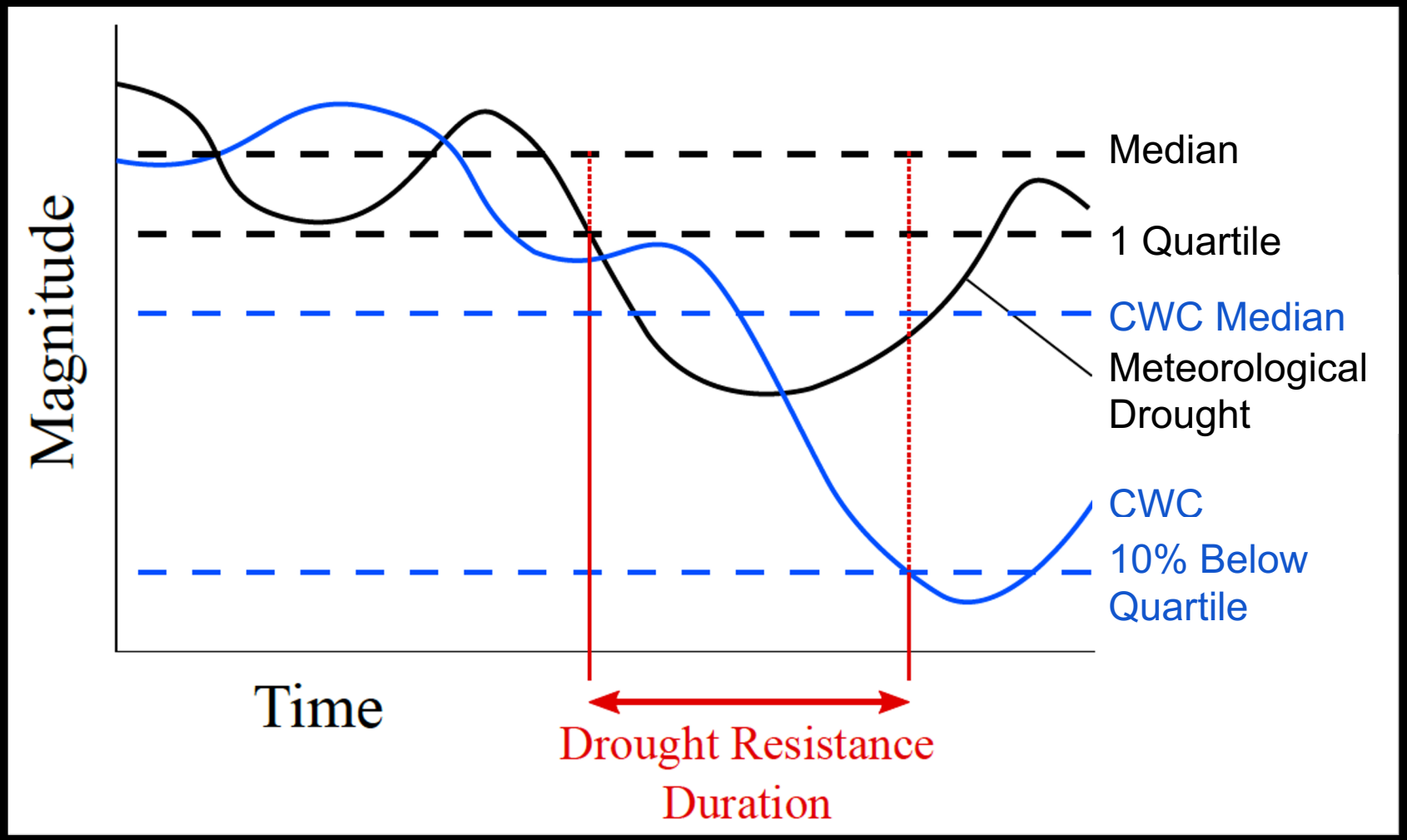
Brodrick et al., GRL 2019

Drought Resistance



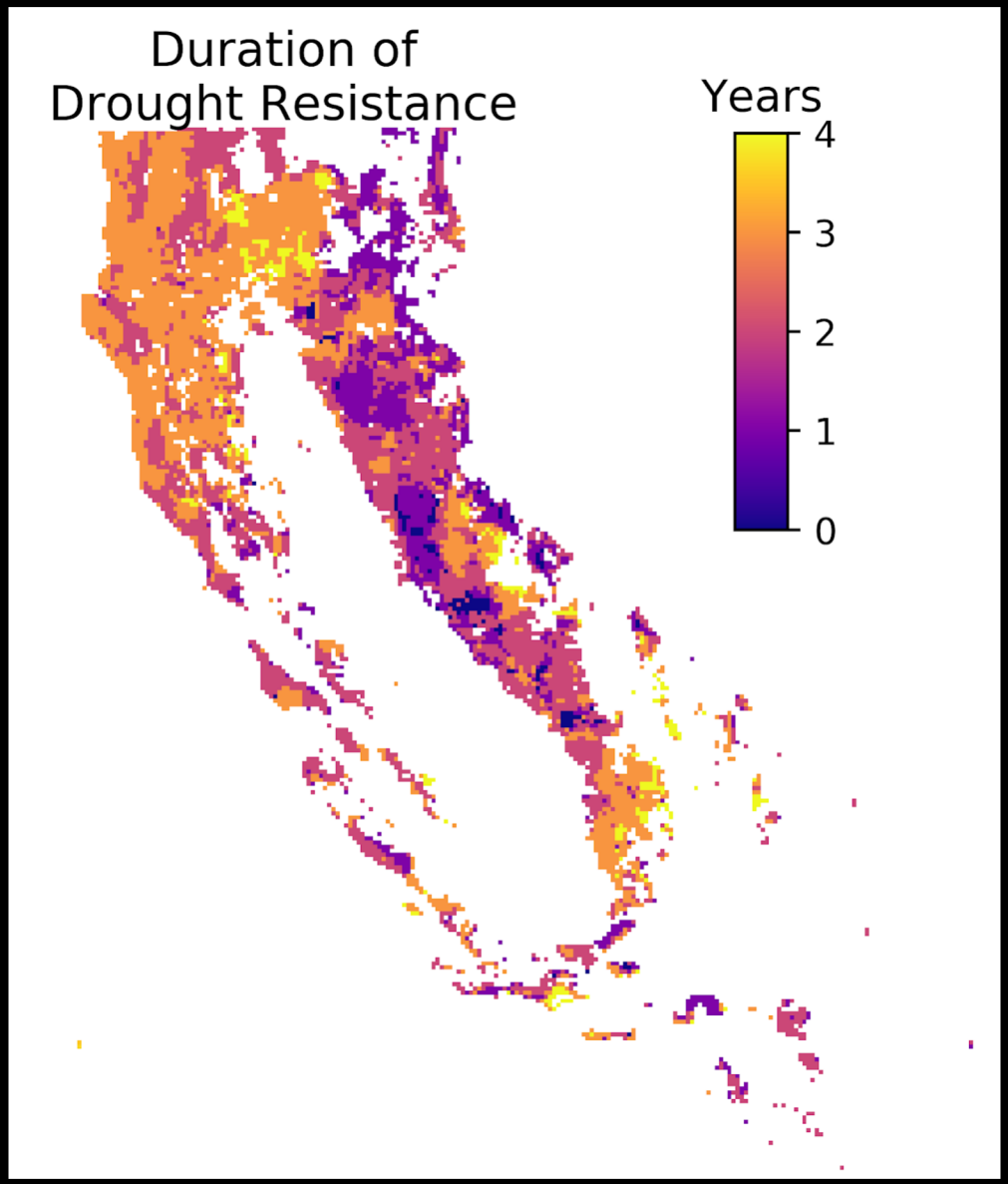
Brodrick et al., GRL 2019

Drought Resistance



Brodrick et al., GRL 2019

Drought Resistance

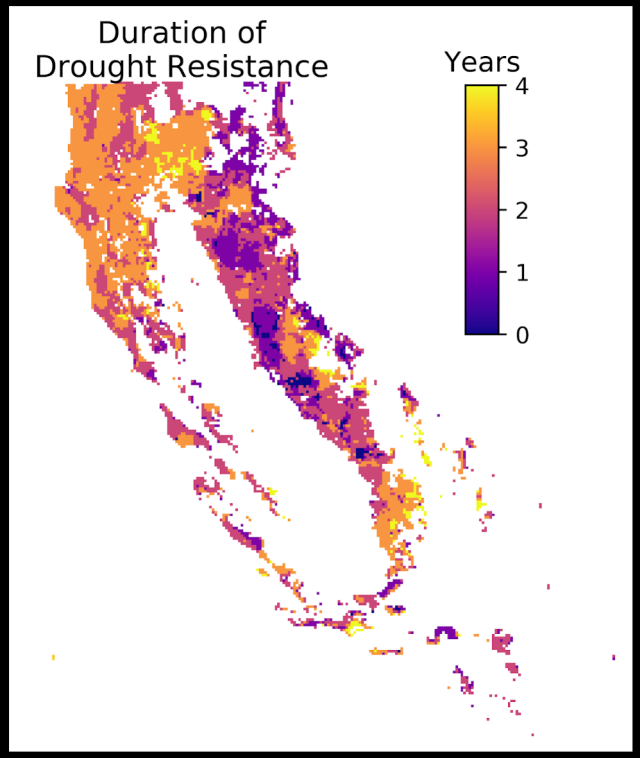


Brodrick et al., GRL 2019

Utilizing Patterns of Drought Resistance

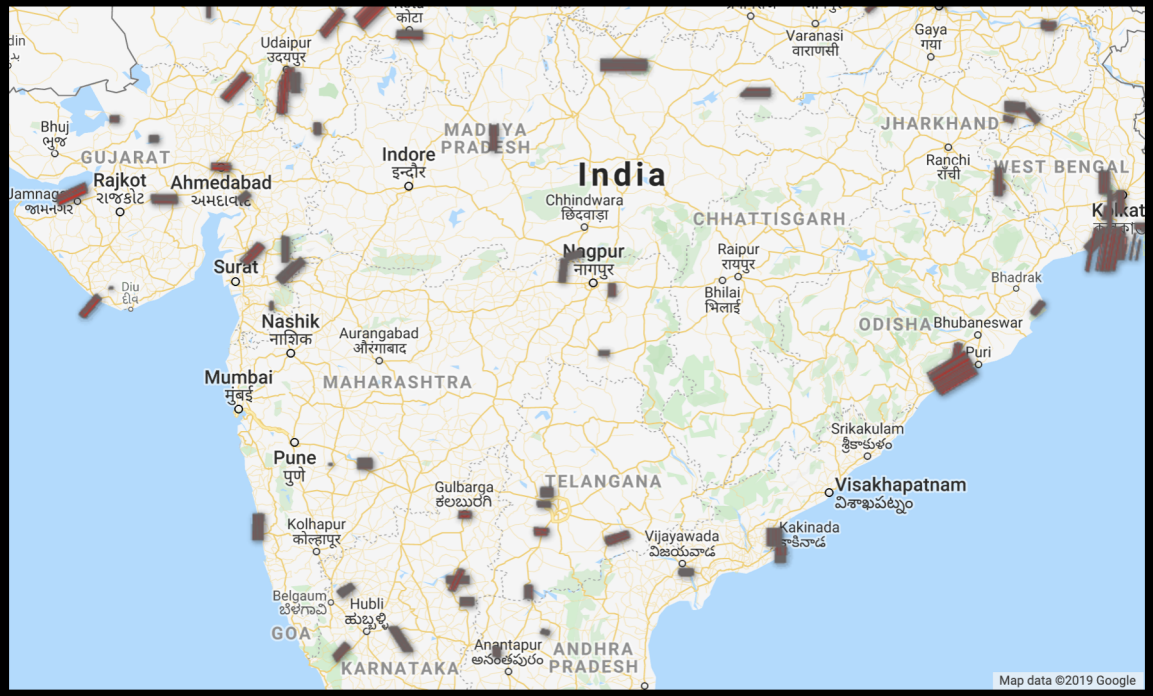
- Consequences for sequestration initiatives: drought resistance is not equally distributed throughout the state

- Ultimately we want to understand ecosystem stability, and resistance is only one of many important aspects



Scaling Globally

- Calibration data exists in many regions
- New VSWIR Optimal Estimation algorithms (Thompson, 2018) let us utilize data collected in challenging atmospheres
- Spatial context can expand the degrees available for upscaling (Brodrick et al., 2019, https://github.com/pgbrodrick/bfg-nets/)



aviris-ng.jpl.nasa.gov/alt_locator

Acknowledgements and Questions

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CB Anderson, NR Vaughn, J Heckler
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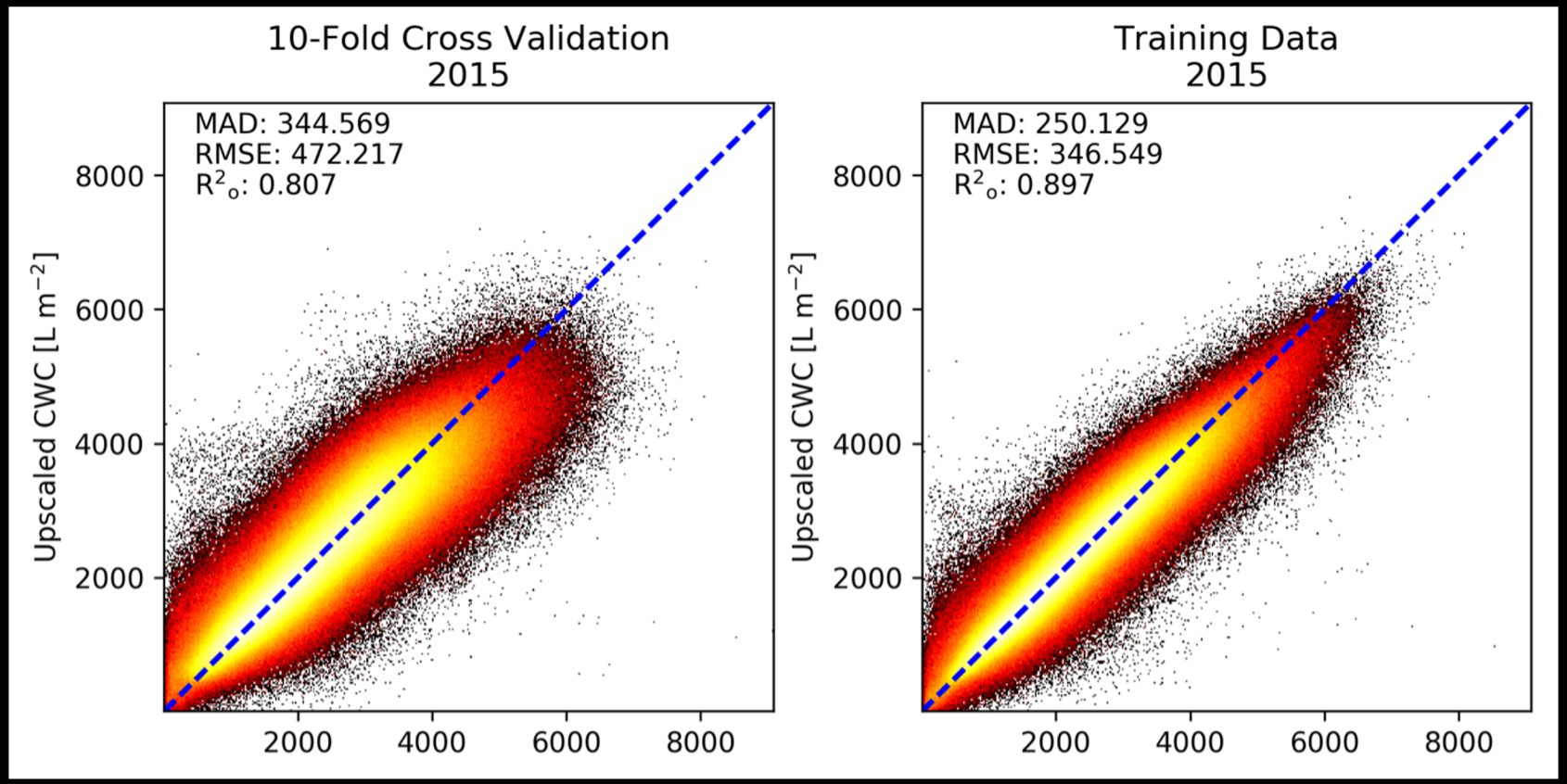
Upscaling Performance



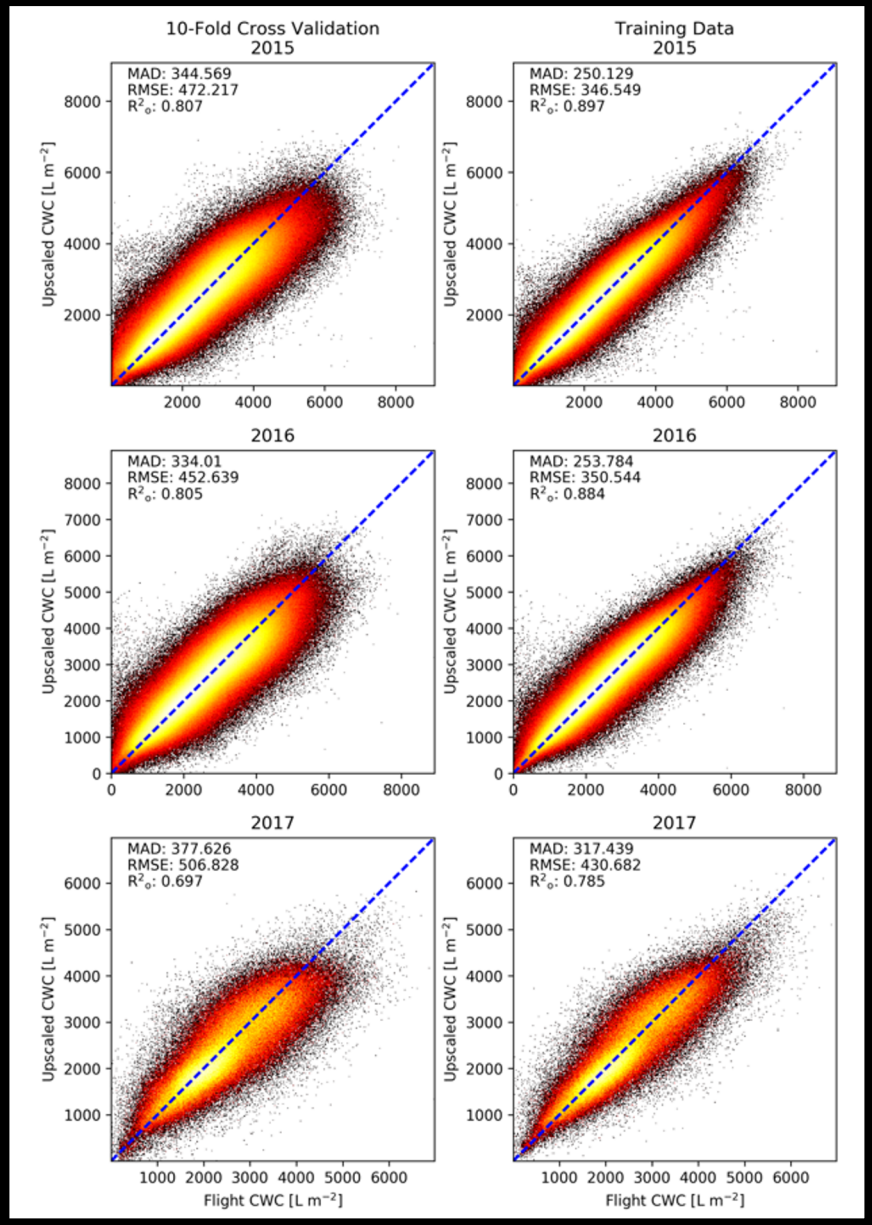
Brodrick et al., GRL 2019

Upscaling Performance

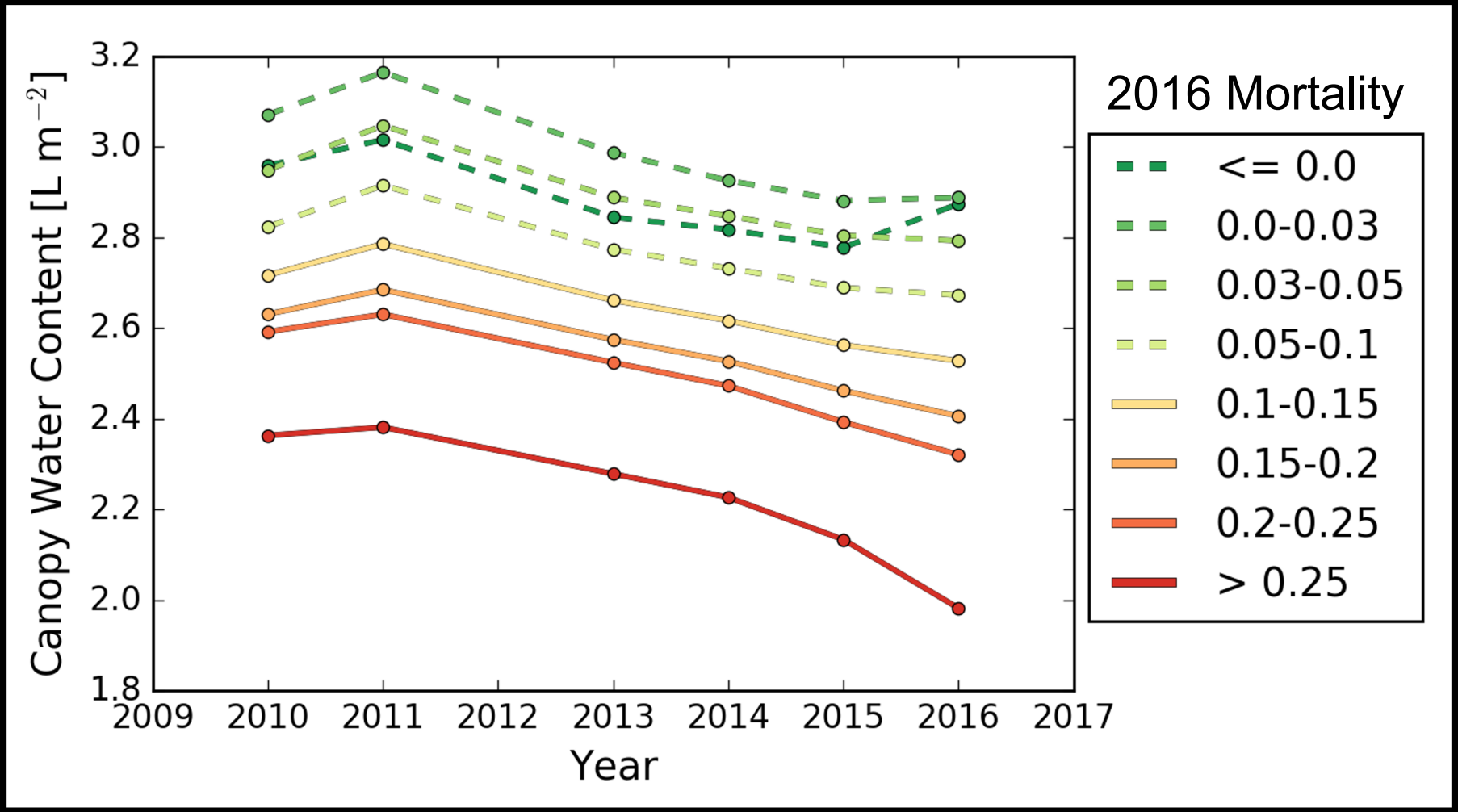
2015

2016

2017

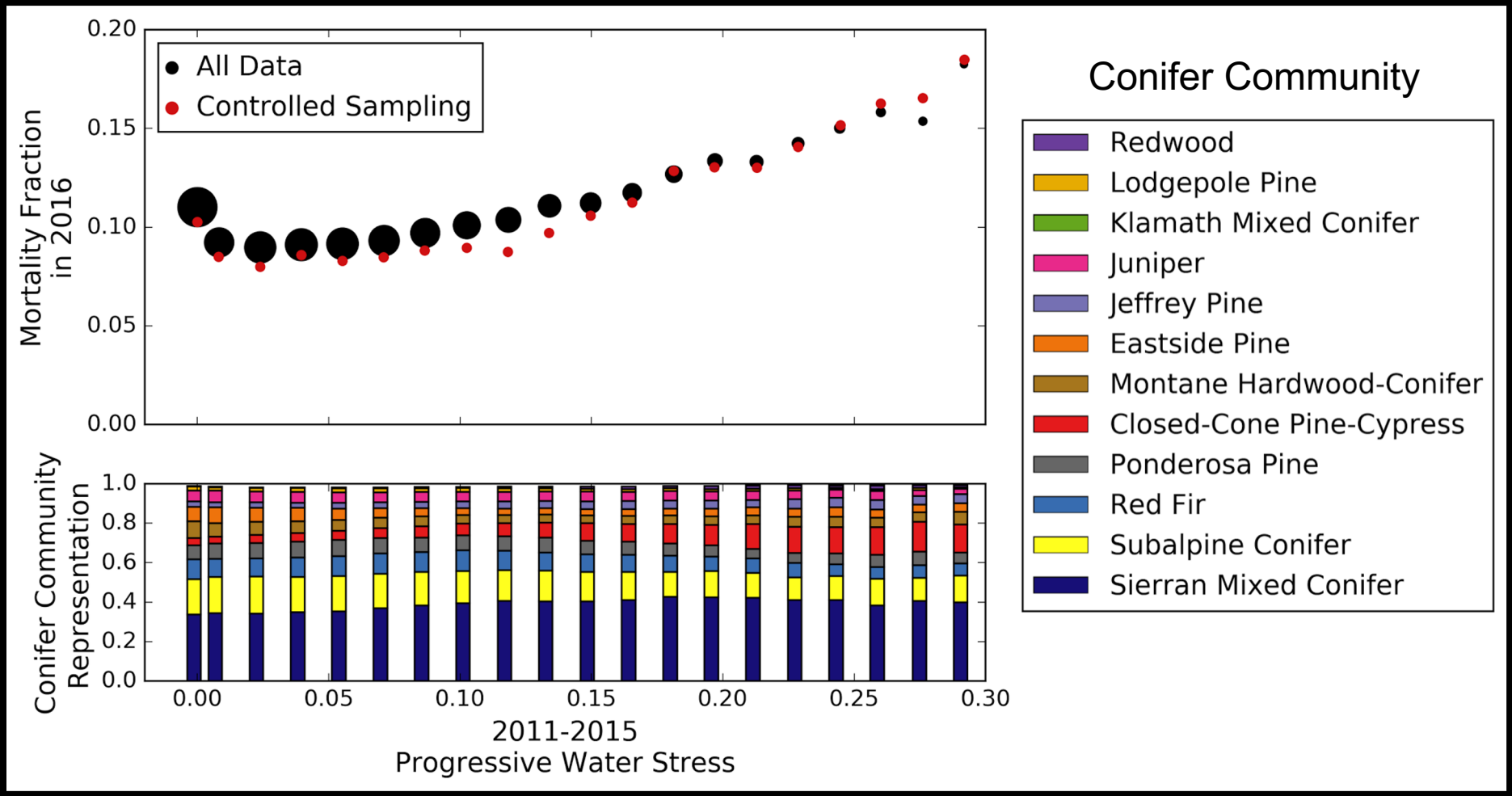


Trends in CWC by Overall Mortality in 2016



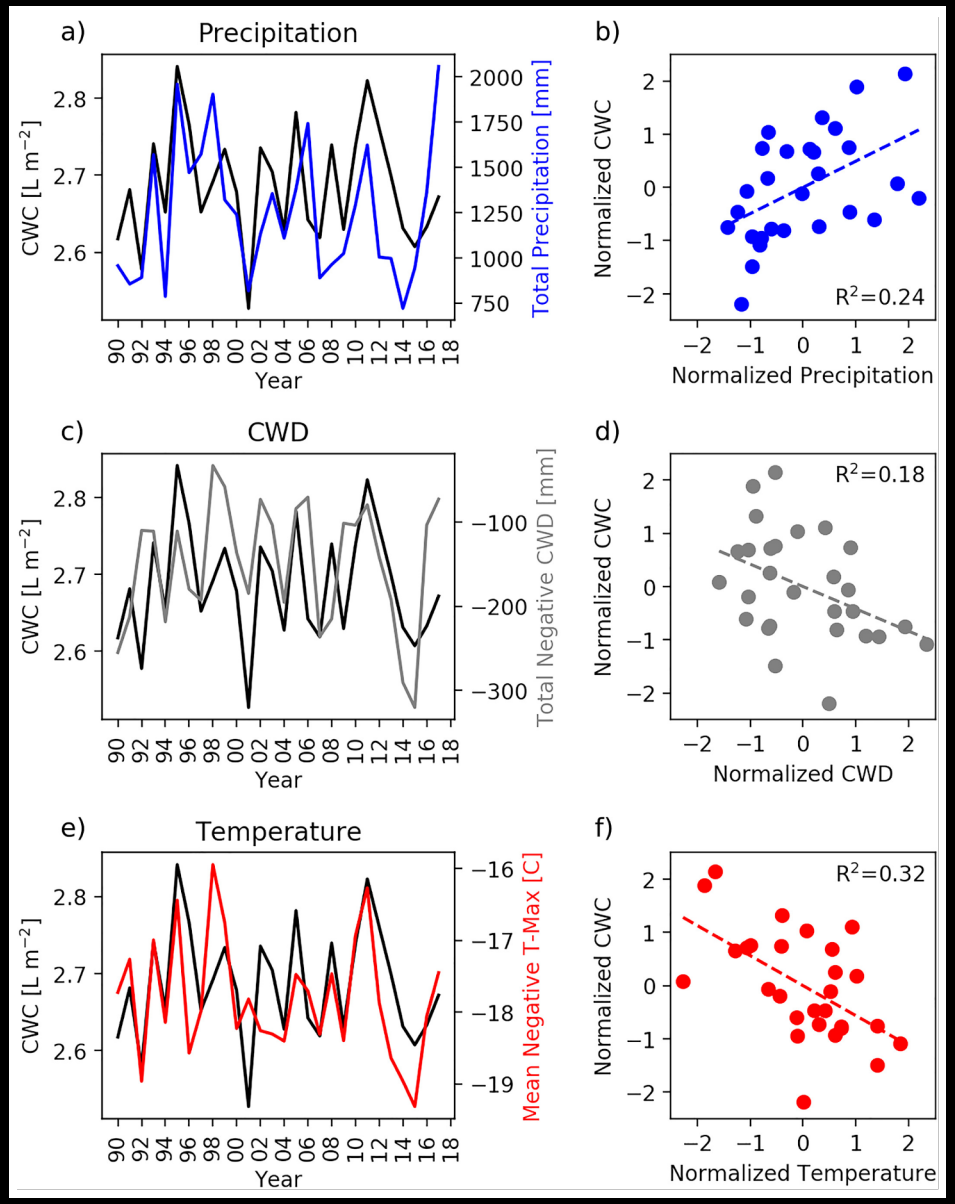
Brodrick et al., GRL 2019

Using PWS to Predict Overall Mortality in 2016

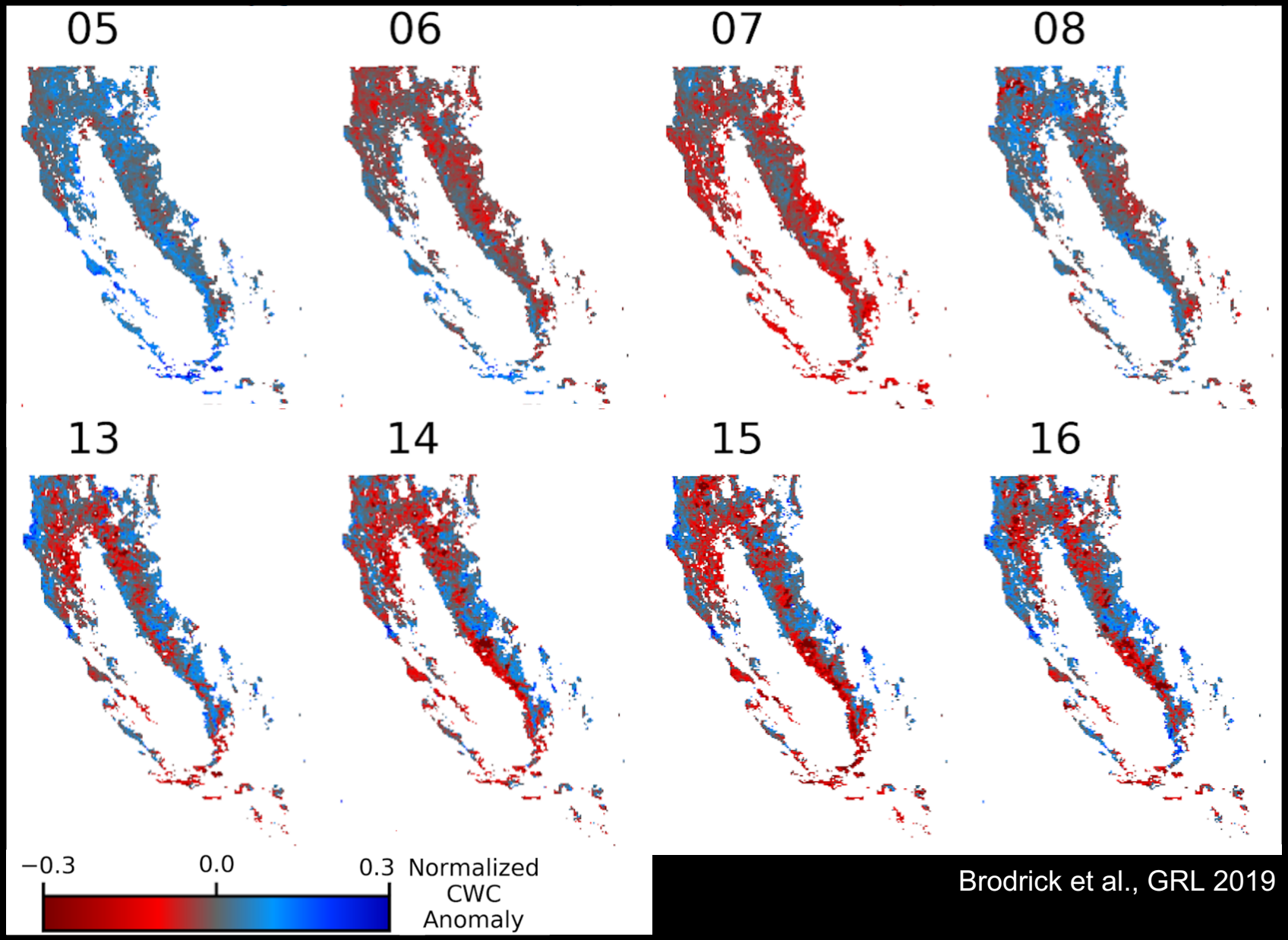


Brodrick et al., GRL 2019

Linking CWC and Meteorological Data



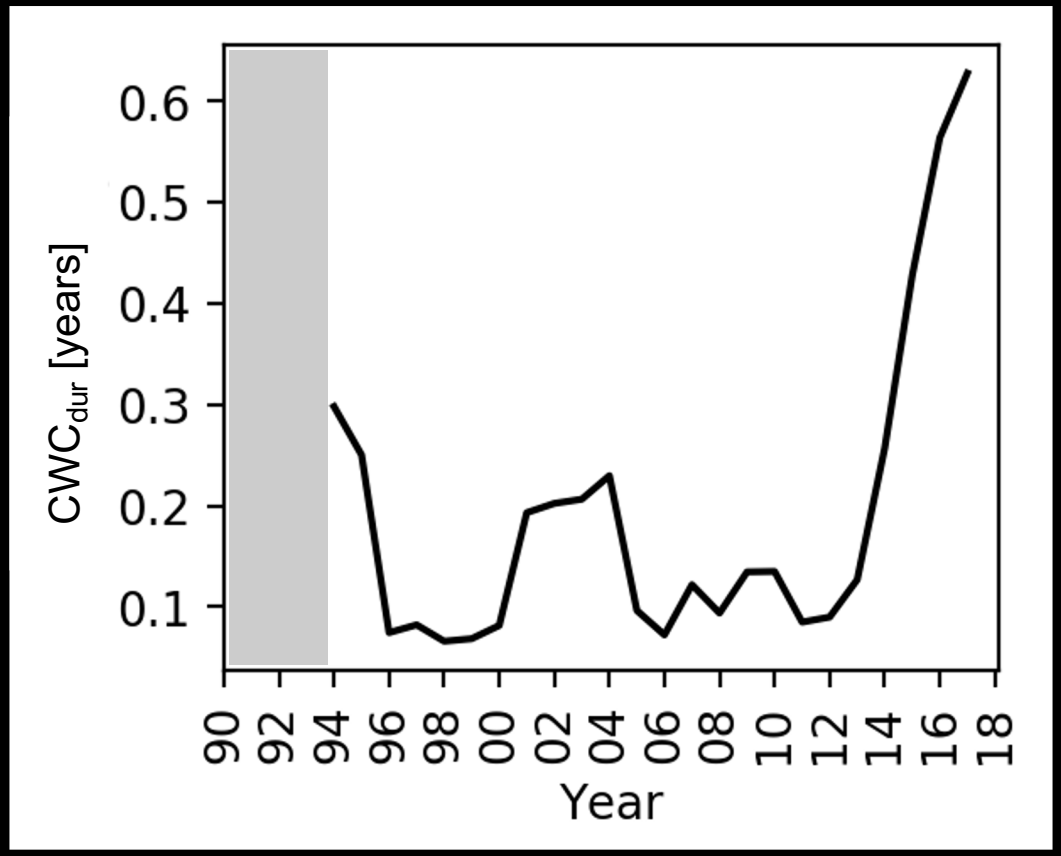
Considering Duration



Brodrick et al., GRL 2019

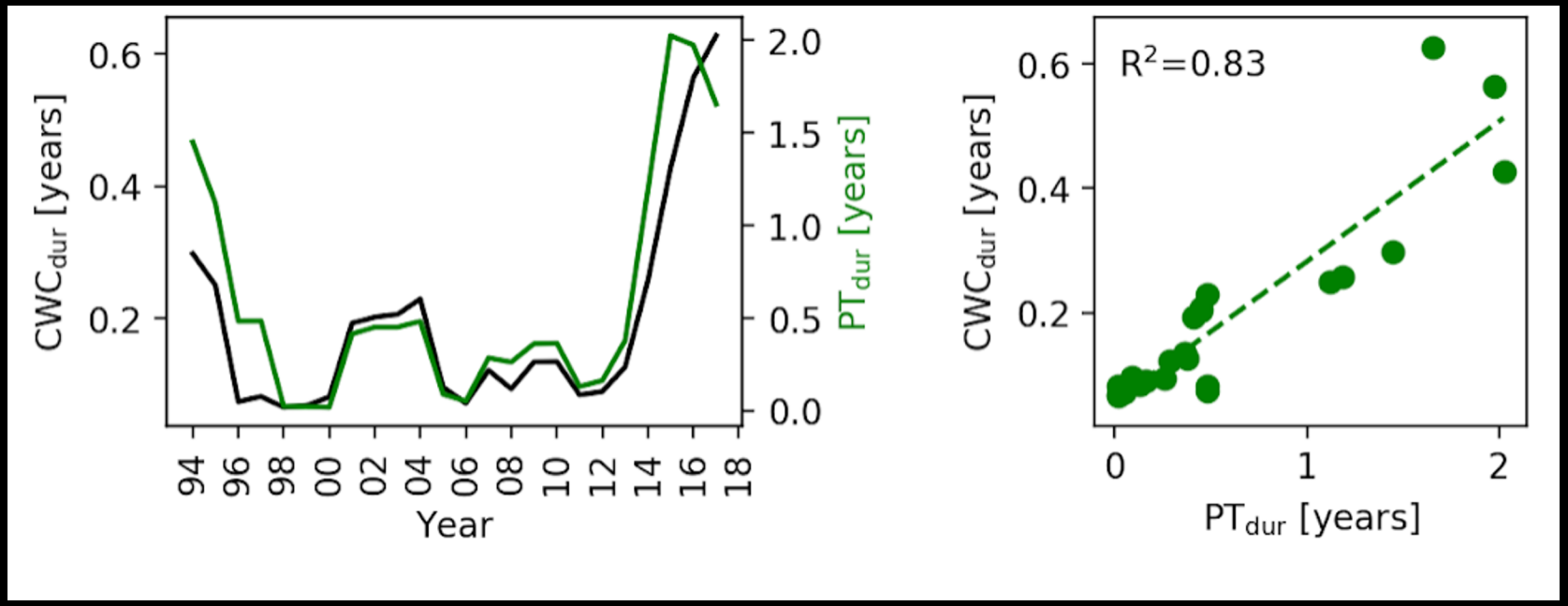
Linking CWC and Meteorological Data

Cumulative duration of significant CWC deviation within a 4-year window



Linking CWC and Meteorological Data

PT

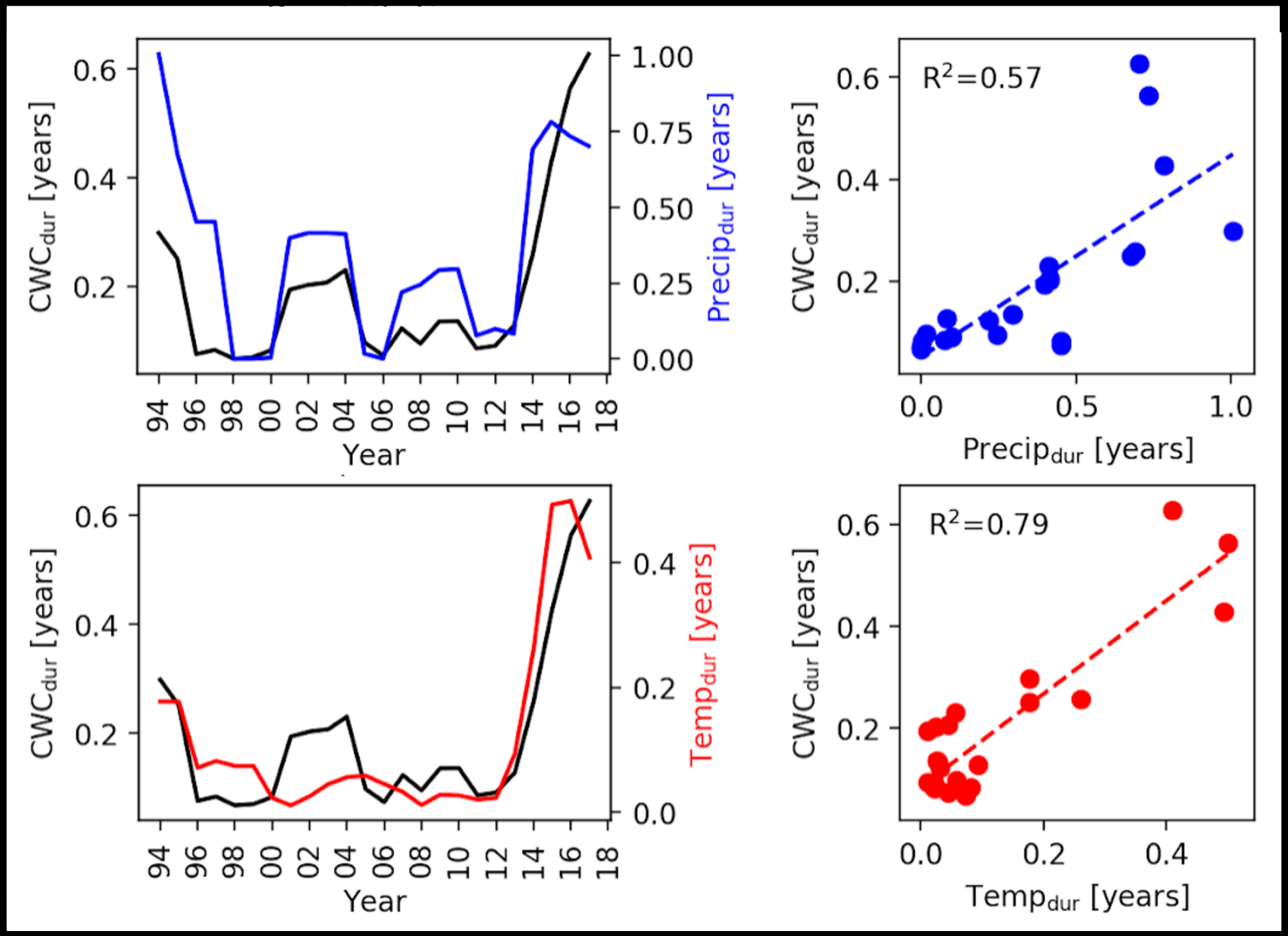


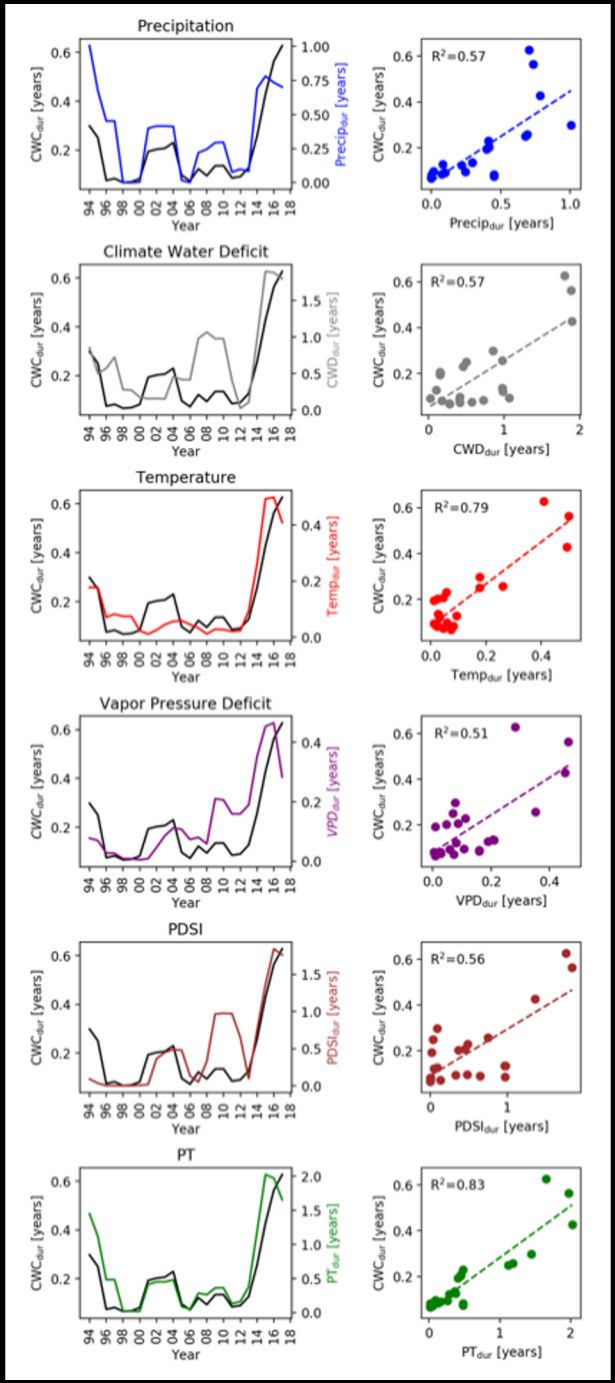
Brodrick et al., GRL 2019

Linking CWC and Meteorological Data

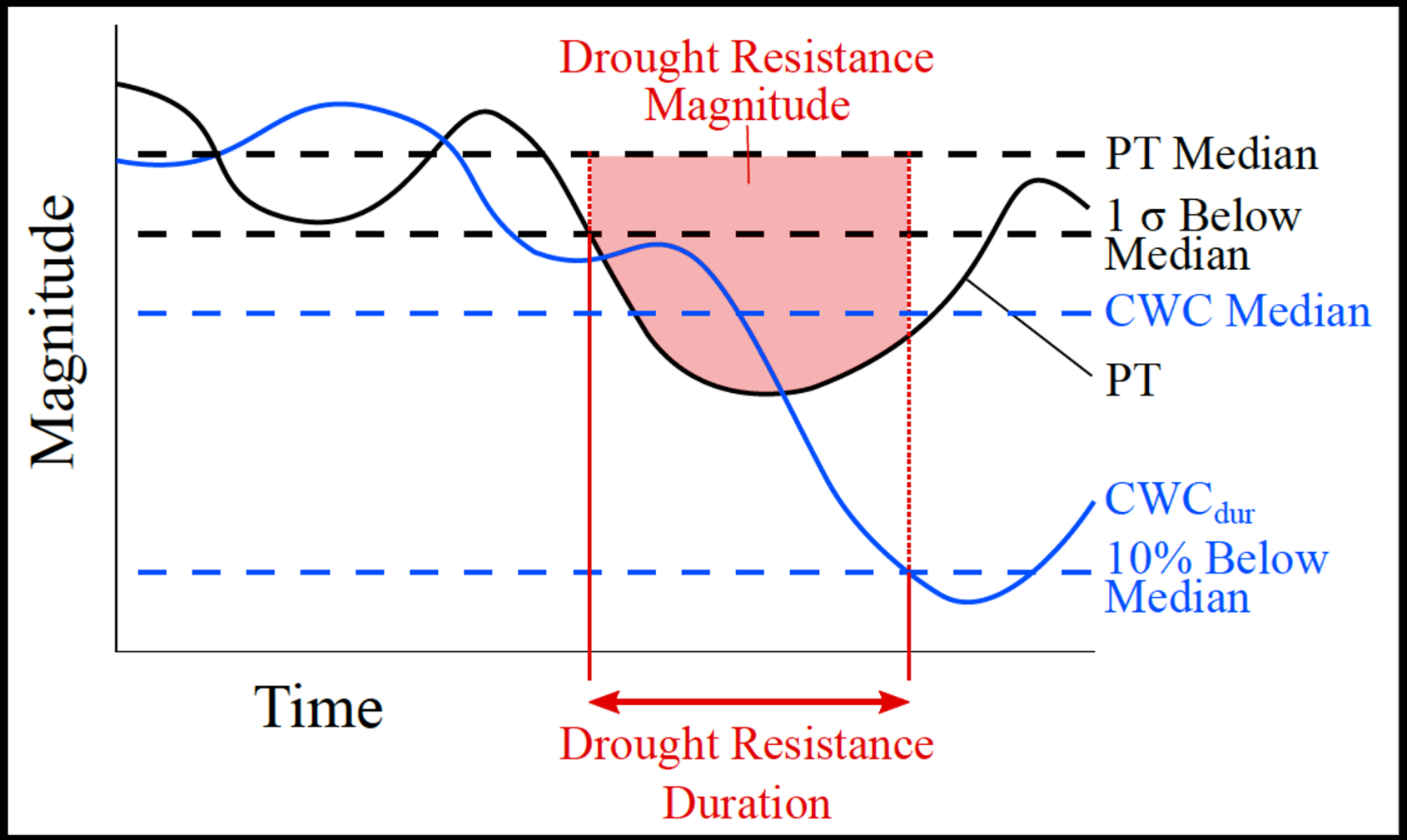
Precipitation

Temperature



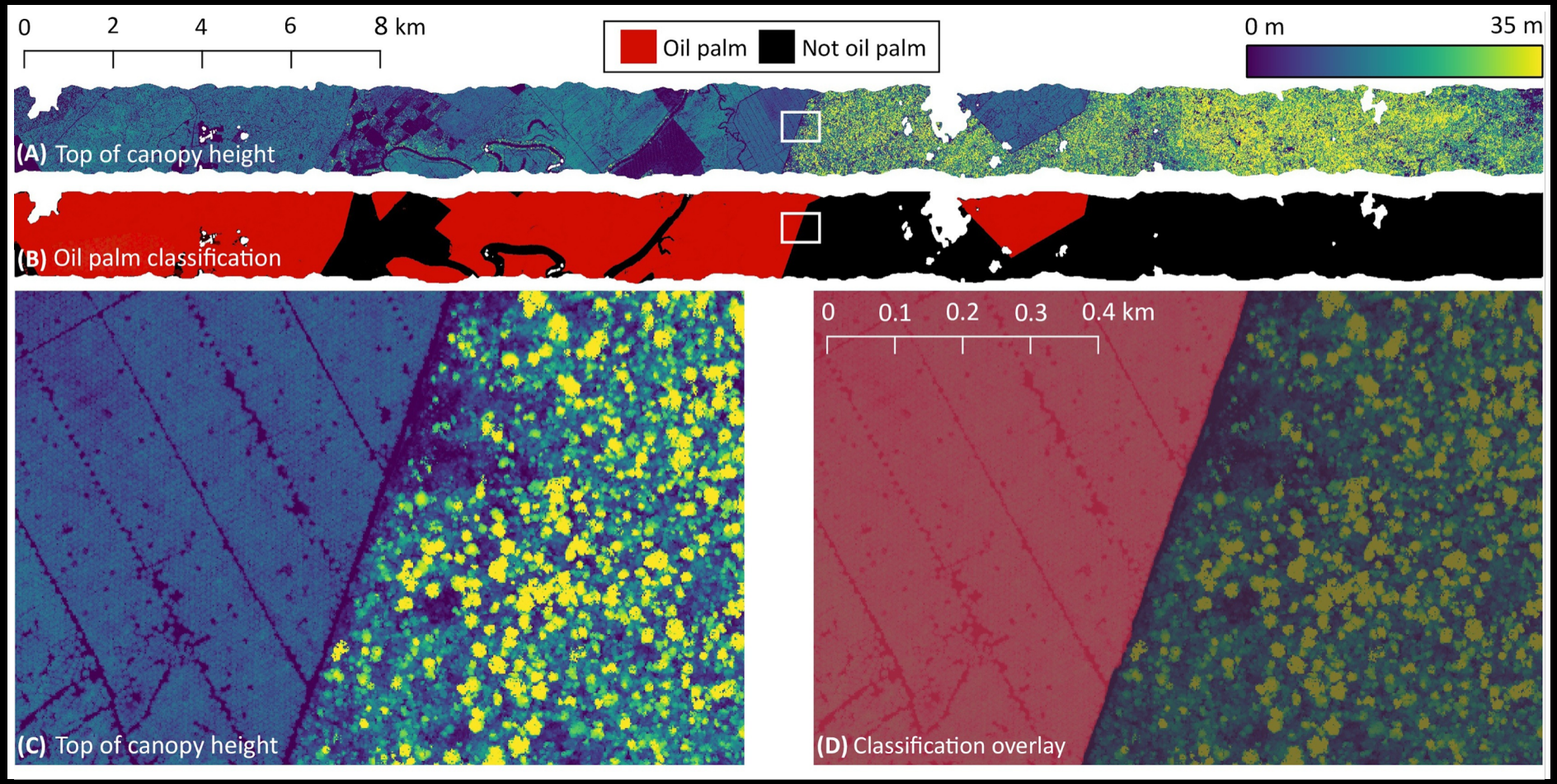

Precipitation
Climate Water Deficit
Temperature
Vapor Pressure Deficit
PDSI
PT
CWCdur [years]
Year
Precipdur [years]
CWDdur [years]
Tempdur [years]
VPDdur [years]
PDSIdur [years]
PTdur [years]
R²=0.57
R²=0.57
R²=0.79
R²=0.51
R²=0.56
R²=0.83

Drought Resistance



Brodrick et al., GRL 2019

Big Friendly Geospatial Networks



Brodrick et al., TREE 2019

https://pgbrodrick.github.io/bfg-nets/