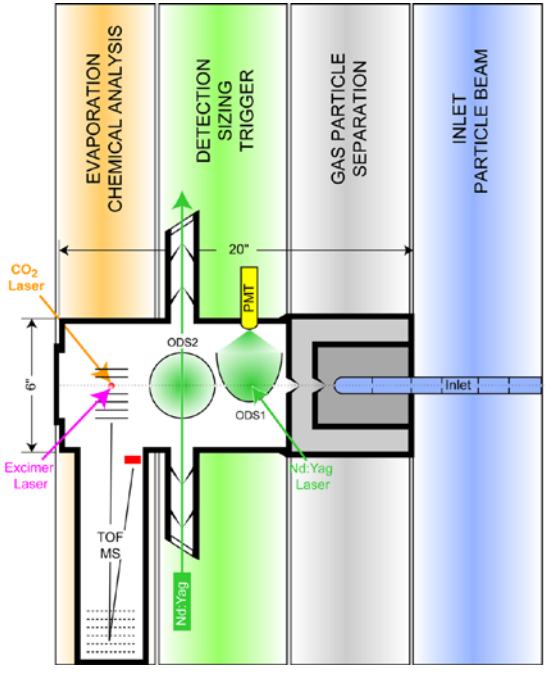
miniSPLAT
at TCAP and TCAP II

Measurements by
Single Particle Mass Spectrometer

Pacific Northwest
NATIONAL LABORATORY

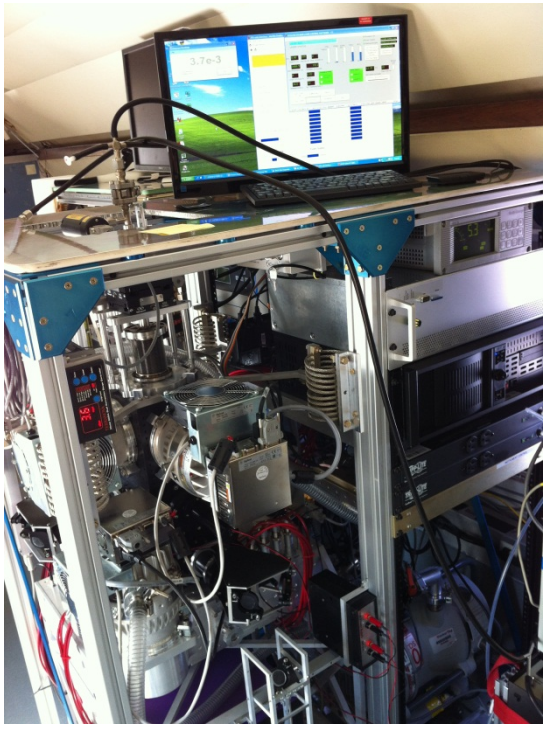
miniSPLAT Measurements

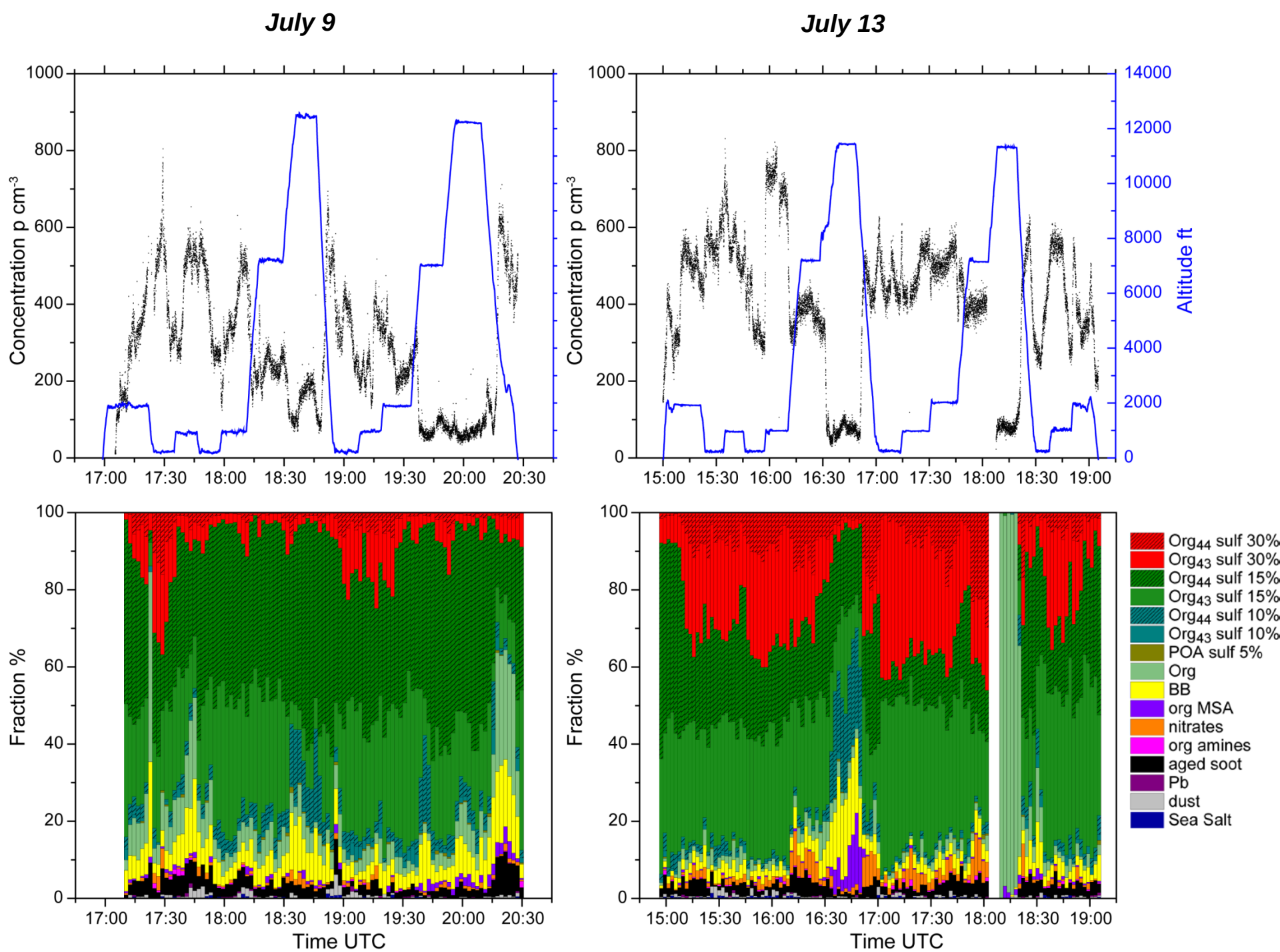


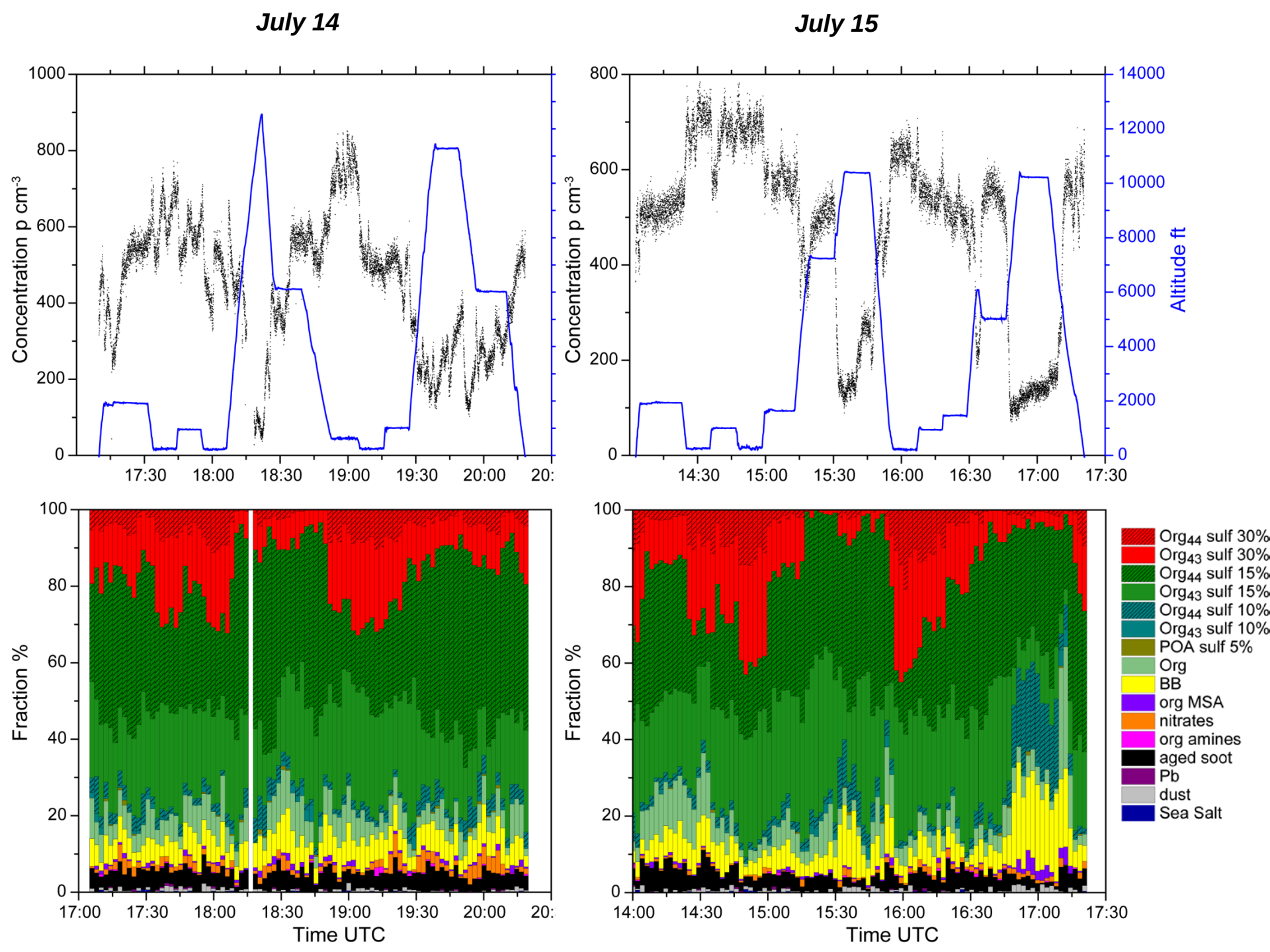
- *Real-time* size and internal composition (mixing state) of individual particles (50 nm to 3 µm, 50% at 85 nm)
- Refractory and non-refractory fractions in each particle
- Number concentrations (1 sec, particles, d>85 nm)
- Size distributions *(d_{va})* (~1 min)
- Sampling rate: size ~5000 p/sec, composition ~20 p/sec)
- *Real-time* information about particle asphericity (1 sec)
- Densities for particle classes with different internal compositions

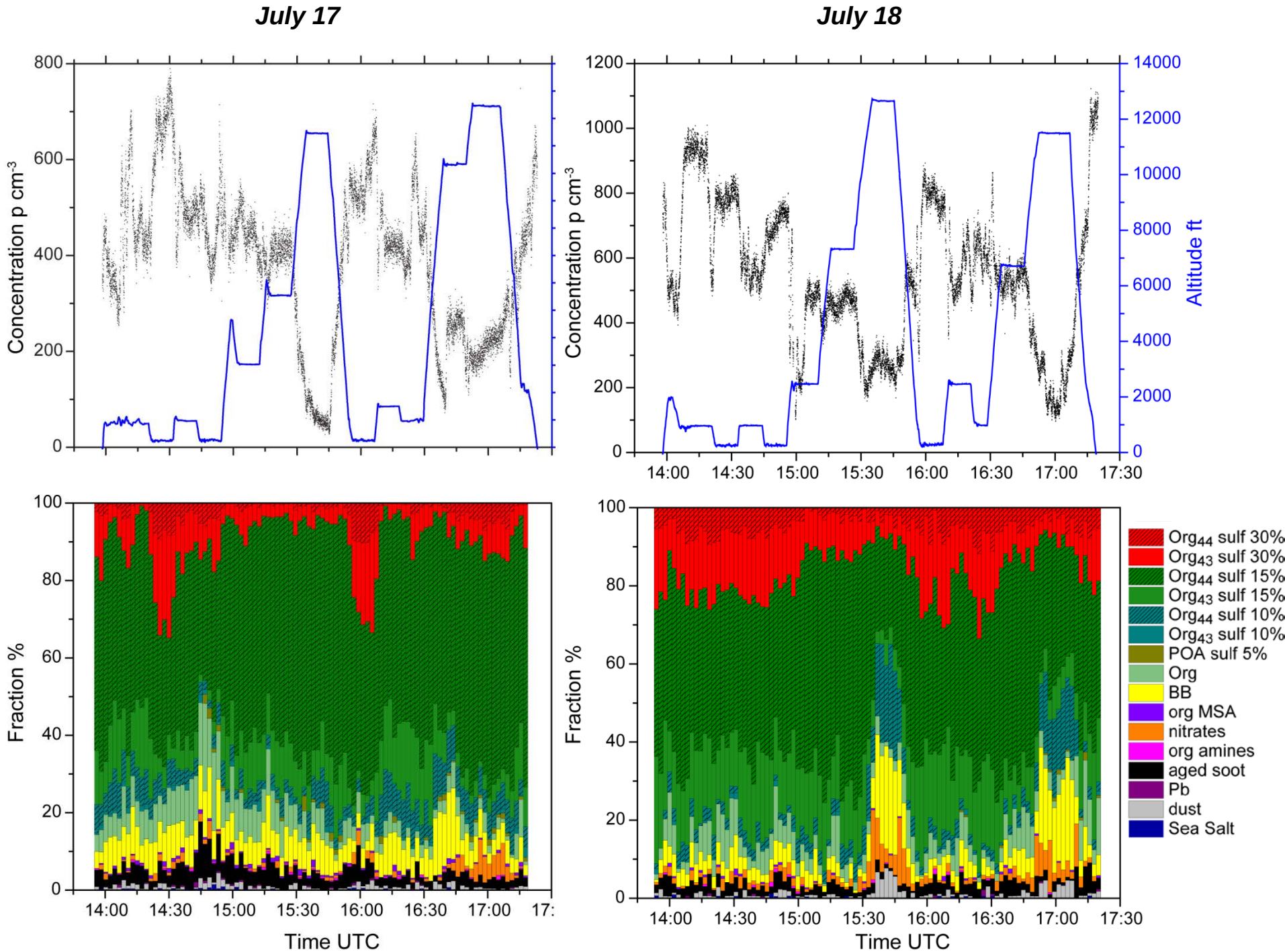
During TCAP I (TCAP II) miniSPLAT:

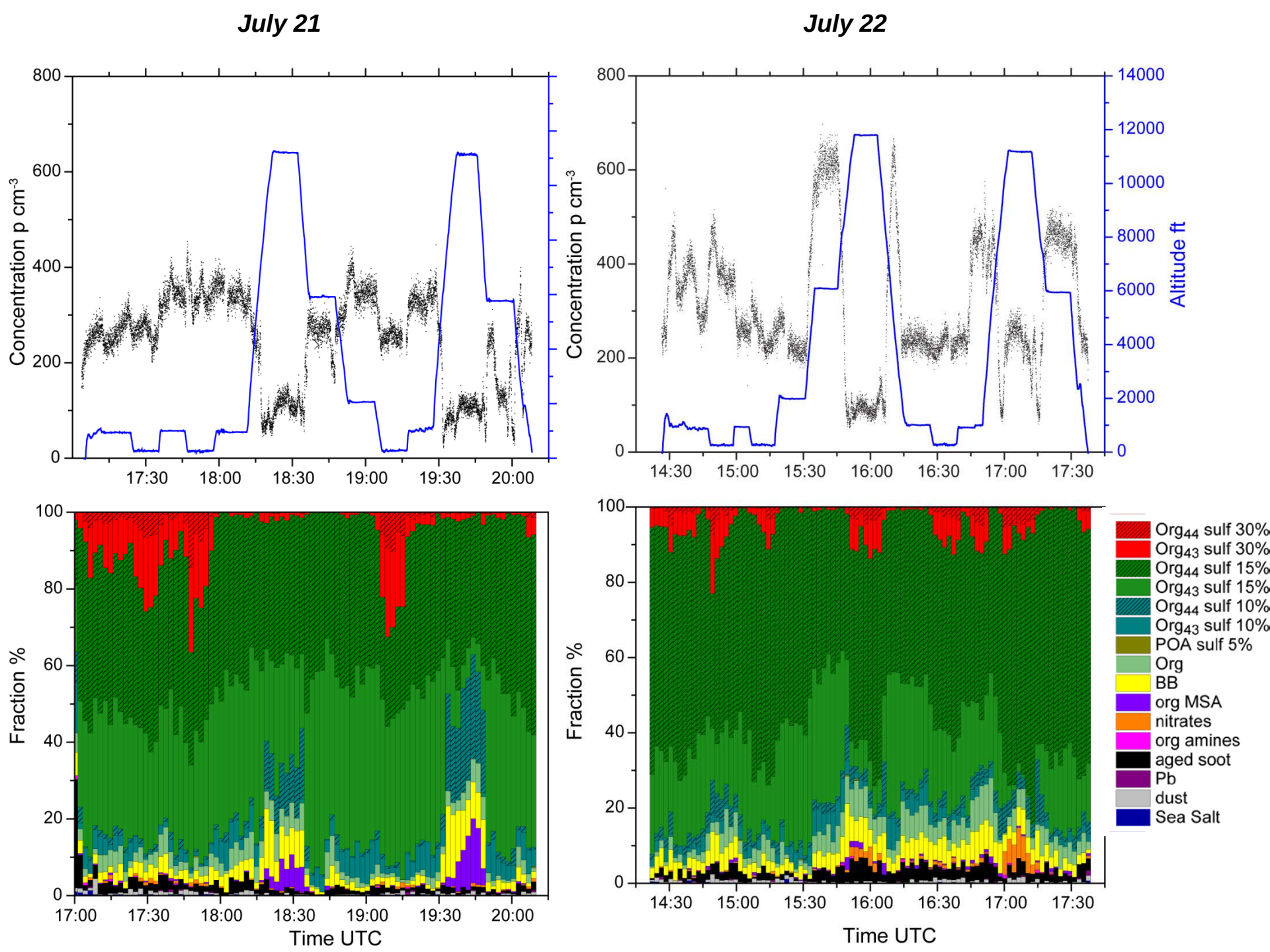
- ✓ Participated in 10 flights (11 flights, limited data for 02/13/13)
- ✓ Sized ~32 million particles (~17 million)
- ✓ Characterized size and mixing state of ~250,000 particles
- ✓ Vast majority – organics mixed with sulfates with different mixing ratios and size distributions (Winter: more sulfate, more nitrate, more sea salt)
- ✓ Sampled through the isokinetic and CVI inlets

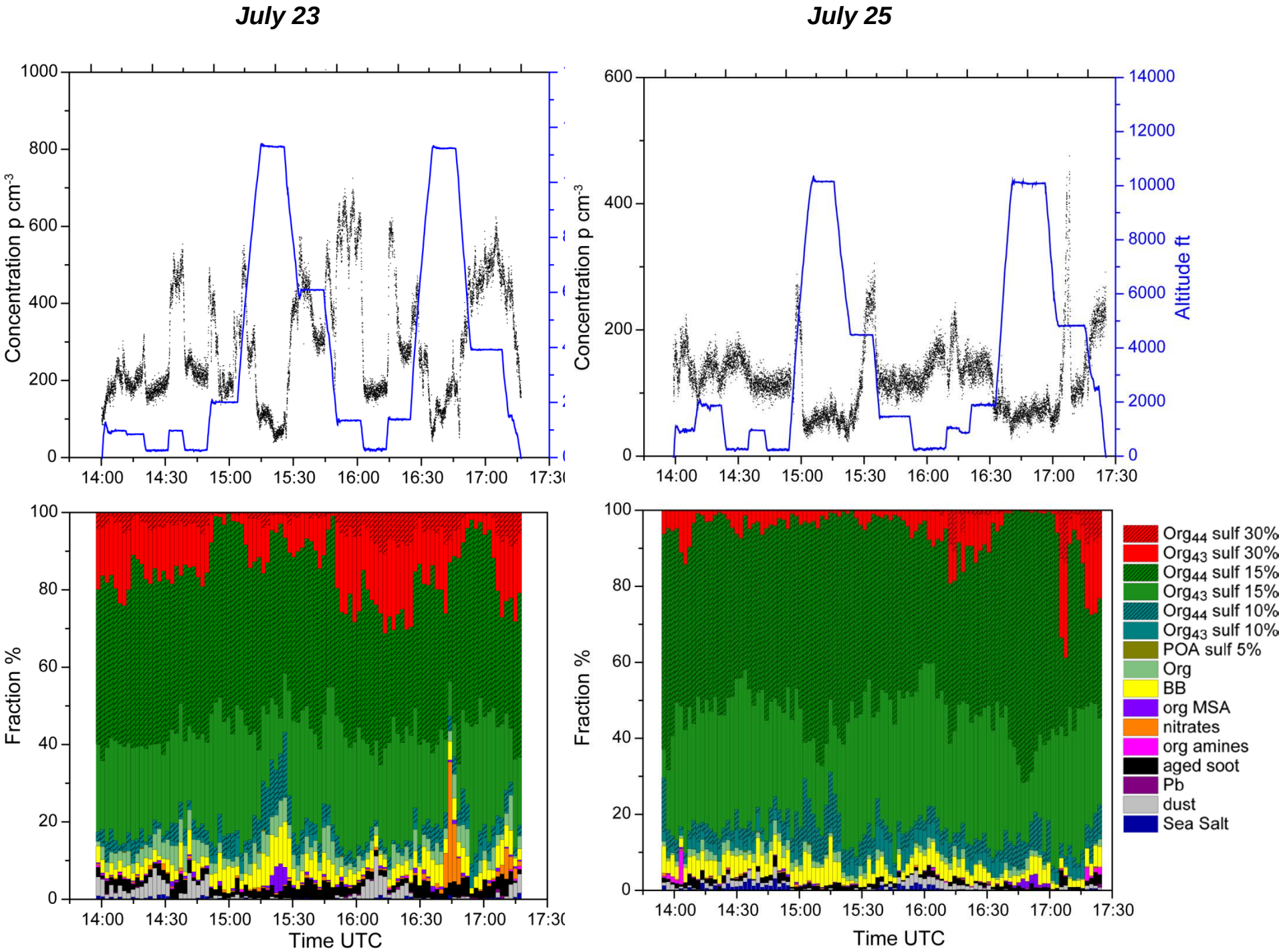



July 9
July 13
Concentration p cm-3
Altitude ft
Fraction %
Time UTC
Org44 sulf 30%
Org43 sulf 30%
Org44 sulf 15%
Org43 sulf 15%
Org44 sulf 10%
Org43 sulf 10%
POA sulf 5%
Org
BB
org MSA
nitrates
org amines
aged soot
Pb
dust
Sea Salt

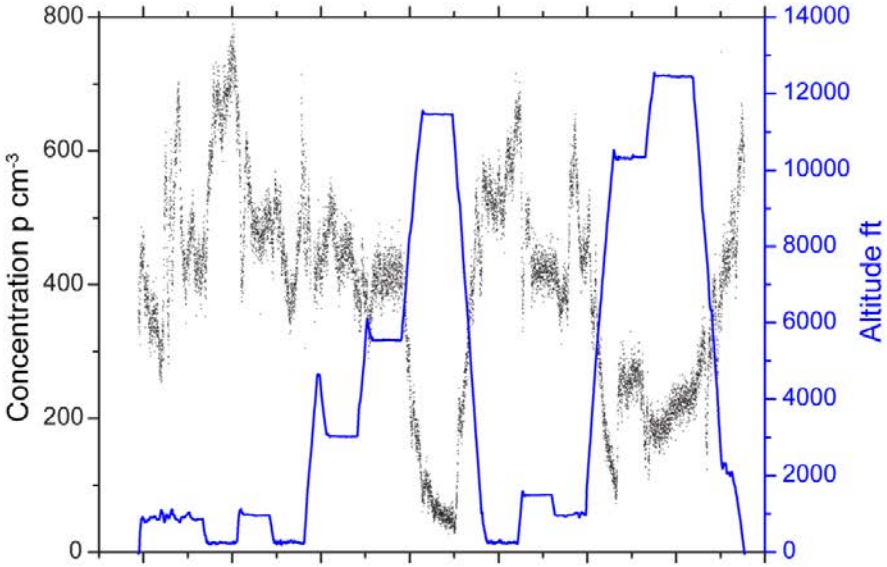

July 14
July 15
Concentration p cm-3
Altitude ft
Fraction %
Time UTC
Org44 sulf 30%
Org43 sulf 30%
Org44 sulf 15%
Org43 sulf 15%
Org44 sulf 10%
Org43 sulf 10%
POA sulf 5%
Org
BB
org MSA
nitrates
org amines
aged soot
Pb
dust
Sea Salt

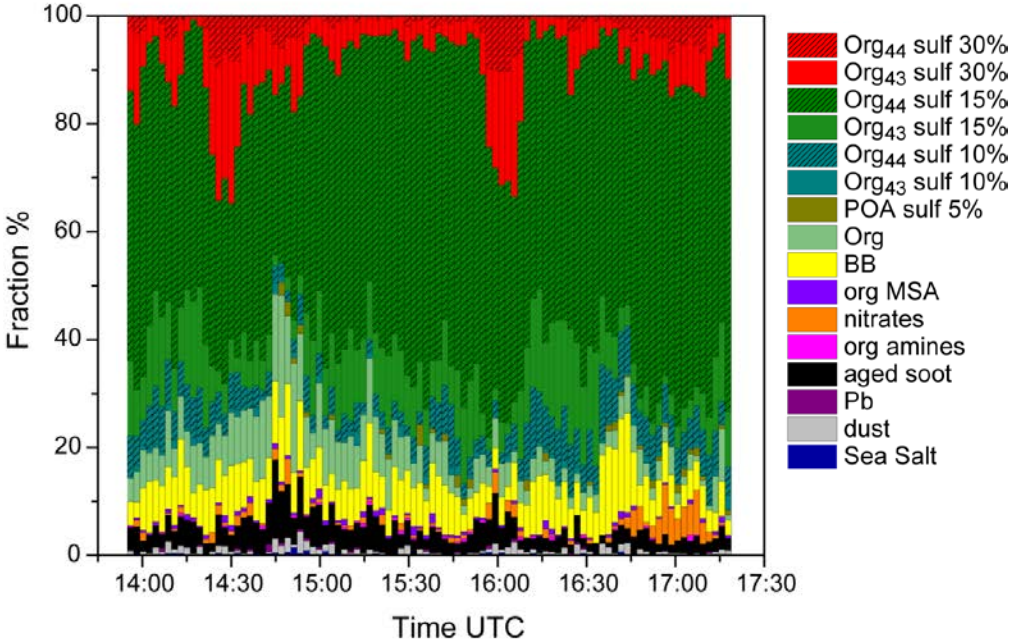

July 17
July 18
Concentration p cm-3
Altitude ft
Fraction %
Time UTC
14:00
14:30
15:00
15:30
16:00
16:30
17:00
17:30
Org44 sulf 30%
Org43 sulf 30%
Org44 sulf 15%
Org43 sulf 15%
Org44 sulf 10%
Org43 sulf 10%
POA sulf 5%
Org
BB
org MSA
nitrates
org amines
aged soot
Pb
dust
Sea Salt

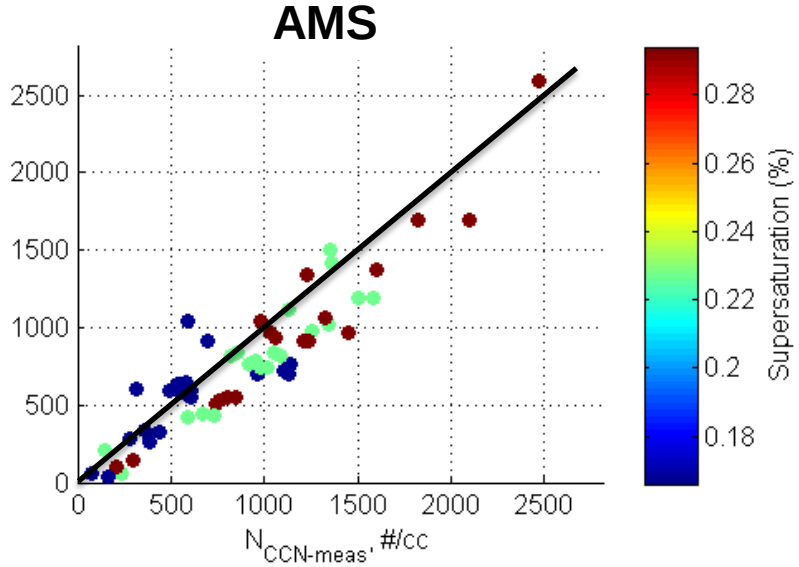

July 21
July 22
Concentration p cm-3
Altitude ft
Fraction %
Time UTC
Org44 sulf 30%
Org43 sulf 30%
Org44 sulf 15%
Org43 sulf 15%
Org44 sulf 10%
Org43 sulf 10%
POA sulf 5%
Org
BB
org MSA
nitrates
org amines
aged soot
Pb
dust
Sea Salt

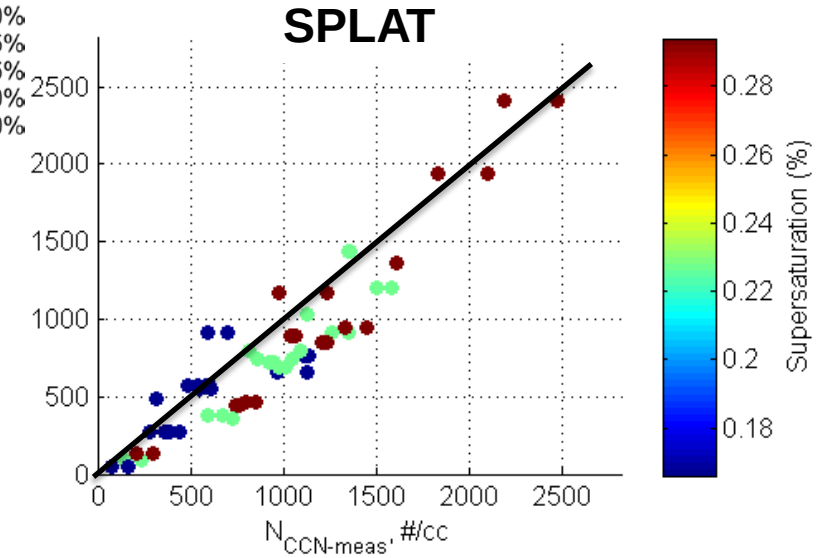

July 23
July 25
Concentration p cm-3
Altitude ft
Fraction %
Time UTC
14:00
14:30
15:00
15:30
16:00
16:30
17:00
17:30
Org44 sulf 30%
Org43 sulf 30%
Org44 sulf 15%
Org43 sulf 15%
Org44 sulf 10%
Org43 sulf 10%
POA sulf 5%
Org
BB
org MSA
nitrates
org amines
aged soot
Pb
dust
Sea Salt

July 17

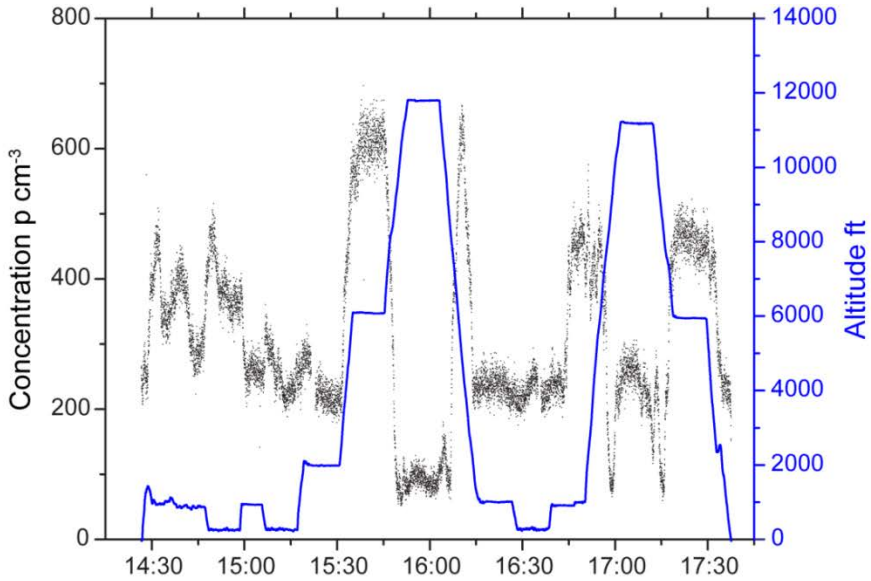

Concentration p cm-3
Altitude ft
800
600
400
200
0
14000
12000
10000
8000
6000
4000
2000
0

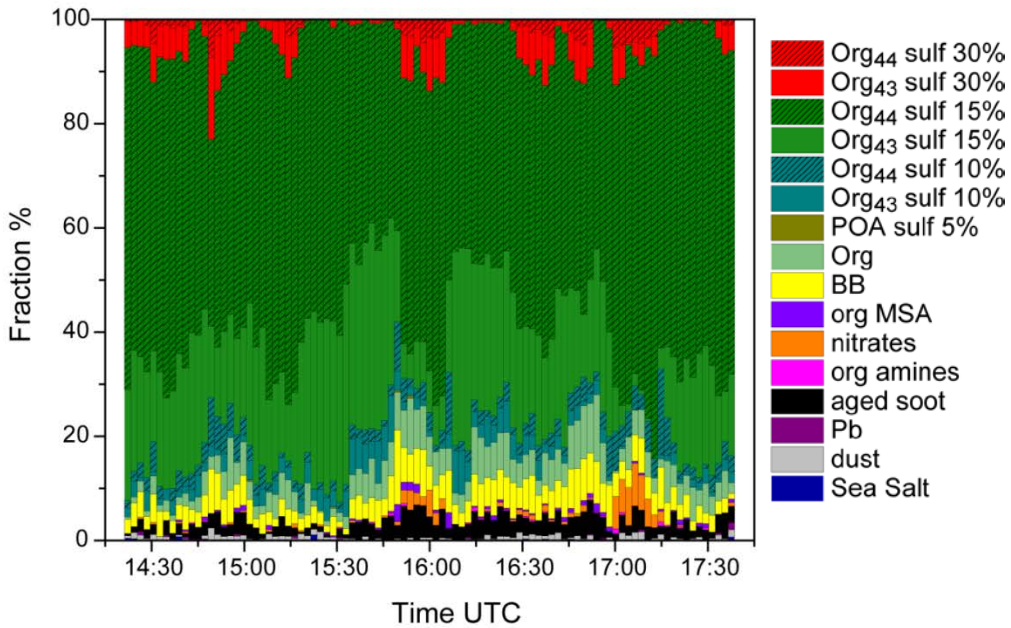

Fraction %
Time UTC
14:00
14:30
15:00
15:30
16:00
16:30
17:00
17:30
Org44 sulf 30%
Org43 sulf 30%
Org44 sulf 15%
Org43 sulf 15%
Org44 sulf 10%
Org43 sulf 10%
POA sulf 5%
Org
BB
org MSA
nitrates
org amines
aged soot
Pb
dust
Sea Salt

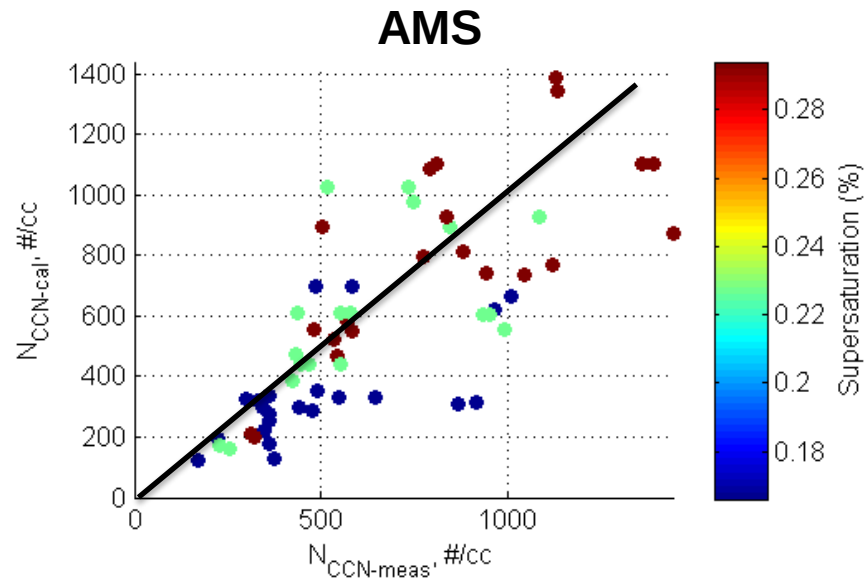

AMS
N CCN-meas, #/cc
Supersaturation (%)

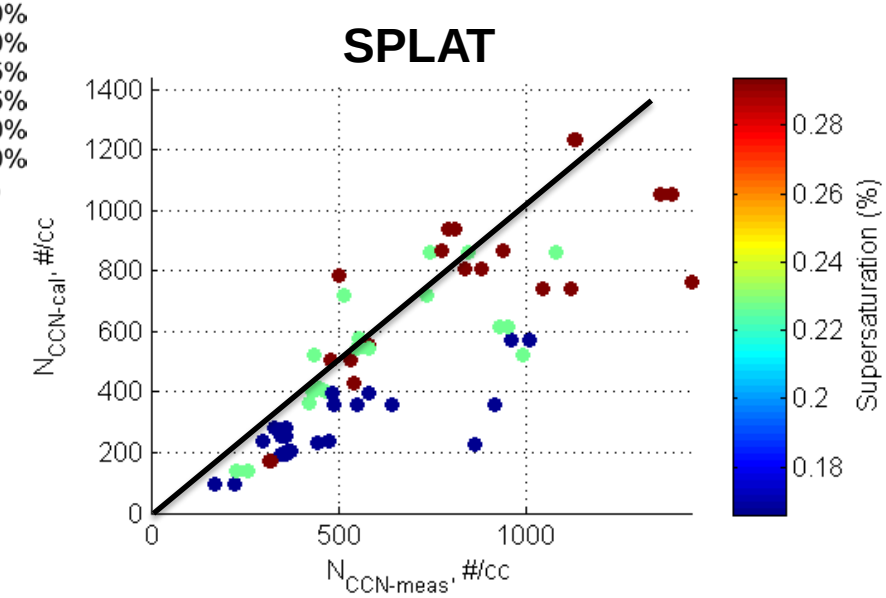

SPLAT
N CCN-meas, #/cc
Supersaturation (%)

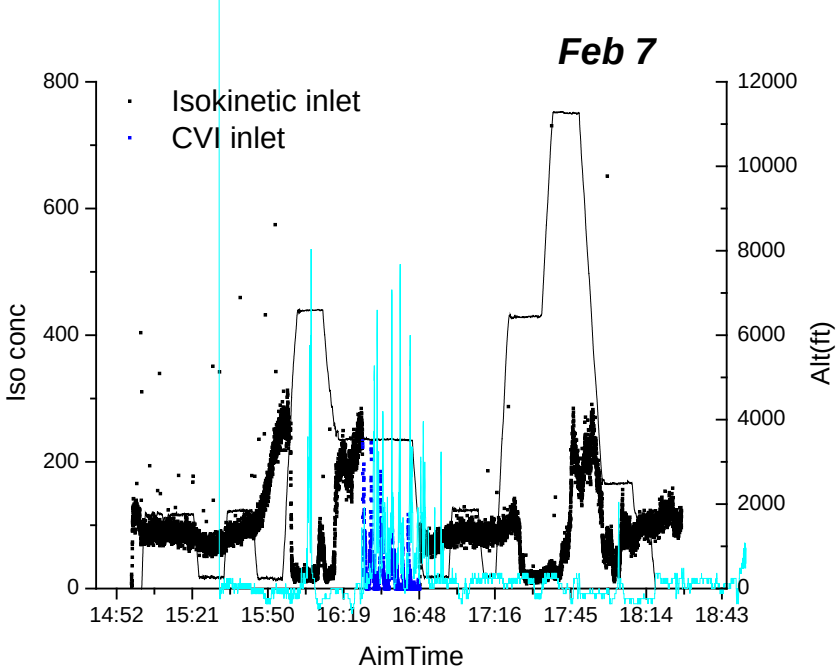
July 22

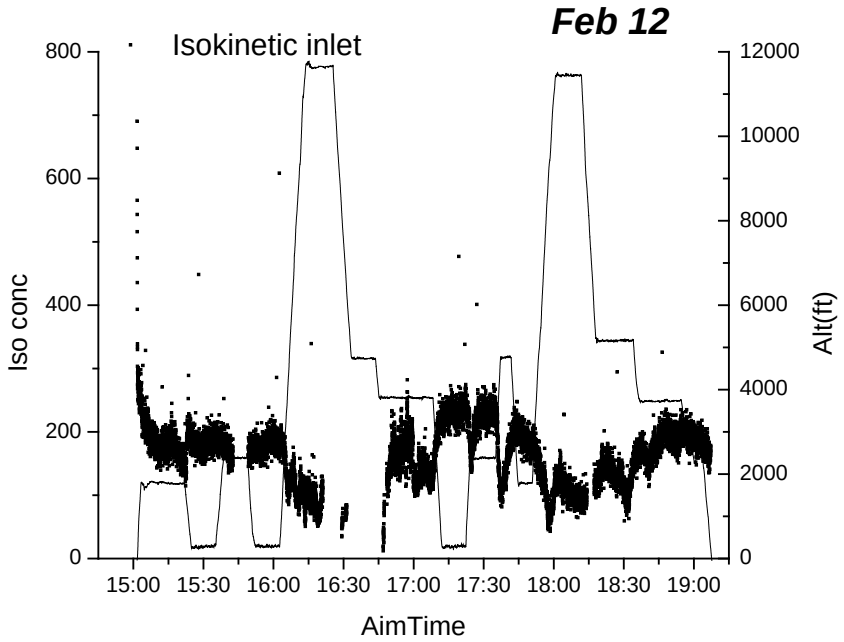

Concentration p cm-3
Altitude ft
800
600
400
200
0
14000
12000
10000
8000
6000
4000
2000
0
14:30
15:00
15:30
16:00
16:30
17:00
17:30

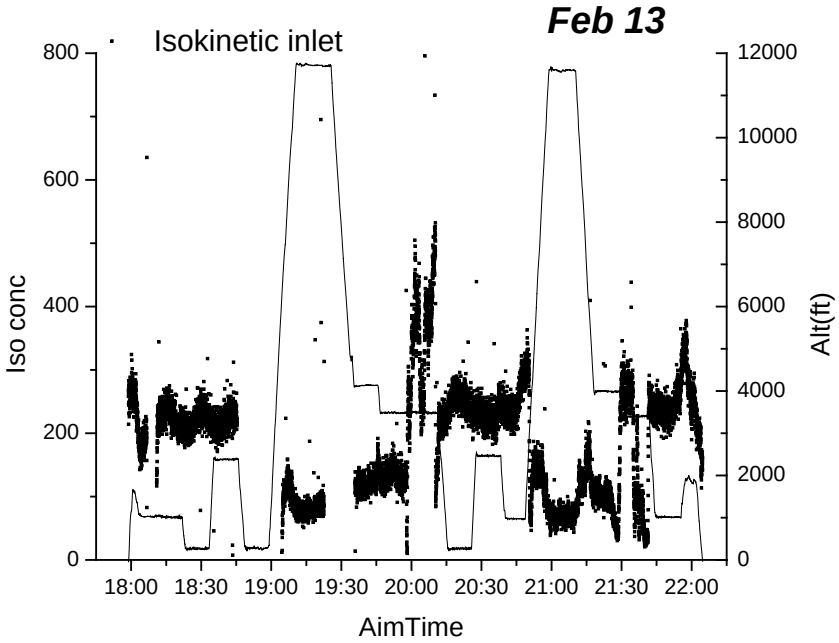

Fraction %
100
80
60
40
20
0
14:30
15:00
15:30
16:00
16:30
17:00
17:30
Time UTC
Org44 sulf 30%
Org43 sulf 30%
Org44 sulf 15%
Org43 sulf 15%
Org44 sulf 10%
Org43 sulf 10%
POA sulf 5%
Org
BB
org MSA
nitrates
org amines
aged soot
Pb
dust
Sea Salt

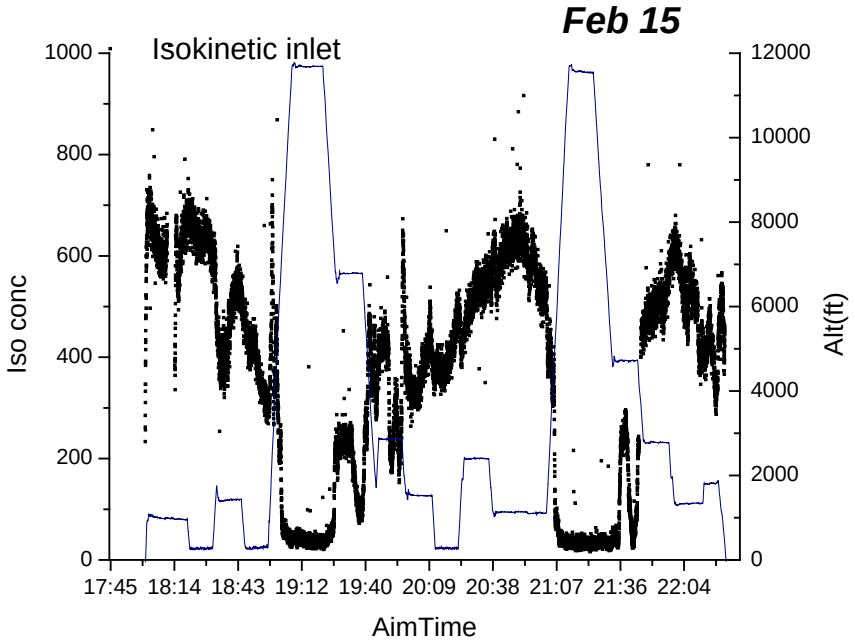

AMS
NCCN-cal, #/cc
NCCN-meas, #/cc
0
500
1000
1400
1200
1000
800
600
400
200
0
Supersaturation (%)
0.28
0.26
0.24
0.22
0.2
0.18

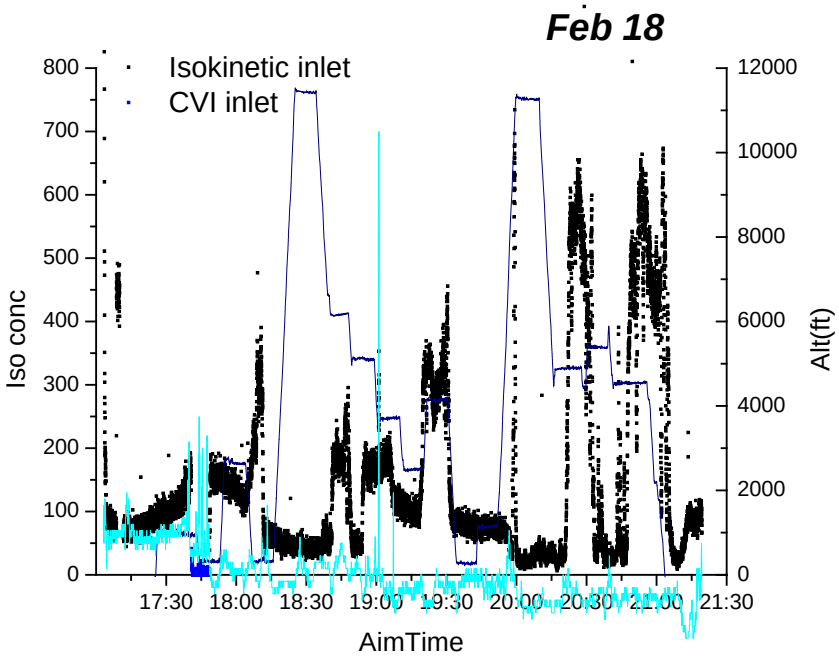

SPLAT
NCCN-cal, #/cc
NCCN-meas, #/cc
0
500
1000
1400
1200
1000
800
600
400
200
0
Supersaturation (%)
0.28
0.26
0.24
0.22
0.2
0.18

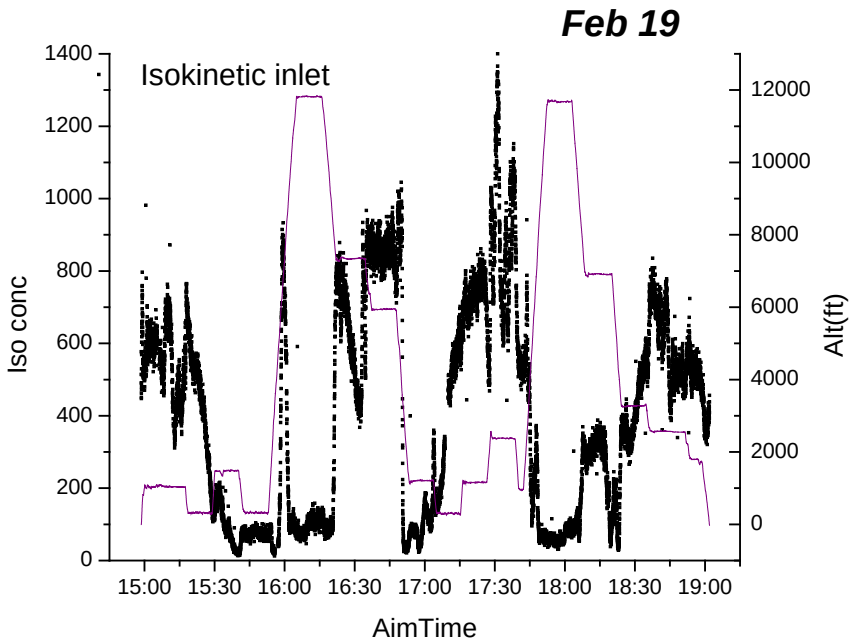

Feb 7
Isokinetic inlet
CVI inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
0
2000
4000
6000
8000
10000
12000
14:52
15:21
15:50
16:19
16:48
17:16
17:45
18:14
18:43

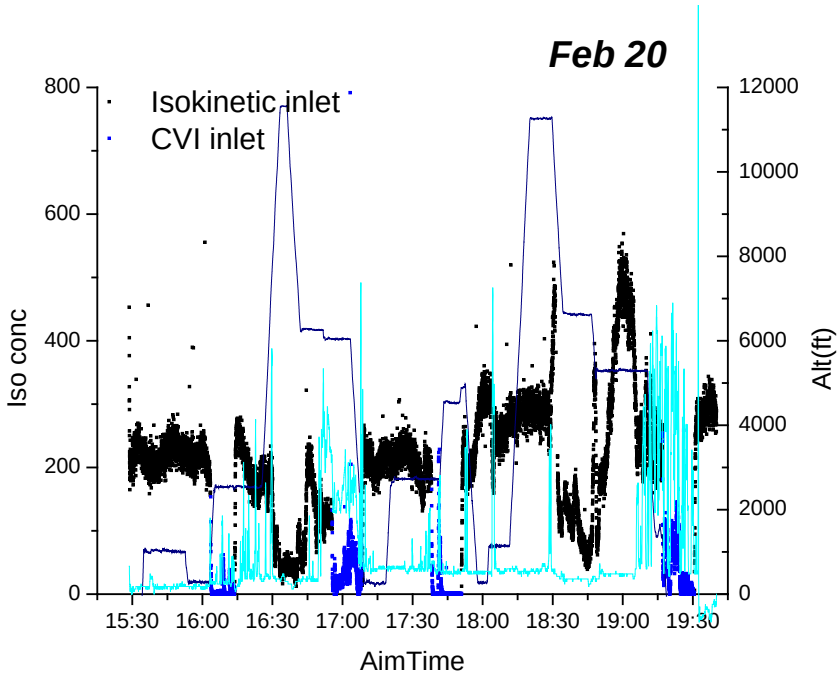

Feb 12
Isokinetic inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
0
2000
4000
6000
8000
10000
12000
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00

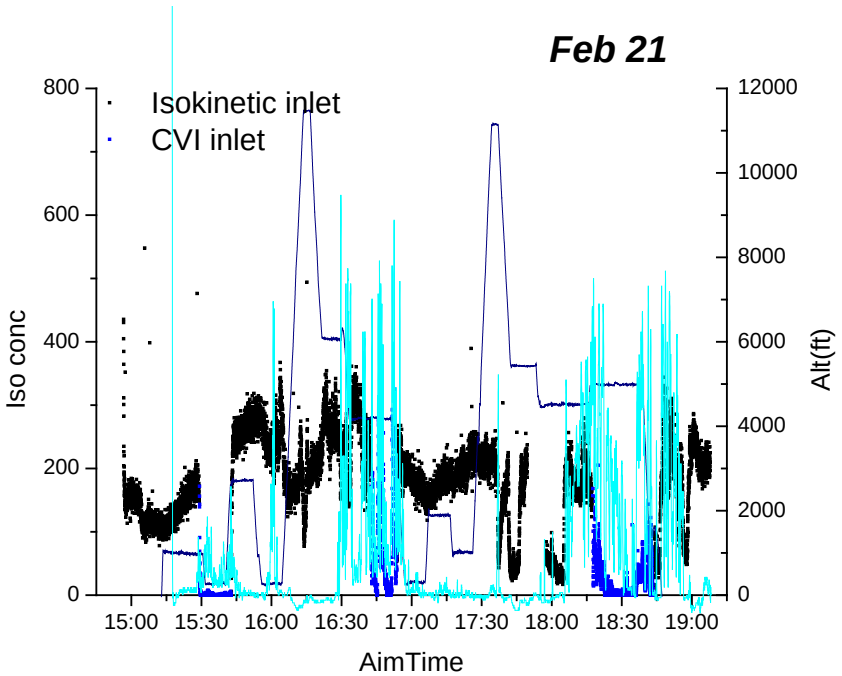

Feb 13
Isokinetic inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
0
2000
4000
6000
8000
10000
12000
18:00
18:30
19:00
19:30
20:00
20:30
21:00
21:30
22:00

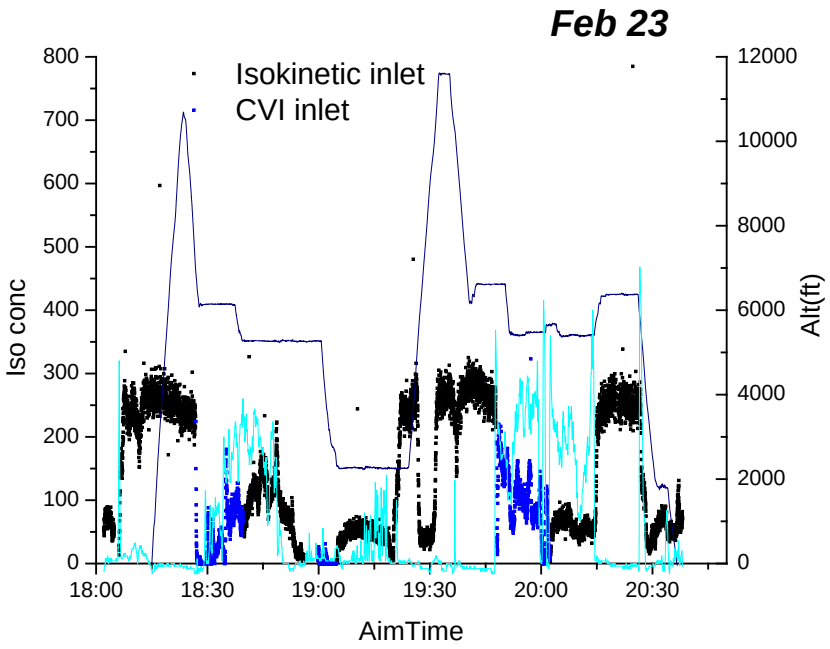

Feb 15
Isokinetic inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
1000
0
2000
4000
6000
8000
10000
12000
17:45
18:14
18:43
19:12
19:40
20:09
20:38
21:07
21:36
22:04

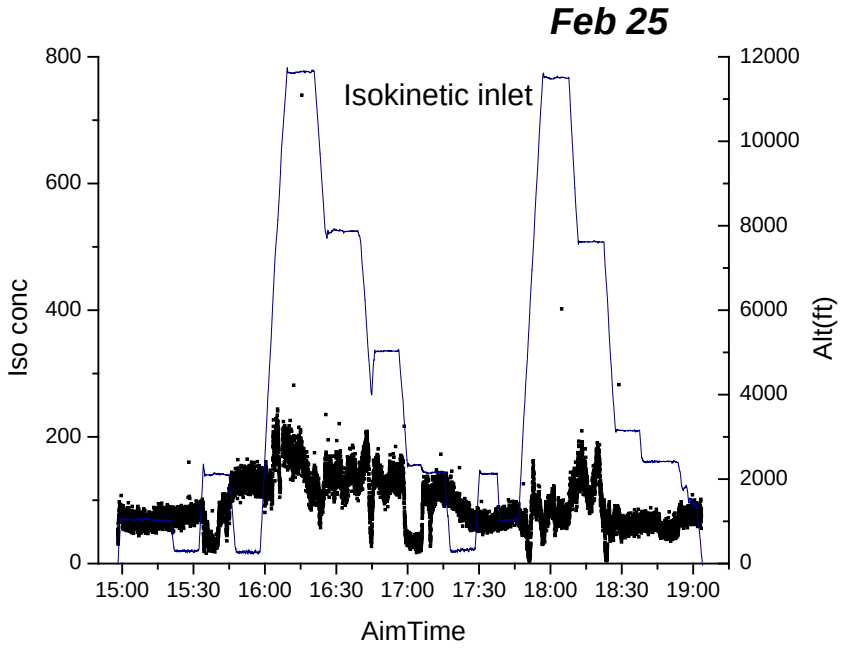

Feb 18
Isokinetic inlet
CVI inlet
Iso conc
Alt(ft)
AimTime
0
100
200
300
400
500
600
700
800
0
2000
4000
6000
8000
10000
12000
17:30
18:00
18:30
19:00
19:30
20:00
20:30
21:00
21:30

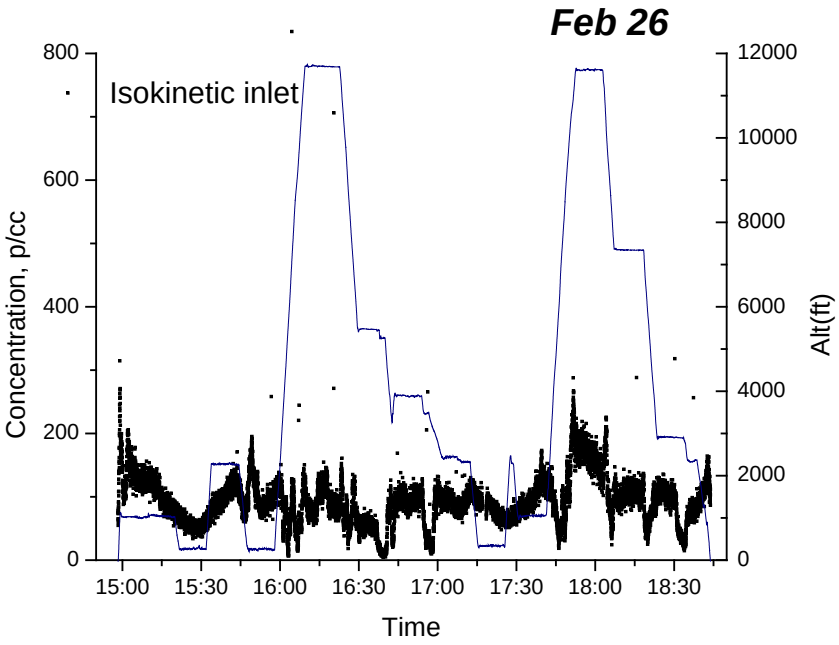

Feb 19
Isokinetic inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
1000
1200
1400
0
2000
4000
6000
8000
10000
12000
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00

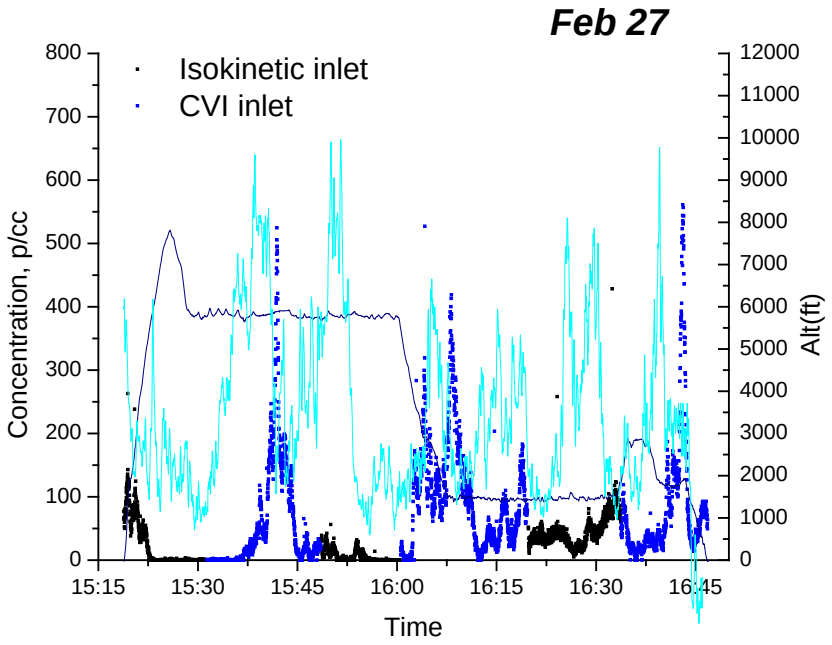

Feb 20
Isokinetic inlet
CVI inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
0
2000
4000
6000
8000
10000
12000
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30


Feb 21
Isokinetic inlet
CVI inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
0
2000
4000
6000
8000
10000
12000
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00

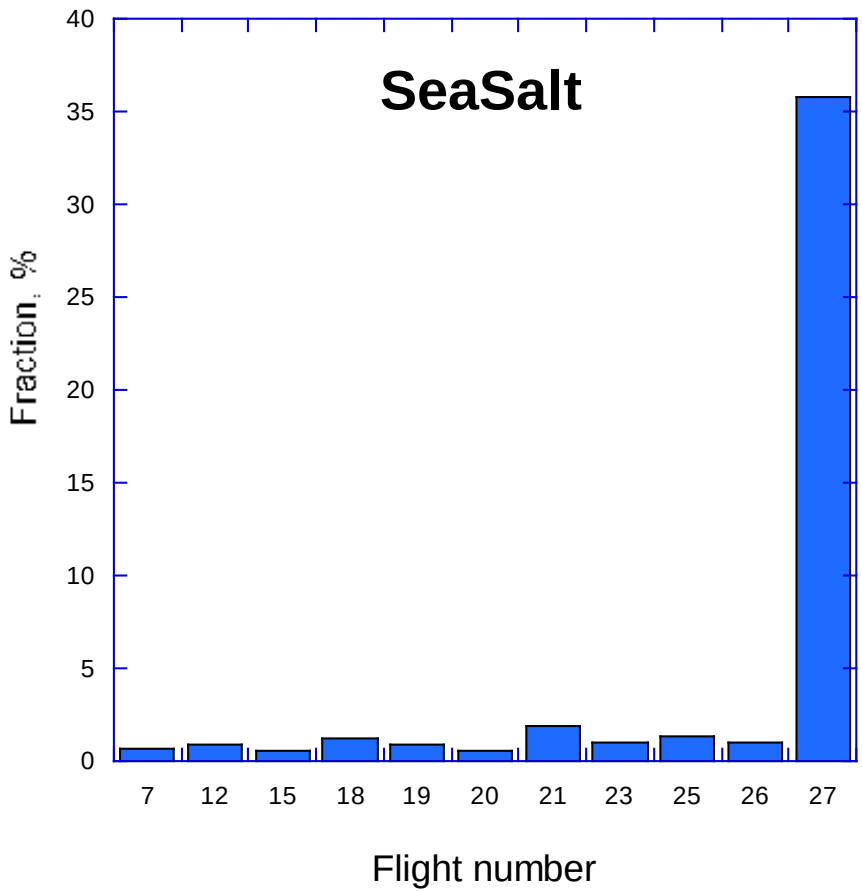

Feb 23
Isokinetic inlet
CVI inlet
Iso conc
Alt(ft)
AimTime
0
100
200
300
400
500
600
700
800
0
2000
4000
6000
8000
10000
12000
18:00
18:30
19:00
19:30
20:00
20:30

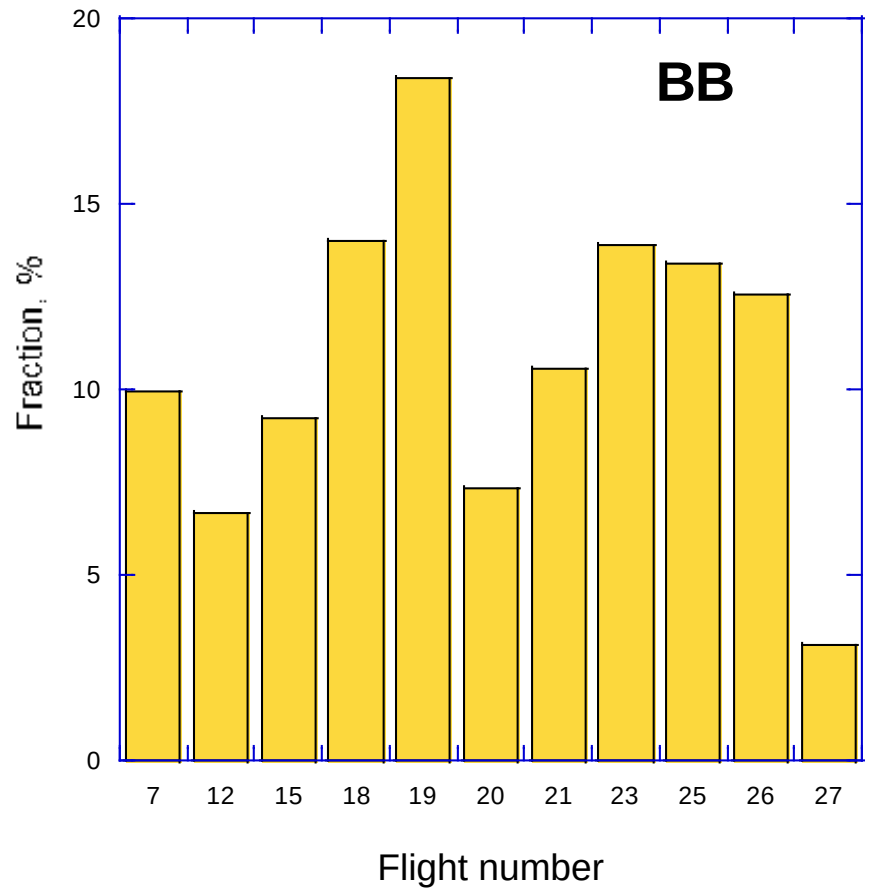

Feb 25
Isokinetic inlet
Iso conc
Alt(ft)
AimTime
0
200
400
600
800
0
2000
4000
6000
8000
10000
12000
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00


Feb 26
Isokinetic inlet
Concentration, p/cc
Alt(ft)
Time
0
200
400
600
800
0
2000
4000
6000
8000
10000
12000
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30

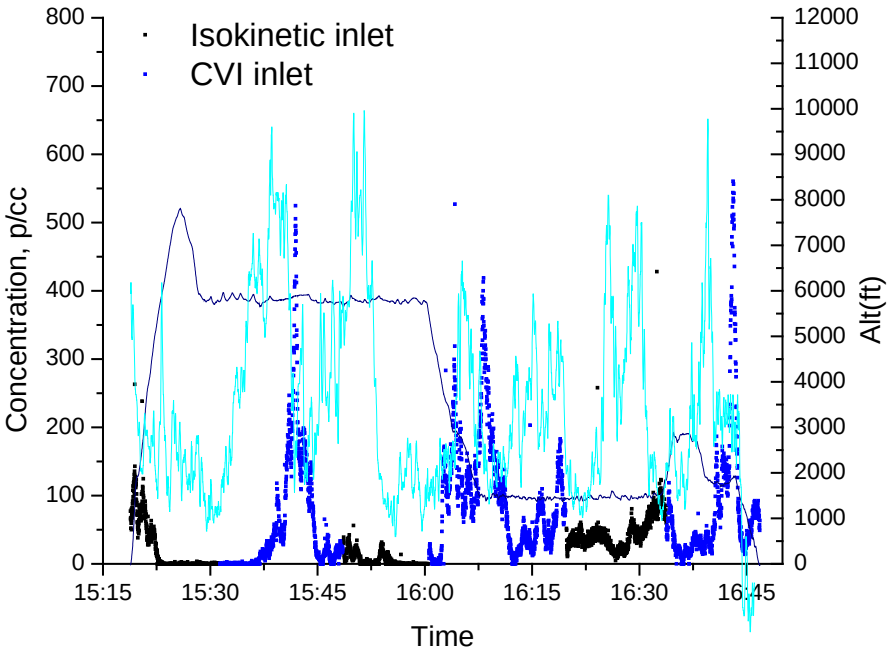

Feb 27
Isokinetic inlet
CVI inlet
Concentration, p/cc
Alt(ft)
Time
0
100
200
300
400
500
600
700
800
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
15:15
15:30
15:45
16:00
16:15
16:30
16:45

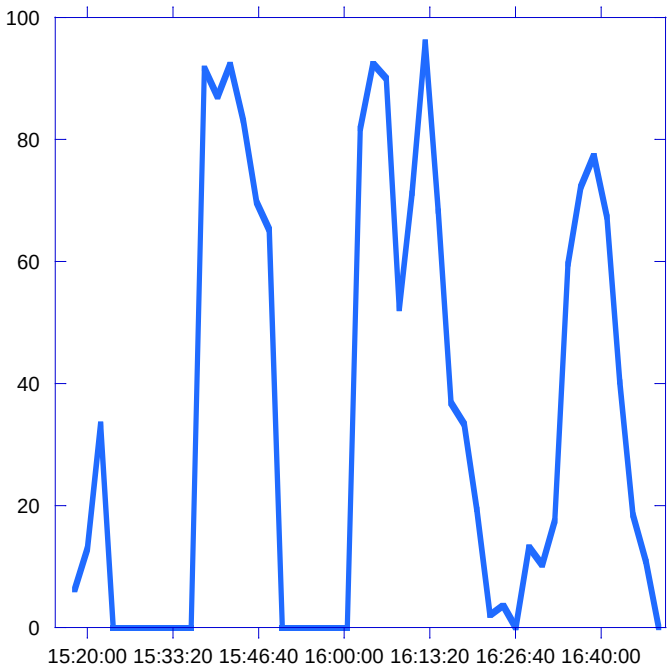
- Ongoing TCAP II data analysis: temporal/spatial evolution of compositions and mixing state
- Vast majority – sulfates mixed with organics with different mixing ratios and size distributions. On average ~40% organics.
- Much more Sea salt (especially last flight), more BB, more nitrate
- CCNC closure and comparison of droplet residuals and background aerosols

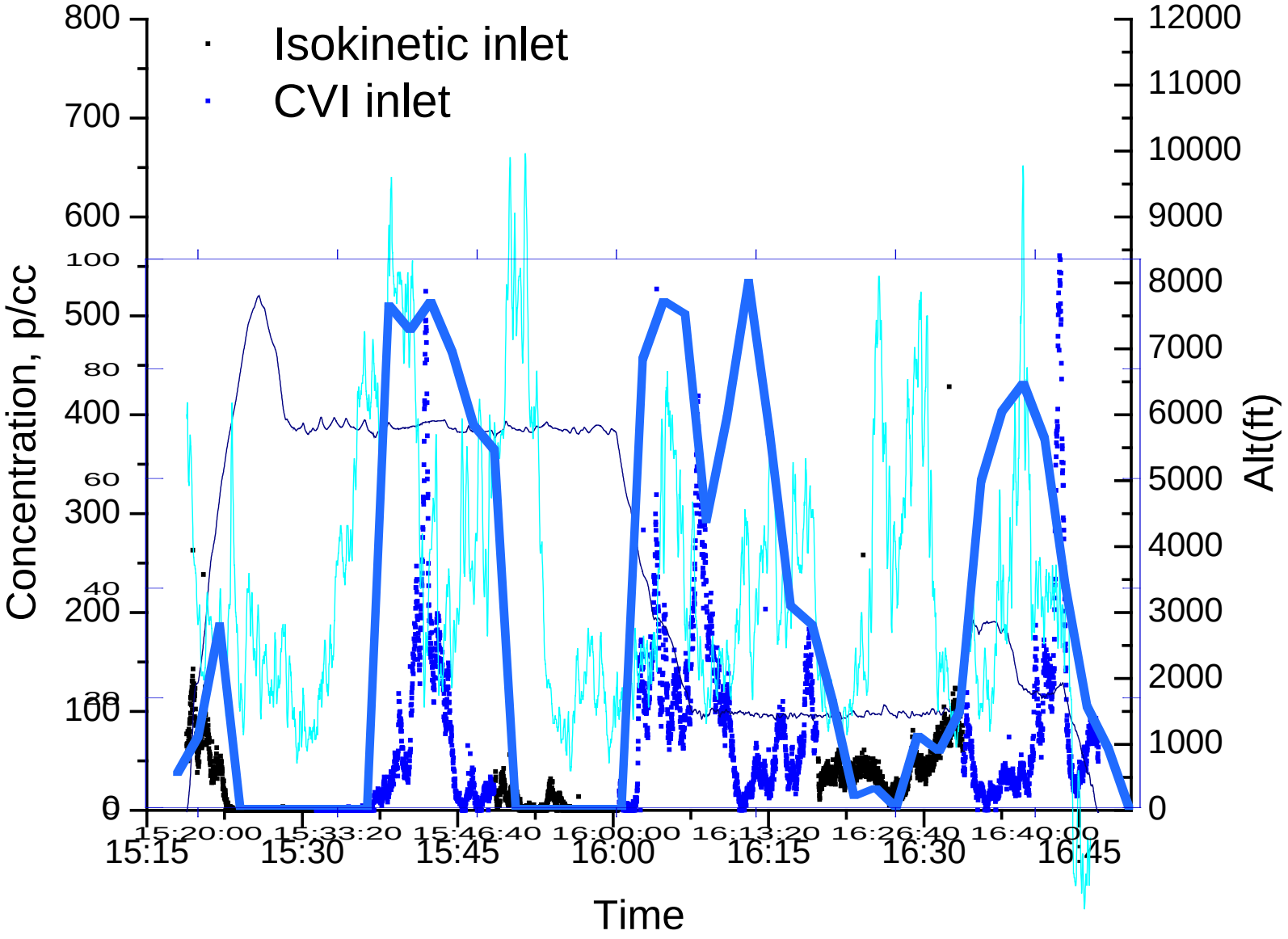




F27 – Temporal Evolution of Sea Salt Particles






Isokinetic inlet
CVI inlet
Concentration, p/cc
Alt(ft)
Time
800
700
600
500
400
300
200
100
0
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
15:20:00
15:33:20
15:46:40
16:00:00
16:13:20
16:26:40
16:40:00
15:15
15:30
15:45
16:00
16:15
16:30
16:45