

FIREX-AQ Chem Otter Science Meeting

Agenda:

1. Overview of campaign and flights
2. Ken Aikin: Update on data archive and data merge
3. Amber Soja: Fire characteristics
4. Andy Weinheimer: NO/NO₂/O₃
5. Mike Robinson: NO_x enhancements and vertical structure
6. Christos Stamatis: VOCs
7. Zach Decker: UW I- CIMS
8. Ann Middlebrook: AMS
9. Rebecca Washenfelder: BrC-PILS
10. Lisa Azzarello: Offline water and filter samples
11. Jay Tomlin: TRAC impactor samples



Flight Summary

Morning Flights = 2

Afternoon Flights = 23

Afternoon / Sunset Flights = 4

Sunset / Night Flights = 11

TOTAL FLIGHTS = 40

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Sunset / Night Flights = 11

TOTAL FLIGHTS = 40



Flight Details

Flight summary: https://docs.google.com/spreadsheets/d/1puikxaDmMgNoscQ_-1vTQKAr1jNtZUYtiOtpqJTifU/edit?usp=sharing

Flight Num	Flight Leg	Start Time (UTC)	Stop Time (UTC)	Duration	Time of Day	Start Airport	Start Code	Stop Airport	Stop Code	Fire Name	Fuel Type	Flight Scientist	Instrument Scientist	Other Details
1	20190729	07/29/2019 17:20:00	07/29/2019 19:25:00	2:05:00	Afternoon	Rocky Mountain Metro	BJC	Rocky Mountain Metr	BJC	Small ag fire	Grass fire	Mike Robinson	Ale Franchin	
2	20190803	08/03/2019 22:08:00	08/04/2019 00:28:00	2:20:00	Afternoon	Boise Airport	BOI	Boise Airport	BOI	None	N/A	Mike Robinson	Rebecca Washenfelde	Calibration of met probes
3	20190805_L1	08/05/2019 21:49:00	08/05/2019 22:33:00	0:44:00	Afternoon	Boise Airport	BOI	Twin Falls Airport	TWF	None (Transit)	N/A	Ale Franchin	Geoff Tyndall	
4	20190805_L2	08/05/2019 23:43:00	08/06/2019 01:44:00	2:01:00	Afternoon	Twin Falls Airport	TWF	Twin Falls Airport	TWF	Goose		Ale Franchin	Geoff Tyndall	
5	20190805_L3	08/06/2019 02:37:00	08/06/2019 03:22:00	0:45:00	Sunset	Twin Falls Airport	TWF	Boise Airport	BOI	None (Transit)	N/A	Ale Franchin	Geoff Tyndall	
6	20190809_L1	08/09/2019 15:21:00	08/09/2019 16:58:00	1:37:00	Morning	Boise Airport	BOI	La Grande Airport	LGD	Granite Gulch		Mike Robinson	Brett Palm	
7	20190809_L2	08/09/2019 17:58:00	08/09/2019 20:31:00	2:33:00	Afternoon	La Grande Airport	LGD	La Grande Airport	LGD	HK163		Mike Robinson	Brett Palm	
8	20190809_L3	08/09/2019 21:26:00	08/09/2019 23:40:00	2:14:00	Night	La Grande Airport	LGD	Boise Airport	BOI	Nethker				
9	20190810	08/10/2019 15:18:01	08/10/2019 17:22:01	2:04:00	Morning	Boise Airport	BOI	Boise Airport	BOI	None (Nethker?)		Ale Franchin	Zach Decker	Missed approaches of McCall; sampling N
10	20190811	08/11/2019 22:46:00	08/12/2019 00:52:00	2:06:00	Afternoon	Boise Airport	BOI	Boise Airport	BOI	None	N/A	Mike Robinson	Ann Middlebrook	No fires, no smoke
11	20190816_L1	08/16/2019 21:17:00	08/16/2019 23:40:00	2:23:00	Afternoon	Boise Airport	BOI	McCall Airport	MYL	Granite Gulch		Ale Franchin	Zach Decker	
12	20190816_L2	08/17/2019 00:49:00	08/17/2019 03:15:00	2:26:00	Sunset	McCall Airport	MYL	McCall Airport	MYL	Granite Gulch		Ale Franchin	Zach Decker	
13	20190816_L3	08/17/2019 04:12:00	08/17/2019 06:56:00	2:44:00	Night	McCall Airport	MYL	Boise Airport	BOI	Granite Gulch		Ale Franchin	Zach Decker	
14	20190817_L1	08/17/2019 23:12:00	08/18/2019 01:48:00	2:36:00	Afternoon	Boise Airport	BOI	McCall Airport	MYL	Granite Gulch		Mike Robinson	Ann Middlebrook	
15	20190817_L2	08/18/2019 02:43:00	08/18/2019 05:15:00	2:32:00	Sunset/Night	McCall Airport	MYL	Boise Airport	BOI	Granite Gulch		Mike Robinson	Ann Middlebrook	
16	20190820_L1	08/20/2019 19:29:00	08/20/2019 21:48:00	2:19:00	Afternoon	Cedar City Airport	CDC	Cedar City Airport	CDC	Castle (also Little Bear?)		Ale Franchin	Zach Decker	Coordinated ER-2 flight
17	20190820_L2	08/20/2019 22:45:00	08/21/2019 01:19:00	2:34:00	Afternoon	Cedar City Airport	CDC	Cedar City Airport	CDC	Little Bear		Ale Franchin	Zach Decker	Coordinated ER-2 flight
18	20190820_L3	08/21/2019 02:18:00	08/21/2019 05:01:00	2:43:00	Sunset/Night	Cedar City Airport	CDC	Cedar City Airport	CDC	Castle		Ale Franchin	Zach Decker	Coordinated ER-2 flight
19	20190821_L1	08/21/2019 20:35:00	08/21/2019 22:54:00	2:19:00	Afternoon	Cedar City Airport	CDC	Cedar City Airport	CDC	Little Bear		Mike Robinson	Matt Roberts	Coordinated ER-2 flight
20	20190821_L2	08/22/2019 00:03:00	08/22/2019 02:47:00	2:44:00	Afternoon	Cedar City Airport	CDC	Cedar City Airport	CDC	Castle		Mike Robinson	Ann Middlebrook	Coordinated ER-2 flight
21	20190821_L3	08/22/2019 03:42:00	08/22/2019 06:12:00	2:30:00	Sunset/Night	Cedar City Airport	CDC	Cedar City Airport	CDC	Castle		Mike Robinson	Ann Middlebrook	Coordinated ER-2 flight
22	20190824_L1	08/24/2019 21:15:00	08/24/2019 23:41:00	2:26:00	Afternoon	Boise Airport	BOI	Baker City Airport	BKE	204 Cow		Mike Robinson	Lisa Azzarello	
23	20190824_L2	08/25/2019 00:46:00	08/25/2019 03:28:00	2:42:00	Afternoon/Sunset	Baker City Airport	BKE	Baker City Airport	BKE	204 Cow		Mike Robinson	Steve Brown	
24	20190824_L3	08/25/2019 04:18:00	08/25/2019 06:20:00	2:02:00	Night	Baker City Airport	BKE	Boise Airport	BOI	204 Cow		Mike Robinson	Steve Brown	
25	20190825_L1	08/25/2019 20:38:00	08/25/2019 23:19:00	2:41:00	Afternoon	Boise Airport	BOI	Ontario Airport	ONO	204 Cow		Mike Robinson	Ale Franchin	
26	20190825_L2	08/26/2019 00:12:00	08/26/2019 02:52:00	2:40:00	Afternoon/Sunset	Ontario Airport	ONO	Ontario Airport	ONO	204 Cow		Mike Robinson	Ale Franchin	
27	20190825_L3	08/26/2019 03:48:00	08/26/2019 06:12:00	2:24:00	Night	Ontario Airport	ONO	Boise Airport	BOI	204 Cow		Mike Robinson	Ale Franchin	
28	20190827_L1	08/27/2019 19:57:00	08/27/2019 22:31:00	2:34:00	Afternoon	Boise Airport	BOI	Ontario Airport	ONO	204 Cow		Ale Franchin	Brett Palm	
29	20190827_L2	08/28/2019 02:26:00	08/28/2019 05:02:00	2:36:00	Sunset/Night	Boise Airport	BOI	Boise Airport	BOI	204 Cow		Ale Franchin	Brett Palm	
30	20190828_L1	08/28/2019 19:44:00	08/28/2019 22:22:00	2:38:00	Afternoon	Boise Airport	BOI	Ontario Airport	ONO	204 Cow		Mike Robinson	Brett Palm	
31	20190828_L2	08/28/2019 23:24:00	08/29/2019 01:37:00	2:13:00	Afternoon	Ontario Airport	ONO	Ontario Airport	ONO	204 Cow		Mike Robinson	Brett Palm	
32	20190828_L3	08/29/2019 02:32:00	08/29/2019 05:07:00	2:35:00	Sunset/Night	Ontario Airport	ONO	Boise Airport	BOI	204 Cow		Mike Robinson	Brett Palm	
33	20190903_L1	09/03/2019 19:38:00	09/03/2019 22:20:00	2:42:00	Afternoon	Boise Airport	BOI	Baker City Airport	BKE	204 Cow		Ale Franchin	Zach Decker	
34	20190903_L2	09/03/2019 23:30:00	09/04/2019 01:37:00	2:07:00	Afternoon	Baker City Airport	BKE	Baker City Airport	BKE	204 Cow		Ale Franchin	Zach Decker	

RA data status: <https://docs.google.com/spreadsheets/d/1ix1jEWzFsehuB1Ad5IAv-i3uZwD9DZS2oIF6nCaj4Cs/edit?usp=sharing>

Ken Aikin

Amber Soja and Emily Gargulinski

FIREX-AQ Chem Otter Meeting
Update – Plans and Your Suggestions
Tossing ideas for discussion



We intend to provide details and calculate detailed emissions and fuels for every fire in the spreadsheet

https://docs.google.com/spreadsheets/d/1_Jfc3GP9taF8lvP82VHplX1lgsUvvQV7P9CTxrJNRV8/edit#gid=0

Fuels data – FCCS (forest service), ICS-209, ground crews, reports, FCCS global, satellite data comparisons

Daily Record: This is a draft. If you have any comments, please email Amber Soja (amber.j.soja@nasa.gov) or Emily Gargulinski (Emily.m.Gargulinski@nasa.gov)

Date	Day	Start Time (UTC)	Stop Time (UTC)	Fire Name	State/ Province	Platform	Lat	Lon	Notes	MODIS IGBP 2017 Ecog class	Fuels (FCCS 2014) 30m	Fuels (Inolweb, NWCG, New g)	Fuels Narrative (209 Reports)	SPOT Fuel Bed	WFA 3 Fuel Type	Fire Danger (Forecasted)	Fire Danger (Observed)	Severe Fire Weather Potential	BI Fire Behavior Potential (FBP)	Structures Damaged/Destroyed	MODIS FRP (FRP 24-hr Local Time Sum (MW/km2))	VIIRS FRP (FRP 24-hr Local Time Sum (MW/km2))	MODIS FRP 24-hr Local Time Min (MW/km2)	MODIS FRP 24-hr Local Time Max (MW/km2)	MODIS FRP 24-hr Local Time Mean (MW/km2)	VIIRS FRP 24-hr Local Time Min (MW/km2)	VIIRS FRP 24-hr Local Time Max (MW/km2)	VIIRS FRP 24-hr Local Time Mean (MW/km2)	Fuel Moisture %/10A, 1'-2" diameter	Fuel Moisture %/10A, 1'-2" diameter	Fuel Moisture %/1000-h, 3-8" diameter
7/22/19									Transit from Peninsula Medialdy																						
7/23/19																															
7/24/2019				Sheep	ID	DC-8	43.56	-112.88		Grasslands	Sagebrush shrubland - post prescribed burn (VCT)	Tall Grass, Brush	Sage-Grouse Habitat, Juniper, grass and sagebrush	N/A	Grass	High			One minor out to	1002.90	1490.98	15.40	92.00	50.10	234	280.480	245.55				
7/24/2019				Shady (Fly-B)	ID	DC-8	44.52	-115.02		Woods/ Savanna/ Grasslands	Modified or Managed/eric Understory 2	Timber and tall grass	Timber (Lime and Understory), Tall Grass (2.5 feet), Heavy Logging Slash	(partial)	Timber, Shrubs/Bush, Grass	High			None	None	20.62	None	None	None	20.62	20.62	20.62				
7/25/2019				Shady	ID	DC-8	44.52	-115.02		Woods/ Savanna/ Grasslands	Modified or Managed/eric Understory 2	Timber and tall grass	Timber (Lime and Understory), Tall Grass (2.5 feet), Heavy Logging Slash	(partial)	Timber, Shrubs/Bush, Grass	Moderate			None	228.50	20160.00	13.00	762.00	176.80	427	384.160	694.80				

Total direct carbon emissions (C_t), based on the original work of Seiler and Crutzen [1980]:

$$C_t = A B f_c \beta$$

where A is area burned by fire in hectares,
 B is biomass density in tons per hectare ($t\ ha^{-1}$),
 f_c is the carbon fraction of the biomass, and
 β is the fraction of biomass consumed during fire events.

Emission factors can be taken from this campaign or Akagi et al.,
Andrea and Merlet

Burned Area

Smoldering
Flaming

Priorities

Considerations

ICS-209

Geomac

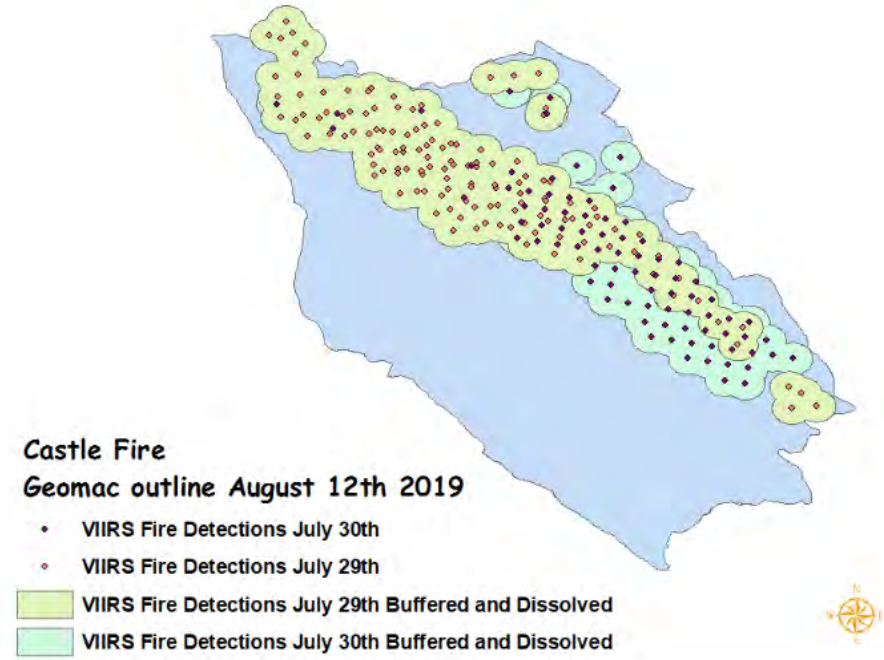
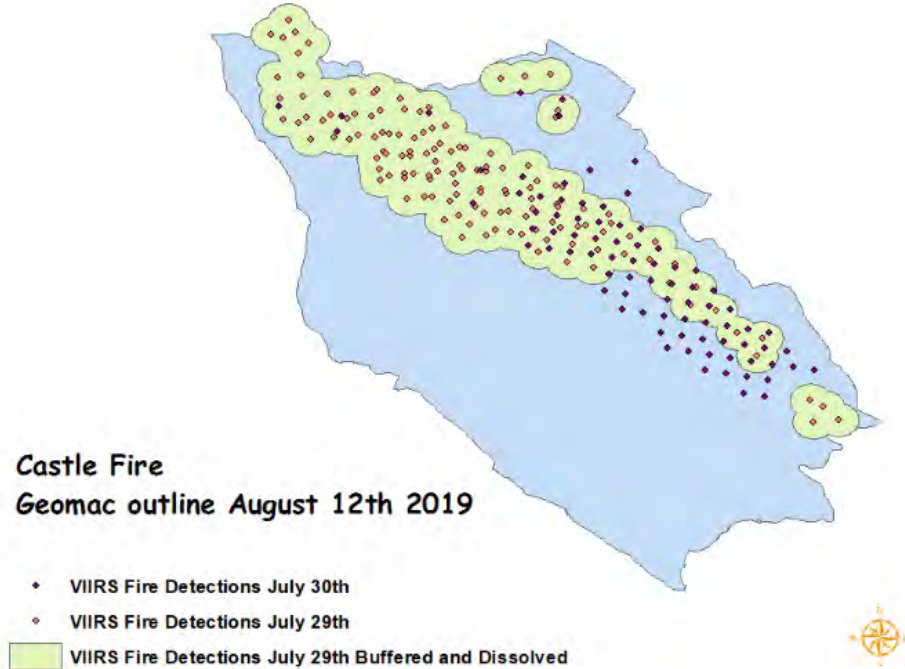
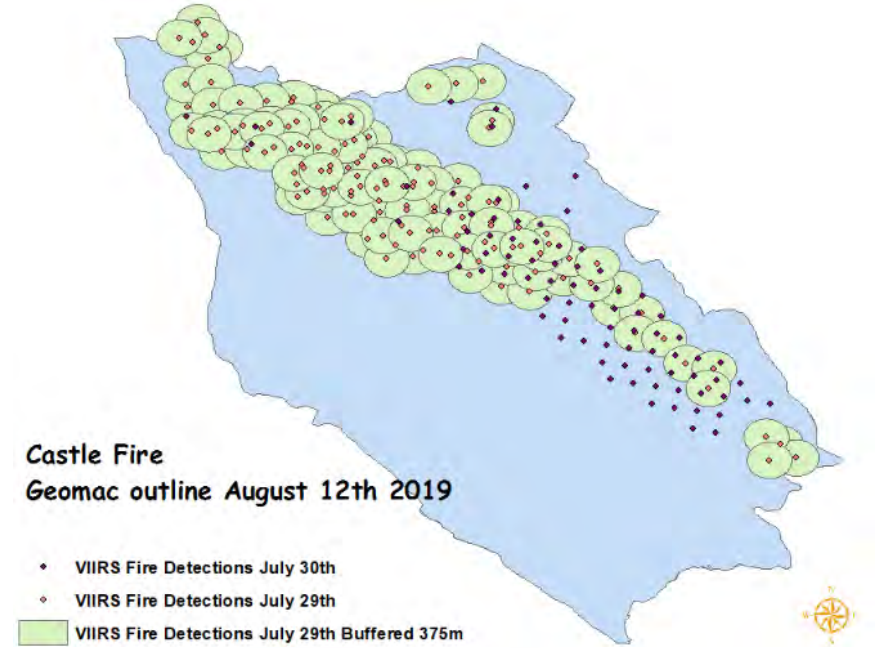
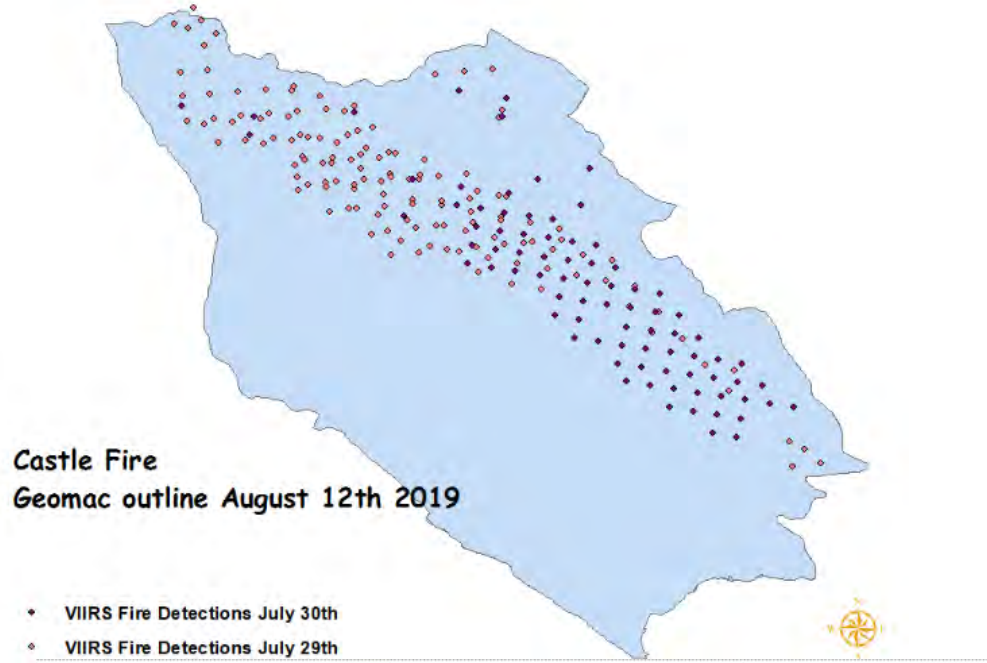
NIROPS

fire weather

VIIRS

MODIS

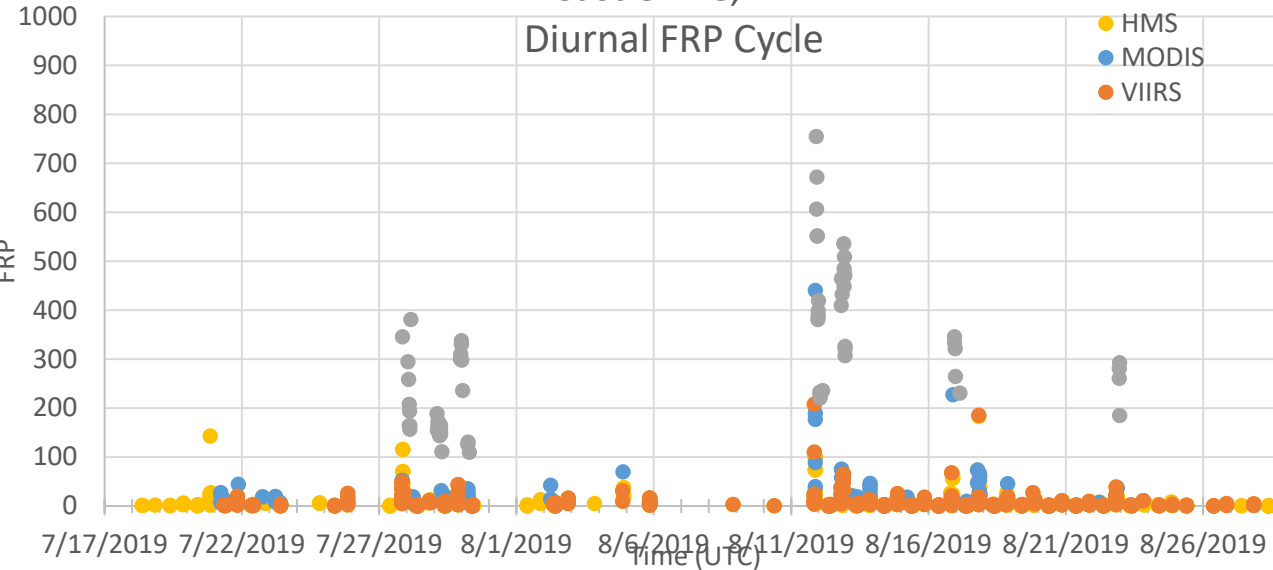
GOES



Castle Fire, AZ

Diurnal FRP Cycle

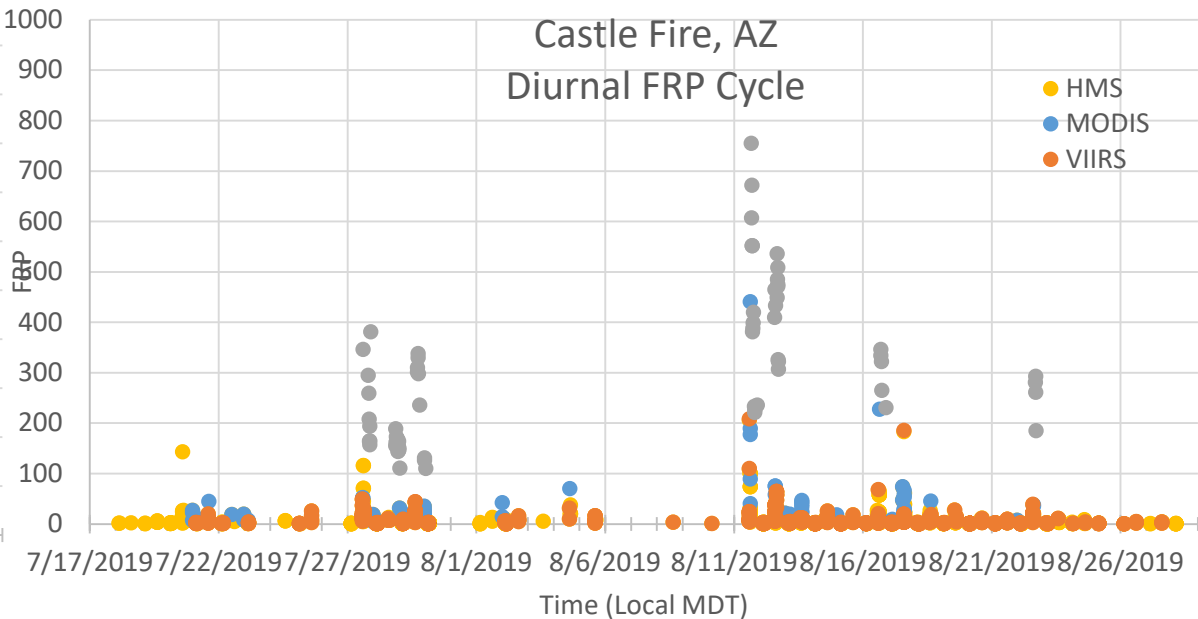
- HMS
- MODIS
- VIIRS



Castle Fire, AZ

Diurnal FRP Cycle

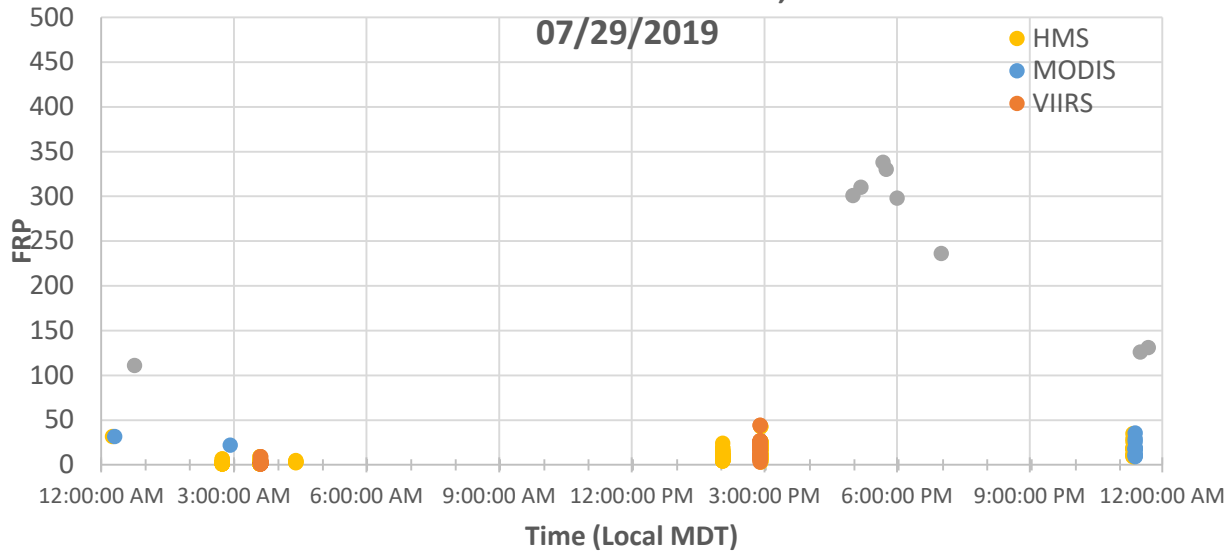
- HMS
- MODIS
- VIIRS



Diurnal FRP: Castle Fire, AZ

07/29/2019

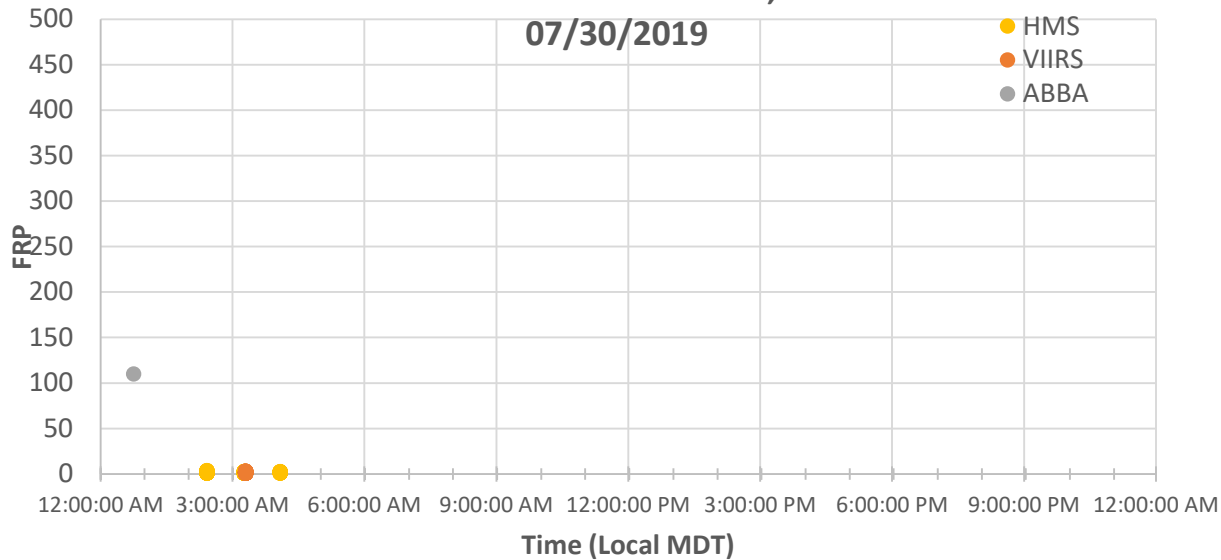
- HMS
- MODIS
- VIIRS



Diurnal FRP: Castle Fire, AZ

07/30/2019

- HMS
- VIIRS
- ABBA



Twin Otter Gas-Phase Instruments

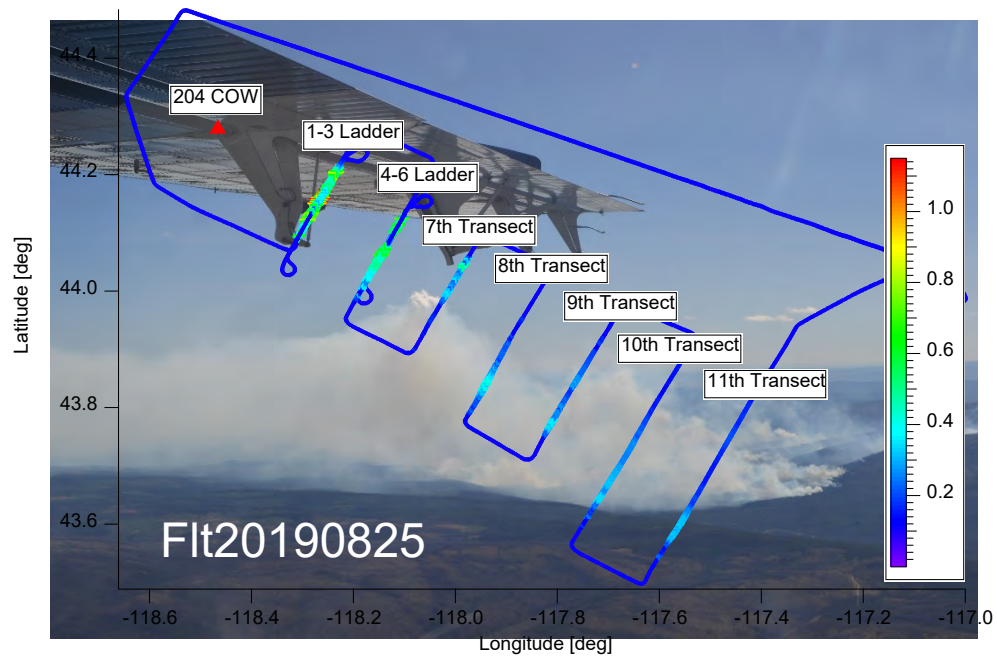
Instrument	Species Measured	Investigators	Institution
Chemiluminescence	NO, NO ₂ , O ₃	Andy Weinheimer, Denise Montzka, Geoff Tyndall, Frank Flocke	NCAR
LiNO ₂	NO ₂ photolysis rate	Mike Robinson	NOAA CSD
Tenax cartridge sampler	Speciated VOCs	Kelley Barsanti, Lindsey Hatch, Avi Lavi, Paul Van Rooy	UC Riverside
ToF CIMS	Acids (HNO ₃ , HONO, Organics), acid gases (N ₂ O ₅ , ClNO ₂), Oxygenated organics, Organic nitrates, Halogens	Joel Thornton, Brett Palm, Carley Fredrickson, Zach Decker	University of Washington NOAA
Picarro CRDS	CO, CO ₂ , CH ₄ , H ₂ O	Colm Sweeney, Mike Robinson	NOAA GMD

Andy Weinheimer: NO/NO₂/O₃

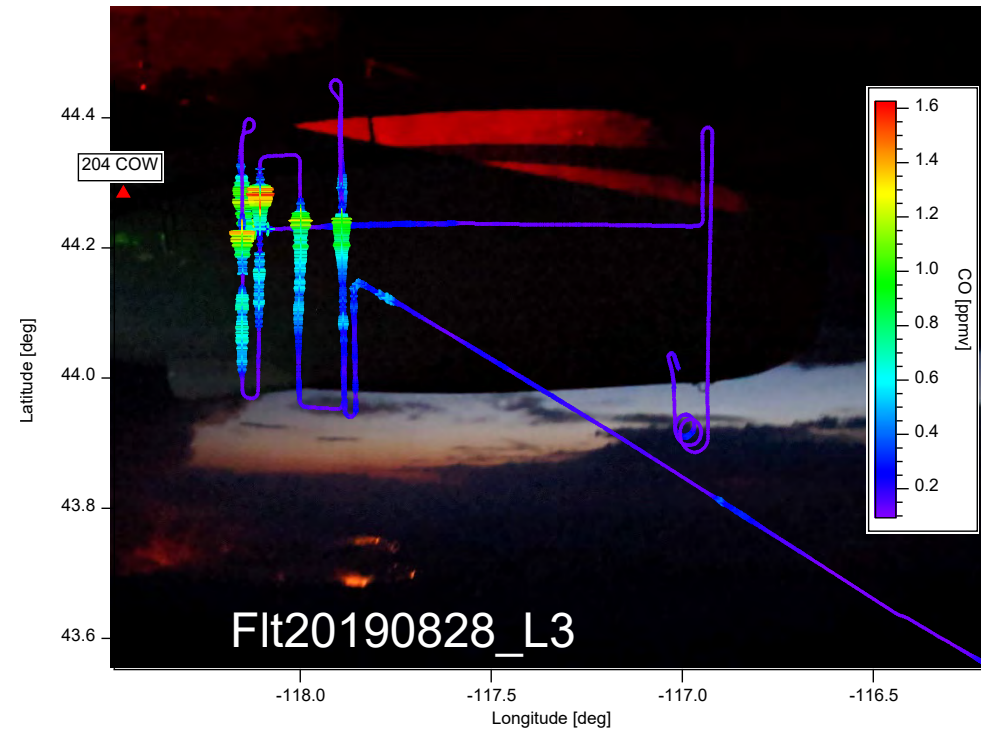
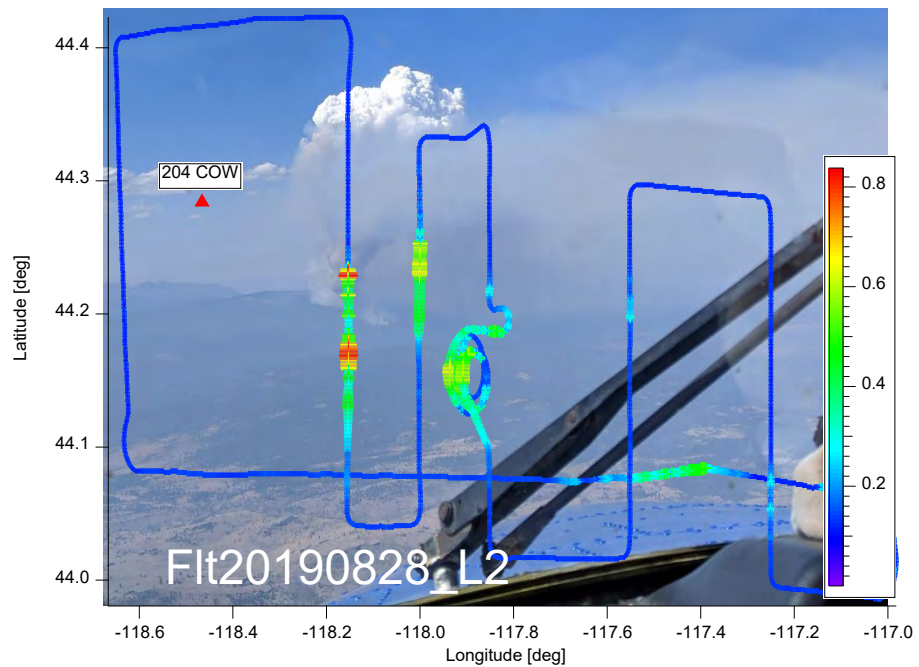
- Reduction is ongoing; still a ways to go. Plan to make the Feb. 1 deadline.
- Our clock was 30-40 seconds fast throughout, and by an increasing amount. Still need to adjust our time base to synchronize in a manner compatible with others.
- No initial results to present at this time.

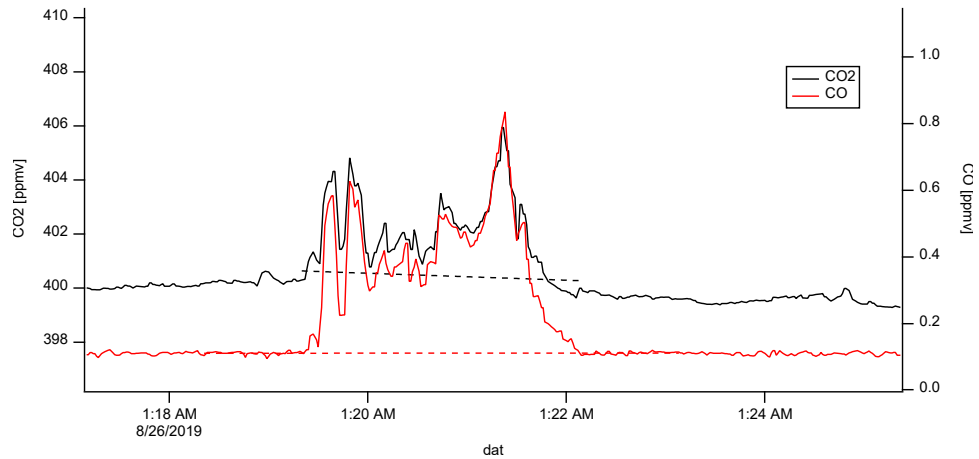
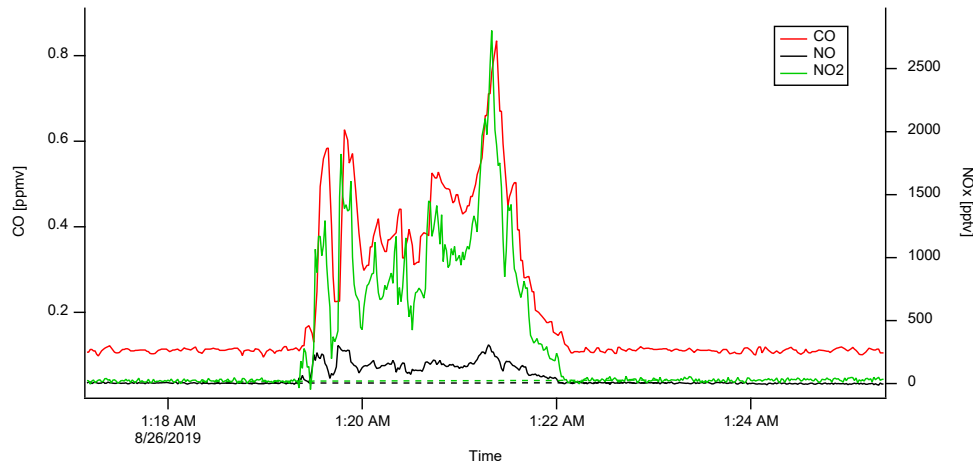
Mike Robinson

NO_x enhancements and
vertical structure from the
204 COW Fire: 8/25, 8/28, 9/3



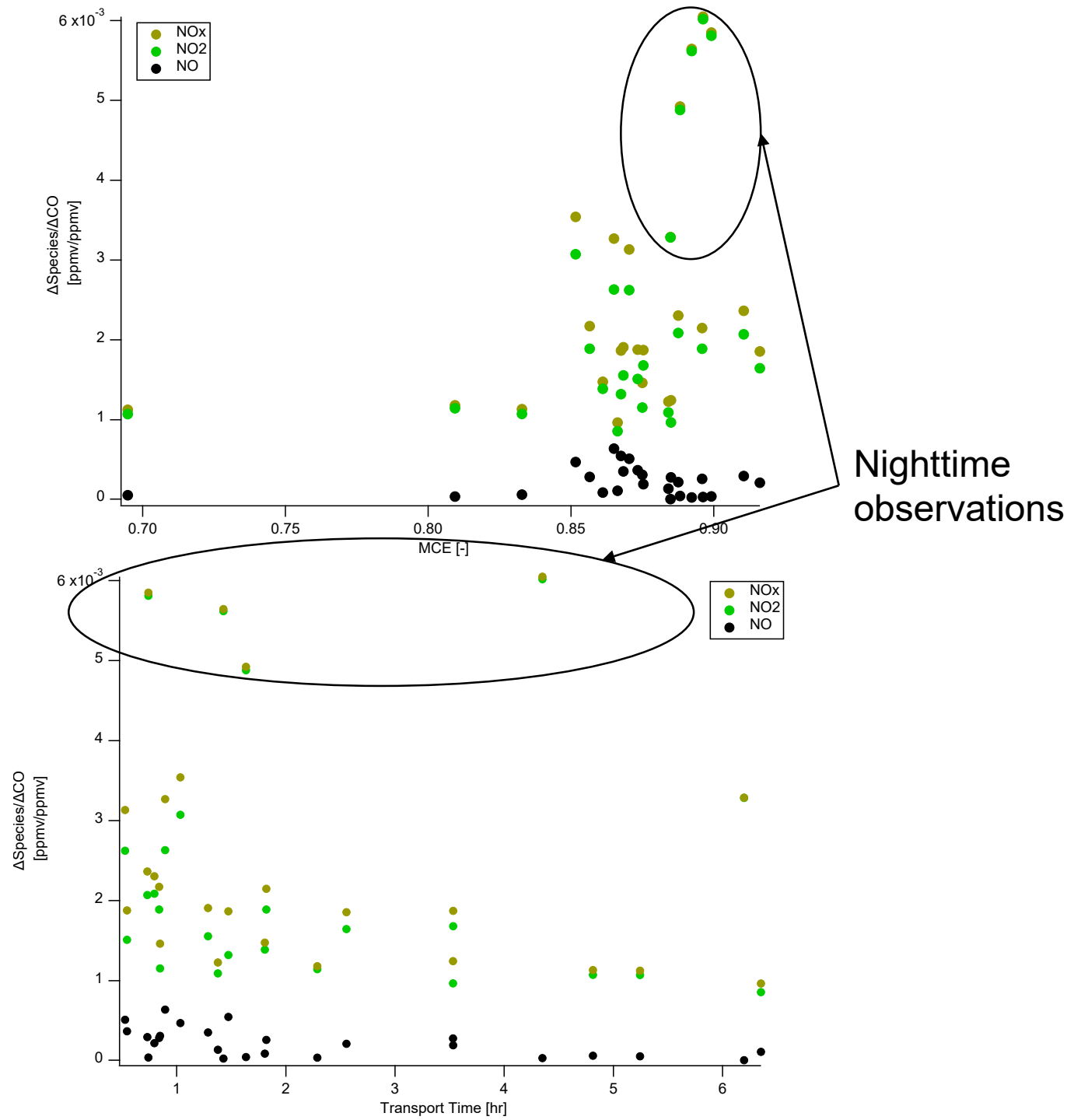
- I've been looking at 3 days from 204 COW:
- 1) Daytime photochemistry flights
 - 2) Nighttime NO_x
 - 3) Daytime vertical profile flight





$$MCE = \frac{\Delta CO_2}{\Delta CO_2 + \Delta CO} = \frac{1}{1 + \frac{\Delta CO}{\Delta CO_2}}$$

$$Transport\ Time = AvgWindSpd / TransportDistance$$



Christos Stamatis: VOCs

Completed

- Mobile lab samples: *GC × GC runs complete*
- Twin Otter samples: *GC × GC runs complete*

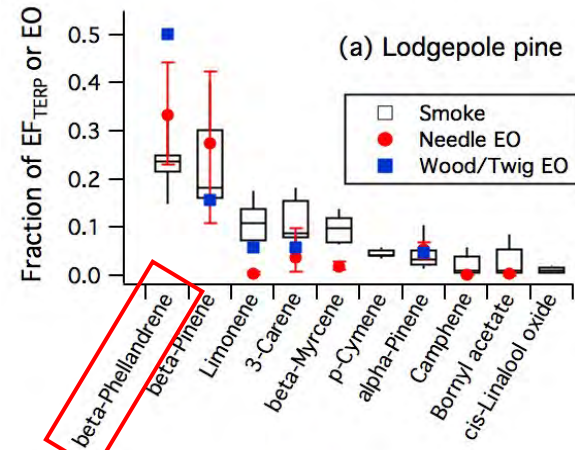
Upcoming

- Run standards to validate compounds
- Run calibrations to quantify
- Normalize to plume concentration
- **Fire Lab 2016** data: Post processing (currently)

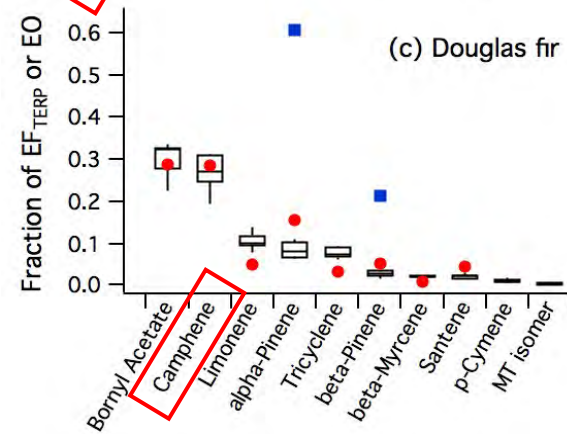
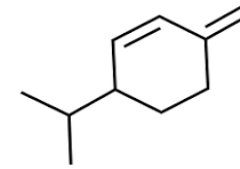




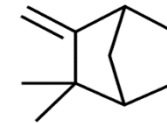
bars = smoke, symbols = essential oils



beta-phellandrene

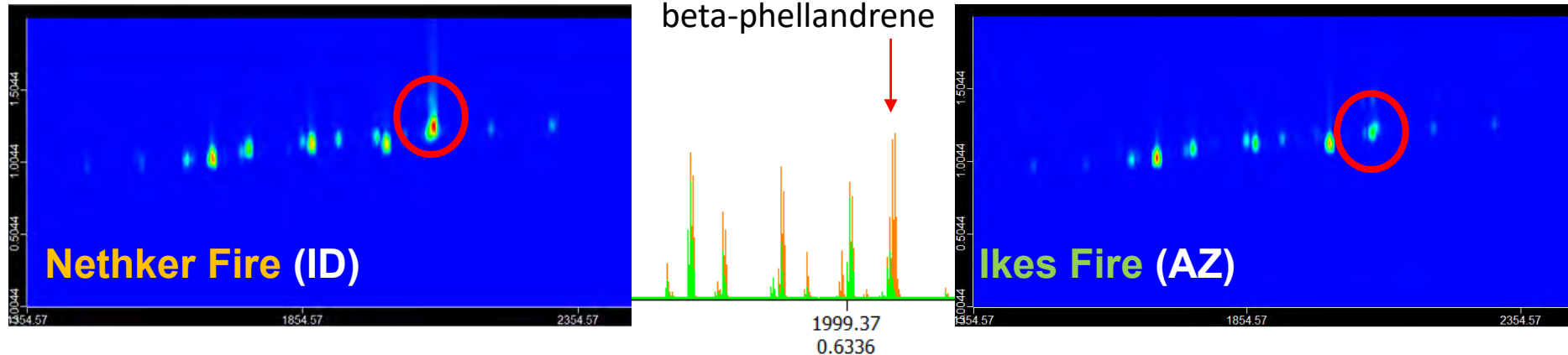


camphene



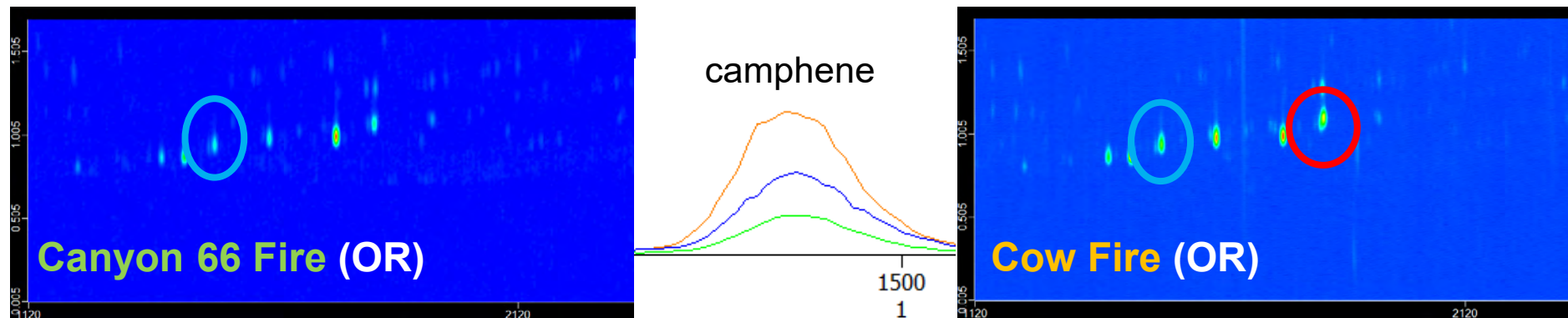
Based on fuels report, Nethker Fire burned large fraction of lodgepole pine, large beta-phellandrene signal

Aerodyne Mobile Lab



Based on fuels report, Canyon Fire burned shrubs, grasses, Ponderosa pine; no beta-phellandrene signal, very small camphene signal

NOAA Twin Otter



Zach Decker: UW I- CIMS

Achieved 90% data coverage

- **RA data includes**
 - HCN
 - HNCO
 - HNO₃
 - HNO₂
 - CH₂O₂
 - C₂H₄O₂
 - SO₂
 - HCl
 - C₆H₆O (includes phenol)
 - C₆H₆O₂ (includes catechol)
 - C₇H₈O₂ (includes guaiacol)
 - C₅H₁₀O₃
 - C₅H₉O₄N
 - C₉H₁₄O₄
 - C₁₀H₁₆O₃
 - C₆H₁₀O₅
- **R0 will also include**
 - N₂O₅
 - ClNO₂

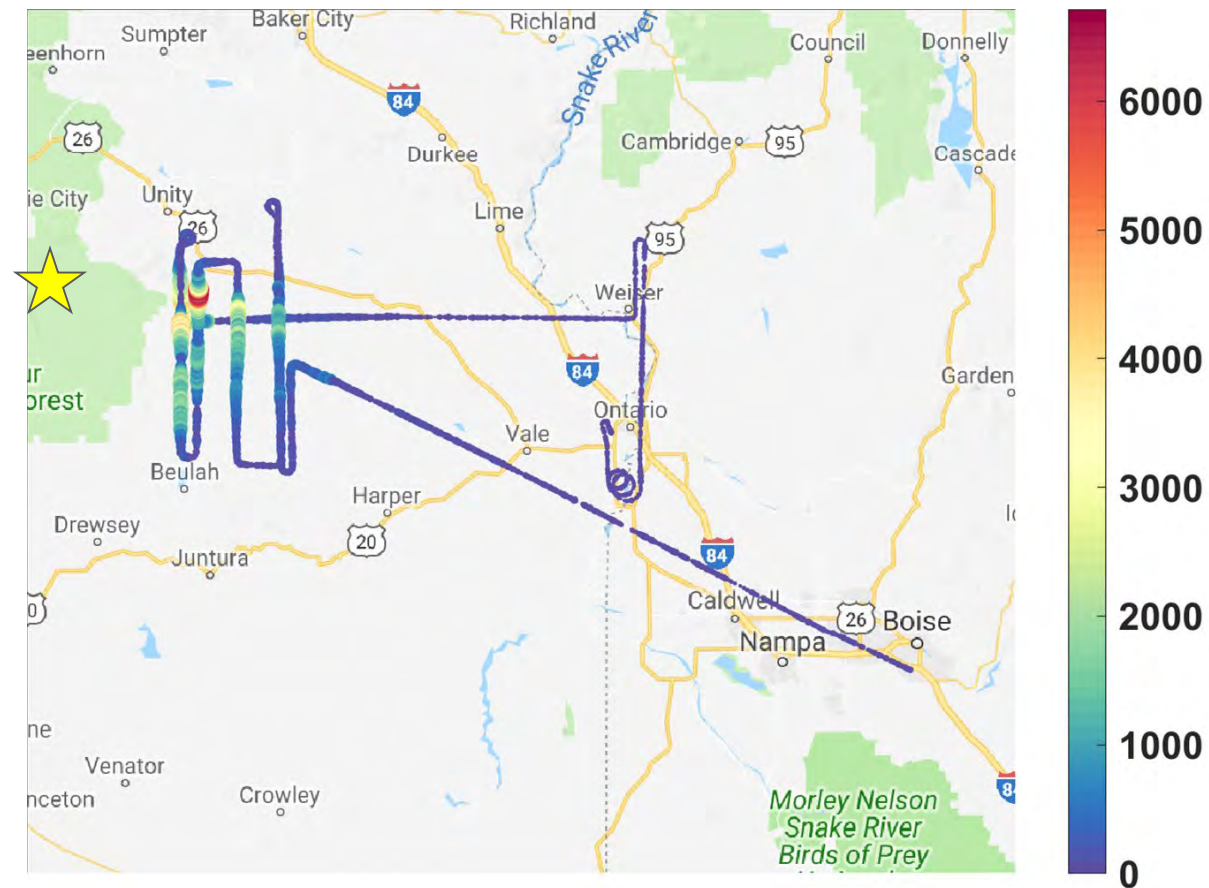
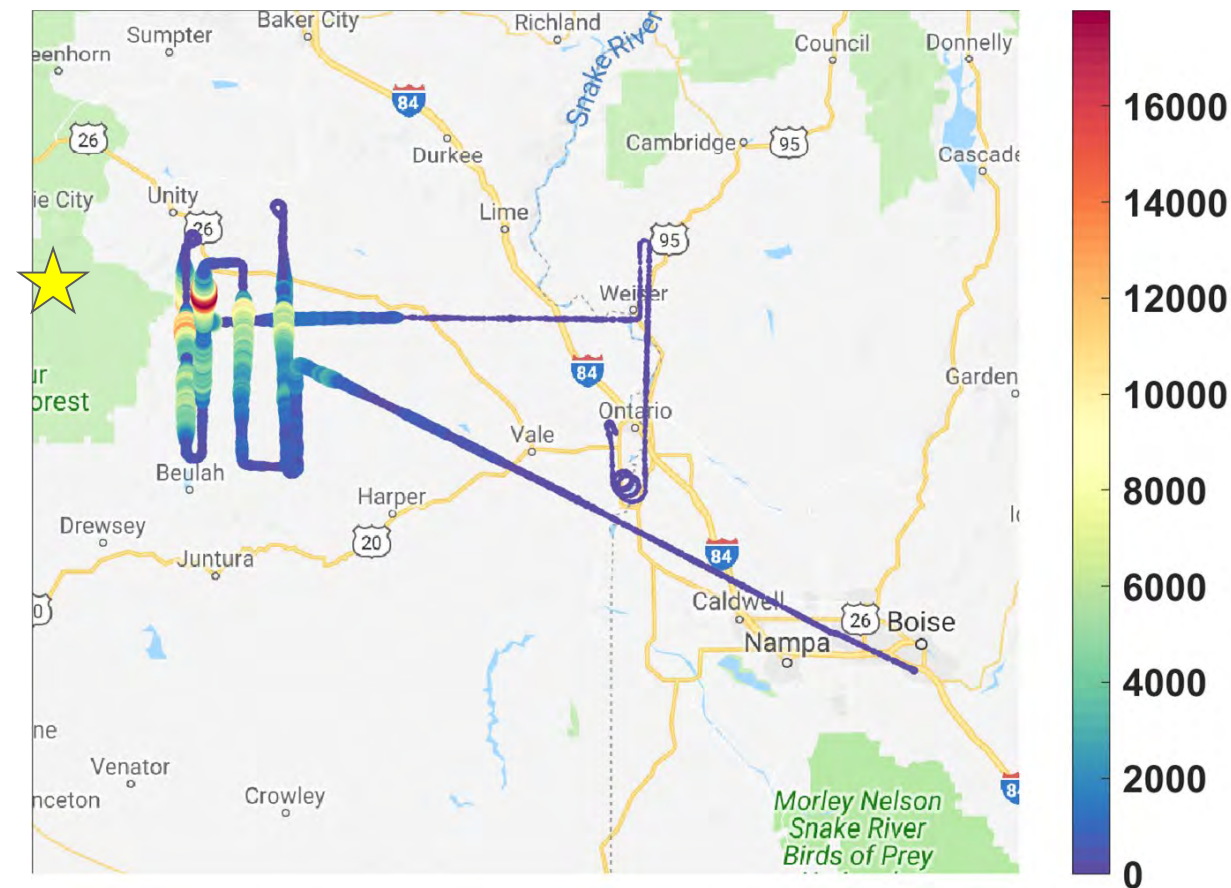
Date	Fire	Availability
8/3	McCall Test Flight	Available
8/5	Goose	No data
8/9	Granite/HK/Nethker	Available
8/10	Nethker	Available
8/11	Nethker	Available
8/16	Granite	L1/L2/L3
8/17	Granite	Corrections needed
8/20	Little Bear	Available
8/21	Little Bear / Castle	Available
8/24	Cow	Available
8/27	Cow	Available
8/28	Cow	Available
9/3	Cow	Available
9/4	Canyon 66	Available
9/5	Smith Knob	Available

Oxygenated Aromatics are routinely observed

★ Cow Fire (Aug 28 L3)

C₆H₆O₂ isomers including catechol (ncps)

C₇H₈O₂ isomers including guaiacol (ncps)



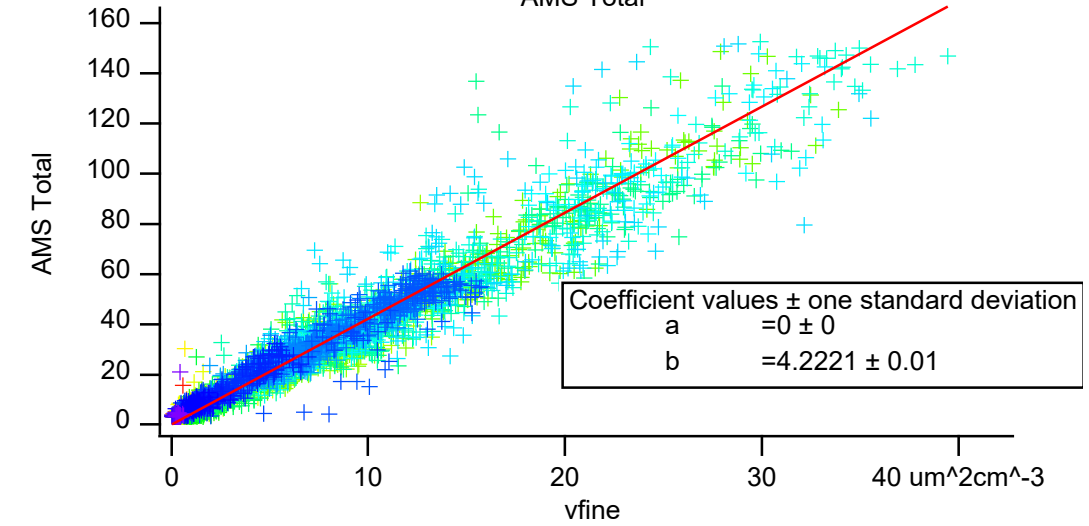
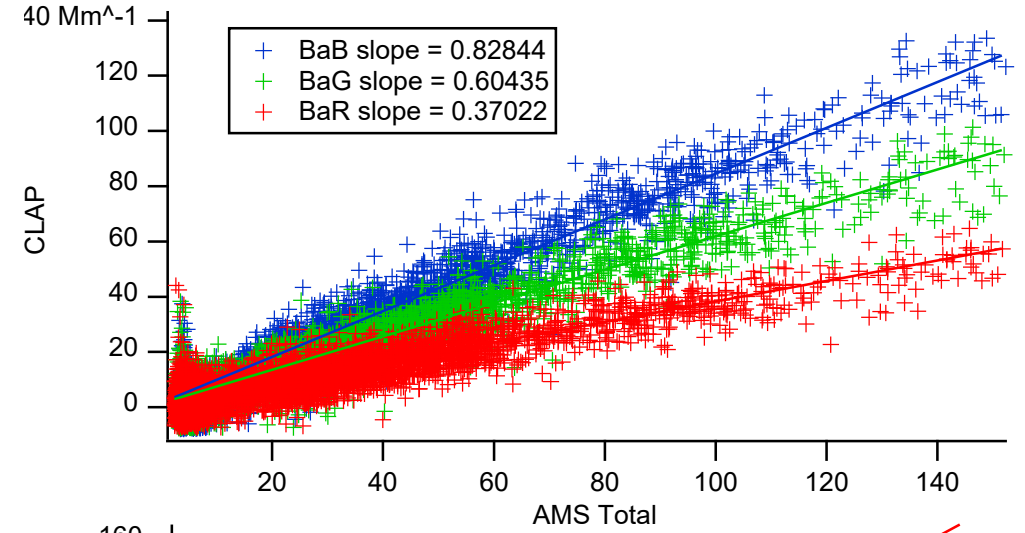
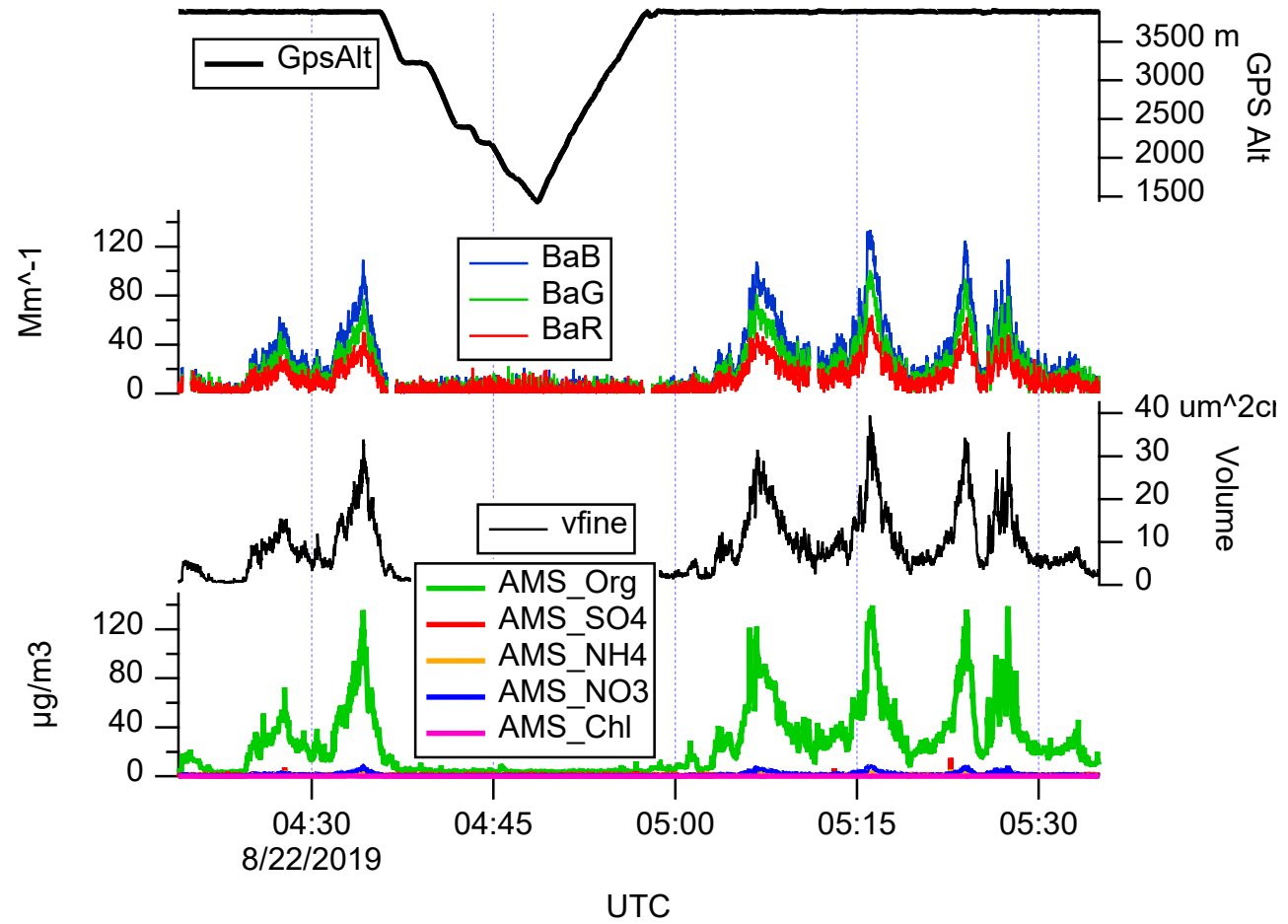
Twin Otter Aerosol Instruments

Instrument	Species Measured	Investigators	Institution
★ High-Resolution AMS	Aerosol composition	Ann Middlebrook, Ale Franchin, Kathy Hayden, Shao-Meng Li	NOAA CSD Environment Canada
★ Brown Carbon PILS	Water-soluble aerosol absorption Water-soluble organic carbon concentration	Rebecca Washenfelder, Lisa Azzarello	NOAA CSD
Aethelometer	Aerosol absorption at three wavelengths	Ale Franchin	NOAA CSD
Optical Particle Counter	Aerosol size distribution	Ale Franchin, Ann Middlebrook	NOAA CSD
★ Water and Filter Samples	Aerosol composition, size-resolved absorption	Cora Young, Lisa Azzarello	York University
★ Aerosol Impactor	Particle morphology, composition, and mixing state	Alex Laskin, Jay Tomlin, Kevin Jankowski	Purdue University

Ann Middlebrook

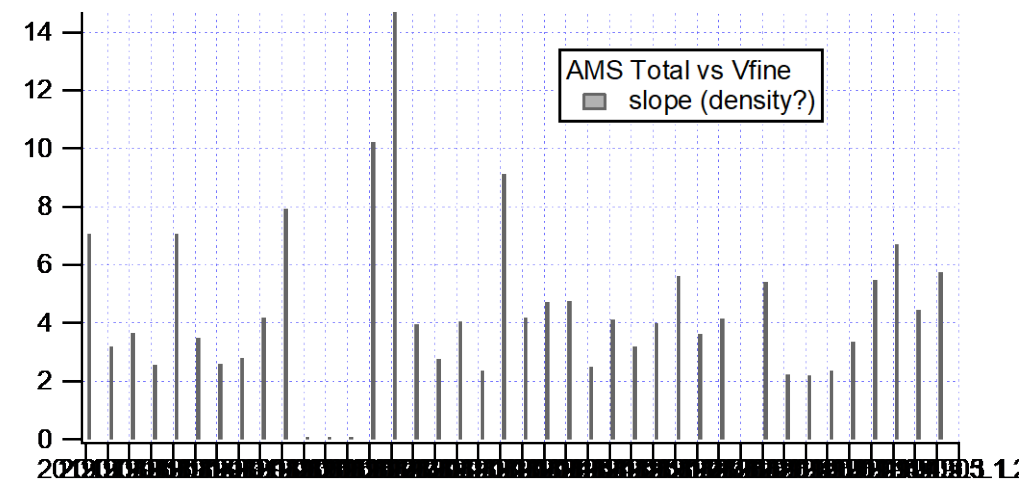
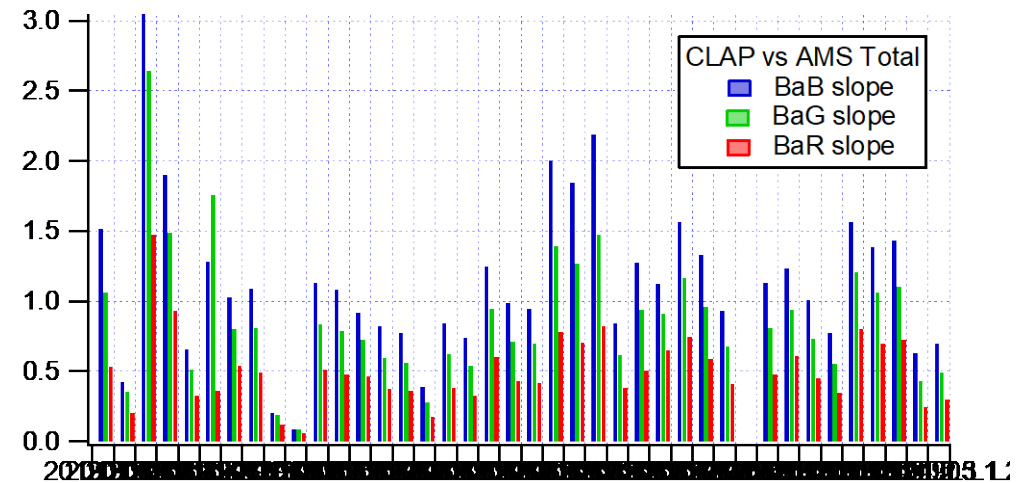
Aerosol Rack Data Status: RA for AMS, CLAP, and UHSAS have been posted

Example: 20190821_L3 flight, Castle Fire at Night



Aerosol Rack Data Status: Known Issues


- Still learning HR-AMS analysis
- AMS data has incorrect IE for flights on 8/16
- Time misalignment for flights on 8/3, 8/9, and 8/24
- Some good aerosol correlations
 - Mass vs Volume slopes are high (some unreasonable)
- Need to re-check before posting all final data



Rebecca Washenfelder: BrC-PILS

Resolved time offset issues between the shared inlet, absorption measurement, and TOC measurement.

Ready to turn the crank on all RA data! It will be posted very soon.

	RA Posted
	Coming soon
	Partial data or problems
	No data

Date	Fire	Availability
7/29	Colorado Test Flight	L1
8/3	McCall Test Flight	L1
8/5	Goose	L1/L2/L3
8/9	Granite/HK/Nethker	L1/L2/L3
8/10	Nethker	L1
8/11	Nethker	L1
8/16	Granite	L1/L2/L3
8/17	Granite	L1/L2
8/20	Little Bear	L1/L2/L3
8/21	Little Bear / Castle	L1/L2/L3
8/24	Cow	L1/L2/L3
8/27	Cow	L1/L2
8/28	Cow	L1/L2/L3
9/3	Cow	L1/L2/L3
9/4	Canyon 66	L1/L2/L3
9/5	Smith Knob	L1/L2

BrC-PILS Science Questions



What is the **lifetime** of brown carbon downwind of a fire during **day vs night**?

What is the major **loss process**?

Lisa Azzarello

Offline Water and CLAP Filter Samples

- Summary of work to be done:
 - Chromatographic separation of cations and anions
 - Quantitative analysis of chloride, nitrite, bromide, nitrate, sulphate, phosphate, ammonium, and amines
 - Amines of interest:
 - monopropylamine (MPA), monoethylamine (MEA), monomethylamine (MMA), diethylamine (DEA), isopropylamine (IMPA), ethanolamine (ETA), dimethylamine (DMA), monobutylamine (MBA), triethylamine (TEA), and trimethylamine (TMA)
 - Size exclusion chromatography with UV-vis (SEC-UV) absorption density measurements
 - Water samples do not require an extraction process
 - CLAP filters will be sonicated in methanol or water and subjected to IC and SEC-UV

My Work Thus Far

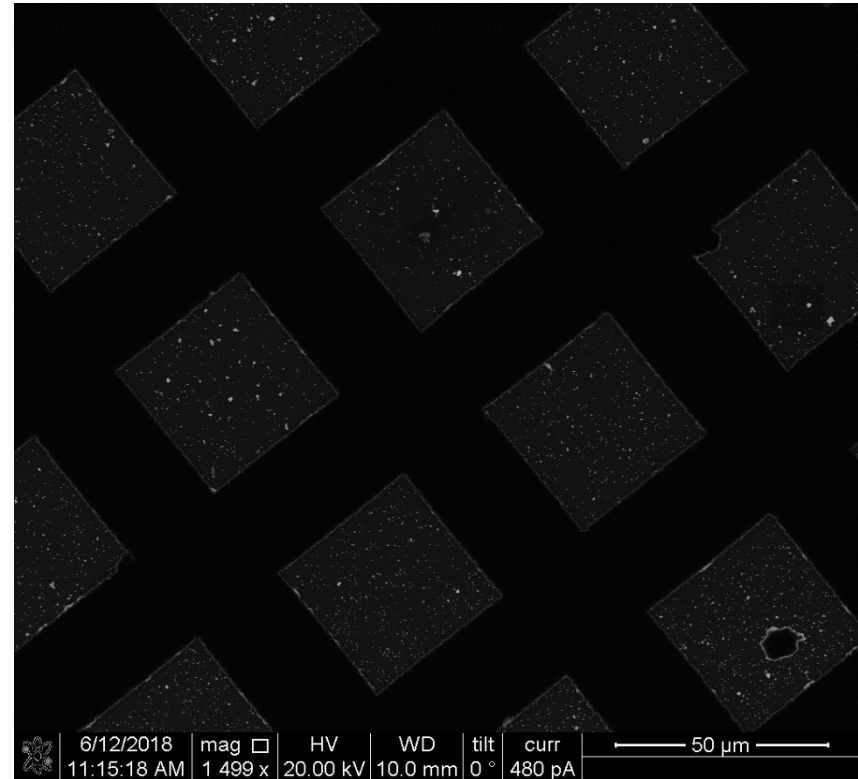
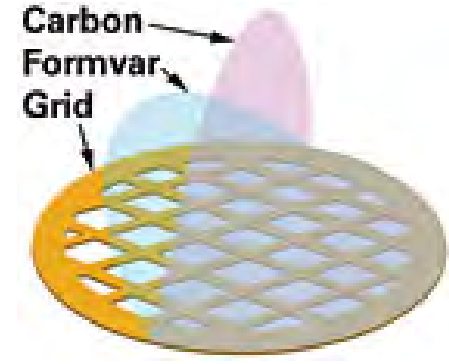
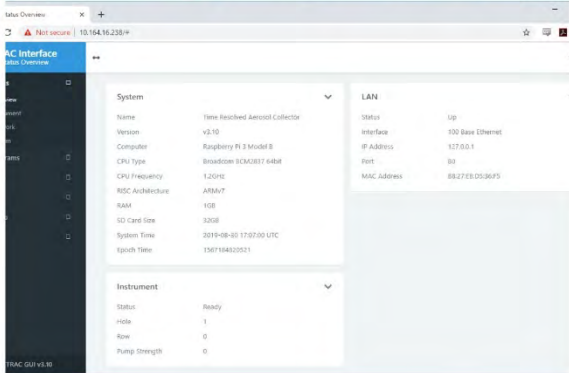
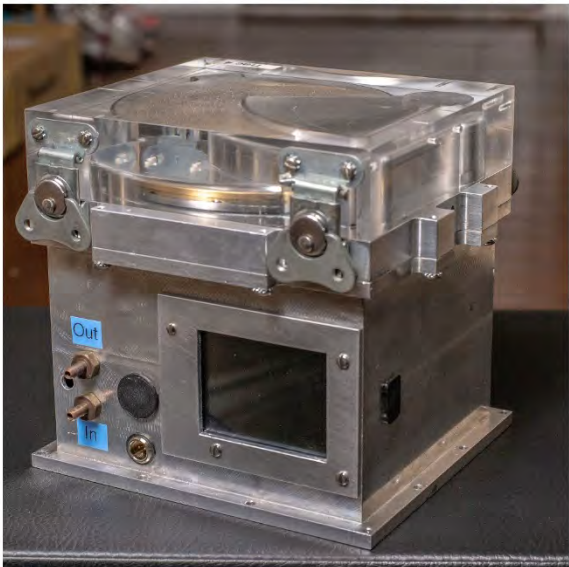
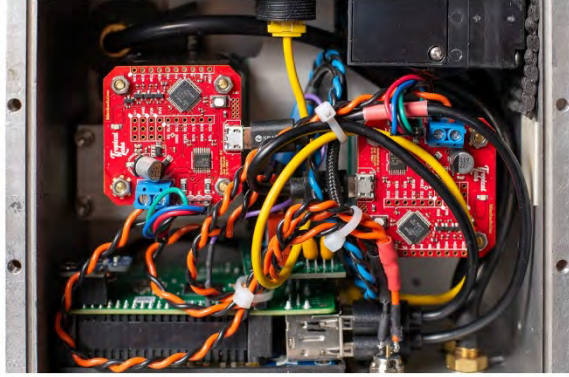
Task/Challenge	Solution
Water samples subjected to anion mode detected analytes below LOQ	Optimized IC by installing a concentrator column to increase sensitivity
Concentrator column requires a sample injection of 1 mL → for some water samples, there is not enough sample volume for 1 mL injections for both cation and anion mode and for SEC-UV analysis	Dilute samples
Calculate LOD and LOQ of instrument for target ions	In progress
Modify calibration scheme to include more dilute standards to more accurately quantify analytes	In progress

Future Work

Tentative Timeline	
Run water samples in anion mode	November
Run water samples in cation mode	November – December
Extract and run CLAP filters in anion mode	December – January
Run CLAP filters in cation mode	January – February
Run all samples SEC-UV analysis	March

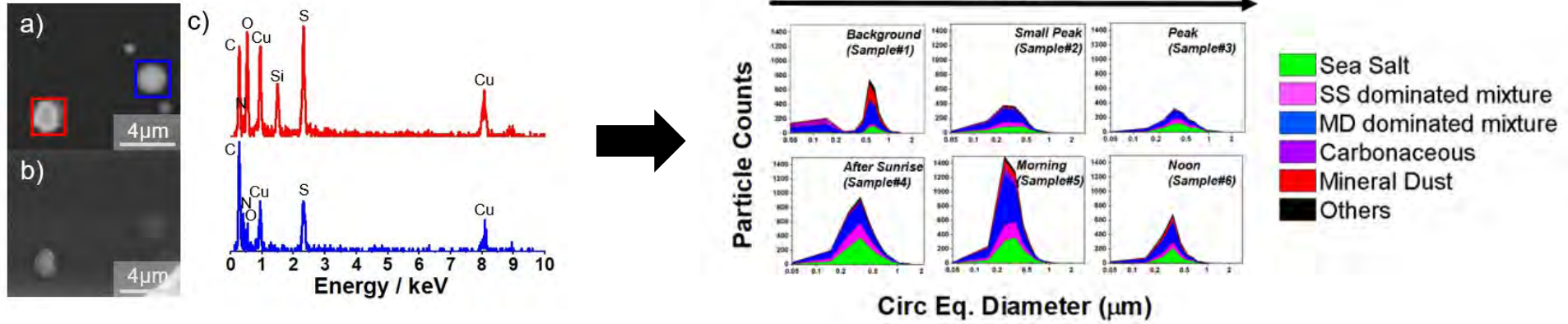
Jay Tomlin: TRAC

Time Resolved Aerosol Collector (TRAC)

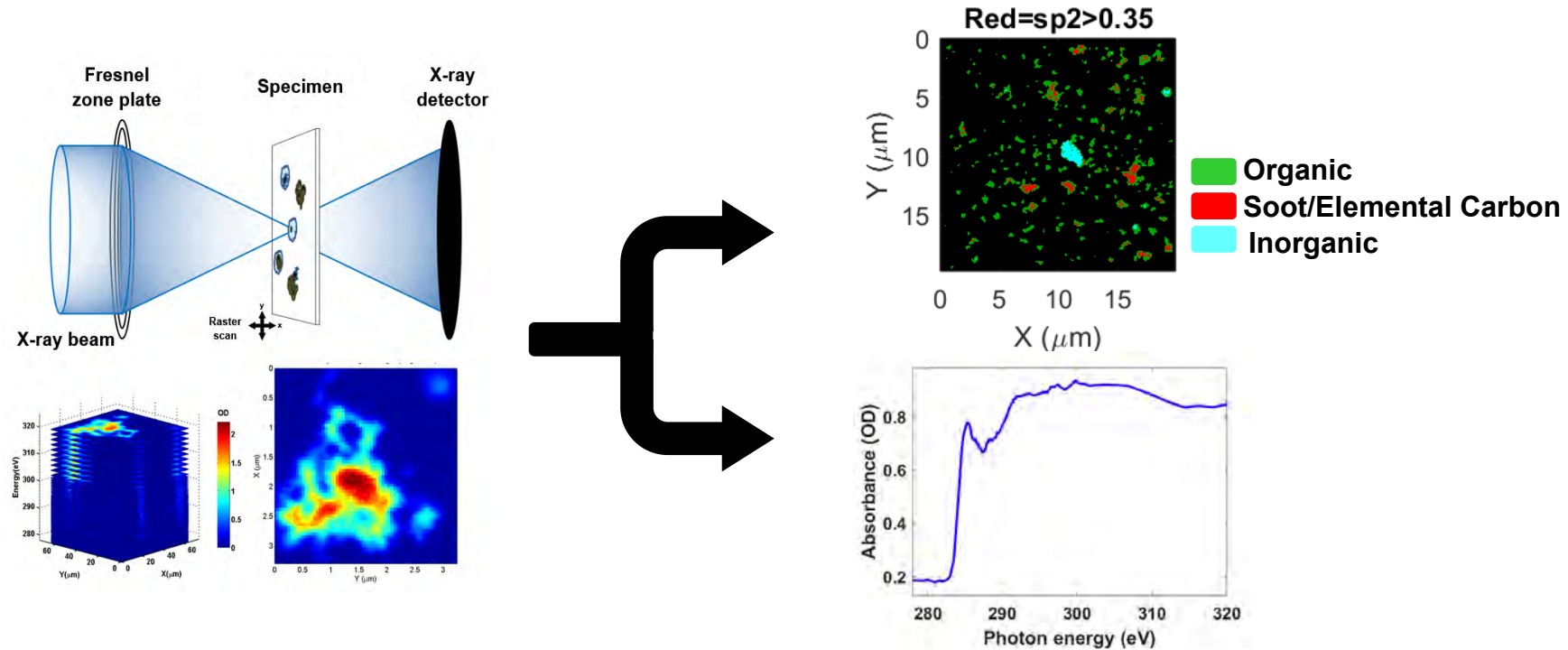


Compositional Analysis of Individual Atmospheric Particles

I. Particle Composition and Elemental Microanalysis



II. Carbon NEXAFS Analysis of Biomass Burning Particles



Selecting Samples for Particle Analysis

Flight No.	Flight Leg	Time of Day	Fire Name
4	20190805_L2	Afternoon	Goose
11	20190816_L1	Afternoon	Granite Gulch
12	20190816_L2	Sunset	Granite Gulch
13	20190816_L3	Night	Granite Gulch
15	20190817_L2	Afternoon	Granite Gulch
17	20190820_L2	Afternoon	Little Bear
20	20190821_L2	Afternoon	Castle
26	20190825_L2	Afternoon/Sunset	204 Cow
32	20190828_L3	Sunset/Night	204 Cow
37	20190904_L2	Afternoon	Canyon 66
40	20190905_L2	Afternoon	Smith Knob

- Total of 827 substrates...
- Real-time data from AMS, BrC-PILS, etc. or suggestions from onsite flight scientist to see which particular flights are of interest
- Determine priority for off-line spectromicroscopy analysis

Next Steps

1. Complete and post RA data by December 2019.
2. Telecon with Twin Otter and mobile lab scientists (TOMLG) at the beginning of December.
3. Monthly Chem Otter science telecons in January, February, and March 2020.
4. Complete and post R0 data by 1 February 2020.
5. Science meeting for all FIREX-AQ participants in Langley, Virginia during the week of 16 March 2020.

