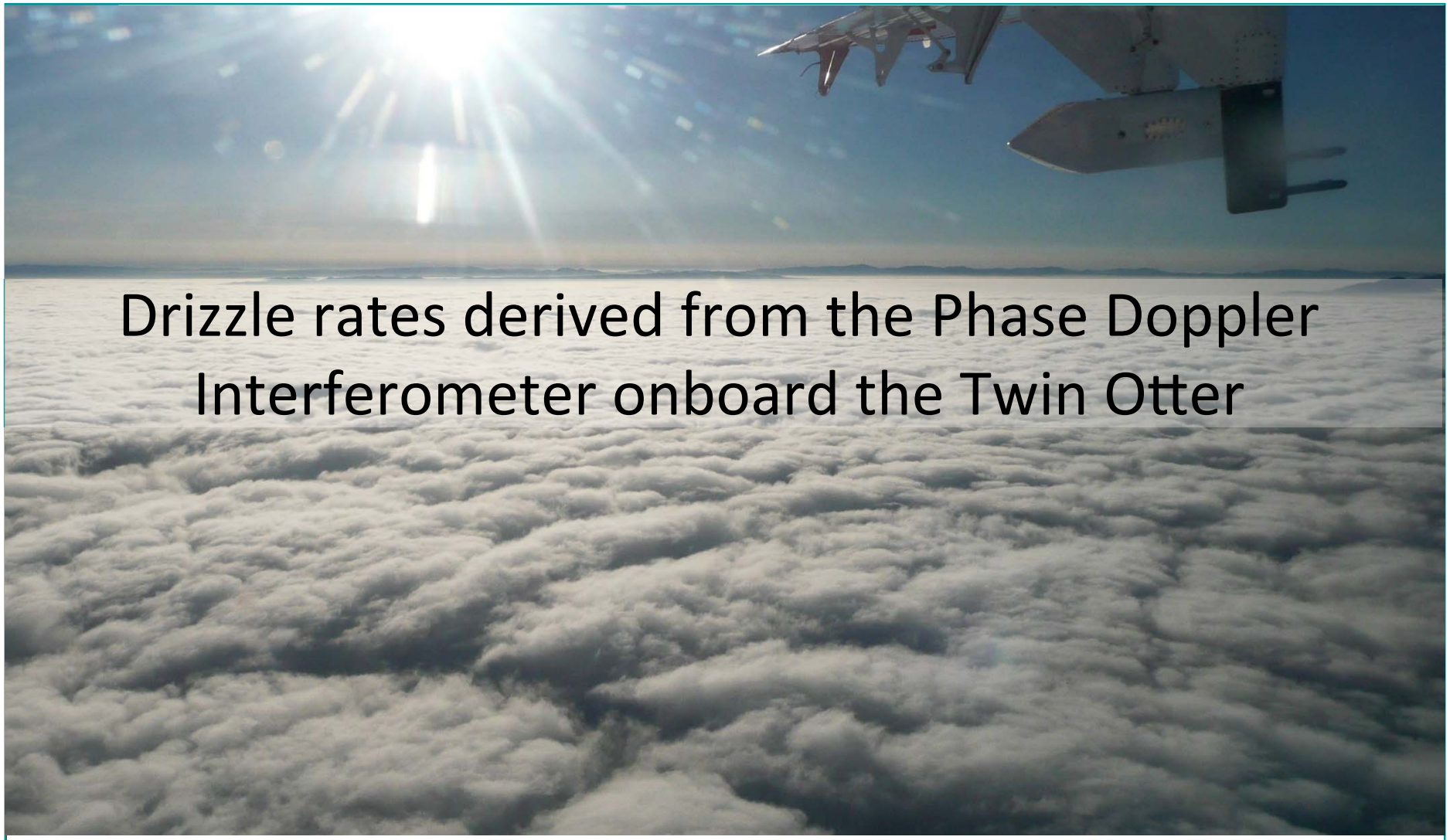
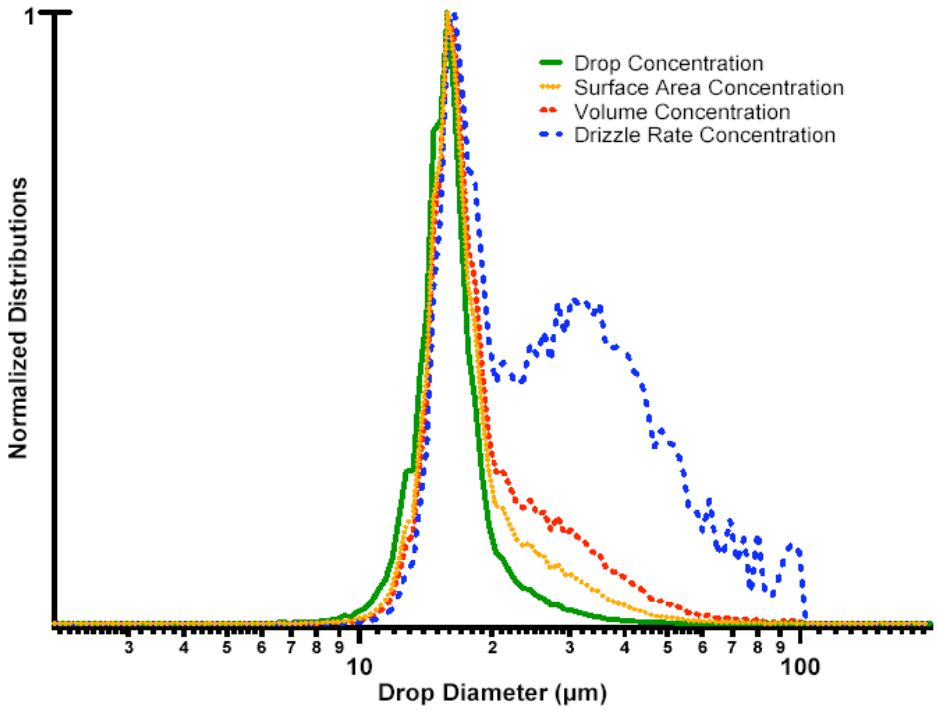


Drizzle rates derived from the Phase Doppler Interferometer onboard the Twin Otter

Dione Lee Rossiter and Patrick Chuang
University of California, Santa Cruz
VOCALS Meeting
July 13th, 2009

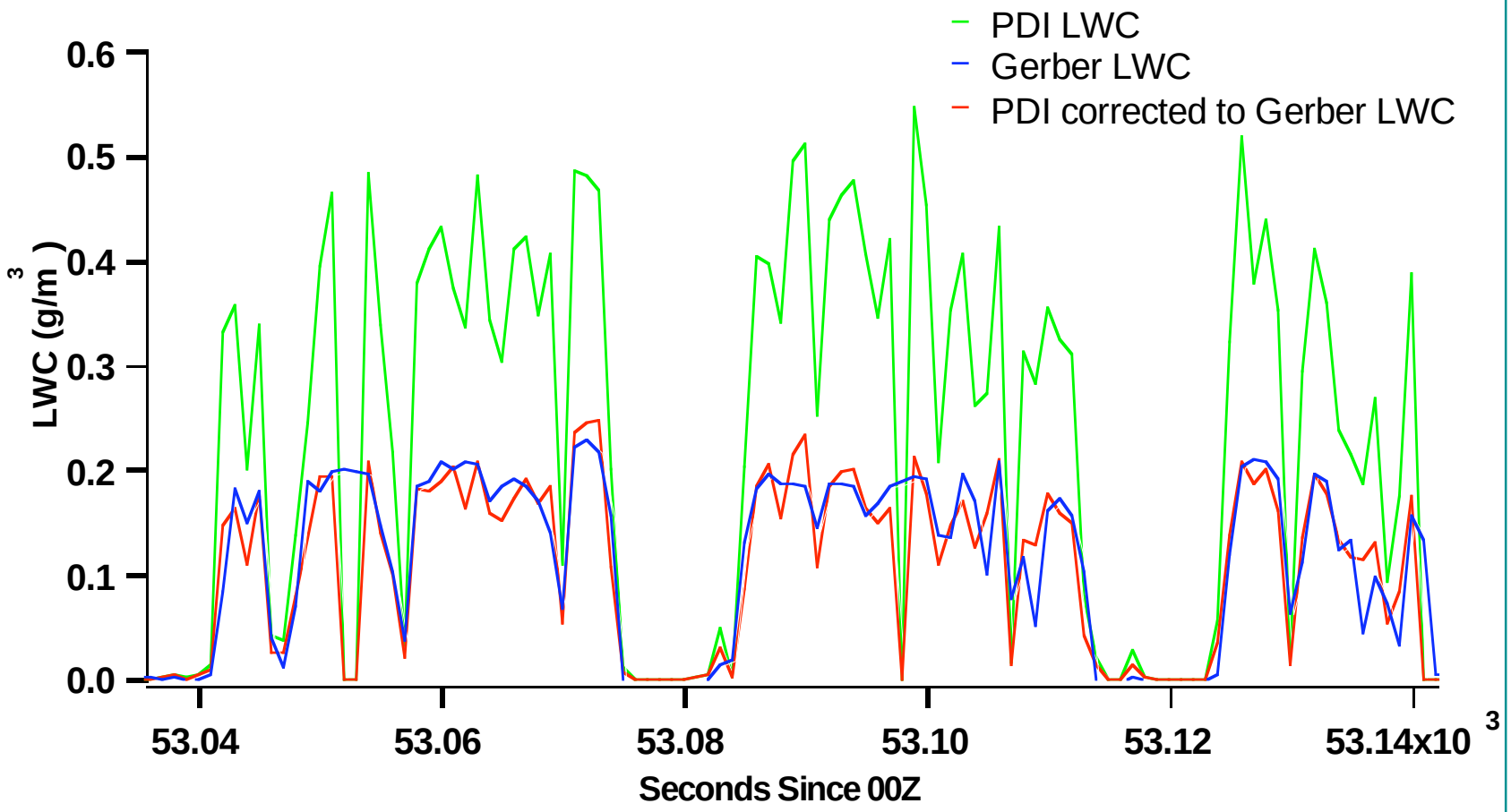
Phase Doppler Interferometer (PDI)



1-100Hz size distributions of drop concentration, surface area, volume, terminal velocity, mass, etc. can be derived

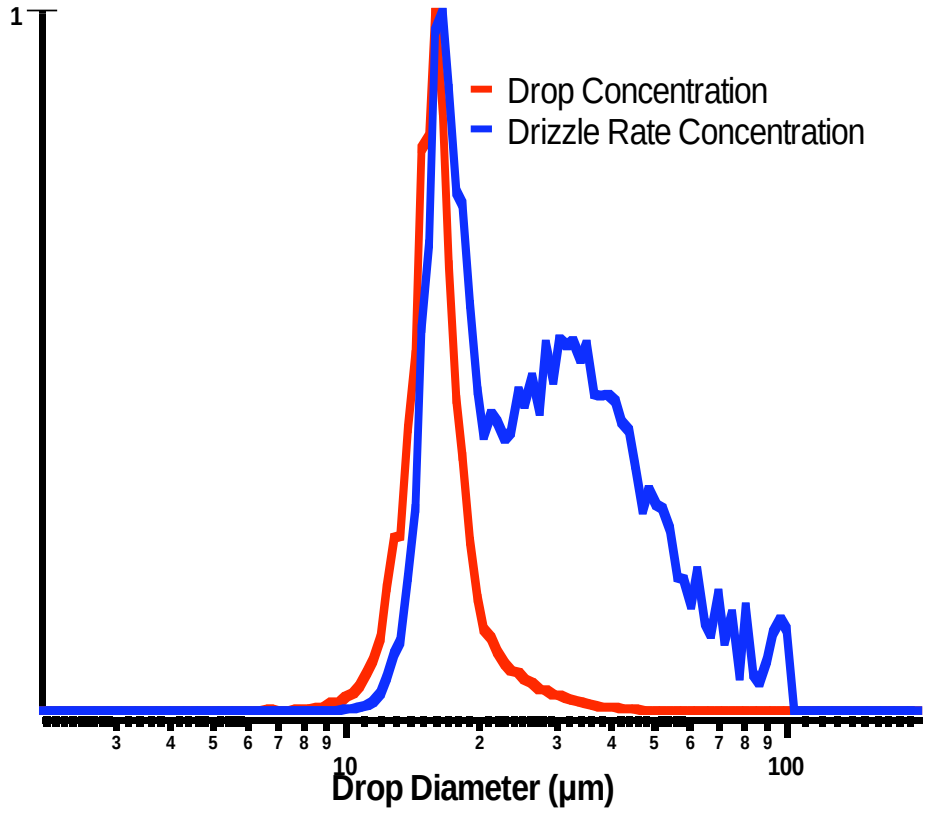
Fundamentally measures cloud drop size and velocity

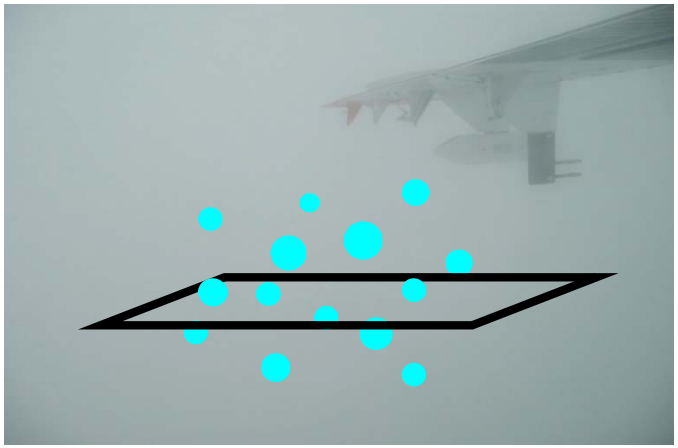
LWC Comparison with Gerber Probe



Drizzle Rate

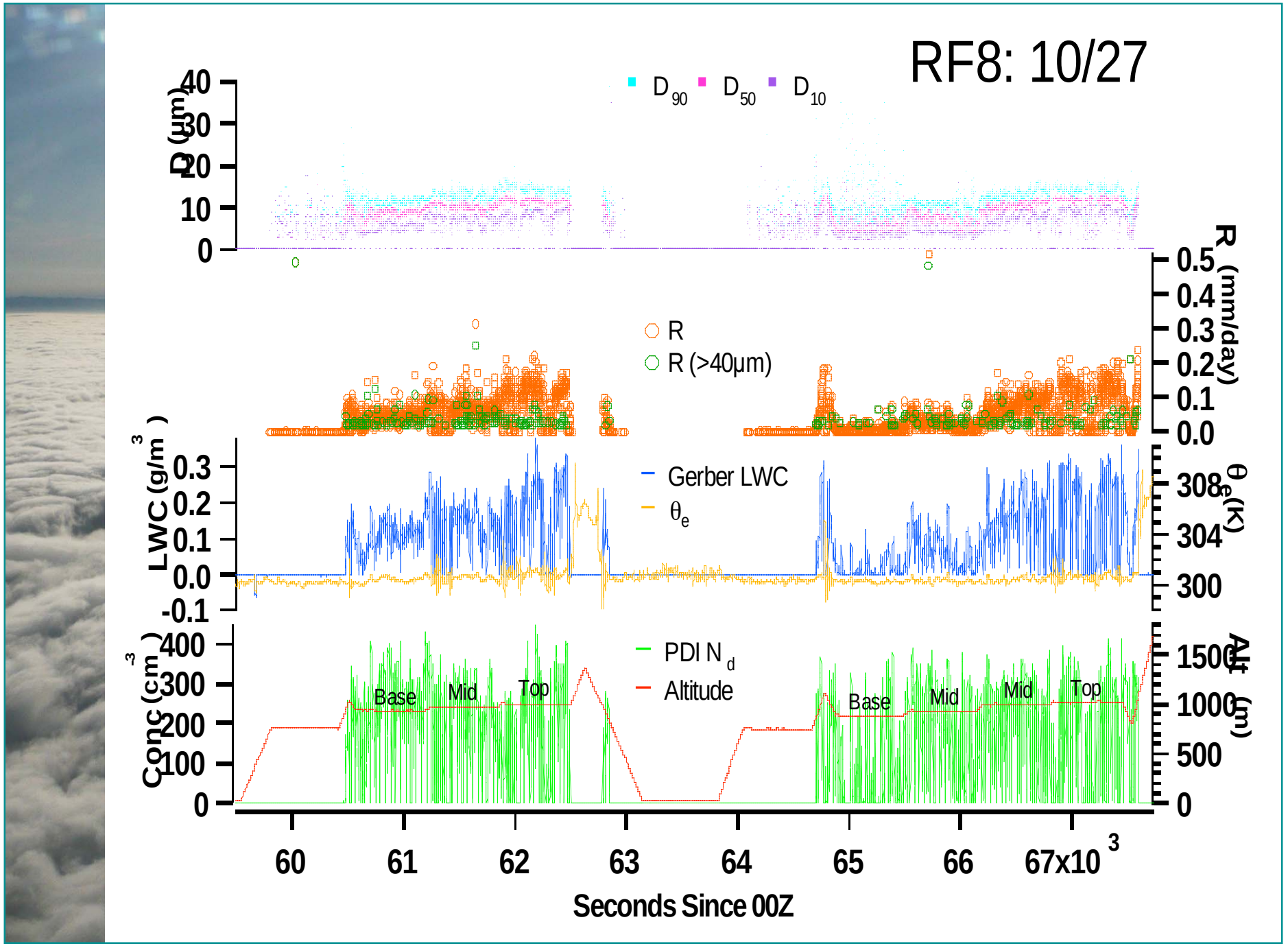
$$dR_i = \frac{\pi}{6} D_i^3 \left(\frac{dN}{d \log d} \right)_i (\Delta \log D_i) w_T(D_i)$$

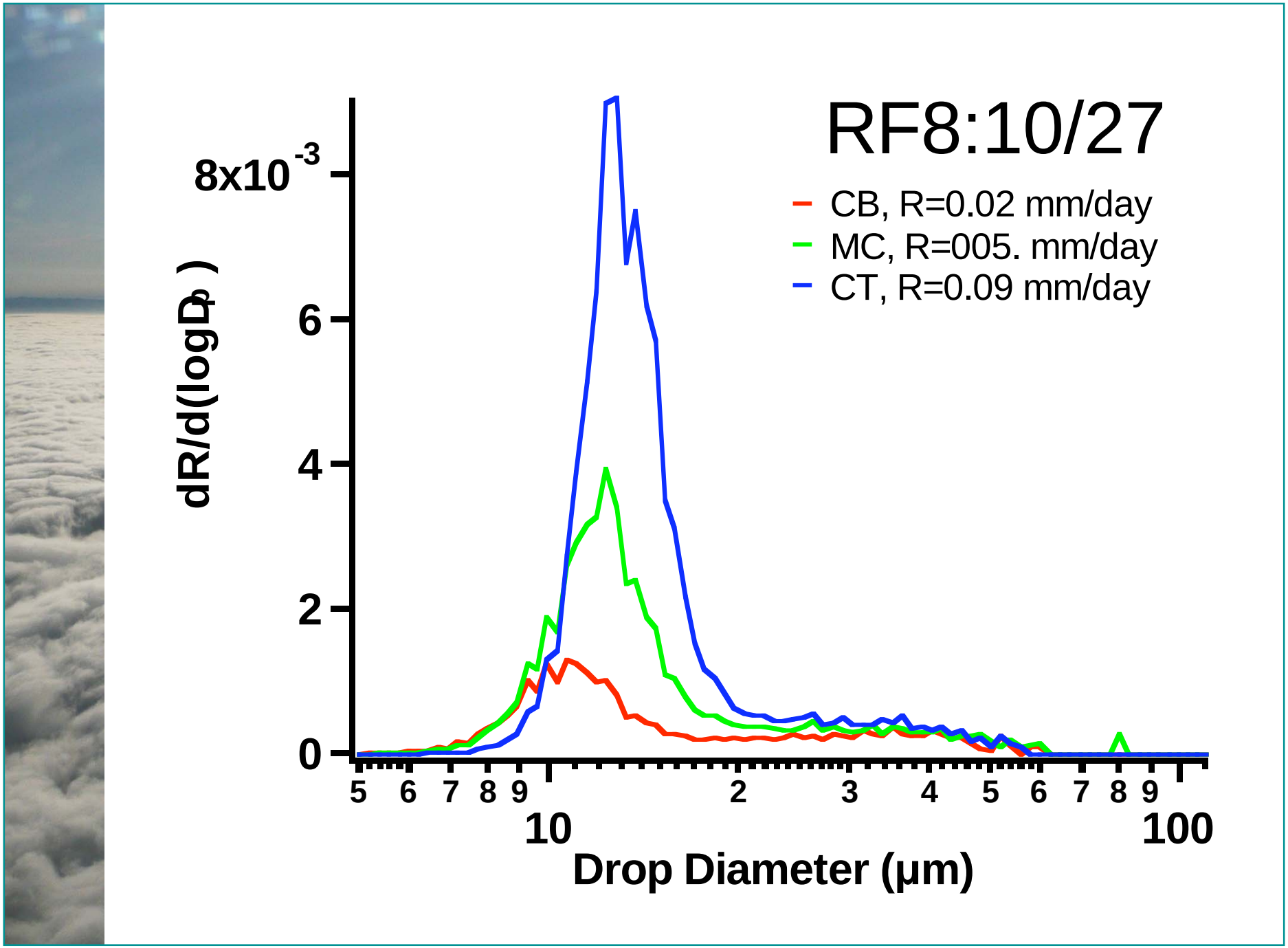


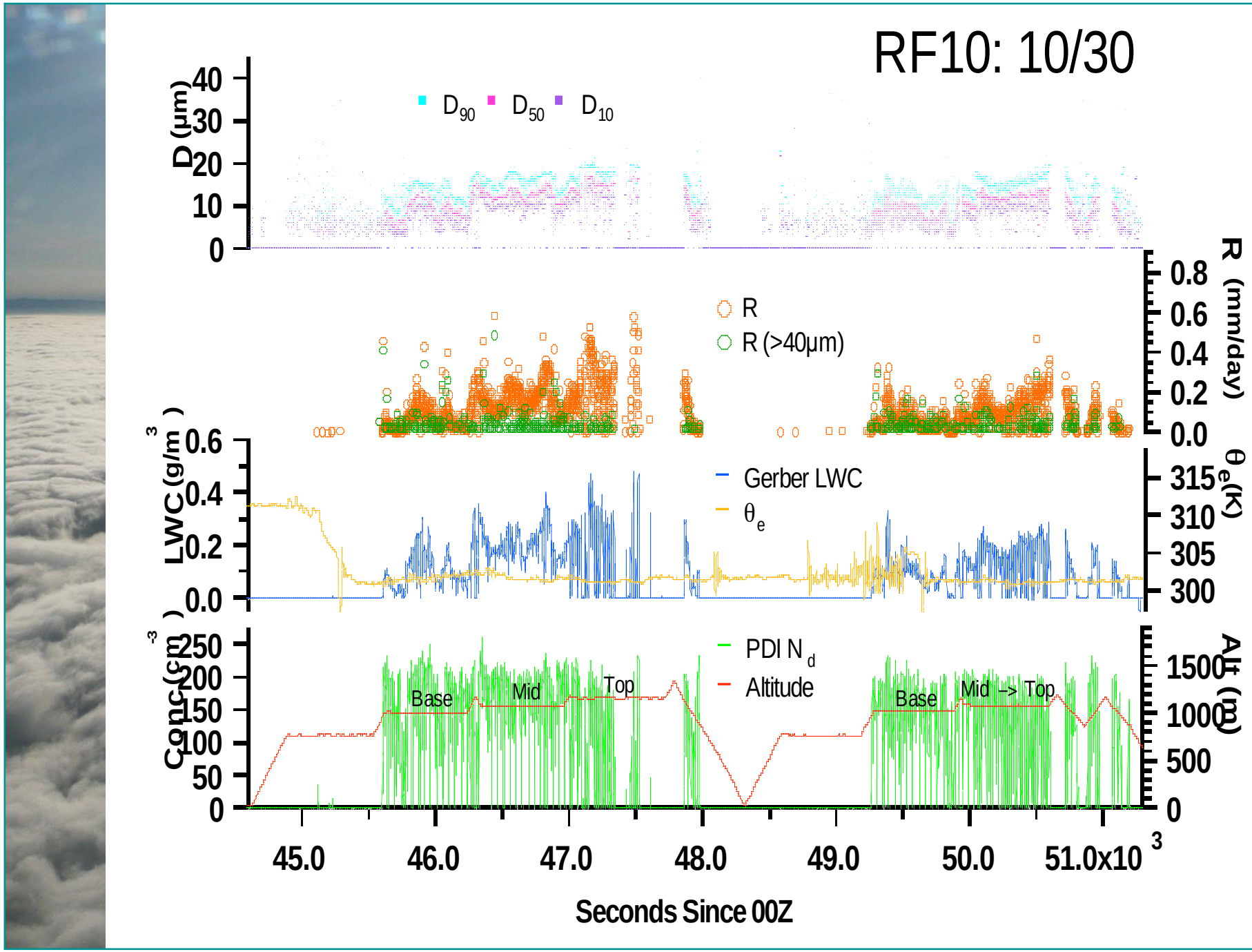


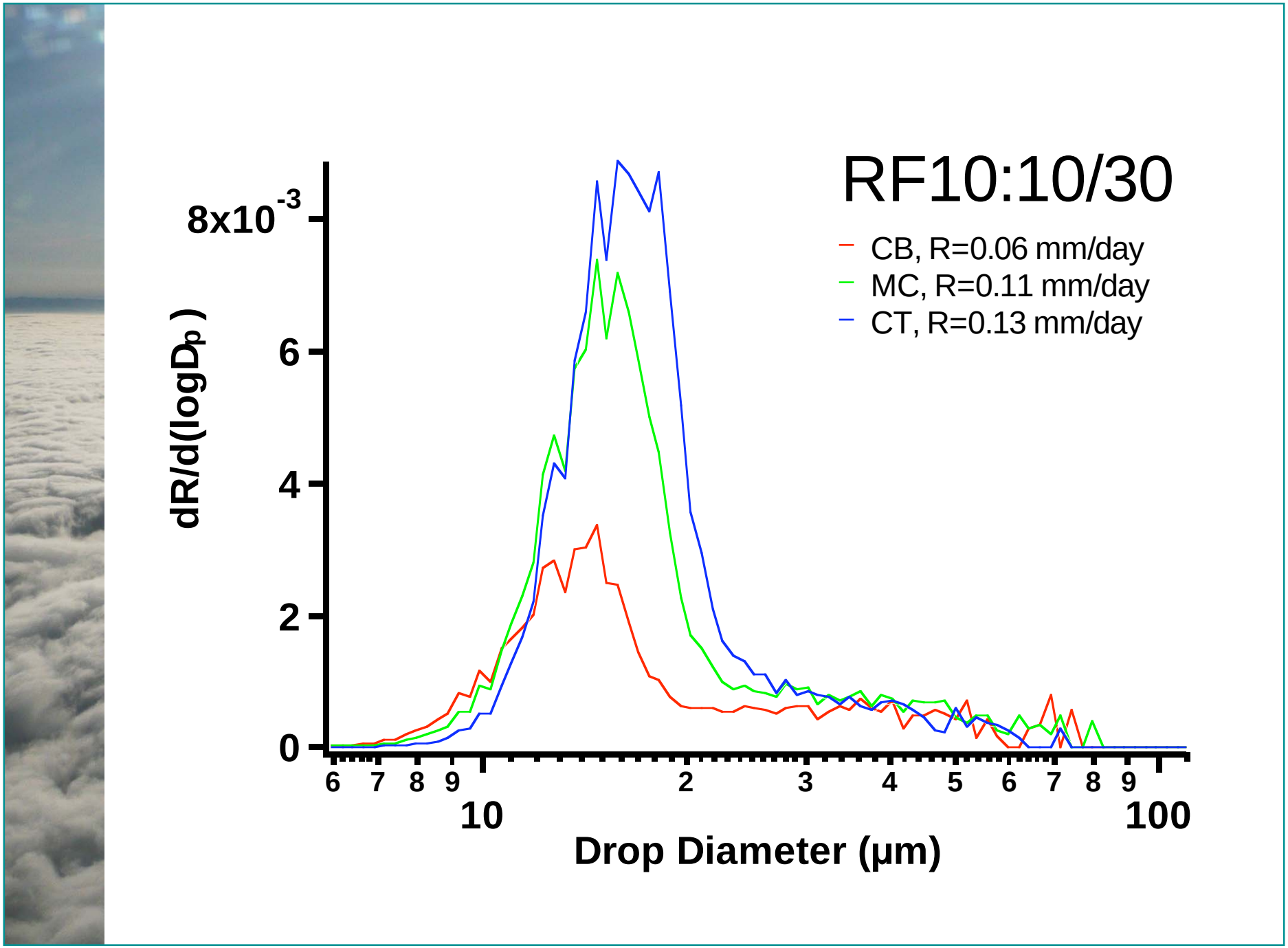
TO Flights

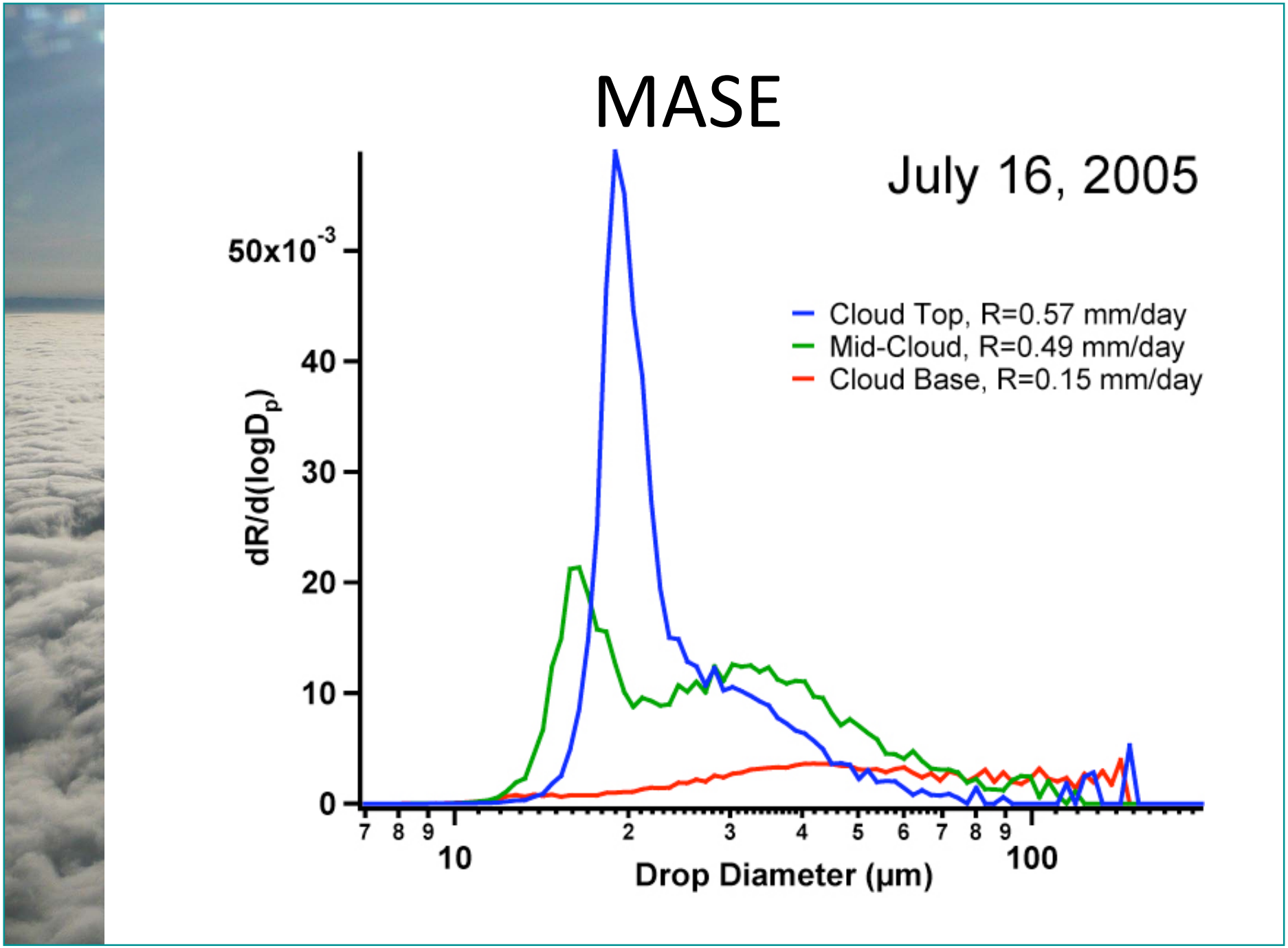
RF#	Date	PCASP (Sub)	Cloud top z	PDI R	Wind speed	SST	Cloud thickness	Approx. LWP
		cm-3	m	mm/day	m/s	deg C	m	g/m
1	16-Oct	494	925		7.2	16.6	325	93
2	18-Oct	580	900		4.9	16.8	200	54
3	19-Oct	645	1000	0.09	2.4	16.5	300	82
4	21-Oct	426	950	0.05	4.3	16.9	200	38
5	22-Oct	440	1050	0.08	3.3	17.0	250	55
6	24-Oct	348	1000		2.3	18.2	100	11
7	26-Oct	524	975	0.04	5.1	17.4	175	35
8	27-Oct	465	1000	0.05	5.6	17.9	210	39
9	29-Oct	319	1250	0.17	3.6	18.2	460	136
10	30-Oct	280	1100	0.08	5.8	18.3	320	96
11	1-Nov	229	1300	0.27	6.3	18.4	900	198
12	2-Nov	461	1100	0.29	2.5	18.4	450	160
13	4-Nov	302	1150	0.04	5.1	18.5	250	40
14	5-Nov				3.9			
15	8-Nov	291	900, 1450	0.02	5.6	19.1	400	79
16	9-Nov	270	1300	0.06	5.9	19.2	250	43
17	10-Nov	577	1200	0.05	5.2	19.3	200	45
18	12-Nov	503	1150	0.09	2.7	19.1	250	62
19	13-Nov	396	1150	0.05	2.2	19.1	200	32

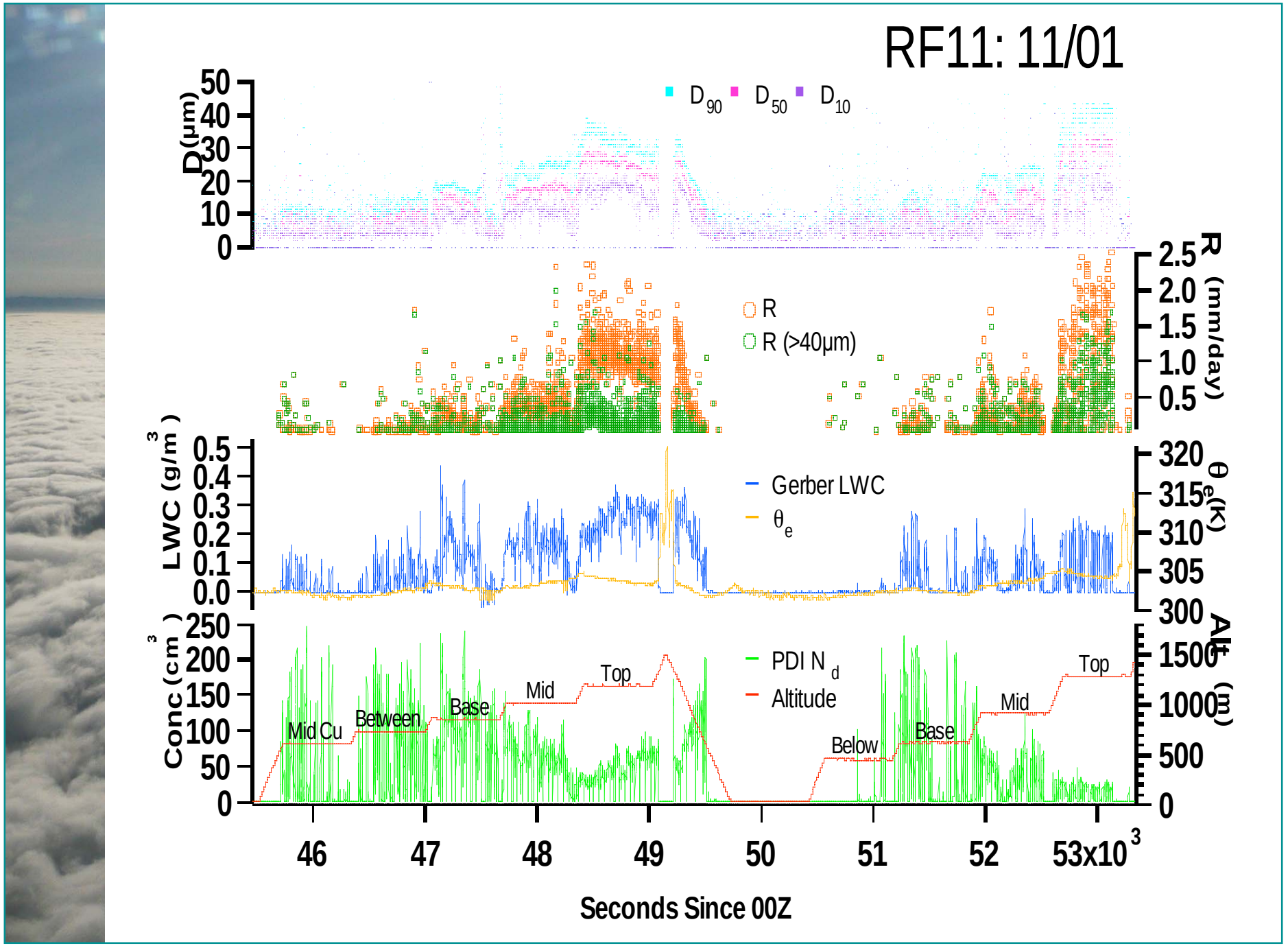

RF8: 10/27
D90
D50
D10
D (μm)
R
R (>40μm)
R (mm/day)
Gerber LWC
θe
LWC (g/m3)
θe (K)
PDI Nd
Altitude
Conc (cm-3)
Alt (m)
Base
Mid
Top
Base
Mid
Mid
Top
Seconds Since 00Z
60
61
62
63
64
65
66
67x10 3

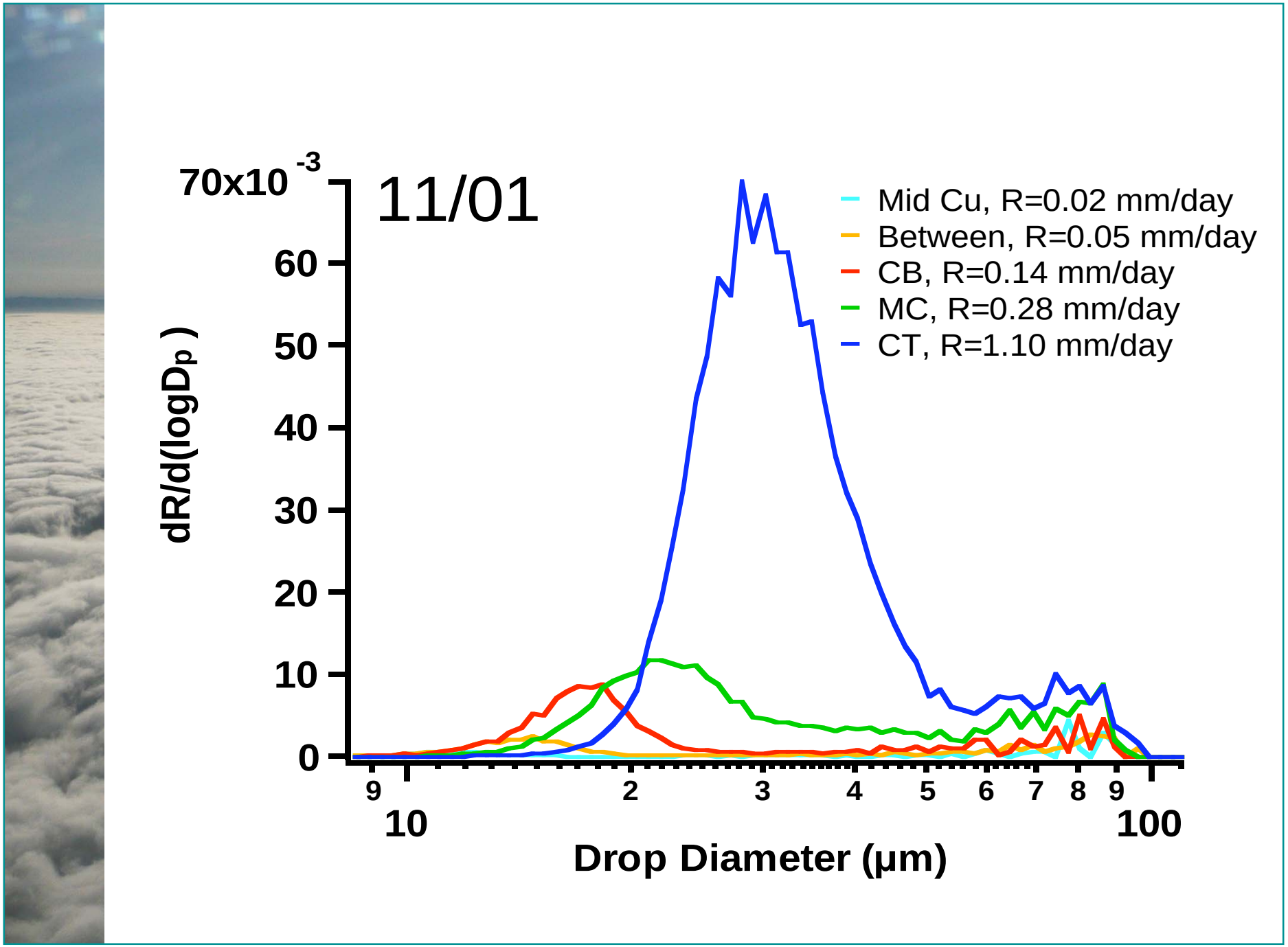

RF8:10/27
CB, R=0.02 mm/day
MC, R=005. mm/day
CT, R=0.09 mm/day
8x10-3
6
4
2
0
dR/d(logDp)
5 6 7 8 9
10
2 3 4 5 6 7 8 9
100
Drop Diameter (μm)

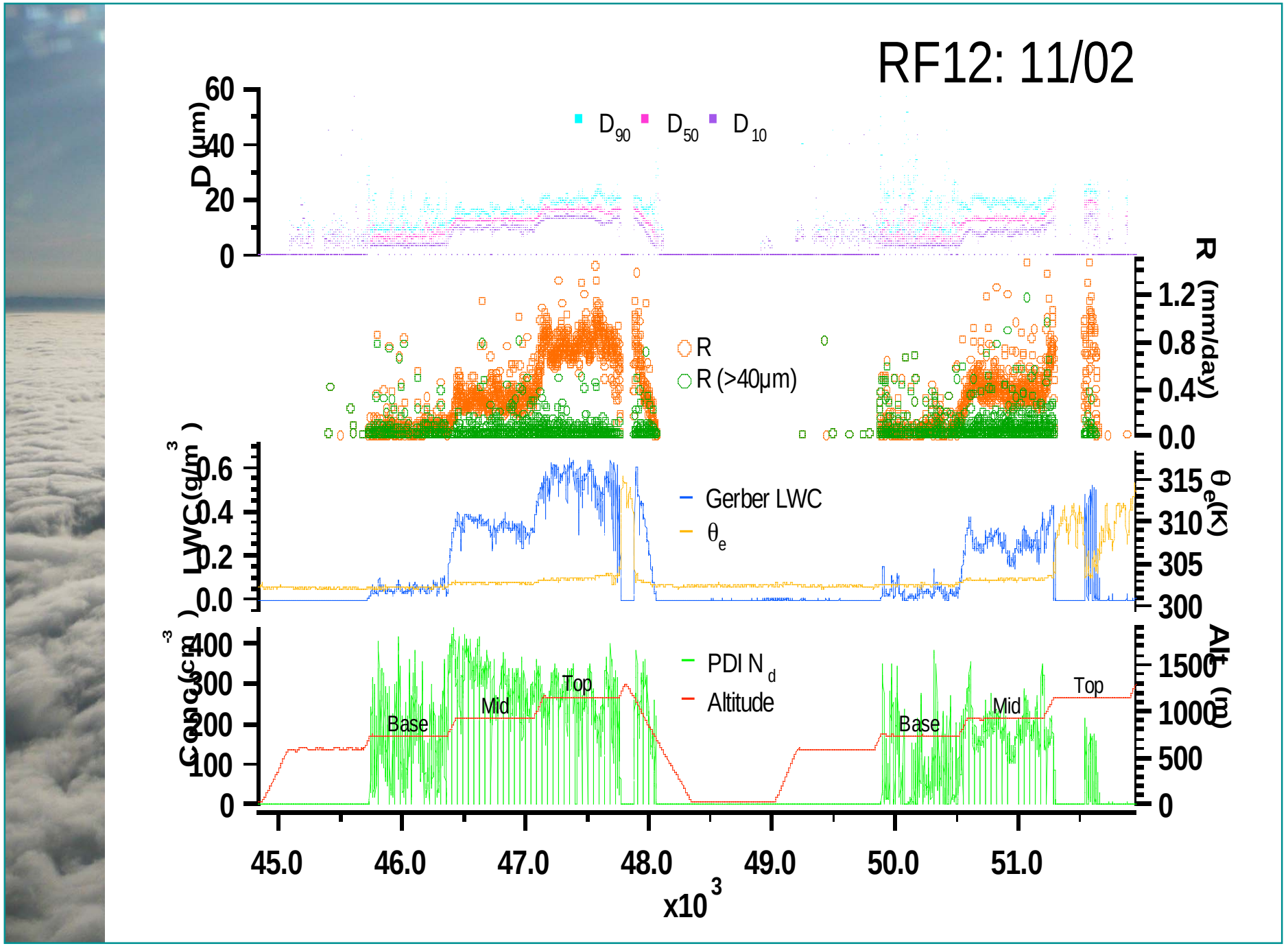

RF10: 10/30
D (μm)
D90
D50
D10
R (mm/day)
R
R (>40μm)
LWC (g/m3)
Gerber LWC
θe
θe(K)
Conc (cm-3)
PDI Nd
Altitude
Alt (m)
Base
Mid
Top
Base
Mid -> Top
Seconds Since 00Z

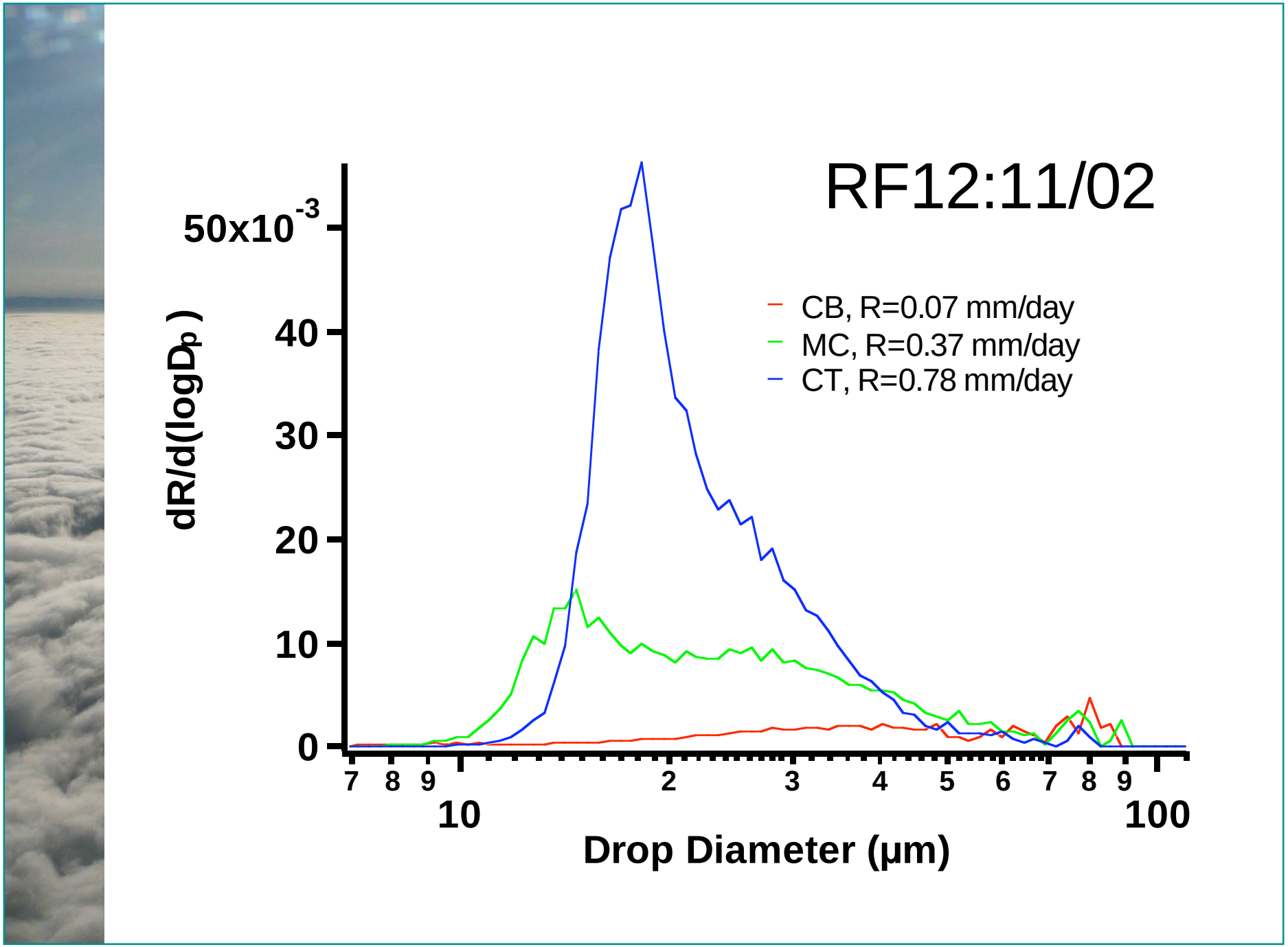

RF10:10/30
CB, R=0.06 mm/day
MC, R=0.11 mm/day
CT, R=0.13 mm/day
8x10-3
6
4
2
0
dR/d(logDp)
6 7 8 9
10
2
3
4
5
6 7 8 9
100
Drop Diameter (μm)

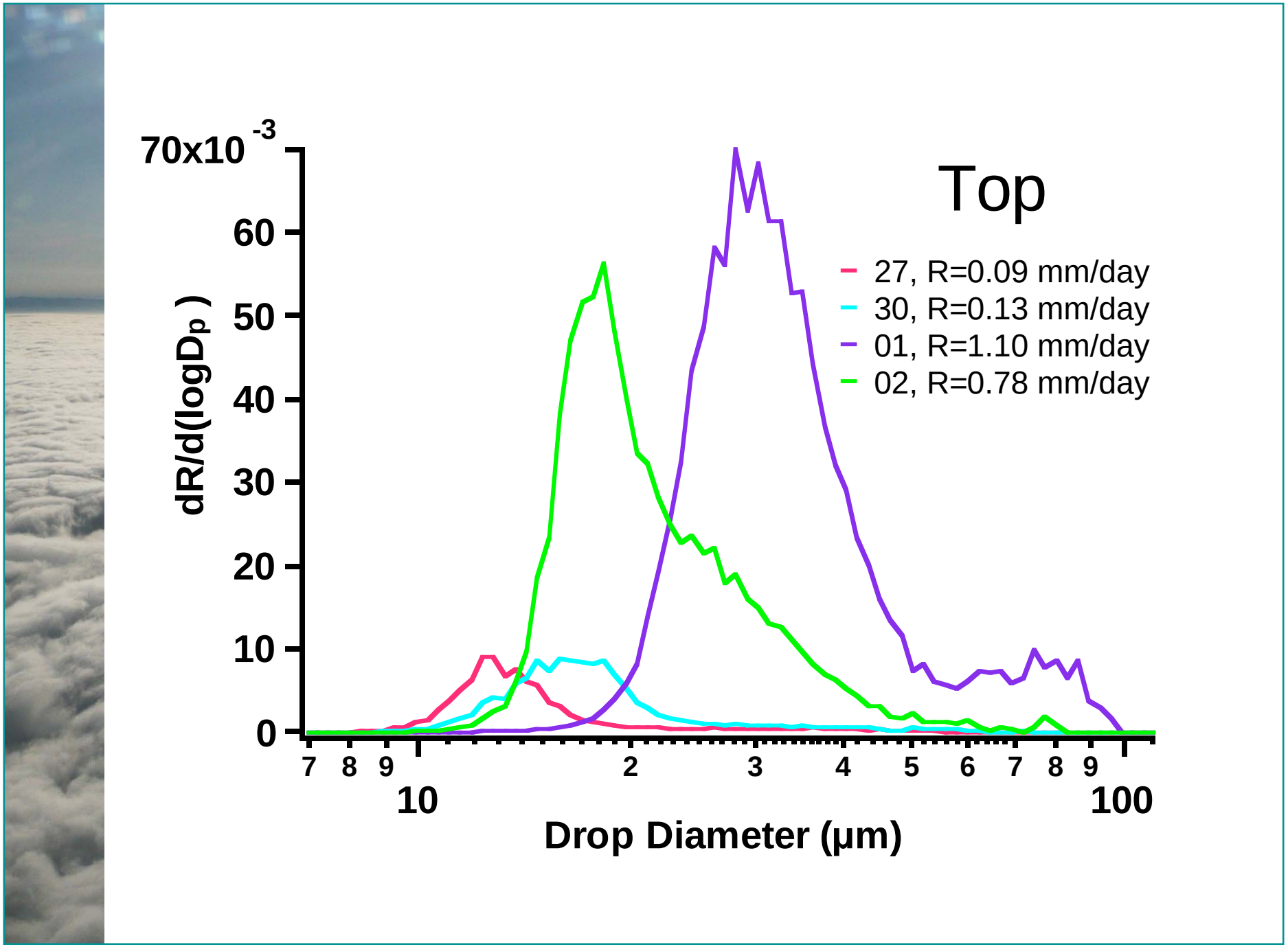

MASE
July 16, 2005
50x10-3
40
30
20
10
0
dR/d(logDp)
Cloud Top, R=0.57 mm/day
Mid-Cloud, R=0.49 mm/day
Cloud Base, R=0.15 mm/day
7 8 9
10
2
3
4
5
6
7
8
9
100
Drop Diameter (μm)

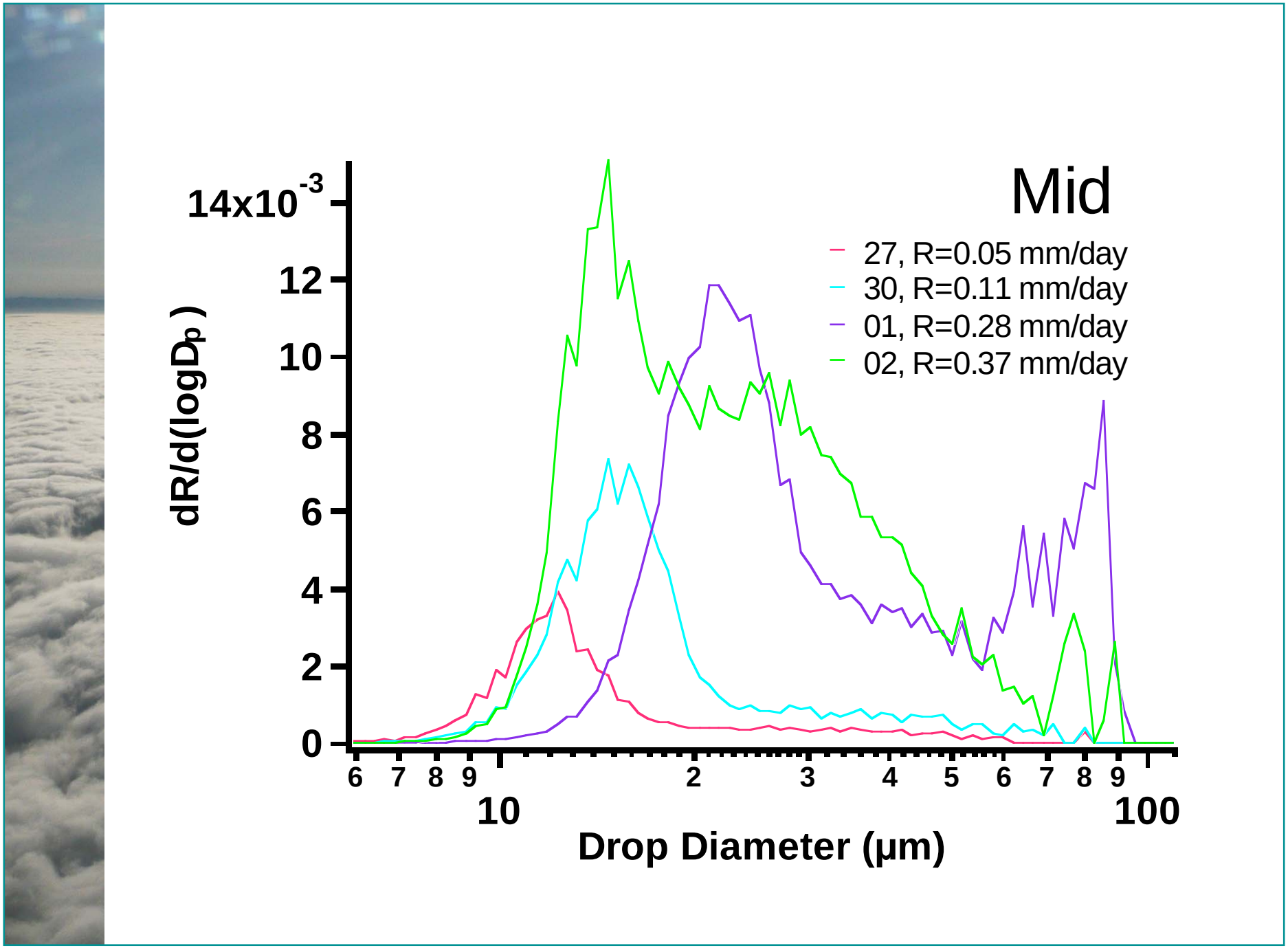

RF11: 11/01
D (μm)
D90
D50
D10
R (mm/day)
R
R (>40μm)
LWC (g/m3)
Gerber LWC
θe
θe(K)
Conc (cm3)
PDI Nd
Altitude
Alt (m)
Mid Cu
Between
Base
Mid
Top
Below
Base
Mid
Top
Seconds Since 00Z
46
47
48
49
50
51
52
53x10^3

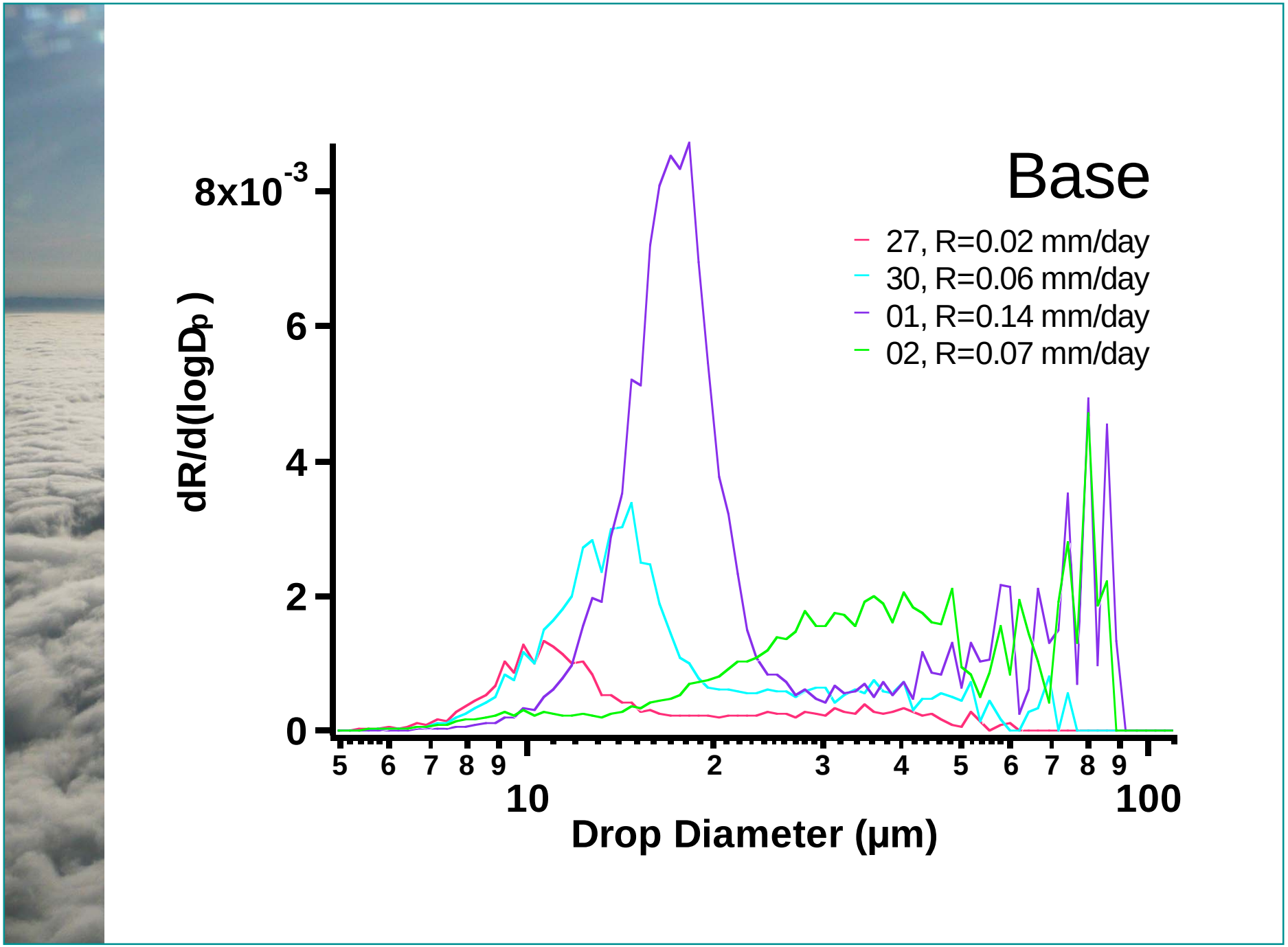

11/01
70x10 -3
60
50
40
30
20
10
0
dR/d(logDp)
Mid Cu, R=0.02 mm/day
Between, R=0.05 mm/day
CB, R=0.14 mm/day
MC, R=0.28 mm/day
CT, R=1.10 mm/day
9
10
2
3
4
5
6
7
8
9
100
Drop Diameter (µm)

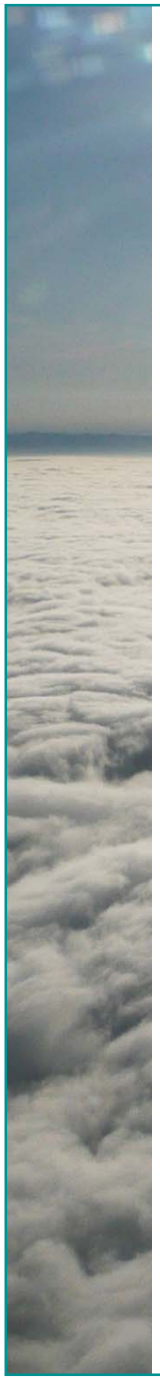

RF12: 11/02
D (μm)
D90
D50
D10
R (mm/day)
R
R (>40μm)
LWC (g/m3)
Gerber LWC
θe
θe(K)
Conc (cm-3)
PDI Nd
Altitude
Alt (m)
Base
Mid
Top
Base
Mid
Top
x10 3


RF12:11/02
50x10-3
40
30
20
10
0
dR/d(logDp)
CB, R=0.07 mm/day
MC, R=0.37 mm/day
CT, R=0.78 mm/day
7 8 9
10
2
3
4
5
6
7 8 9
100
Drop Diameter (μm)


70x10 -3
60
50
40
30
20
10
0
dR/d(logDp)
Top
27, R=0.09 mm/day
30, R=0.13 mm/day
01, R=1.10 mm/day
02, R=0.78 mm/day
7 8 9
10
2
3
4
5
6
7 8 9
100
Drop Diameter (μm)


Mid
27, R=0.05 mm/day
30, R=0.11 mm/day
01, R=0.28 mm/day
02, R=0.37 mm/day
14x10-3
12
10
8
6
4
2
0
dR/d(logDp)
6 7 8 9
10
2 3 4 5 6 7 8 9
100
Drop Diameter (μm)


Base
27, R=0.02 mm/day
30, R=0.06 mm/day
01, R=0.14 mm/day
02, R=0.07 mm/day
8x10-3
6
4
2
0
dR/d(logDp)
5 6 7 8 9
10
2 3 4 5 6 7 8 9
100
Drop Diameter (μm)



Conclusion

- In terms of drizzle, clouds at Point Alpha are generally not well-developed
- Exceptions are Nov 1st and 2nd