

Development of a Harmonized Multi-Sensor Global Active Fire Data Set: Current Status and Multi-Product Validation

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Motivation



The recent deployment of the new generation of weather satellites provides an opportunity for the establishment of a robust global network of geostationary fire data that can greatly complement existing polar orbiting satellite fire products.

Table 1

Summary of the key advances in the latest generation of geostationary Earth observation satellites, compared to their predecessors.

| Geostationary Sensor | Spatial Resolution* (km) | Spectral Bands | Mid-wave Infrared Channel Saturation (K) | Full-Disk Temporal Resolution (min) |
|--|--------------------------|----------------|--|-------------------------------------|
| Previous Generation GOES Imager | 4 | 5 | 335 | 180 |
| GOES-R ABI | 2 | 16 | 400 | 5 – 15 |
| Meteosat First Generation MVIRI | 5 | 3 | 250 | 30 |
| Meteosat Second Generation SEVIRI | 3 | 12 | 335 | 5 – 15 |
| Previous Generation Himawari-7 (MTSAT-2) | 4 | 5 | 330 | 30 |
| Advanced Himawari Imager-8 | 2 | 16 | 400 | 10 |

* Applicable to mid-wave infrared channel used in active fire detection.

Main Goals

Augment existing GWIS fire mapping capabilities

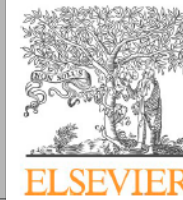
- Incorporate harmonized multi-sensor geostationary fire data sets following **comprehensive data validation/quality assessment**
- Promote common GIS-friendly fire data format
- Incorporate essential science data layers (e.g., FRP, cloud cover, block-out zones) supporting robust regional fire assessment

Educate users on product characteristics and potential applications

- Promote regional workshops

Project Status

Project began July 2018



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Validation of GOES-16 ABI and MSG SEVIRI active fire products

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GOES-16 ABI and MSG SEVIRI data validation complete (Summer 2019)

- Paper published: <https://www.sciencedirect.com/science/article/pii/S0303243419306336>

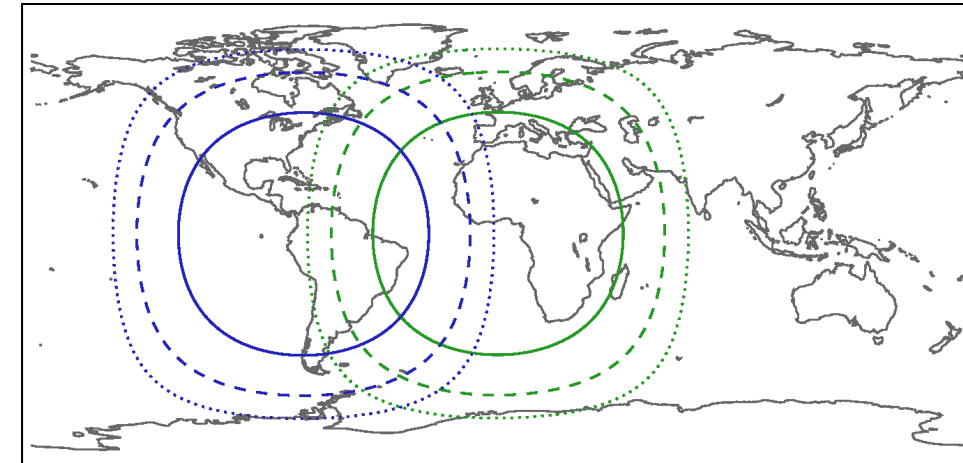
Prototype harmonization of GOES-16 and MSG active fire data

Active Fire Products

Advanced Baseline Imager (ABI) on board the NOAA GOES-16 satellite

Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) on board the ESA Meteosat Second Generation (MSG) satellite series

| | GOES-16 ABI | MSG SEVIRI |
|-----------------------------------|--|--|
| Product | Fire Detection and Characterization (FDC; Schmidt et al., 2012) | Fire Radiative Power (FRP-PIXEL; Wooster et al., 2015) |
| Spatial Resolution | 2km at nadir | 3km at nadir |
| Temporal Resolution | Full Disk: 15 minutes CONUS: 5 minutes | Full Disk: 15 minutes Europe: 5 minutes |
| Active Fire Product Values | 10(30) = processed 11(31) = saturated 12(32) = cloudy 13(33) = high prob. 14(34) = med prob. 15(35) = low prob. | Fire Confidence (0 – 100%) |

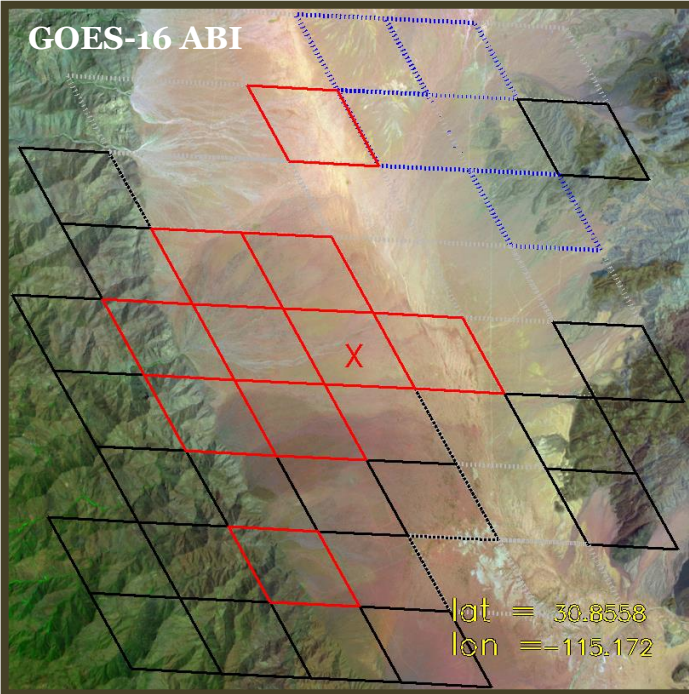


Solid, dashed, dotted lines indicate the boundaries at which the area of the pixel footprint grows to a factor of 2, 4, and 8 times larger than at the sub-satellite point.

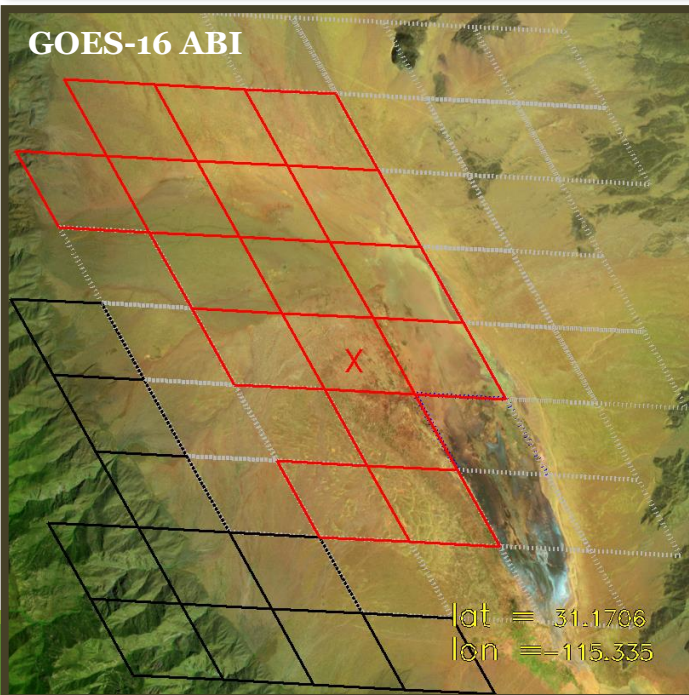
Validation Summary

| | GOES-16 ABI FDC | MSG SEVIRI FRP-PIXEL |
|---|--|--|
| Validation Date Range | 18 Jul 2018 – 30 Sep 2018 (87 days) | 1 Nov 2017 – 28 Feb 2018 (120 days) |
| Total number of Landsat-8 scenes (within 5/6 minutes separation from mid-scan) | 5,760 | 14,032 |
| Total number of pixels sampled (includes fire/non-fire/land/water/clouds) | 43,113 | 300,945 |
| Total number of <u>non-fire</u> pixels with coincident reference fire activity (omission error) | 36,384 (84%) | 295,227 (98%) |
| Pixels flagged as fire <u>with</u> coincident reference fire activity (true positives) | 1527 (23%) | 5,261 (92%) |
| Pixels flagged as fire <u>without</u> coincident reference fire activity (commission error) | 5214 (77%) | 457 (8%) |

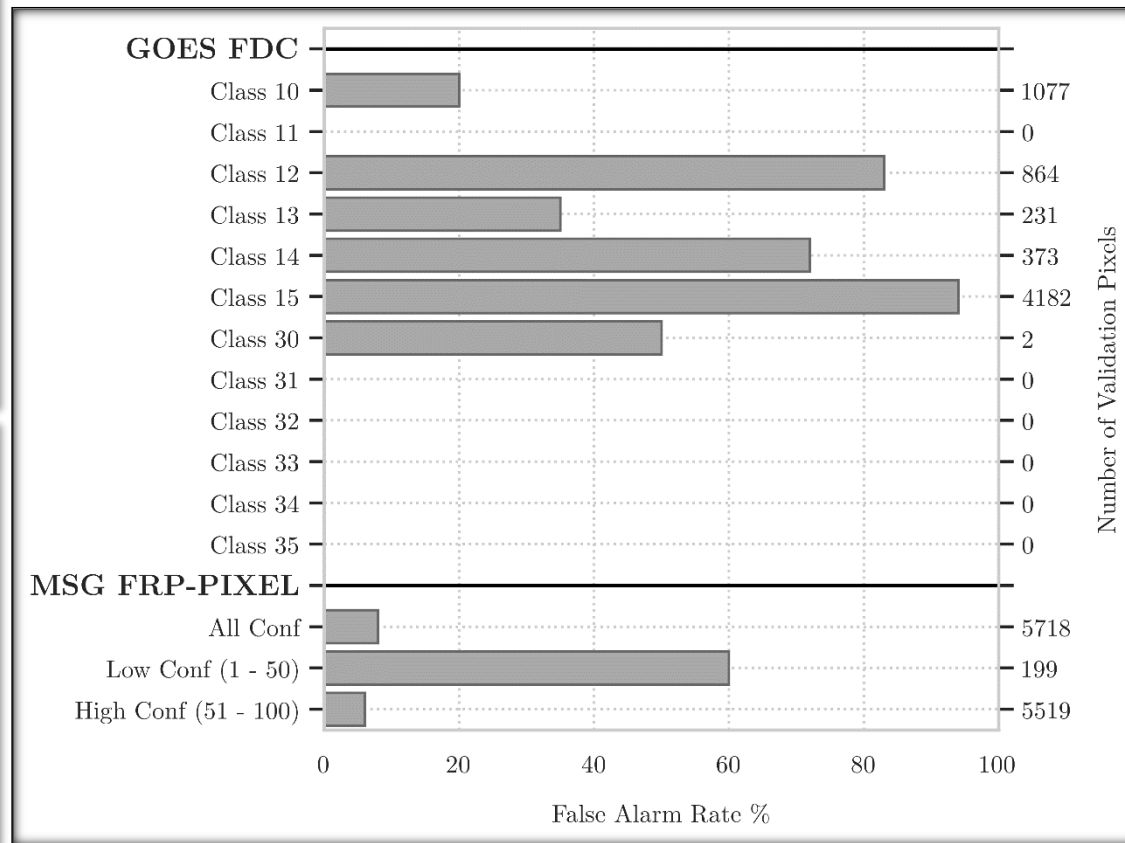
GOES-16 ABI



GOES-16 ABI



Commission & Omission Errors

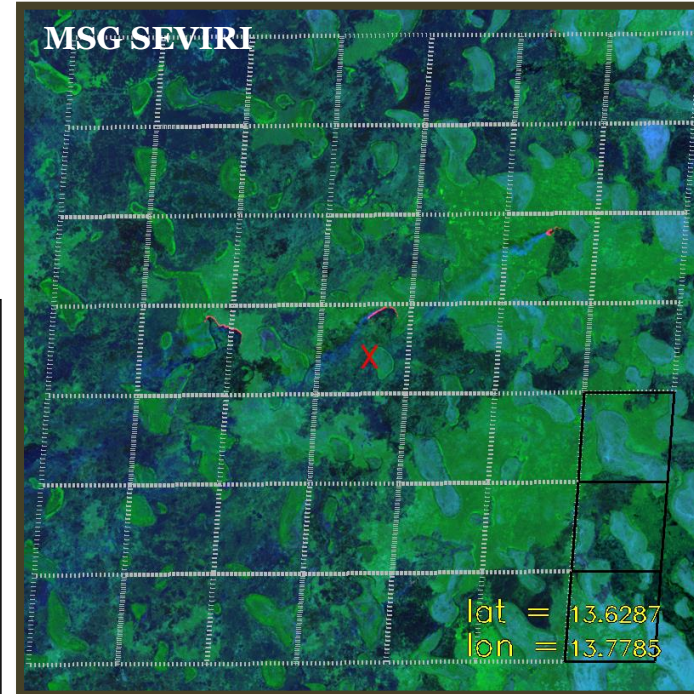


False Alarms:
Bare Soil Regions

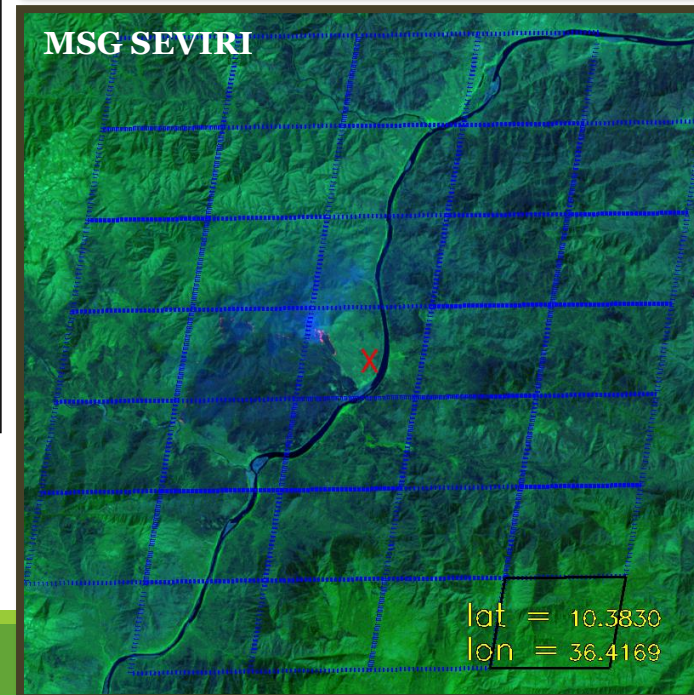
Omissions: Cloud &
Water Mask

Clear Land
 Fire
 Blockout Zone
 Cloud
 Water/Invalid Ecosystem

MSG SEVIRI



MSG SEVIRI



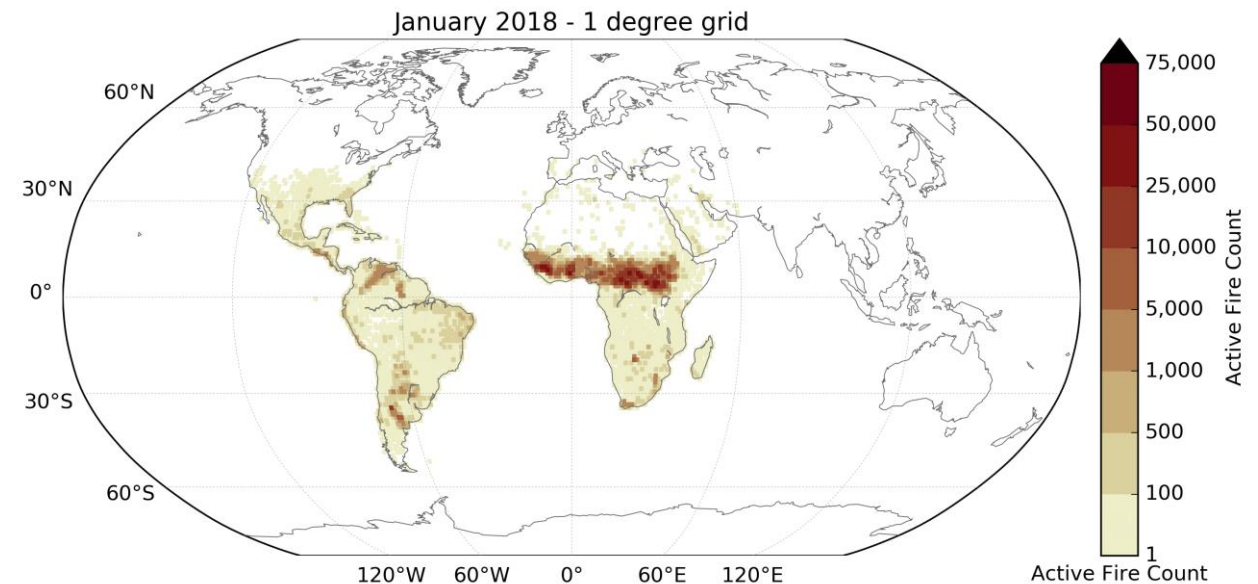
Data Harmonization: Initial Look

Objective: reconcile existing geostationary fire products, addressing differences in methodology, and leveraging algorithm development efforts

- Promote algorithm comparison/exchange and learn from experience

Active Fire Count within 1 degree grid cell

- All Fires
- High Confidence Fires
- Non-Veg. Fire Removal



High Confidence Fires with Non-Veg. Fire Removal

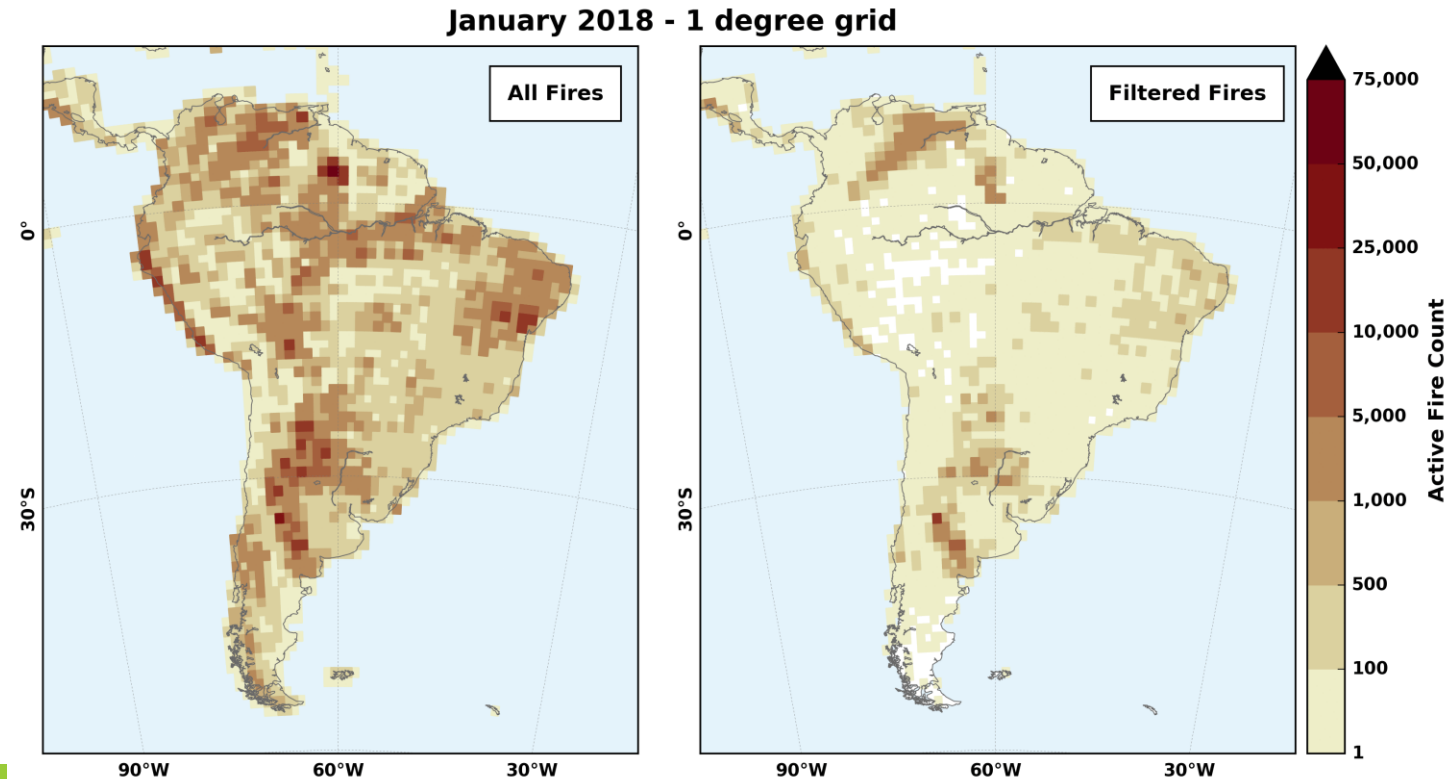
Filtering Fires By Class/Confidence

GOES-16 ABI FDC product suffers from large commission errors

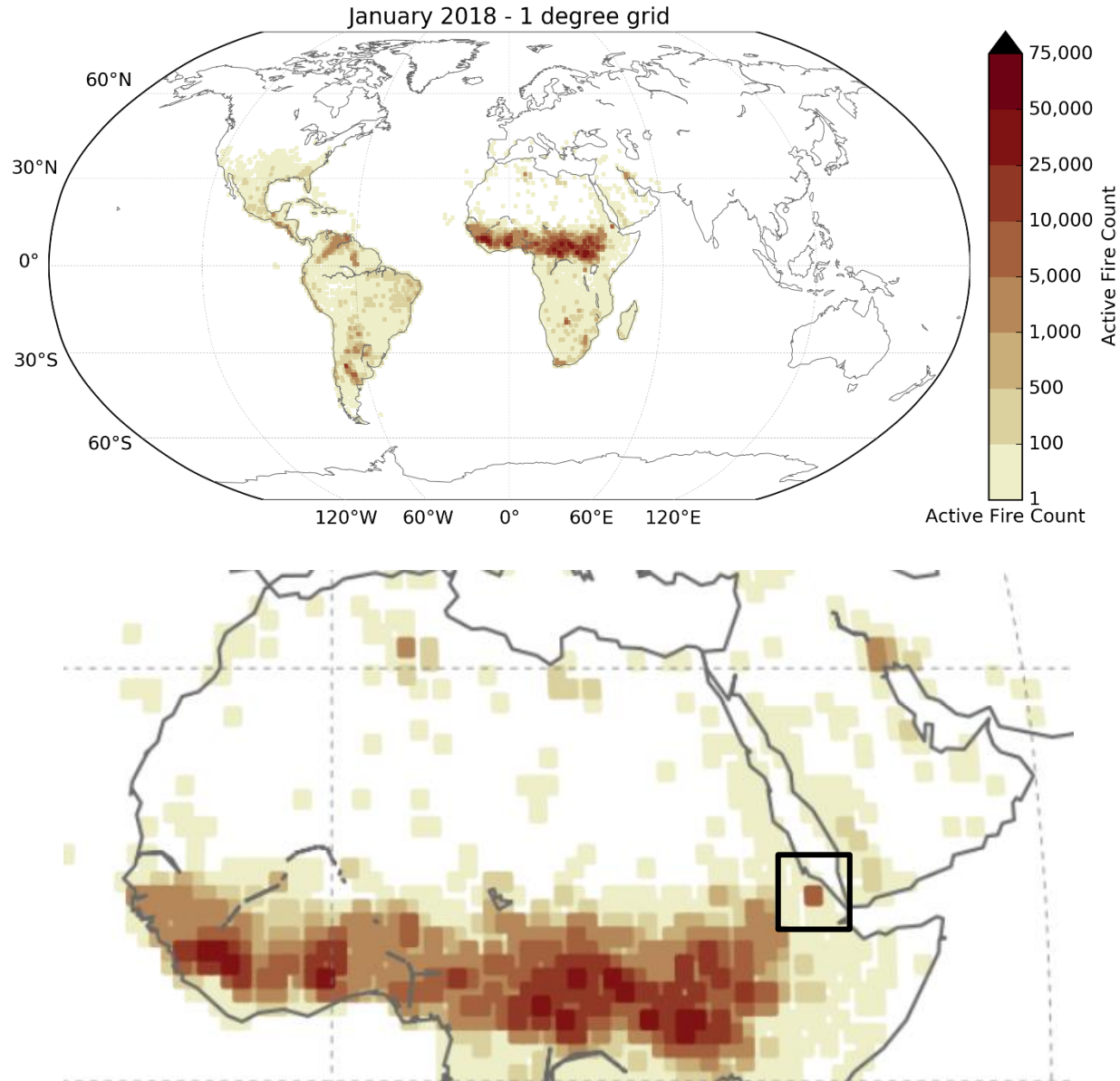
Removing Class 15 is a bare minimum

Figure: Filtered Fires (right) contain high probability fires with non-vegetation fire sources removed

FDC Class: 10(30), 11(31), 13(33)
FRP-PIXEL: Confidence > 50%



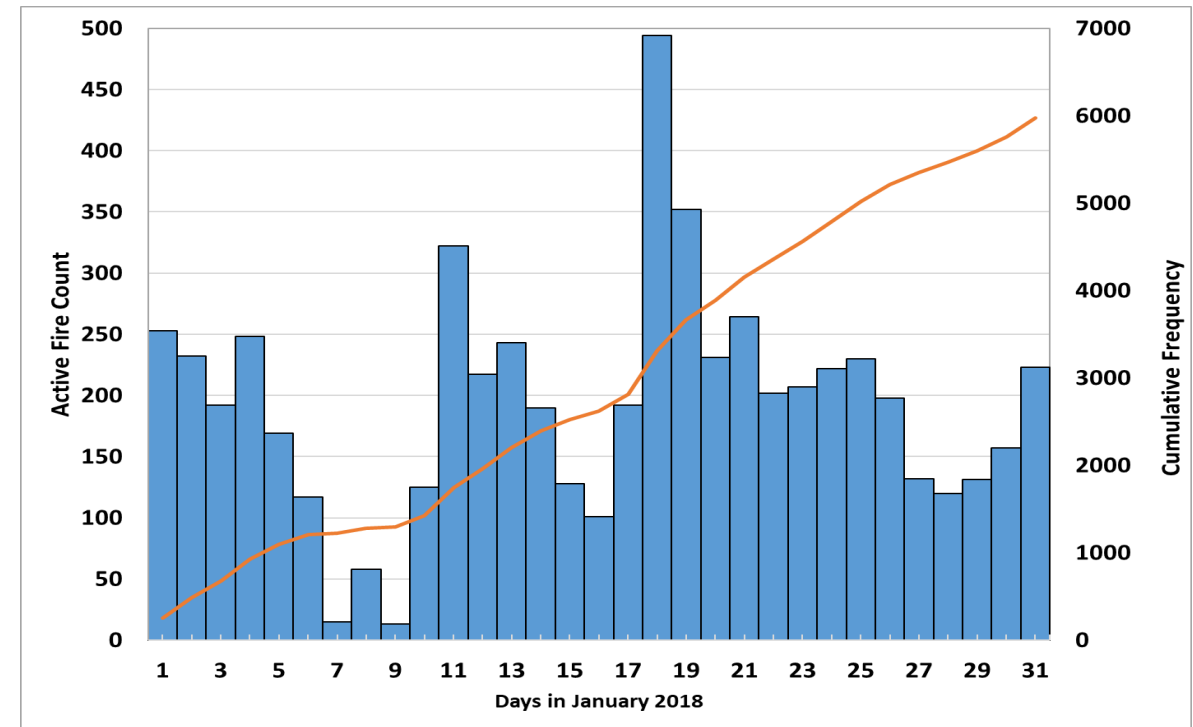
High Conf. Fires WITHOUT Non-Veg. Fire Removal



Erta Ale Shield Volcano, Ethiopia

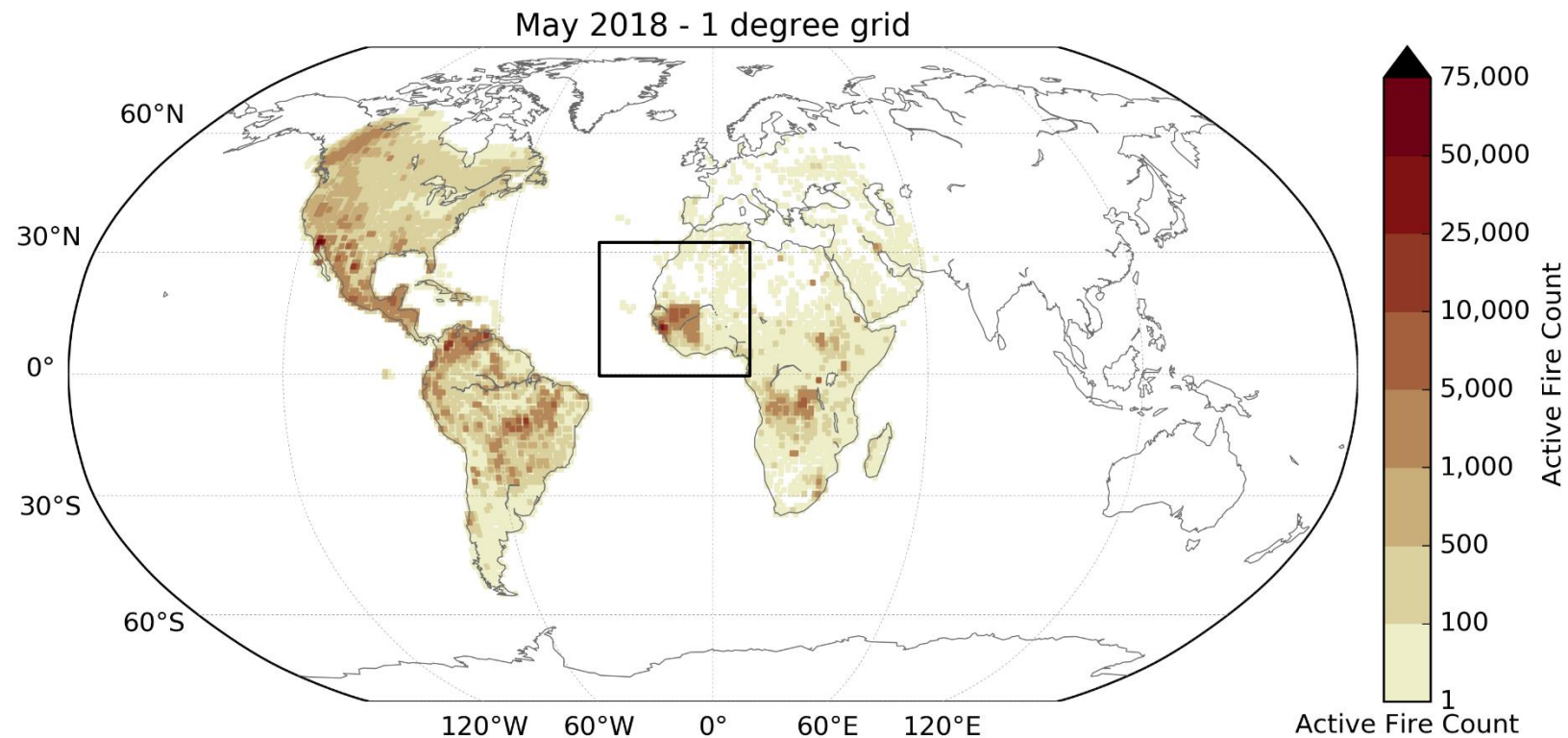
5,979 fires in a 1 degree grid cell in January 2018

We want to avoid including non-vegetation fires in harmonization

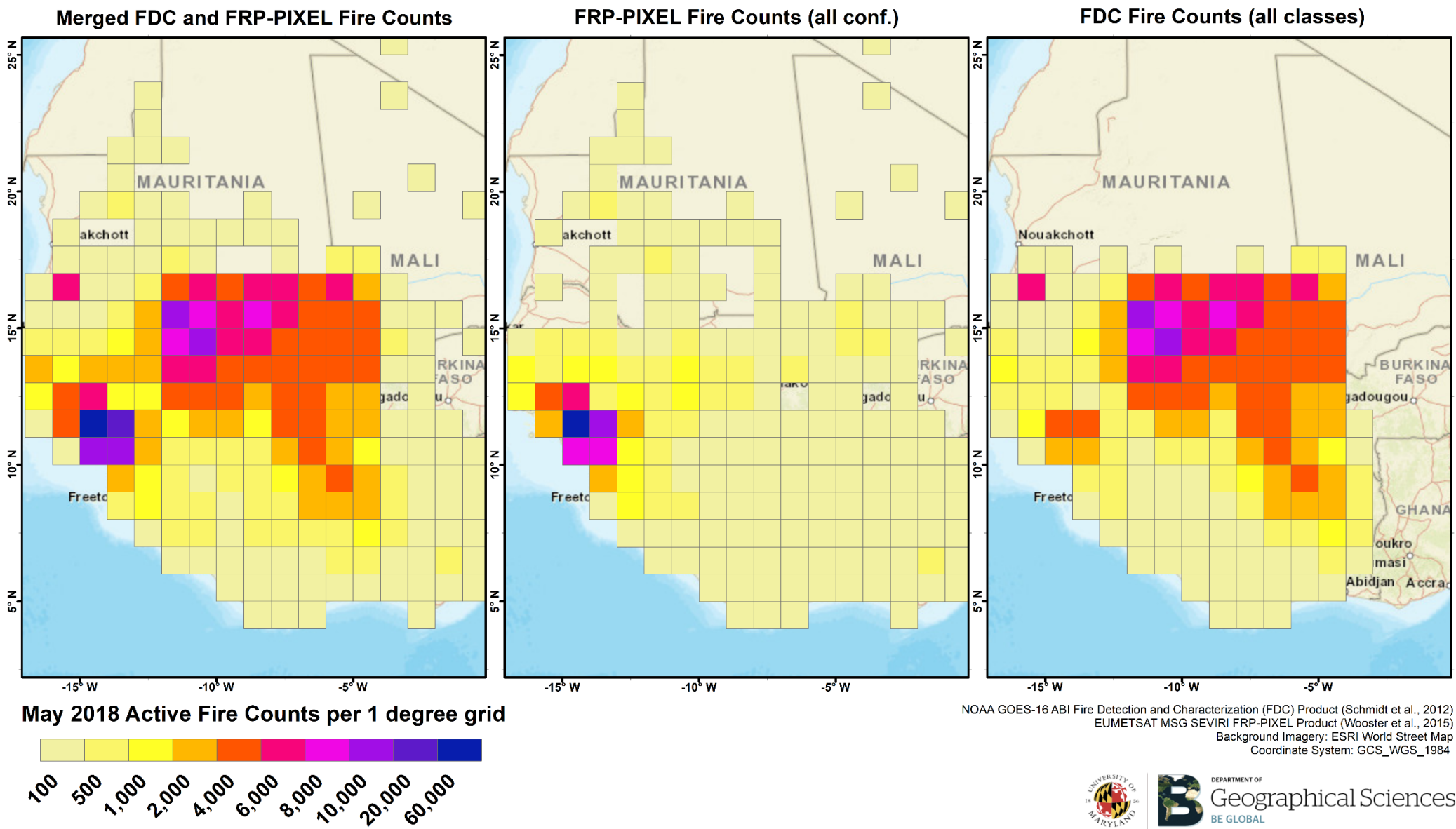


Artificial Boundary: False Alarms

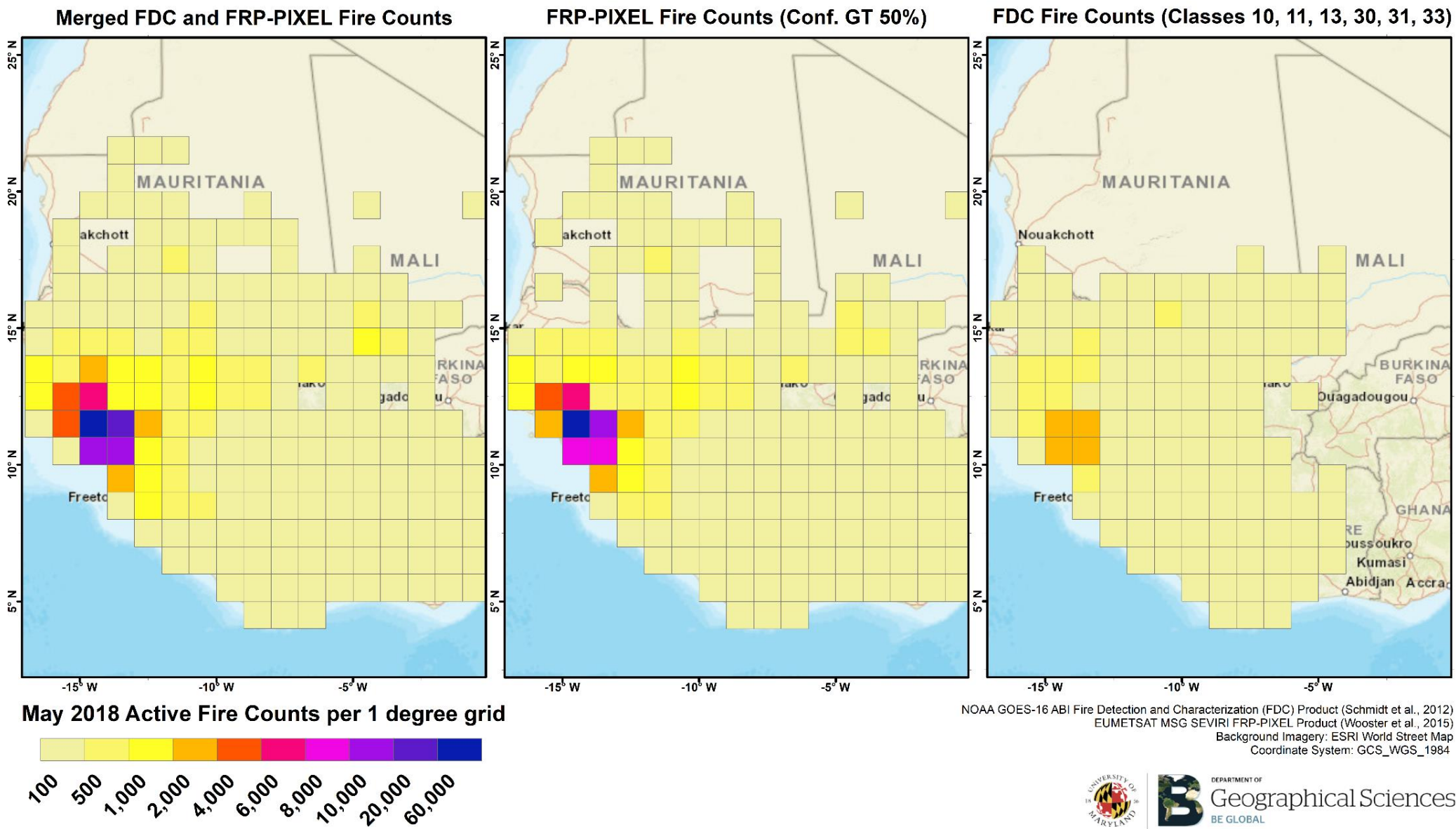
Issue with GOES-16 ABI FDC product over Western Africa bare soil regions



All Fires



High Conf. Fires & Non-Vegetation Fire Removal



Next Steps

Implement more sophisticated harmonization method

Implement GEO-specific persistent source masks

- Supplement MODIS mask now being used
- Large commission error in GOES-16 FDC product

GWIS distribution

- User documentation

Thank You
