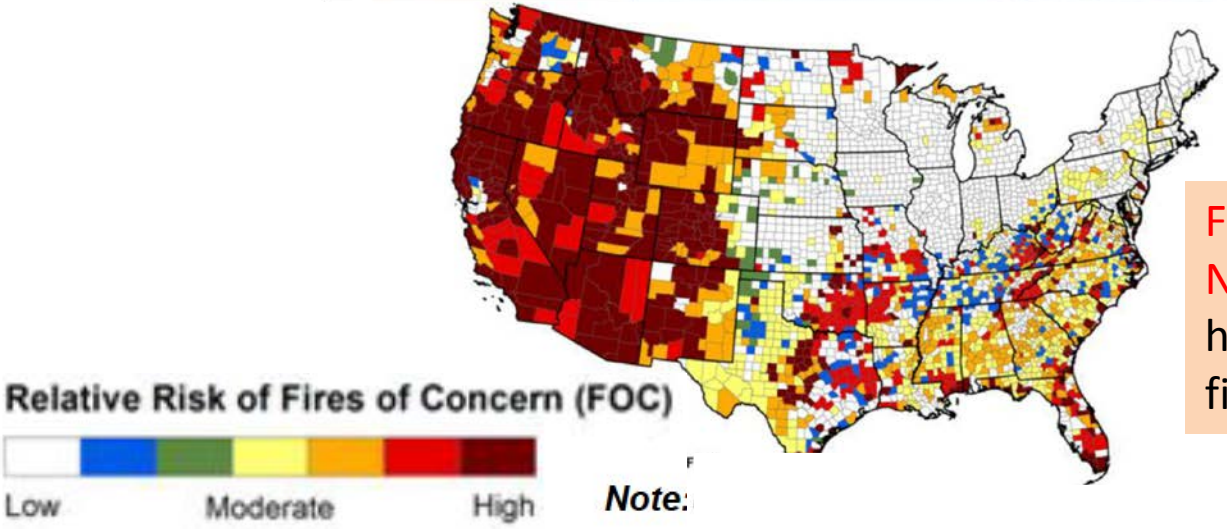
Fire Influence on Regional and Global Environments Experiment (FIREX)

The Impact of Biomass Burning on Climate and Air Quality: An Intensive Study of Western North America Fires



FIREX: Field Experiment from the NOAA Chemical Sciences Division http://esrl.noaa.gov/csd/projects/firex/

Note:

NOAA Field and Laboratory Studies during 2015-2019

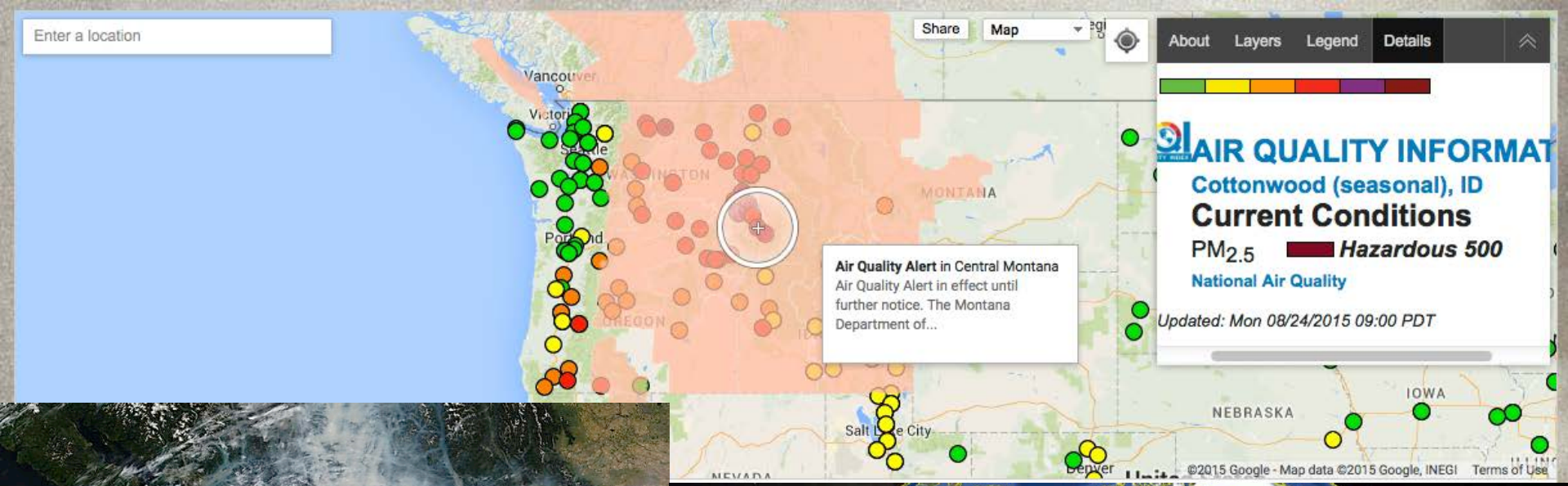
Outline for Discussion Today

1) Update on planned FIREX activities and timing

2) Other platforms

3) JFSP FASMEE

4) Preliminary instrument wish lists
   - Missoula Fire Lab
   - NOAA P3
   - NOAA Twin Otter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AIR QUALITY INFORMAT
Cottonwood (seasonal), ID
Current Conditions
PM2.5
Hazardous 500
National Air Quality
Updated: Mon 08/24/2015 09:00 PDT
Air Quality Alert in Central Montana
Air Quality Alert in effect until further notice. The Montana Department of...
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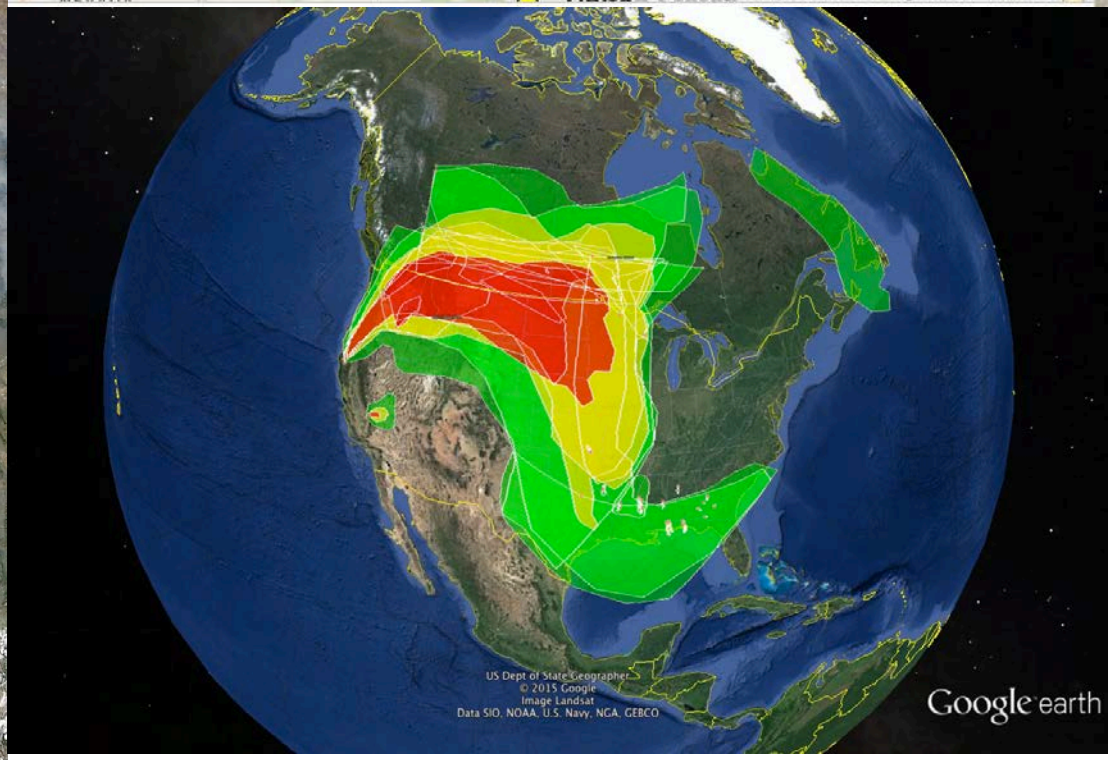
US Dept of State Geographer
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Main FIREX Science Questions in 5 Categories

1) What are the emissions of gases, aerosols, aerosol precursors, air toxics and greenhouse gases from North American fires?
What is the composition and volatility of the previously unidentified fraction of the emissions?

2) What is the chemical transformation of those emissions?
What are the formation mechanisms for secondary species (ozone, SOA and sulfate)?

3) What is the local air quality and visibility impact of North American fires?
How important is nighttime smoke for populated areas?
How well do local air quality forecast models work?

4) What are the regional and long-term impacts of North American fires?

5) What are the climate-relevant properties of BB aerosols?
What role does brown carbon and coatings on black carbon particles play in the optical properties?
What is the composition of PM2.5?

Detailed Science Questions in White Paper draft
We should update these!!!
available at: http://esrl.noaa.gov/csd/projects/firex/

The new science and capabilities FIREX will generate

1) **New instrumentation and satellites**

2) **Comprehensive effort with large science community using ground, mobile, laboratory and aircraft**

3) **Simultaneously deployments of platforms**

4) **Nighttime fires and smoke**

1) **Years building knowledge before large field experiment**

Timetable

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
		Individual Activities			Intensive	
1	Instrument, model development initial lab and field experiments					
2	Emission data incorporation in inventories and model development					
3	Fire lab: emission factors, compound identification (typical NA fuels)					
4	Simulation chamber study for chemical transformation of new compounds					
5	Field observations with small aircraft, mobile lab and ground site					
6	Large multi-platform intensive					
7	Fire lab and simulation chamber: (2018 intensive measured fuels)					
8	Coordinating studies with other agencies, Interpretation and Analysis					

FY with major work for activity
FY with minor work for activity
FY with large-scale field experiment

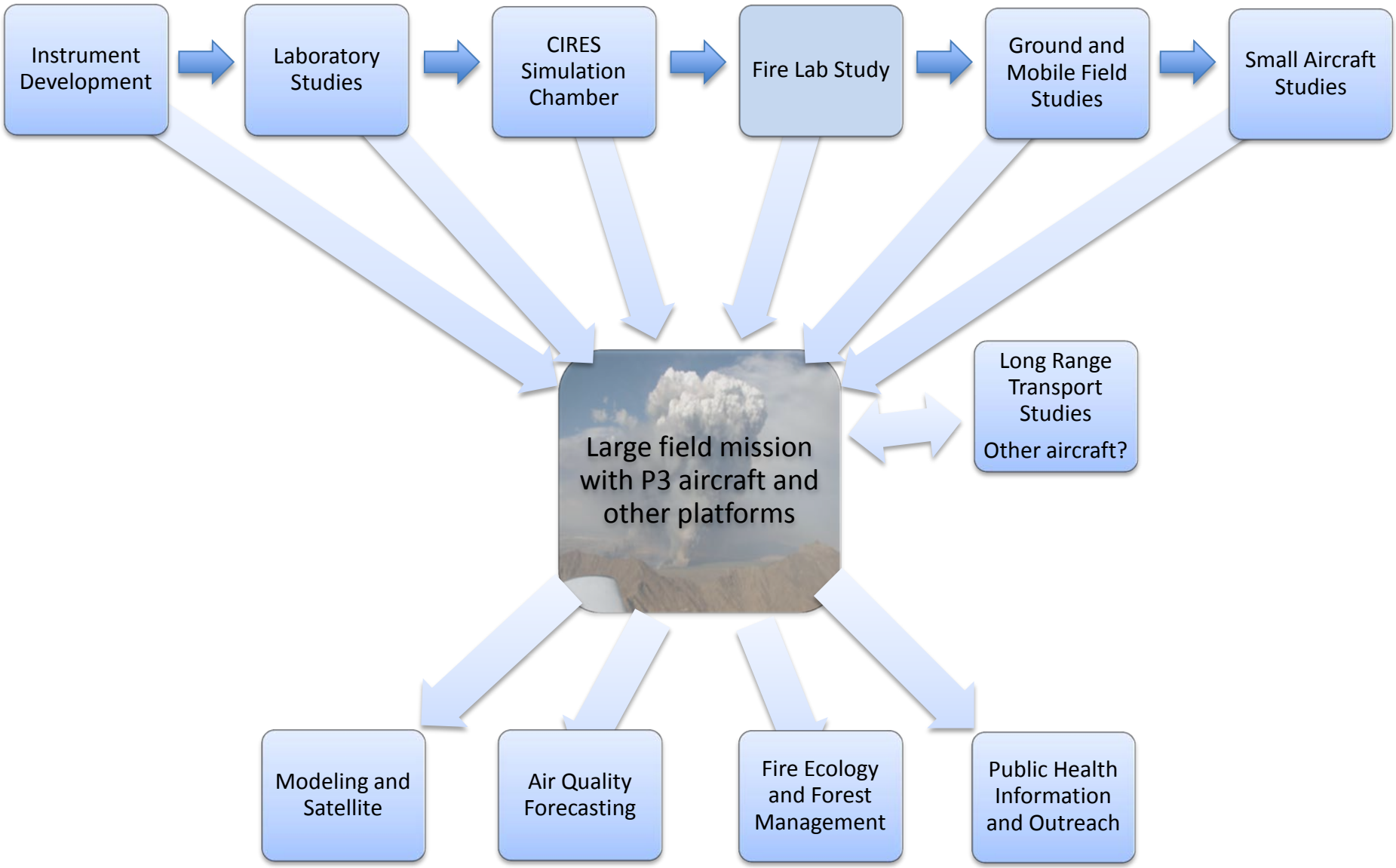
3 years building knowledge before large field campaign

- Digest previous few years of BB observations
- Develop new ideas and approaches
- Next generation of satellites

FIREX Steering Committee

Carsten Warneke, Jim Roberts, Joshua Schwarz, Bob Yokelson

Others to come soon

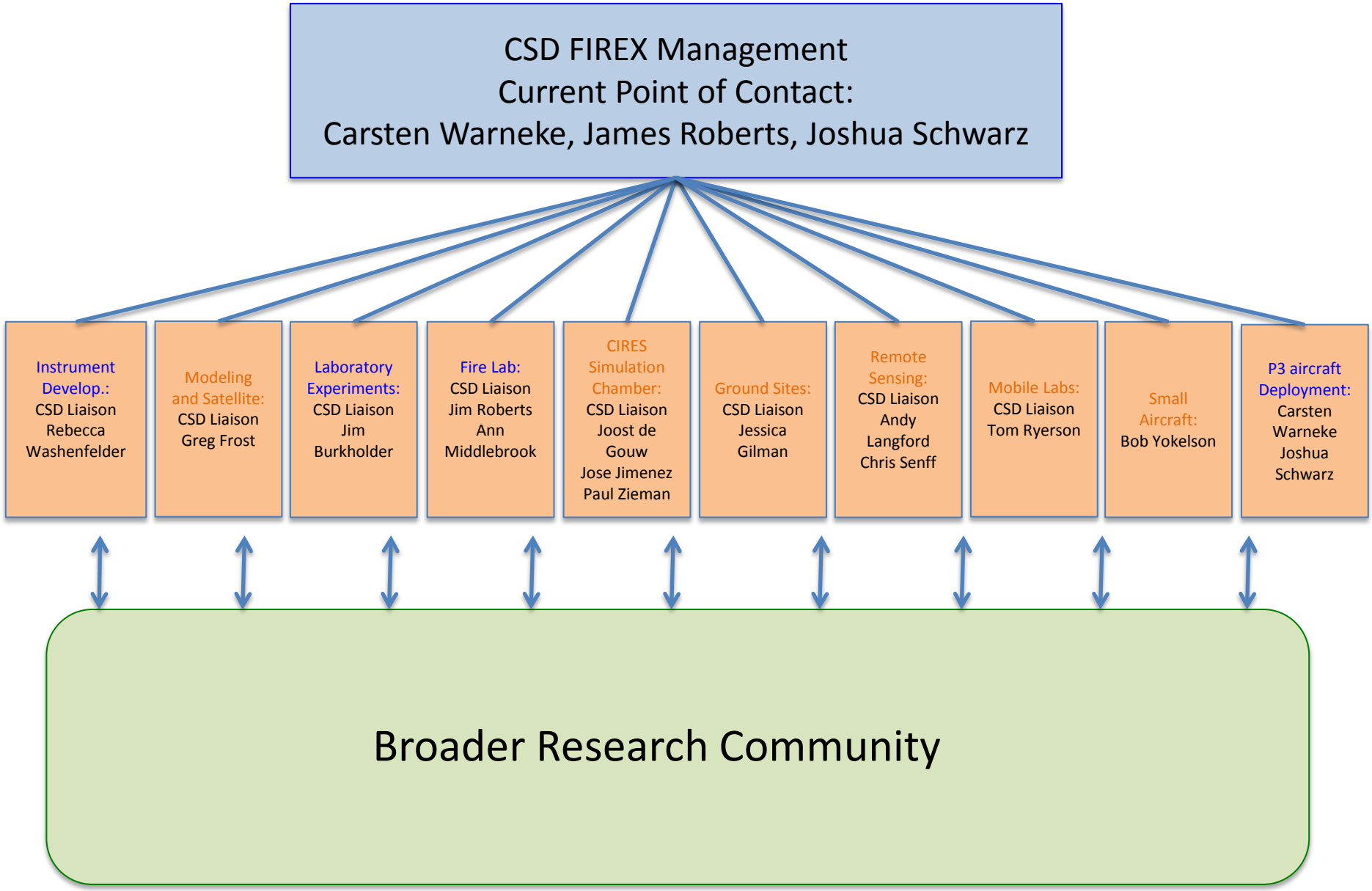


Tentative Timetable

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2015			**SONGNex**				LOI due		AC 4 pro-posals due			
2016				KORUS	AC4 fund decisions				**Fire Lab**			
						ATom						
2017							Storm Peak					
			Chamber Study (TBD)						ONFIRE ??			
	ATom					Small aircraft			ATom			
2018						**NOAA Flights**						
						Storm Peak				FASMEE		
	SOCRATES			ATom		small aircraft/mobile labs						
2019			Chamber Study (TBD)						**Fire Lab**			
		FASMEE					Storm Peak			FASMEE		

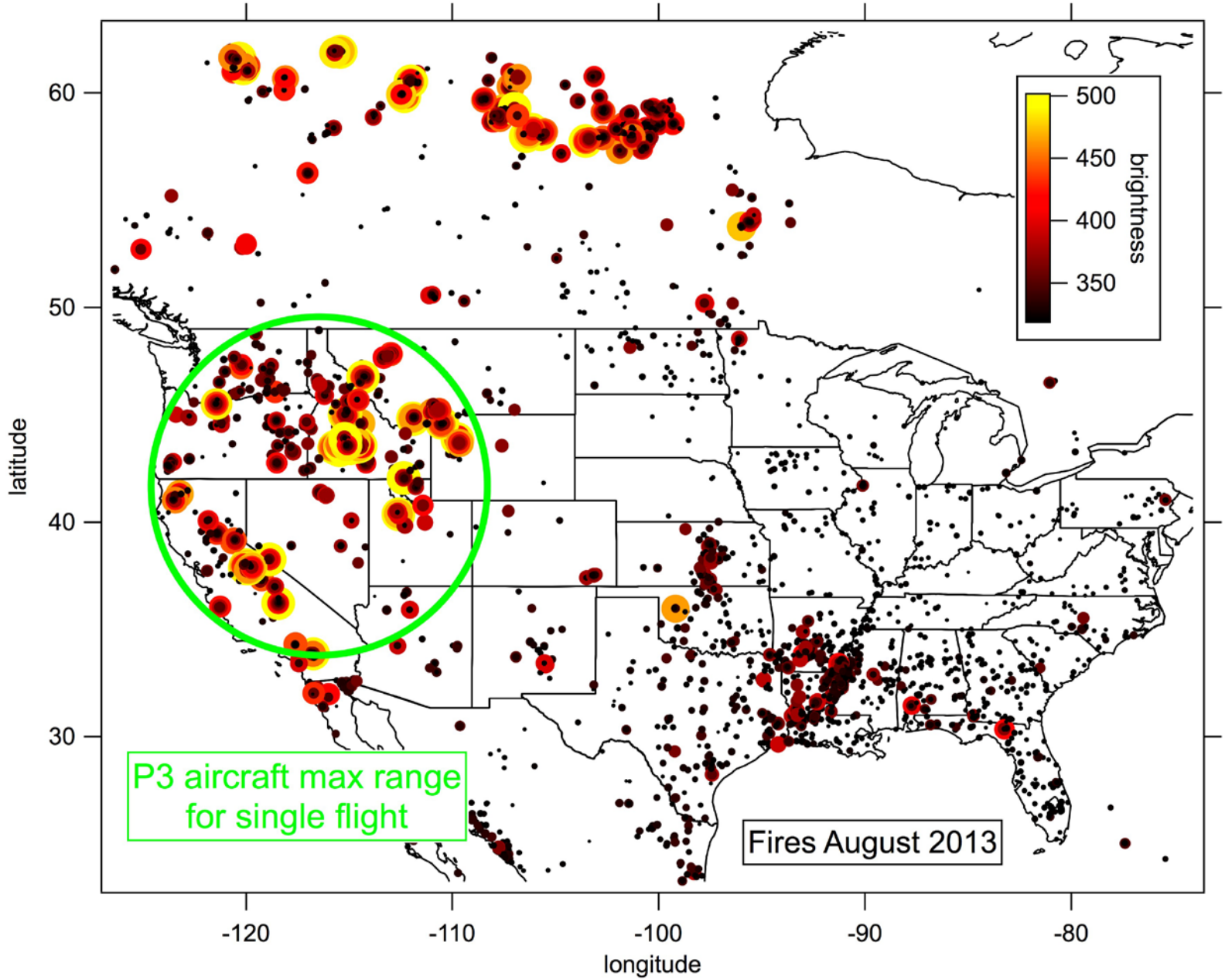
CSD lead

CSD involved

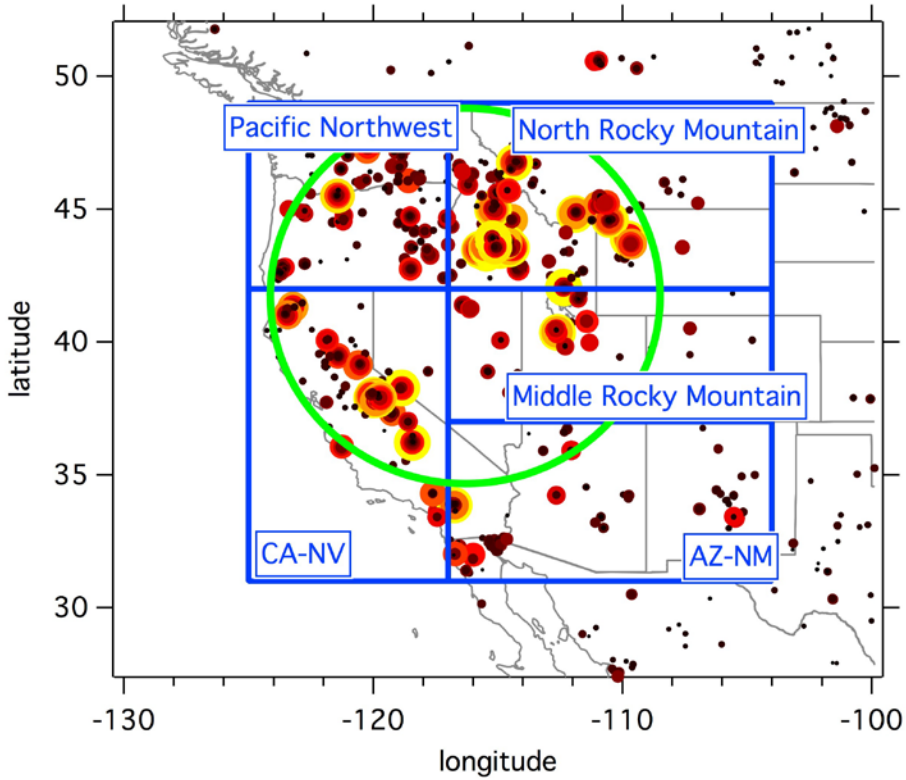


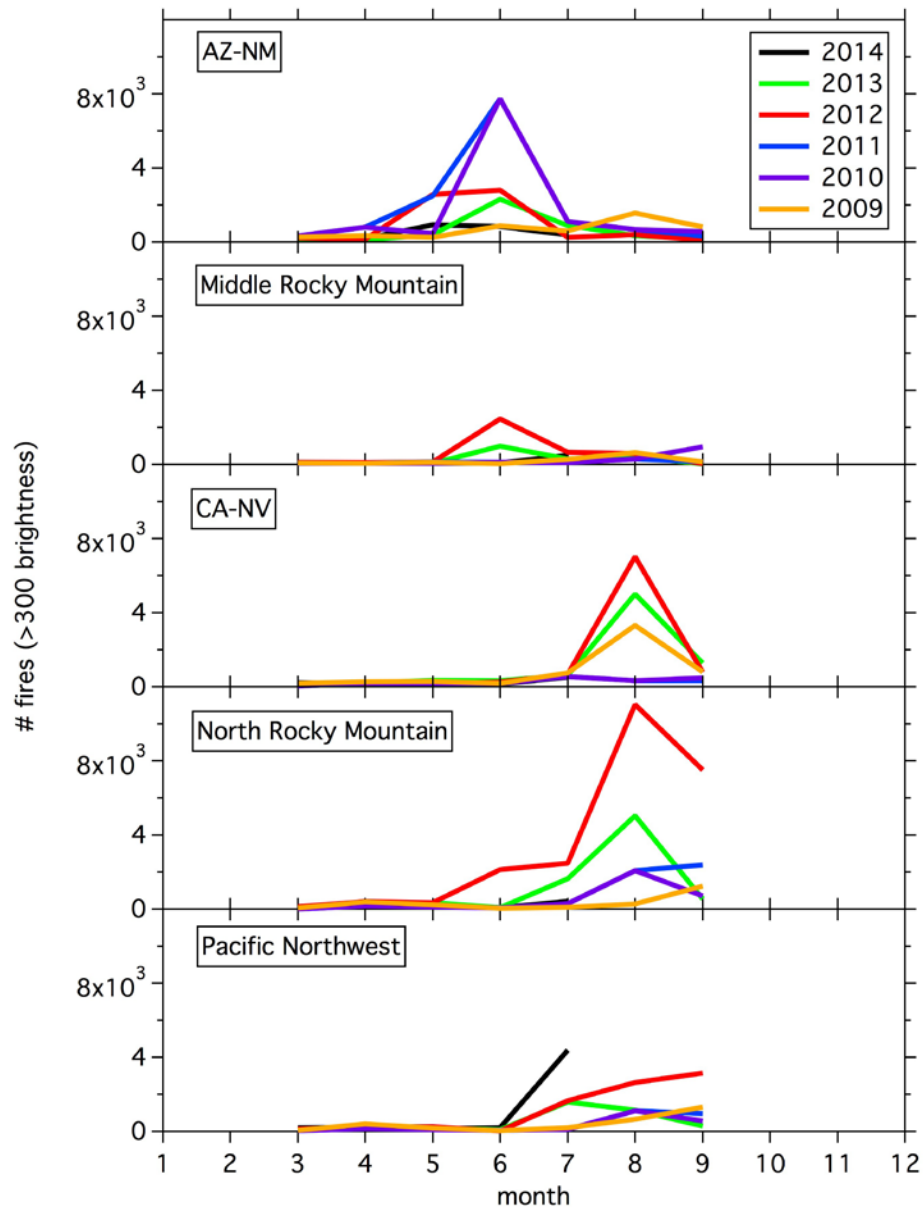
LOI for NOAA AC4 Call to support of FIREX from the research community and coordination with other funding agencies

NOAA WP-3 Aircraft Range in Fire Season



NOAA WP-3 Aircraft Range in Fire Season





Additional Mobile Platforms

- Aircraft:
  - NOAA Twin Otter for 2017, 2018 and 2019
  - DOE G1
  - NSF Wyoming King Air:
  - NASA Remote payloads
- Mobile Labs
  - NOAA CSD
  - Aerodyne
  - NASA
- Unmanned aircraft
  - NOAA
  - Others

Joint Fire Science Program: FASMEE

Fire and Smoke Model Evaluation Experiment (FASMEE)

- Provide observational data necessary to evaluate and advance operationally used fire and smoke modeling systems and their underlying scientific models

- 4-8 large prescribed burns during 2018-2020 (not in fire season)

- Research disciplines: meteorology, fuel and consumption, fire dynamics, plume dynamics, emissions, transport, photochemistry)

- Funding and collaboration opportunity

Tentative Instrument Wish List P3 Gas Phase

Species	Name	Description
Tracer		
CO	carbon monoxide	TBD
CH_4, CO_2	Picarro	CO_2 and methane with IR laser absorption in a high-finesse cavity
SO_2, SO_x	sulfur dioxide	SO_2
N-containing		
$NO/NO_2/NO_y/O_3$	nitrogen oxides and ozone	chemiluminescence detection with photolytic or catalytic conversion
	NOx cavity ringdown absorption spectrometer	$NO_x/NO_y/O_3$ in laser absorption in high-finesse cavities
HNO_3 CIMS	HNO_3 Chemical Ionization Mass Spectrometer	nitric acid using chemical ionization mass spectrometery with SiF_5^- as reagent ion
HNO_3		I-CIMS
NH_3 CIMS	NH_3 Chemical Ionization Mass Spectrometer	Ammonia using chemical ionization mass spectrometry with the protonated acetone dimer as reagent ion
NH_3		Picarro
PAN CIMS	PeroxyAcyl Nitrate Chemical Ionization Mass Spectrometer	PANs using chemical ionization mass spectrometry with I^- as reagent ion
NO_3, N_2O_5	NOx cavity ringdown absorption spectrometer	NO_3, N_2O_5 in laser absorption in high-finesse cavities
N_2O		Los Gatos
VOCs		
ethane	ethane	Aerodyne ethane analyzer
HCHO	Laser Induced Fluorescence	formaldehyde (HCHO)
HVOCs	Highly volatile organic compounds	iWAS: hydrocarbons, alkyl nitrates and halocarbons using canister samples for immediate GC-MS analysis
VOCs	H_3O+ CIMS: volatile organic compounds	various VOCs using chemical ionization mass spectrometer using H_3O^+ as reagent ion
VOCs	Airborne Cavity Enhanced Spectrometer	Glyoxal using Cavity Enhanced Absorption Spectroscopy
LVOCs	Low volatility organic compounds	I-CIMS: organic and inorganic acids using chemical ionization mass spectrometry with acetate as reagent ion
LVOCs	Adsorbent Sampler	Adsorbent cartridge sampling for large hydrocarbons
ELVOCs	Extreme low volatility organic compounds	Nitrate ion CIMS: highly oxygenated, extremely low volatility using CIMS with nitrate ions
Hydroperoxides	Hydroperoxides	Gas-Phase Hydroperoxides by Chemical Ionization Mass Spectrometry with CF_3O^-
OH, HO_2, H_2SO_4	hydroxyl (OH) and hydroperoxyl (HO_2) radicals	CIMS (or LIF)
Remote Sensing		
LIDAR		
DOAS	NO_2, HONO, HCHO, O_3, SO_2	20km ahead of the aircraft
Zaphrod	Spectral radiometer	

Tentative Instrument Wish List P3 Aerosol

Species	Name	Description
Aerosol		
inlet	Aerosol inlet	Low-turbulence inlet
composition	Fine mode composition	(High-resolution) AMS
BC	Black carbon MMR, microphysical state	Single Particle Soot Photometer (SP2)
Absorption, extinction	Aerosol optical properties	CRD-AES and PAS, multiple wavelengths, denuded absorption and humidified extinction
distributions	Size distributions	NMASS/UHSAS/WLOPC/POPS
clouds	Cloud probes	CDP et al
	Morphology	Filter based sampling/microscopy
optical properties	Aerosol optics	UV BB-CES
absorption	Aerosol absorption	Photo-thermal interferometer
WSOC	Water-soluble OC	Particle-in-liquid sampling
absorption	Aerosol absorption	CLAP/PSAP
OC/EC	OC/EC	Filter based collection
IC	Ice nucleation	IN chamber, potential speciation of IN residudal via SP2 or PALMS
CCN	Water activity	CCN/DASH-SP/Humidified Nephelometer
BrC	Brown carbon absorption	Filter based sampling and absorption spectrometry
composition	Reactive oxygen species	Filter/PILS based coupled with x-ray florescence
extinction	Ambient total extinction	Open path extinction
phase function	(uv phase function)	(uv imaging nephelometer)
phase function	Aerosol polarized phase function	3-wl imaging polarized nephelometer

Instrument Wish List Firelab Gas Phase

Species	Name	Description
GAS PHASE SPECIES		
CO, CO_2, CH_4, $HCHO$, NO, NO_2, NH_3, HCN, $HONO$, etc.	OP-FTIR	Open path FTIR spectrometer, situated at the top of the stack. Can also sample room burns.
Total Fixed Nitrogen	N_y	Catalytic conversion of all N-containing species (except N_2 and N_2O)
Amines, Amides?	CIMS	Acetone-dimer CIMS
VOCs	H_3O^+ CIMS	Various VOCs using chemical ionization mass spectrometer using H_3O^+ as reagent ion
VOCs	GC/MS	Gas chromatograph/Mass spectrometer, direct or canister sampling
VOCs	PTR-QiTOF	Proton Transfer, Hi Res Time of Flight Mass Spec
VOC/LVOC	Gas/Particle Sampling	GCxGC-HRTOFMS including both Electron Impact (EI) ionization and softer vacuum ultraviolet (VUV) ionization
VOC/LVOC	Cartridge	Cartridge sampling with HR-2D-GC, and GC/MS
LVOC/ELVOC		GC/MS, UPLC/DAD-ESI-QToFMS, ACSM, and FIGEARO-CIMS
I/SVOC	Cartridge	GCXGC/TOF-MS (EI) and LC/MC
AEROSOL MEASURMENTS		
Fine Mode Composition	ToF AMS	Aerosol mass spectrometer with time-of-flight MS
Ice Nuclei	IN	Ice nuclei condensation counter
Black Carbon	SP2	Single Particle Soot Photometer (SP2)
Black Carbon/Brown Carbon	Intercomparison	Numerous Methods
Brown Carbon Absorption	PiLS UV spec	PiLS sampler with long path liquid phase UV-vis absorption spectrometer
BC/BrC/Optical Prop	SP-AMS CAPS-SSA CRD/PAS	Soot particle Aerosol Mass Spectrometer Cavity Attenuated Phase-Shift, Single Scattering Albedo Cavity Ring Down Photoacoustic Spectrometer
Aerosol Chem/Optics	Nephelometry	?
Aerosol Optical Properties	?	?some kind of multi wavelength /polarizing neph, with Dan Murphy still?
Aerosol Chemistry	Filters	General availability
SMOKE PROCESSING & MODELING		
Potential Aerosol Mass	PAM	Measure of changes in aerosol mass, chemistry and other properties in a flow reactor at high reactant (e.g. OH) concentrations
SOA Formation	Model	Plume modules for large models
Ozone, SOA Formation	Dual chamber	Mobile dual (paired) chamber facility

Tentative Instrument Wish List Twin Otter

Species	Name	Description
Tracer		
CO	carbon monoxide	TBD
CH_4, CO_2	Picarro	CO_2 and methane with IR laser absorption in a high-finesse cavity
$NO/NO_2/NO_y/O_3$	NOx cavity ringdown absorption spectrometer	$NO_x/NO_y/O_3$ in laser absorption in high-finesse cavities
VOCs		
VOCs	H_3O+ Chemical Ionization Mass Spectrometer	various VOCs using chemical ionization mass spectrometer using H_3O^+ as reagent ion
LVOCs	Low volatility organic compounds	I-CIMS: organic and inorganic acids using chemical ionization mass spectrometry with acetate as reagent ion
Aerosol		
composition	Fine mode composition	High-resolution AMS

NOAA Twin Otter Options: 2017, 2018 and 2019

- 2017 first test flights after fire lab and CIRES chamber
- 2018 together with P3 (need partners!)
- FASMEE in 2019

QUESTIONS!