Health and Air Quality Applied Sciences Team (HAQAST)

Quantifying Pollution from Prescribed and Smaller Fires: The conundrum in our National Emissions Inventory

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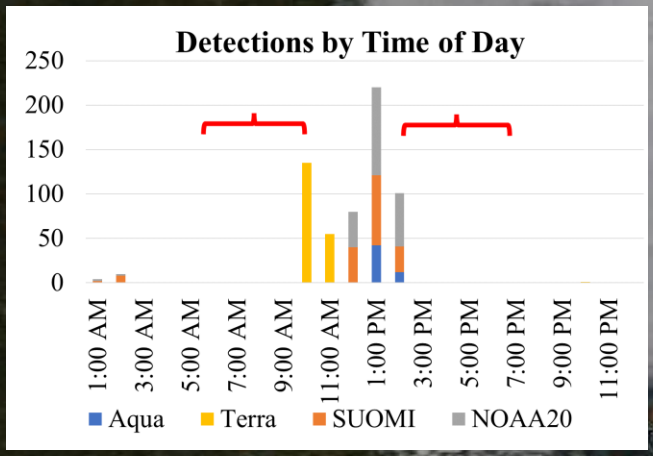
- **Wildfires are devastating, and increased treatments (prescribed fire/mechanical) will decrease potential extreme and devastating fires.**
- **There is good fire, but there are no good smoke pollutants.**
- **Small prescribed fires often exceed or are equivalent to the area burned by western wildland fire.**
- **Small fires are NOT well defined in any of our emissions inventories due to instrument resolution, timing, clouds.**
- **Very High-Resolution data can quantify small fires.**

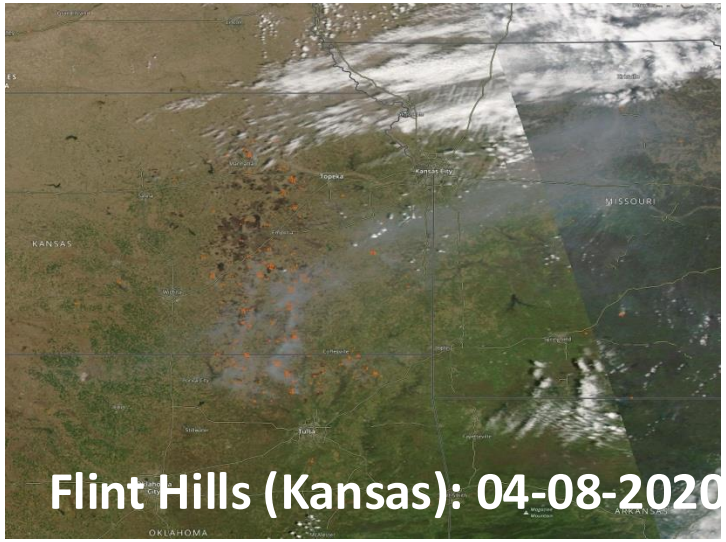


Satellites miss when people burn, morning and afternoons

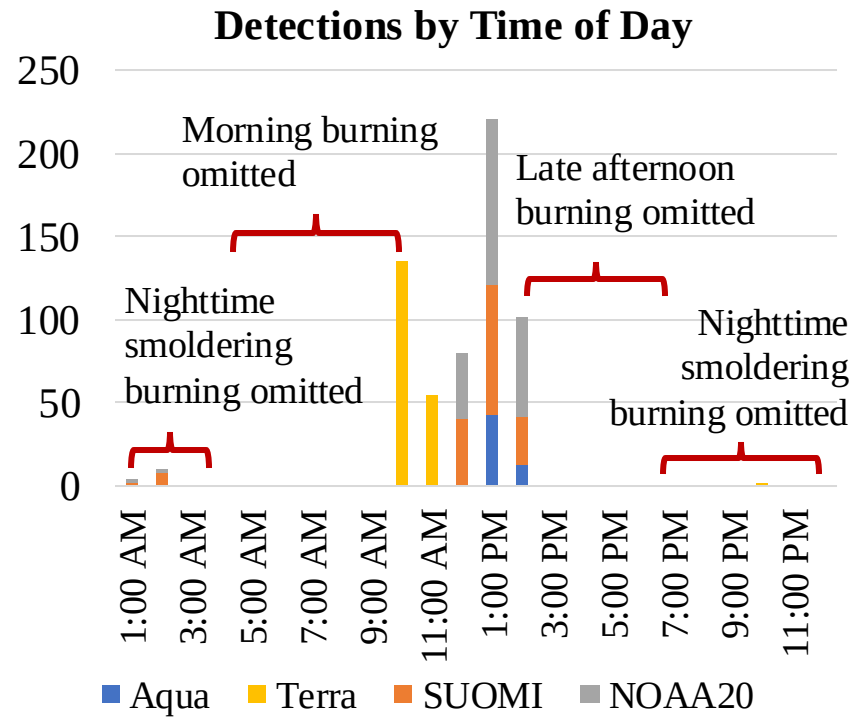
High-res Sentinel 2

Motivation

- The National Fire Emissions Inventory (NFEI) is generated by the EPA with states, and it is used to initialize the Community Multiscale Air Quality Model (CMAQ) that is used to evaluate fire and smoke, as a basis for Rules and Regulations.
- Even though wildfire receives the most notoriety, prescribed and small-fire burning often exceeds or is equivalent to the area burned by western wildland fire (*Melvin, 2015; EPA, 2016; Nowell et al., 2018, Weise et al, 2015*).
- Satellite detection is inhibited due to incongruous overpass and fire timing; persistent cloud cover; and the size and intensity of small fires (Soja et al., 2006; Soja et al., 2009; Huang et al., 2018; Nowell et al., 2018).
- Most small fires and burned area (BA) are not well defined by satellites or resource-limited states.



Satellites miss when people burn



Missing prescribed/ small active fires and burned area

Challenges are:

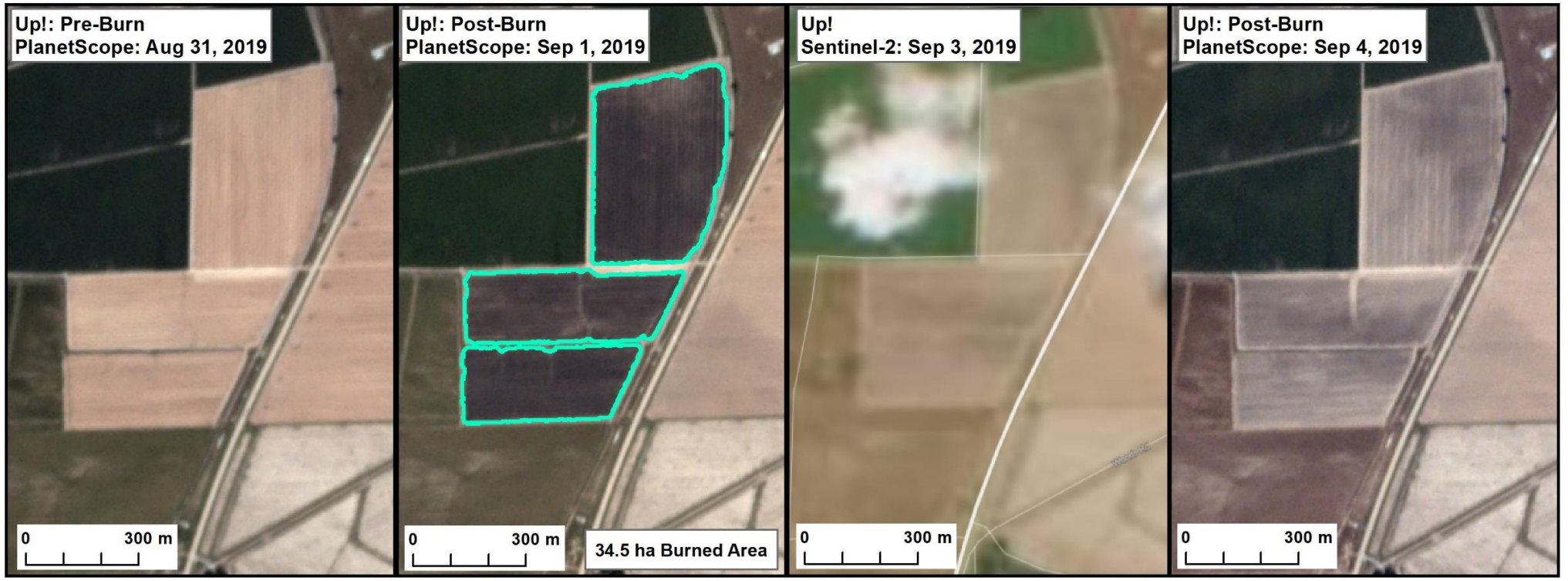
Burn scars recover quickly

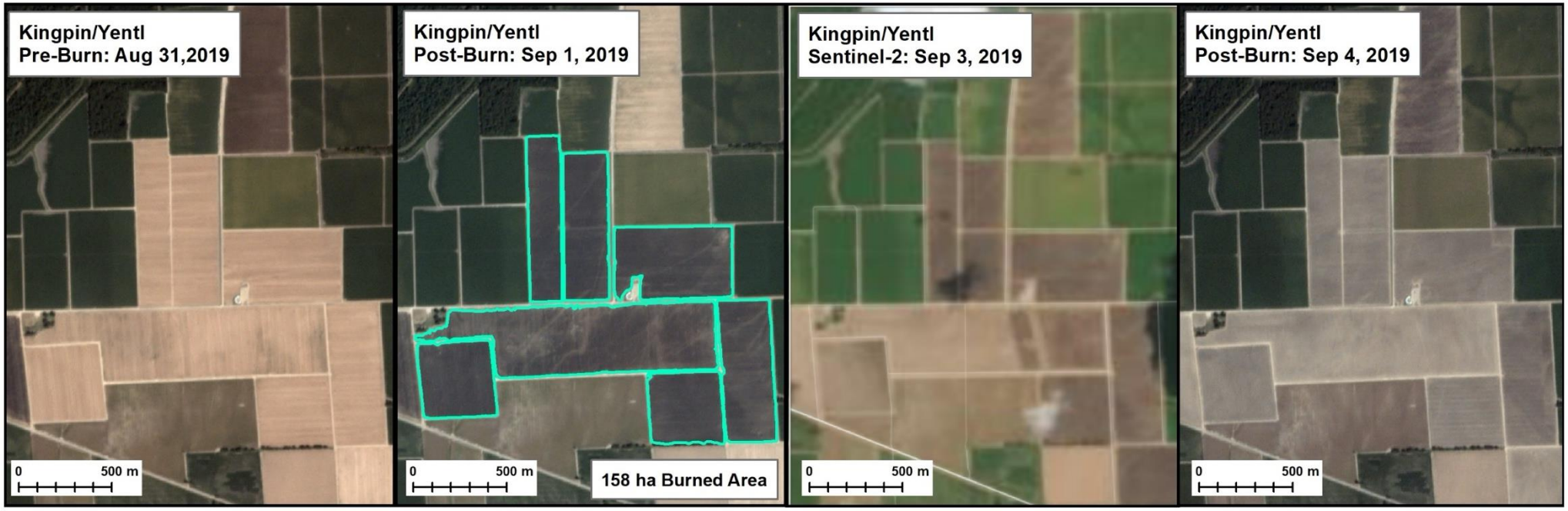
Cloud cover

Incongruous overpass and fire timing.
2 times/day each (MODIS, VIIRS)

Intensity/Resolution

Geostationary satellites, lower 2-km resolution





Flint Hills, Kansas

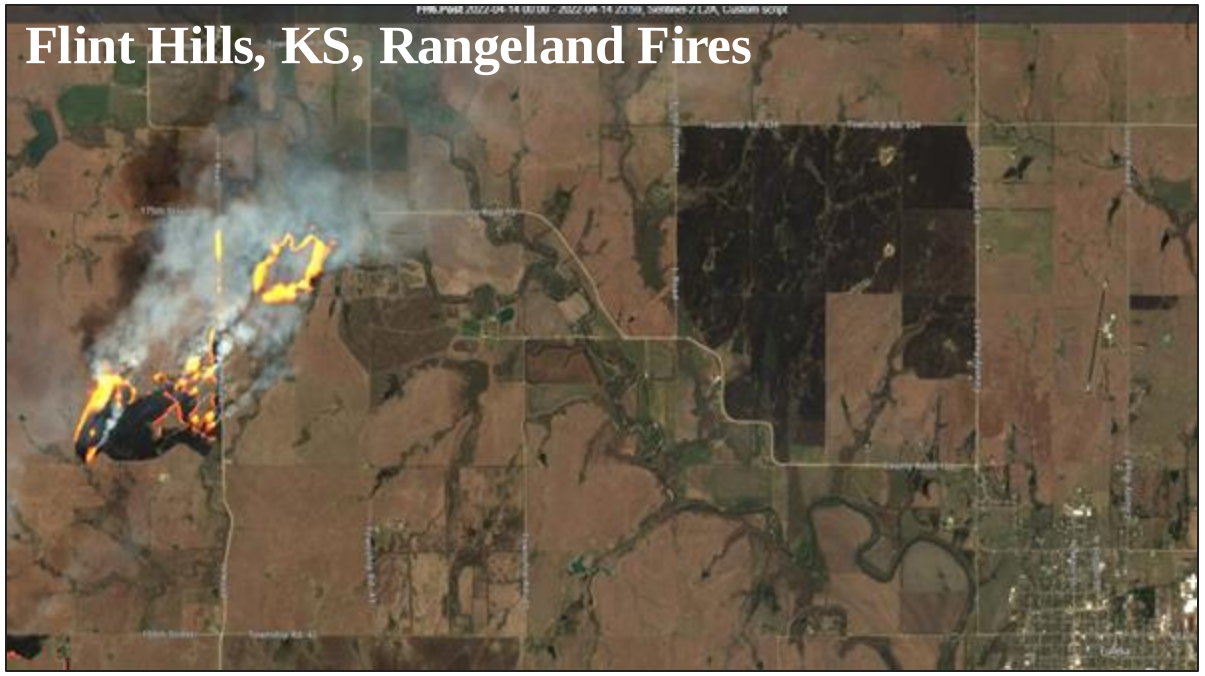
Using very-high to high-resolution satellite data, we analyze these landscapes before, during, and after fires, every day of the 3-6 month burning season.

Fire scars are digitized for full comparisons with satellite data.

Data Sources

- NASA Commercial Satellite Data Acquisition
- (e.g., Sentinel, PlanetScope, Maxar)
- MODIS and VIIRS active fire
- MODIS burned area
- NASA CALIOP on CALIPSO vertical aerosols
- NOAA HMS smoke plumes
- MODIS Aerosol Optical Depth (AOD)
- EPA National Fire Emissions Inventory
- State & Federal Forest Service inventories

Flints Hills grasslands



A lack of complete fire emissions inventories hinders the ability of federal, state and local fire, health and Air Quality managers and regulators to monitor, evaluate, track, and statistically analyze fire and smoke impacts.

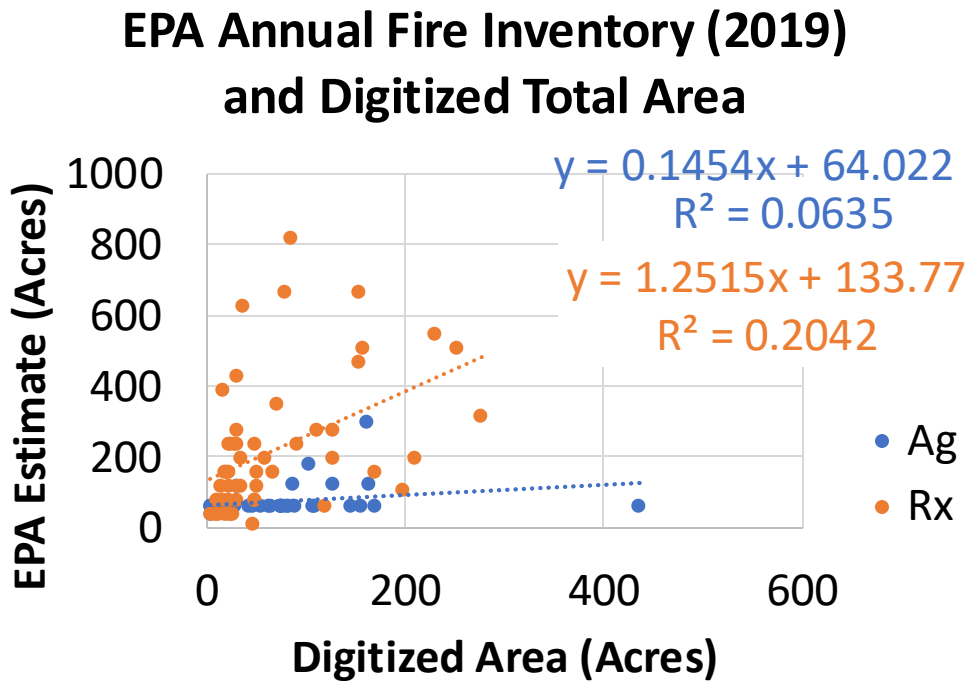
The Goal: Enhance the data and Improve the Process (timing , filters, AC, warnings).

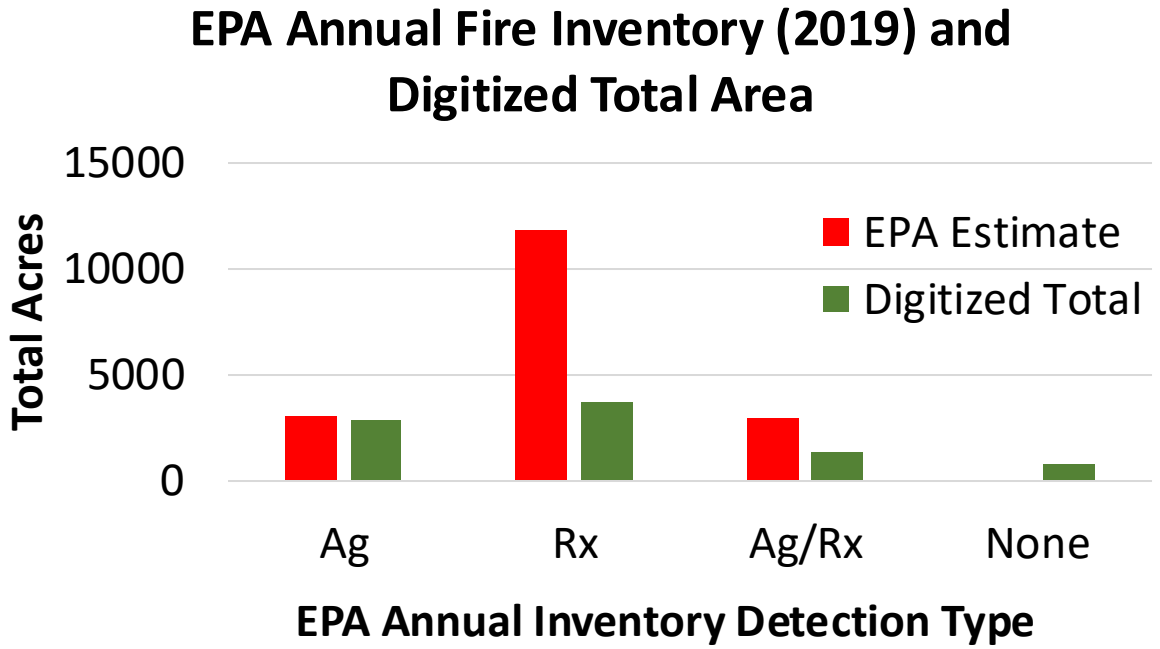
Performance of Satellite products

Fire Detection Products	
Satellite	**Flint Hills, KS Captured**
MODIS Aqua	8%
MODIS Terra	20%
VIIRS Suomi	35%
VIIRS NOAA20	33%
All satellites	**47%**

MODIS Burned Area Product			
Region	Intersection (Agreement)	Commission (Overestimate)	Omission (Missed)
Flint Hills, KS & OK	**65%**	8%	27%

Comparisons of Burned Area in Iowa croplands (ditches, prescribed, agriculture burning)

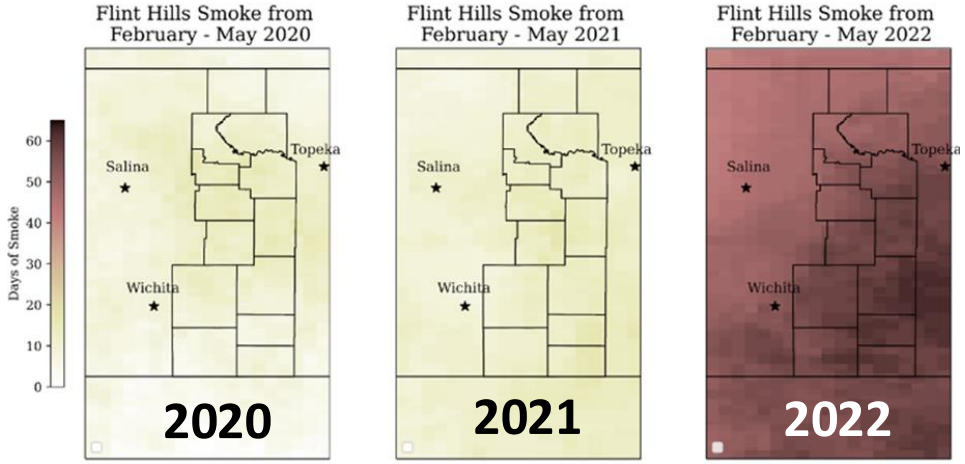




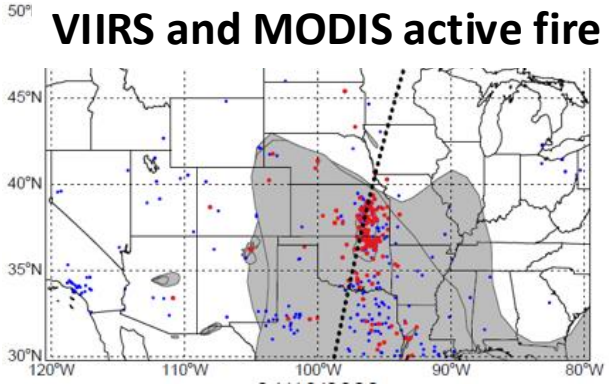
Ditches

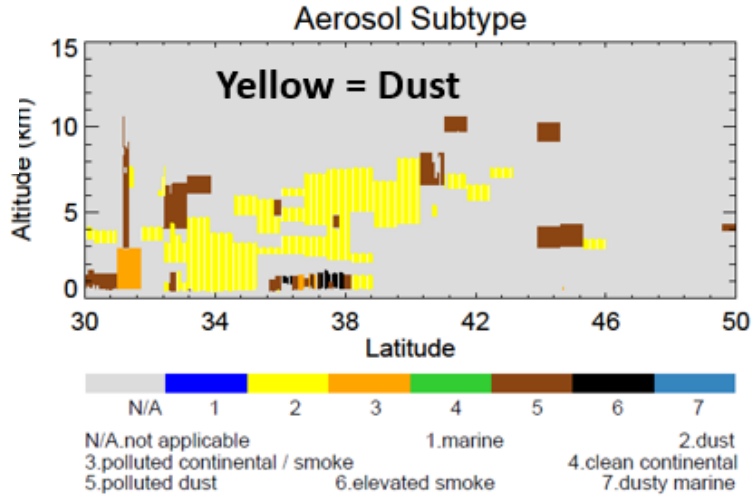
Agricultural Fields

Multiple satellite sensors used to aid and verify with partners



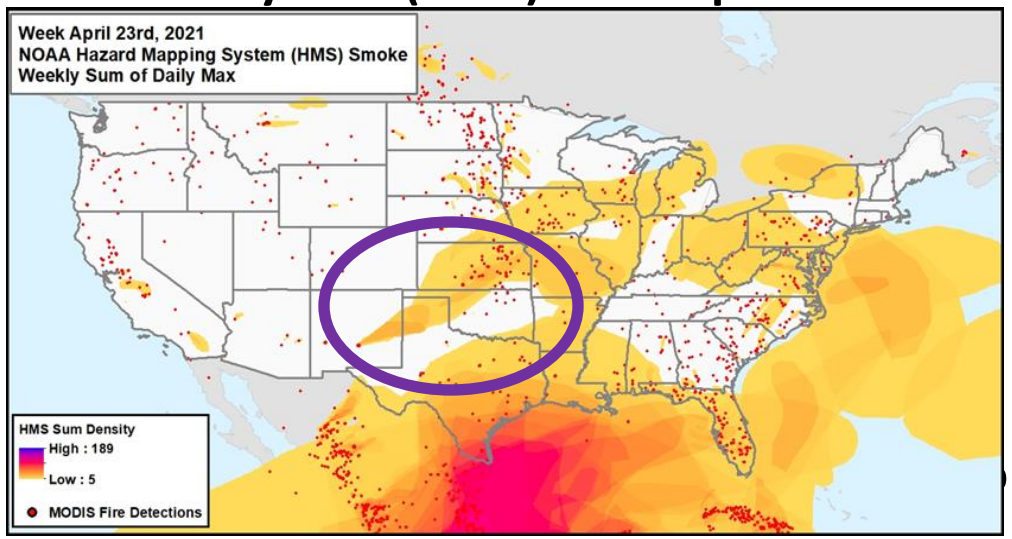
MODIS Aerosol Optical Depth (AOD): Flint Hills

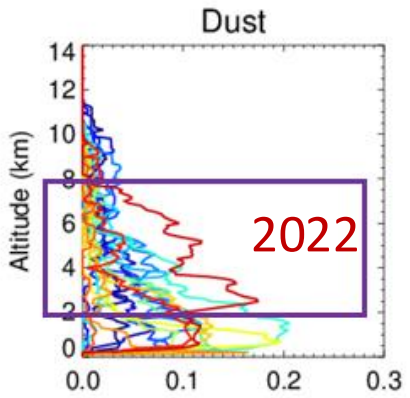




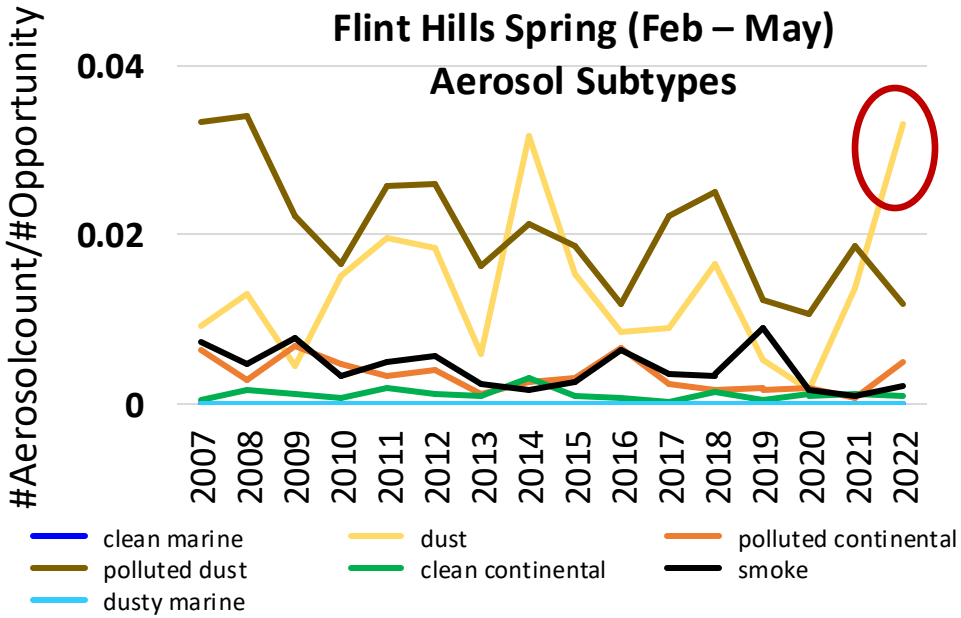
NASA CALIPSO vertical data, MODIS and VIIRS Active Fire detections, and HMS were able to provide insight and validation to our partners in analysis of the Flint Hills, Kansas

Identify and delete smoke originating from outside the Flint Hills using the NOAA Hazard Mapping System (HMS) smoke plumes





Annual Vertical distribution of dust aerosols



EPA values HAQAST work

- Amber Soja's team:
  - ✓Helped evaluate fire types challenging to characterize due to their small size but important due to the large number that happen in certain areas on a small number of days (like grassland burning in the Flint Hills and ag/ditch burning in the midwest).
- Tiger Team projects:
  - ✓Integrated GOES-R aerosol optical depth (AOD) data into operational air quality monitoring data systems such as EPA's AirNow.
  - ✓Evaluated new TEMPO retrievals to facilitate the transition of prior ozone-focused satellite applications.

Additional fire-related research needs

- Fundamental work that improves characterization of fires including
  - Fire type,
  - Fuels burned,
  - Emissions, and
  - Transport of smoke
- Needed for
  - Operational forecast systems (external to EPA), and
  - Retrospective model assessments (internal to EPA) considered high value.

Additional fire-related research needs

- Research that improves tools that:
  - Estimate current smoke exposure,
  - Predict near-term exposure,
  - Communicate smoke exposure and risks, and
  - Minimize human exposure (e.g., indoor air filters, behavior changes).