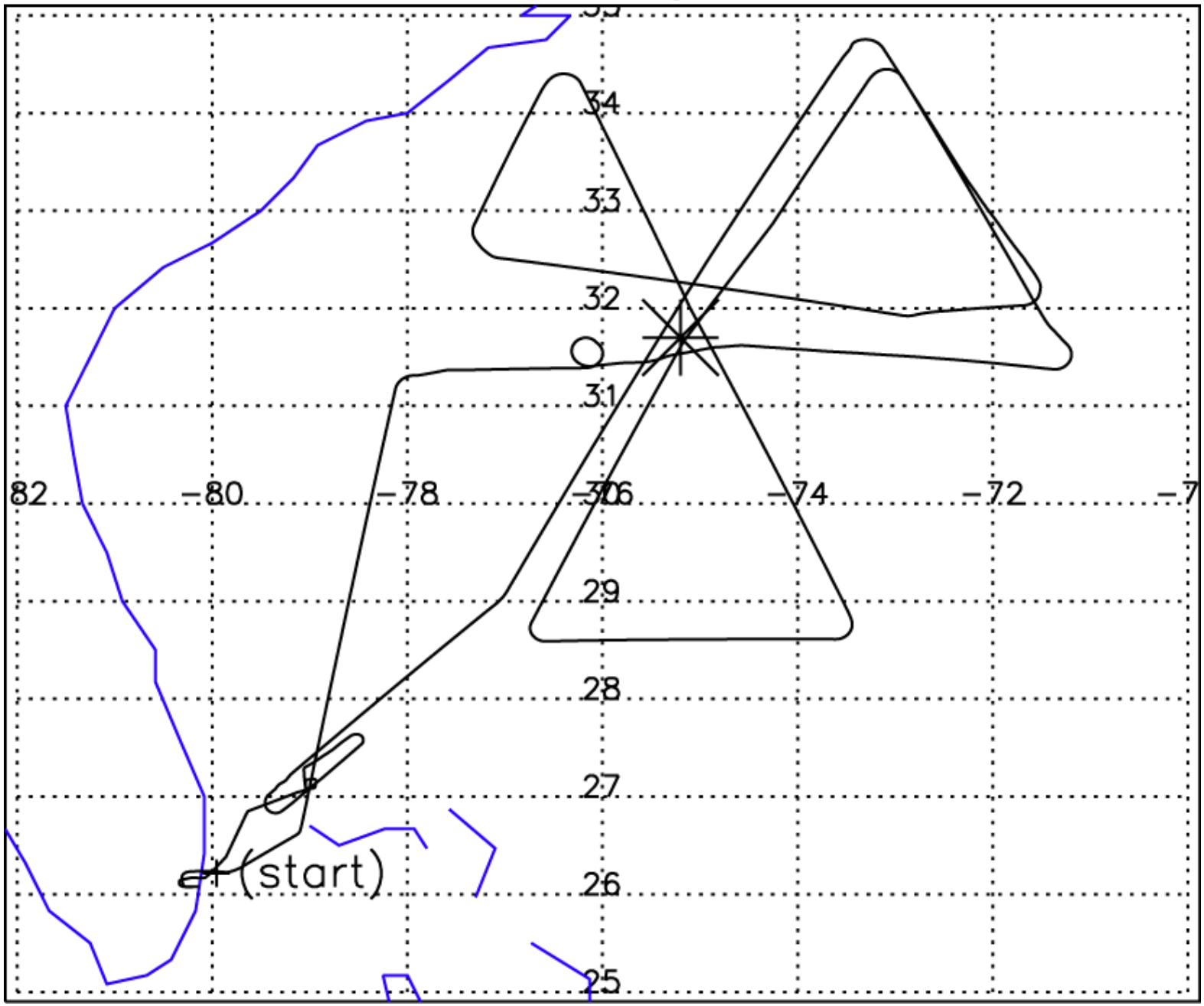
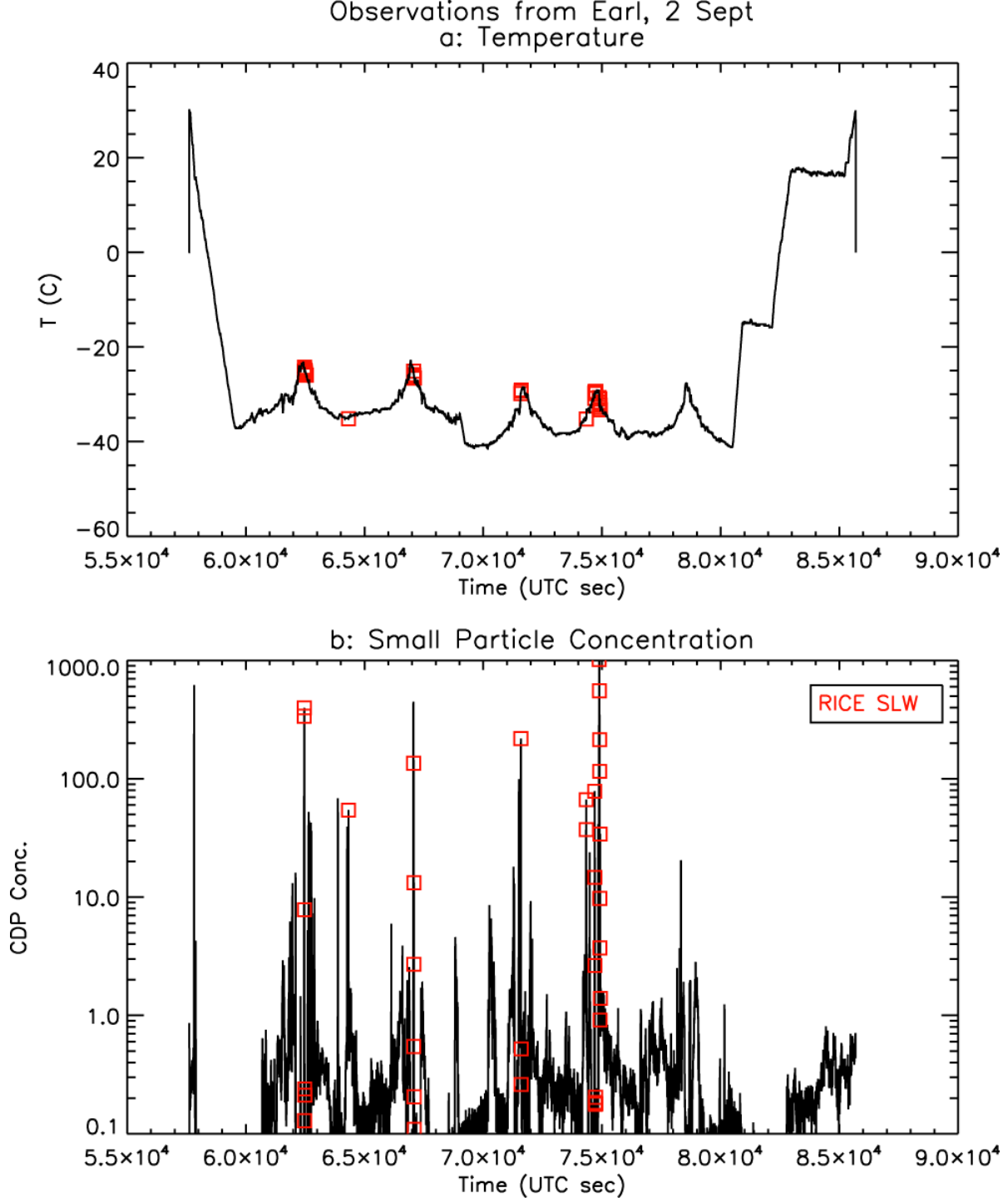
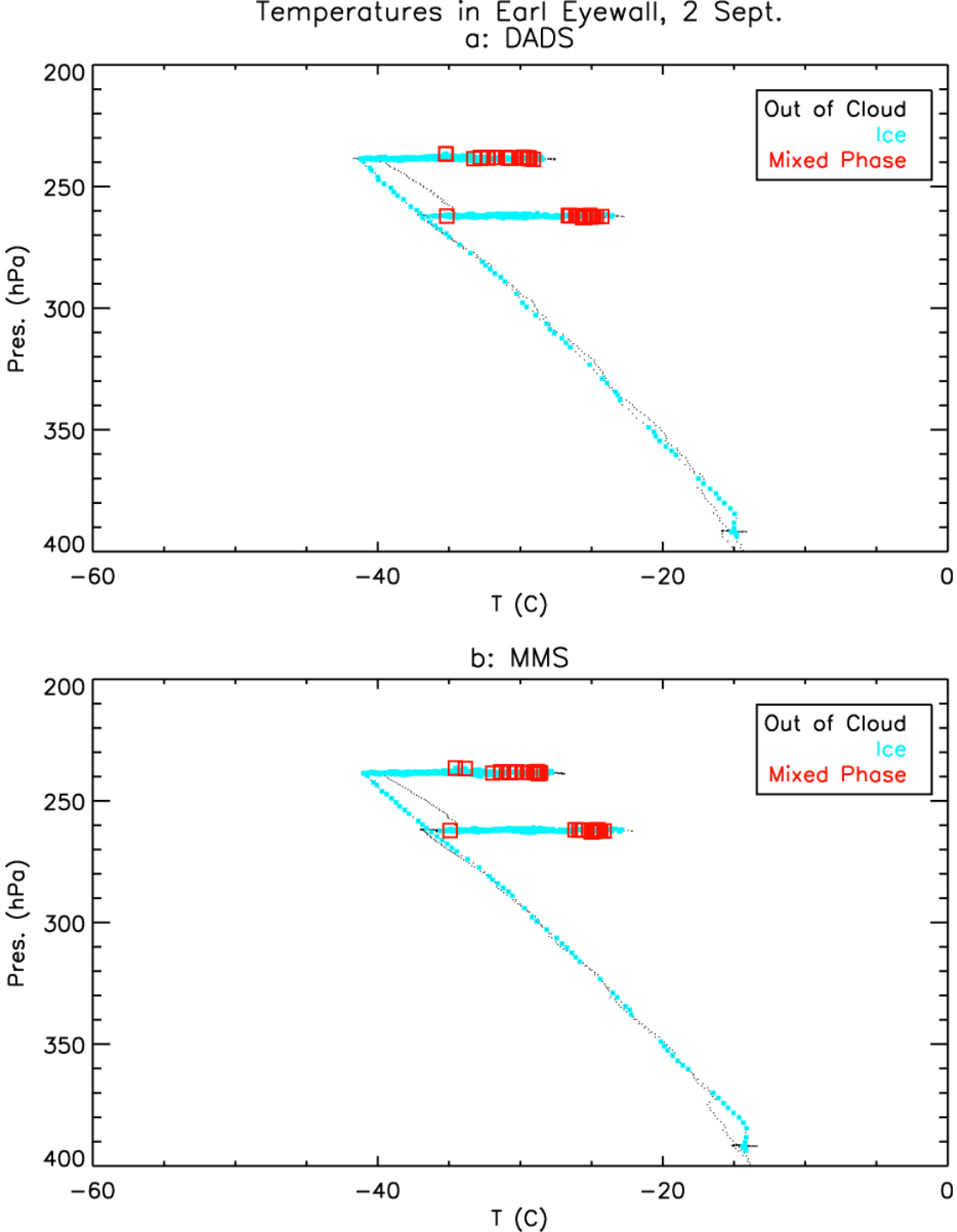
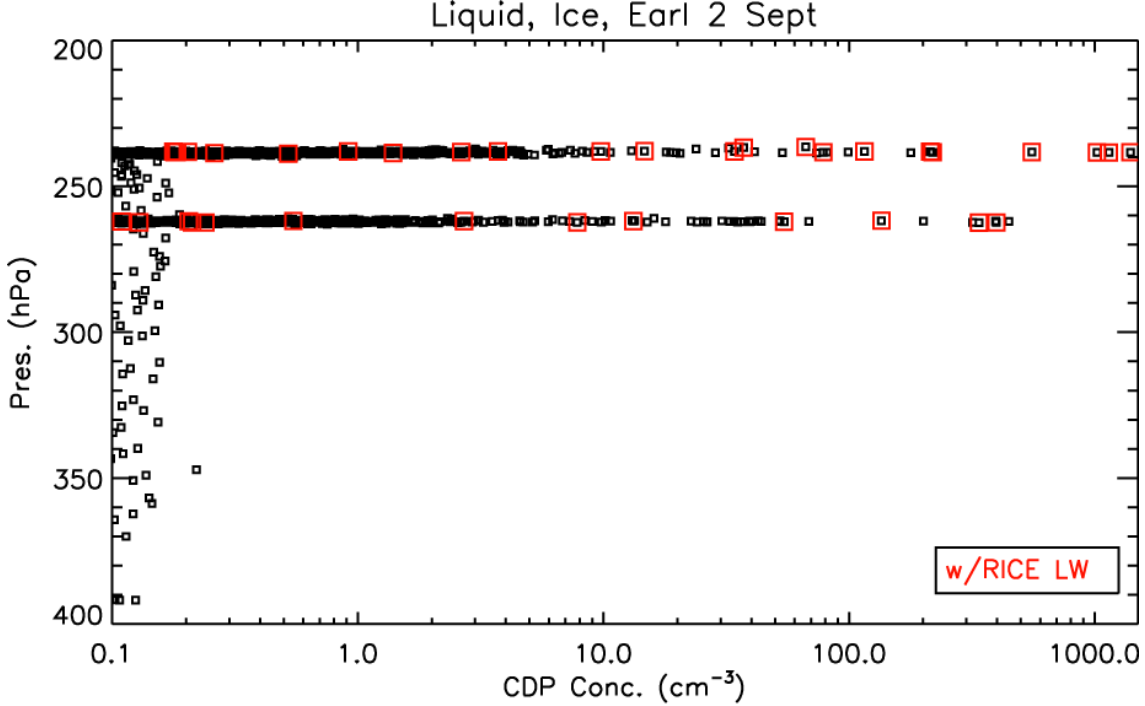
Microphysical Observations in Hurricane Earl

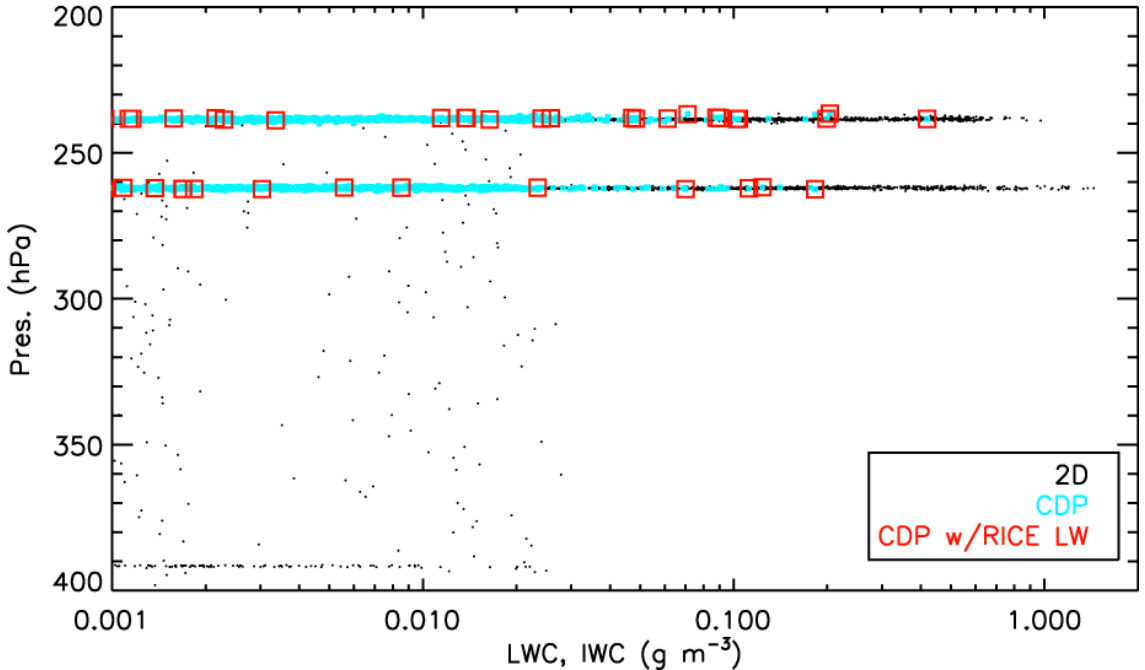
Andrew Heymsfield and Aaron Bansemer, NCAR
Yaitza Luna-Cruz, Howard University

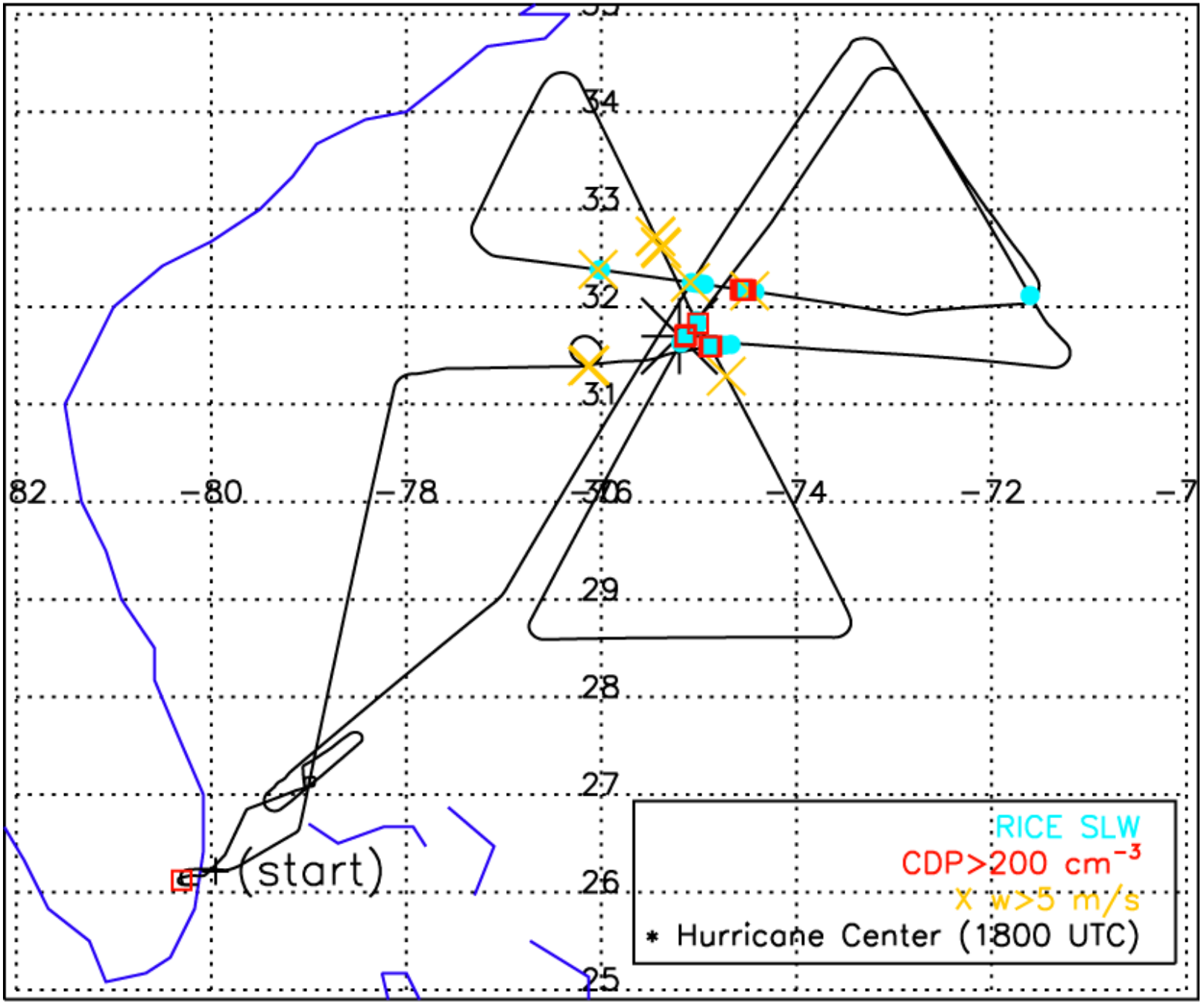

Earl, 2 Sept. Flight Track
34
33
32
31
29
28
27
26
25
82
80
78
76
74
72
(start)


Observations from Earl, 2 Sept
a: Temperature
T (C)
40
20
0
−20
−40
−60
5.5×10⁴
6.0×10⁴
6.5×10⁴
7.0×10⁴
7.5×10⁴
8.0×10⁴
8.5×10⁴
9.0×10⁴
Time (UTC sec)
b: Small Particle Concentration
CDP Conc.
1000.0
100.0
10.0
1.0
0.1
RICE SLW
5.5×10⁴
6.0×10⁴
6.5×10⁴
7.0×10⁴
7.5×10⁴
8.0×10⁴
8.5×10⁴
9.0×10⁴
Time (UTC sec)

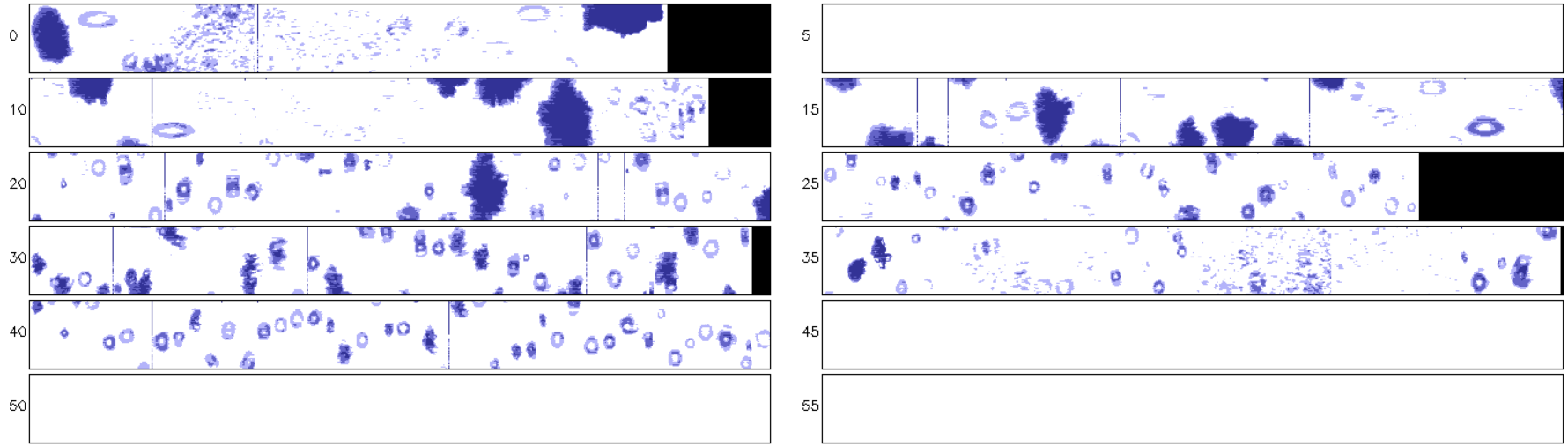

Temperatures in Earl Eyewall, 2 Sept.
a: DADS
Out of Cloud
Ice
Mixed Phase
Pres. (hPa)
200
250
300
350
400
−60
−40
−20
0
T (C)
b: MMS
Out of Cloud
Ice
Mixed Phase
Pres. (hPa)
200
250
300
350
400
−60
−40
−20
0
T (C)


Liquid, Ice, Earl 2 Sept
Pres. (hPa)
200
250
300
350
400
0.1
1.0
10.0
100.0
1000.0
CDP Conc. (cm^{-3})
w/RICE LW

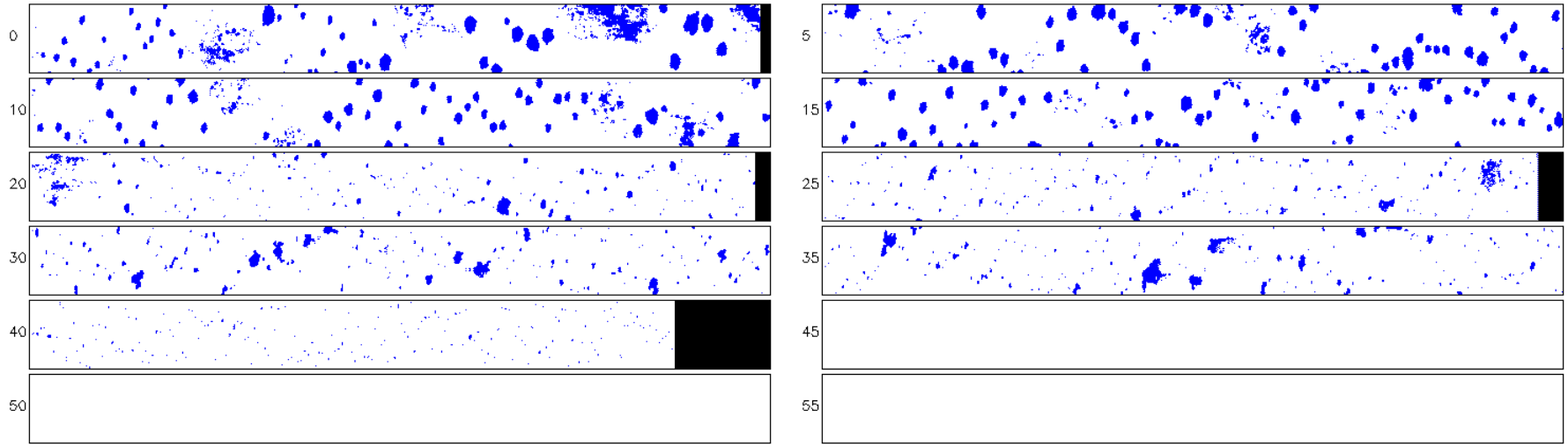

Pres. (hPa)
200
250
300
350
400
0.001
0.010
0.100
1.000
LWC, IWC (g m^{-3})
2D
CDP
CDP w/RICE LW

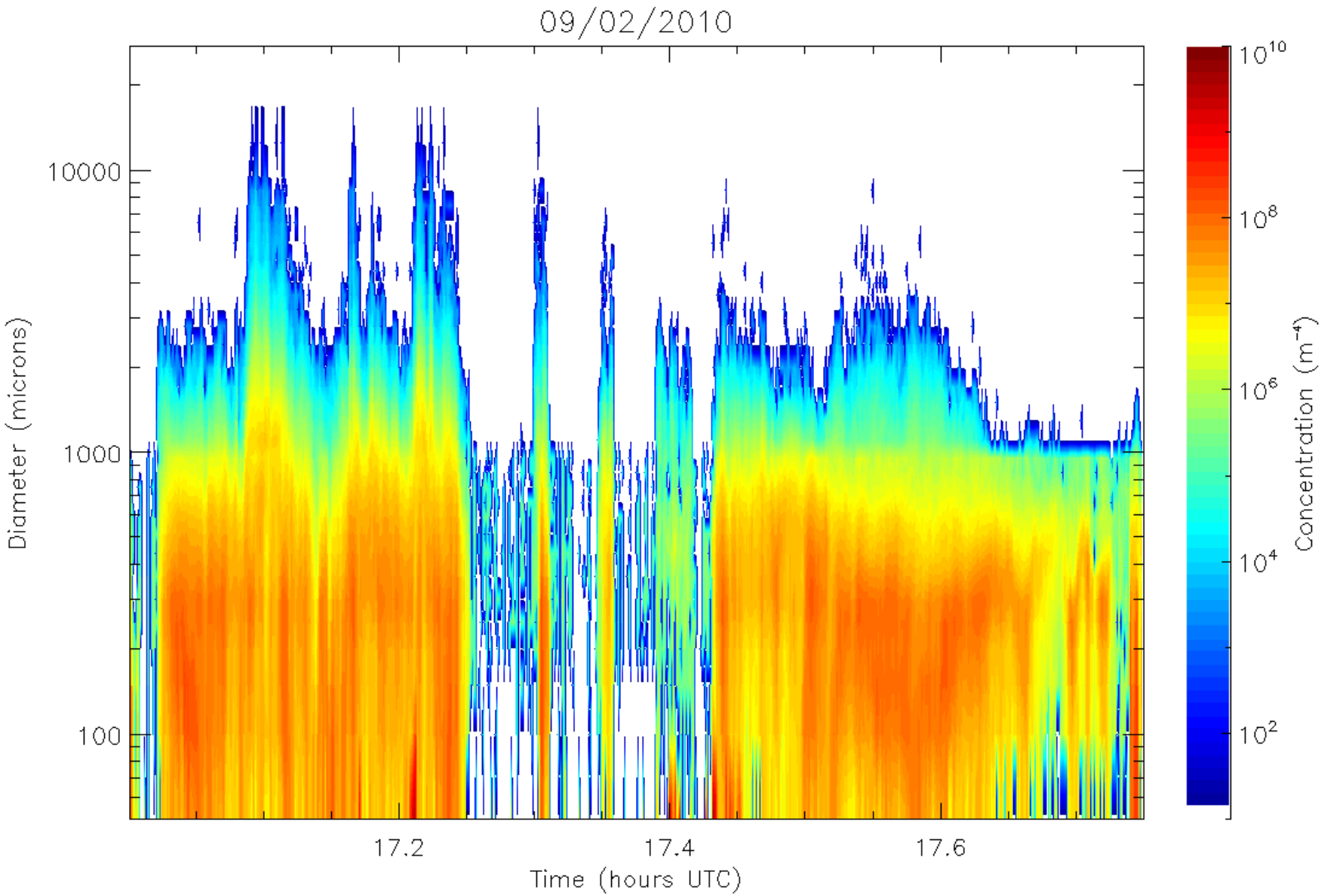

Earl, 2 Sept. Flight Track
34
33
32
31
29
28
27
26
25
82
80
78
76
74
72
(start)
RICE SLW
CDP>200 cm^{-3}
X w>5 m/s
* Hurricane Center (1800 UTC)

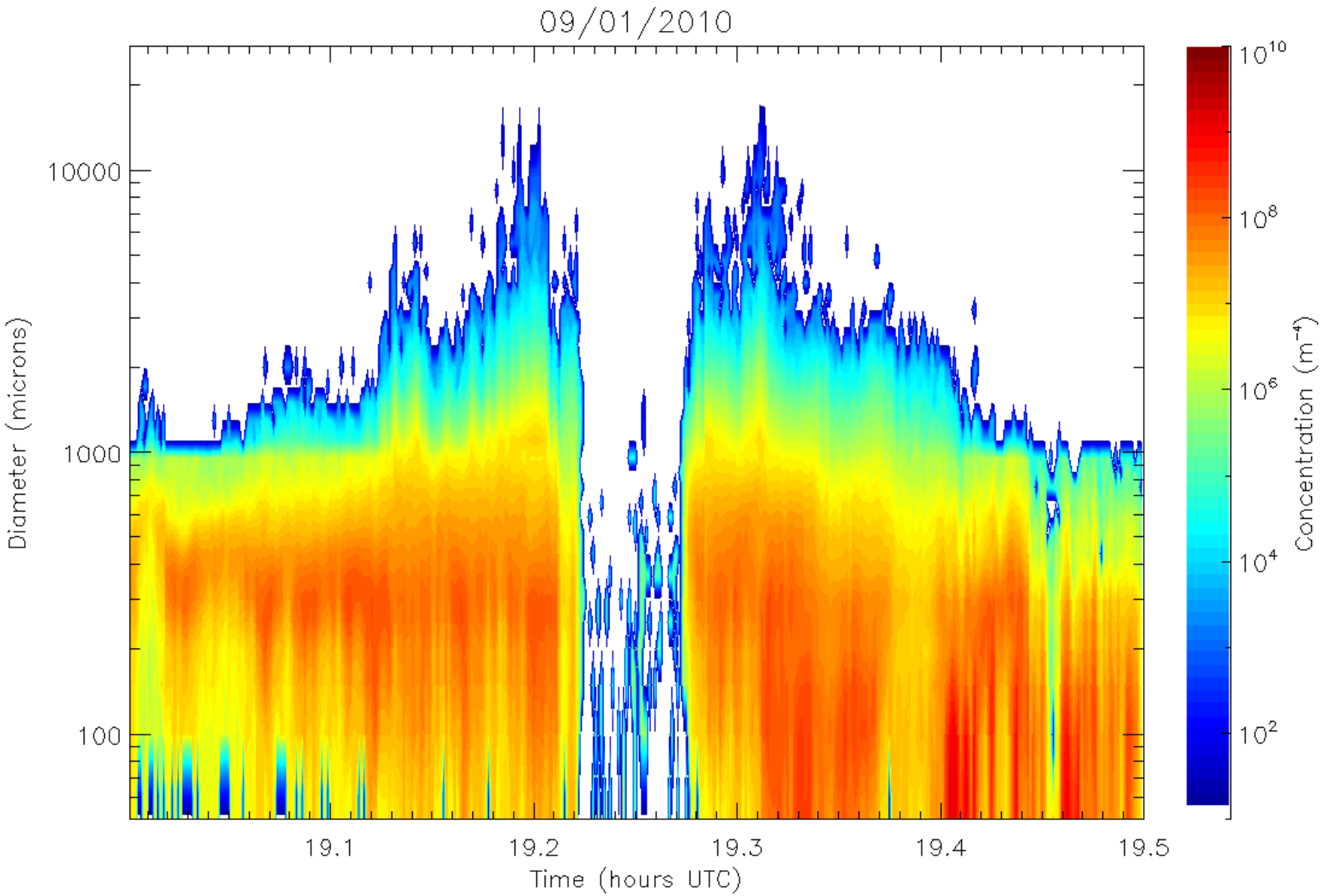
09022010 171800 Buffer width = 960 microns.
Project: GRIP Probe: CIPG Resolution: 15 microns
This image represents one minute of flight time.

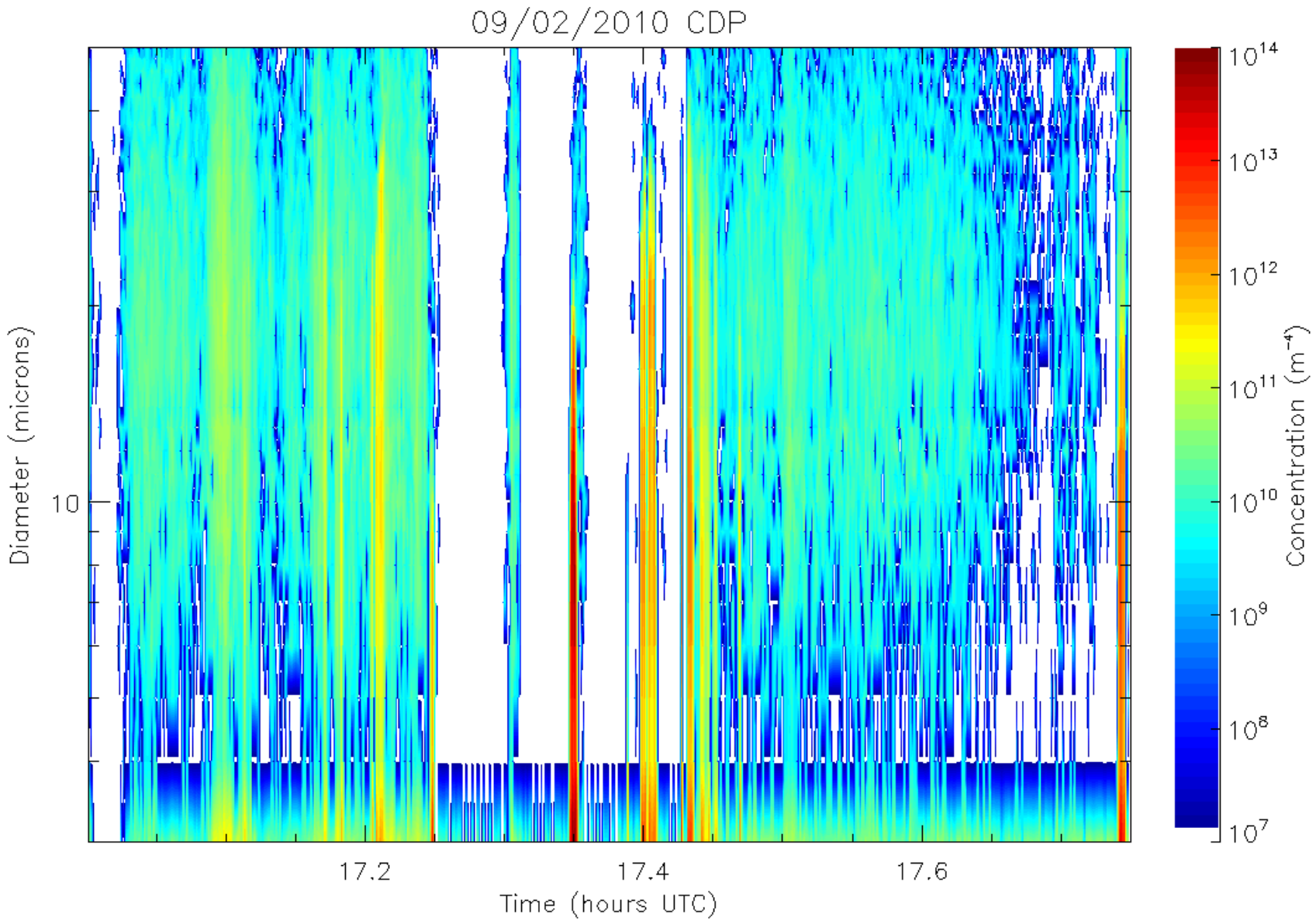


09022010 171800 Buffer width = 6400 microns.
Project: GRIP Probe: PIP Resolution: 100 microns
This image represents one minute of flight time.

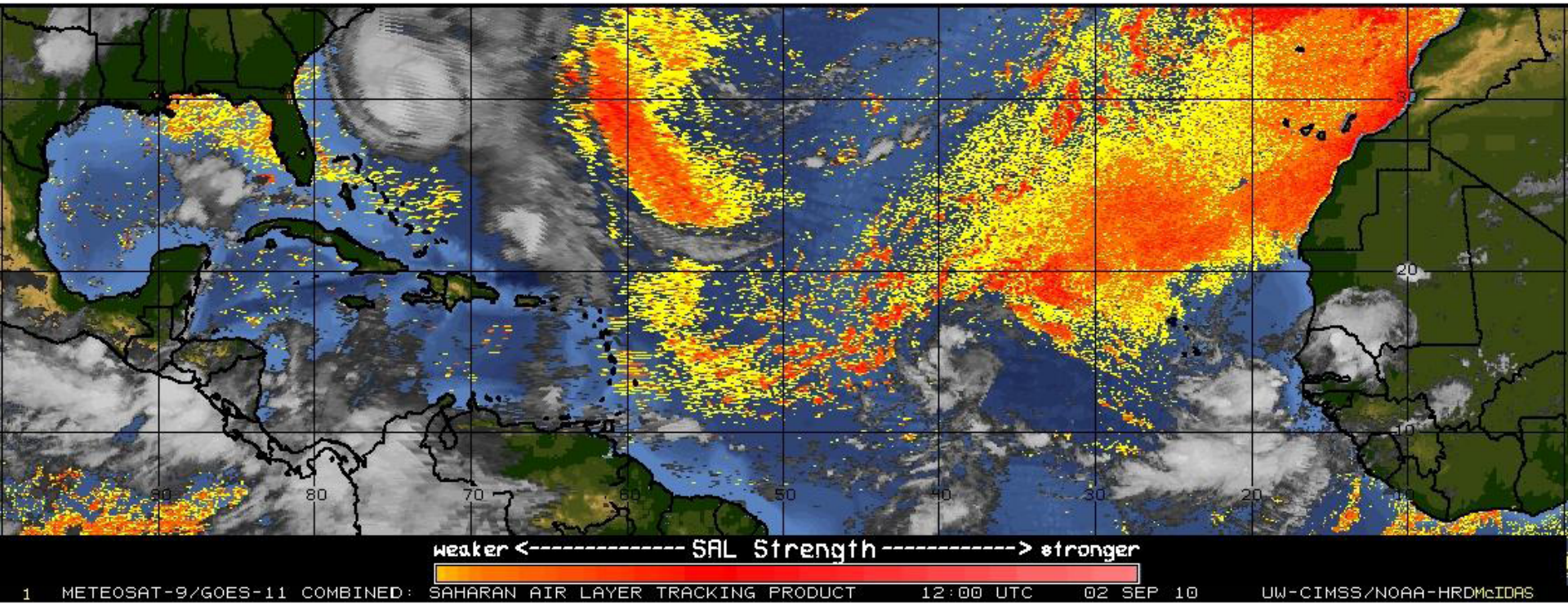



09/02/2010
10000
1000
100
Diameter (microns)
17.2
17.4
17.6
Time (hours UTC)
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
Concentration (m^{-4})


09/01/2010
10000
1000
100
Diameter (microns)
19.1
19.2
19.3
19.4
19.5
Time (hours UTC)
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
Concentration (m^{-4})

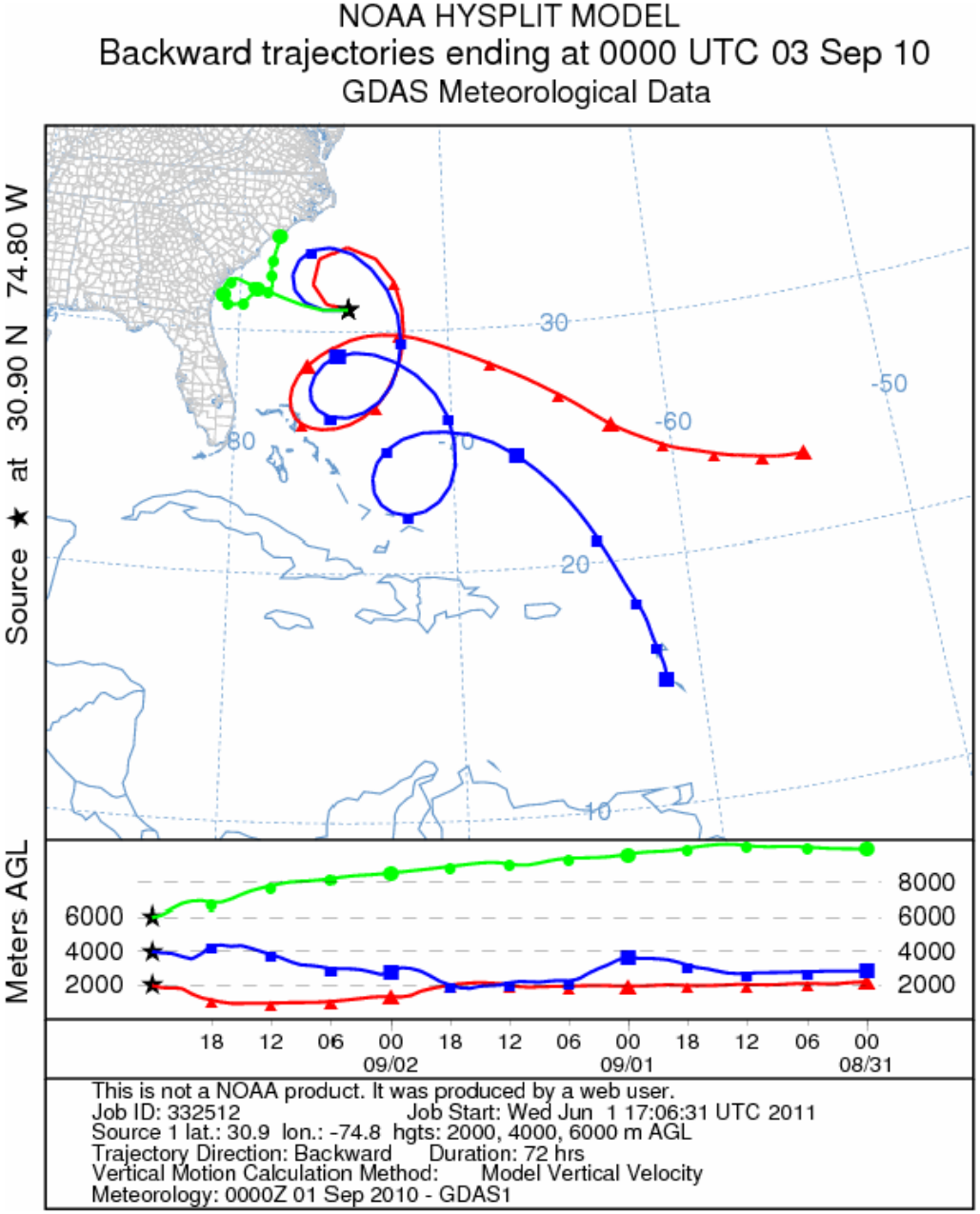

09/02/2010 CDP
Diameter (microns)
10
17.2
17.4
17.6
Time (hours UTC)
10^{14}
10^{13}
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
Concentration (m^{-4})

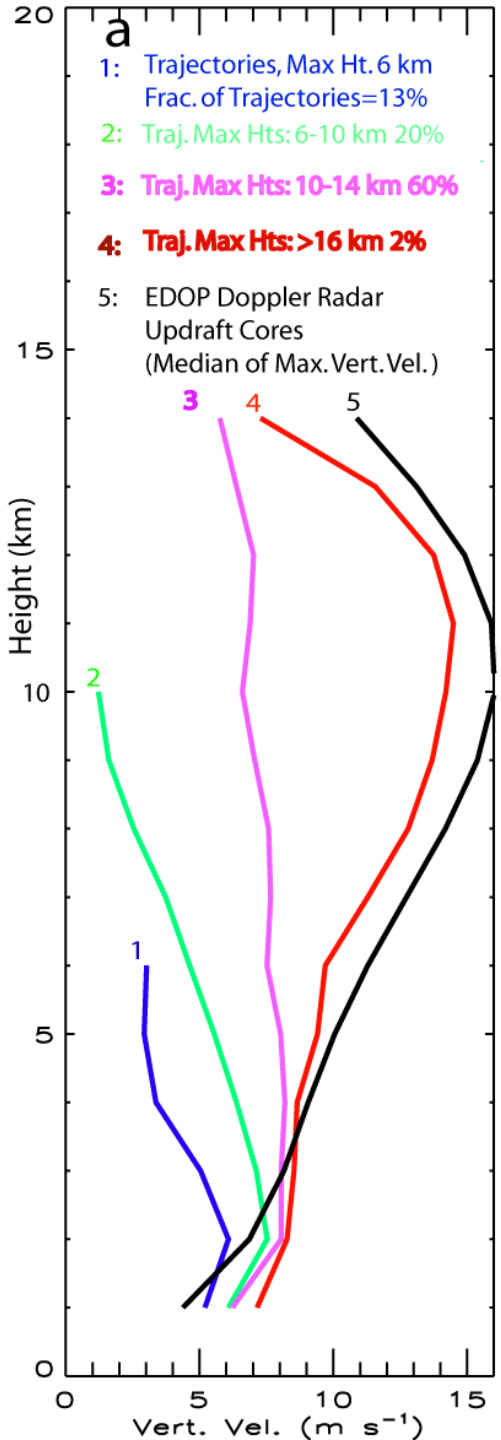
Saharan Air Layer Tracking Product
Meteosat-9/GOES-11

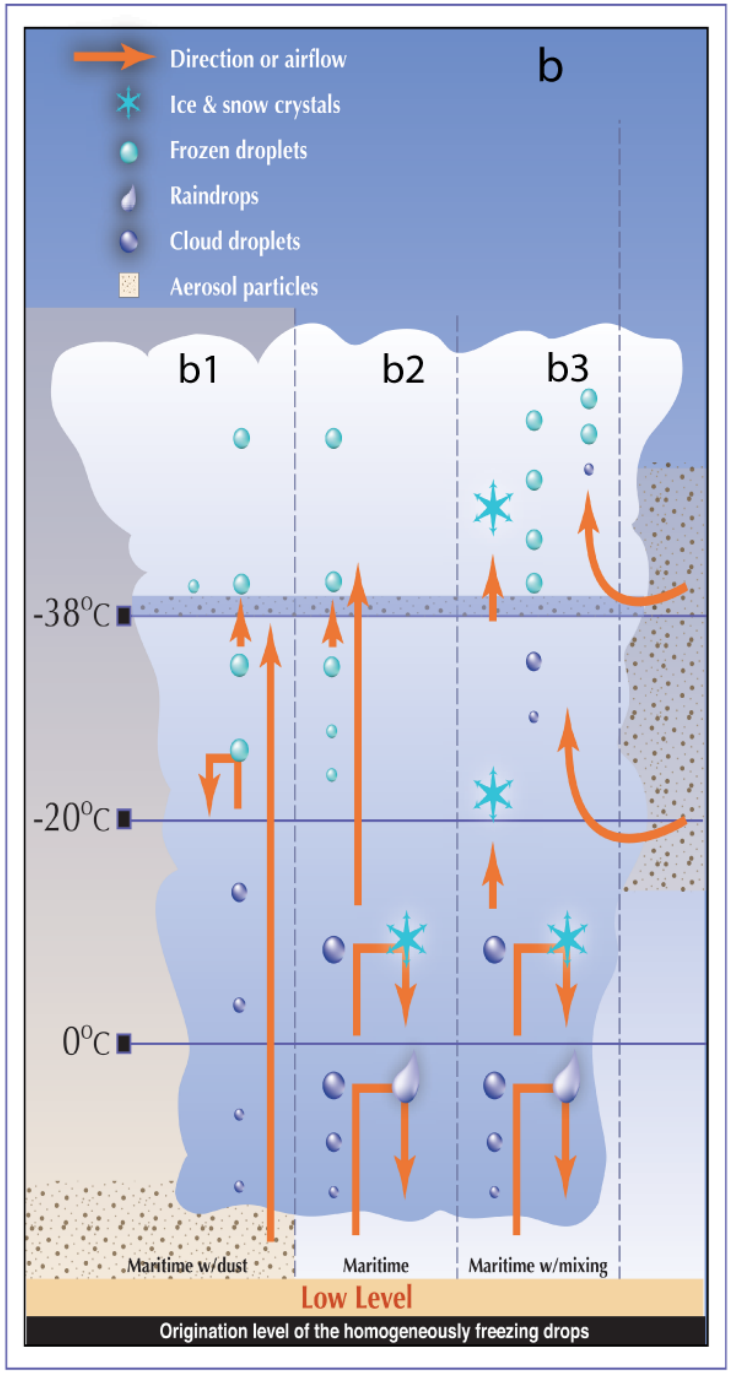


September 2, 2010 – 12:00:00 UTC

NOAA Back Trajectories







Heymsfield et al (2009, JAS), NAMMA

Summary and Conclusions

- Highly supercooled liquid water observed in Hurricane Earl
- High concentrations of small cloud droplets
  - First direct observation of activation of dust aerosols to cloud droplets in a hurricane
  - Small cloud droplets are resistant to collection by drops and freezing to ice
- Droplets likely activated aloft rather than near cloud base
- Delayed latent heating from droplet freezing to ice likely did not play a major role in dynamics
- Radiative properties of high concentrations of small ice likely significant
- What influence did the eyewall replacement have on the production and transport of drops in the updrafts?