Enhancing Emissions in our Nation's National Fire Emissions Inventory: *Quantifying Pollution from Prescribed and Smaller Fires*

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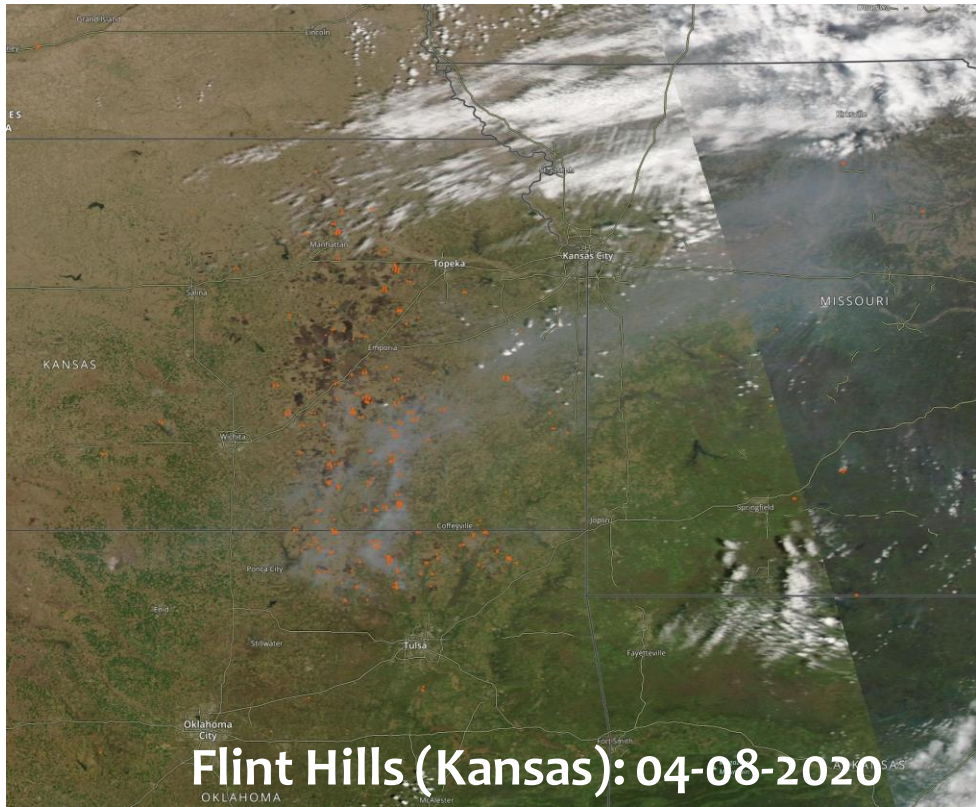
HAQAST: *"Quantifying Pollution from Prescribed and Smaller Fires: The massive conundrum in our National Emissions Inventory"*

- 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*).
- The lack of accurate emissions inventories hinders the ability of federal, state and local health and Air Quality managers and regulators to monitor, evaluate, track, and statistically analyze fire impacts.

We aim to know:

- *How much is burning?*
- *When does the burning occur?*
- *What are the capabilities of our satellites to see this burning?*

Southeast US: 11-18-2020



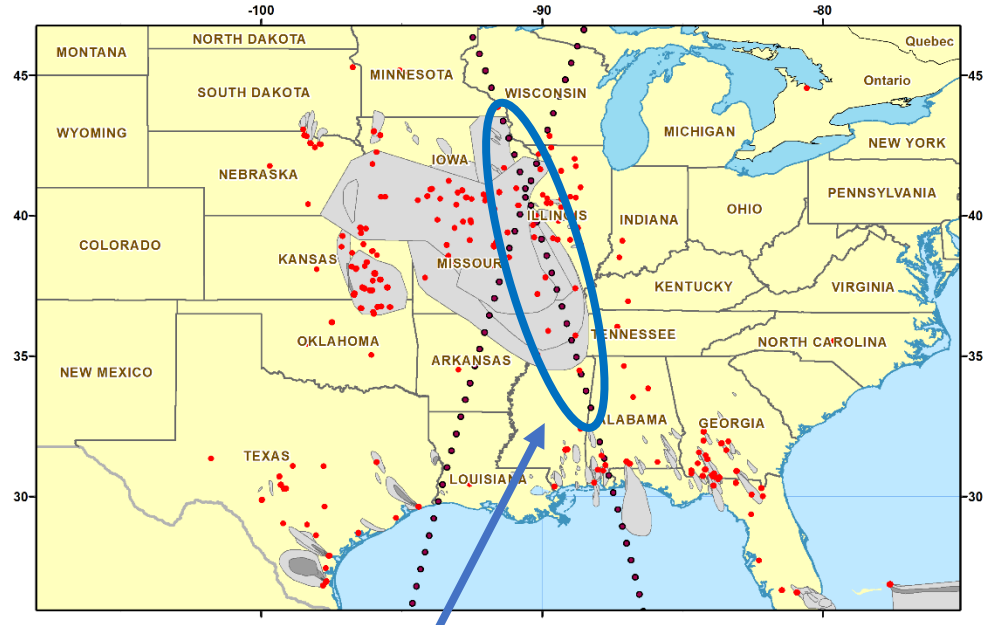
Flint Hills (Kansas): 04-08-2020

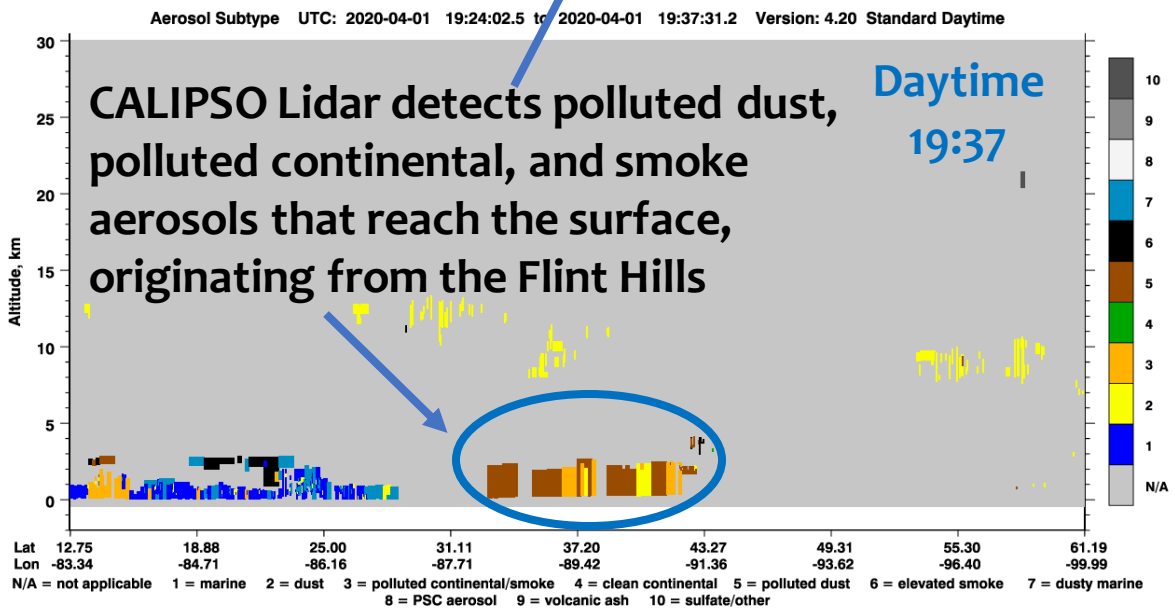
The Challenge: Balancing Burning And Health

- While the benefits of prescribed fire to mitigate wildfire risks in communities are unequivocal (decreased fuels for safety, select for endangered and desired flora and fauna, decrease invasive species, open seed cones), how to balance these risks with smoke management, AQ and human health is complex.

- The lack of accurate baseline burned area data hinders the ability of federal, state and local health and AQ managers and regulators to monitor, evaluate, track, and statistically analyze fire impacts.

- As climate changes, we must learn to balance choices, not only the landscapes we desire, but how often we burn, relative to risk.

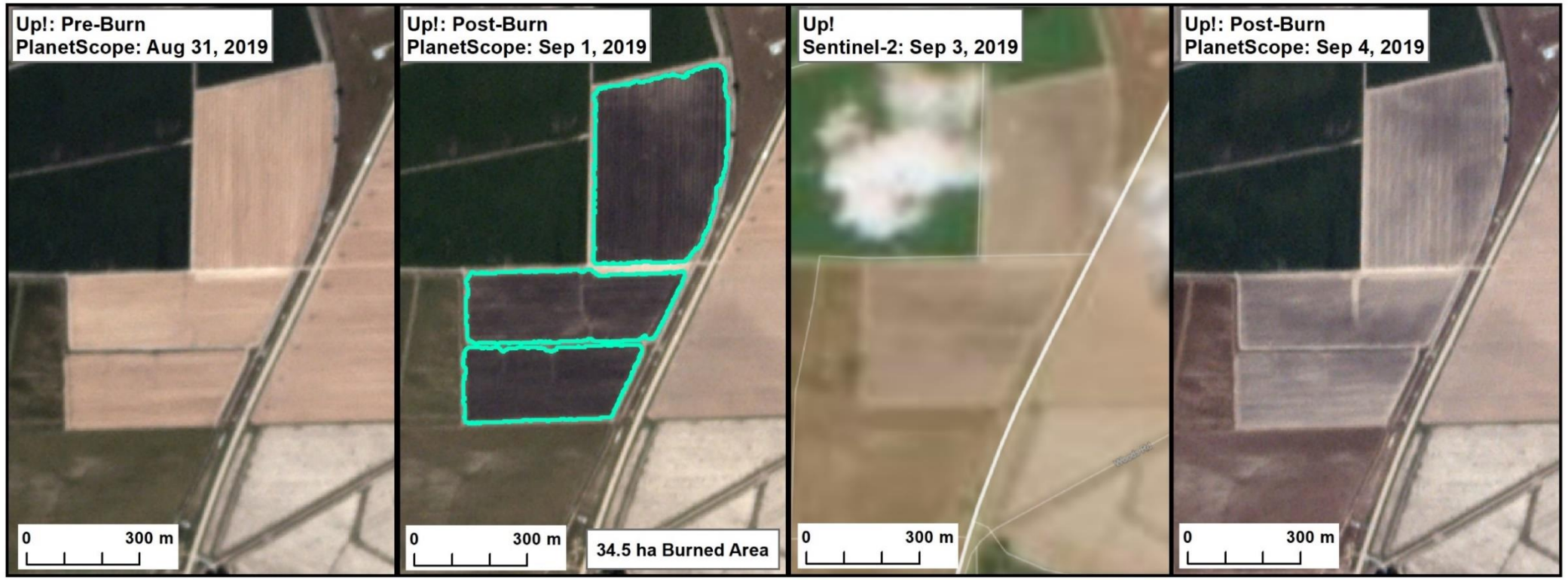


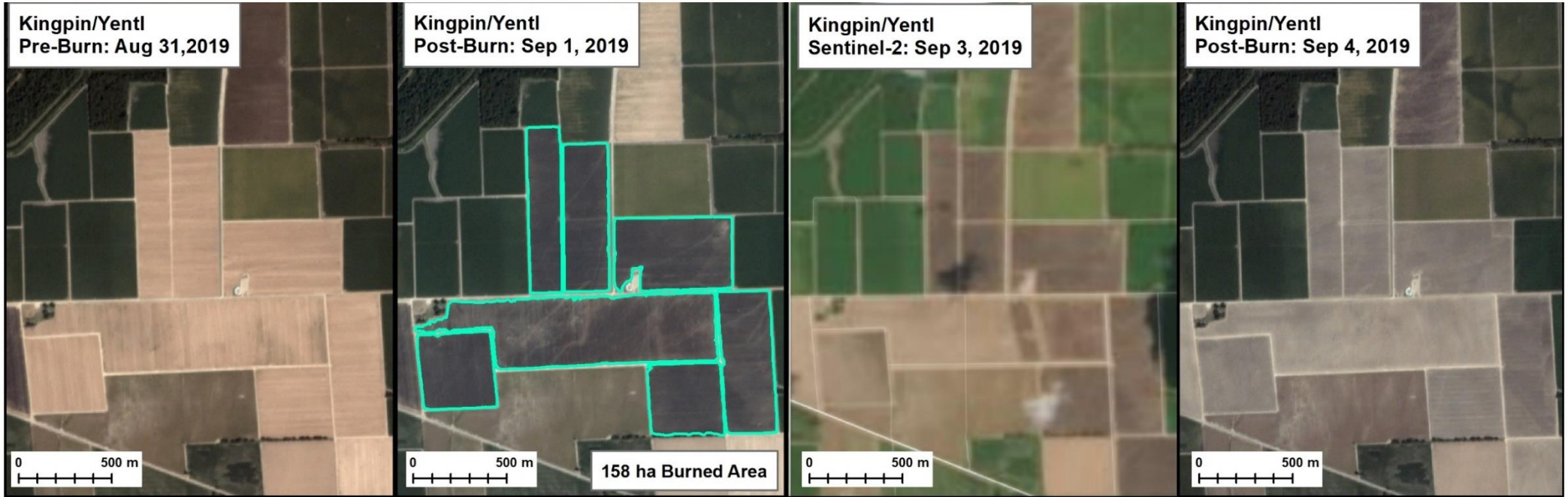


Figures by Hyundeok Choi

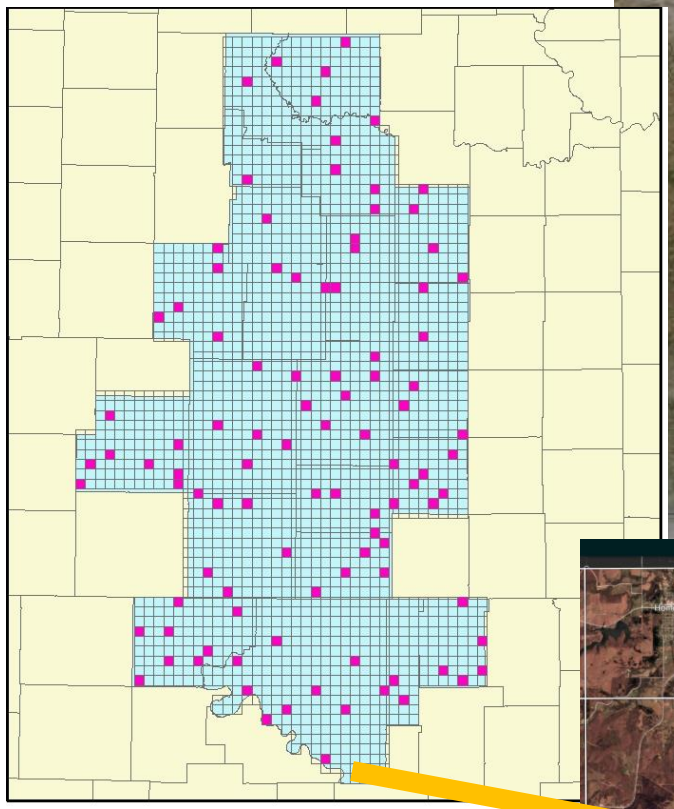
Digitizing Small Burned Areas

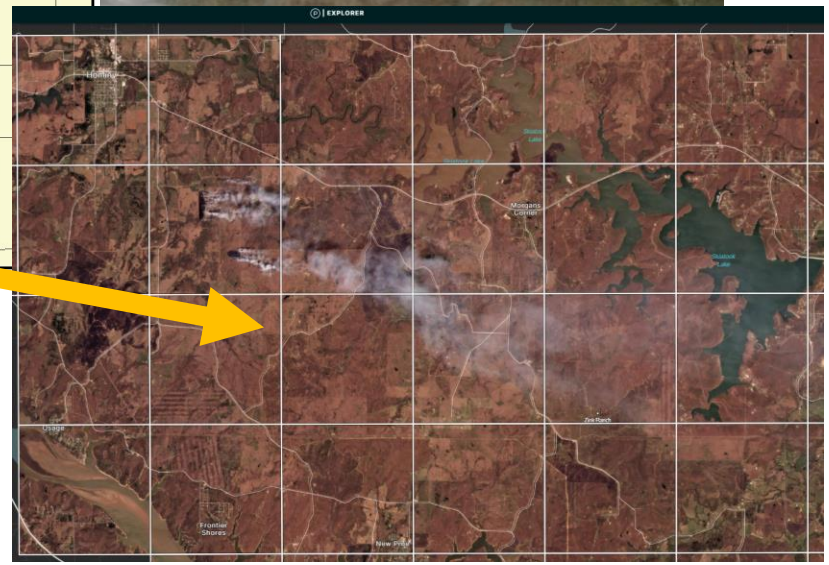
Example taken from FIREX-AQ campaign

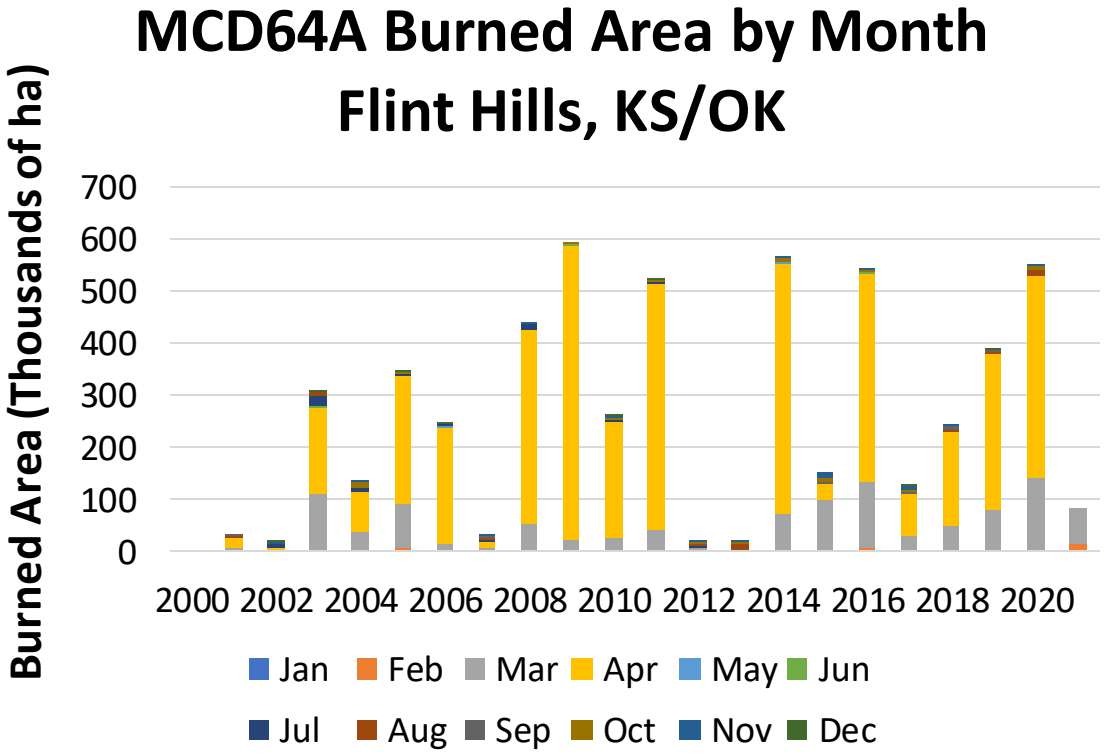


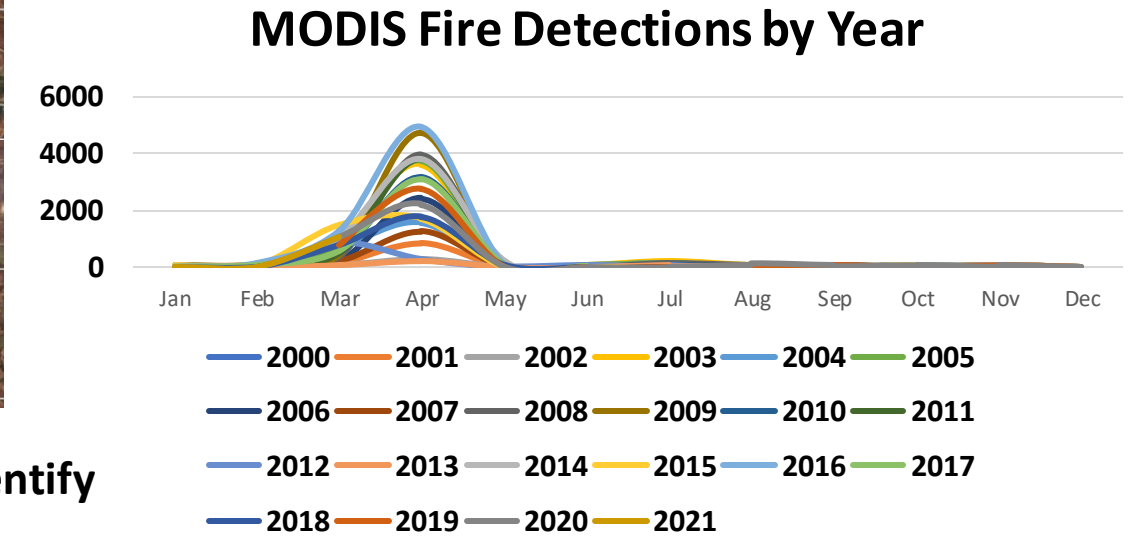


Flint Hills in Oklahoma and Kansas





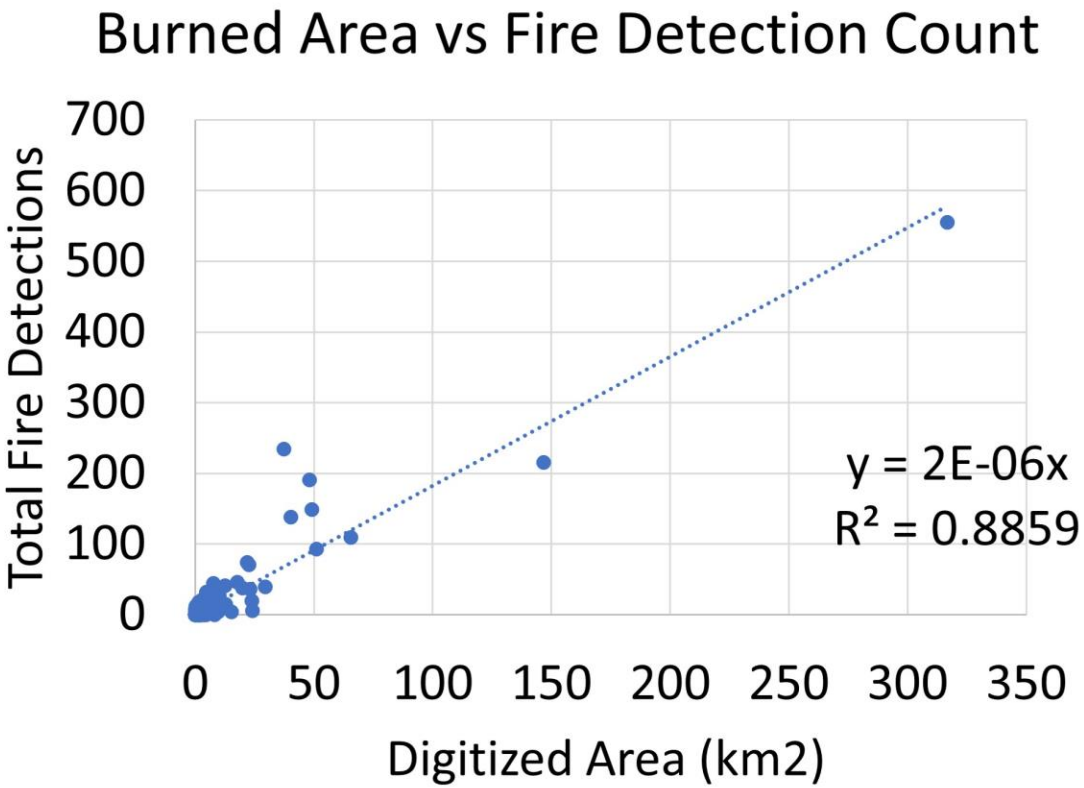




Randomly select ~5% of 5x5 km tiles from the ~2000 tiles. Labelers identify scars in pre- and post-burn images and hand digitize burn scars.

Results: Fire Detections (FDs)

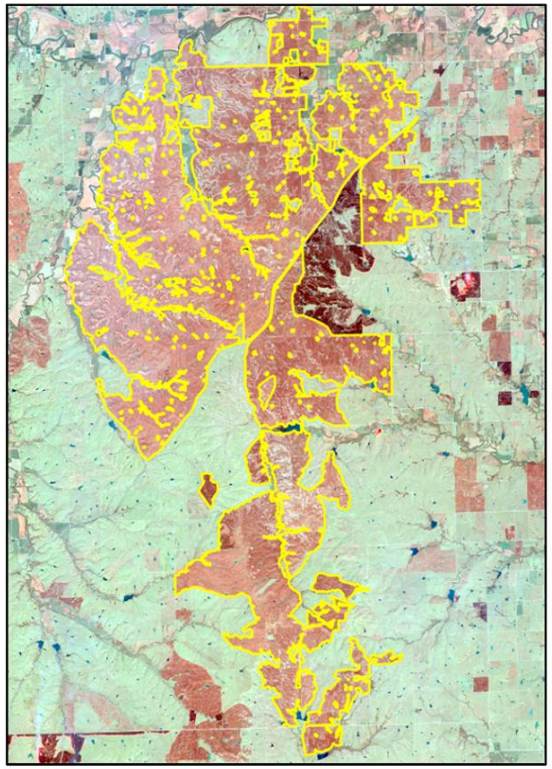
- Digitized 364 burning events in spring 2022 season, 1,340 km^2 total
- 46.4% of the burn scars had at least one fire detection
- Burn scars without detections averaged 0.49 km^2
- Burn events with detections averaged 8.45 km^2 (1.12 km^2 median)



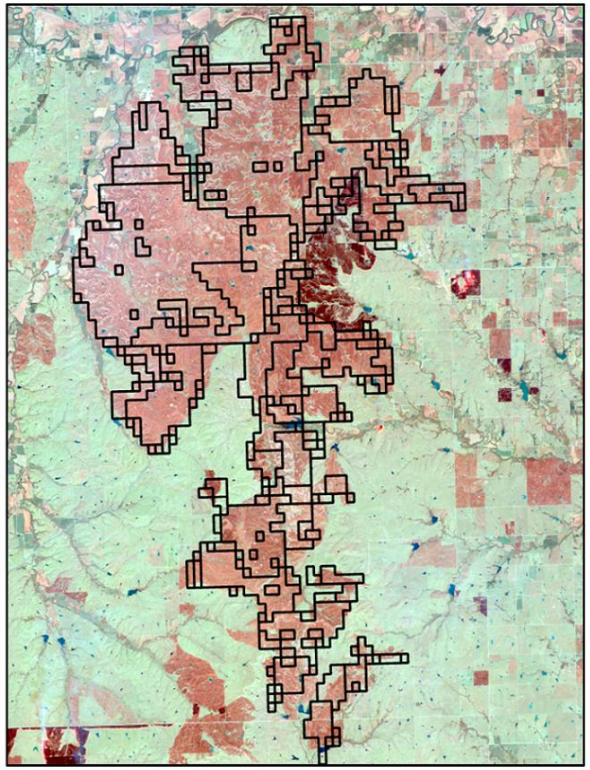
	Captured	Missed
MODIS Aqua	5.8%	94.2%
MODIS Terra	13.7%	86.3%
VIIRS NOAA 20	33.5%	66.5%
VIIRS Suomi	36.8%	63.2%
Any satellite	46.4%	53.6%

Comparative Results: MODIS Burned Area Product

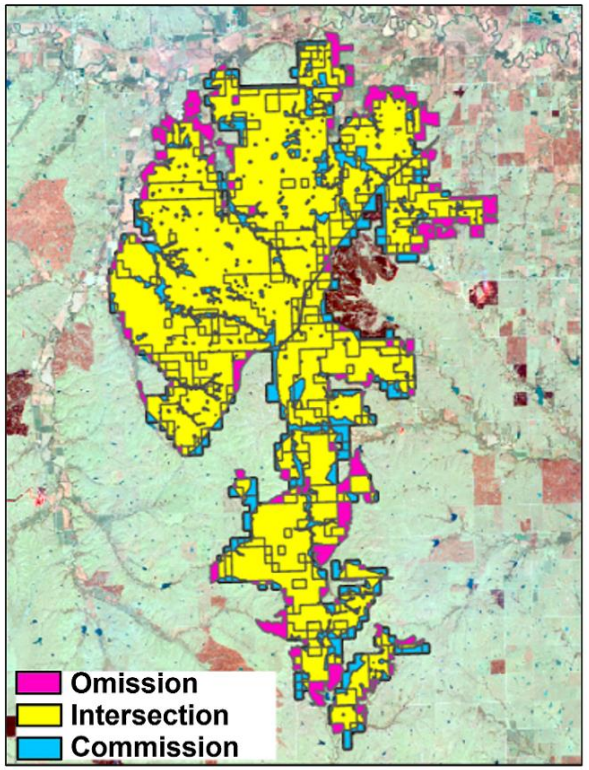
Intersection	Commission	Omission
65%	8%	27%



Sentinel-2 Digitized Burn Scar



MODIS Burned Area MCD64A product



Intersection

- No event under 0.75 km2 was recognized by MODIS BA product
- Seven events contributed to 50% of the total area digitized
- Total of 182 km2 missed area due to no MODIS BA coverage, 462 km2 omitted overall
- Very little missed area came from differences in MODIS BA burn date versus the timeframe of the fire burned.
  - ignoring temporal restraint, MODIS captures 68% of the area burned

Senitnel-2 to Kansas Department of Health and Environment (KDHE)

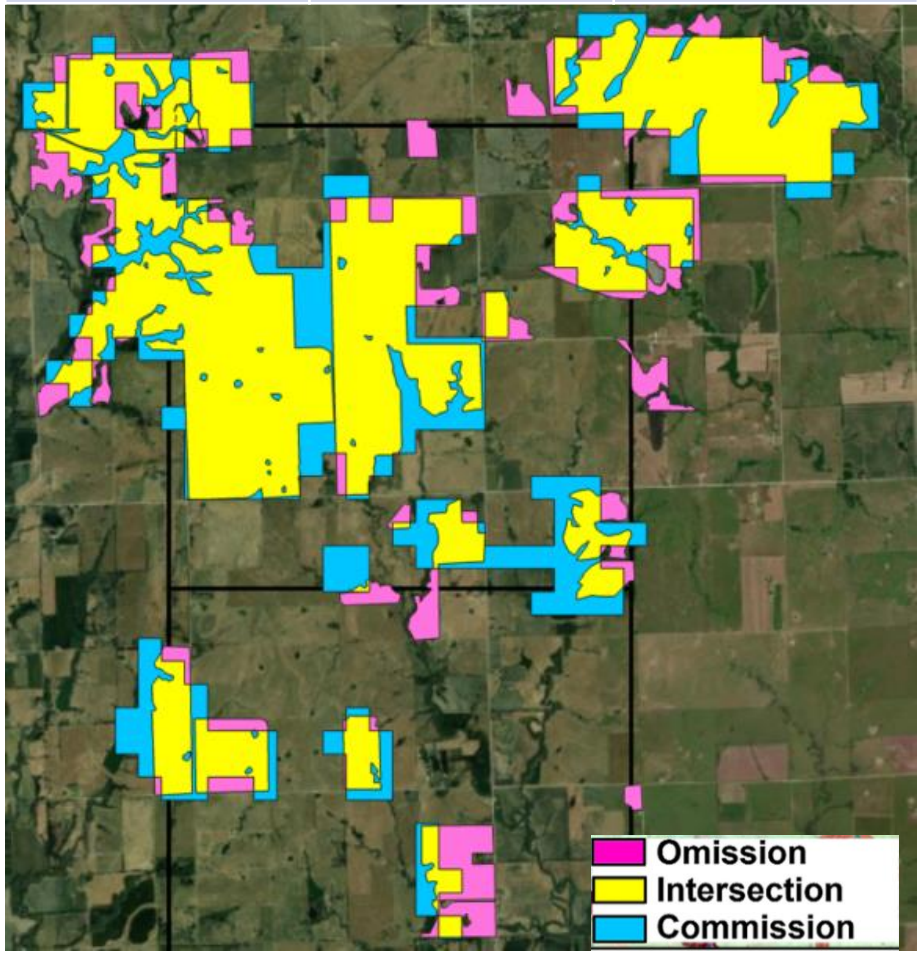
KDHE Burned Area product is an improved-upon MODIS MCD64A1 product specific to the Flint Hills. Burned area is grouped every few days.

If ignoring the temporal restraint, KDHE BA captures 89% of our Sentinel-2 dataset

Differences come from:

- resolution differences (10-m vs 250 m)
- KDHE not able to take out small ponds, etc.
- Difference in timeframe comparison (KDHE is not daily, so it is not a perfect comparison)
- KDHE **was** able to capture some smaller burns (<0.75 sq km), though all of the crops undetected by KDHE were <0.75 sq km

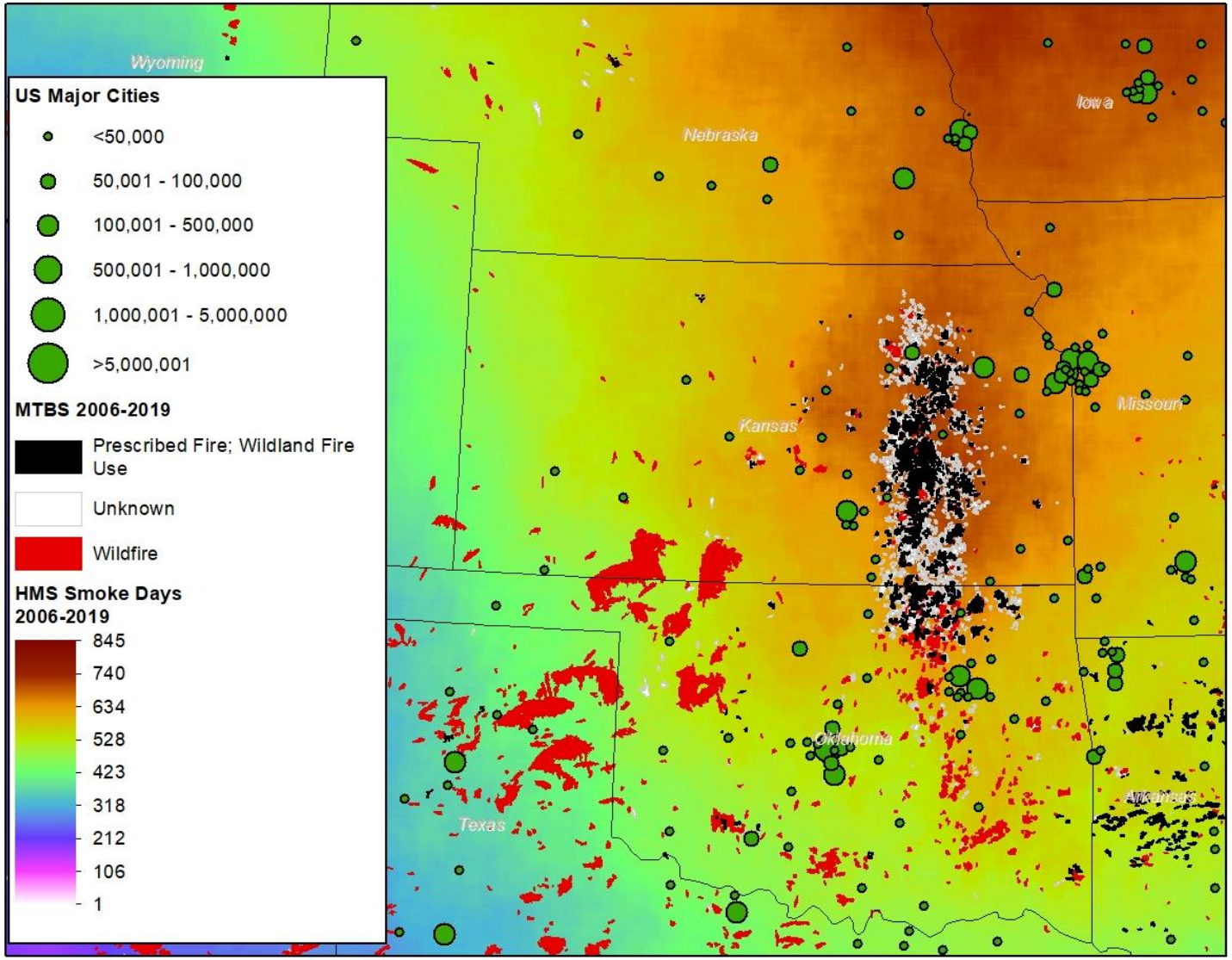
Intersection	Commission	Omission
77%	12%	11%



Future Health Analysis: Prescribed (Rx) fires vs Exceptional Wildfire (WF) Events

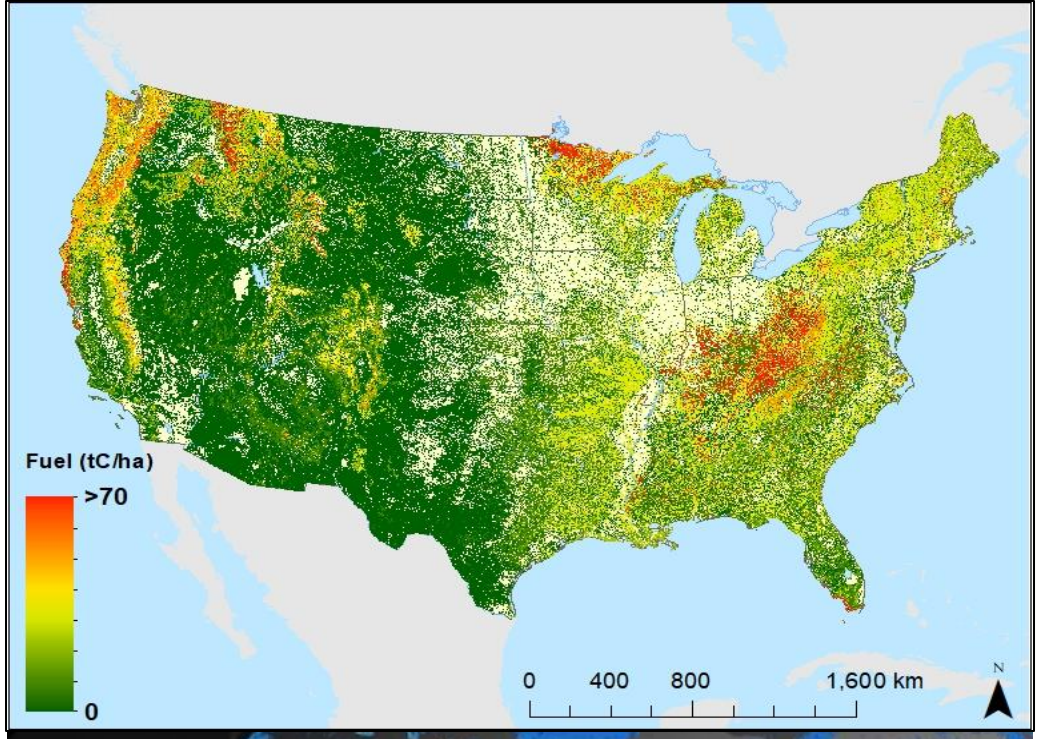
In collaboration with Yang Liu, Colleen Reed, and Daniel Tong

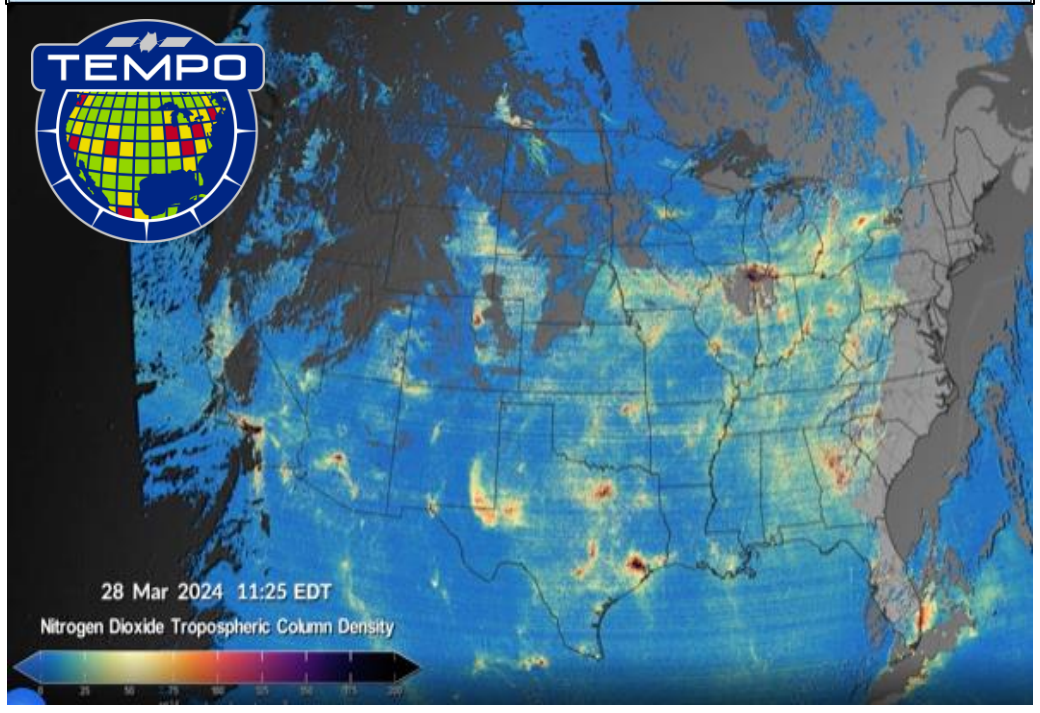
1. **Distinguishing WF vs. Rx fires** using expertise and data sources like the EPA's National Fire Emissions Inventory and the National Interagency Fire Center.
2. **Estimating PM2.5 exposure** with simulations separating WF and Rx fires
3. **Utilizing existing health data**, particularly emergency room data from 11 states, with minimal associated costs covered by current funding.
4. **Conducting reduced exposure classification** using categorical variables for severe smoke days
5. **Performing case-crossover analysis** to assess the association of PM2.5 exposure with emergency department visits, considering various exposure metrics and lag times.
6. **Exploring birth outcomes** using multiple years of data, focusing on parameters like birth weight.
7. **Statistical analysis** of exposure



Ongoing/New Projects

- Analyzing West Palm Beach sugarcane burning and satellite capture
- Understanding small fire occurrence in the mid/southeast (EPA requests)
  - Piles
  - Prescribed/Agriculture
  - Three summer interns to help digitize: Anna Hart, Caitlyn Feldpausch, and Esme Petitjean
- Understanding exceptional fire events and their contribution to ozone events (e.g. Connecticut)
  - *Tiger Team (Arlene Fiore): "Analysis to support air quality and health TEMPO applications for surface ozone"*
- Creating Global Fire Consumption database to estimate emissions that closely resemble those actually injected the atmosphere.
  - *Tiger Team (Brad Pierce): "Mitigating Uncertainties in Lateral Boundary Conditions used for Regional Air Quality Assessment Modeling"*





Conclusion

- Our goal is to provide the data and information necessary to establish relationships between fire and human health in a unique understudied regions, where burning is persistent and has been traditionally underestimated.

- Prescribed burning isn’t going away. As climate changes, we must learn to balance choices, not only the landscapes we desire, but how often, where, when, and how we burn, relative to preventative measures and risk.

- Only with accurate data can we improve emissions estimates that can influence modeling of air pollution concentrations and thus the health impacts of these social and policy tradeoffs.