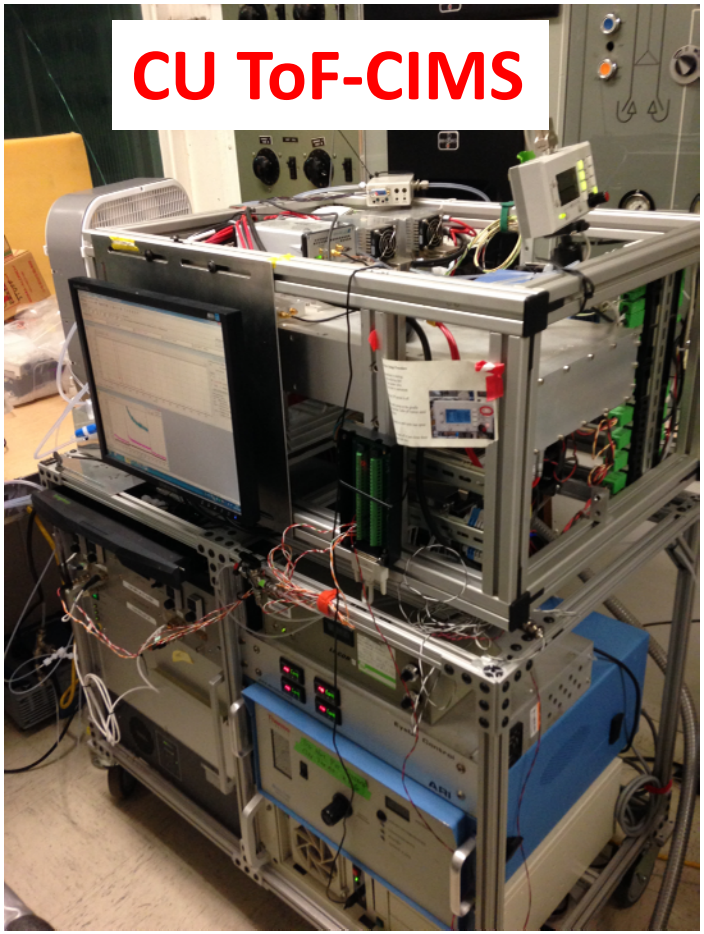
Emissions and chemistry of biomass burning: I^- ToF-CIMS during the FireLab 2016 campaign



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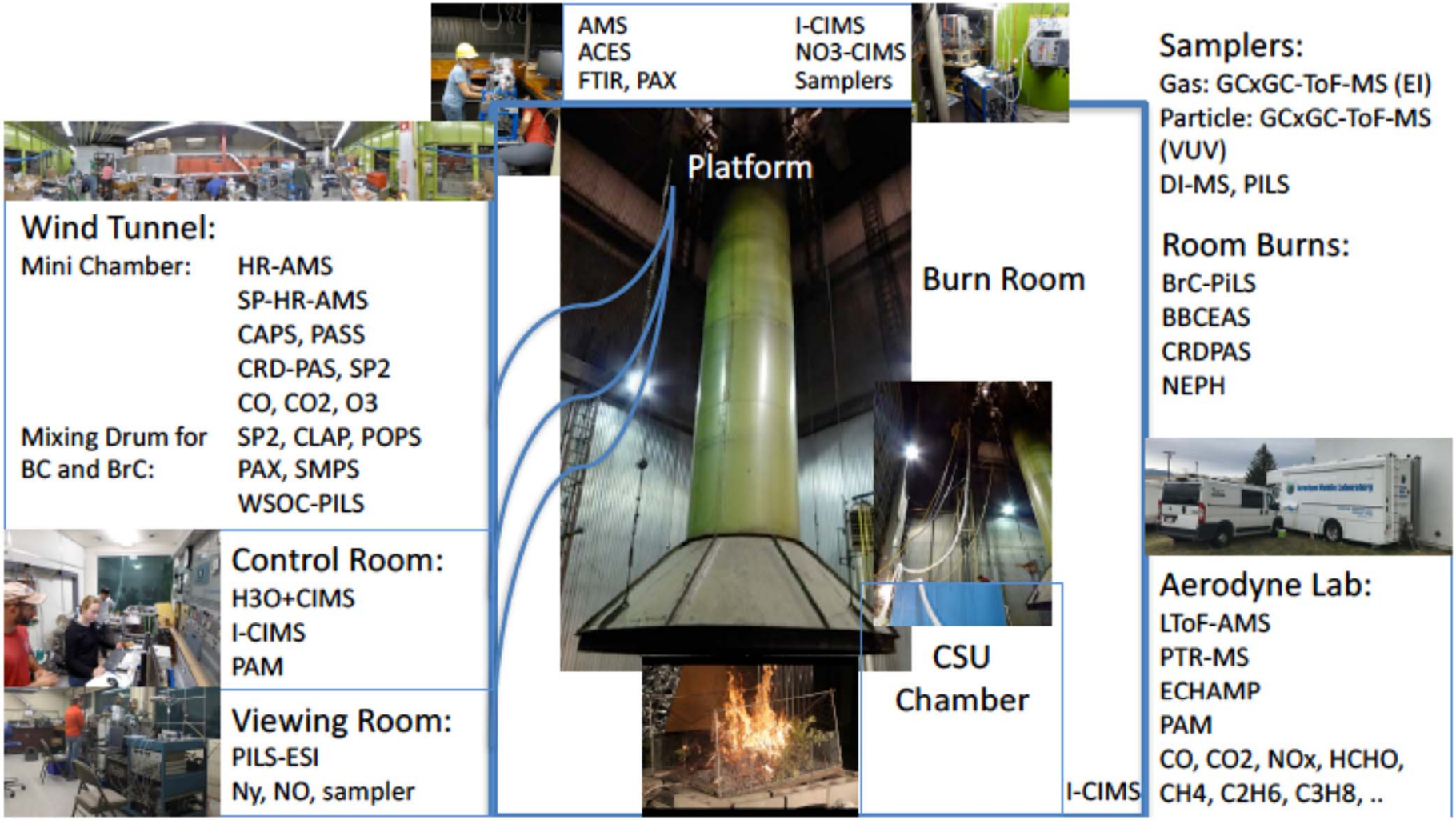
Aerodyne User Meeting in Beijing
May, 2017

Outline

- ❑ **FireLab 2016 campaign**
- ❑ **Iodide CIMS results**
- ❑ **Inter-comparison with other instruments**

FireLab 2016



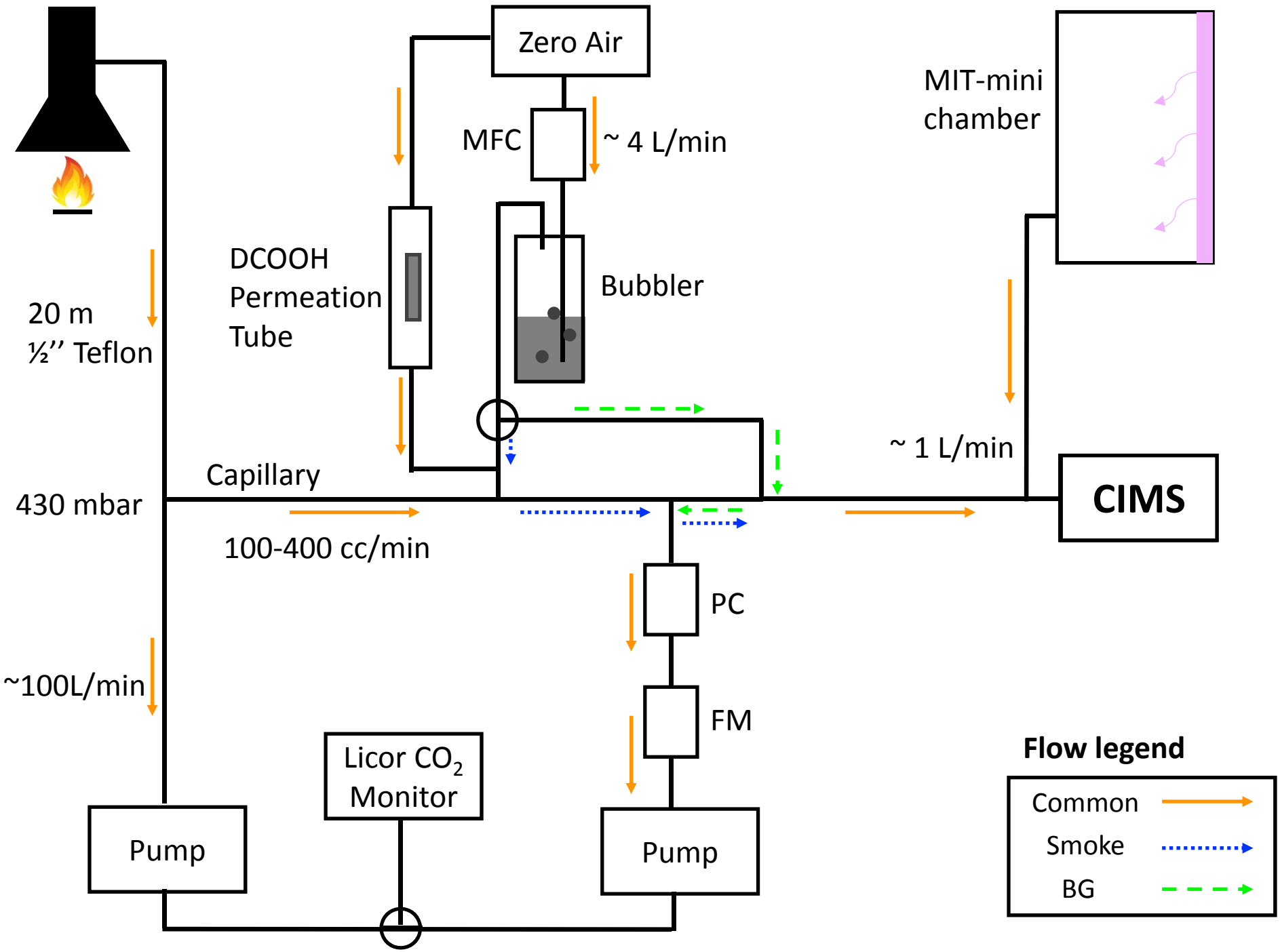
Iodide ToF-CIMS

$$I^- + X \text{ ----------> } IX^-$$

Inorganic acids: HONO, HNCO, HNO_3, HCl

Organic species:

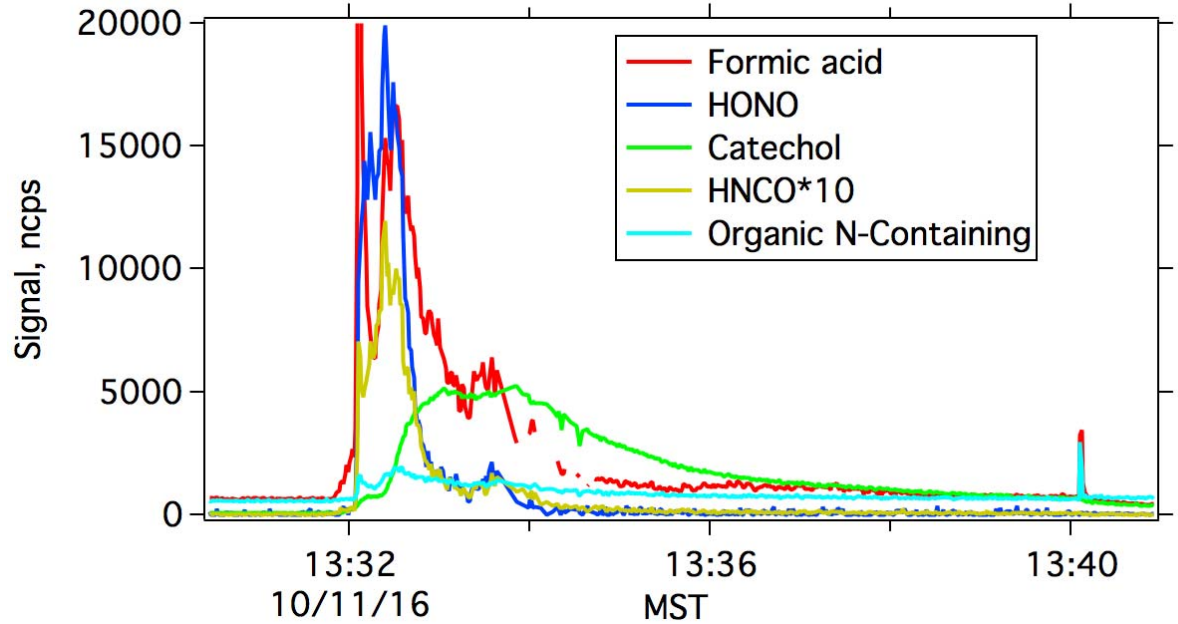
- **Oxygenated VOCs (≥2 O)**
- **Organic nitrates (and nitro compounds)**


Zero Air
MFC
~ 4 L/min
MIT-mini
chamber
DCOOH
Permeation
Tube
Bubbler
20 m
½'' Teflon
~ 1 L/min
Capillary
430 mbar
CIMS
100-400 cc/min
PC
~100L/min
FM
Licor CO_2
Monitor
Pump
Pump
Flow legend
Common
Smoke
BG

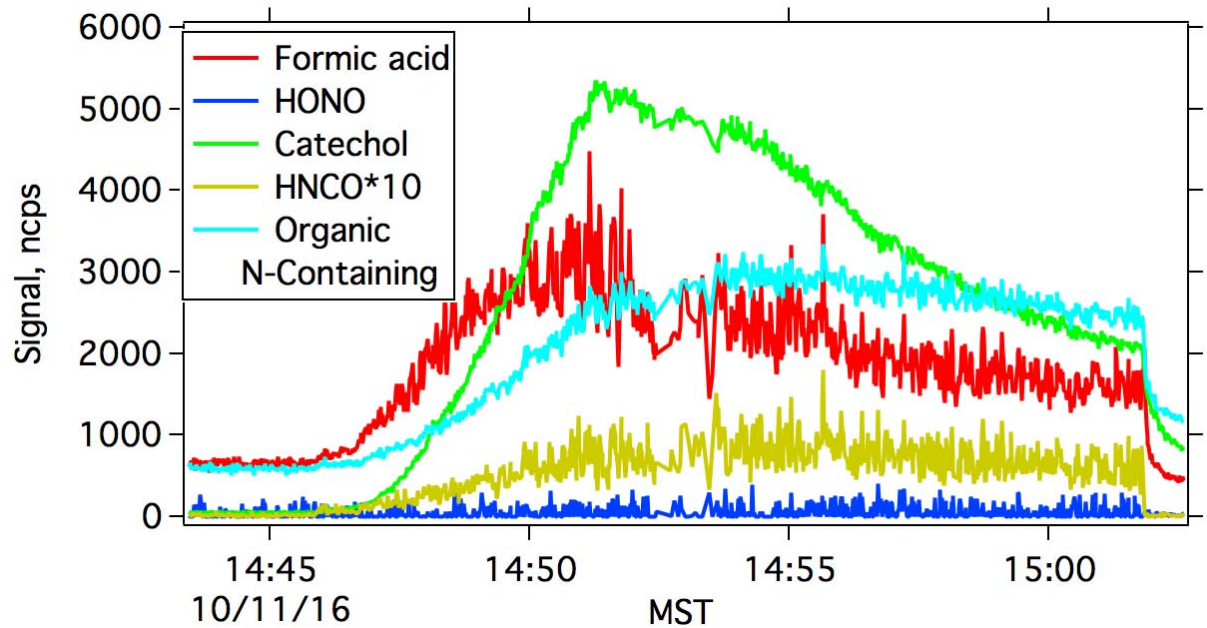
Engelmann Spruce

Flaming → Smoldering

Fire25: Canopy
Mainly Flaming
MCE=0.953
med-N fuel



Fire26: Duff
Smoldering
MCE=0.818
high-N fuel

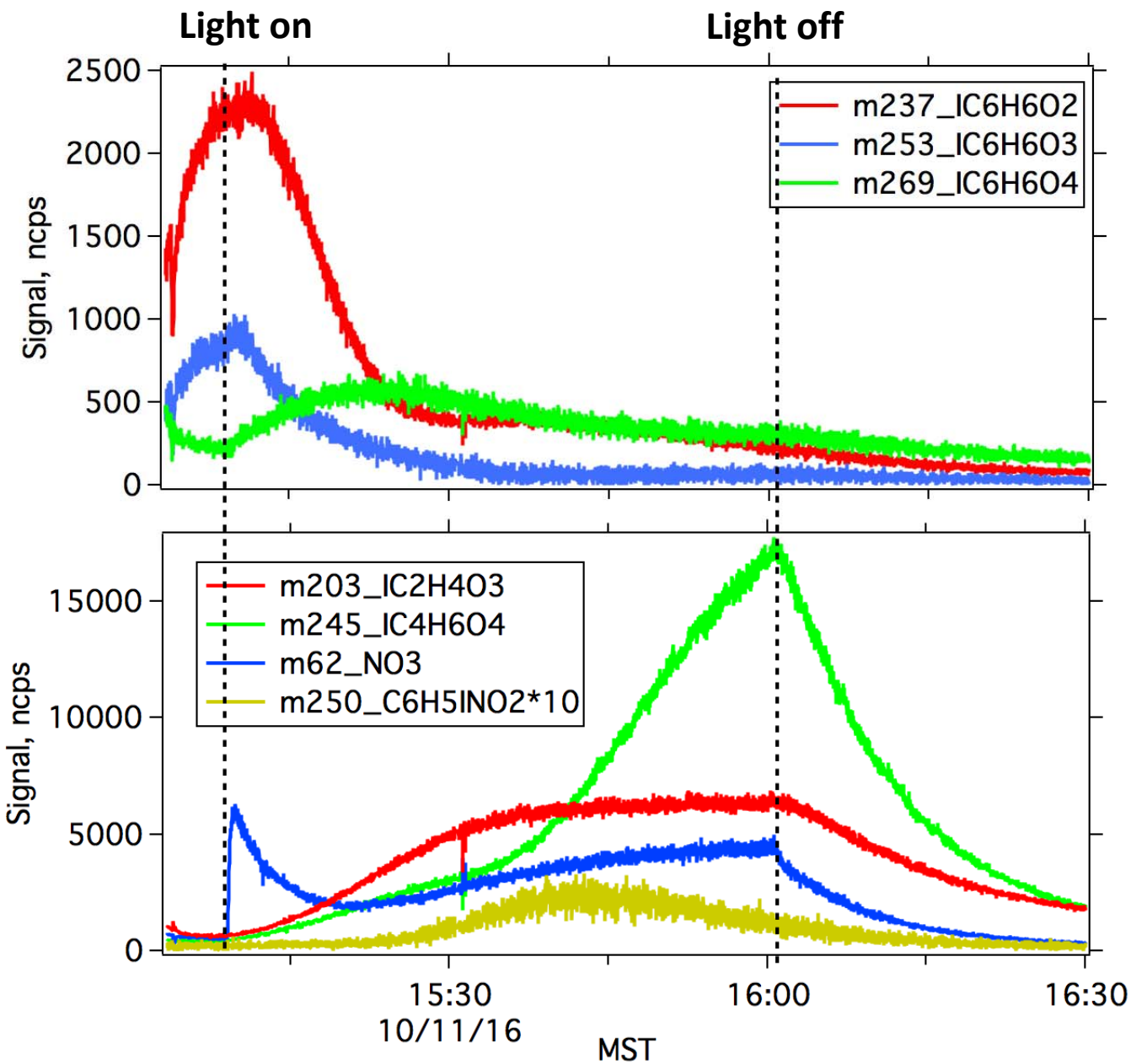


	Fire25: Canopy		Fire26: Duff	
1	M173 ICH2O2	Formic acid	M237 IC6H6O2	Catechol
2	M237 IC6H6O2	Catechol	M173 ICH2O2	Formic acid
3	M174 IHNO2	HONO	M251 IC7H8O2	Guaiacol/MethylCatechol
4	M217 IC3H6O3	Lactic acid	M253 IC6H6O3	Trihydroxylbenzene
5	M251 IC7H8O2	Guaiacol/Methylcatechol	M265 IC8H10O2	Dimethoxybenzene
6	M253 IC6H6O3	Trihydroxylbenzene	M259 IC5H8O4	Glutaric acid
7	M259 IC5H8O4	Glutaric acid	M252 C6H7INO2	??
8	M243 IC5H8O3	Levulinic acid	M187 IC2H4O2	Acetic acid
9	M203 IC2H4O3	Glycolic acid	M271 IC6H8O4	Dimethyl Maleate
10	M263 IC8H8O2	Phenylacetic acid	M219 C3H8O3	Glycerol
11	M229 IC4H6O3	Ketobutyric acid	M222 C5H5INO	Pyridone??
12	M187 IC2H4O2	Acetic acid	M229 IC4H6O3	Ketobutryric acid
13	M241 IC5H6O3	Dihydro-furancarboxylic acid	M243 IC5H8O3	Levulinic acid
14	M271 IC6H8O4	Dimethyl maleate	M203 IC2H4O3	Glycolic acid
15	M265 IC8H10O2	Dimethoxybenzene	M273 IC6H10O4	Adipic acid
16	M249 IC7H6O2	Benzoic acid	M279 IC8H8O3	Vanillin
17	M219 IC3H8O3	Glycerol	M241 IC5H6O3	Dihydro-furancarboxylic acid
18	M227 IC4H4O3	Hydroxy-furanone	M251 IC8H12O	Tetramethylfuran
19	M215 IC3H4O3	Pyruvic acid	M92 C2H4O4	Oxalic acid
20	M239 IC5H4O3	Furoic acid	M154 IHCN	HCN

Aromatics Furans Simple organic acids N-Containing Inorganic

Fire26: Engelmann Spruce -Duff

MIT Mini-Chamber

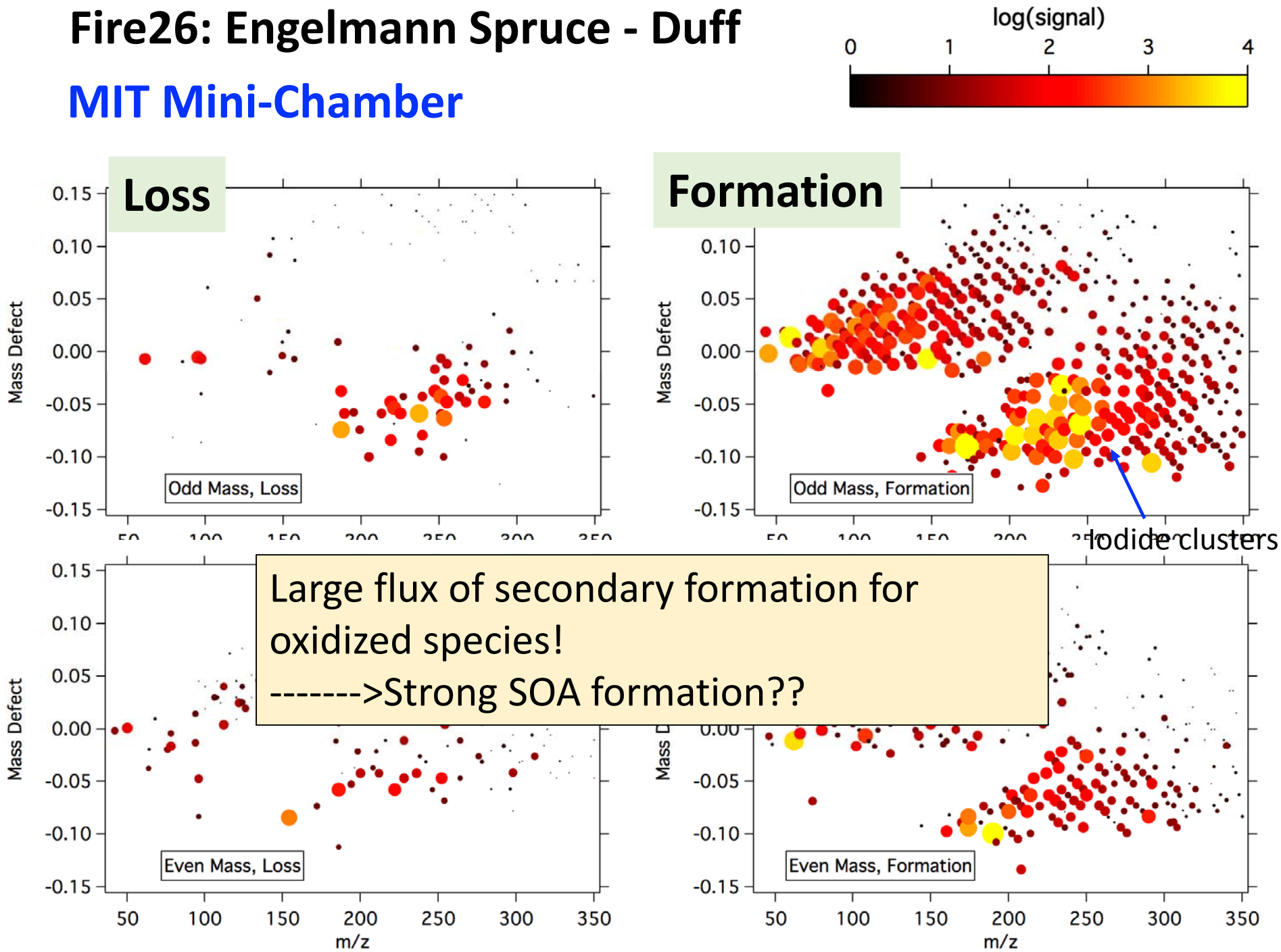


Catechol
Trihydroxylbenzene
Tetrahydroxylbenzene

Glycolic acid
Succinic acid
NO_3^- fragment
Nitrobenzene

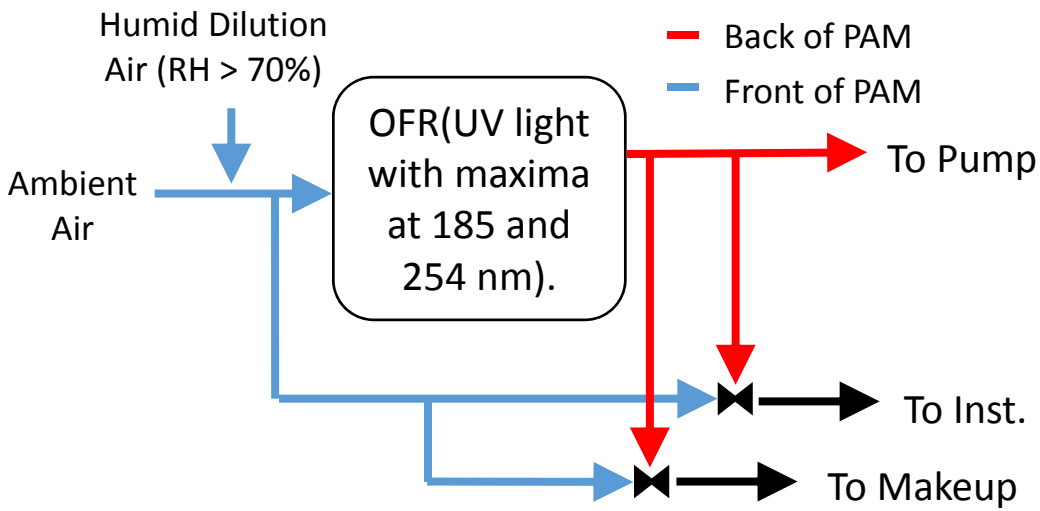
Fire26: Engelmann Spruce - Duff

MIT Mini-Chamber



Large flux of secondary formation for oxidized species!
------->Strong SOA formation??

Oxidation Flow Reactor (OFR)



- Ages smoke in real-time
- OH exposure is fixed
- Investigation of smoke chemistry as a function of burn stage (e.g., flaming vs. smoldering)

OFR OH Generation

$H_2O + h\nu_{185} \rightarrow OH + H$

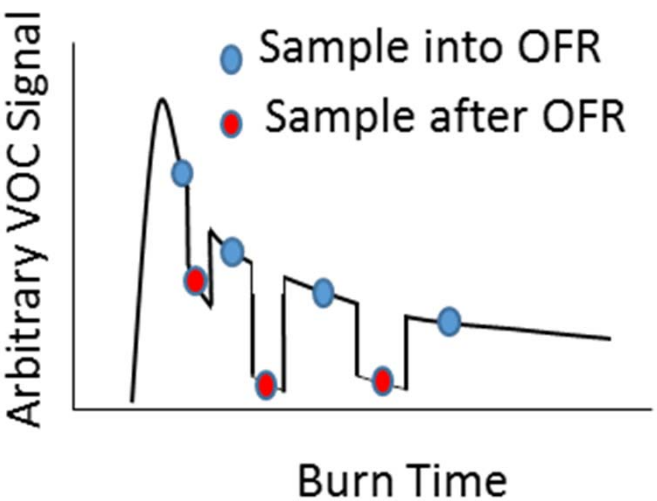
$O(^3P) + O_2 + M \rightarrow O_3$

$H + O_2 \rightarrow HO_2$

$O_3 + h\nu_{254} \rightarrow O(^1D) + O_2$

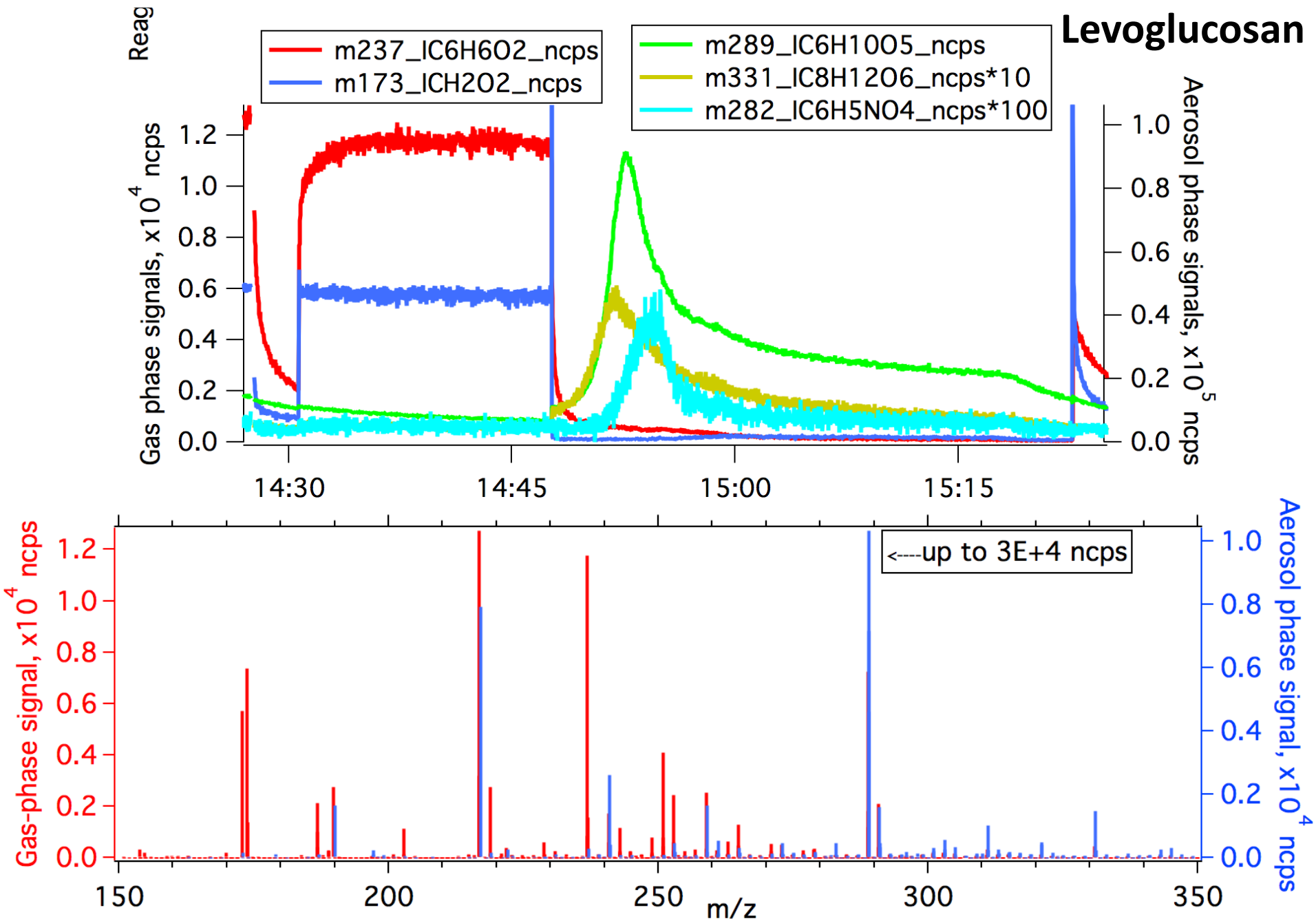
$O_2 + h\nu_{185} \rightarrow 2O(^3P)$

$O(^1D) + H_2O \rightarrow 2OH$

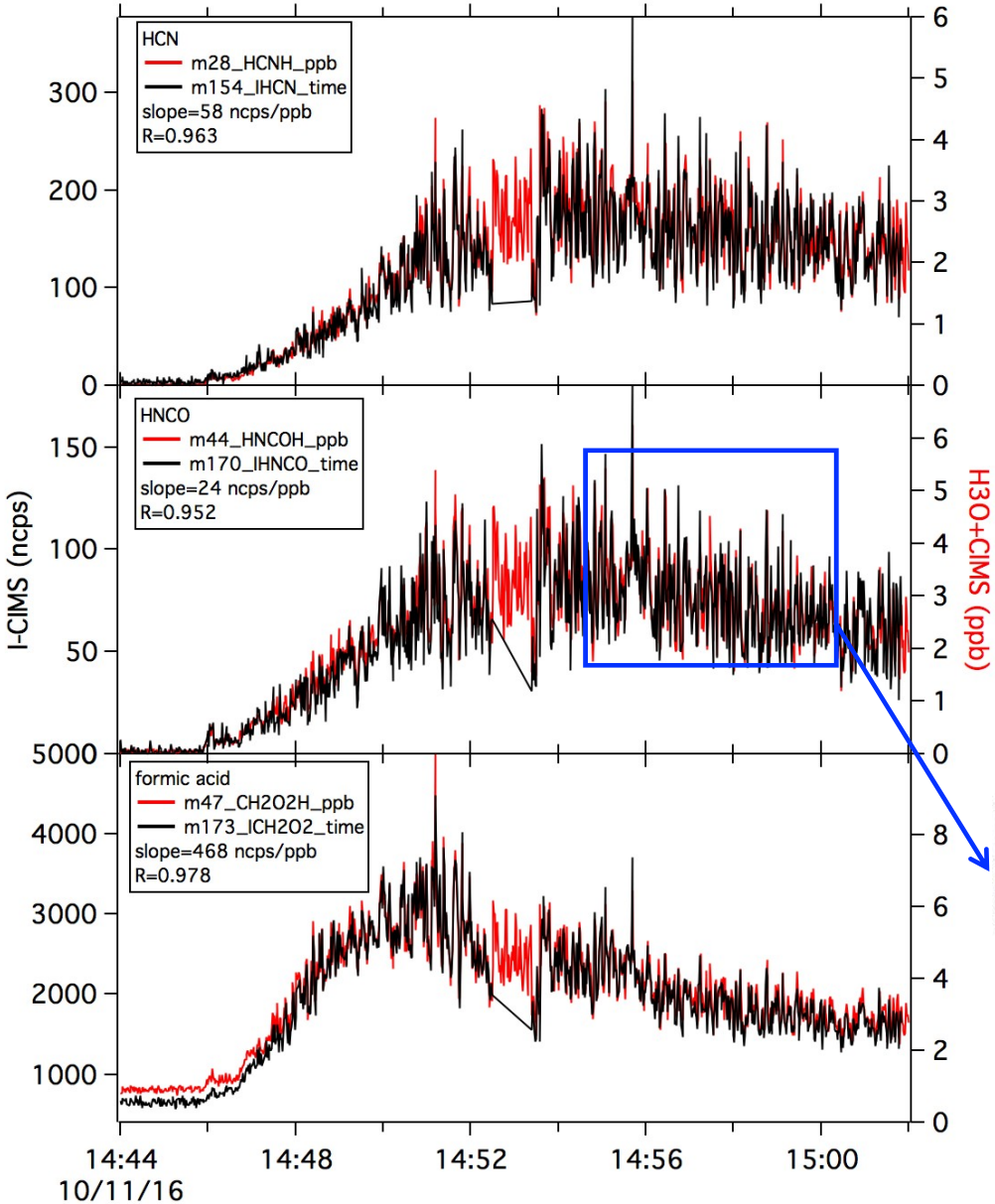


*Leaded by Matt Coggon

Iodide ToF-CIMS + FIGAERO

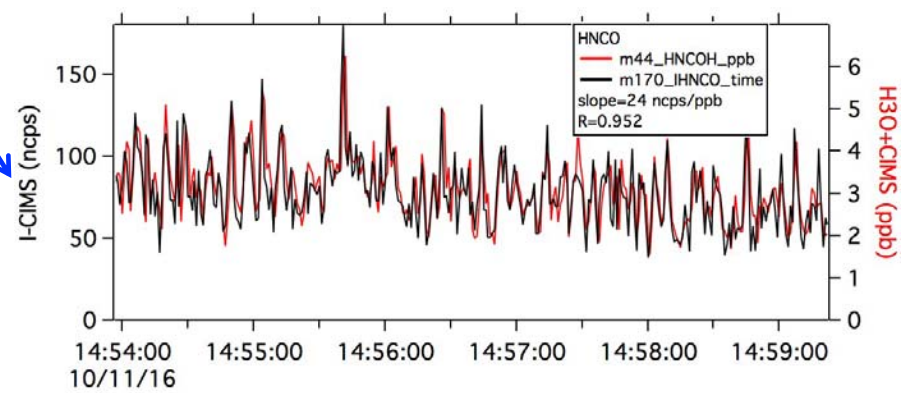


Fire26: Engelmann Spruce- Duff

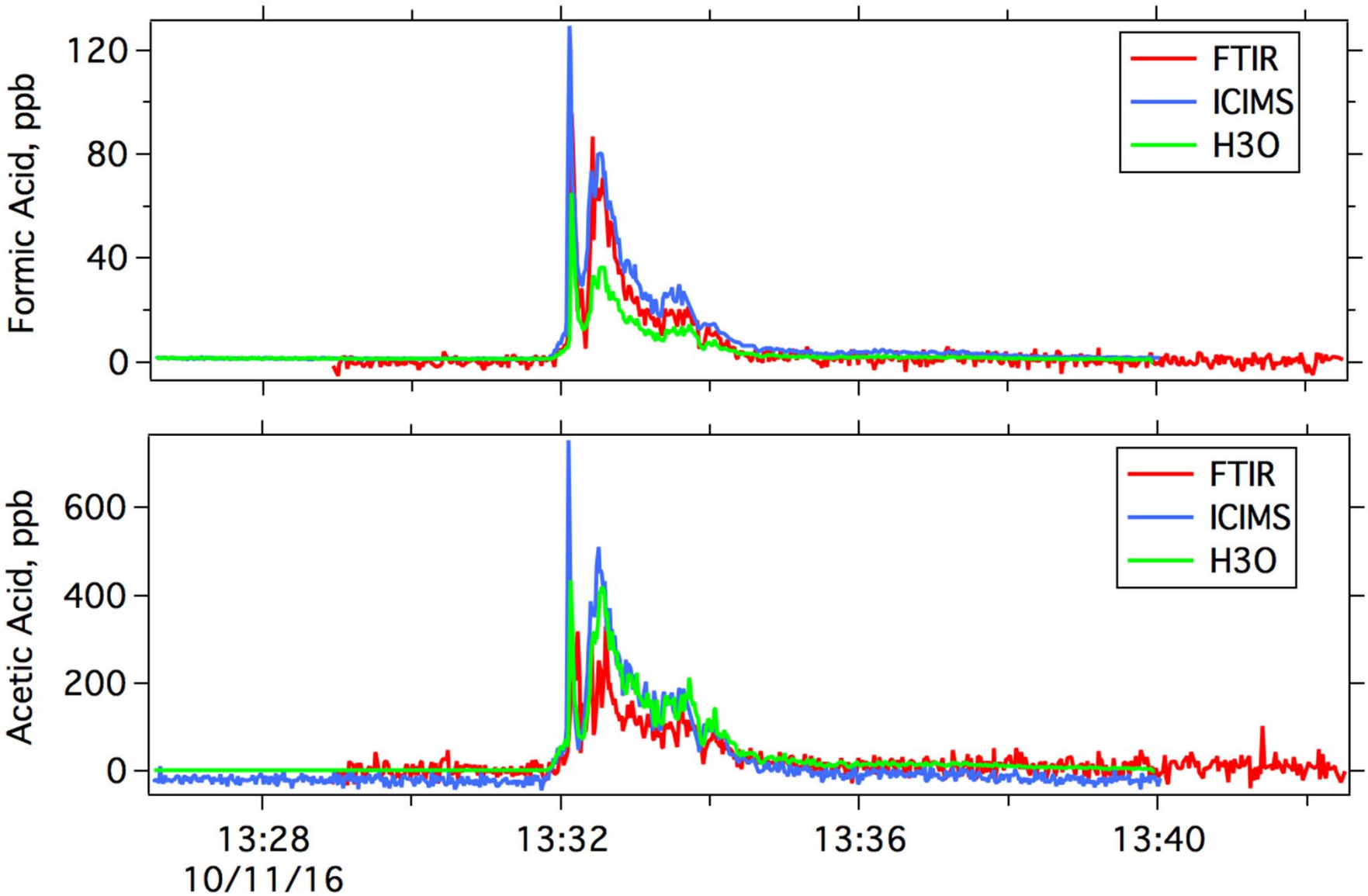


Inter-comparison between H_3O^+ CIMS (i.e. PTR-TOF) and I^- CIMS

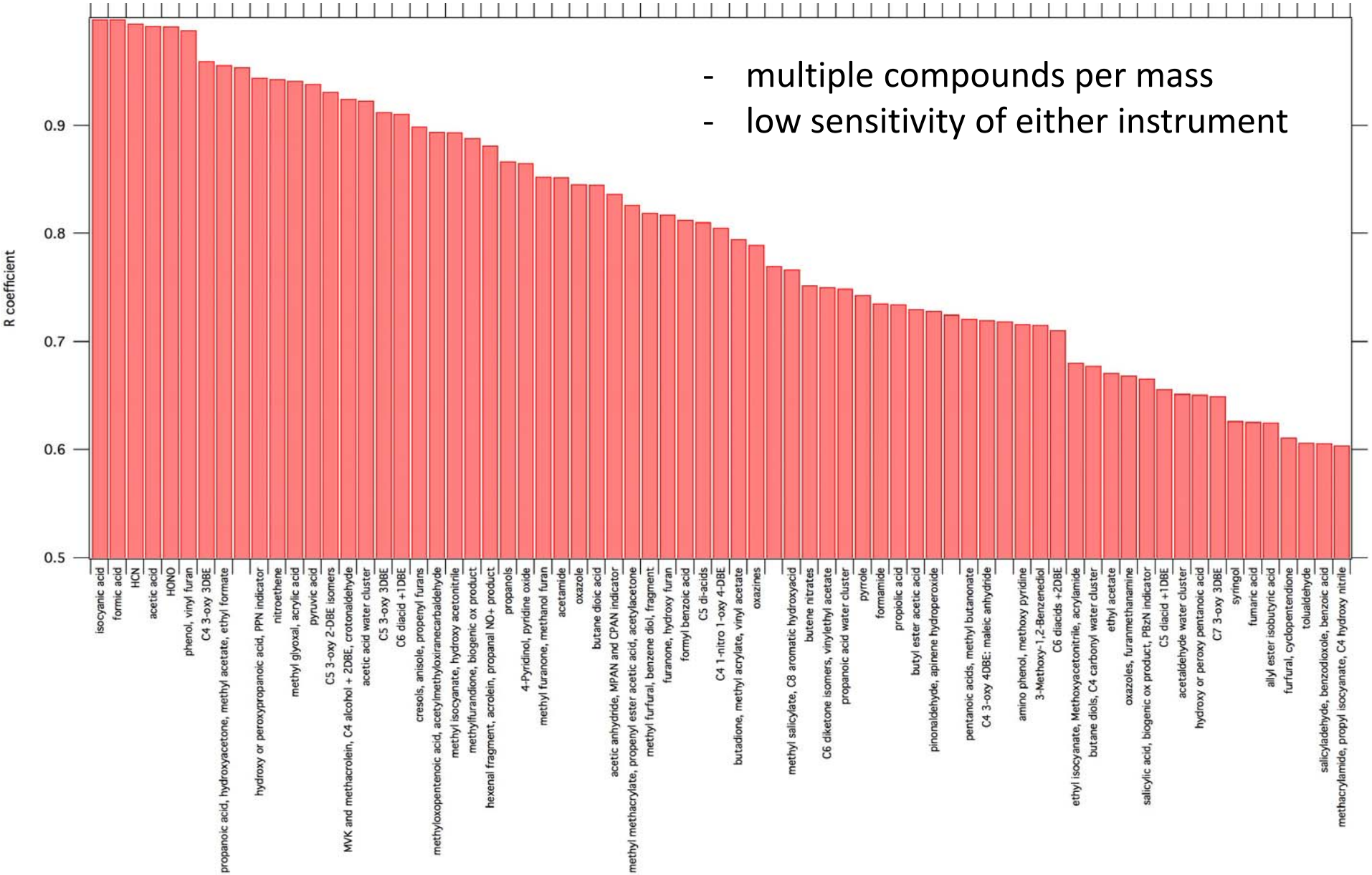
- High variability burn
- Good agreement



Inter-comparison for Fire 25

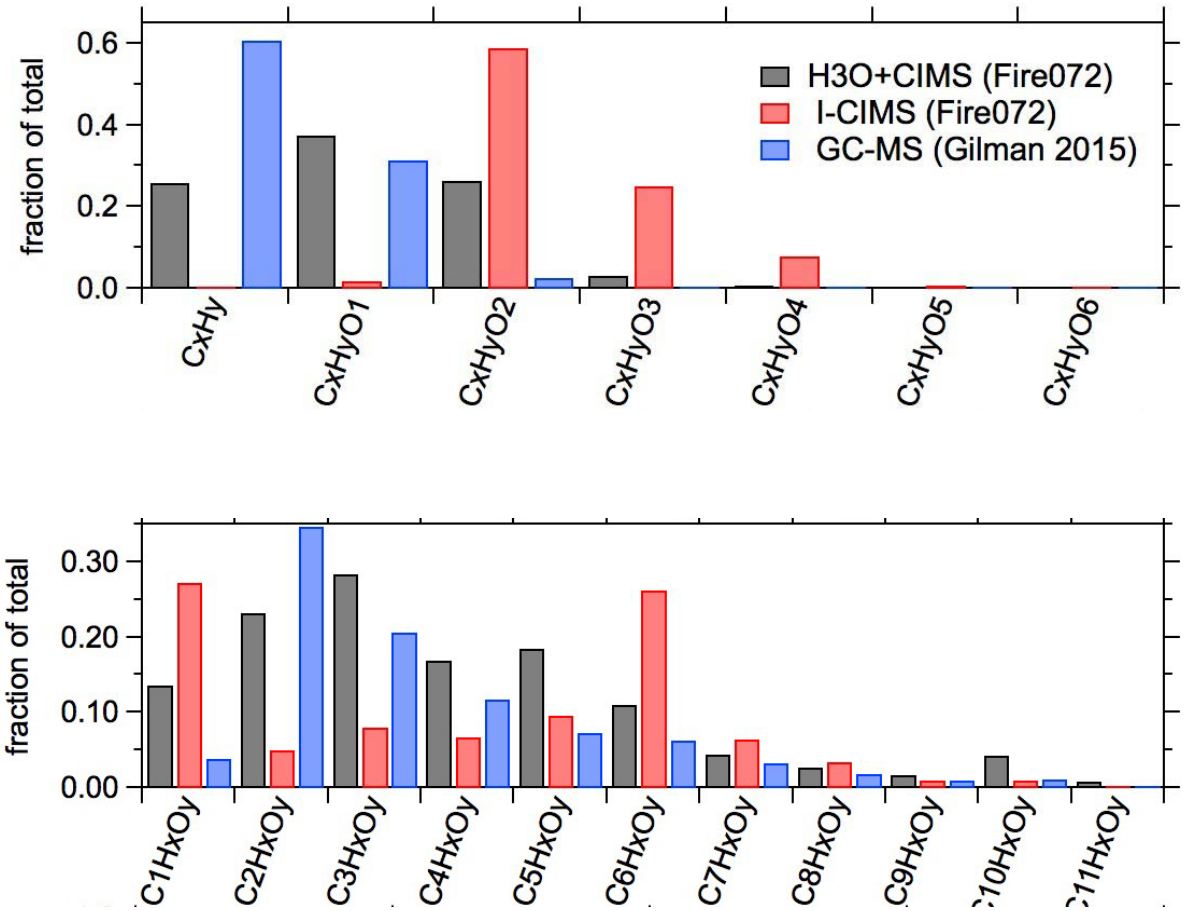


I-CIMS vs H_3O^+ CIMS



- multiple compounds per mass
- low sensitivity of either instrument

GC-MS, H_3O^+ CIMS and I^- CIMS



Fraction of signal from each instrument

GC-MS

- ❑ Signal dominated by hydrocarbons and O1

H3O+CIMS (i.e. PTR-TOF)

- ❑ HC, O1, O2 dominant

I-CIMS

- ❑ No hydrocarbons, most signal >O2
- ❑ Oxygenated aromatics are important

- Three instruments measure different compounds/classes with some overlap

Summary

- VOC emissions from biomass burning depend on the types of fuels, combustion efficiency and fuel compositions;
- I- CIMS indicates a large flux of oxygenated VOCs from the aging of biomass burning plumes;
- Different VOC instruments may be measuring different classes of compounds;

Acknowledgement

NOAA ESRL CSD

Carsten Warneke, Jim Roberts, Matt Coggon, Abby Koss, Joost de Gouw

University of Colorado Boulder

Jordan Krechmer, Hyungu Kang, Harald Stark, Jose Jimenez

Massachusetts Institute of Technology

Christopher Lim, Jesse Kroll

University of Montana

Vanessa Salimovic, Robert Yokelson