NASA HEALTH AND AIR QUALITY APPLIED SCIENCES TEAM
Connecting NASA Data and Tools with Health and Air Quality Stakeholders

Aligning Wildland Fire Emissions Data and Information to Answer Specific Health Questions to Inform Public Action

SESSION 4B: IMPROVING EMISSIONS INVENTORIES WITH SATELLITE DATA

HAQAST MEETING- ST. LOUIS, MO

11/06/2025

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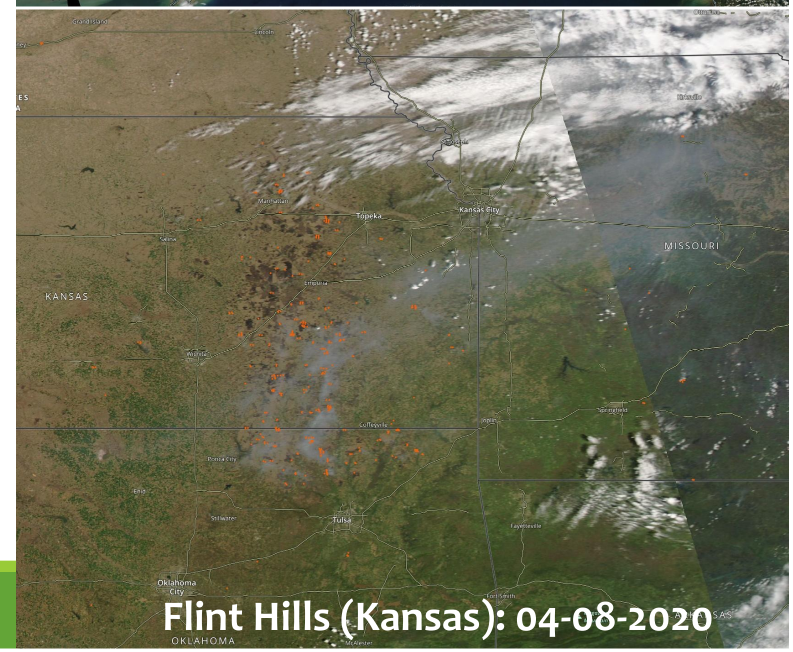
Prescribed and Agricultural Fires

- 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.

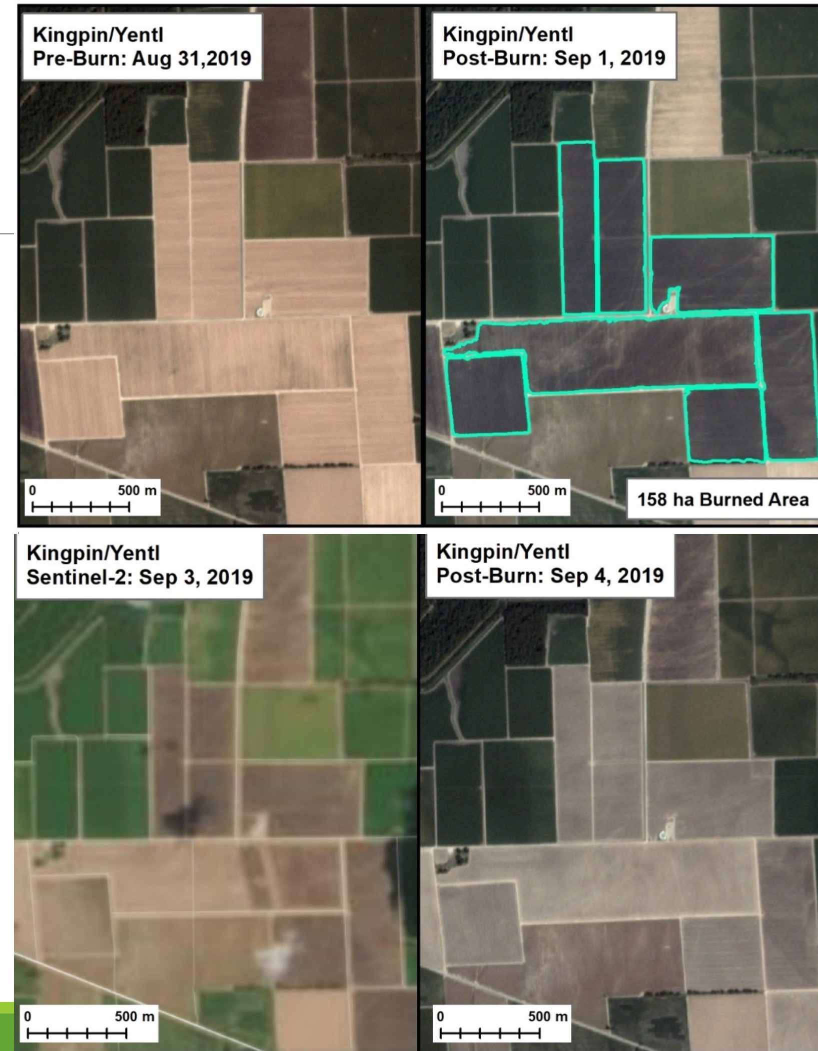
- *How much is burning?*
- *When does the burning occur?*
- *What are the capabilities of our satellites to see this burning?*



Challenges of Detecting Fires in the Central & Southeastern U.S.

Satellite detection is inhibited in the C&SE due to persistent cloud cover and the size, timing, and intensity of these fires (Huang et al., 2018; Nowell et al., 2018; Soja et al., 2006; 2009).

Many fires are less intense, understory fires and/or short-lived [burn < 50 acres]. **Humans set these fires**, at times when they are easiest to control, which is often early morning and late afternoon, when polar-orbiting satellites are not overhead and under limited visibility conditions.

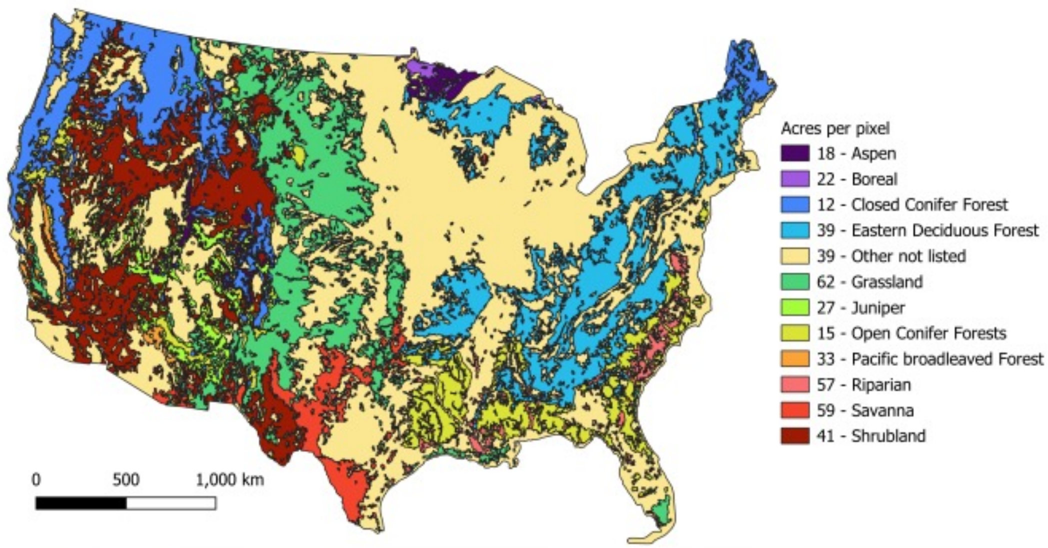


National Emissions Inventory: Fire Activity

EPA estimates area of burn based on HMS detections and location: EPA relies on reported fires and databases (States, Federal, Tribal, permits), but states report differently and there are gaps. They do their best with NOAA's Hazard Mapping System Fire Detection (HMS), but not even HMS's collection of sees everything.

- HMS detections (MODIS, VIIRS, GOES) is assigned area based on the average area per detection over a fire perimeter

Fire Activity includes: Agriculture burn, Wildfire, Prescribed Fire (Forest and Rangeland/Grassland), Yard Waste burning, and Piles/Slash/Logging burn

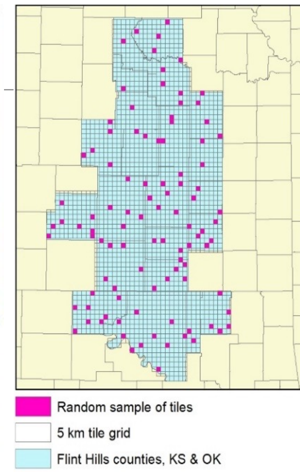


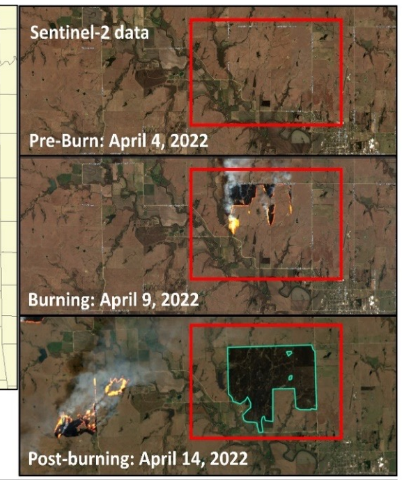
Average acres assigned to fire pixel based on general ecotype, Credit: EPA, James Beidler

Previous HAQAST Work: Digitizing Small Burned Area

Fire Detection Product		
Satellite	**Flint Hills, KS Captured**	**Everglades Agriculture Area, FL Captured**
MODIS Aqua	**8%**	**4%**
MODIS Terra	**20%**	**16%**
VIIRS Suomi	**35%**	**10%**
VIIRS NOAA20	**33%**	**13%**
Any satellite	**47%**	**30%**

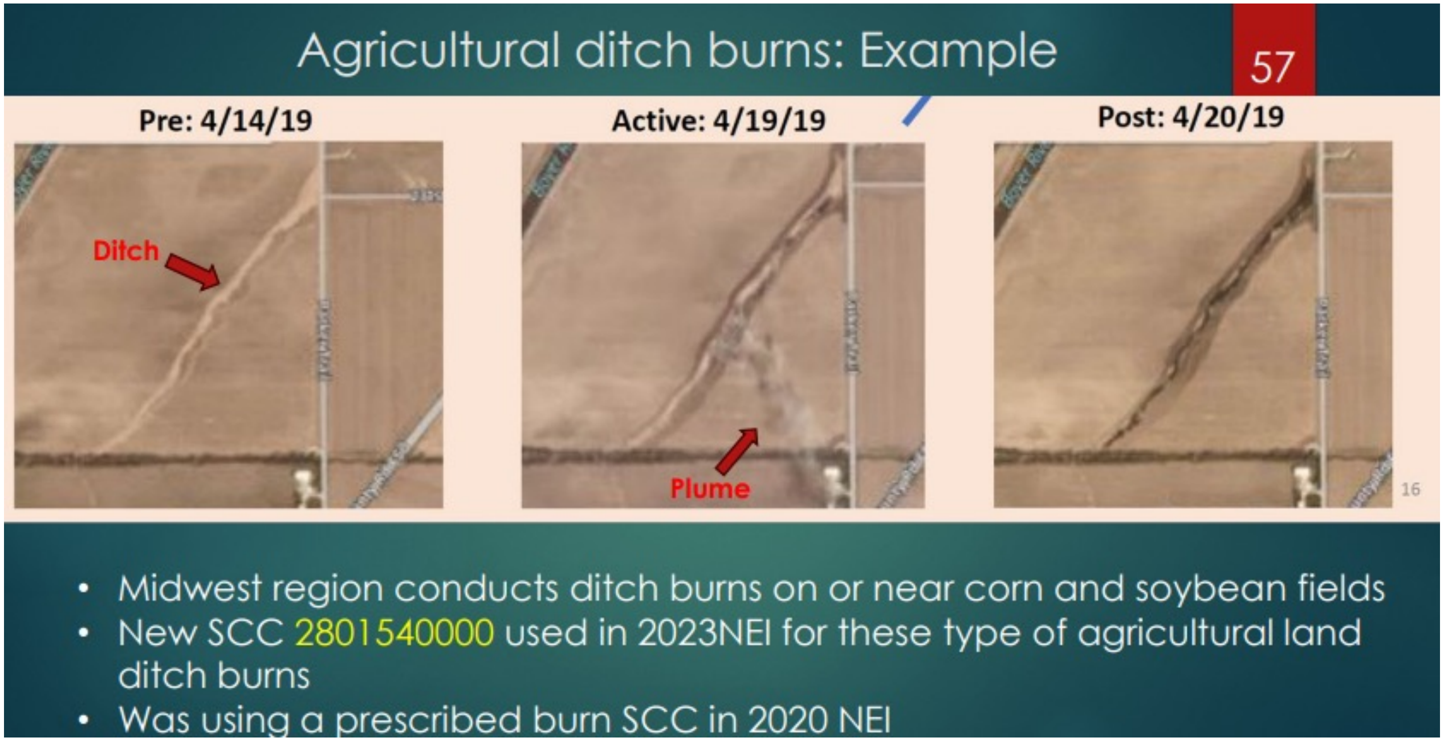
MODIS Burned Area Product			
Region	Intersection (Agreement)	Commission (Overestimate)	Omission (Missed)
Flint Hills, KS & OK	**65%**	8%	27%
Everglades Agriculture Area, FL	24%	23%	**53%**





Burned Area Product	Intersection	Commission	Omission
MODIS Burned Area Product (MCD64A1)	**65%**	**8%**	**27%**
Kansas Department of Health & Environment	**77%**	**12%**	**11%**

Satellite Research influences EPA's National Emissions Inventory

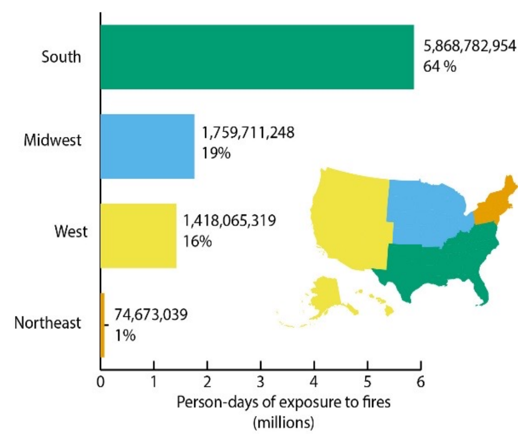


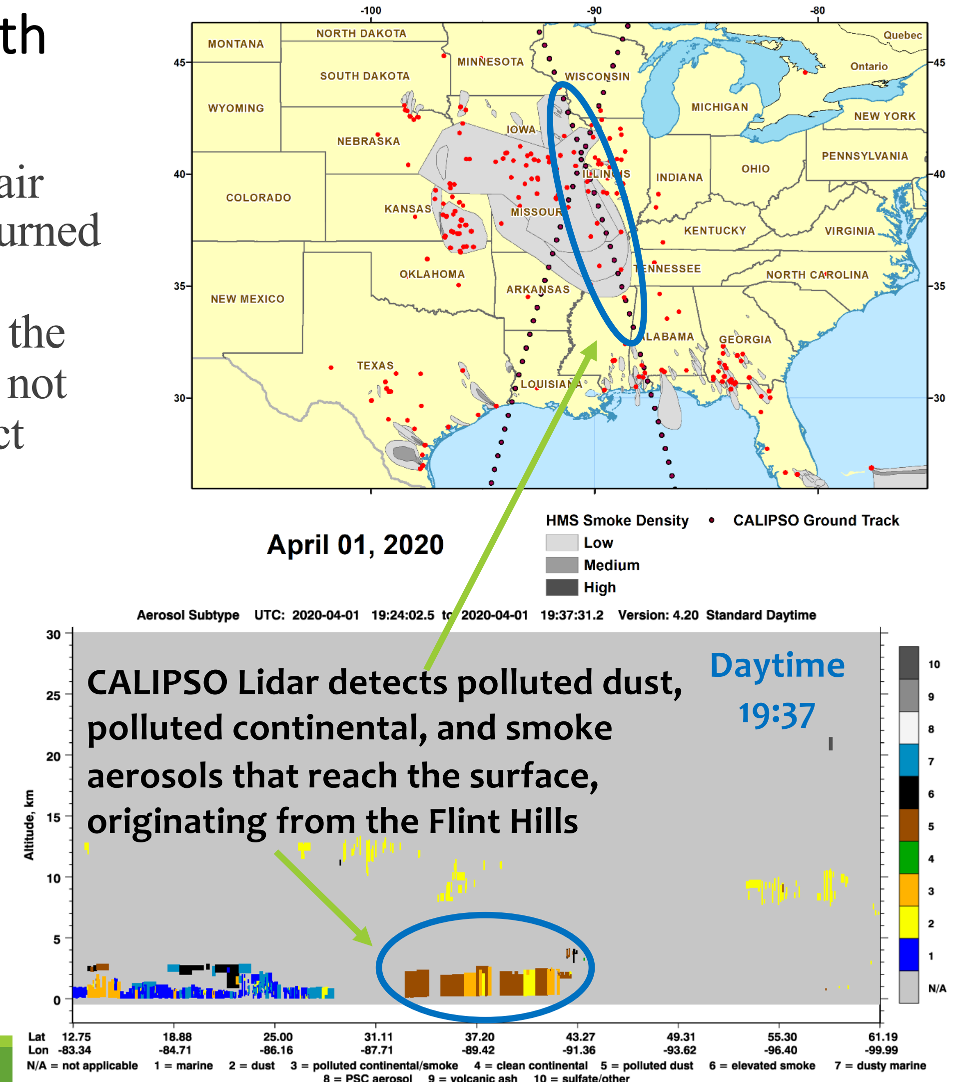
Credit: James Beidler, EPA's EIC Workshop Sep 2025

The Challenge: Balancing Burning And Health

Prescribed fire reduces wildfire risk and supports ecosystems, but balancing these benefits with smoke, air quality, and human health is challenging. Inaccurate burned area data limits federal, state, and local agencies from effectively monitoring and evaluating fire impacts. As the climate changes, we must balance how often we burn, not just to shape landscapes, but to manage risk and protect health.

Preliminary analysis of the direct fire exposure using MODIS fire-detection data shows that US residents experienced a total of 9.1 million person-days of fire exposure between 2004 and 2023. *Credit: Emory University, Yang Liu*



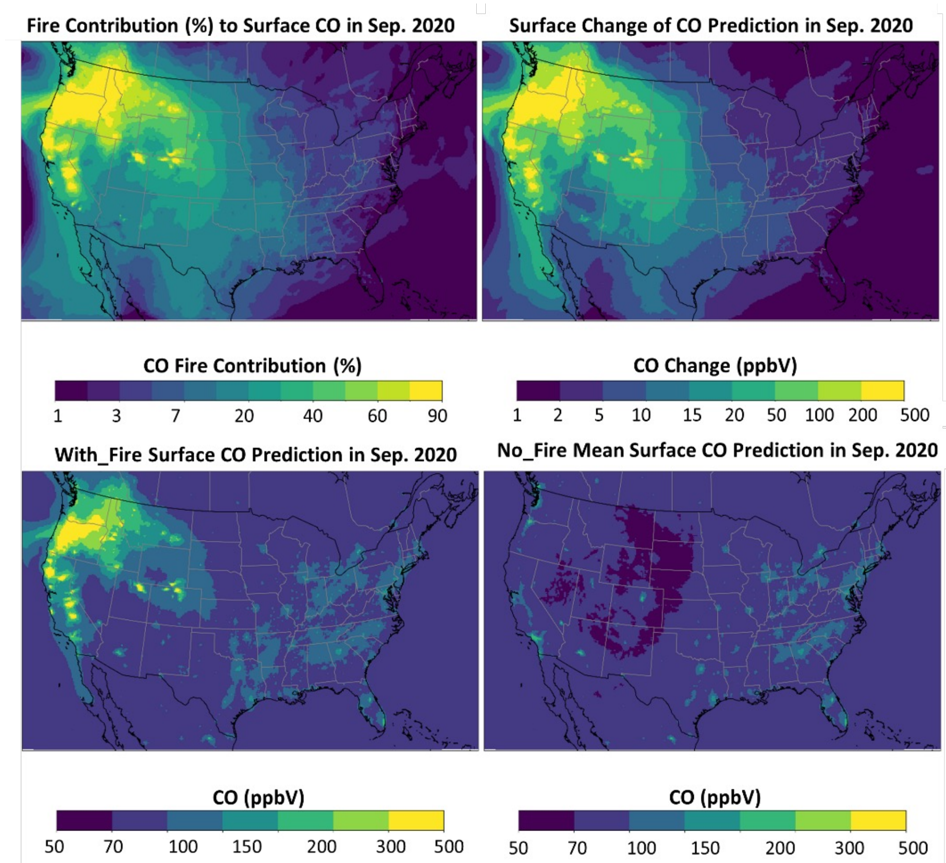


Figures by Hyundeok Choi

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

In collaboration with Yang Liu, Daniel Tong, Youhua Tang

1. **Distinguishing WF vs. Rx fires** using expertise and data sources like the EPA's National Fire Emissions Inventory
2. **Estimating PM2.5 exposure** with 12km CMAQ 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

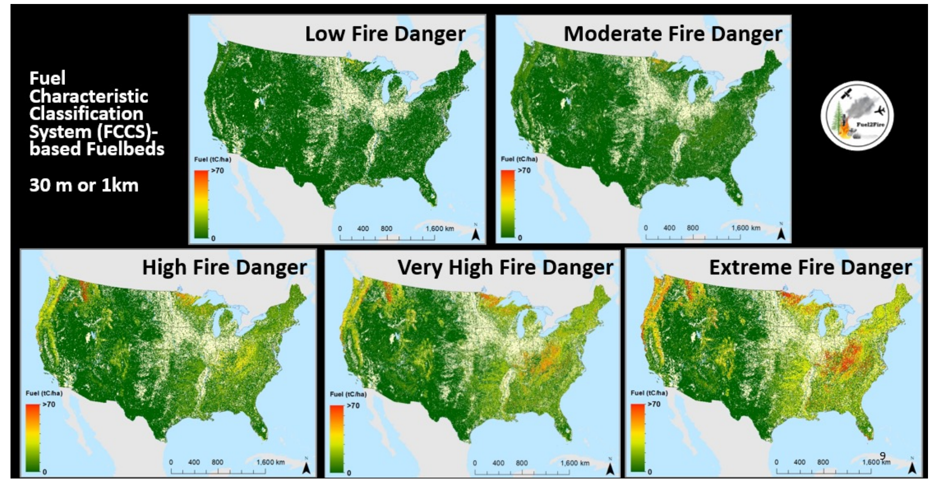


Specific-emissions example. Fire CO contribution in % (upper-left) and mixing ratios (ppbv) (upper-right), which are calculated from watchfire (lower-left) and no_fire (lower-right), averaged for September 2020. Credit: Daniel Tong's Group

CURRENT AND POTENTIAL PARTNERS, ACTIONS, AND OUTREACH

We developed a fuels database that is ready to use with Active Fire Detection and Fire Radiative Power (FRP) to enhance fire/smoke emissions in current Air Quality models. Current testing by:

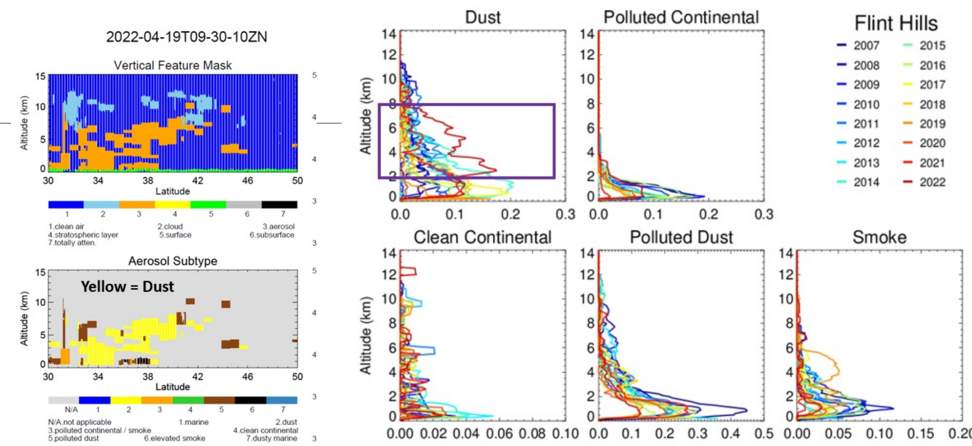
- NOAA (R. Ahmadov) for RAVE
- P. Saide team at U of California



Working with Travis Toth and NASA Langley, he will bring lidar expertise from ESA's EarthCare (vertical extent of aerosols and clouds in Atm.)

Potential use:

- States, Dept. of Environ & Air Quality
- EPA, NOAA, and other organizations



Broader Implications & Takeaways

- **Improving inventories improves health exposure estimates.**
- **There are many ways satellites can help fill gaps, especially in fire and air quality, but continued research helps uncover areas we may have be missing**
- **It takes every community to get the whole picture**
- **Policy relevance**:
    - Better understanding of Rx vs. WF fire emissions can inform smarter land management.
    - Helps optimize “good fire” vs “bad fire” discussion. All smoke is bad when breathed in, but strategic burning can potentially lessen exposure overall.

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