JPL SIP 2023

Classification of UAVSAR Polarimetric Data for Wildfire Monitoring

334F - Suborbital Radar Science And Engineering

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Jet Propulsion Laboratory
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About Me

- Rising Senior at Case Western Reserve University
- Intern at 334F - Suborbital Radar Science And Engineering
- Data Science and Analytics Major
- Interested in AI/ML

Background - Wildfire

- Wildfires are an ongoing threat to communities due to climate change

- Consequences
  - Habitat Destruction
  - Air Pollution
  - Soil
  - Many more…

- Recent: Maui Fire

How do we prevent or minimize the consequences?

Firefighters suppressing a wildfire in the forest.
Credit: World Health Organization.

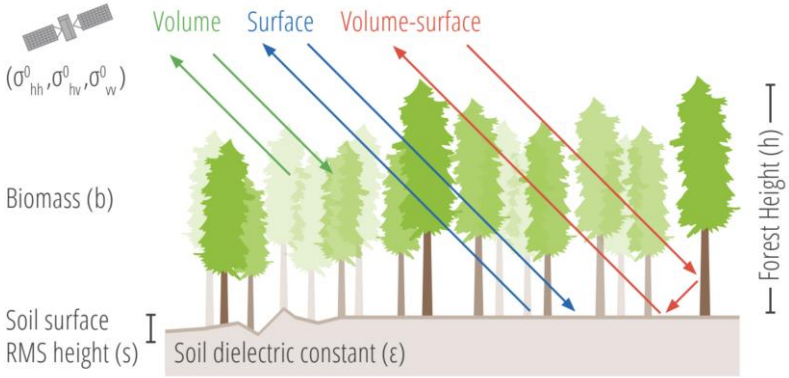
Background – Remote Sensing

- The Acquisition of Earth's information from a distance through electromagnetic waves
- Provides quantitative information
- Active Sensor
  - Emits own electromagnetic radiation
- Passive Sensor
  - Capture radiation (ex: visible and near-infrared light)

Background – Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)

- Active radar sensor
  - Penetration ability
- Polarimetric data
  - Different polarization combination capture different scattering mechanisms
- HV Polarization (volume scattering)
  - Sensitive to forest fuel load
  - Analysis based on pre- and post- fire images

Radar Pod attached to Gulfstream-III. Credit: UAVSAR



Scattering Mechanism. Credit: SAR Handbook

Product

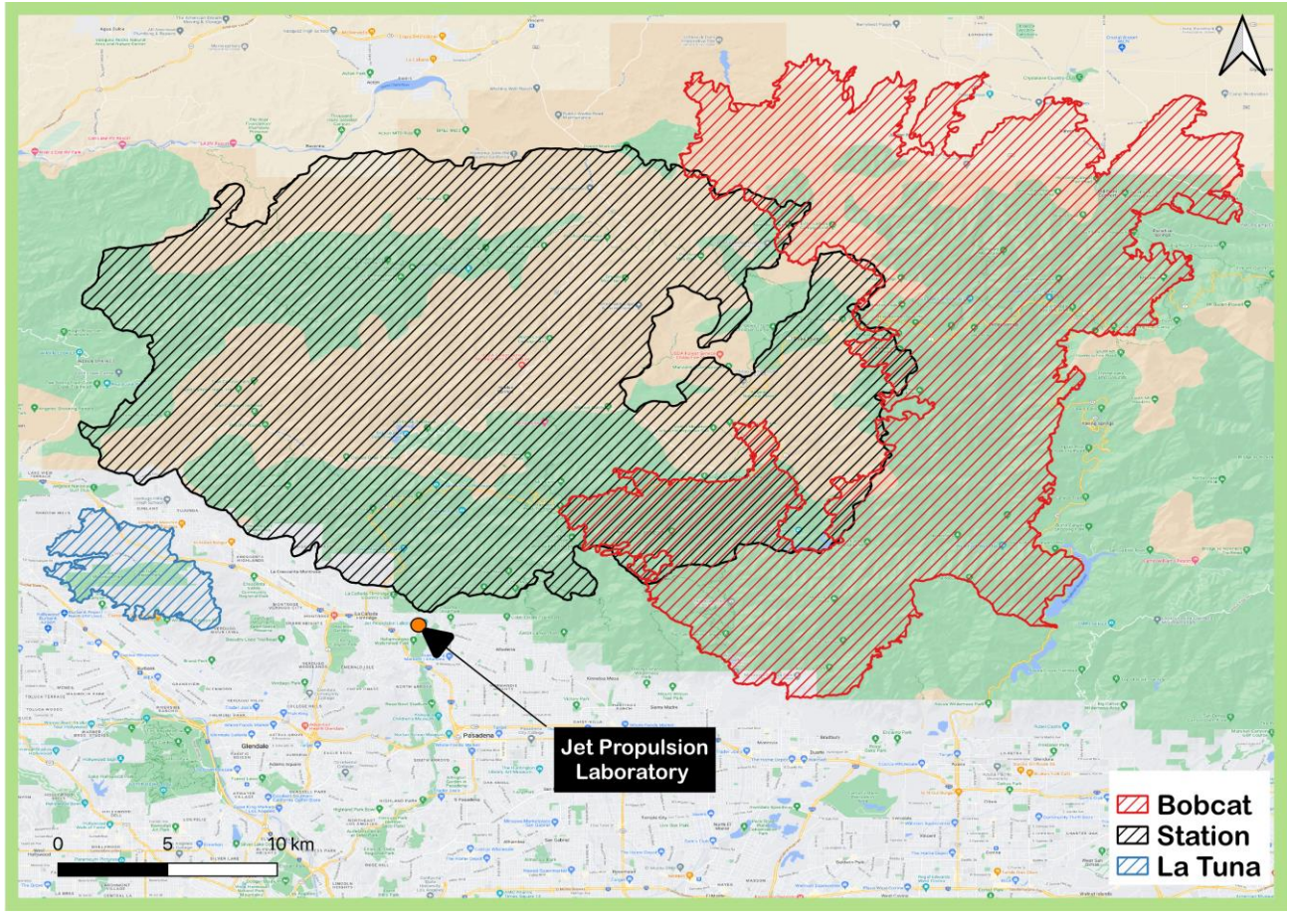
- Fire Perimeter Mapping (GeoJSON)
- Burn Severity Mapping (GeoTIFF)

Both are GIS-Compatible for spatial analysis

Project Motivation

- Improve results from the optical-based fire mapping
- Reduce manual efforts
- Monitor wildfire in real-time to aid disaster response

Fire of Study



Map created with QGIS

Data Timeline

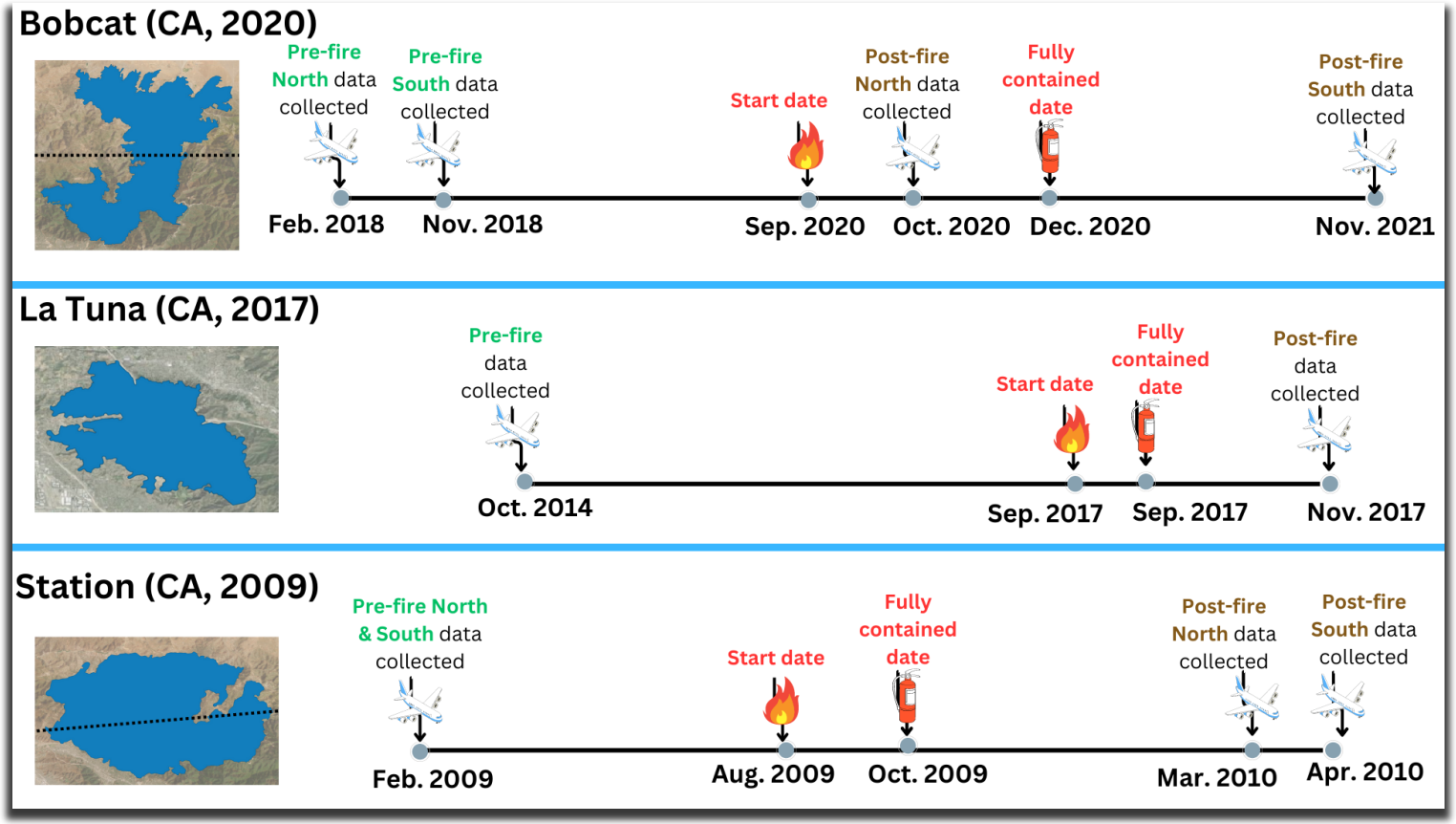
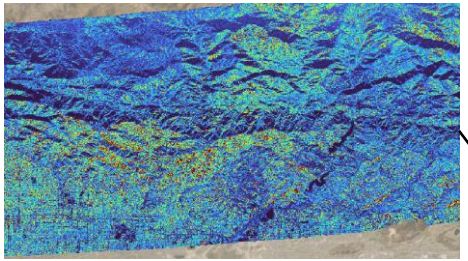
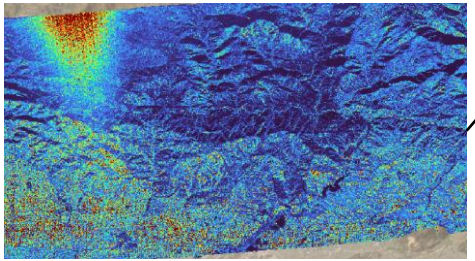


Diagram created with Canva

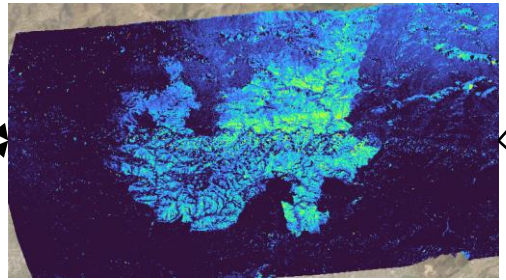
Workflow



Pre-fire HV Image

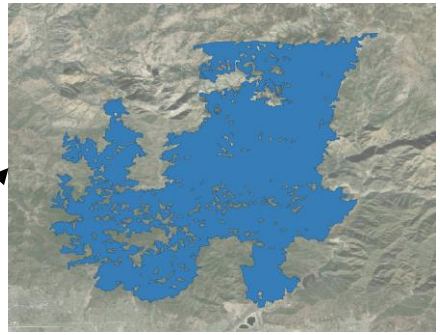


Post-fire HV Image

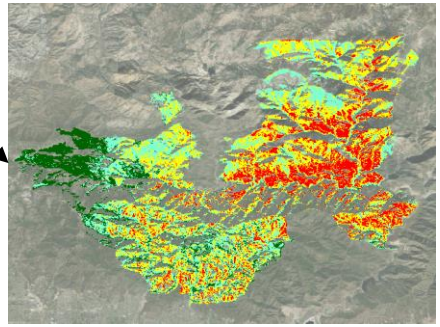


Preprocessed Log Ratio Image

+ Perimeter



UAVSAR Fire Perimeter



UAVSAR Burn Severity Mapping

Images associated with southern region of Bobcat Fire

Maps created with QGIS

Methods

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- Cr
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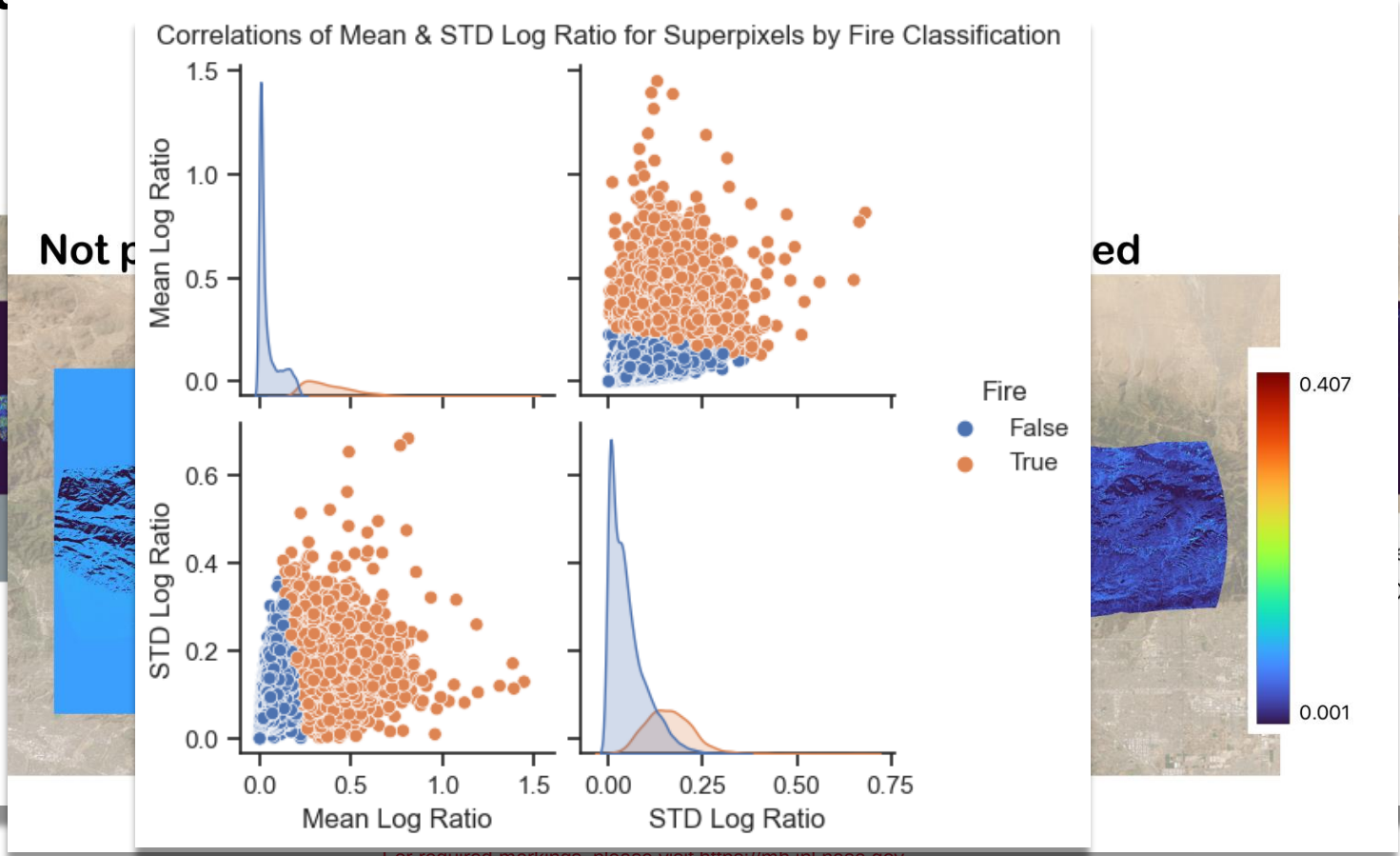
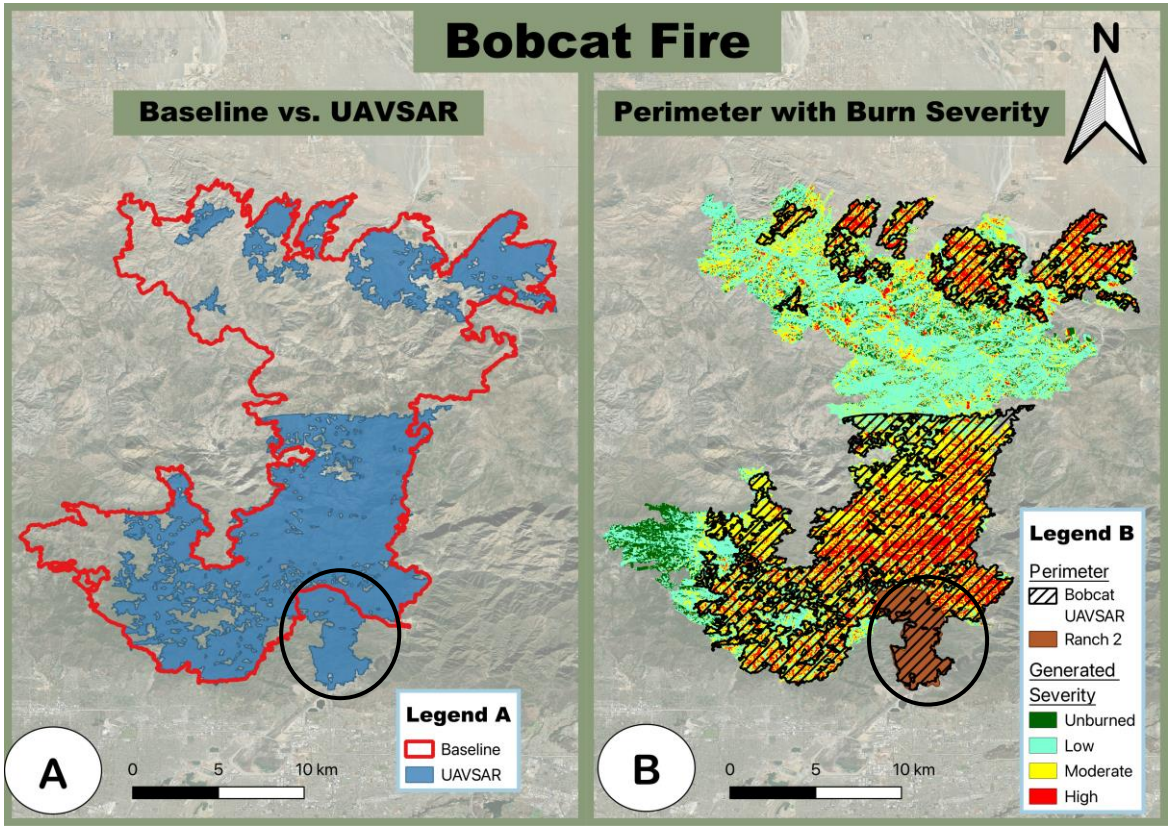
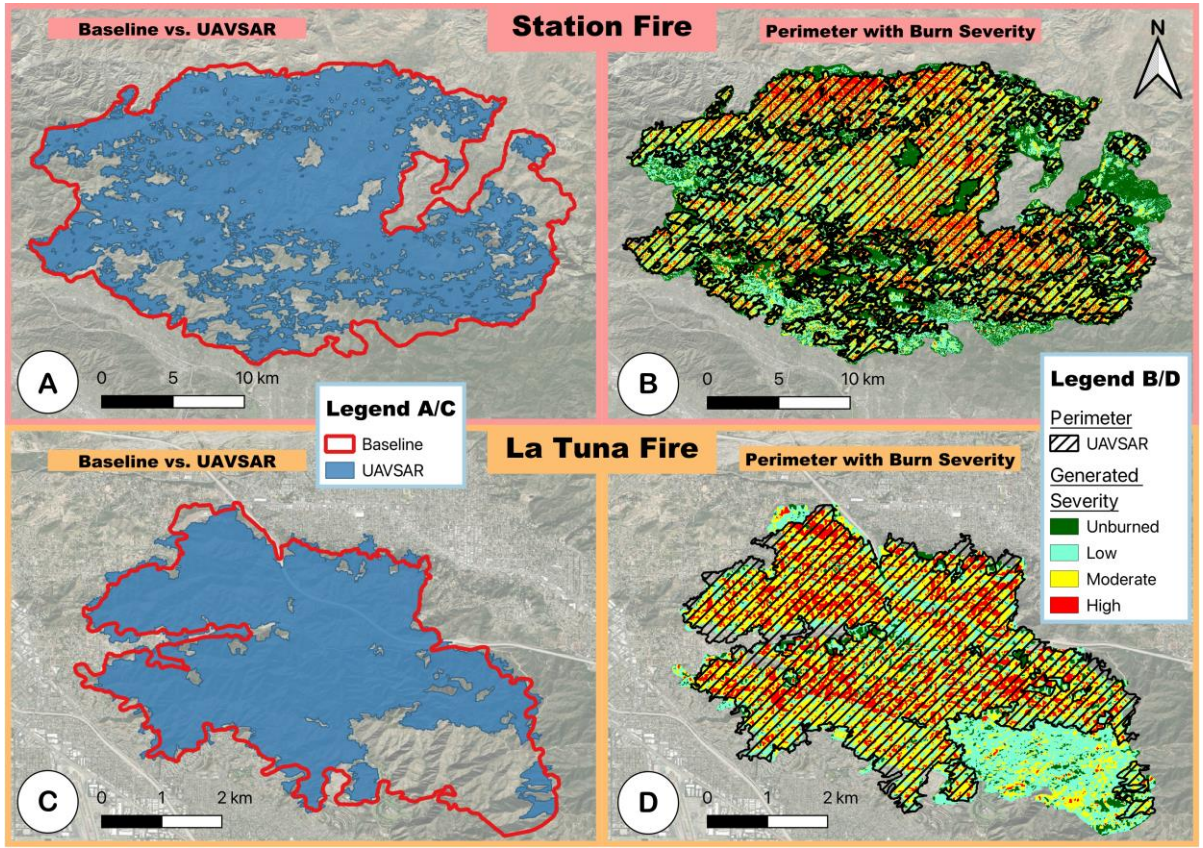


Results – UAVSAR Fire Perimeter (Bobcat)



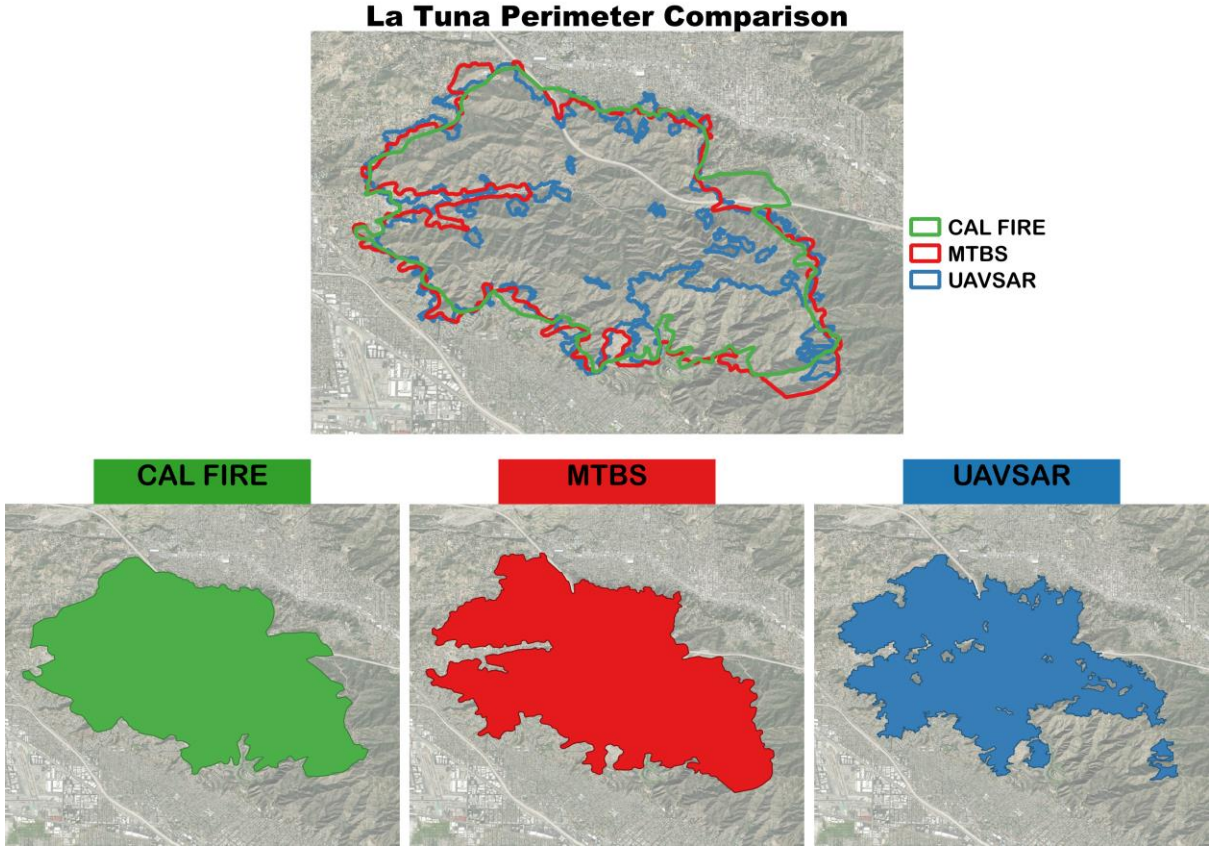
Maps created with QGIS

Results – UAVSAR Fire Perimeter (Station & La Tuna)



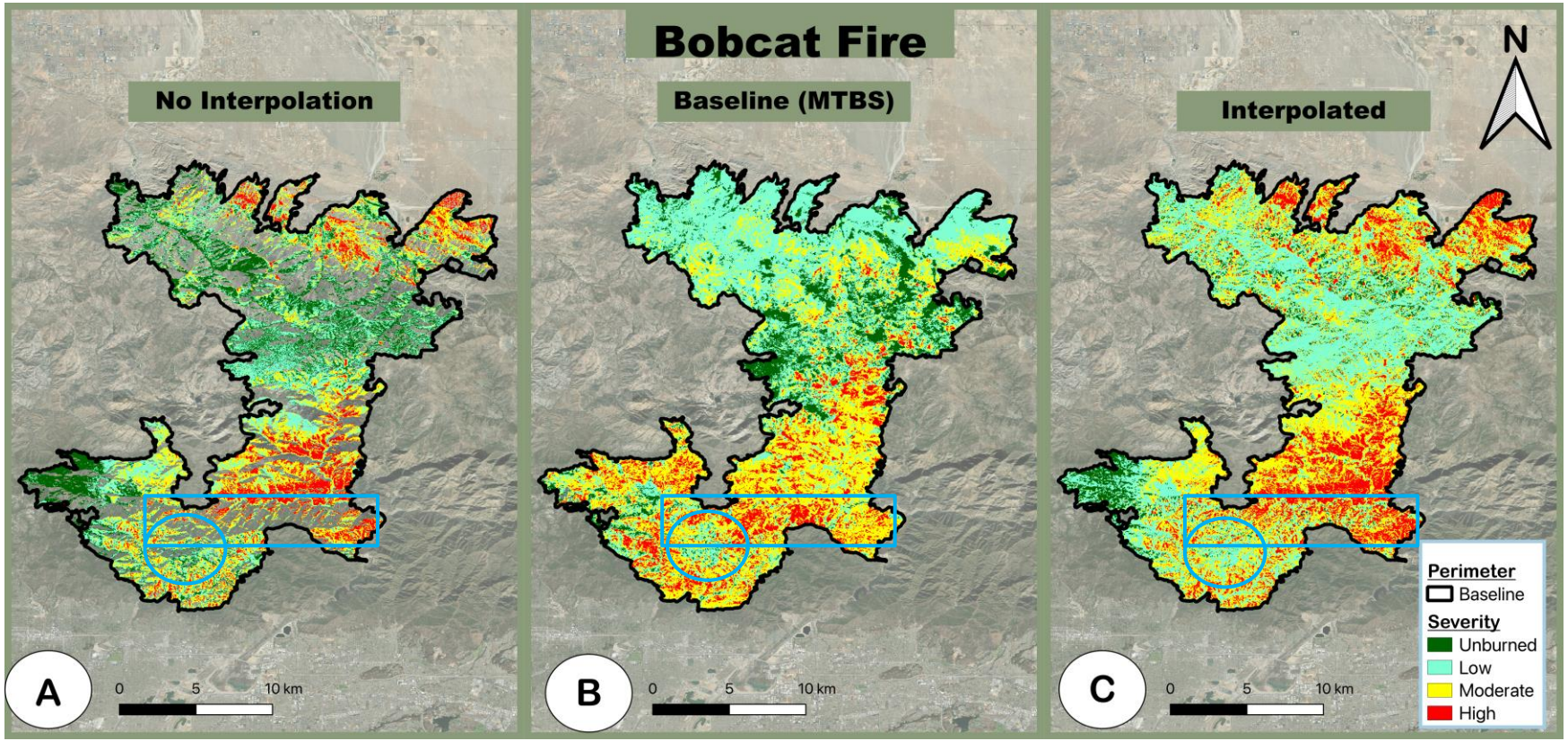
Maps created with QGIS

Perimeter Disagreements! (La Tuna)



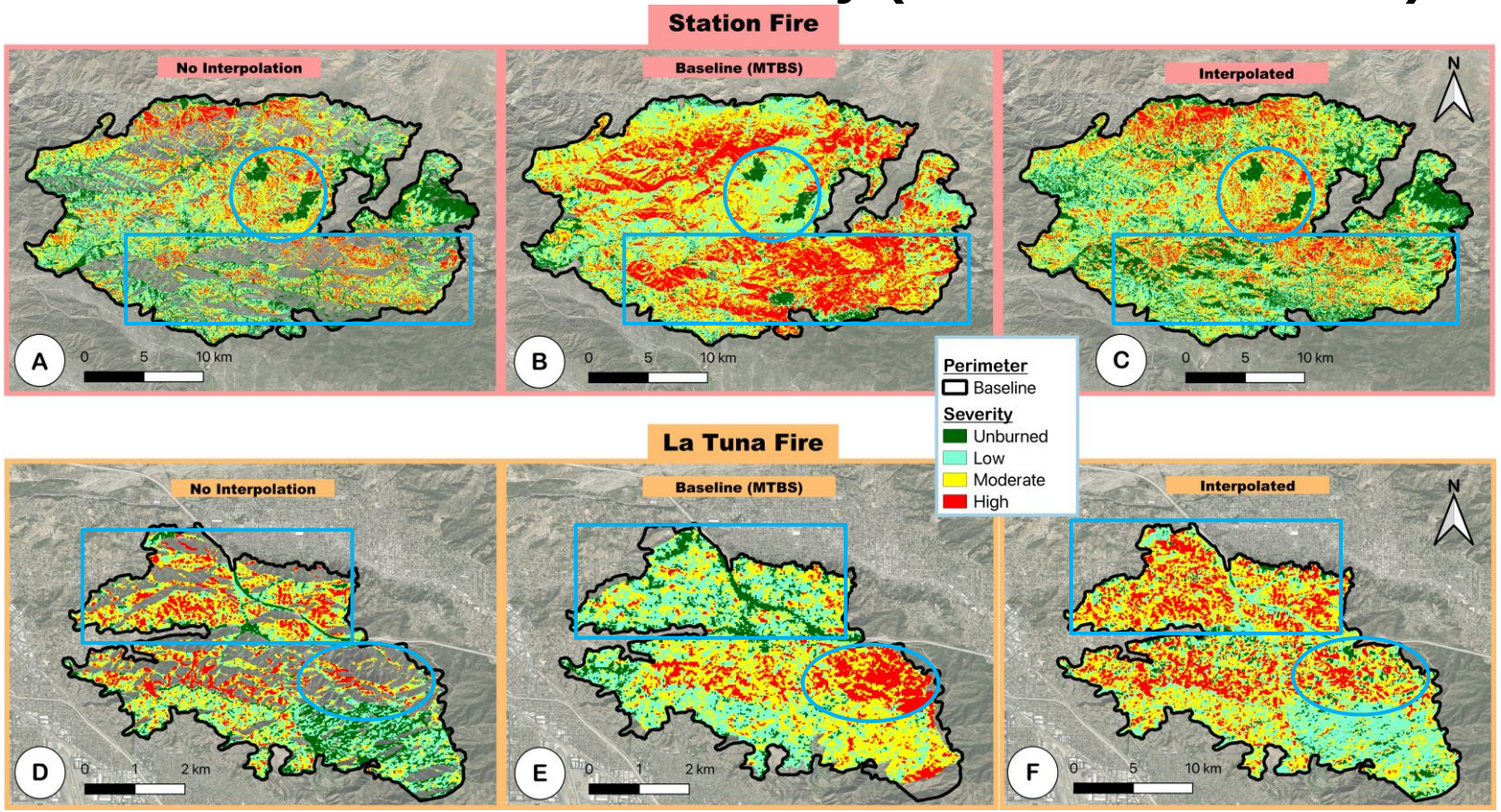
Maps created with QGIS

Results – UAVSAR Burn Severity (Bobcat)



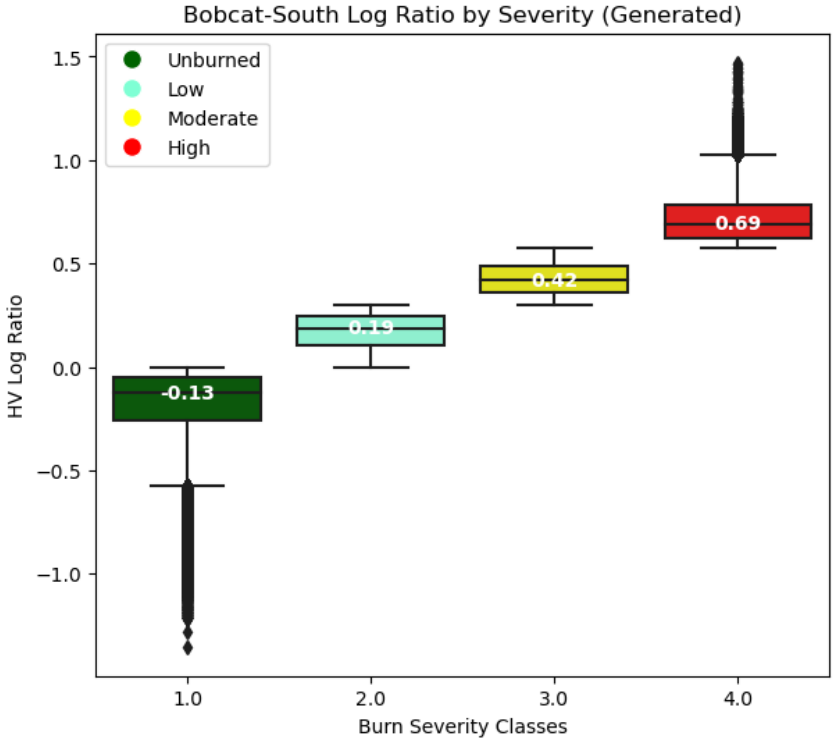
Maps created with QGIS

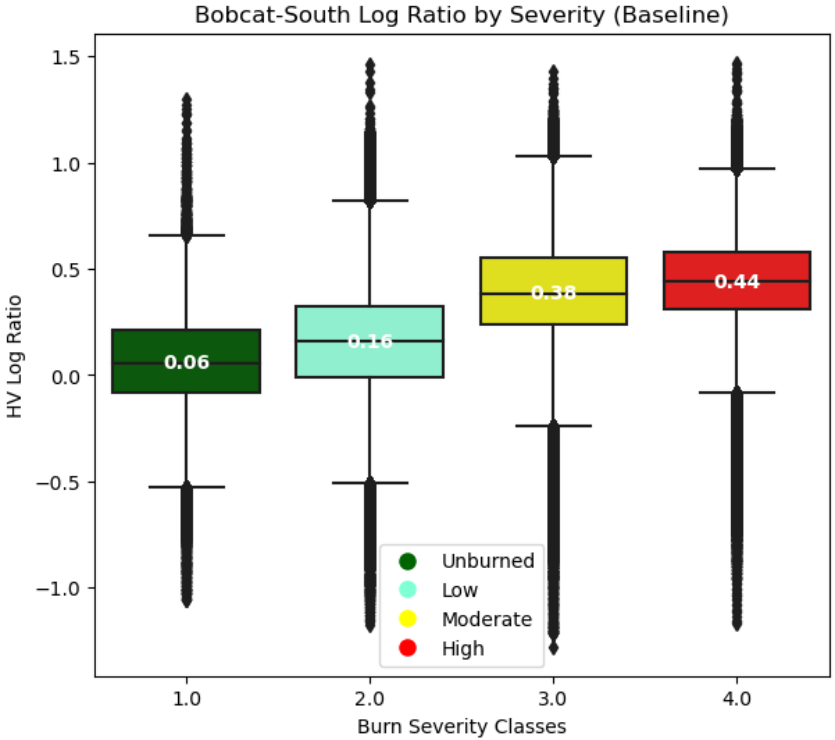
Results – UAVSAR Burn Severity (Station & La Tuna)



Maps created with QGIS

Results – Log Ratio Distribution by Burn Severity





Plots created with matplotlib

- Quick Demo

Future Work

- Thresholds for
  - burned vs. unburned
  - burn severity classes
- Improve perimeter to include unburned areas within
- Improve missing value treatment
- Incorporate other polarizations
- UAVSAR Fire Database

Acknowledgements

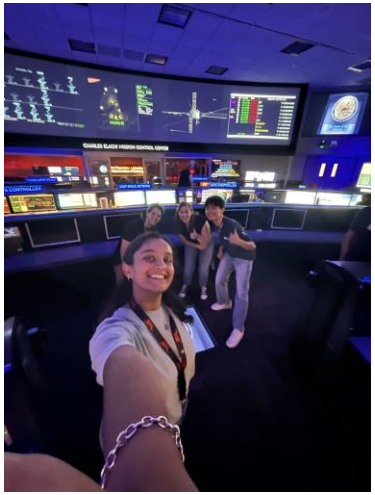
- Karen An & Charlie Marshak
- 334F
- SUDS Community
- Everyone else I’ve met this summer
- Education Office
- JPL

Plans After JPL

- Capstone Project
- Work Experience
- Higher Education

149Q Interns

Deer!!!



SFOF Tour

UAVSAR Flight

JPL Peanut

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Appendix – Data Table

Fire Name	Pre-Fire	Post-Fire
Bobcat **09/06/2020 – 12/18/2020**	SanAnd_08525 on 10/11/2018 SanAnd_08527 on 02/05/2018	SanAnd_08525 on 11/17/2021 SanAnd_08527 on 10/14/2020
La Tuna **09/01/2017 – 09/09/2017**	SanAnd_08525 on 10/23/2014	SanAnd_08525 on 11/02/2017
Station **08/26/2009 – 10/16/2009**	SanAnd_08525 on 02/27/2009 SanAnd_08527 on 02/27/2009	SanAnd_08525 on 03/03/2010 SanAnd_08527 on 04/15/2010