Aerosol Measurements on the WP-3D During NEAQS/ITCT 2004

Data from groups running: PILS, PALMS, AMS, FSSP size distributions, PTRMS, NOy, HNO3, CO, SO2, H2SO4, A/C met., emissions database, etc.

Approach

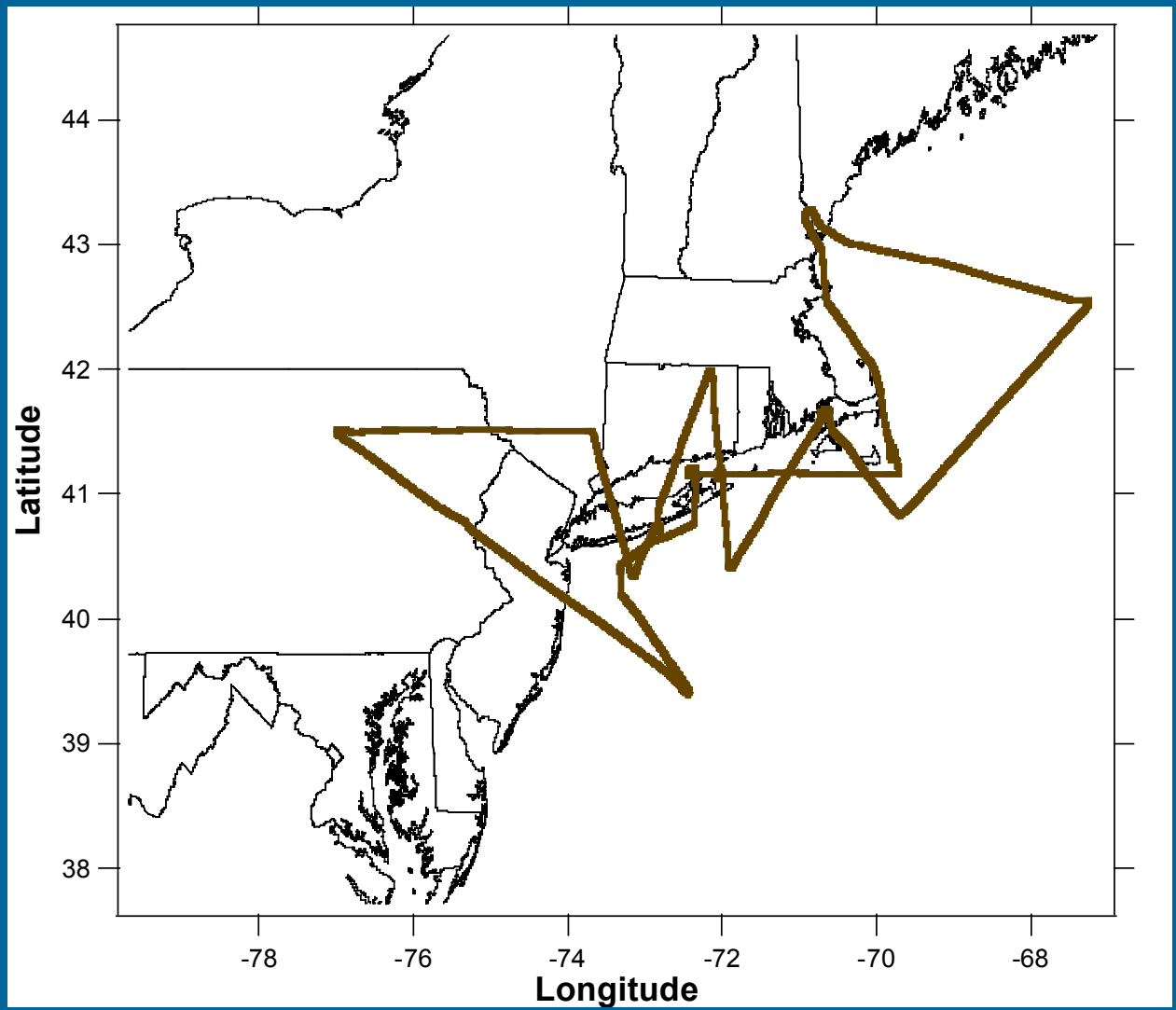
Unite gas & particle phase measurements to produce a coherent and quantitative evaluation of:

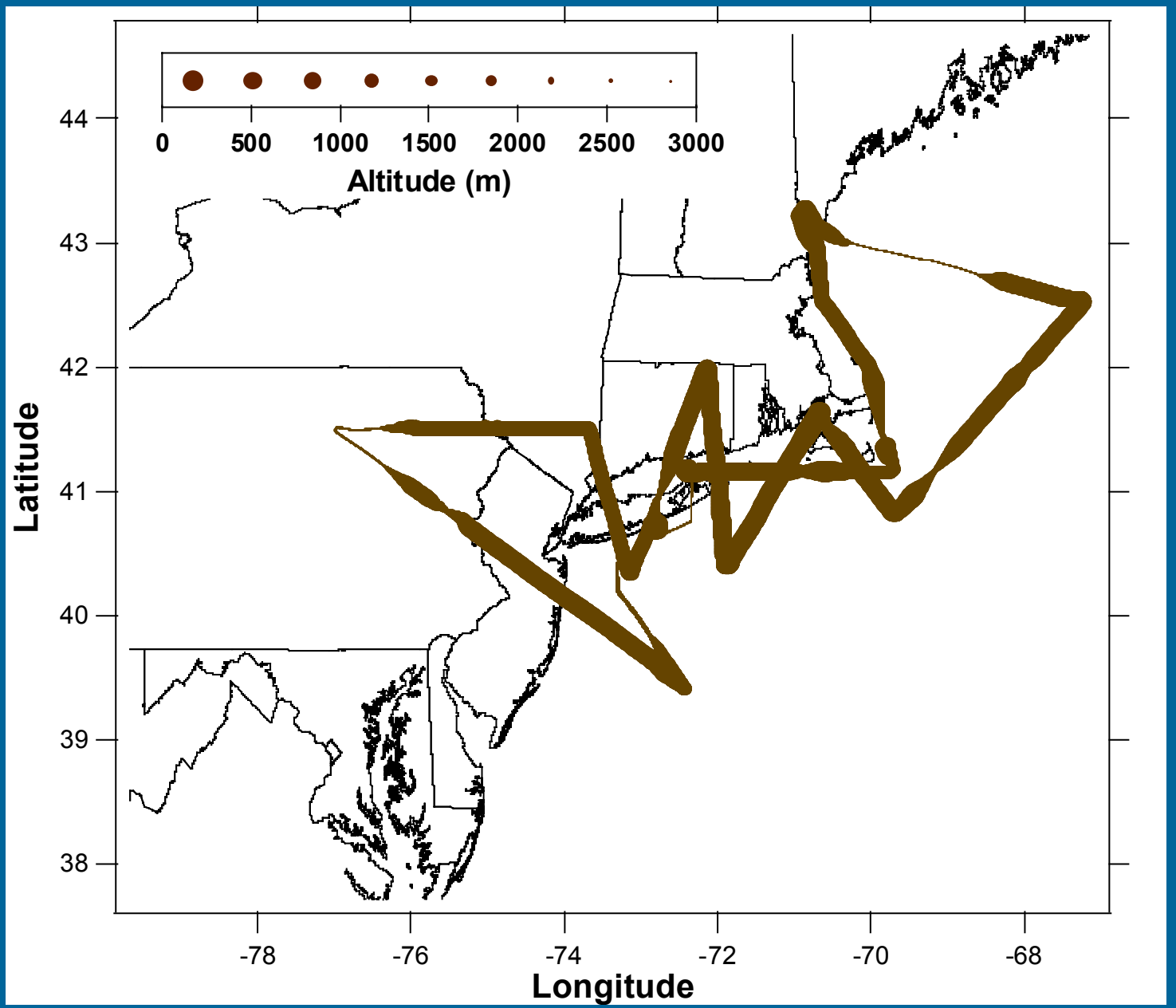
- Sources and transport
- Gas-phase and heterogeneous chemical processes
- Particle microphysics
- Cloud nucleating potential
- Particle optical characteristics (limited)

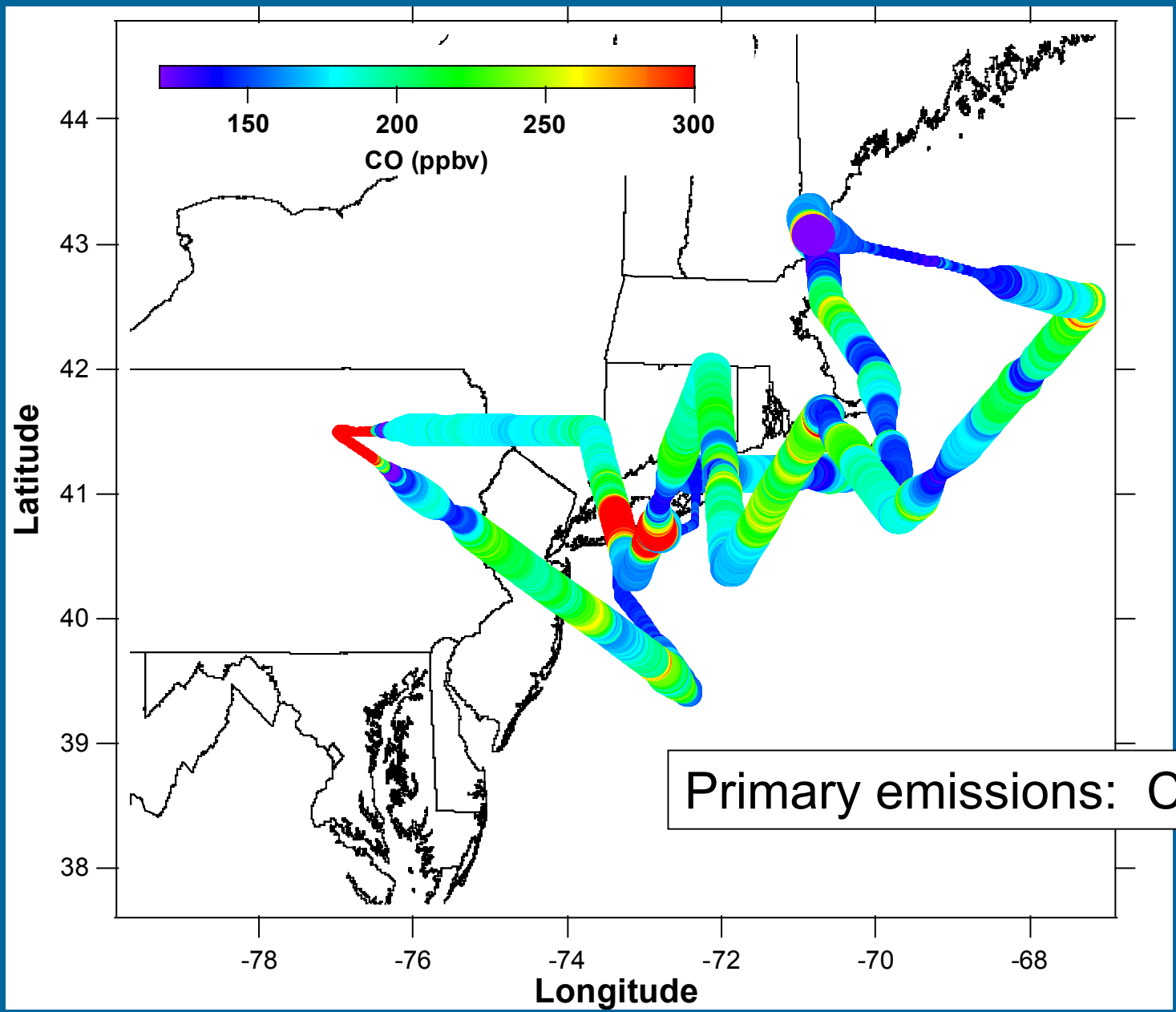
Requirements

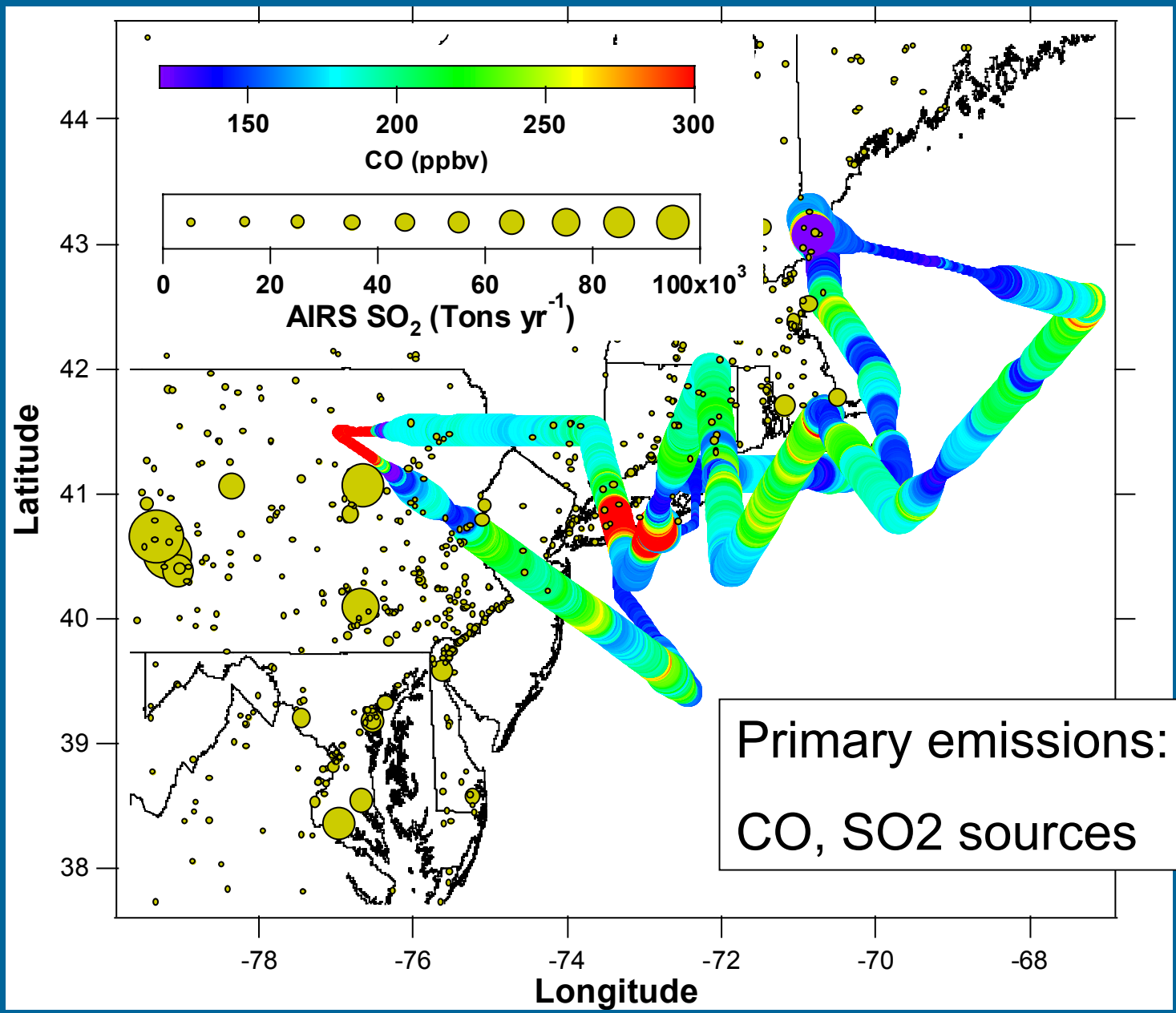
- Measurements with quantified uncertainties
- Meteorology
- Modeling
- Well-characterized sources (emissions databases and/or measurements)

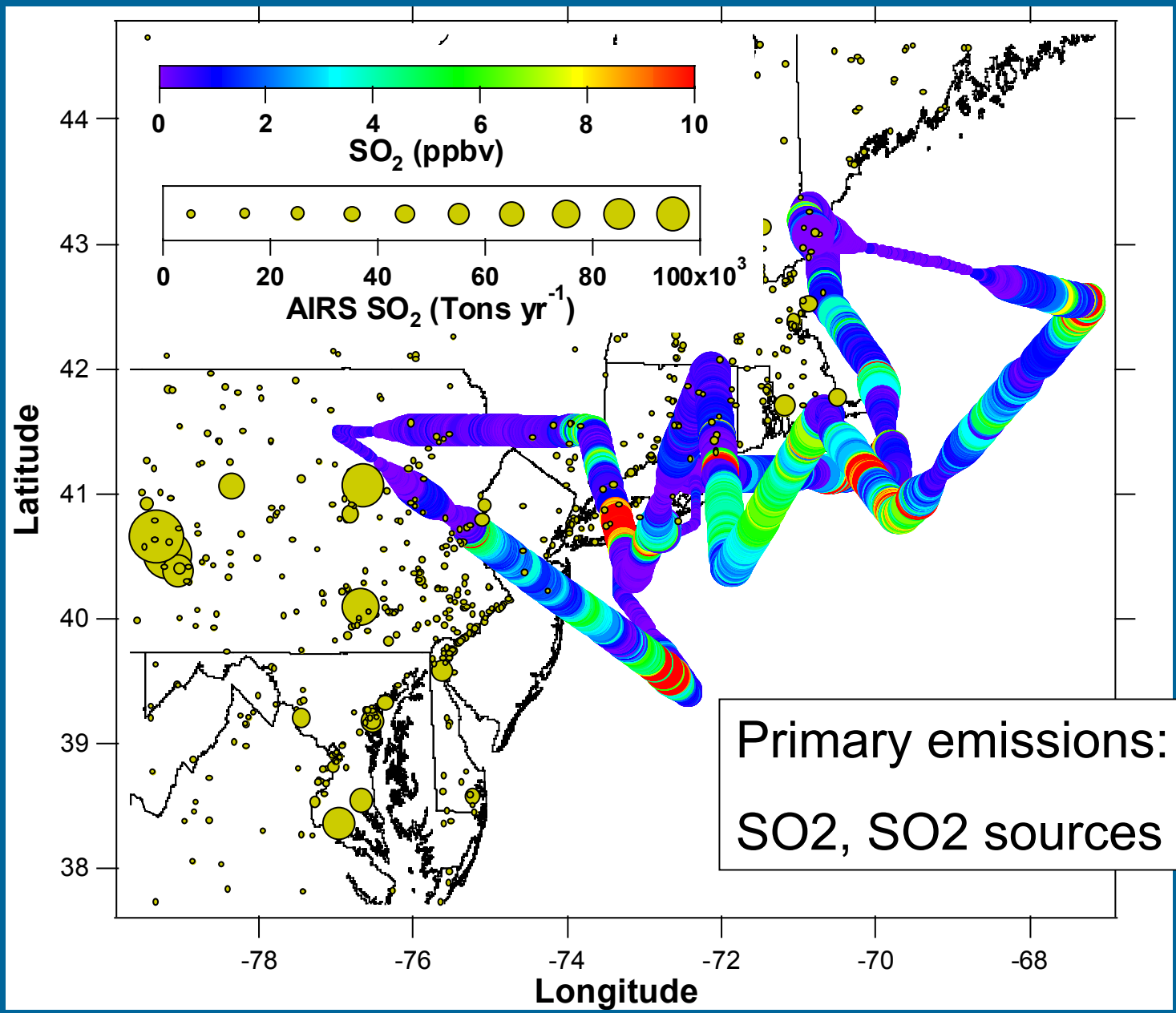
A preliminary and incomplete example: WP-3D flight on July 20th, 2004 near New York City

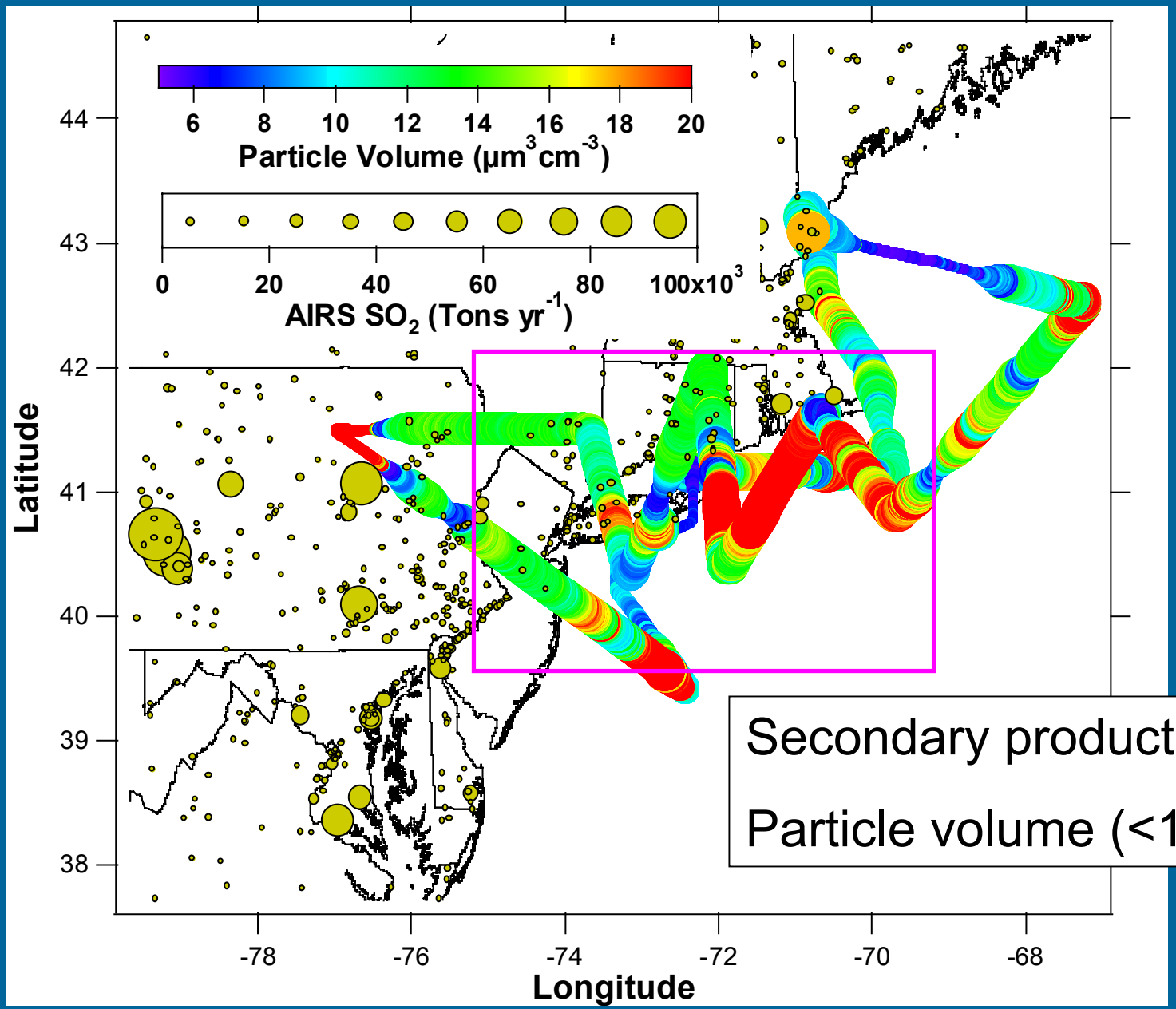


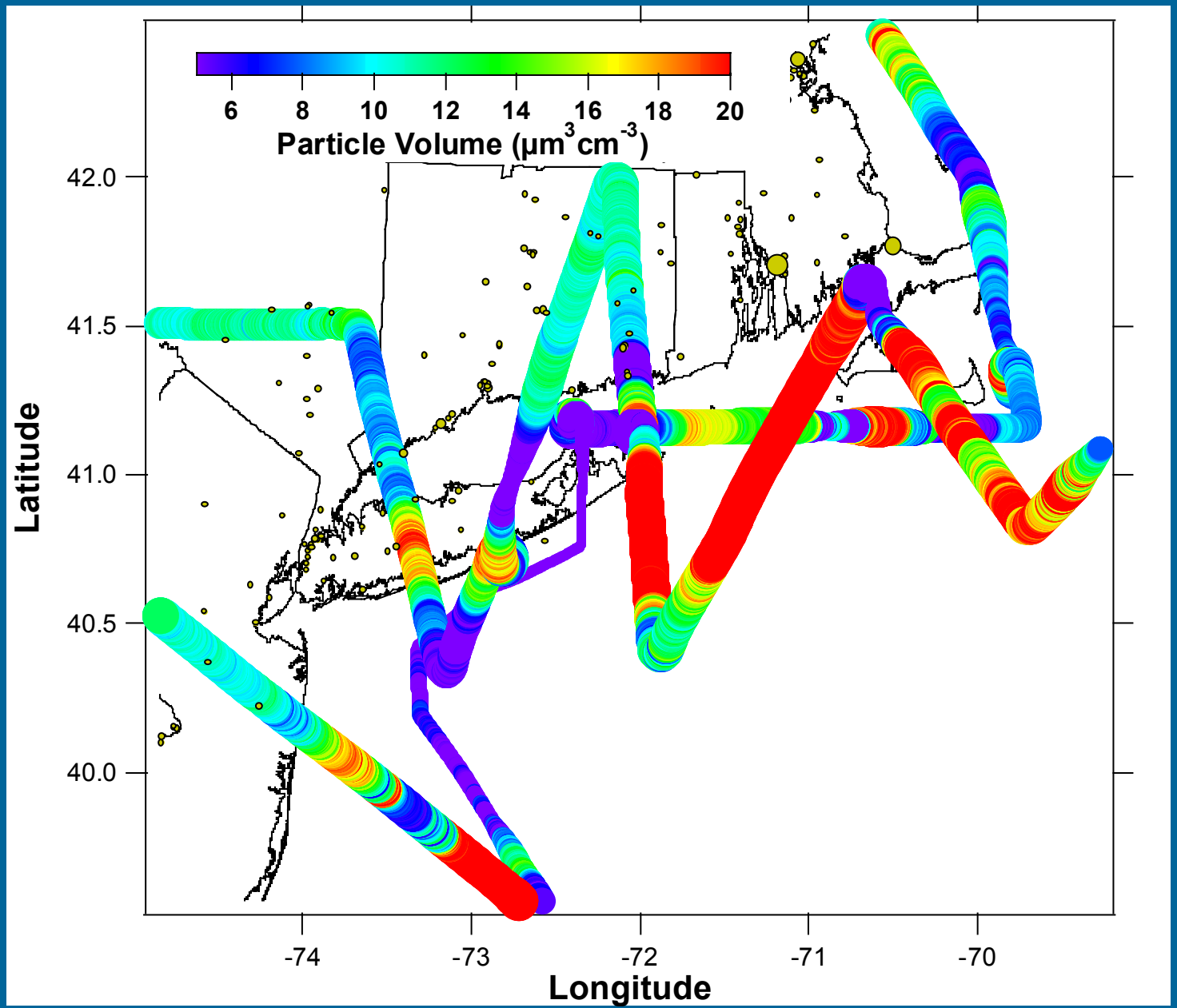

0
500
1000
1500
2000
2500
3000
Altitude (m)
44
43
42
41
40
39
38
Latitude
-78
-76
-74
-72
-70
-68
Longitude

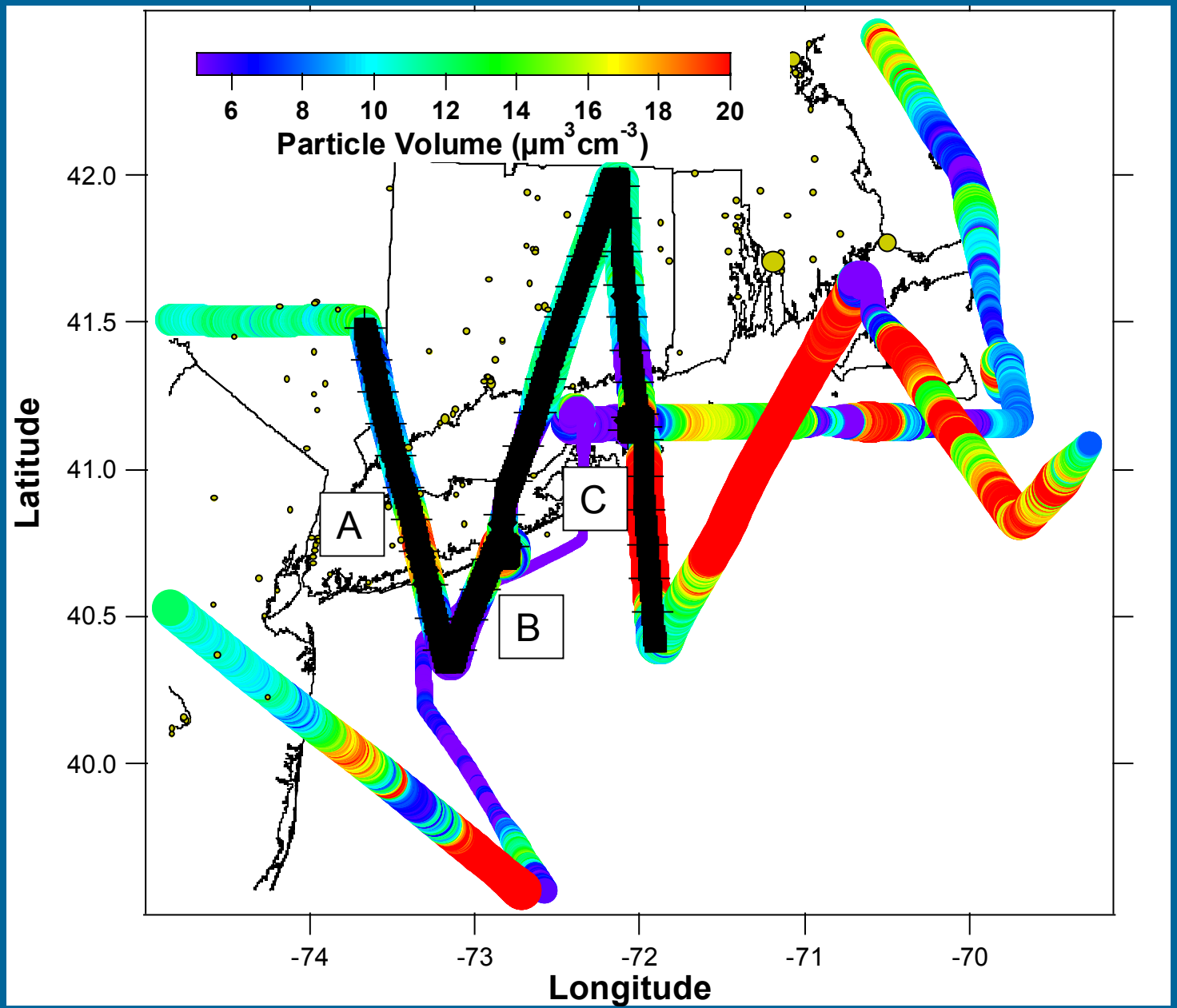

150
200
250
300
CO (ppbv)
44
43
42
41
40
39
38
Latitude
-78
-76
-74
-72
-70
-68
Longitude
Primary emissions: CO

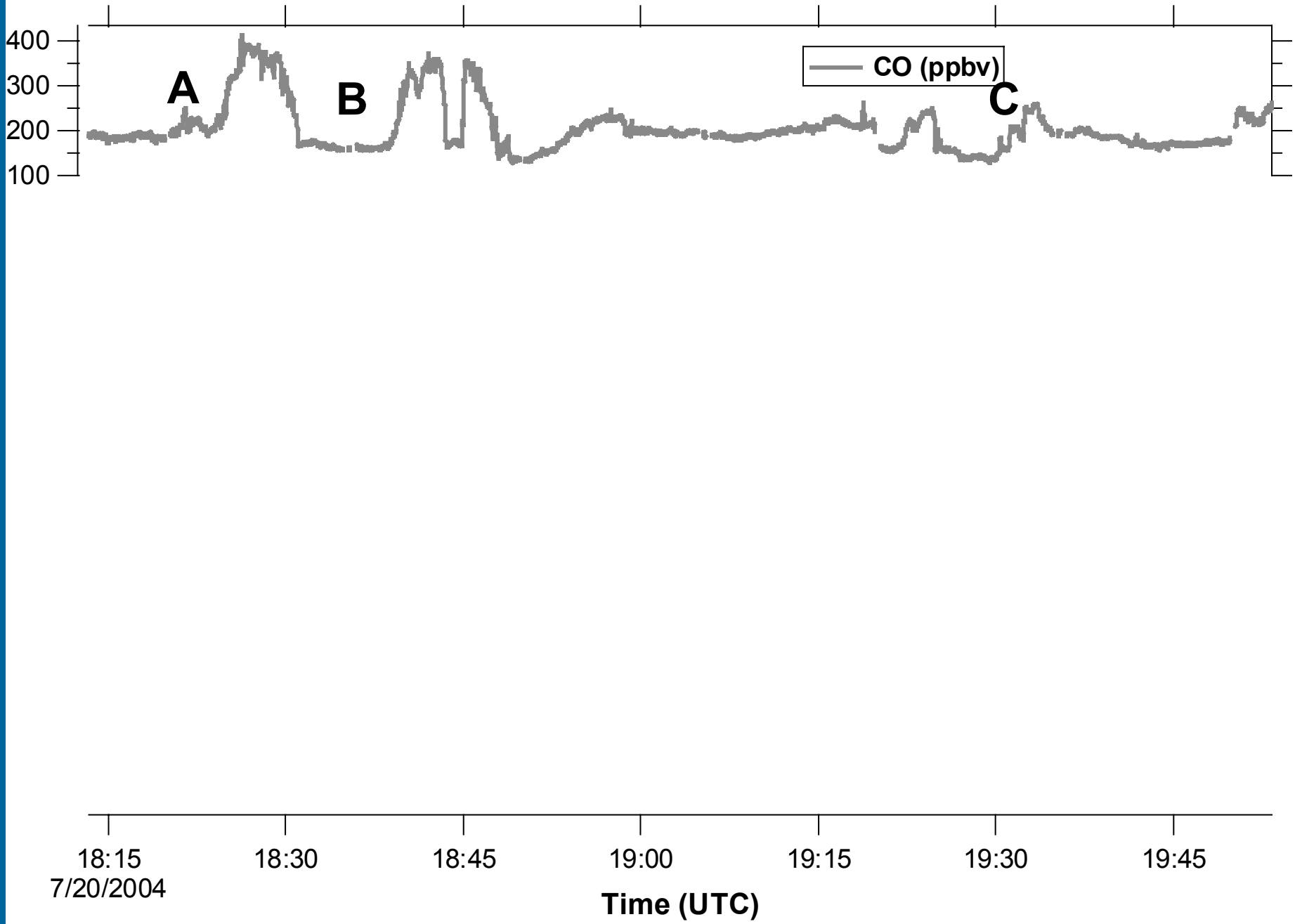

150
200
250
300
CO (ppbv)
0
20
40
60
80
100x10^3
AIRS SO2 (Tons yr-1)
44
43
42
41
40
39
38
Latitude
-78
-76
-74
-72
-70
-68
Longitude
Primary emissions:
CO, SO2 sources

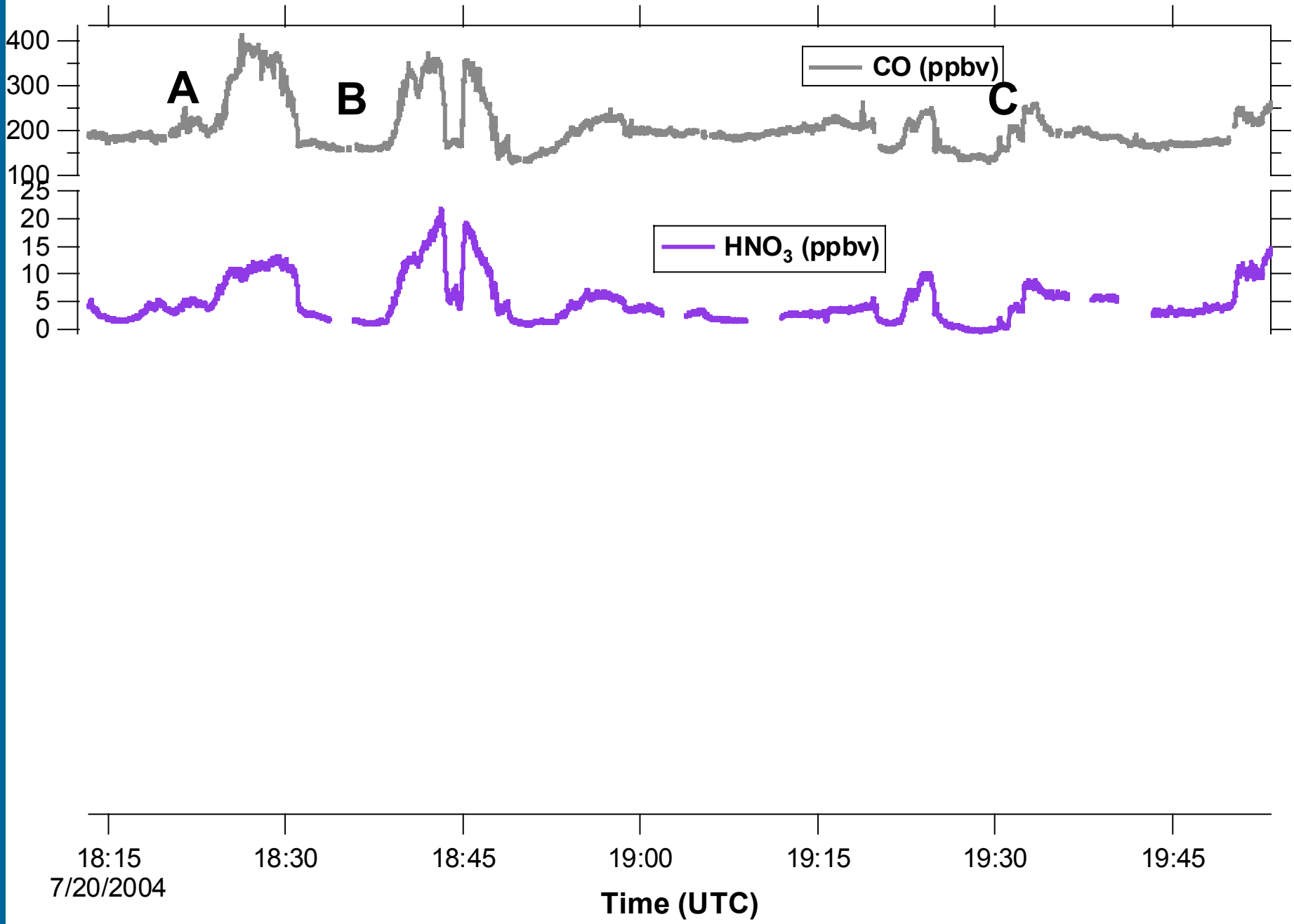

0
2
4
6
8
10
SO2 (ppbv)
0
20
40
60
80
100x10^3
AIRS SO2 (Tons yr^-1)
44
43
42
41
40
39
38
Latitude
-78
-76
-74
-72
-70
-68
Longitude
Primary emissions:
SO2, SO2 sources

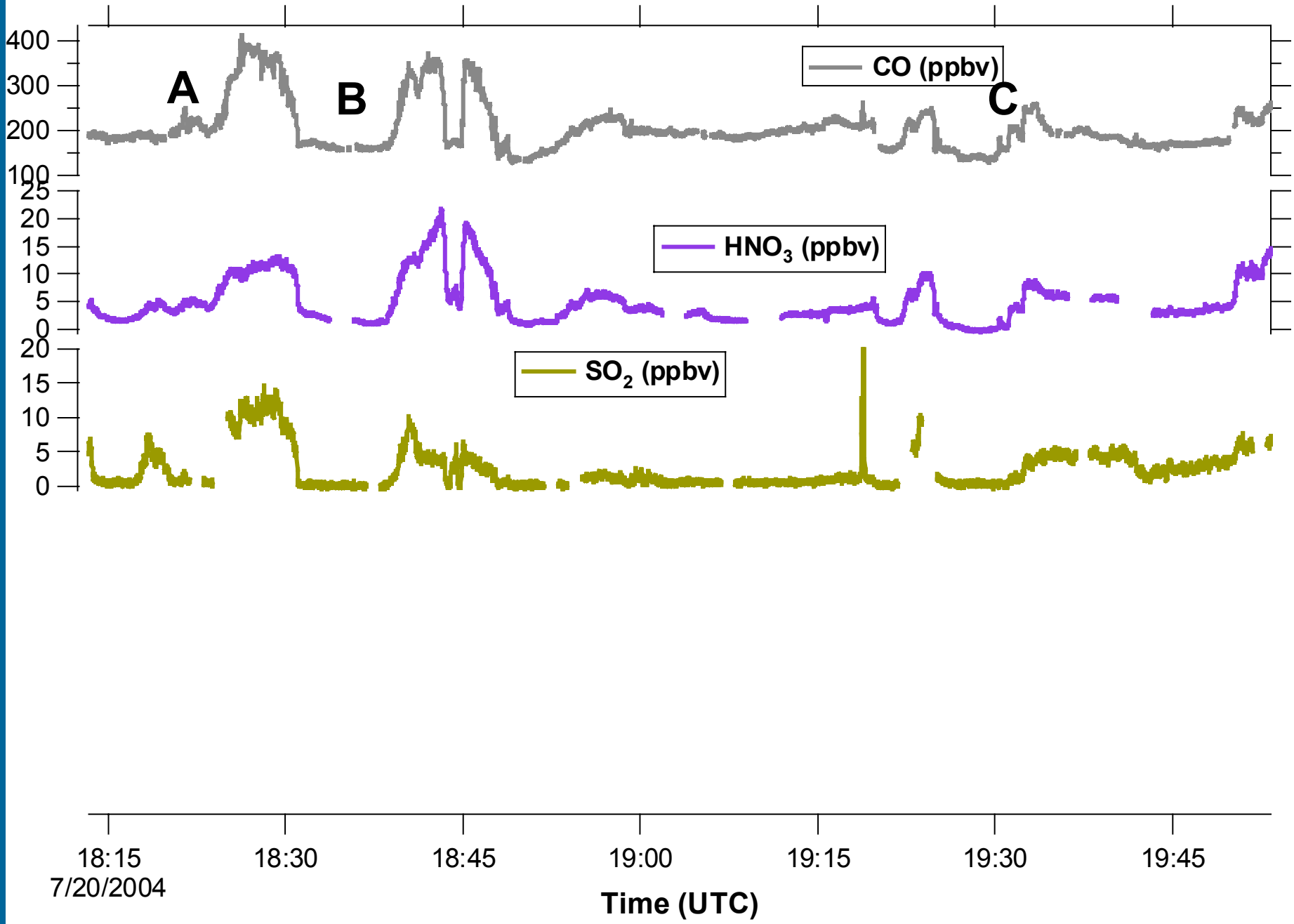

6 8 10 12 14 16 18 20
Particle Volume (μm3cm-3)
0 20 40 60 80 100x10^3
AIRS SO2 (Tons yr-1)
Latitude
44
43
42
41
40
39
38
-78 -76 -74 -72 -70 -68
Longitude
Secondary products:
Particle volume (<1um)

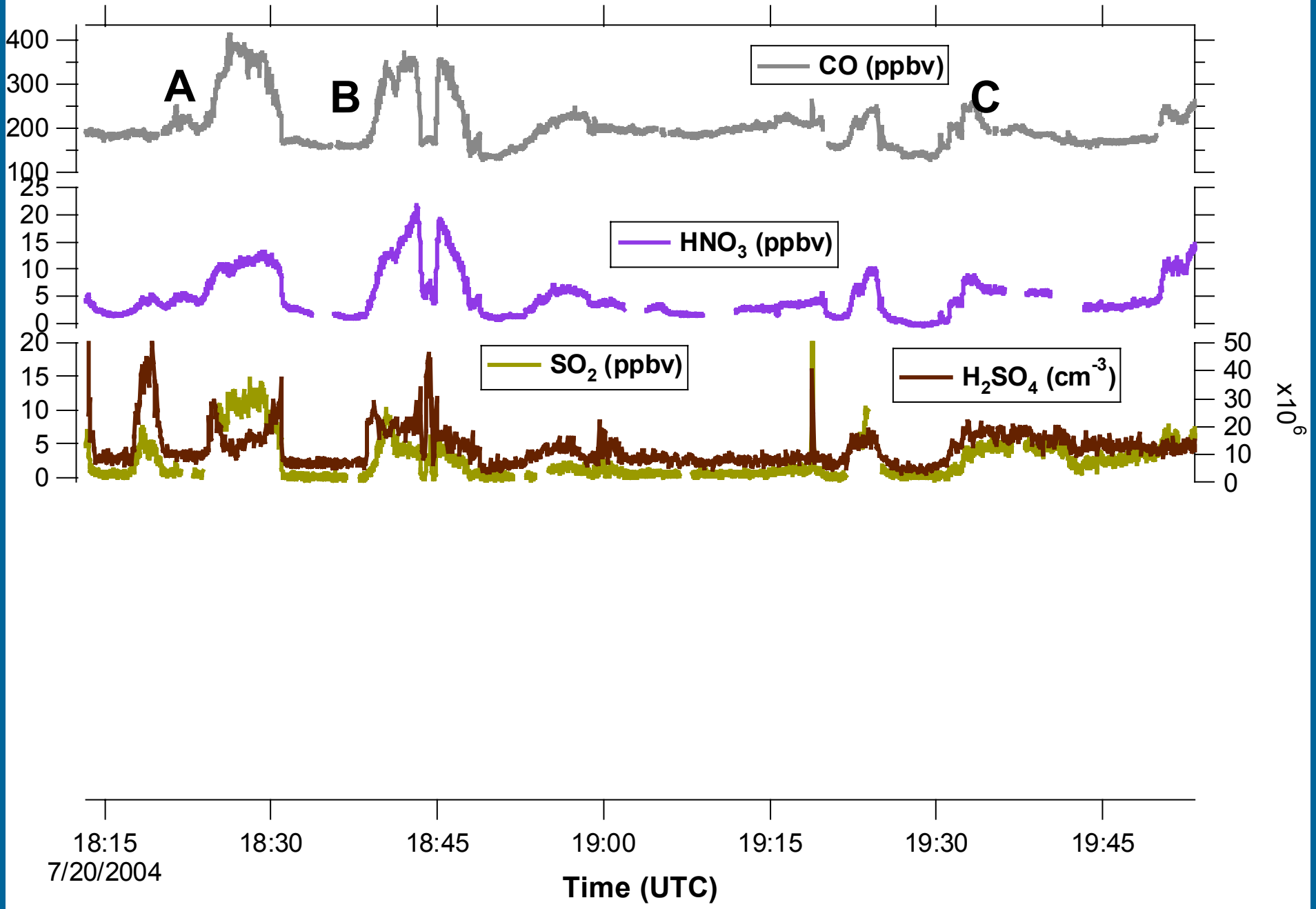

6
8
10
12
14
16
18
20
Particle Volume (μm3cm-3)
42.0
41.5
41.0
40.5
40.0
Latitude
-74
-73
-72
-71
-70
Longitude

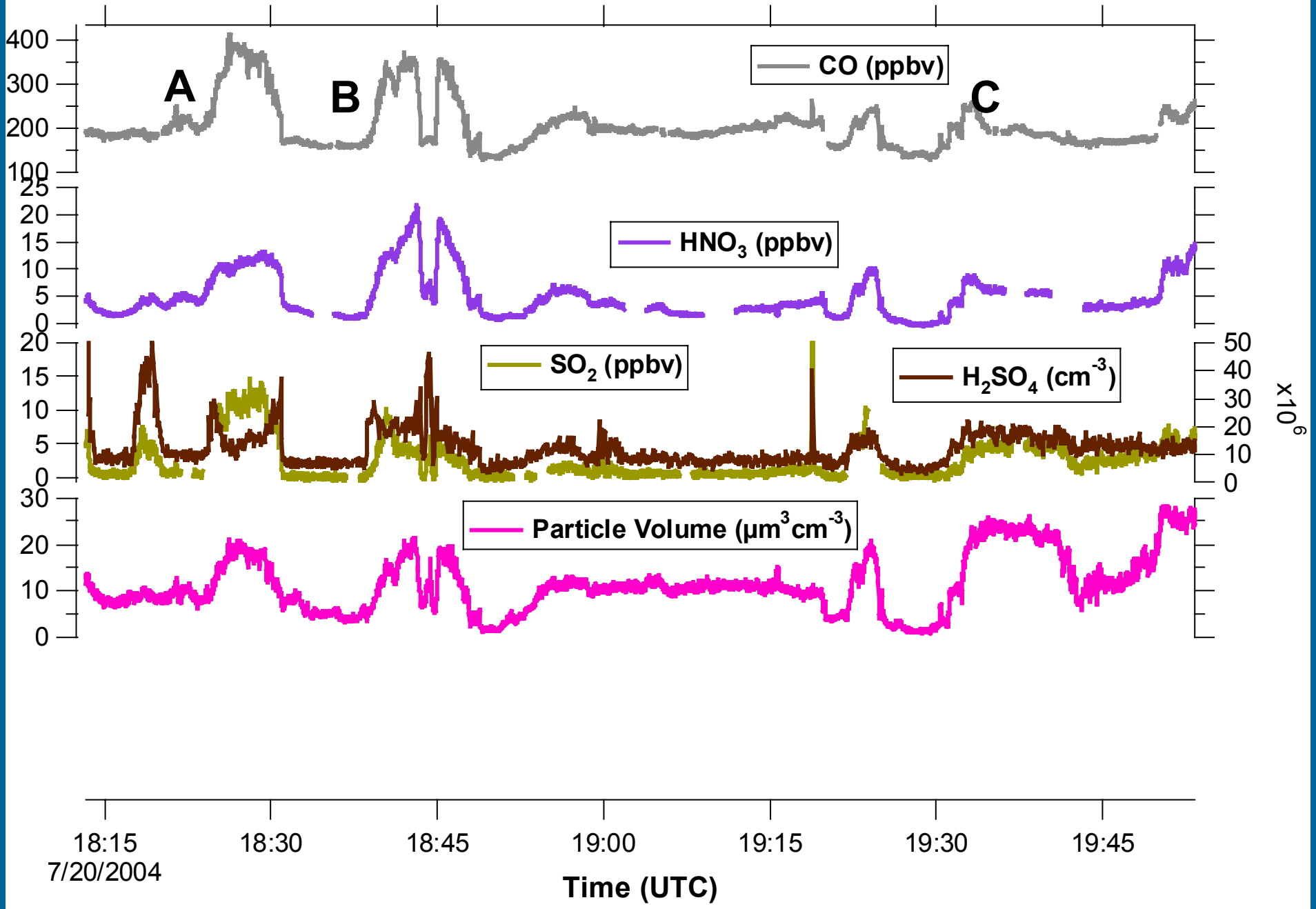

6
8
10
12
14
16
18
20
Particle Volume (μm3cm-3)
42.0
41.5
41.0
40.5
40.0
Latitude
-74
-73
-72
-71
-70
Longitude
A
B
C

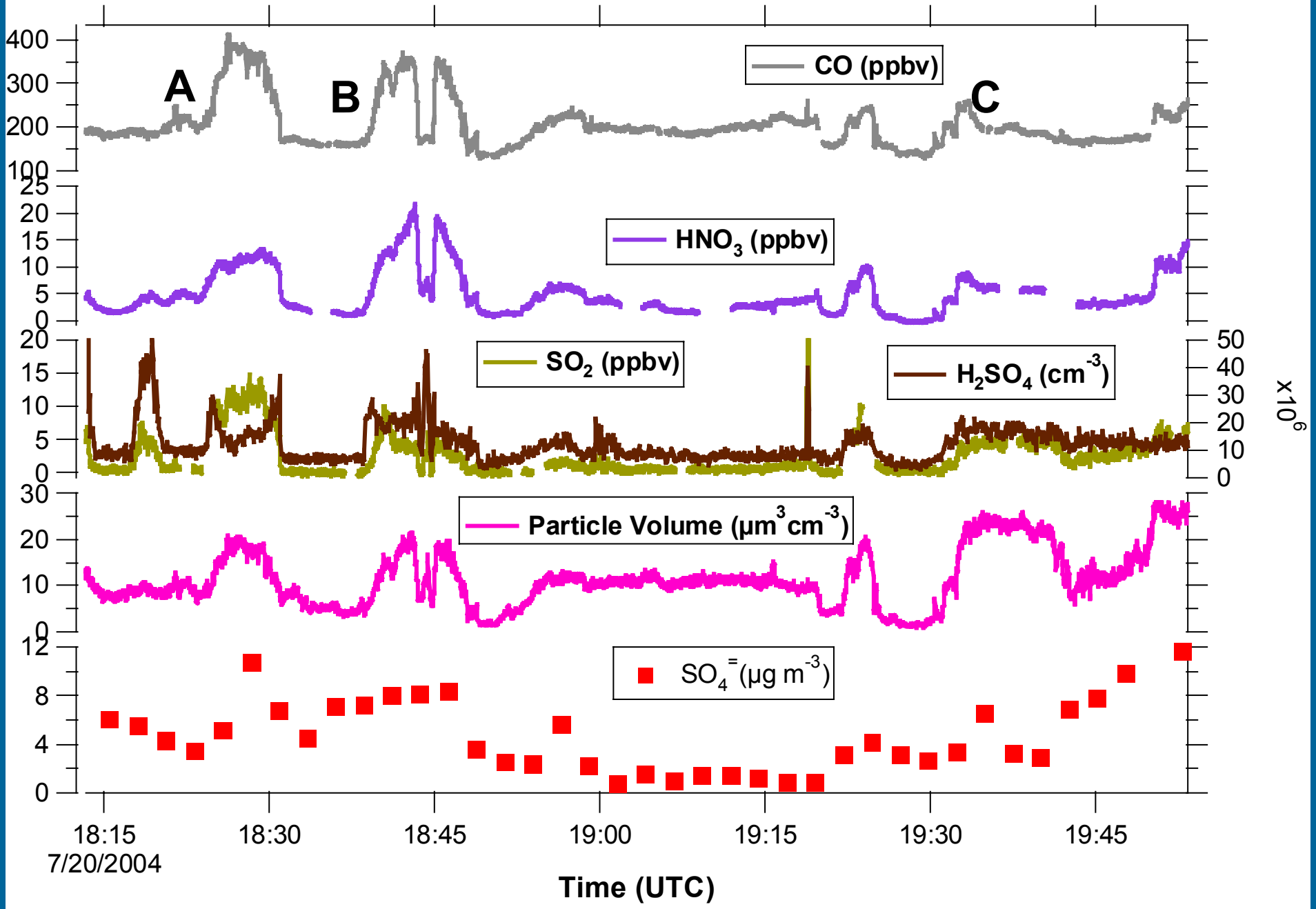

400
300
200
100
A
B
C
CO (ppbv)
18:15
7/20/2004
18:30
18:45
19:00
19:15
19:30
19:45
Time (UTC)

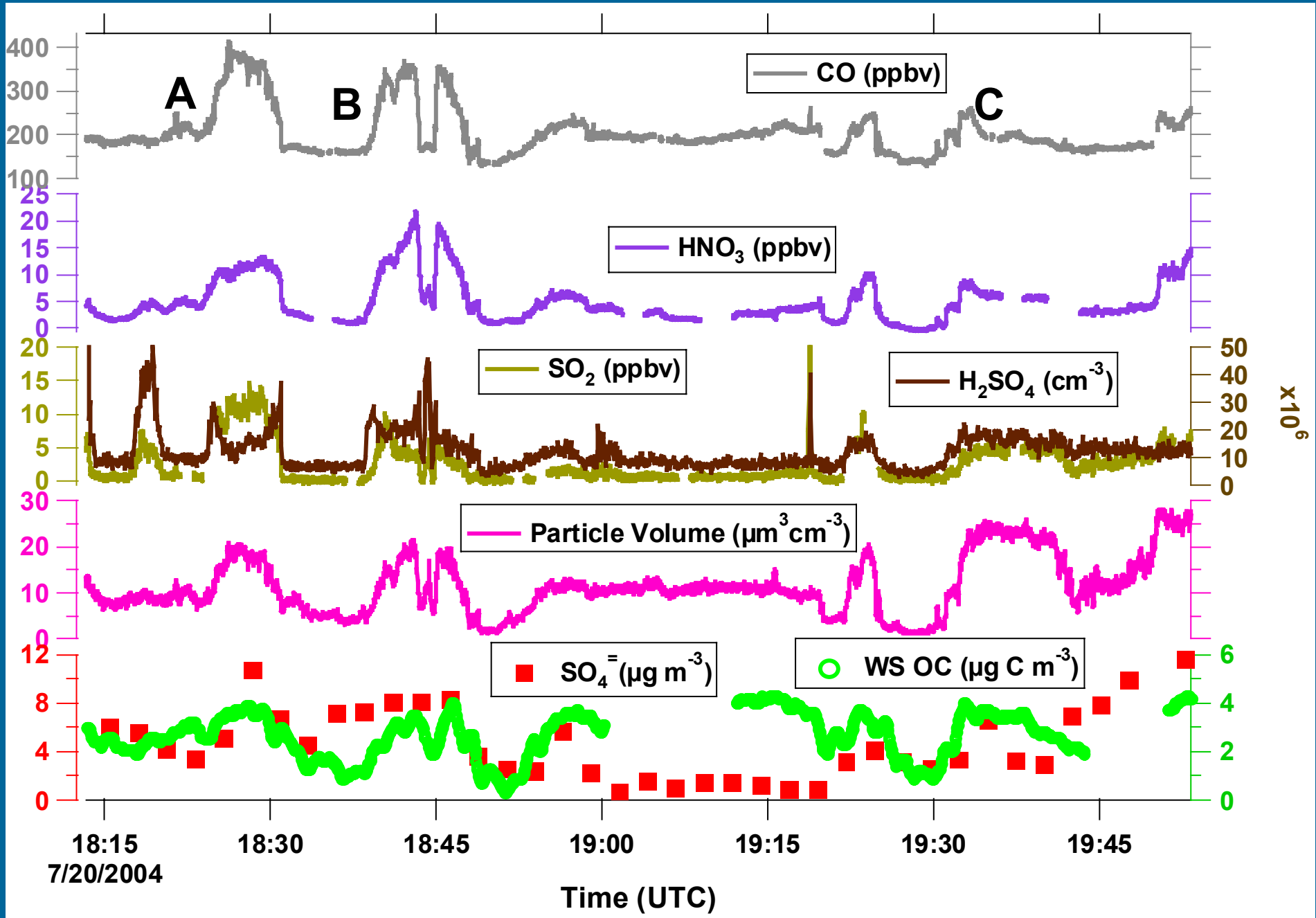

400
300
200
100
A
B
C
CO (ppbv)
25
20
15
10
5
0
HNO3 (ppbv)
18:15
7/20/2004
18:30
18:45
19:00
19:15
19:30
19:45
Time (UTC)


400
300
200
100
A
B
C
CO (ppbv)
25
20
15
10
5
0
HNO3 (ppbv)
20
15
10
5
0
SO2 (ppbv)
18:15
7/20/2004
18:30
18:45
19:00
19:15
19:30
19:45
Time (UTC)

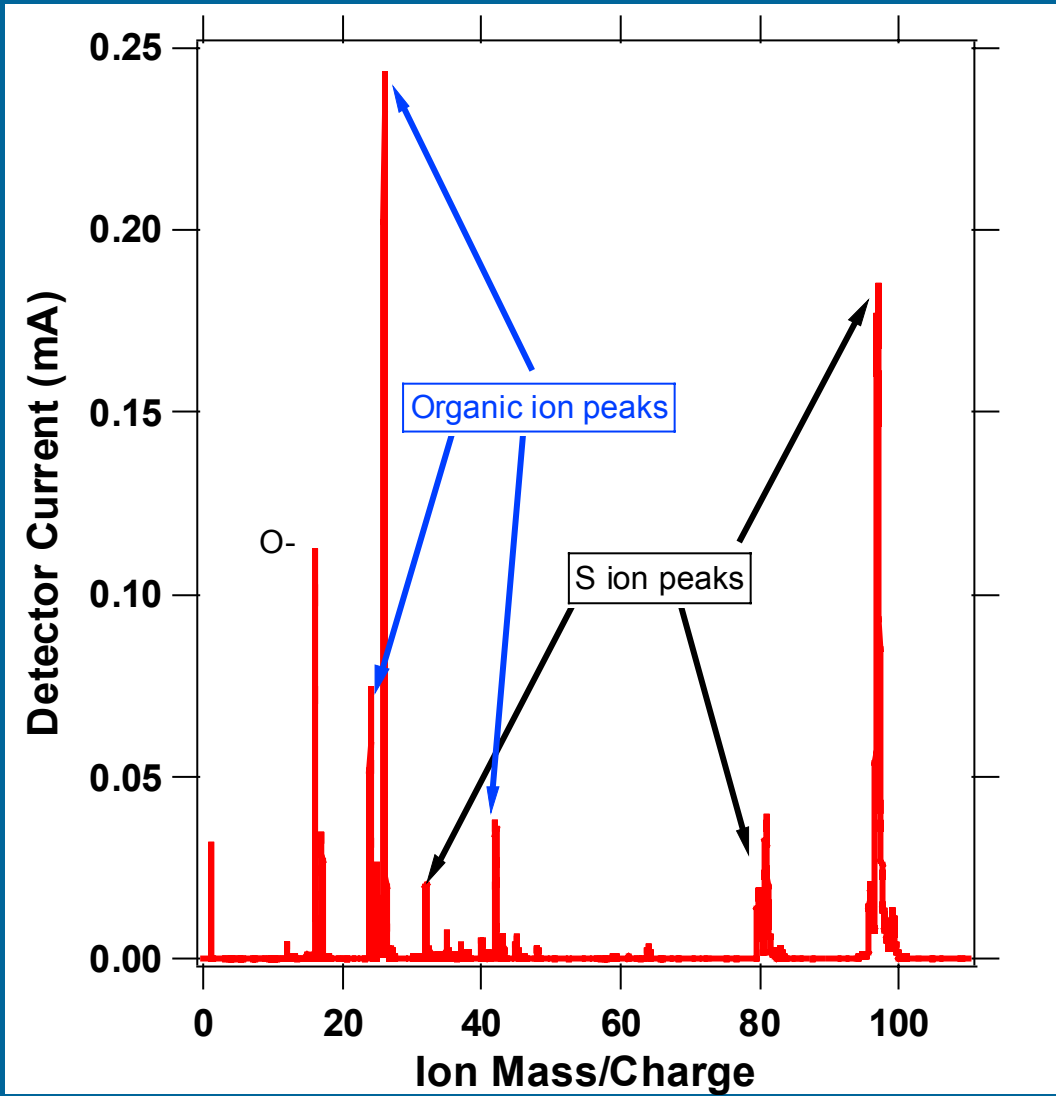

400
300
200
100
A
B
C
CO (ppbv)
25
20
15
10
5
0
HNO3 (ppbv)
20
15
10
5
0
SO2 (ppbv)
H2SO4 (cm-3)
50
40
30
20
10
0
x10^6
18:15
7/20/2004
18:30
18:45
19:00
19:15
19:30
19:45
Time (UTC)

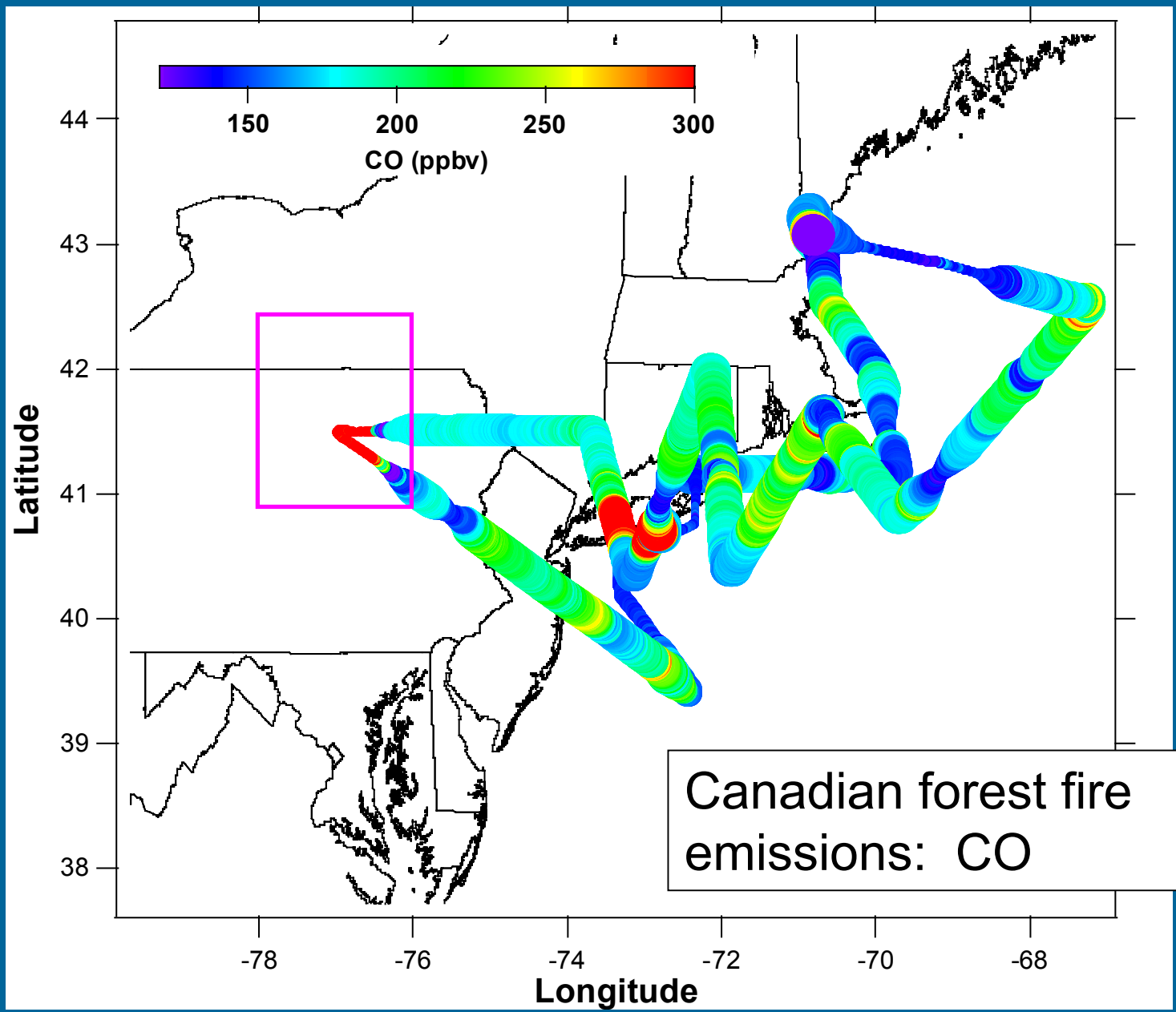

A
B
C
CO (ppbv)
HNO3 (ppbv)
SO2 (ppbv)
H2SO4 (cm-3)
x10^6
Particle Volume (μm3cm-3)
18:15
7/20/2004
18:30
18:45
19:00
19:15
19:30
19:45
Time (UTC)

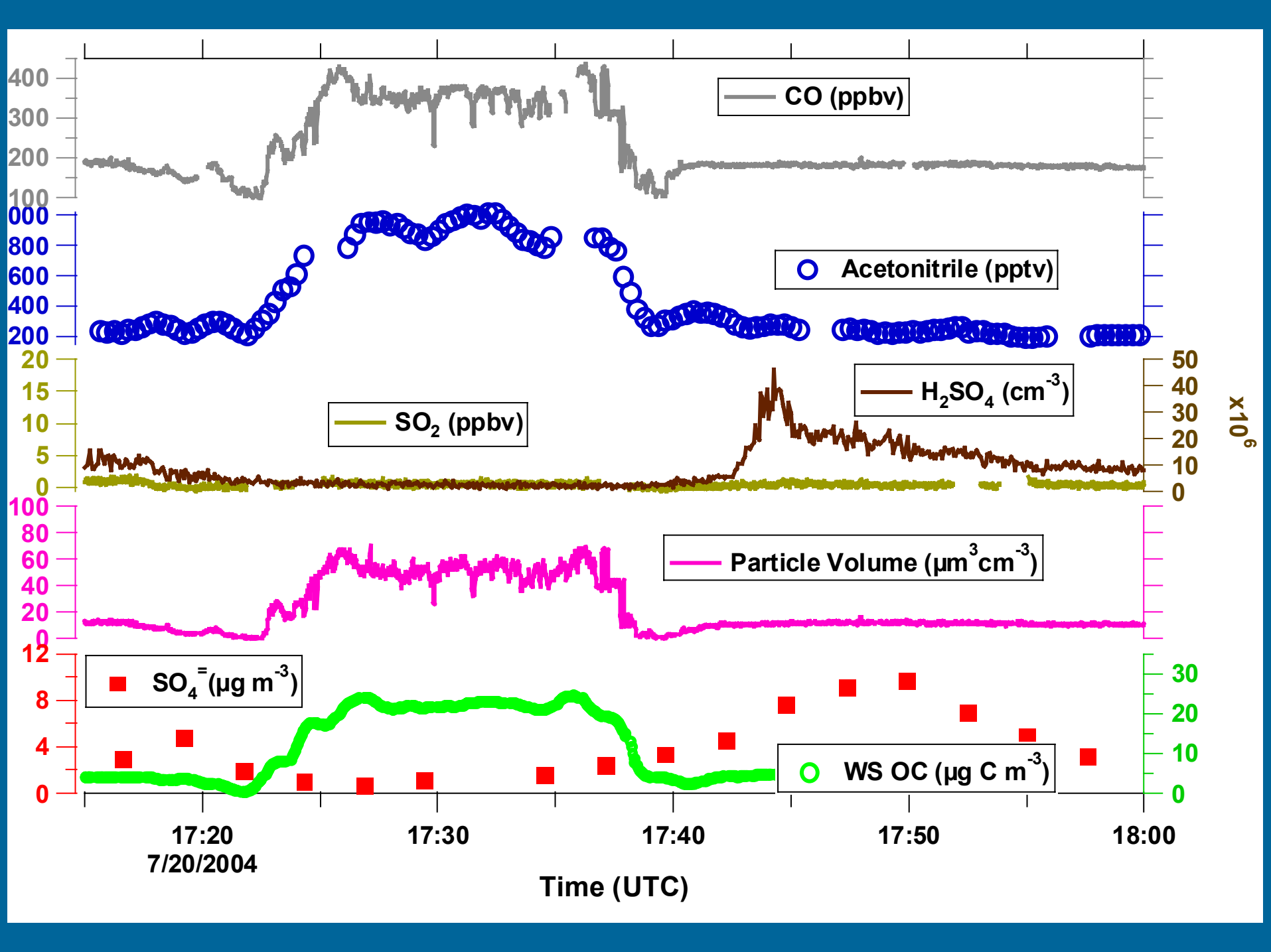

A
B
C
CO (ppbv)
HNO3 (ppbv)
SO2 (ppbv)
H2SO4 (cm-3)
x10^6
Particle Volume (μm3cm-3)
SO4= (μg m-3)
18:15
7/20/2004
18:30
18:45
19:00
19:15
19:30
19:45
Time (UTC)


A
B
C
CO (ppbv)
HNO3 (ppbv)
SO2 (ppbv)
H2SO4 (cm-3)
x10^6
Particle Volume (μm3cm-3)
SO4= (μg m-3)
WS OC (μg C m-3)
18:15
7/20/2004
18:30
18:45
19:00
19:15
19:30
19:45
Time (UTC)

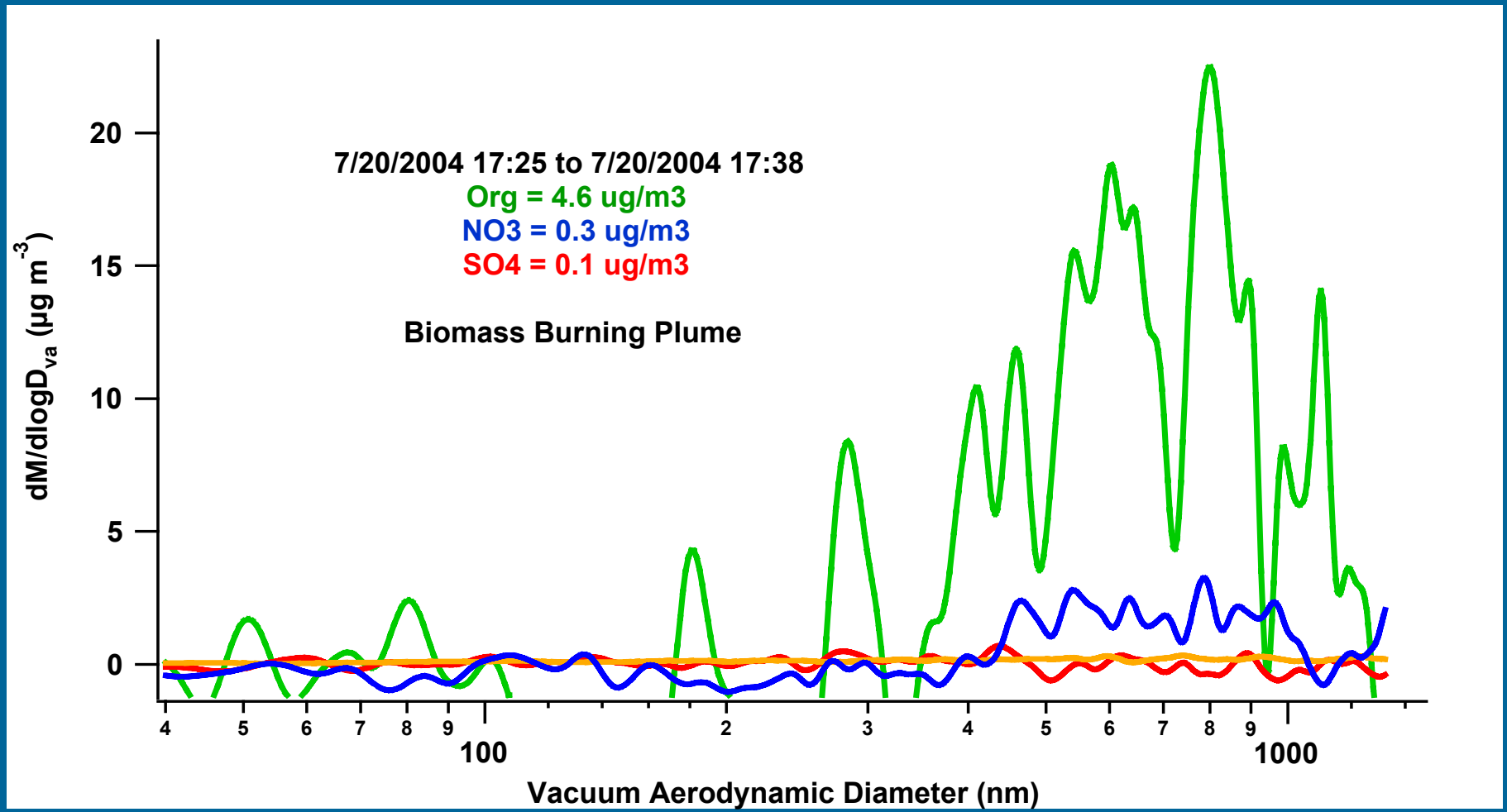
PALMS readers say vast majority of particles in NY plume are mixed organic-sulfate



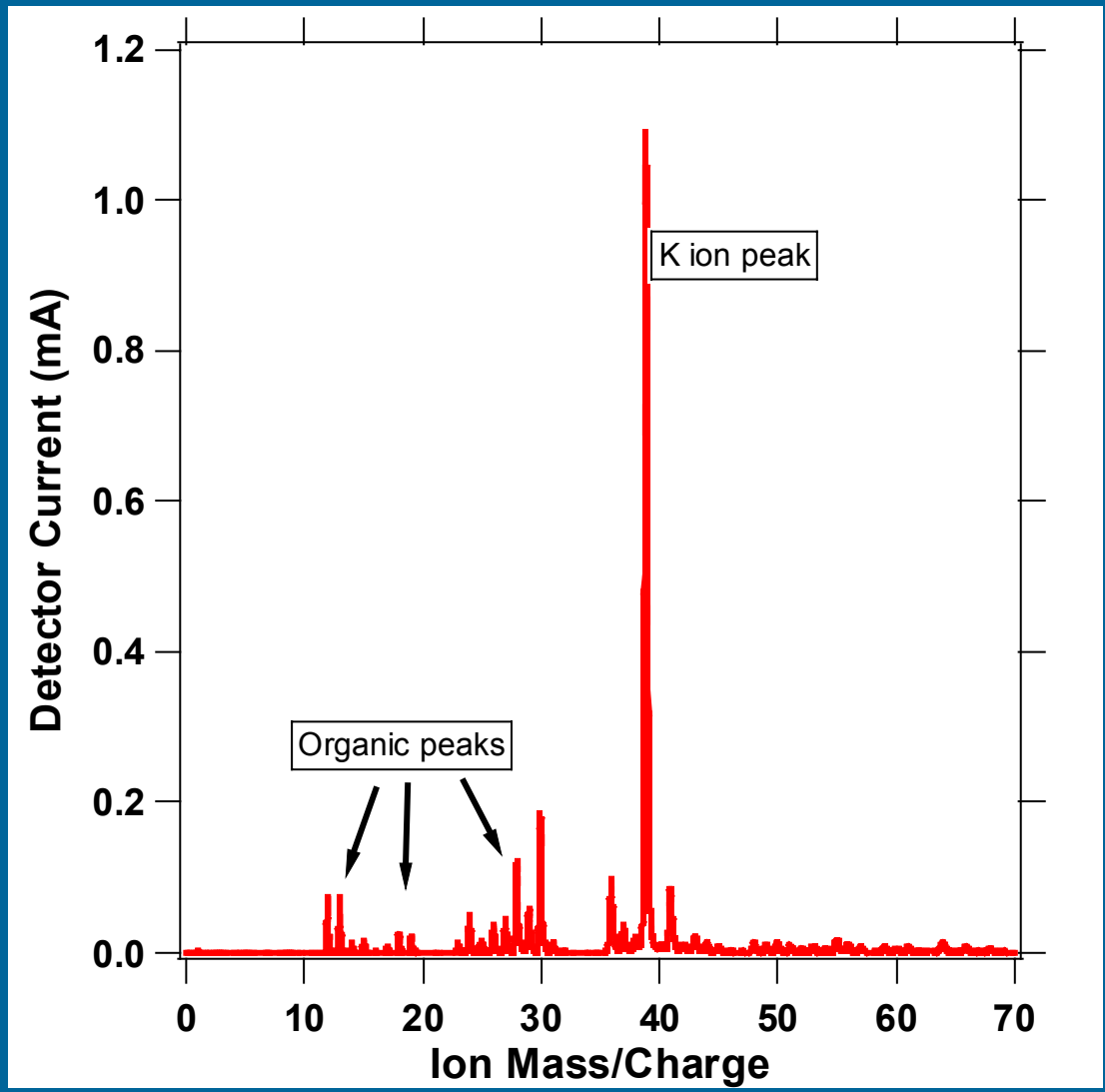

150
200
250
300
CO (ppbv)
44
43
42
41
40
39
38
Latitude
-78
-76
-74
-72
-70
-68
Longitude
Canadian forest fire emissions: CO


CO (ppbv)
Acetonitrile (pptv)
SO_2 (ppbv)
H_2SO_4 (cm^{-3})
x10^6
Particle Volume ($\mu m^3 cm^{-3}$)
$SO_4^=$ ($\mu g\ m^{-3}$)
WS OC ($\mu g\ C\ m^{-3}$)
17:20
7/20/2004
17:30
17:40
17:50
18:00
Time (UTC)

AMS shows organic mass from 0.4 to 1 um D_{va}



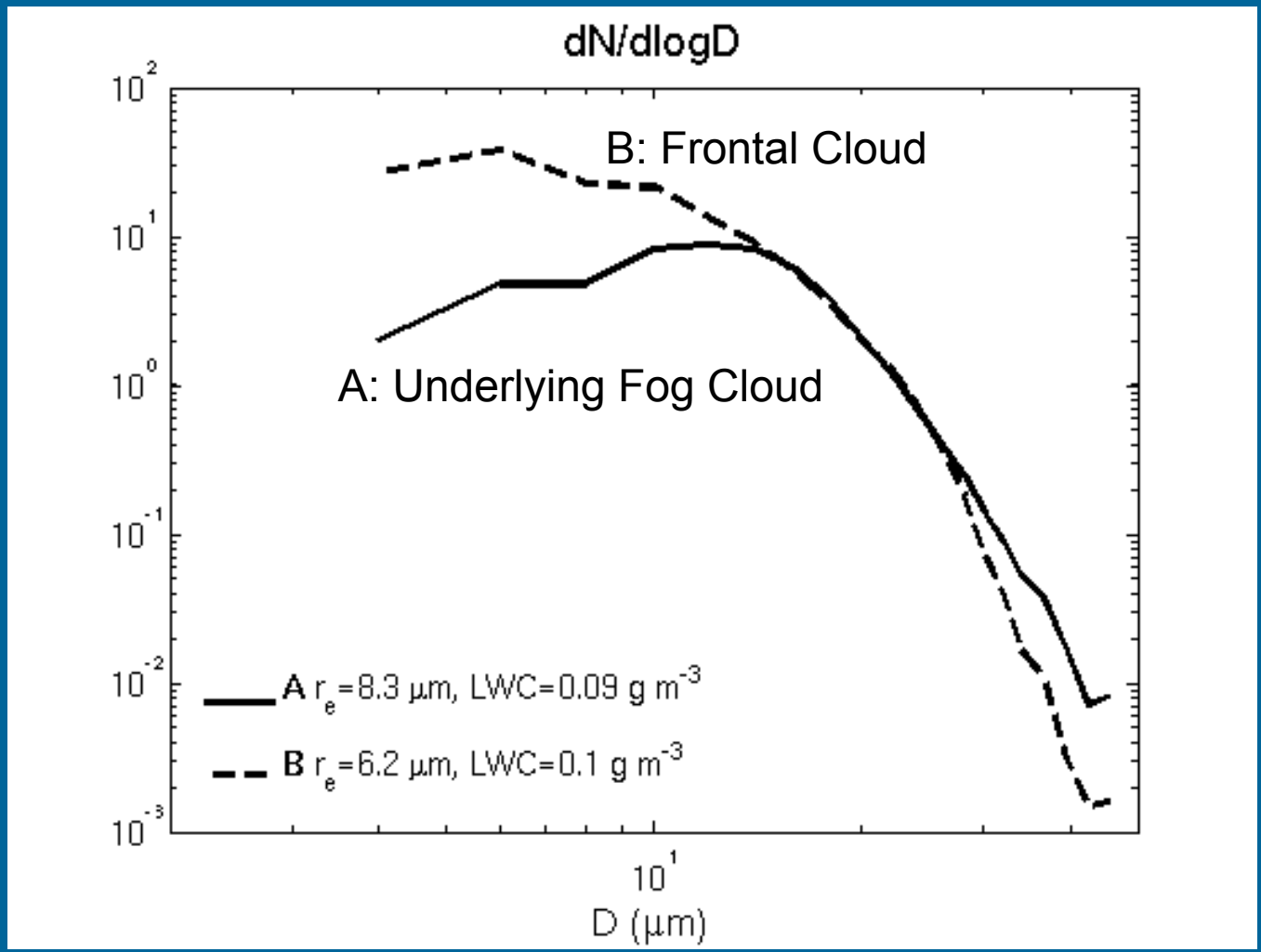
PALMS readers say vast majority of particles in forest fire plume are potassium-rich with organics



Cloud studies

- How do clouds pump pollution into the free troposphere?
- In what way are clouds made brighter and to precipitate less by pollution (aerosol indirect effect)?

July 9



Frontal cloud had much higher sulfate, PAN, and acetone concentrations, but similarly low levels of CO and toluene. Suggests aging of pollution produced cloud with more numerous and smaller droplets.

Summary

- A diverse set of data of high quality
- Complex sources and processes
- Modeling and meteorological analysis will be key in analysis
- Need to incorporate remote sensing, other airborne platforms, surface data