

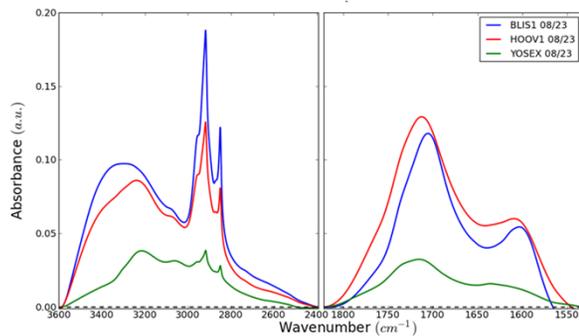
Identifying Smoke Impact In IMPROVE Samples

Ann Dillner, Katie George, Sean Raffuse
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MOTIVATION

- **FT-IR spectra are a rich data set**
 - OM/OC, OM and functional groups
 - TOR OC, EC and TC
- **This project uses FT-IR spectra for**
 - Identification of smoke impacted samples
- **Motivation**
 - IMPROVE data - no direct determination of smoke
 - Exceptional events exemptions, Rule 179b
 - RHR

APPROACH



FT-IR spectra

Fire assessment

Develop detection algorithm

1. Simple method as proof of concept
2. Statistical method for robust predictions

Detection algorithm

Fire detection
Yes/No

OBJECTIVE

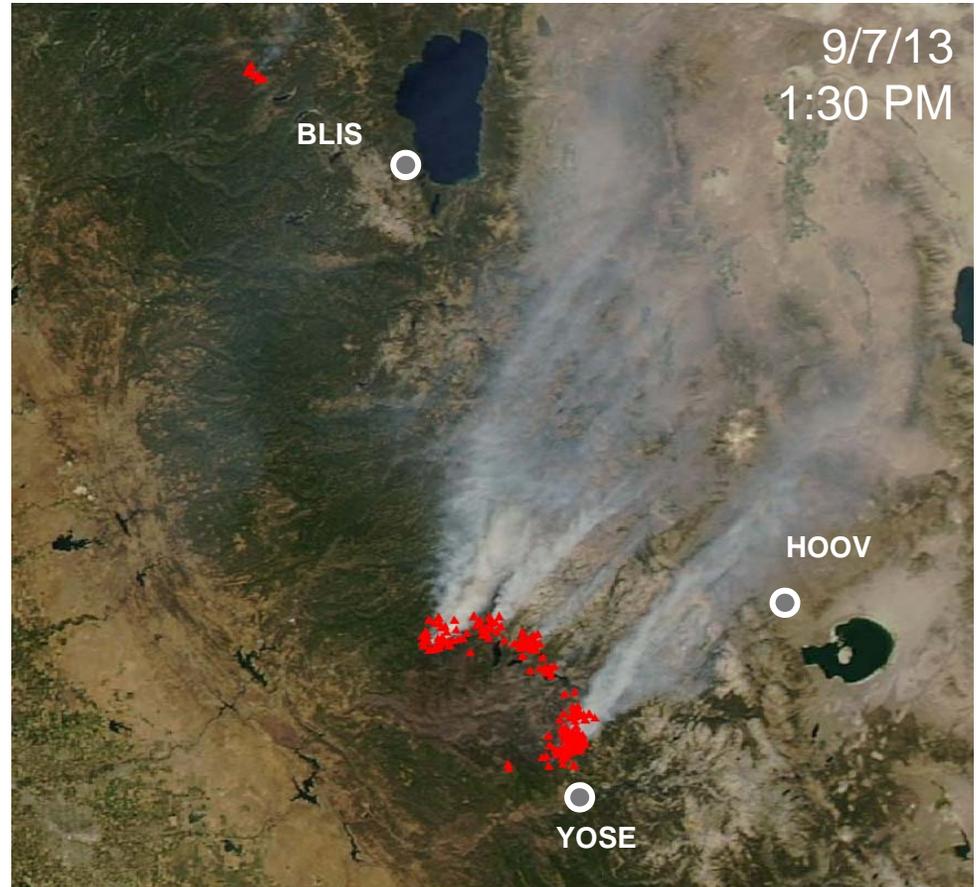
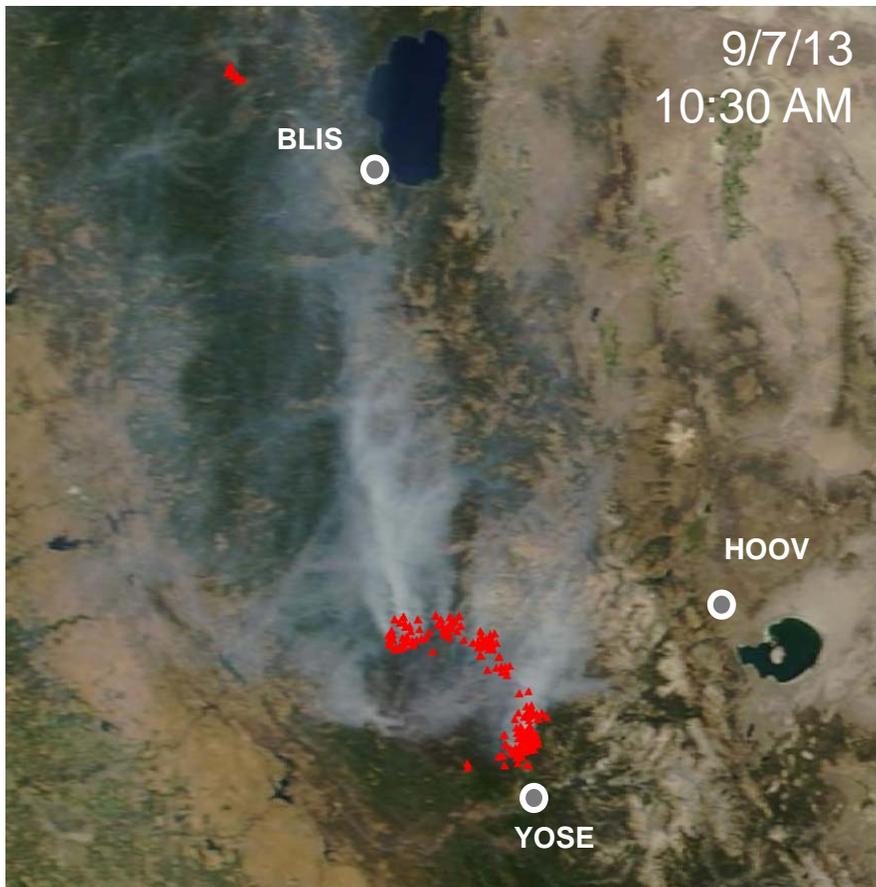
Objective for proof of concept:

To develop a simple method using FT-IR spectra and qualitative fire assessments to identify smoke impacted samples in the IMPROVE network during known fire events in 2013.

- **Forest fire (Rim Fire) in Yosemite**
 - **YOSE, HOOV, BLIS**
- **Prescribed fires in Southeastern US**
 - **ROMA, SAMA, OKEF**

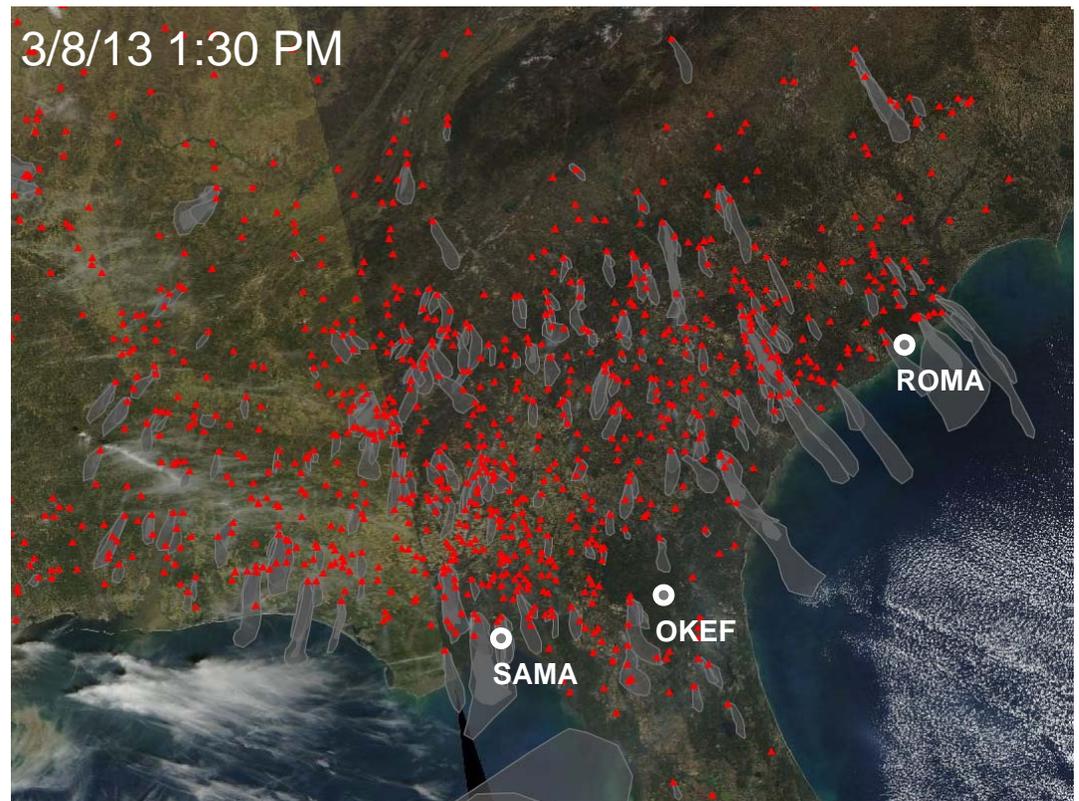
RIM FIRE

- Began on August 17, 2013, ended several weeks later
- Burned 250,000 acres (400 square miles). 3rd largest fire in California history.
- Winds were predominantly from the southwest, and smoke impacts were most severe to the north.

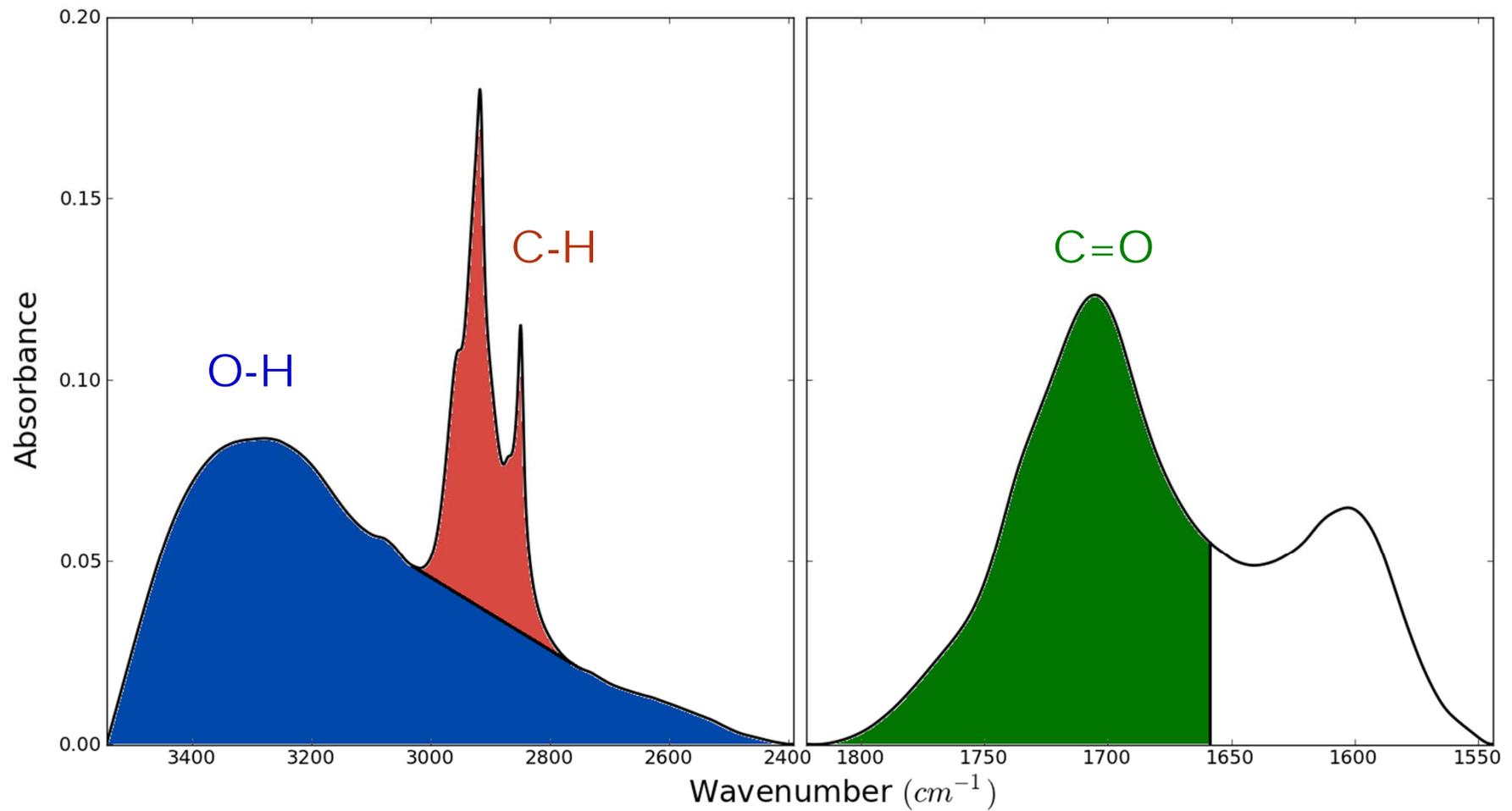


SOUTHEASTERN PRESCRIBED BURNING

- **3-4 million acres burned every year, Nov-Mar**
- **Fires are small (1-100 acres), low intensity**
- **Burning is often synchronized across the region as conditions become ideal**



BASIS FOR FT-IR ANALYSIS



SIMPLE FT-IR CRITERIA:

Rim Forest Fire

Spectral region	Smoke impacted
C-H	> 5%
C=O	> 15%

Southeast Prescribed Burns

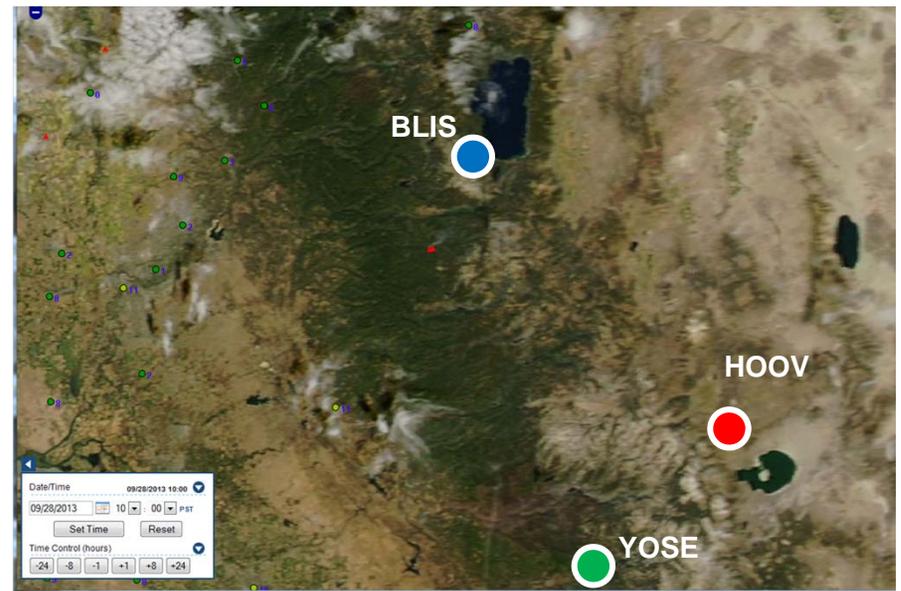
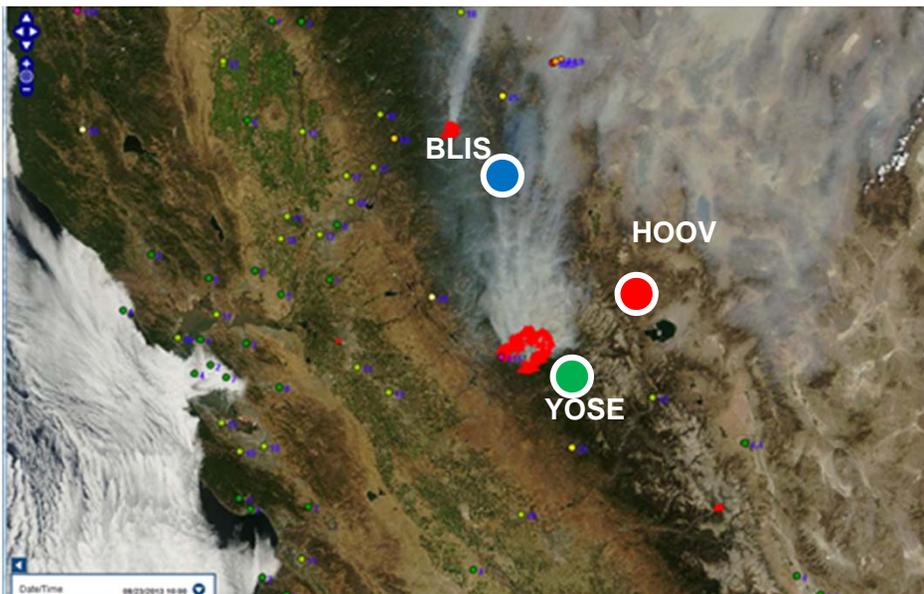
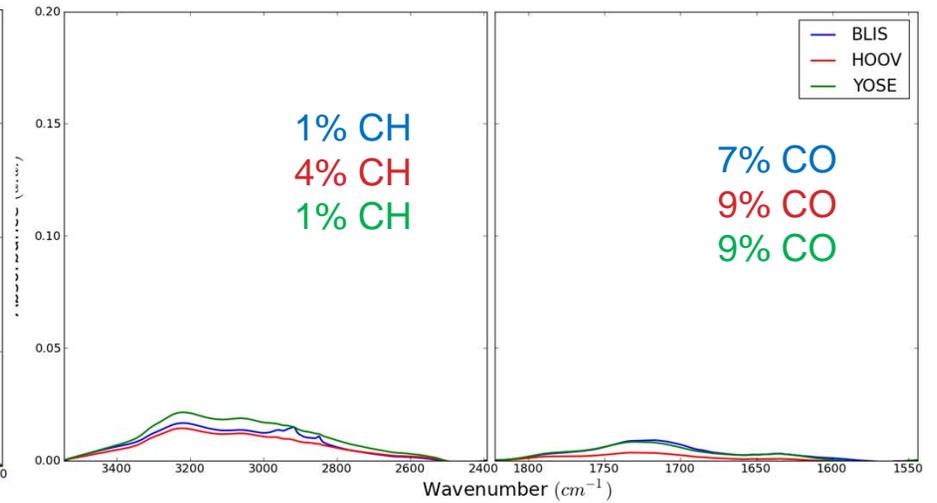
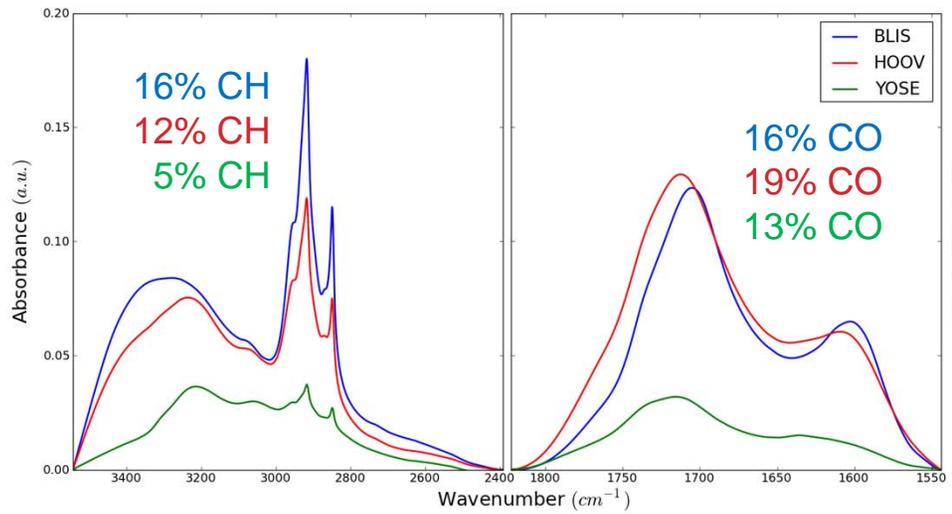
Spectral region	Smoke impacted
C-H	> 2%
C=O	> 8%

FIRE DETECTION METHODS

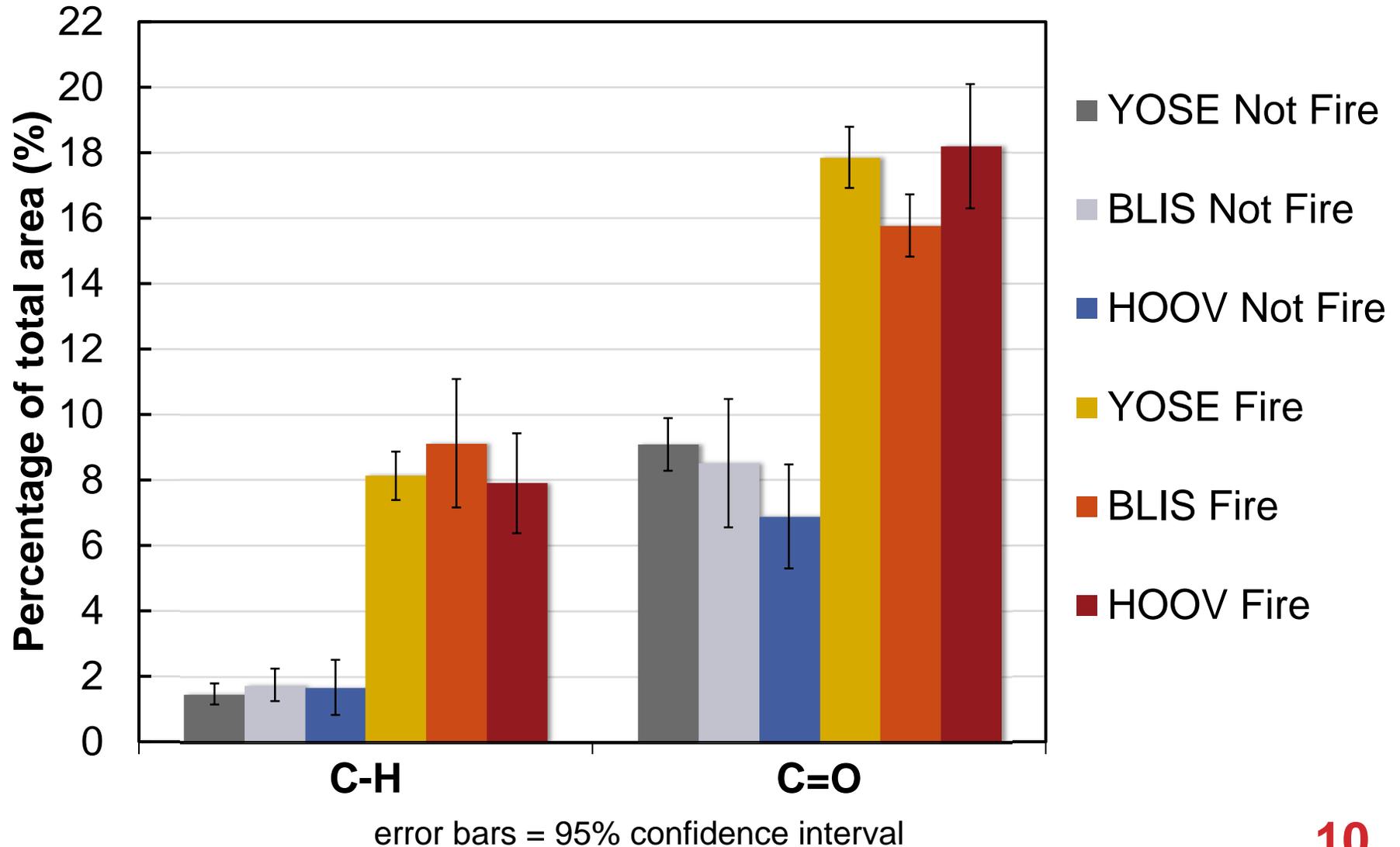
- **Analyze daily detection of “hot spots” from a suite of satellite-based instruments**
 - Number of hot spots within 10/20/30/100 km of site
 - Minimum hot spot distance to site
 - Hot spot kernel density
- **Analyze daily smoke polygons as interpreted by the NOAA Hazard Mapping System**
 - Distance from smoke to site
- **Qualitative interpretation of dates scoring highest for fire or smoke**
 - Visible imagery
 - Back-trajectory analysis
 - Nearby PM_{2.5} monitors
 - Smoke dispersion modeling
- **Sample days were categorized as ‘probable’, ‘maybe’, and ‘no evidence of fire’**

FIRE 8/23

NO FIRE 9/28



RIM FIRE (JUNE 16 - OCT 31): %C-H AND %C=O



FIRE DETECTION CAPABILITY

Qualitative Probable

FT-IR

	Y	N
Y	10	3
N	5	51

Bias = 1.15
POD = 0.77
POFD = 0.09

Qualitative Maybe +

FT-IR

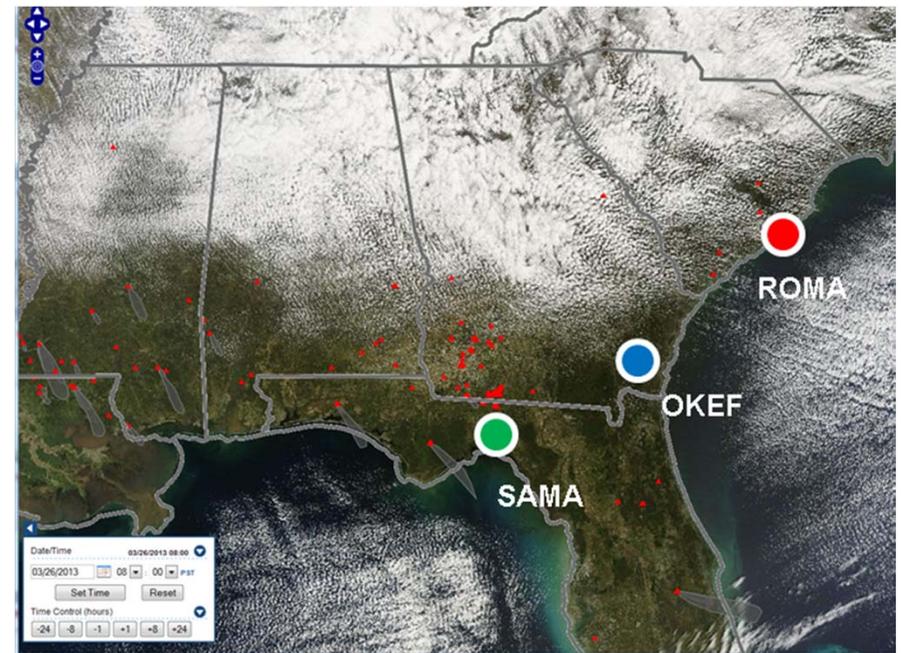
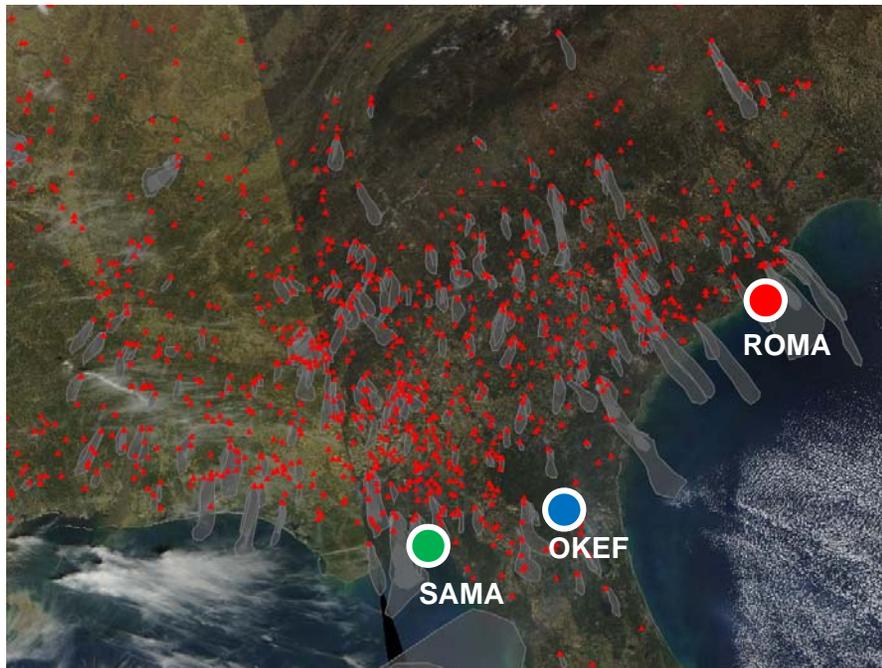
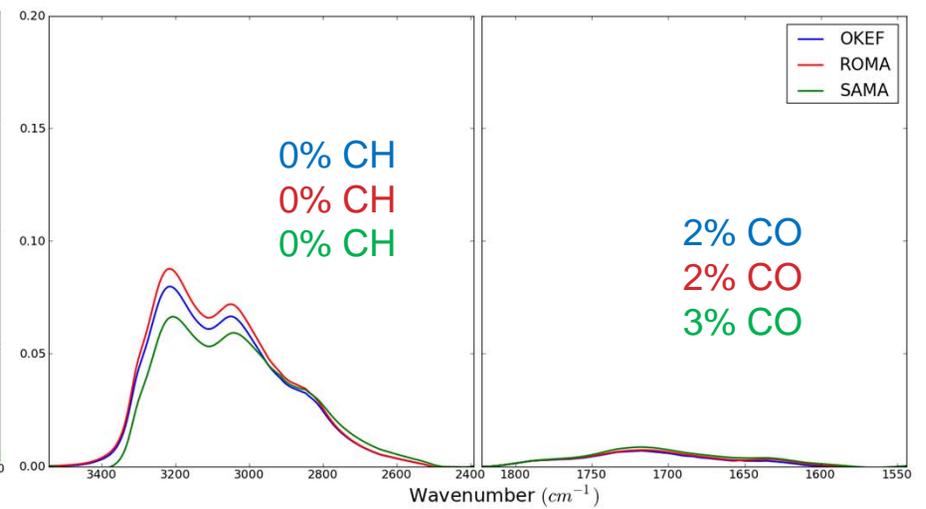
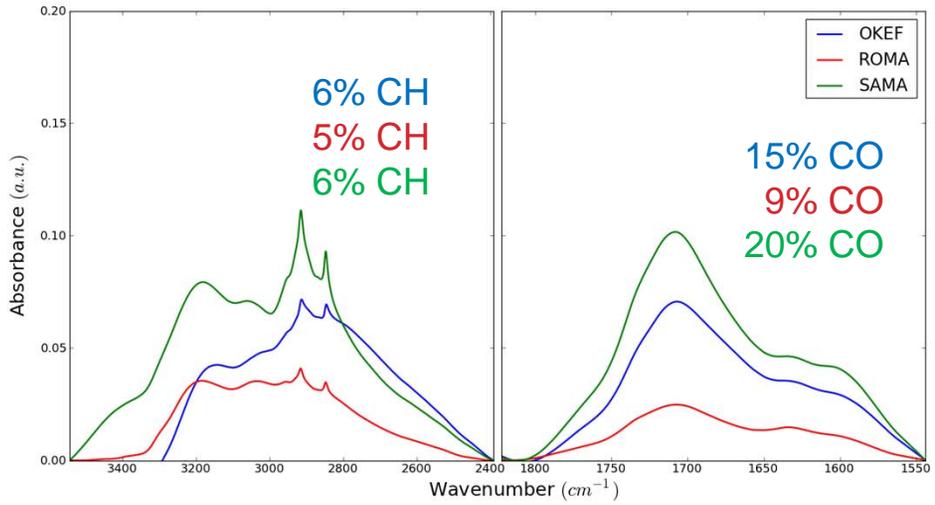
	Y	N
Y	13	1
N	13	42

Bias = 0.54
POD = 0.54
POFD = 0

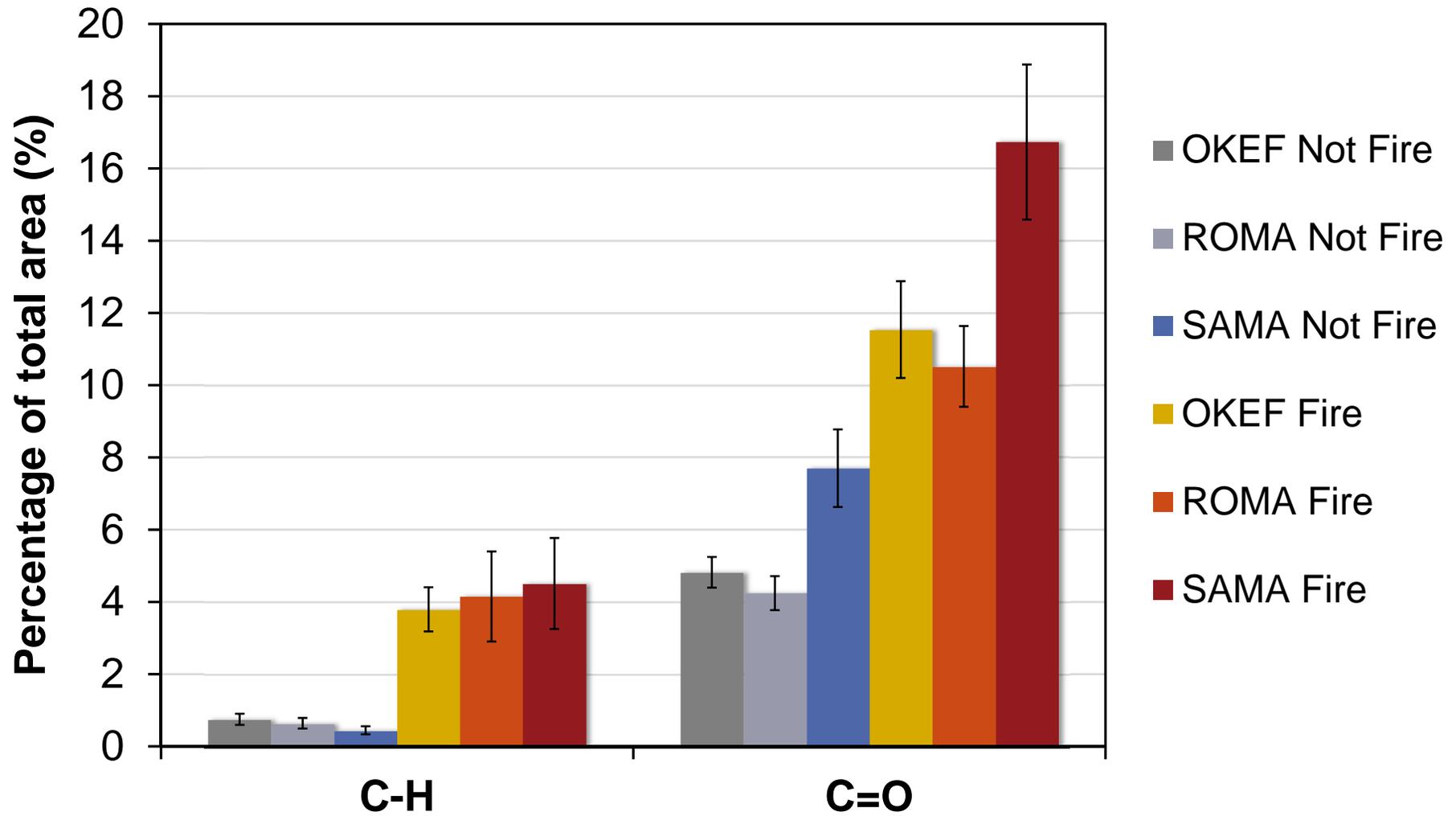


FIRE 3/8

NO FIRE 3/26



SE SITES (FULL YEAR) %C-H AND %C=O



error bars = 95% confidence interval

FIRE DETECTION CAPABILITY

Qualitative Probable

		Y	N
FT-IR	Y	7	15
	N	2	66

Bias = 2.44
POD = 0.78
POFD = 0.19

All 7 Y/Y, OC < 8 $\mu\text{g}/\text{m}^3$
3 Y/Y, OC < 4 $\mu\text{g}/\text{m}^3$

Qualitative Maybe +

		Y	N
FT-IR	Y	11	11
	N	15	53

Bias = 0.85
POD = 0.42
POFD = 0.17

SUMMARY

- **We developed a simple proof of concept detection algorithm to identify smoke from**
 - Wild fires
 - Prescribed burns
- **High quality detection capability for wild fires and good detection capability for prescribed burns**
- **Biogenic organics not identified as smoke**
- **Additional development of both the qualitative methods and FT-IR calibration methods needed to produce robust method for fire detection in IMPROVE network**