# A new satellite data product for studying fire combustion efficiency, fire emission speciation, and fire weather at night and beyond

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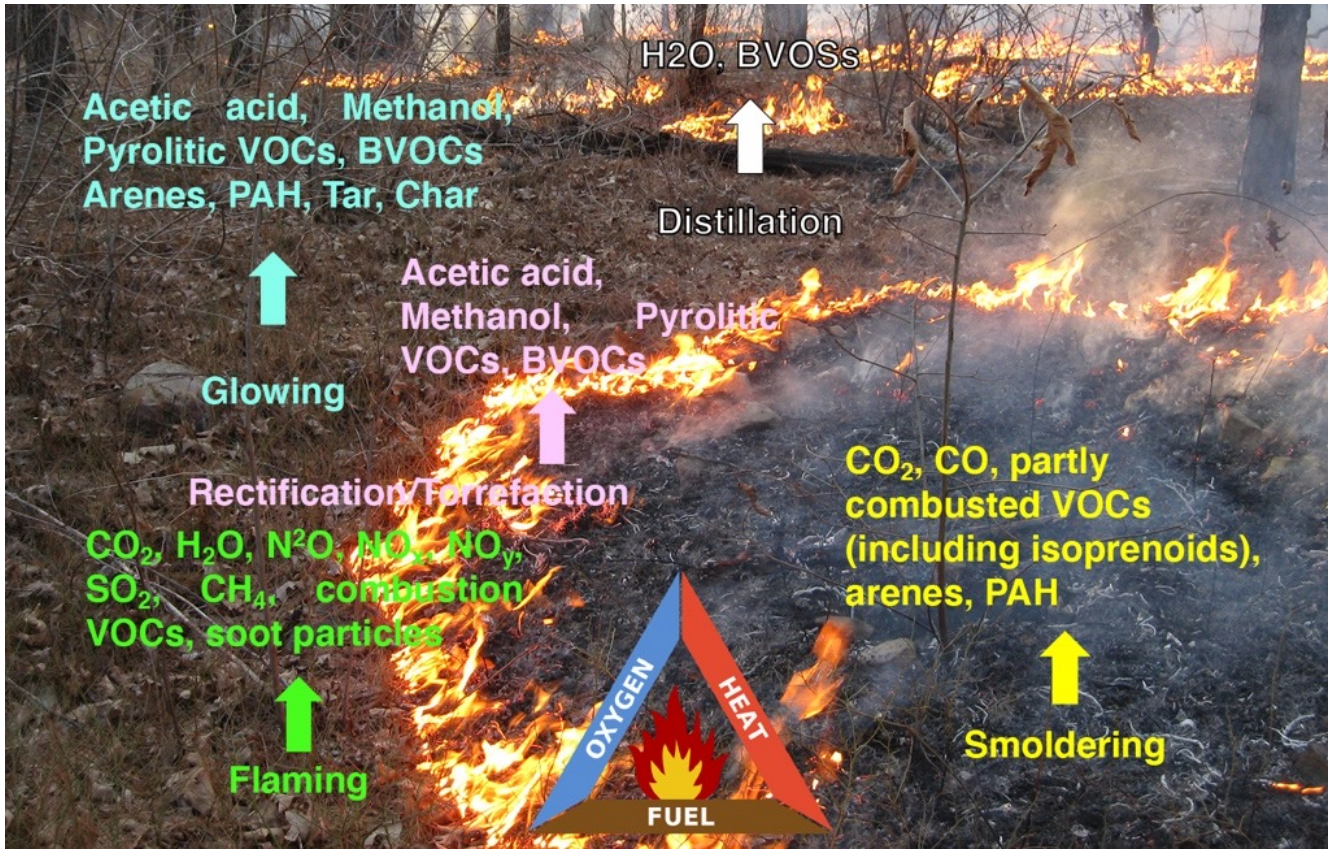
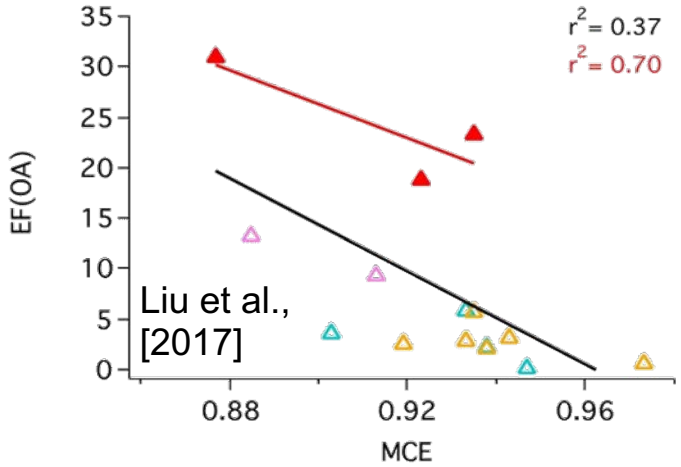
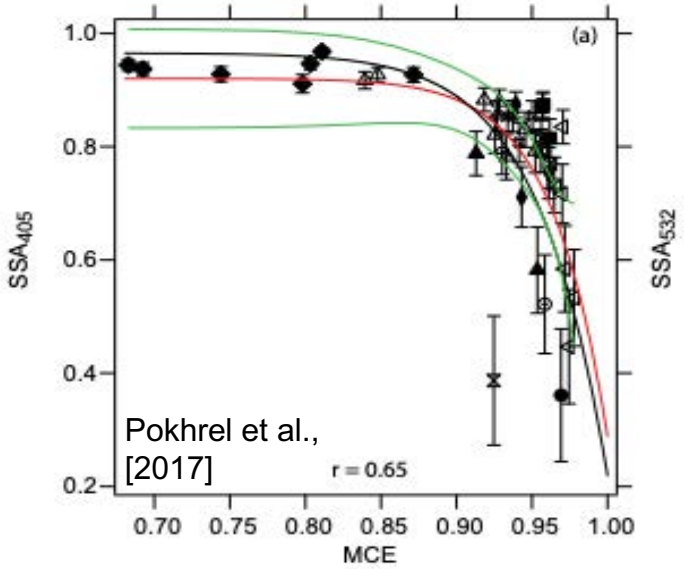
**Modified combustion efficiency** $MCE = \frac{CO_2}{CO_2 + CO}$



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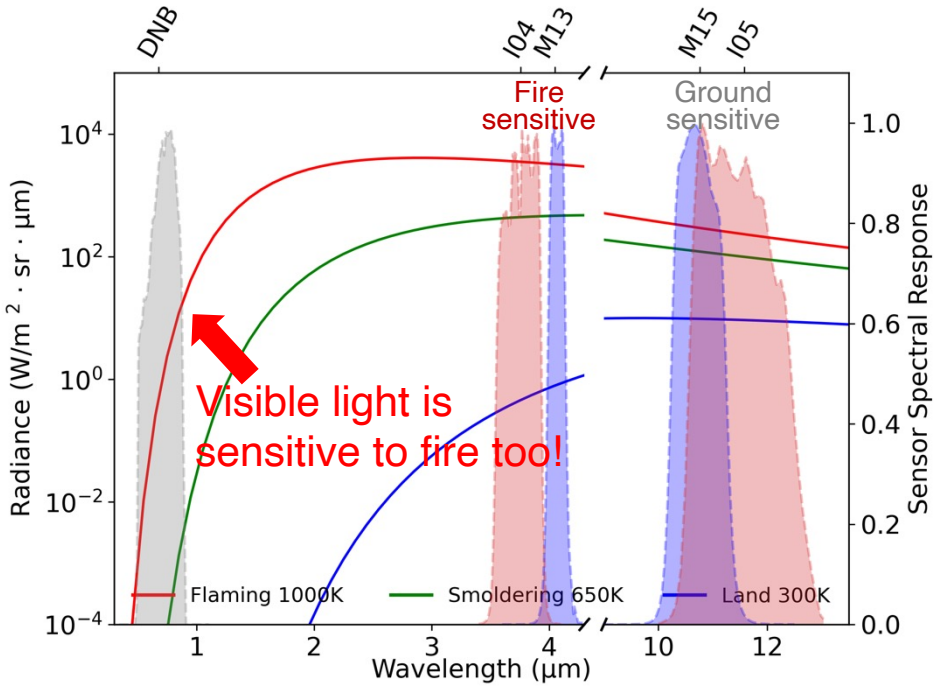
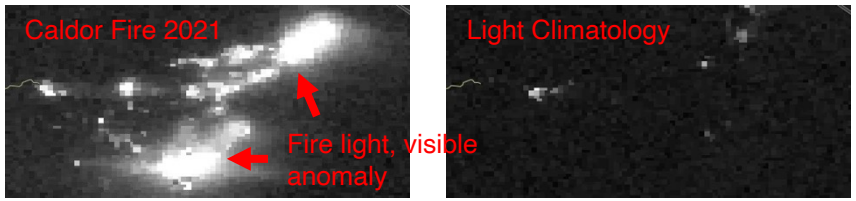
## Fire Light Detection Algorithm version 2 (FILDA-2)




- Visible light is an inherent character of wildfire
- Fire is a transient thing

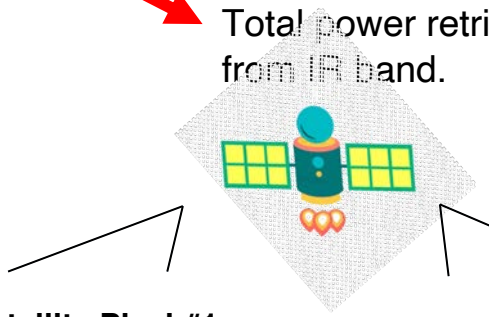
Newly defined parameter for combustion status characterization:

### Visible Energy Fraction (VEF)

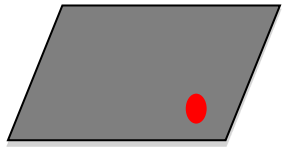
$$VEF = \frac{VLP}{FRP}$$

Visible light power - provided by Nighttime Visible observation

Fire radiative power – Total power retrieved from IR band.

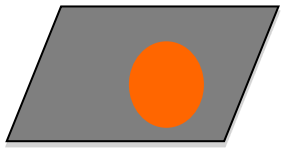


**Satellite Pixel #1**
**High fire temp. Small fire area**



**Flaming, more energy distributed in Visible, High VEF.**

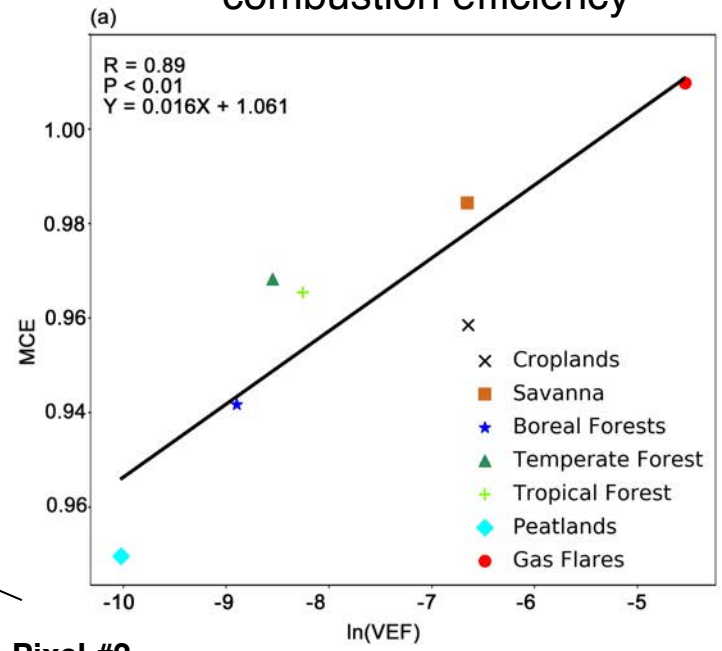
**Satellite Pixel #2**
**Cooler fire temp. Large fire area**



**Smoldering, less energy distributed in Visible, Low VEF.**

**Same FRF, but different VEF at the pixel level.**

VEF is a robust indictor of combustion efficiency




Wang et al., *Remote Sensing of Environment*, 237, 111466, 2020.

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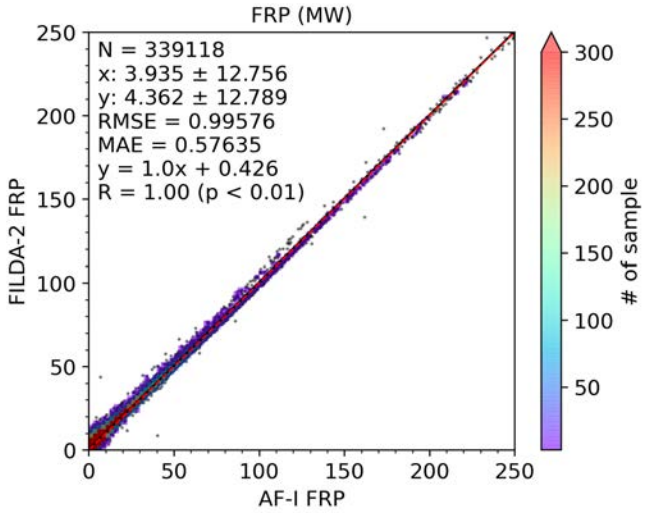
## Validation of FILDA-2

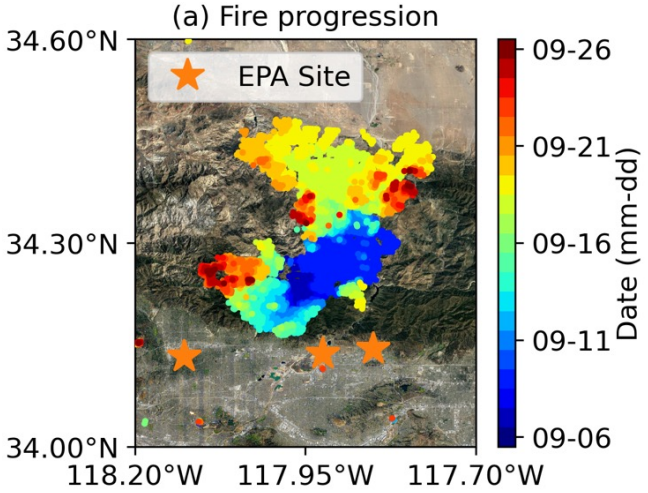
Time: August 2019 ~ August 2020
Scale: Global

1. FRP validation against VNP14IMG
2. VJ1 FILDA is validated against VNP FILDA-2
3. FILDA-2 MCE is validated against EPA molar density ratio

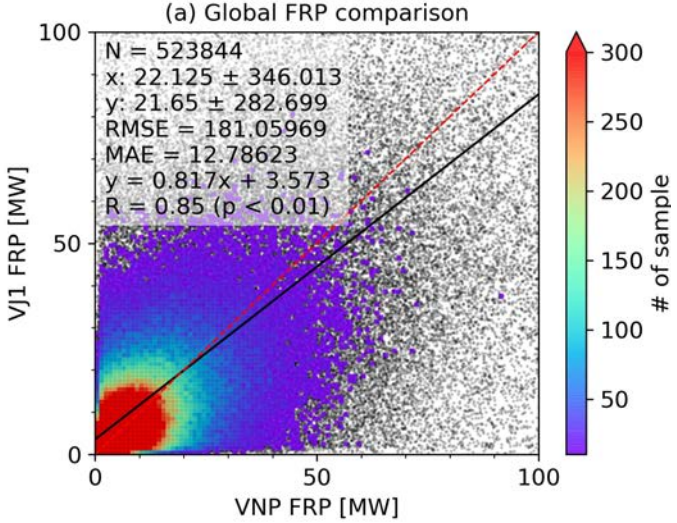
### 1. FRP validation

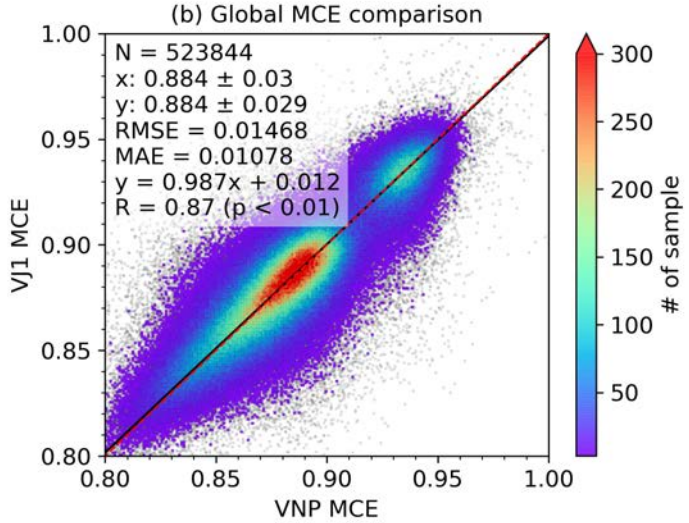


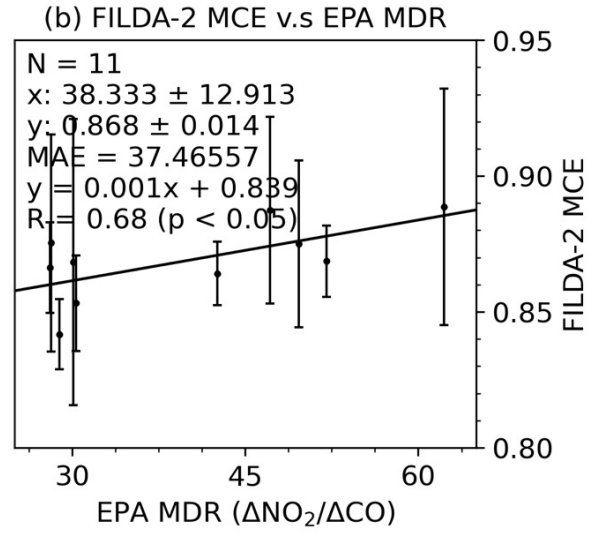

### 3. MCE validation




### 2. VJ1 validation




Zhou et al., *IEEE Transactions on Geoscience and Remote Sensing, vol. 61, 4402420, 2023.*

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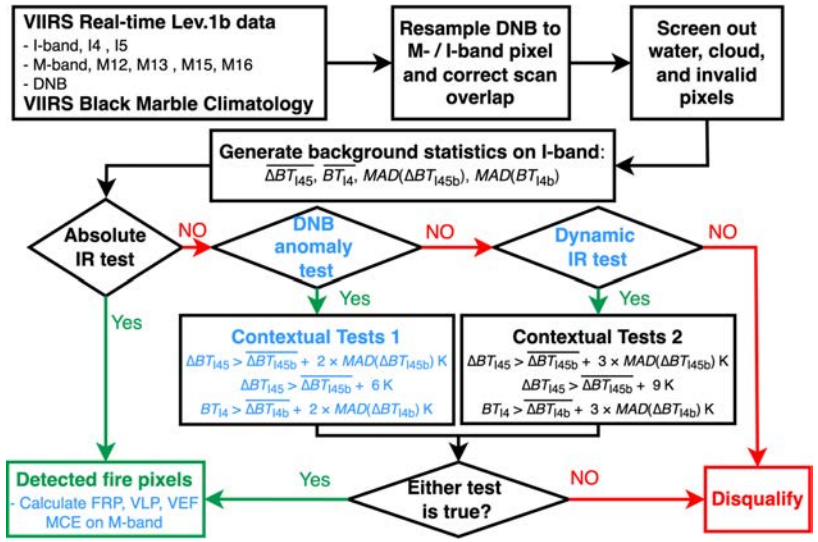
## Progress and next steps




### Progress

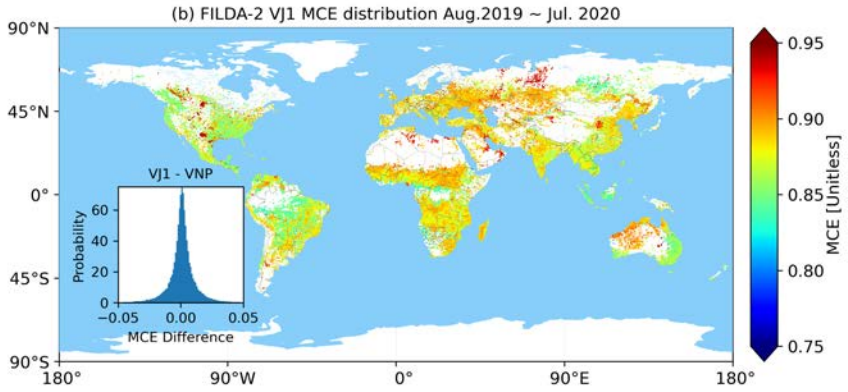
- Software package are ready and delivered to land team
- ATBD are nearly ready and will be published through ATBD tool
- Benchmark run for Aug. 2019 ~ Aug. 2020
- Validation with multiple products including ASTER, VNP14IMG, EPA trace gas measurements, etc.
- Worked with land team to integrate FILDA-2 to SIPS
  - ✓ Provide rules for FILDA-2 run
  - ✓ Provide rules for static input
- Worked with a few users already to finalize the data content
  - ✓ spectrum radiances of fire pixel as attributes

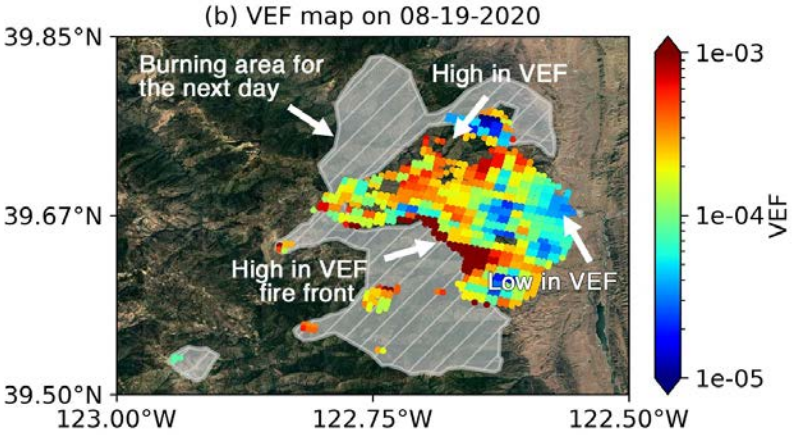
### Challenge & Next Step

- Extension to daytime
- Fire pixel classification
  - waste incineration
  - fracking
  - oil fracking facility
- Assessment & validation
- Adapt to NOAA-21
- Metadata

### Applications…

- Fire lines
- Fire weather




| VJ1.MOD.A2019213.0100.001.nc | VJ1.MOD.A2019213.0100.001.nc | Local File |
|---|---|---|
| DNB_observations | DNB radiance of fire pixel | 1D |
| FP_Area | Pixel area | 1D |
| FP_BG_Temp | Estimated background temperatue | 1D |
| FP_Bowtie | Fraction of bowtie effect | 1D |
| FP_BTD_Mean | Mean background brightness temperature... | 1D |
| FP_CM | Cloud Mask | 1D |
| FP_DNB_POS | DNB abnormal possibility | 1D |
| FP_Fire_Frac | Estimated fire fraction | 1D |
| FP_Fire_Temp | Estimated fire temperatue | 1D |
| FP_Gas_Flaring | Gas Flaring flag 0: Unknown, 1: Gas flarin... | 1D |
| FP_I04_Mean | I04 (3.74 um) brightness temperature of ... | 1D |
| FP_I05_Mean | I05 (11.45 um) brightness temperature of... | 1D |
| FP_Land_Type | MODIS Land cover product MCD12C1 | 1D |
| FP_Latitude | Latitude of fire pixel | 1D |
| FP_Line | Granule line of fire pixel | 1D |
| FP_Longitude | Longitude of fire pixel | 1D |