SPLAT II:

Single Particle Mass Spectrometer

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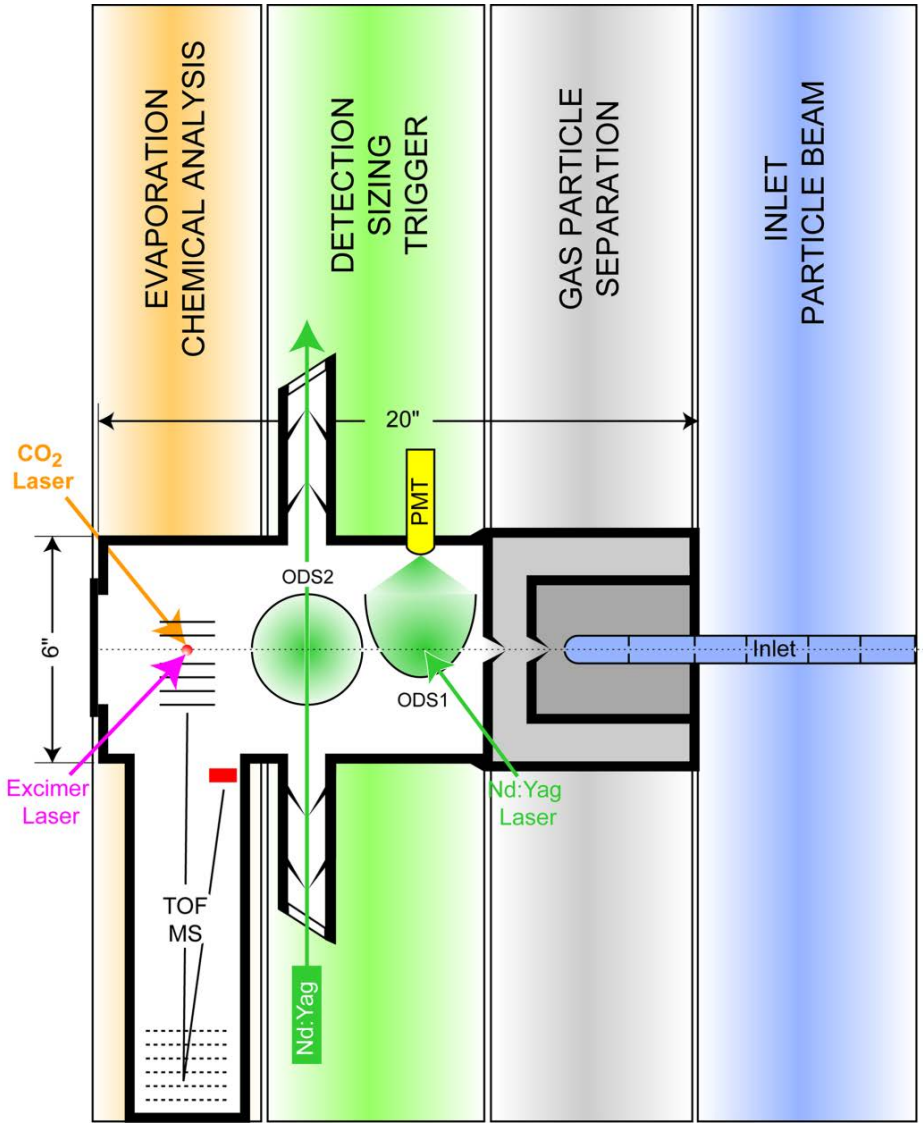
Single Particle Mass Spectrometer - SPLAT II



- Provides in *real-time* the size and internal composition of individual particles in 50 nm to 3 µm size range
- Measures refractory and non-refractory aerosol fractions in each particle
- Yields size distributions (d_{va}) and number concentrations
- Sampling rate: sizes up to 5000 p/sec, 20-100 of which are also chemically characterized
- High sensitivity: detects 50% of 85 nm particles, and at least 1 p/sec for an sample of 1p/cm^3 with d>100 nm
- Provides *real-time* information about particle asphericity
- Yields densities for particle classes with different internal compositions

Zelenyuk, Yang, Imre, Choi **(2009a)** *AS&T,* 43:5,411-424.
Zelenyuk, Yang, Imre, Choi **(2009b)** *AS&T,* 43:4, 305-310.
Zelenyuk, Imre **(2009)** *Int. Rev. Phys. Chem.,* 28(2):309-358.

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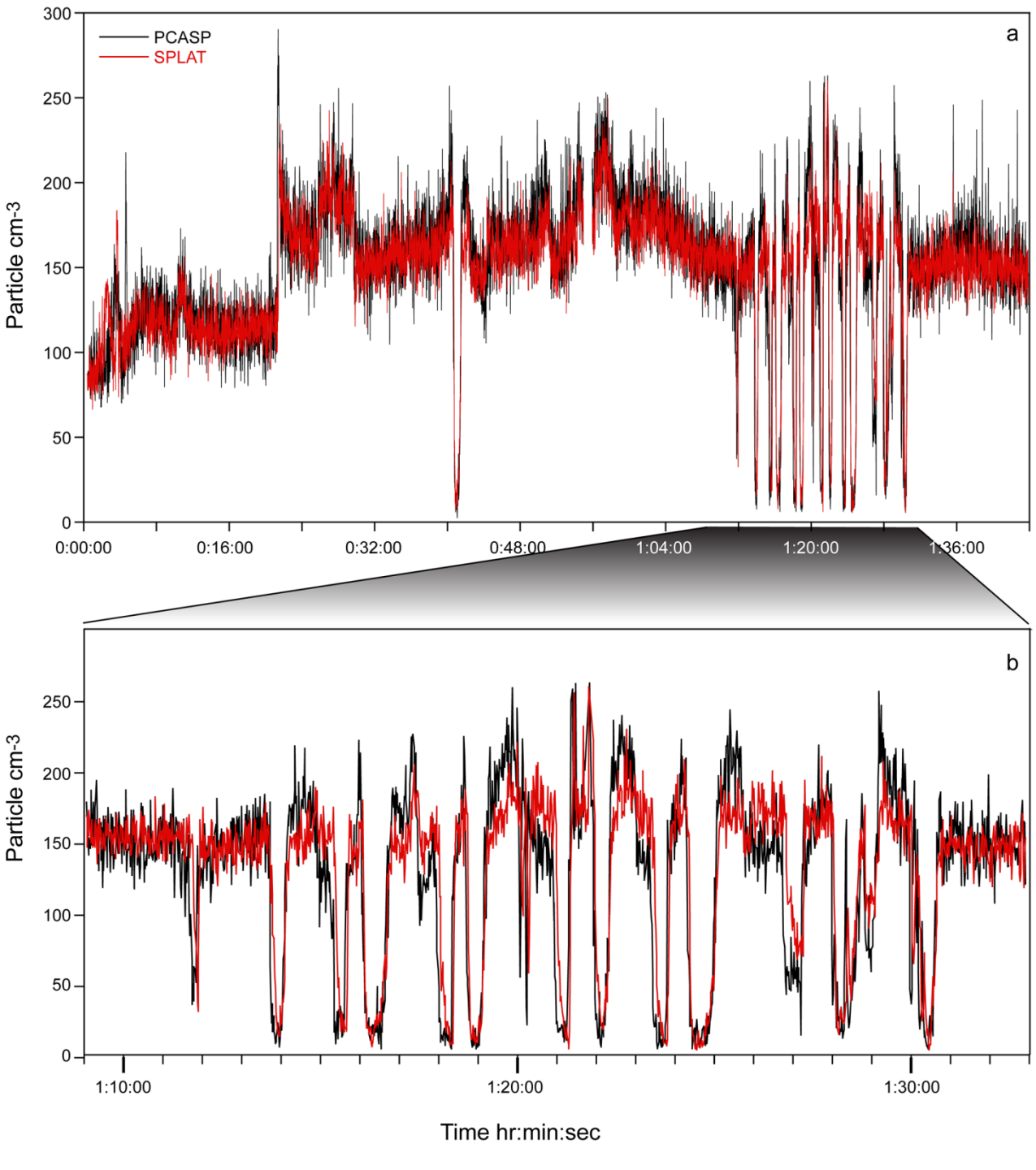
Number Concentrations

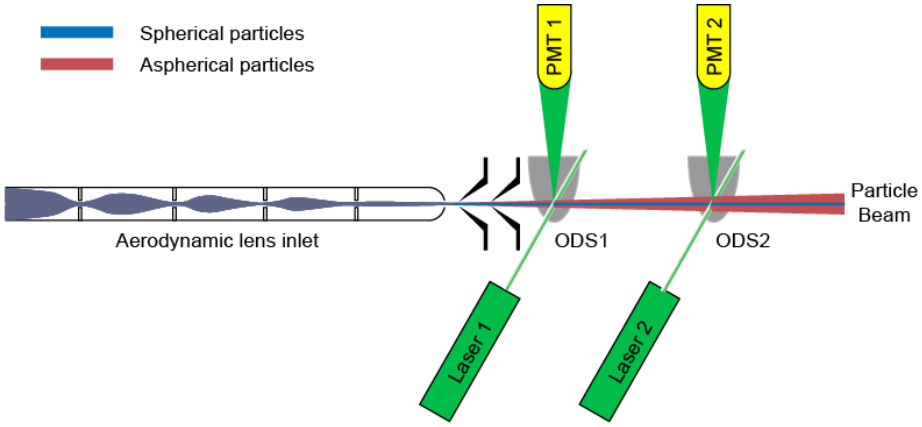


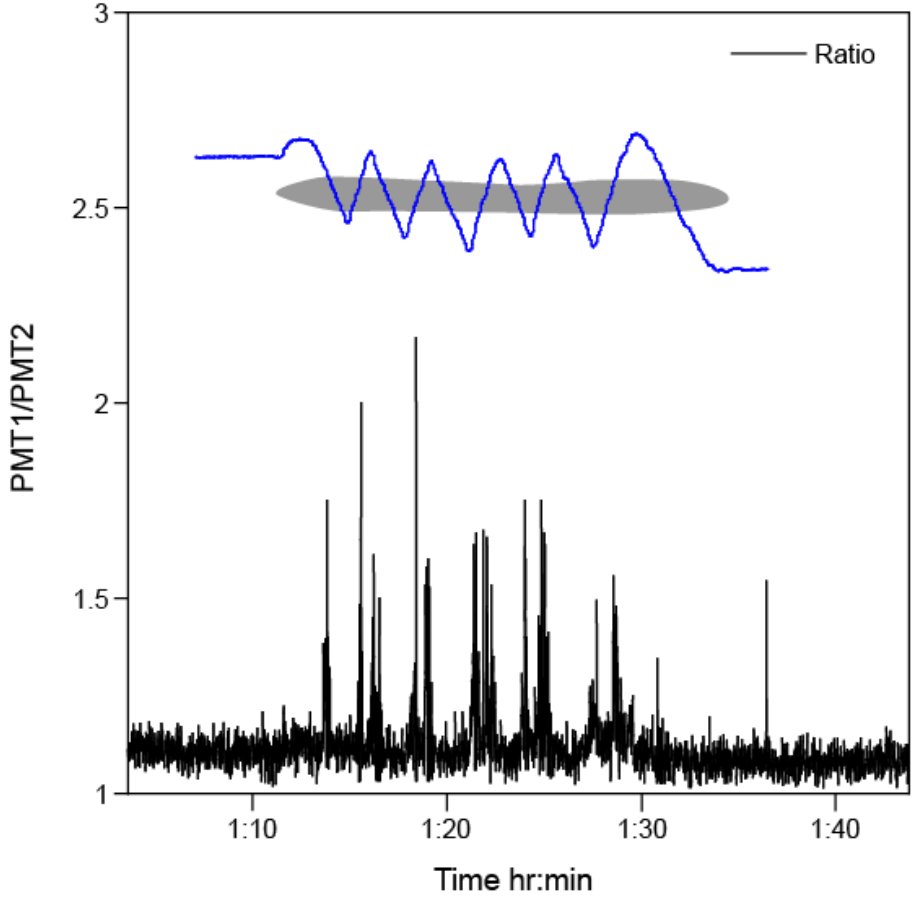
Particle number concentrations measured with 1 sec resolution.

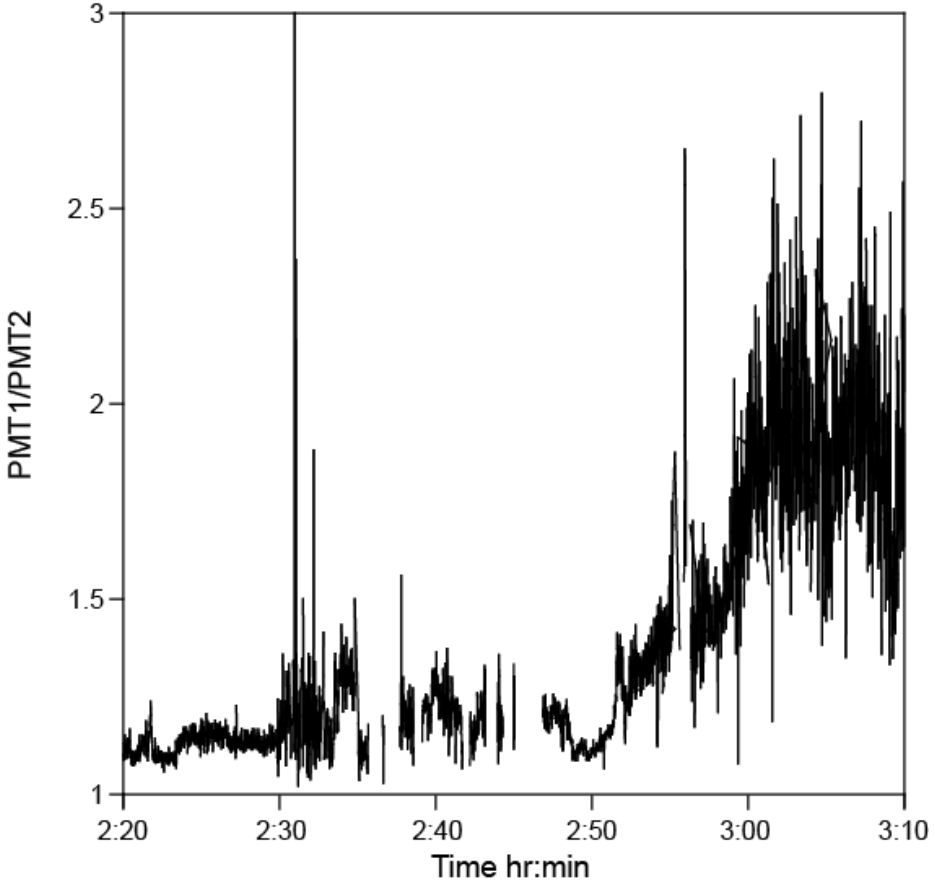
Comparison between SPLAT and PCASP.

Vaden, Imre, Beranek, Zelenyuk **(2011a)** *AS&T,* 45:113.

Aerosol Asphericity

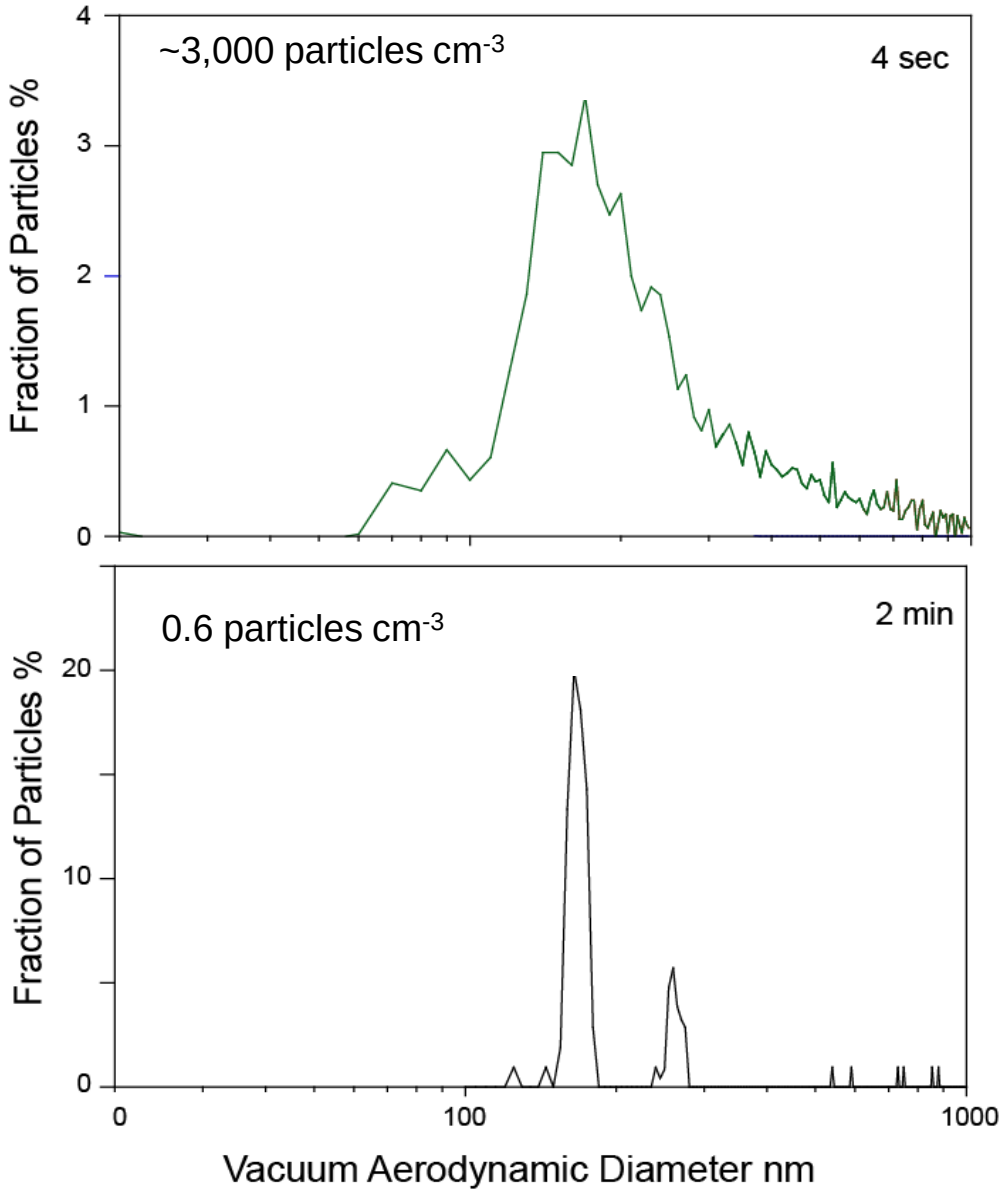






Vaden, Imre, Beranek, Zelenyuk **(2011a)** *AS&T,* 45:113.

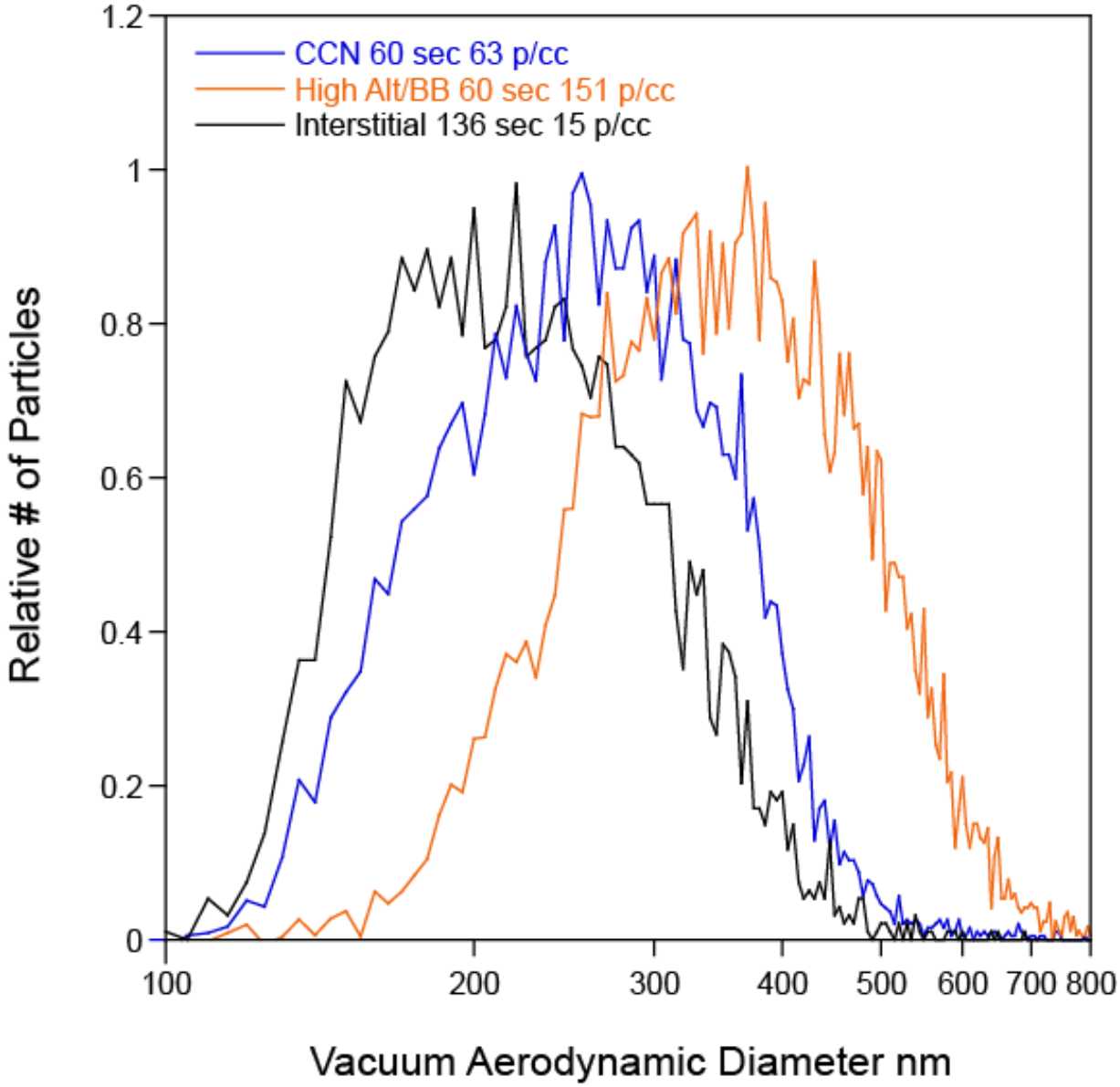
Particle Size Distributions



- ✓ Sizes particles with 0.5% precision
- ✓ Particle size distributions are measured with high temporal resolution, even for very low particle concentrations.

Vaden, Imre, Beranek, Zelenyuk **(2011a)** *AS&T,* 45:113.

Particle Size Distributions



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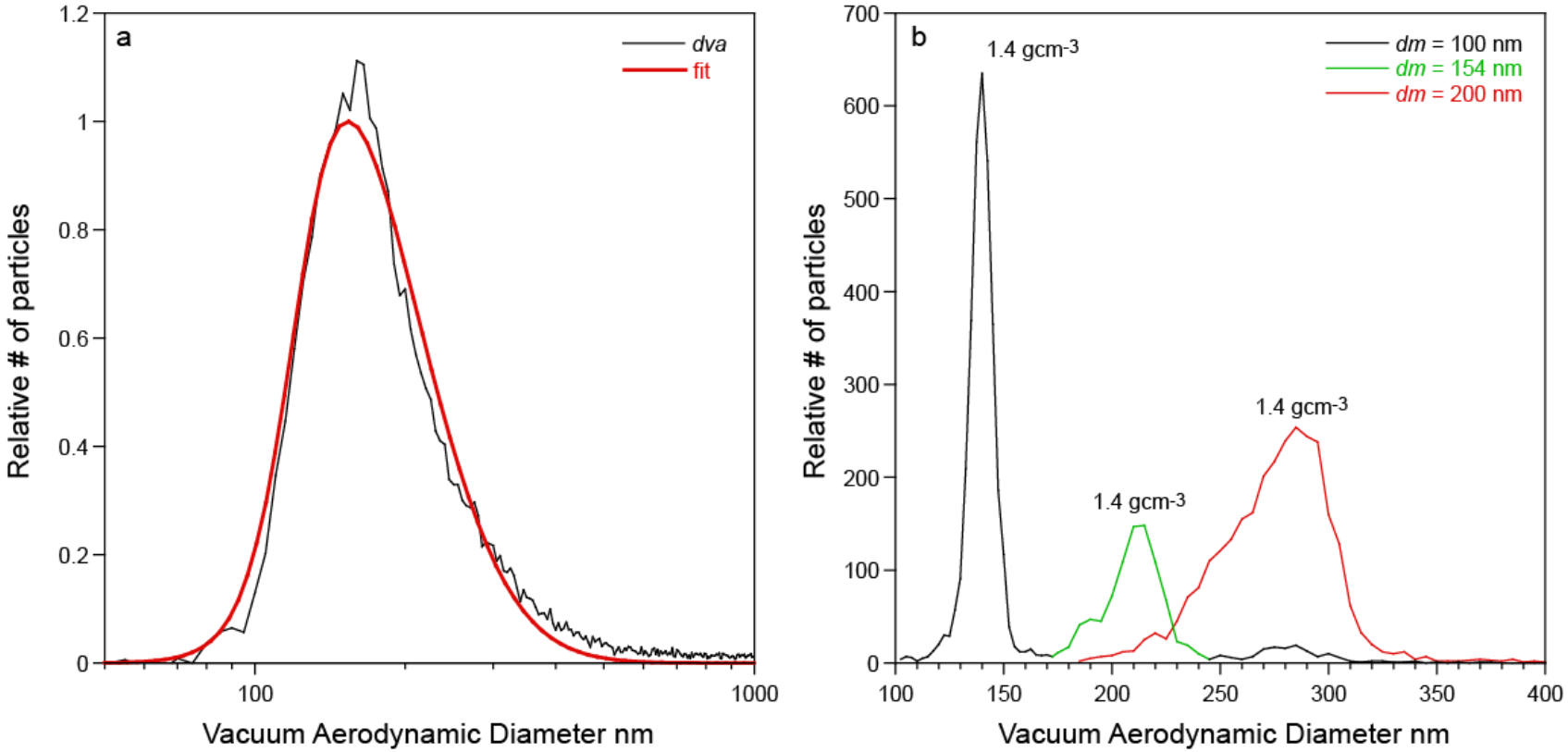
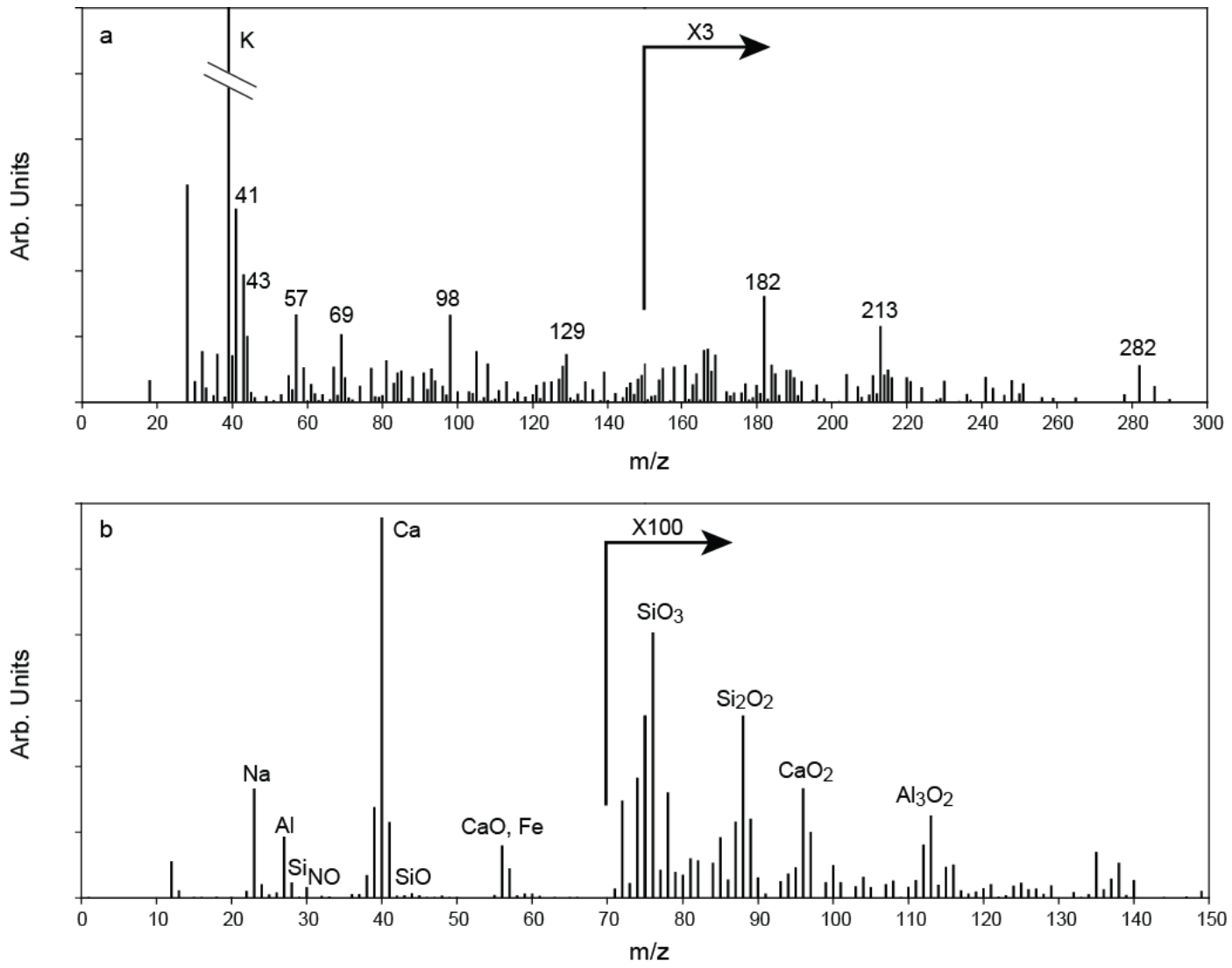
Particle Density from SPLAT (no DMA)



We can measure particle density directly from SPLAT measured size distributions. We can do it for all particles or for composition resolved data.

Individual Particle Composition



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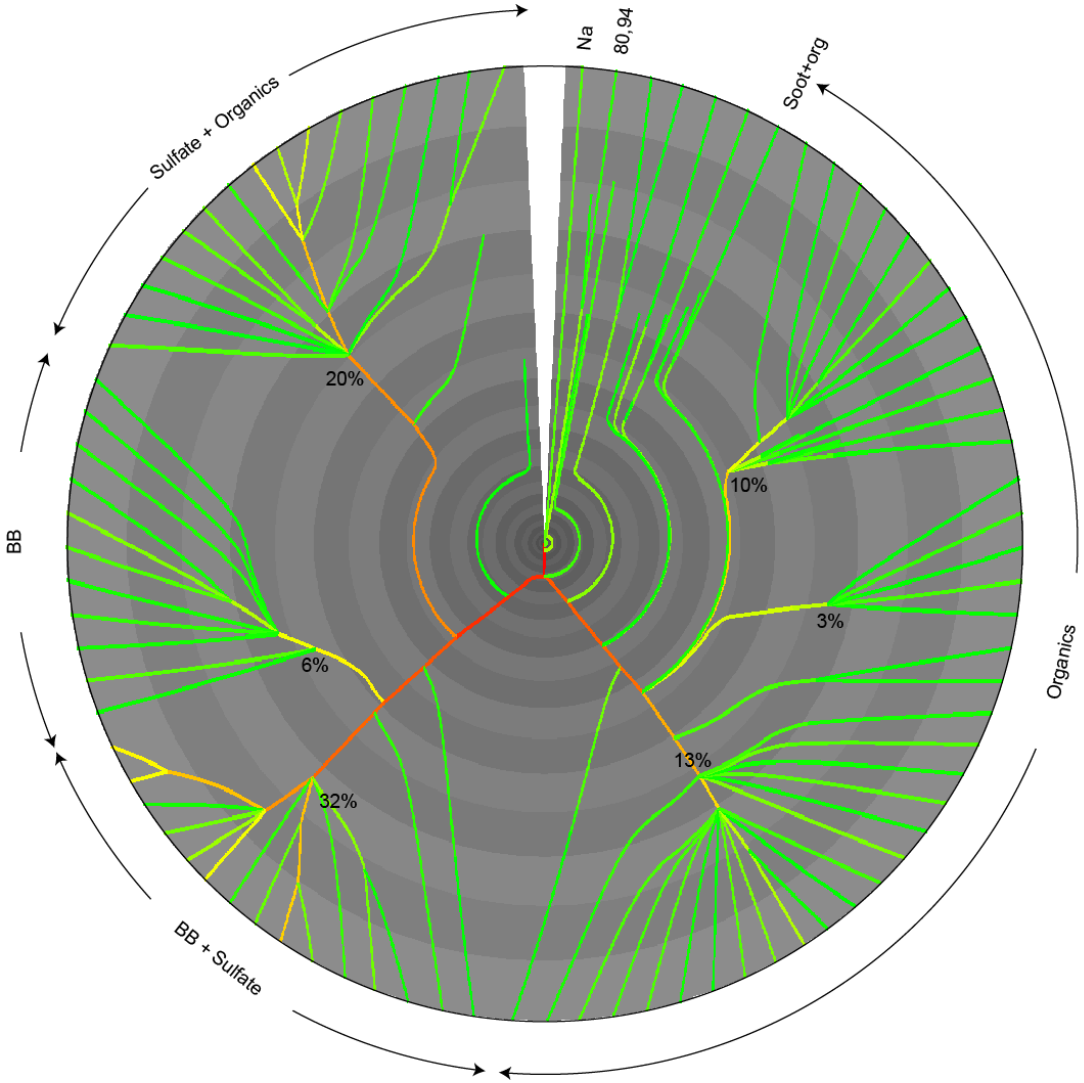
Data Classifications



Composition of 140,000 particles

We classify the mass spectral data and display the results in a circular dendogram that is explore able.

The data for flights 25 and 26 show that the vast majority of the particles fits into 5 major types:

sulfate with some organics

BB

BB with sulfate

Organics

Others

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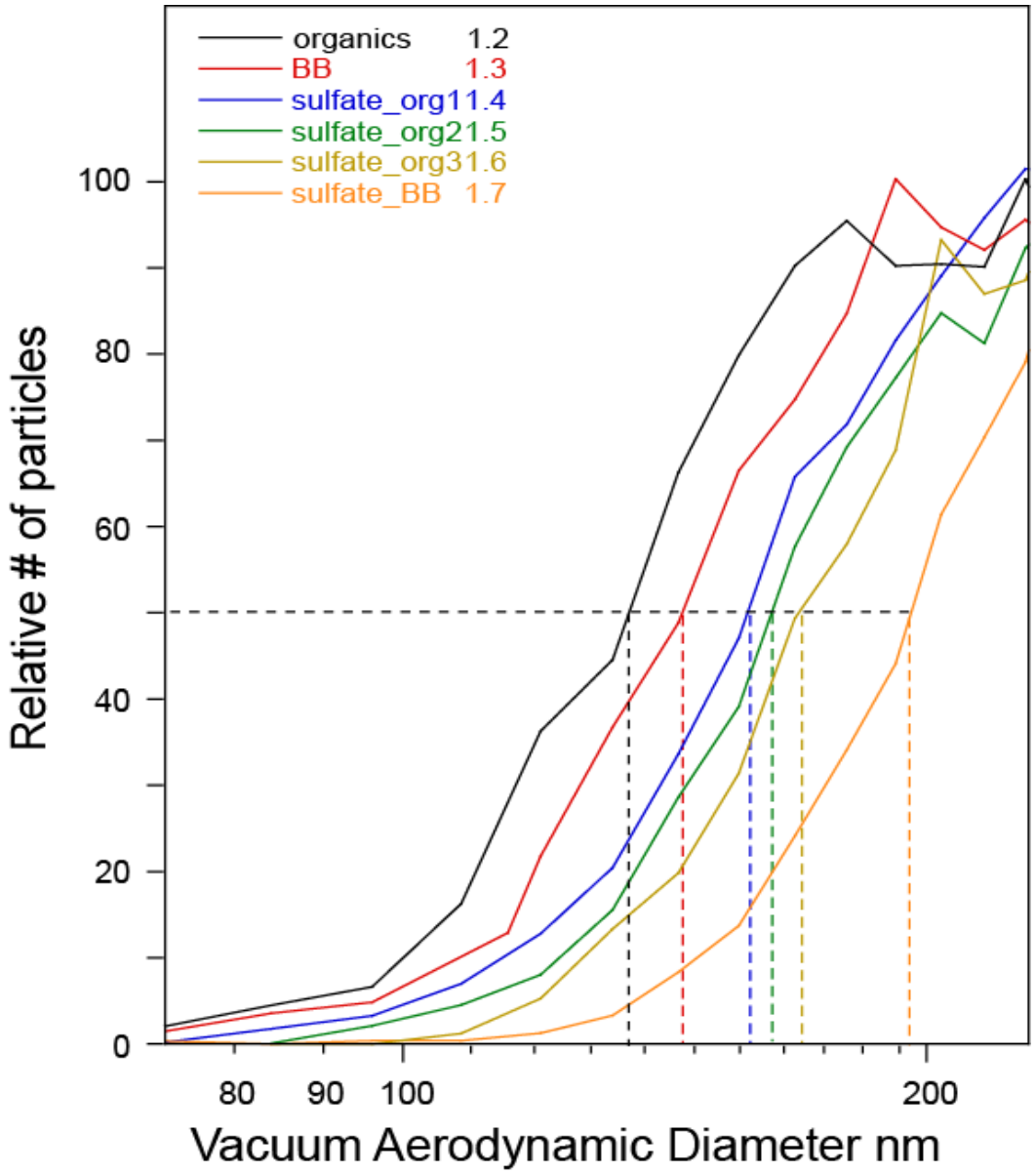
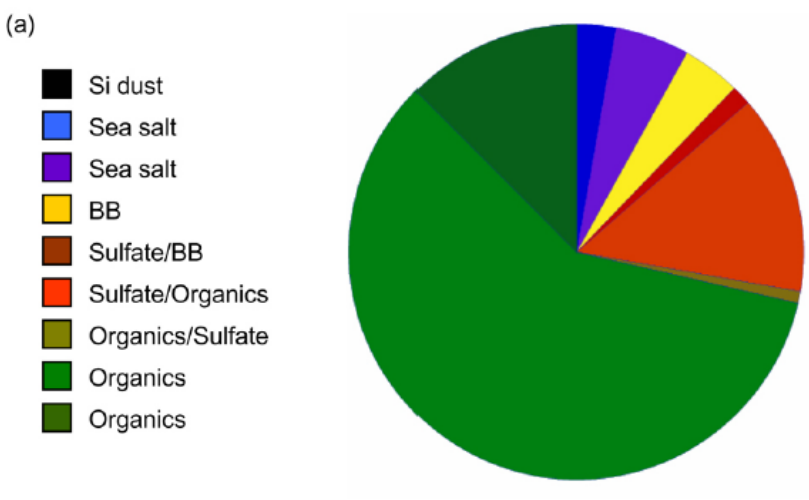
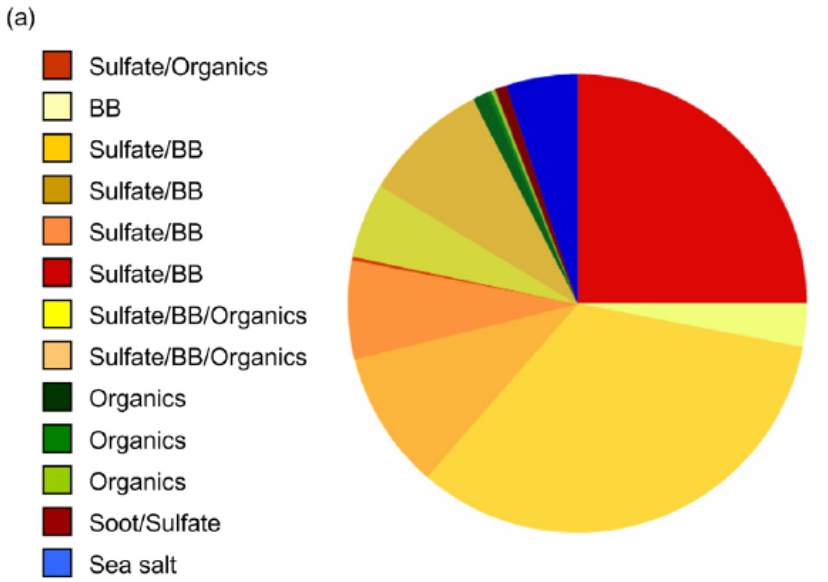
Composition-Resolved Particle Density

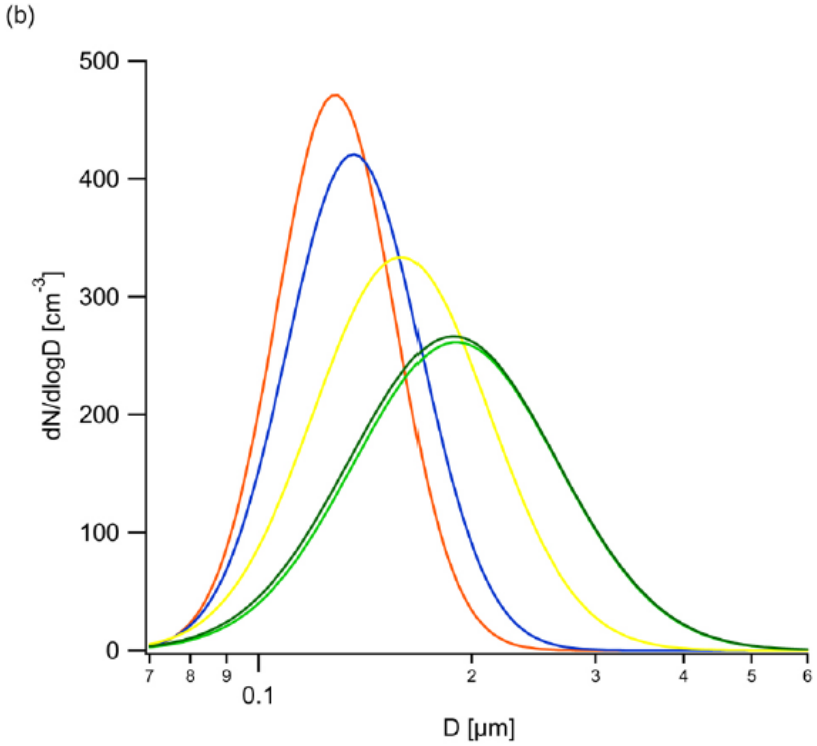


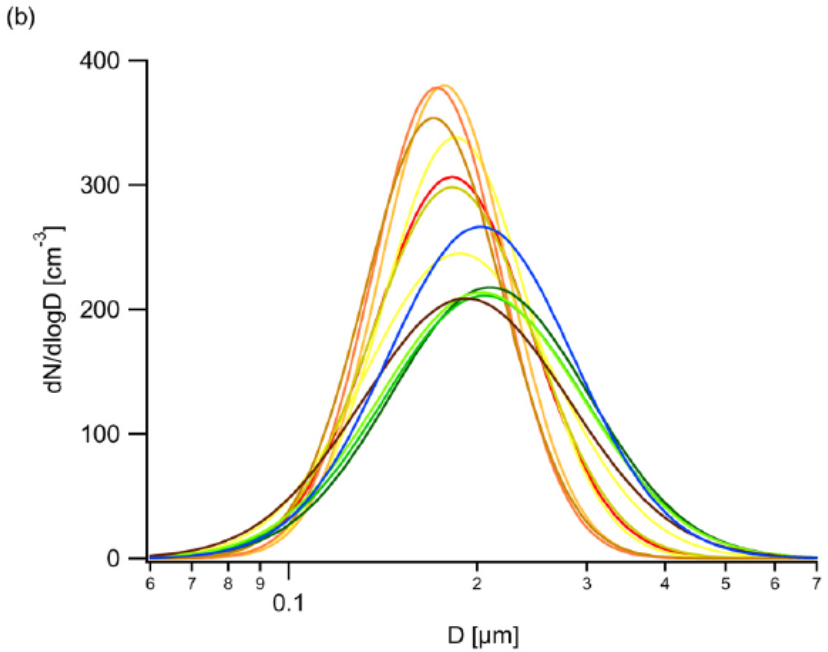
Vaden, Imre, Beranek, Zelenyuk **(2011b)** *AS&T,* 45:125.

Particle Size Distributions



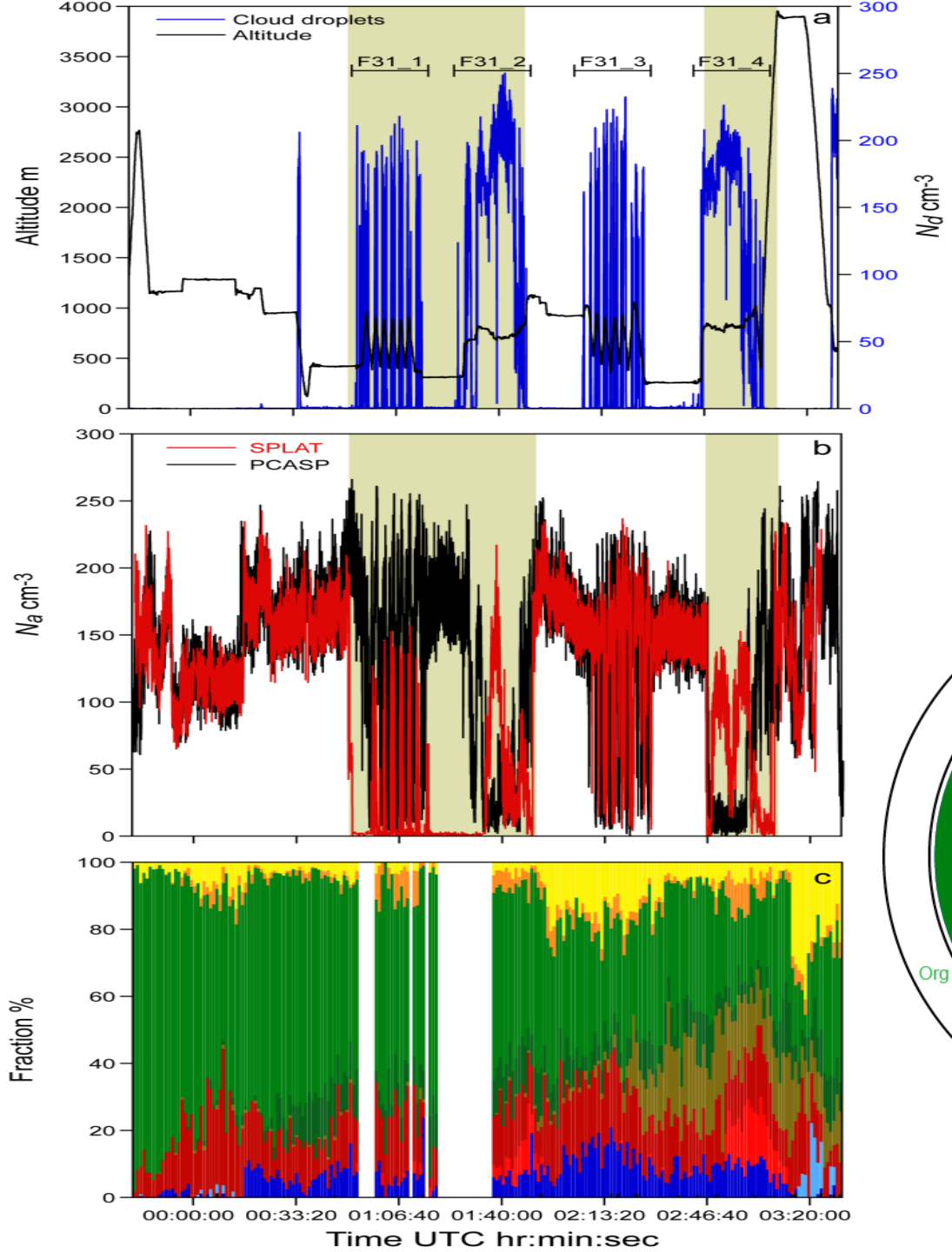


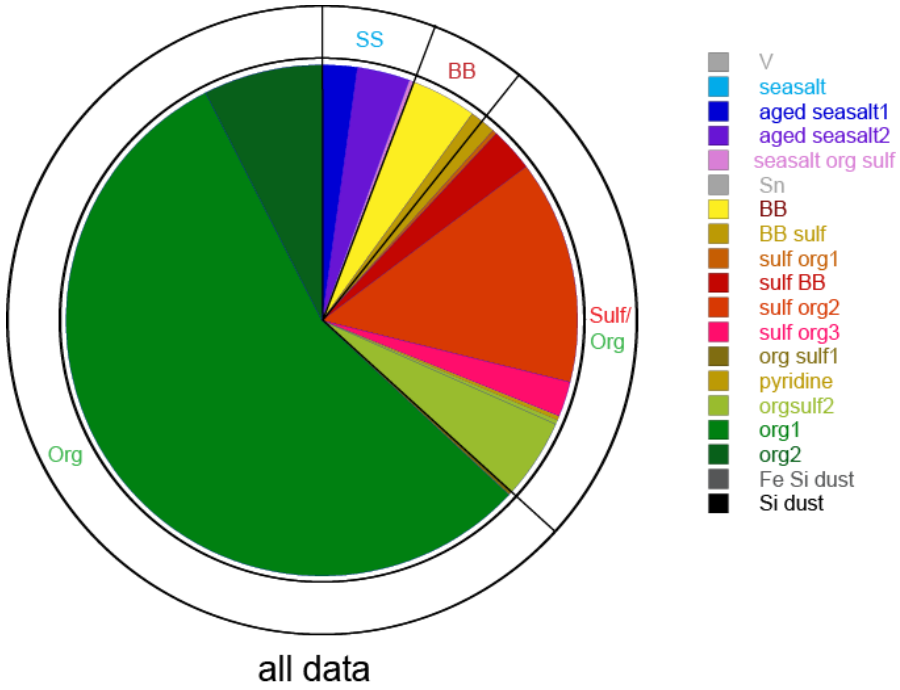




F31: Clean Case, Warm Cloud

Particles were composed of organics and organics mixed with sulfates, biomass-burning (BB) particles, fresh and processed sea salt, and a small number of soot and mineral dust particles.

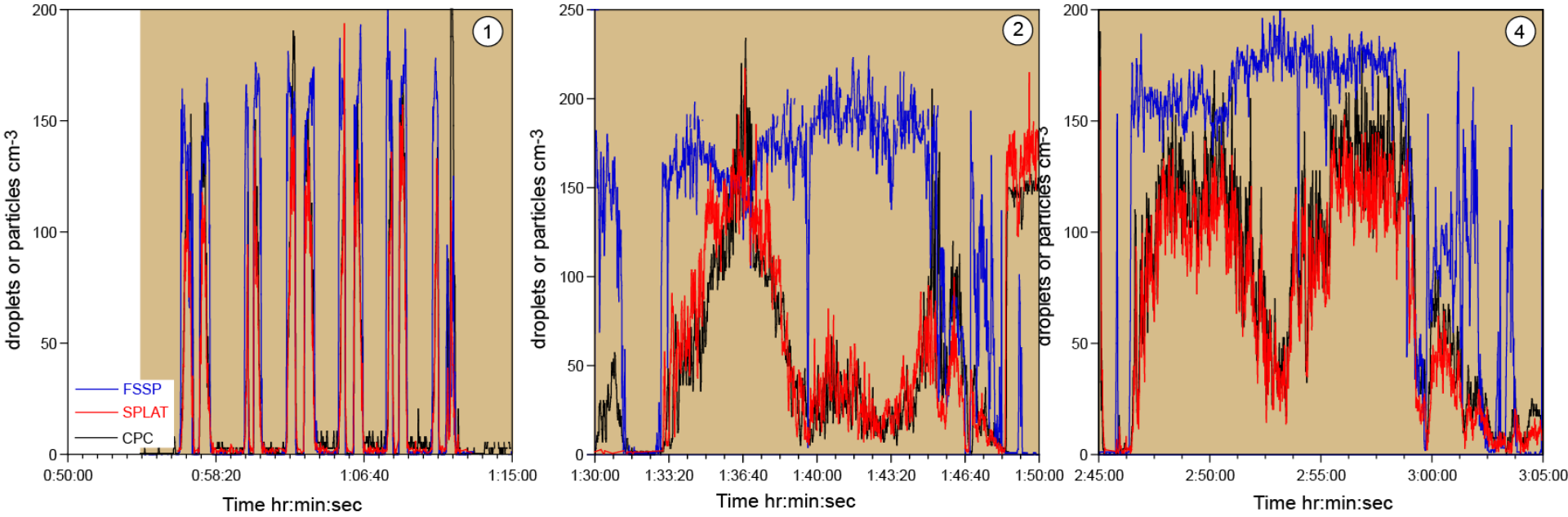




all data

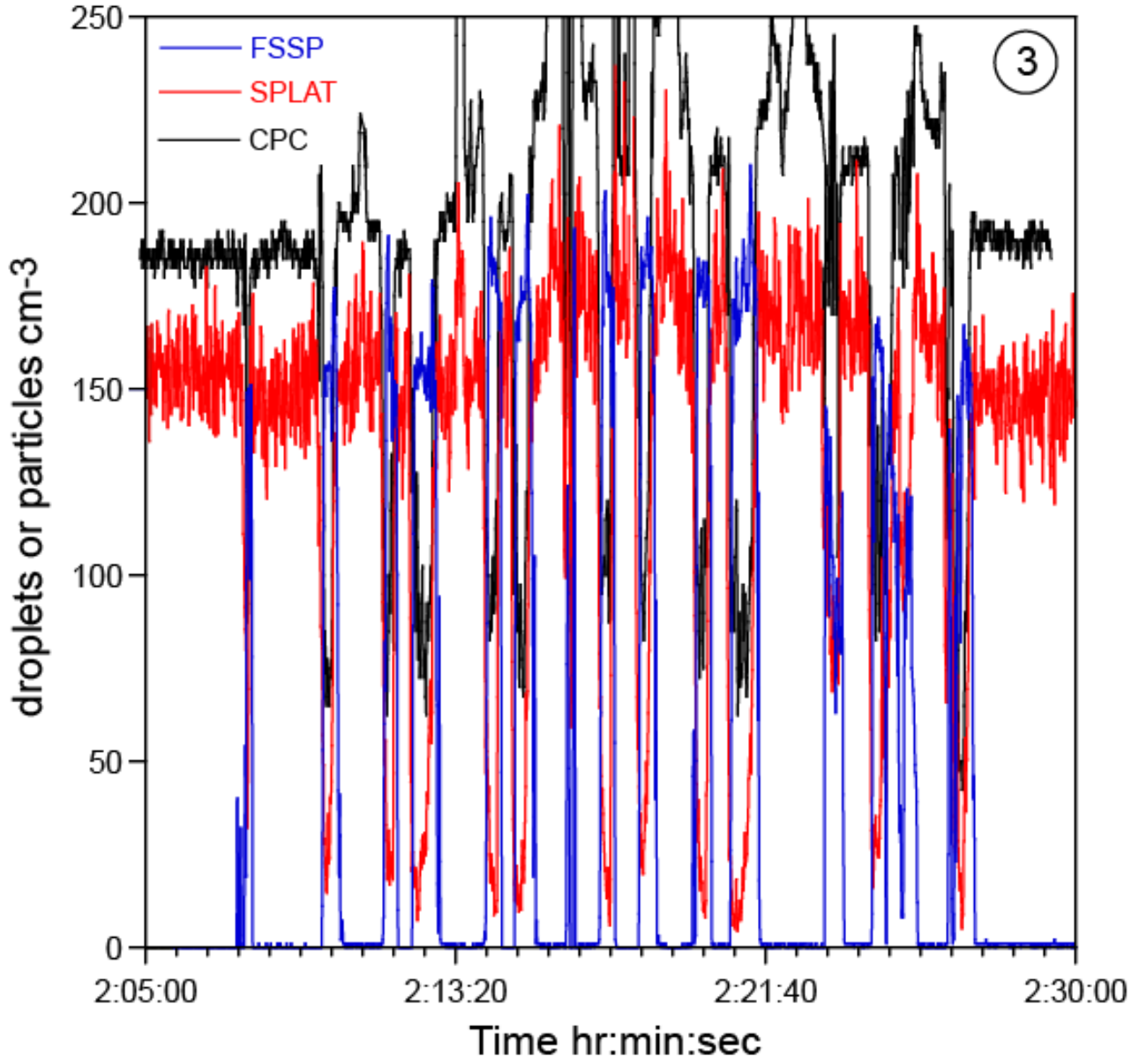
F31: Clean Case, Warm Cloud

Sampling CCN

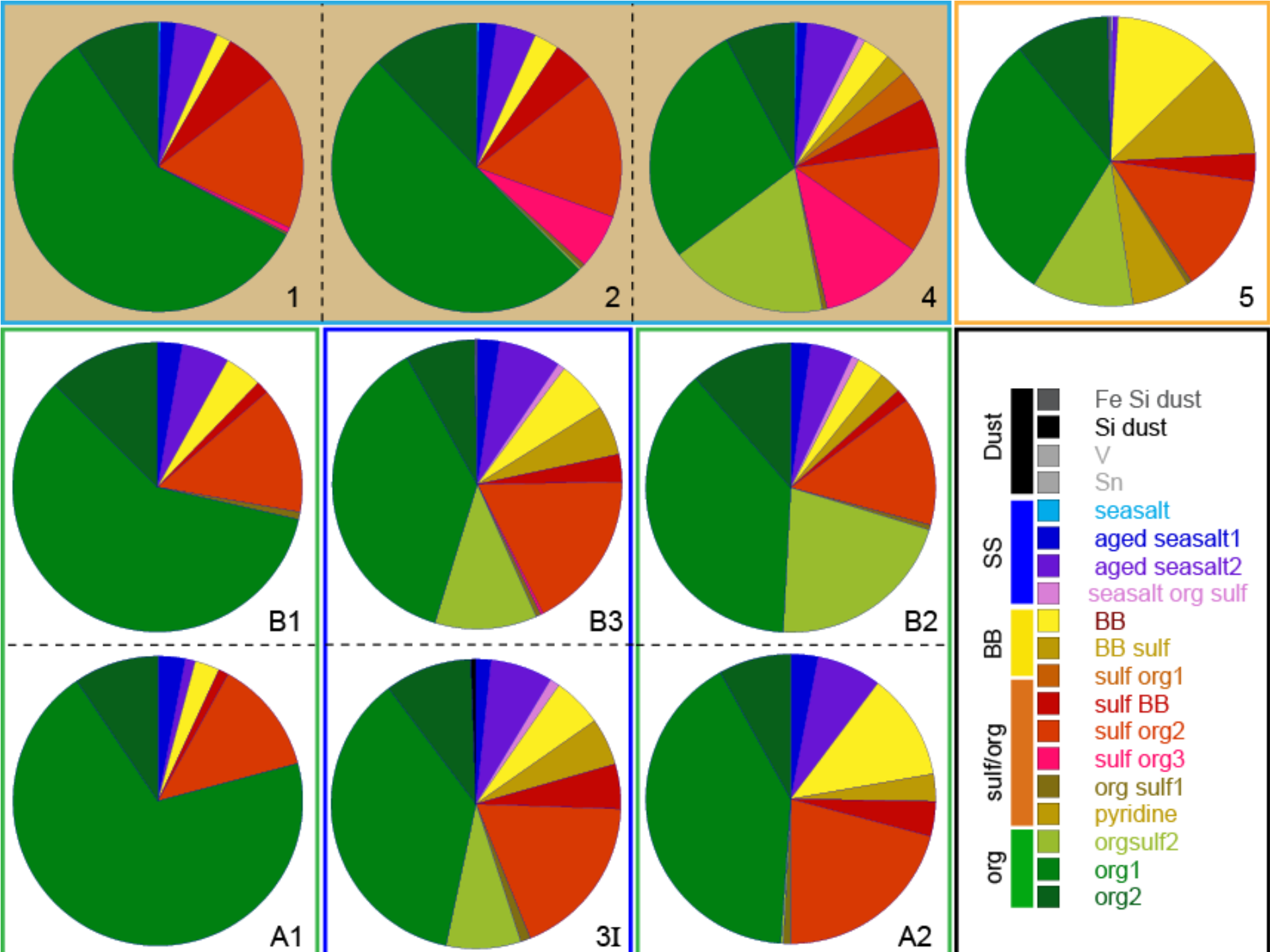


- Segment 1 involved cloud characterization by purposing through the cloud and sampling through the CVI. The number of particles detected by SPLAT is in perfect correlation with the FSSP count.
- Segments 2&4 involved cloud characterization at constant altitude and sampling through the CVI. The number of particles detected by SPLAT is not correlated with the FSSP count, but it is perfectly correlated with the CPC.
- This indicates that the cloud droplets sizes varied through the cloud and a significant fraction was not transmitted by the CVI.

F31: Clean Case, Warm Cloud

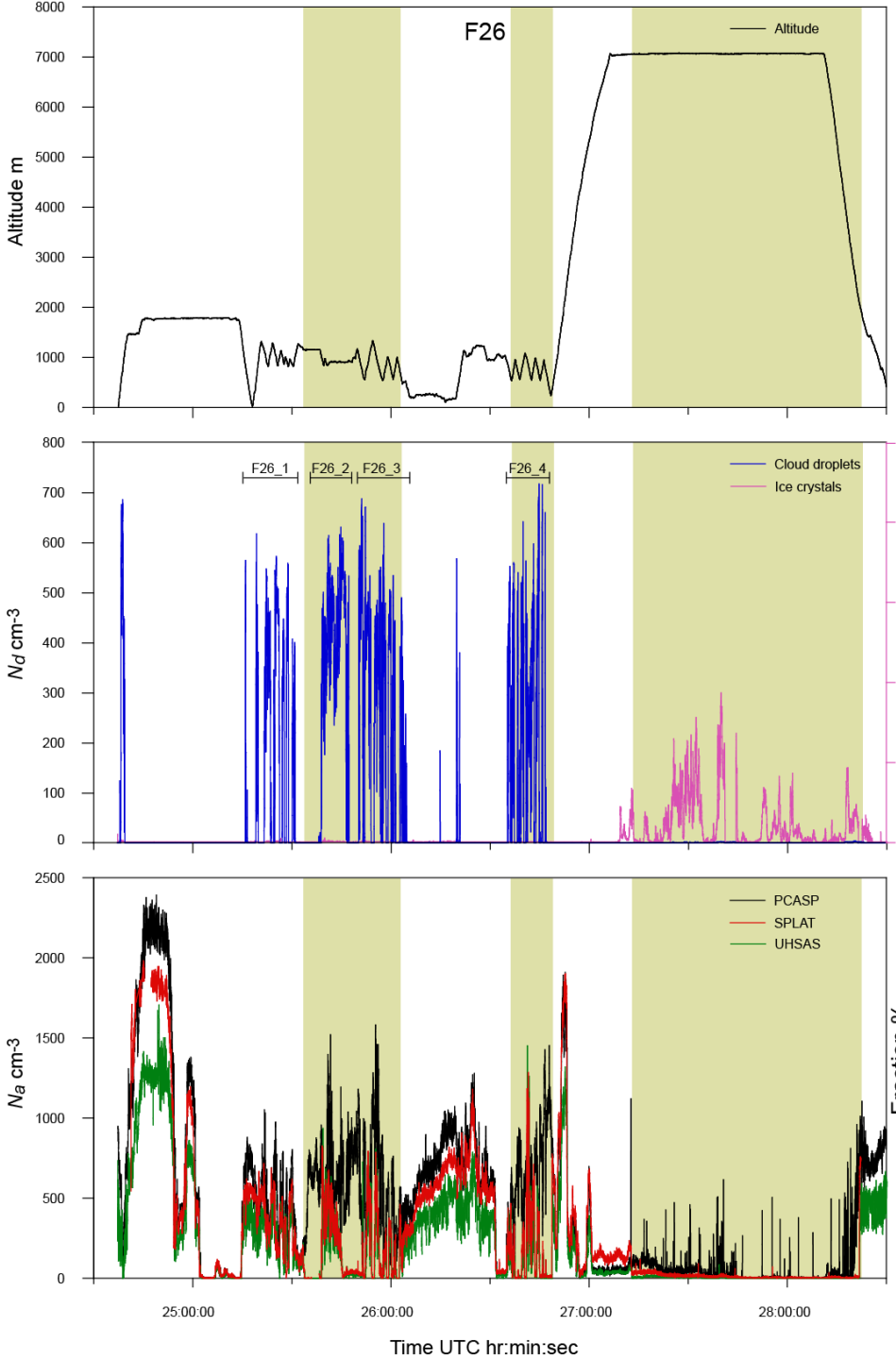


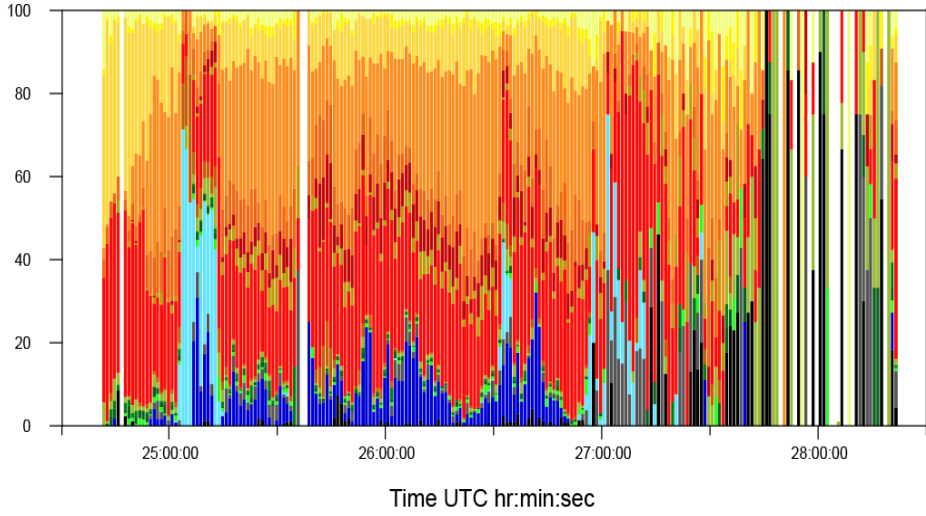
- Segment 3 involved cloud characterization by purposing and sampling without the CVI. The number of particles detected by SPLAT (red) is perfectly anti-correlated with the FSSP count (blue).
- Note that close to 90% of the particles are activated and by looking at the compositions of un-activated particles at the valleys one gets a direct information on interstitial particles.


1
2
4
5
B1
B3
B2
A1
3I
A2
Dust
SS
BB
sulf/org
org
Fe Si dust
Si dust
V
Sn
seasalt
aged seasalt1
aged seasalt2
seasalt org sulf
BB
BB sulf
sulf org1
sulf BB
sulf org2
sulf org3
org sulf1
pyridine
orgsulf2
org1
org2

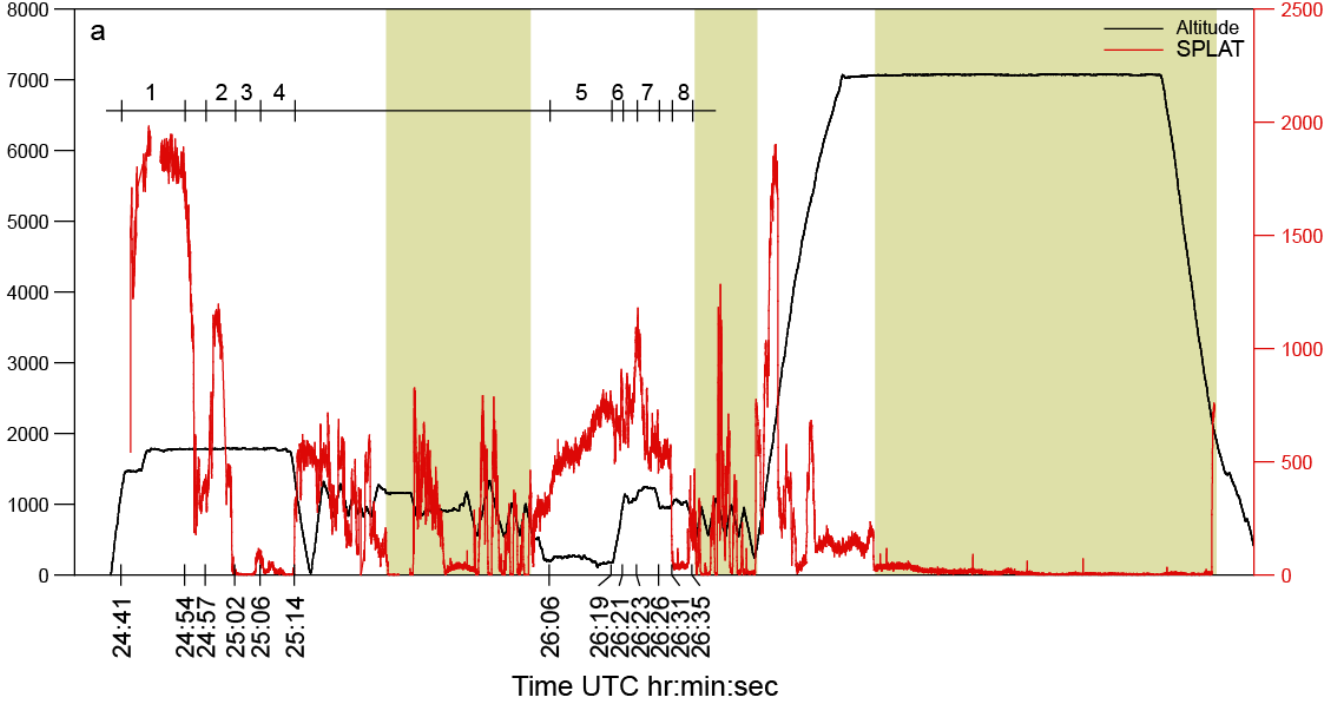
F26 (04/19/08): Polluted Case

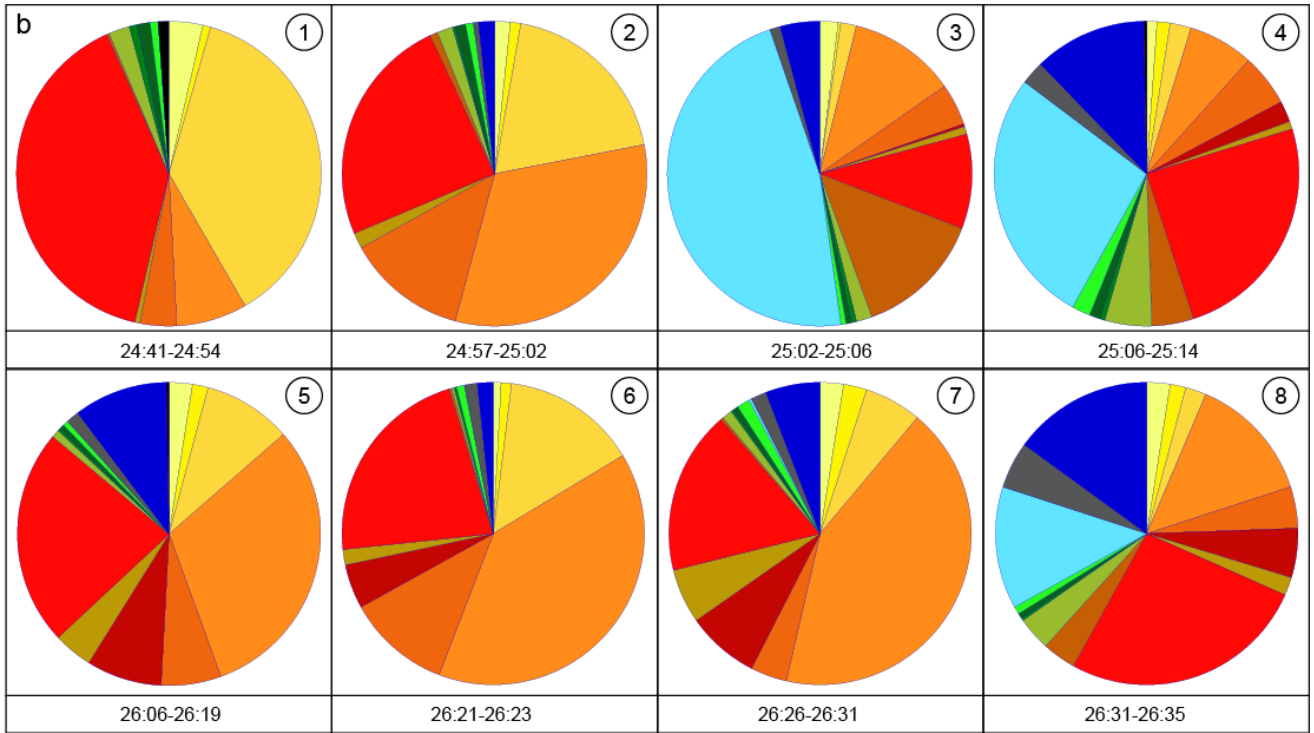
- On polluted days, aerosol plumes with number concentrations of ~2500 cm/cc .
- Arctic spring atmosphere is highly stratified
- Aerosols were dominated by BB particles, and their internal mixtures with sulfate



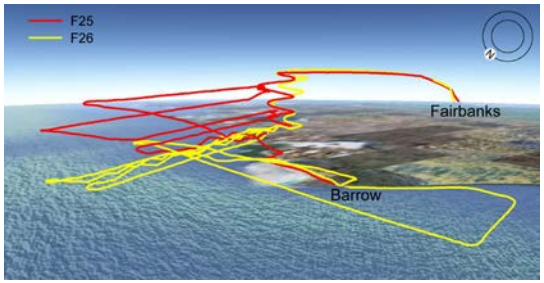


F26:Polluted Case

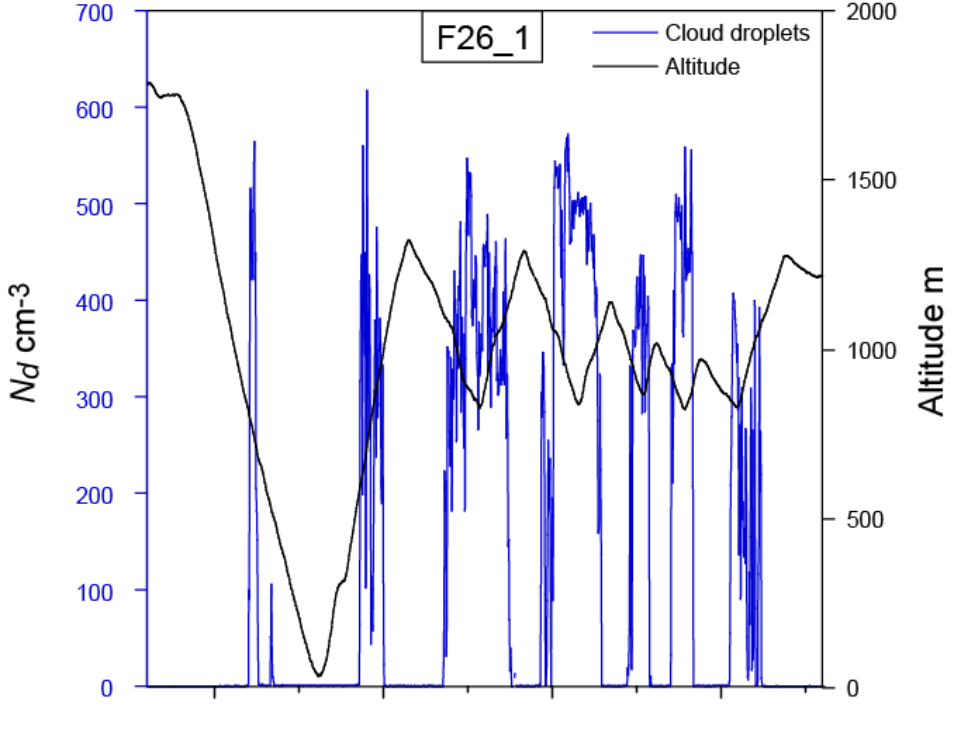


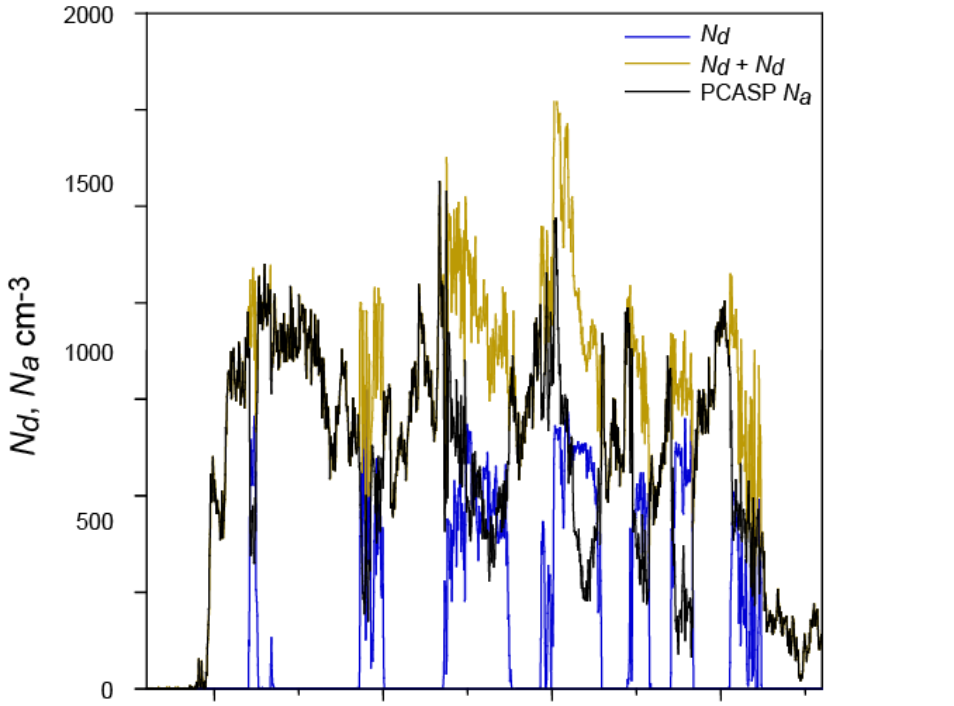


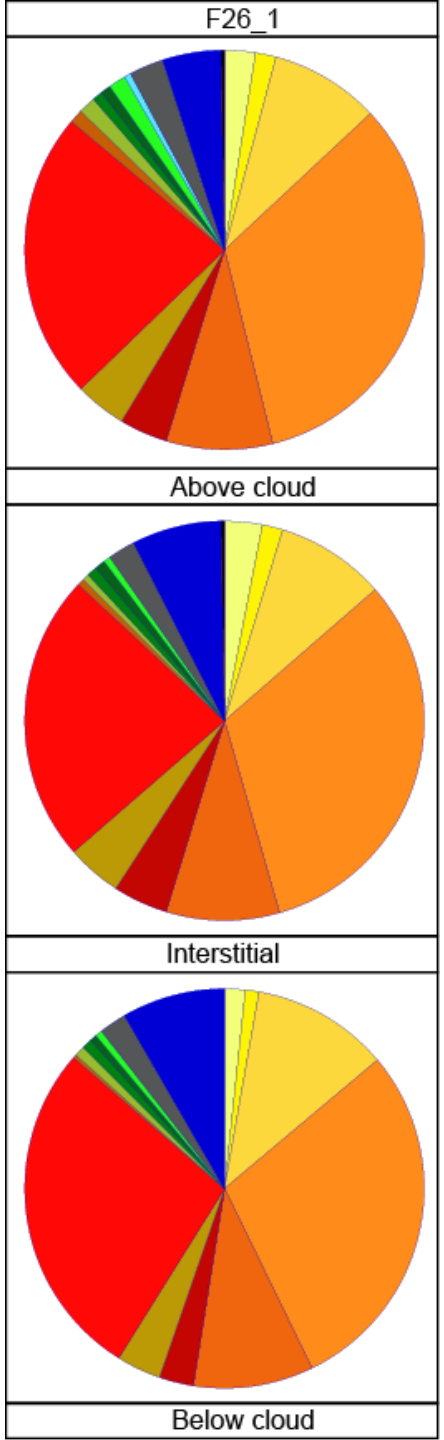
Na cm-3



Color	Class	Density, g•cm^{-3}	Sulfate *WF*, %
	BB	1.32	0
	Low_sulf_BB_org	1.35	15
	BB_low_sulf	1.38	16
	BB_med_sulf	1.47	38
	BB_high_sulf	1.58	61
	Sulf_BB_org	1.45	40
	Soot_sulf_BB	-	-
	Sulf_org	1.47	50
	Org1	1.22	0
	Org2	1.24	0
	Org3	1.24	0
	Org4	1.24	0
	Pyridinium ion	1.5	0
	Soot_org	1.25	0
	SS	1.5	0
	Mineral dust	-	-

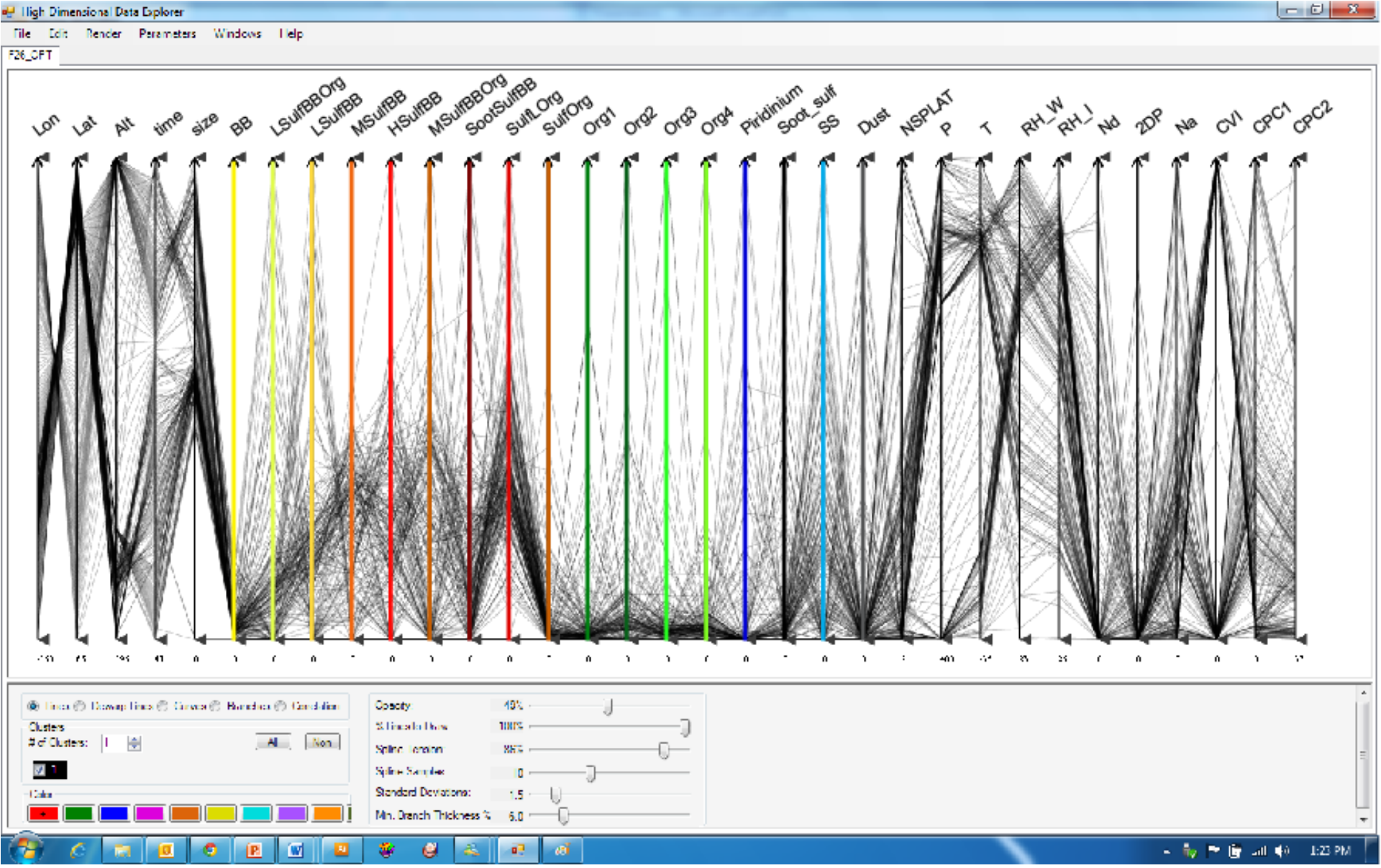




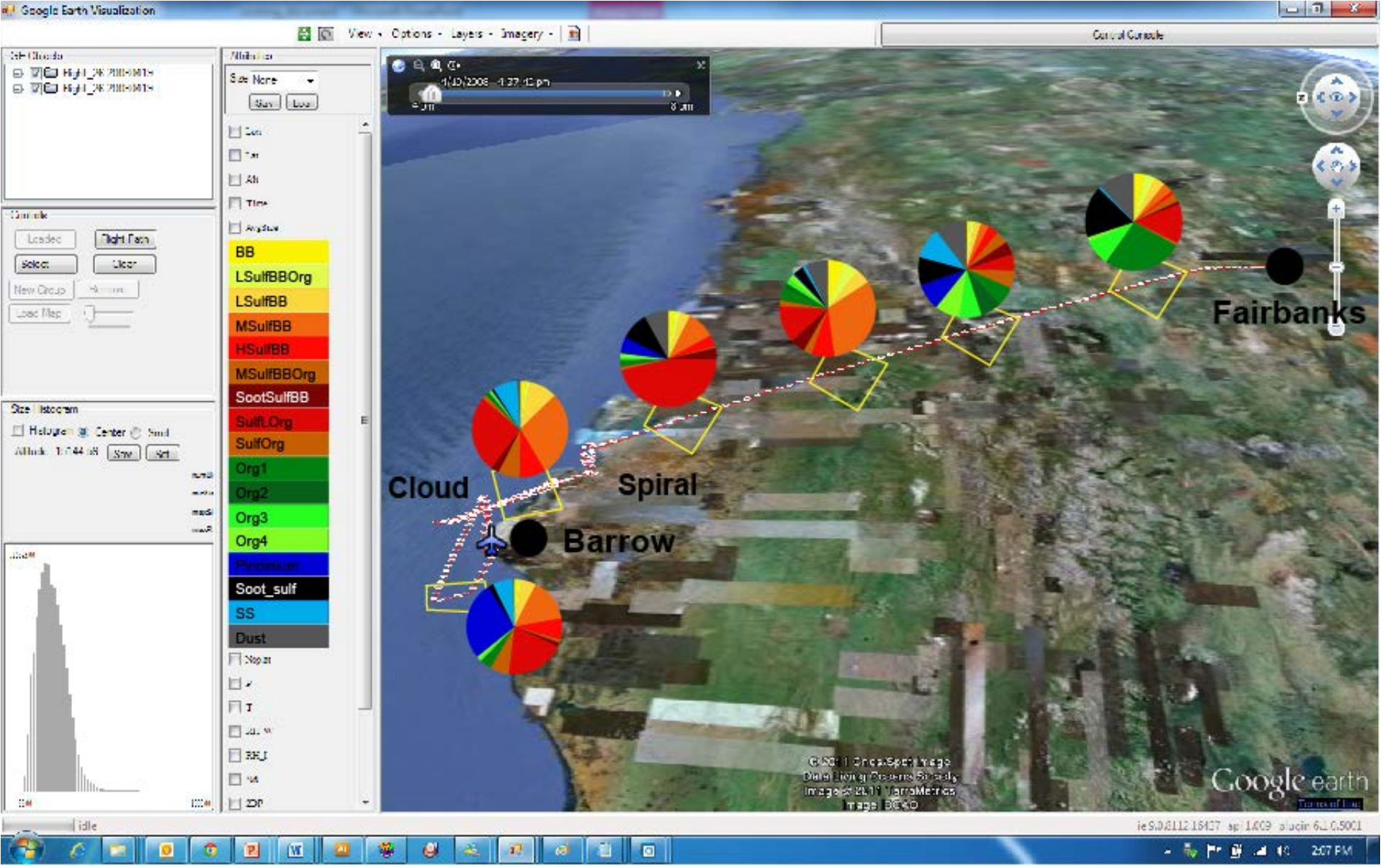


F26:Polluted Case

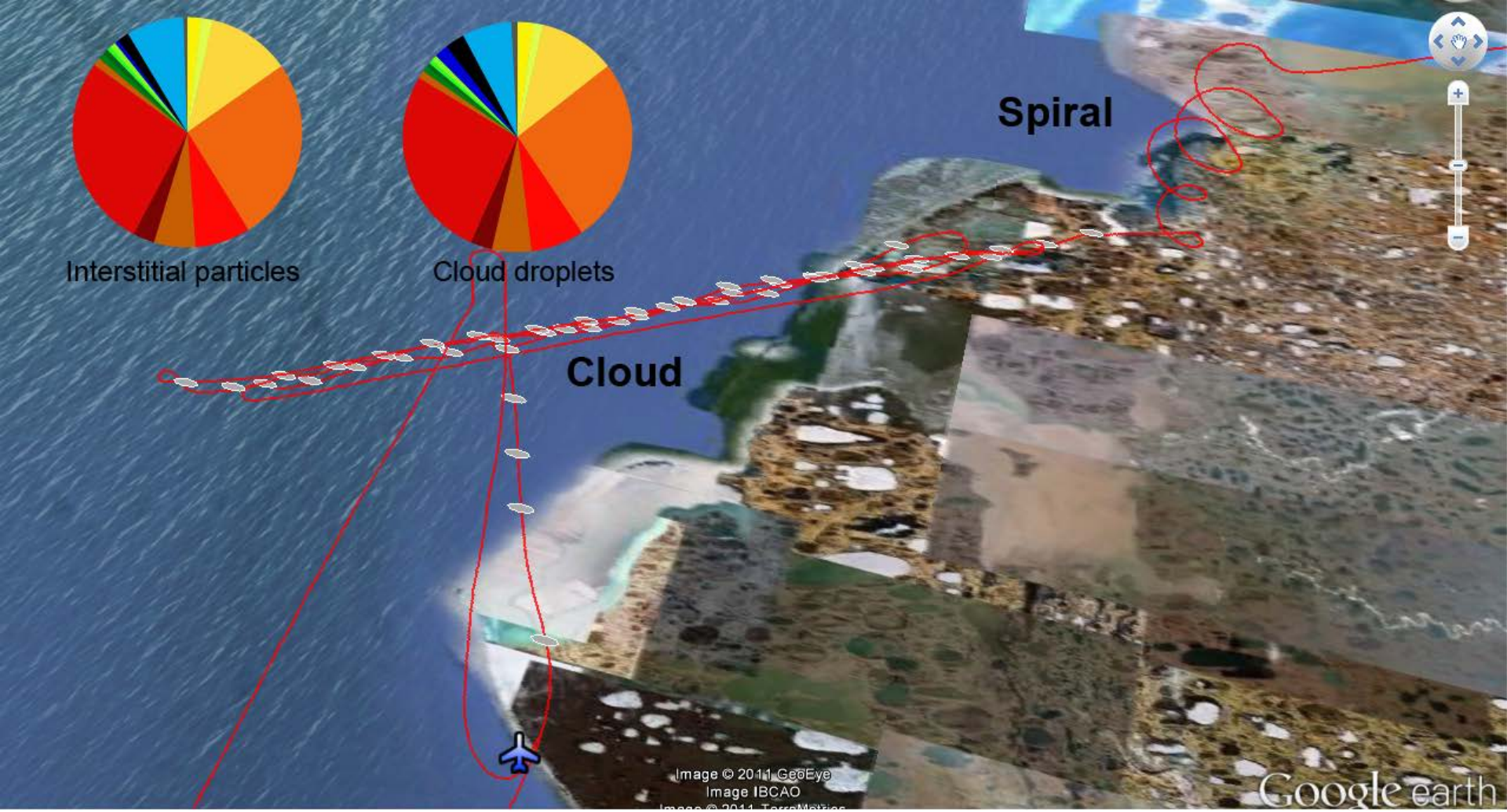
Warm Cloud



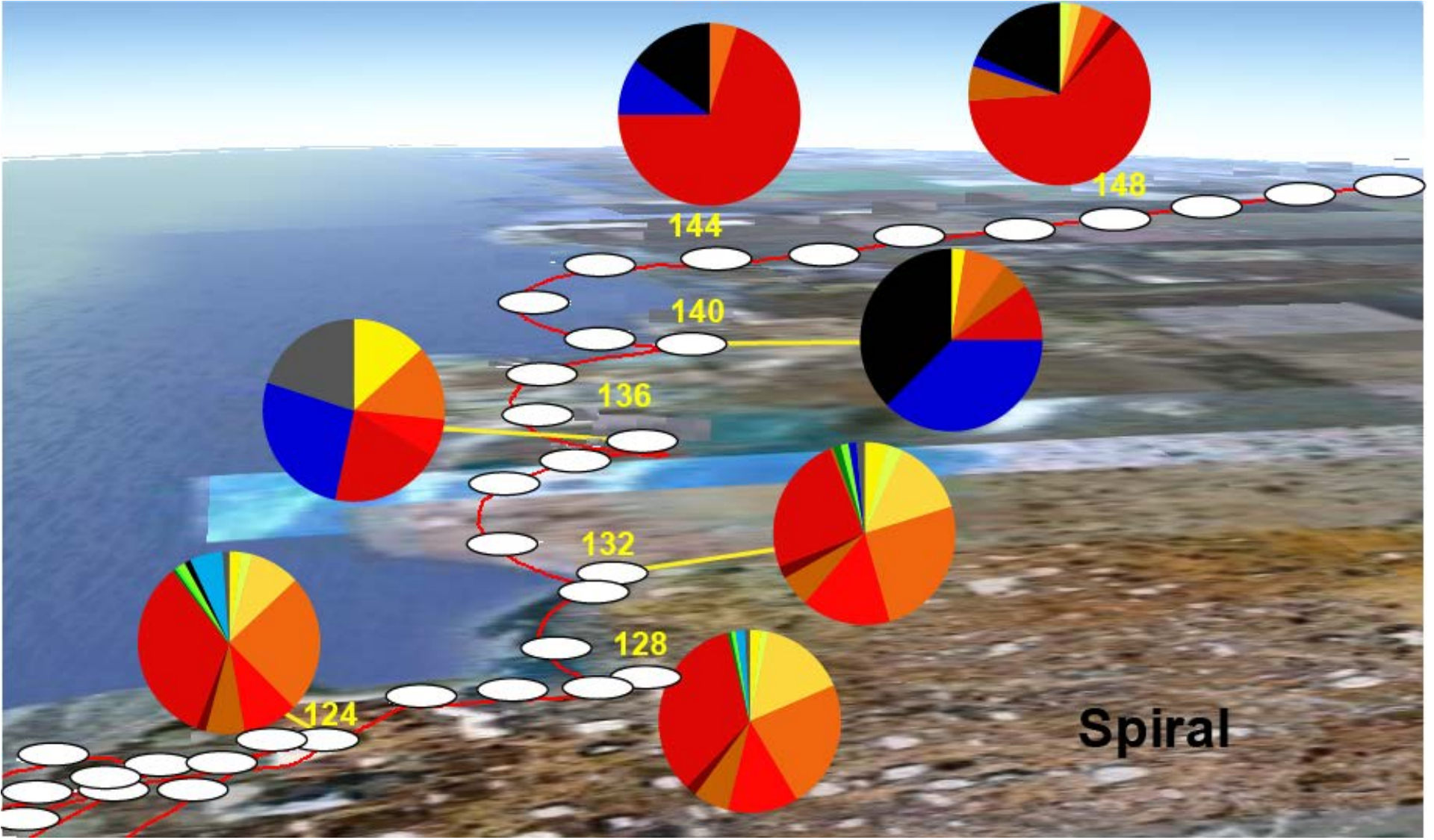
Individual particle compositions, number concentrations, and all other relevant attributes presented in parallel coordinates. The interface makes it possible to filter the data by using the two arrows associated with each coordinate.



F26 flight track (red line) illustrating the use of the select tool to get an overview of how particle compositions change along the flight.



Data points in which a cloud was probed. The pie charts labeled cloud droplets and interstitial particles represent the compositions of particles that activated to form cloud droplets, and particles with the cloud that did not activate, respectively.



Zooming in on the ascending spiral to investigate changes in particle compositions as a function of altitude.