Harnessing the full information content from VIIRS for active fire detection and tracking

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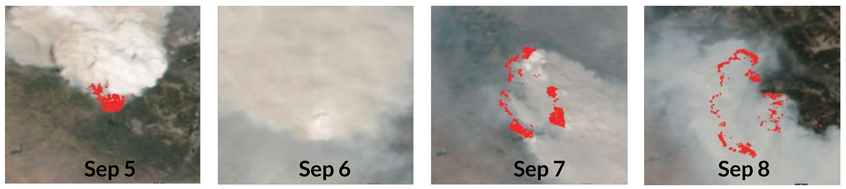
Key Points

- Remote sensing of fires is limited by smoke, cloud, and canopy obscuration, atmospheric attenuation, and instrument sensitivity to small or smoldering fires
- VIIRS Level 2 swaths from 2 satellites include pixels labeled as "background" or "candidate" fires which do not always satisfy other tests to be labeled as active fire detections
- Including background and candidate fire pixels around areas of known fire activity can contribute 20-40+% of total detections, increasing estimates of fire-affected area, fire radiative power (FRP), and fire persistence, amplifying ecosystem impacts and smoke emissions
- This framework to separate initial fire detection from tracking known fire events could improve situational awareness and emissions estimates

Case Study #1: Creek Fire

California, 2020

A pyrocumulonimbus (PyroCb) event obscures VIIRS 375m active fire detections (red) entirely on September 6:

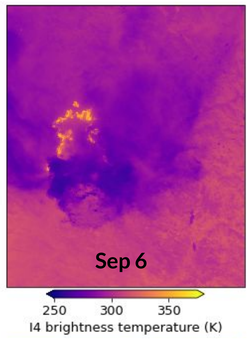


<u>Research question</u>: Is there additional information available in the VIIRS Level 1 and Level 2 swaths to help track the Creek Fire during periods of apparent obscuration?

Short answer: Yes!

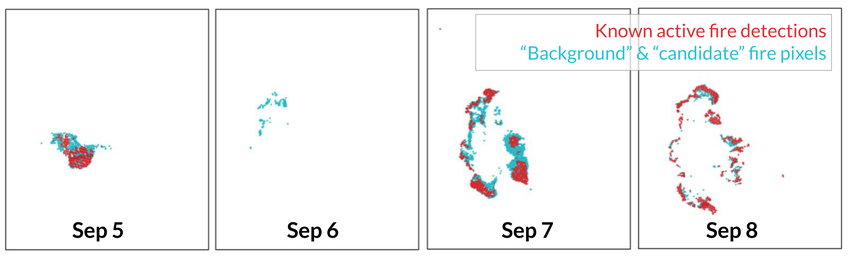
Level 1 infrared imagery for Sep 6 →

- Hot areas were excluded from classification as active fire due to cloud cover and lack of clear land background for differencing



Level 2 swaths

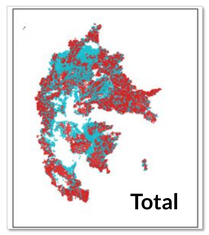
- Quality flags indicate which tests in the VIIRS active fire algorithm were passed/failed for every pixel
- Including pixels flagged as **"background" or "candidate" fire pixels** (but failing other threshold tests to qualify as active fire detections) contributes substantially to the total potential number of detections



"Background" or "candidate" fire pixels constitute

- 36% of total possible daytime detections (right →)
- 11% of total possible nighttime detections

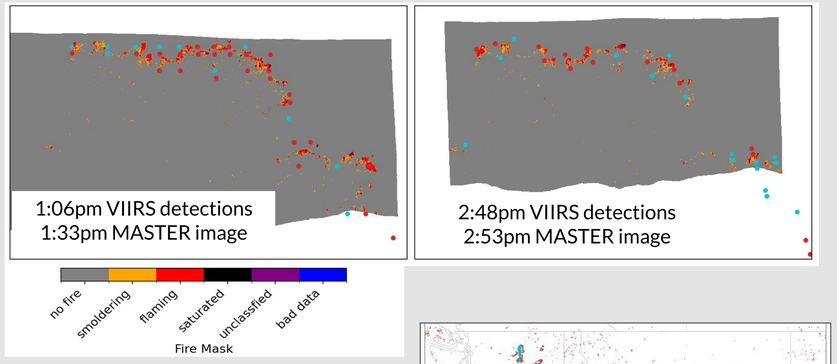
Over the full lifetime of the Creek Fire



Case Study #2: Williams Flats Fire

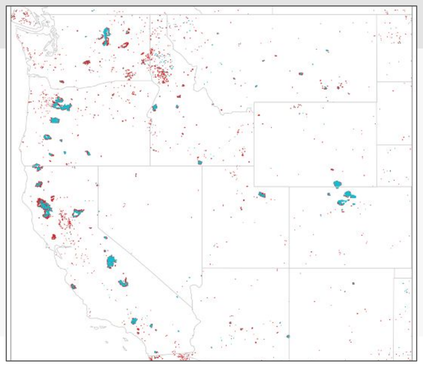
Oregon, 2019

Coincidence of MASTER infrared flight imagery with VIIRS Suomi-NPP satellite overpass on August 6, 2019 allows for qualitative validation of additional fire pixels



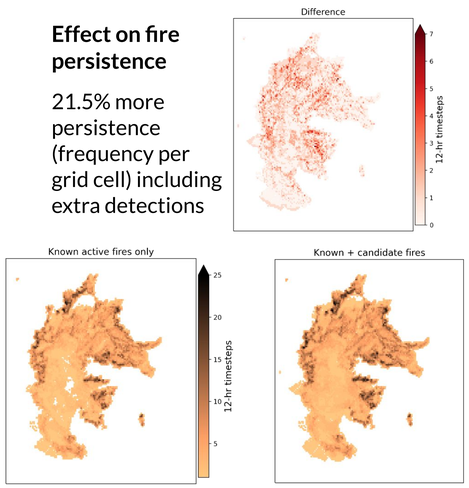
Western US 2020 fire season →

- Daytime: Extra **candidates** account for **27.9%** (29.4% for large fires)
- Nighttime: Extra **candidates** account for **11.7%** (12.2% for large fires)

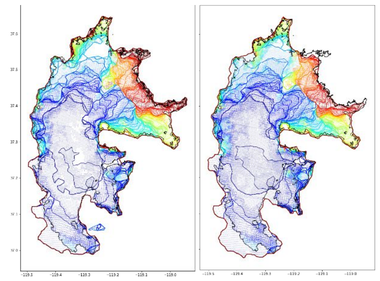


Effect on fire persistence

21.5% more persistence (frequency per grid cell) including extra detections



Effect on fire perimeter tracking (FEDS algorithm[2])



Case Study #3-4: Brazilian Fires

Roraima, Feb-Mar 2019

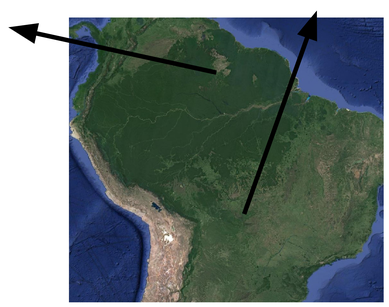
Additional candidate detections may help fill gaps in estimated burned area particularly for closed-canopy forests

Mato Grosso, Jul-Oct 2020

Additional candidate detections (blue) contribute

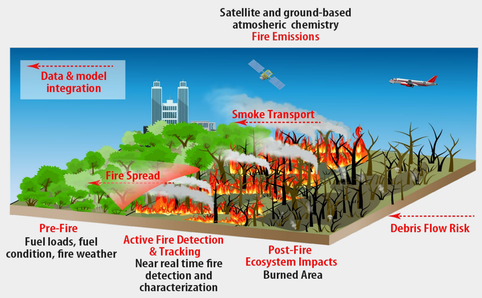
←54%

38%→



Ongoing work and future directions

- Calculating **FRP** contribution of additional candidate detections
- Correcting FRP for atmospheric view angle attenuation
- Analyzing candidate detections and persistence relative to **land cover** and fuels
- Challenges: Validation of additional detections, quantification of **commission error**
- Future: Potential framework for fire tracking and future observation missions, leveraging extra information in cases of known fire activity
- Contributing to the Earth Information System (EIS) Fire objectives of improving active fire detection, tracking, and impacts →



References

1. Schroeder et al. "The New VIIRS 375 m active fire detection data product: Algorithm description and initial assessment." Remote Sensing of Environment 143 (2014): 85-96.
2. Chen et al. "California wildfire spread derived using VIIRS satellite observations and an object-based tracking system." Scientific data 9.1 (2022): 249.

Acknowledgments

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