In situ measurements of aerosol size distributions inside the Asian Summer Monsoon Anticyclone

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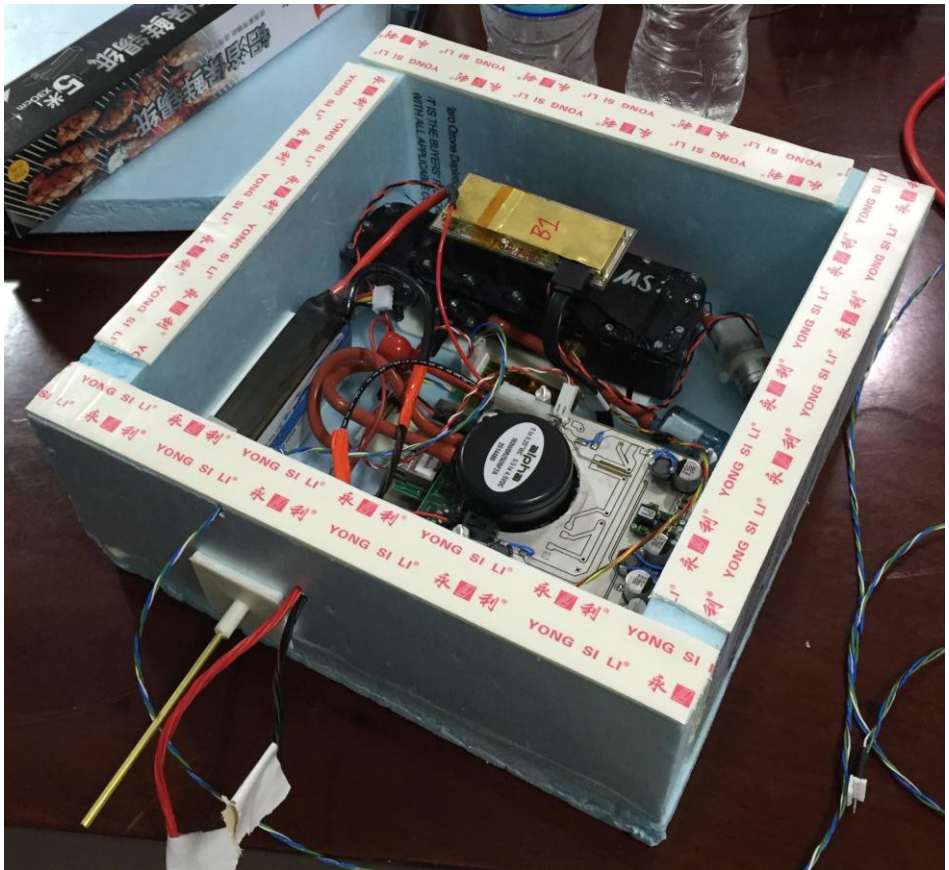
POPS description:

Size range: 140 – 3000 nm diameter (dry)

Sampling: 3 cm^3 s^{-1}

Weight: 1 kg

Communication:
8 size bins with O_3,
CFH, COBALD (limited
by the iMet bandwidth)



The Institute for Atmospheric Physics/Chinese Academy of Science Long Trek VII UAS

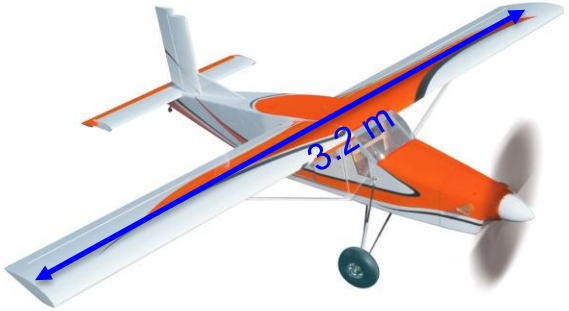
- POPS integration and test flights in November 2015

UAS implementation

The NOAA Pacific Marine Environment Laboratory (PMEL) Manta UAS

- POPS and ULR have been fully integrated
- Successful test flights in January 2015
- First field mission in April 2015 – Svalbard, Norway in collaboration with PMEL

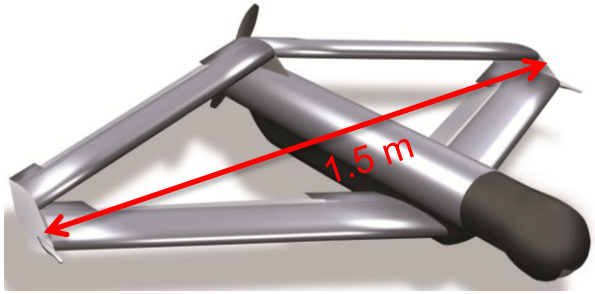
The University of Colorado Pilatus UAS



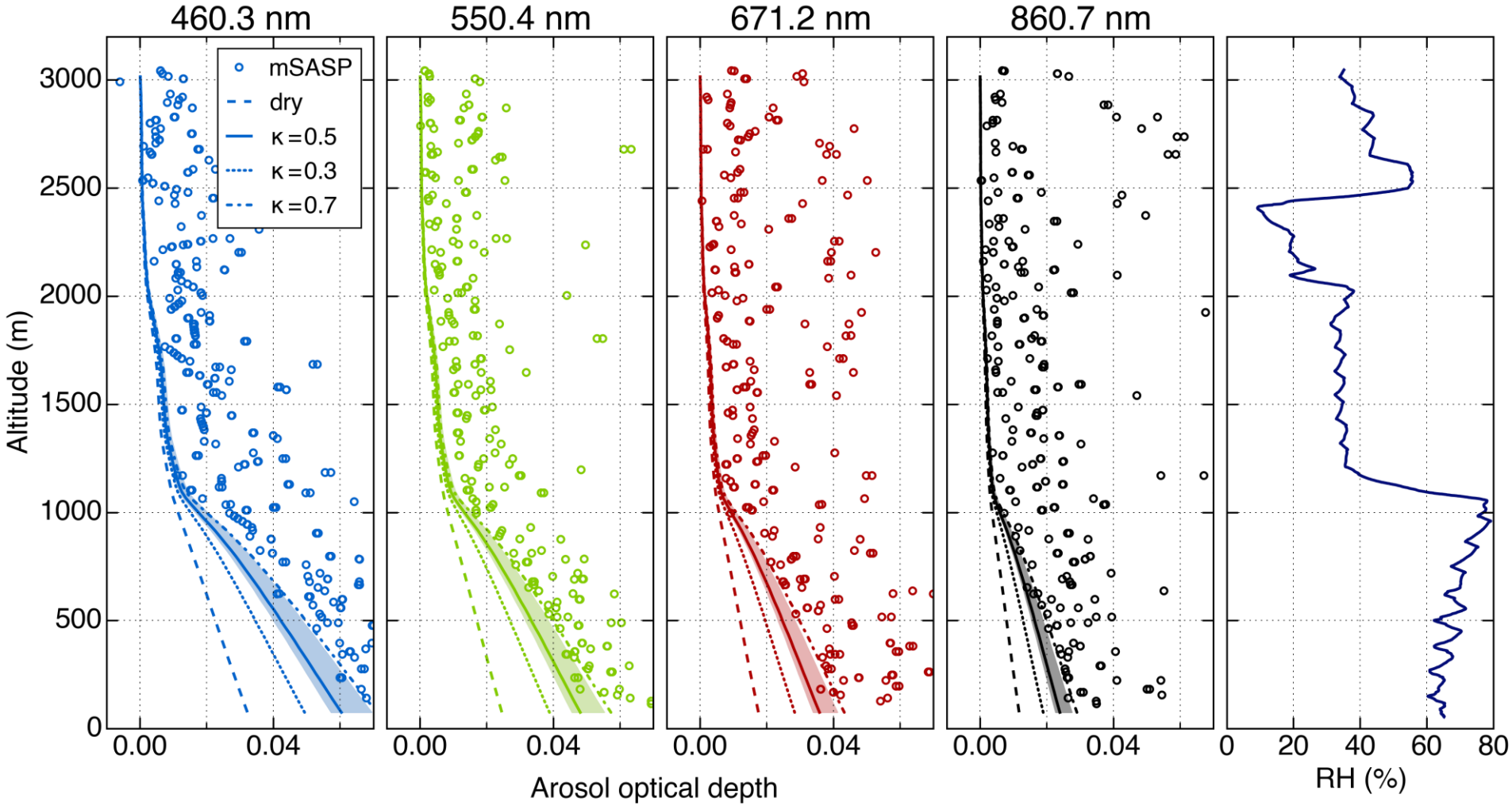
- POPS integration in February 2015
- Test flight in March 2015
- First field mission in April 2015 – Oliktok Point, AK in collaboration with Dept. of Energy, University of Colorado, and Physical Sciences Division (PSD)

The Laboratory for Atmosphere and Cyclone (LACy, Reunion, France) R^2 Drone

- POPS integration right now
- Test flight in this month
- First field mission in Indian Ocean
  in collaboration with LACy



POPS (optical particle counter) and miniSASP (sun photometer): Aerosol optical density and hygroscopicity



Instrumented auto-homing glider (Skywalker X8)

Total weight = 5.6 lbs.

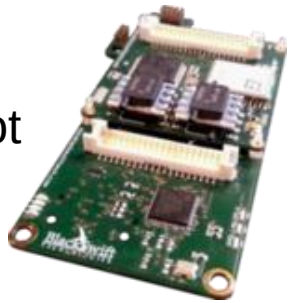
POPS (optical particle counter)

ECC ozone sensor

miniSASP (sun photometer

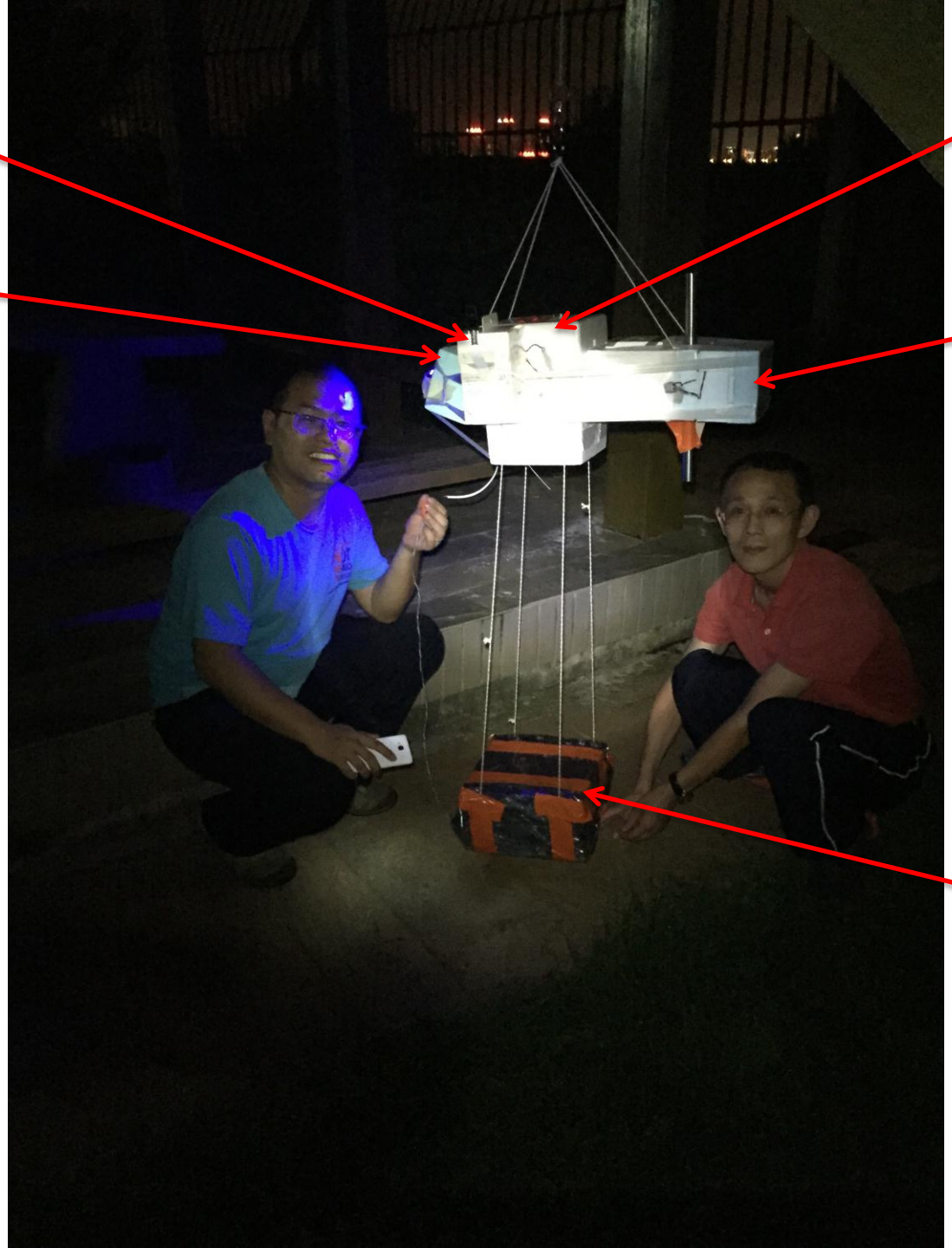
2.1 m

Flight control by Black Swift Technologies

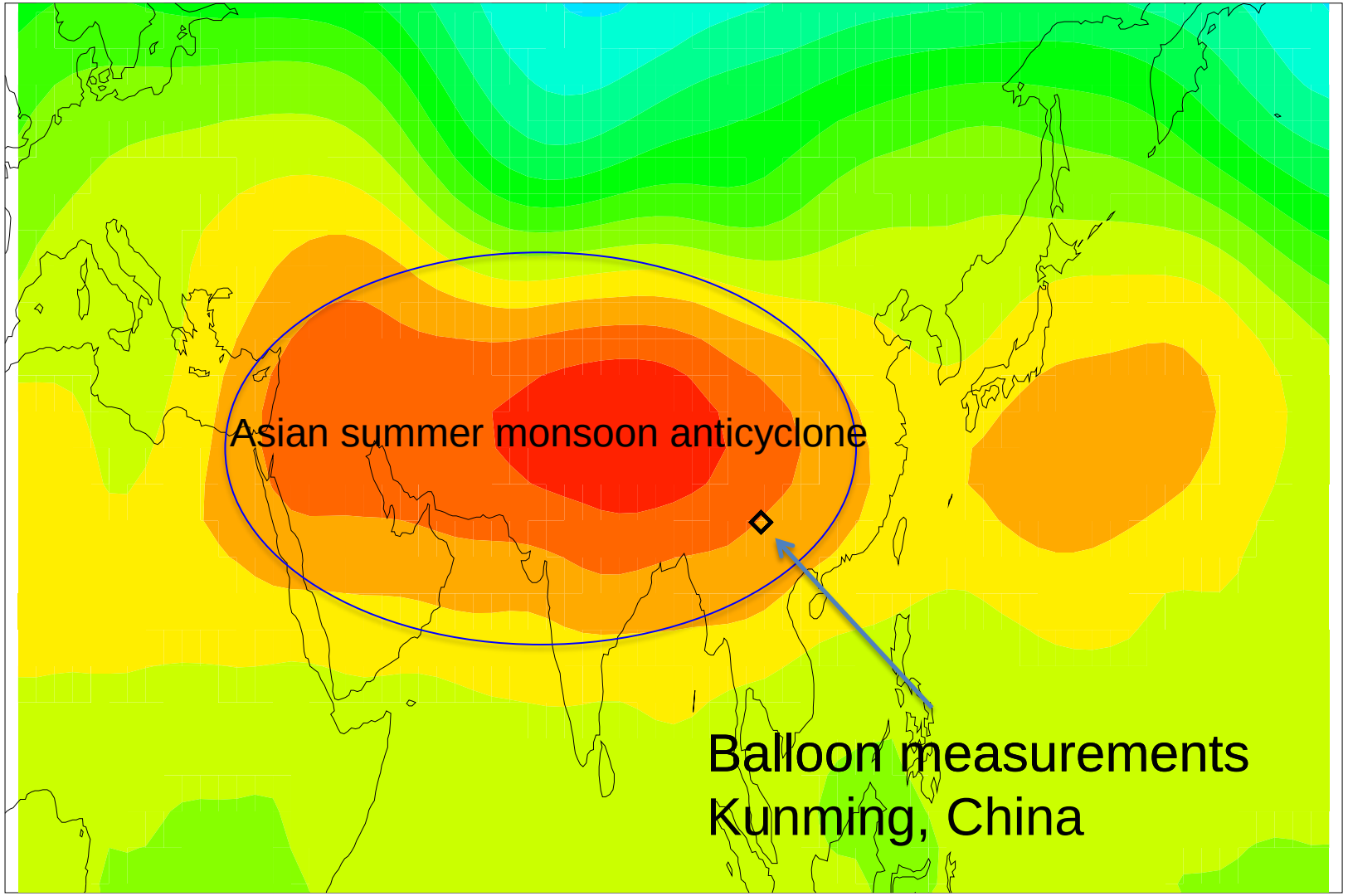
Autopilot 

Tablet UI 

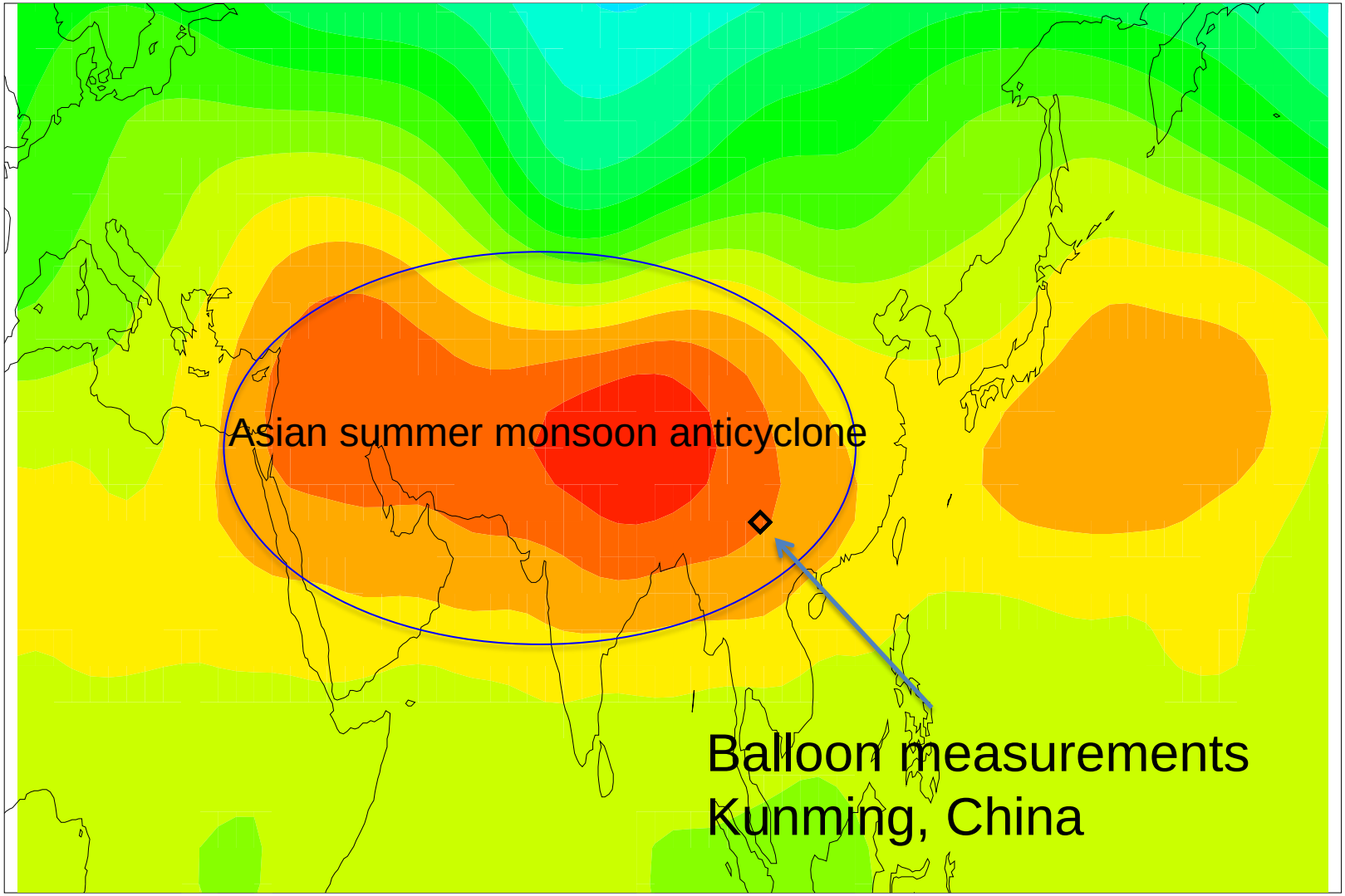
Ground station 


iMet
COBALD
O_3
CFH
POPS
(Printed
Optical
Particle
Spectrometer)

Aug 13, 2015: NCEP 100 mb hgt



Aug 14, 2015: NCEP 100 mb hgt

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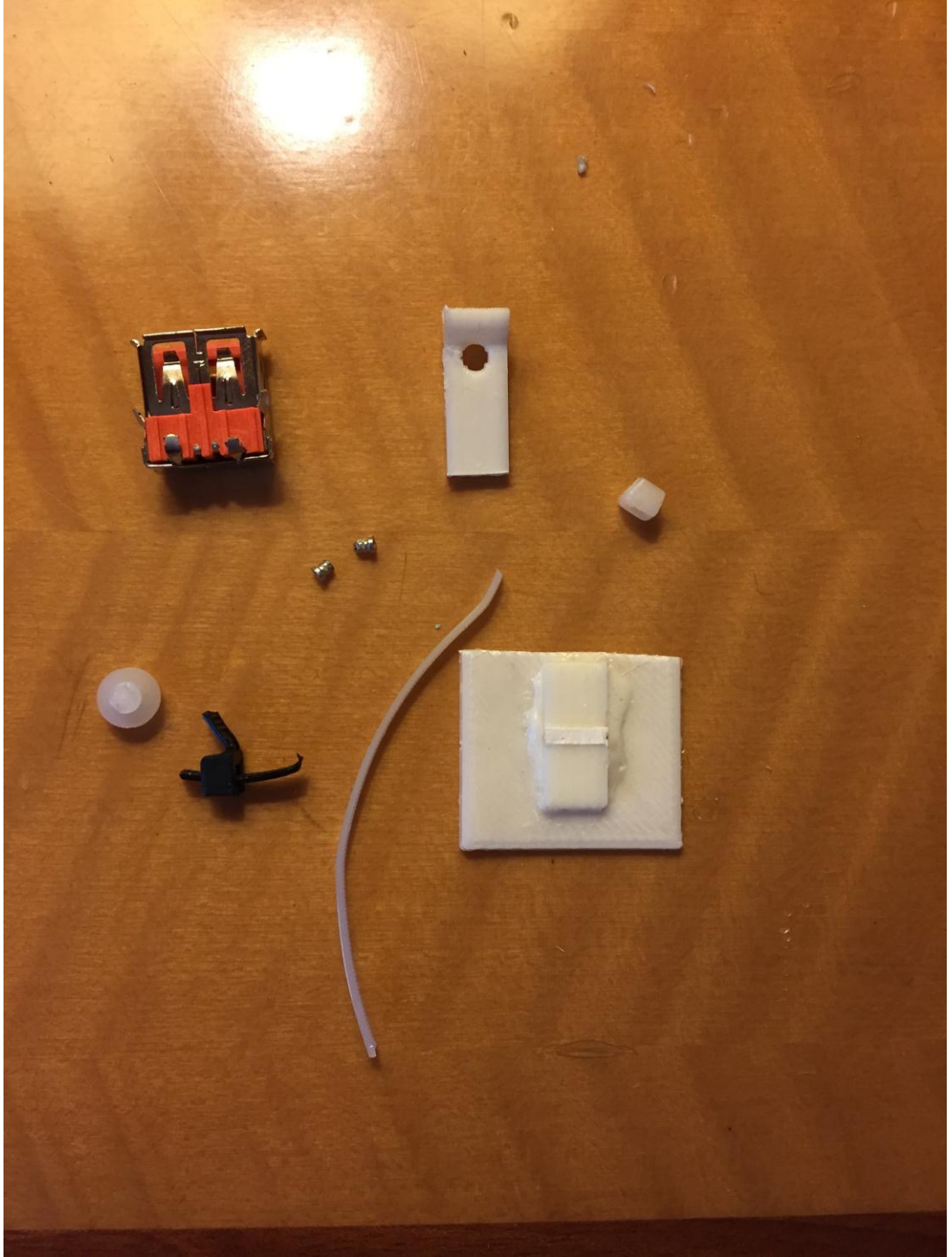
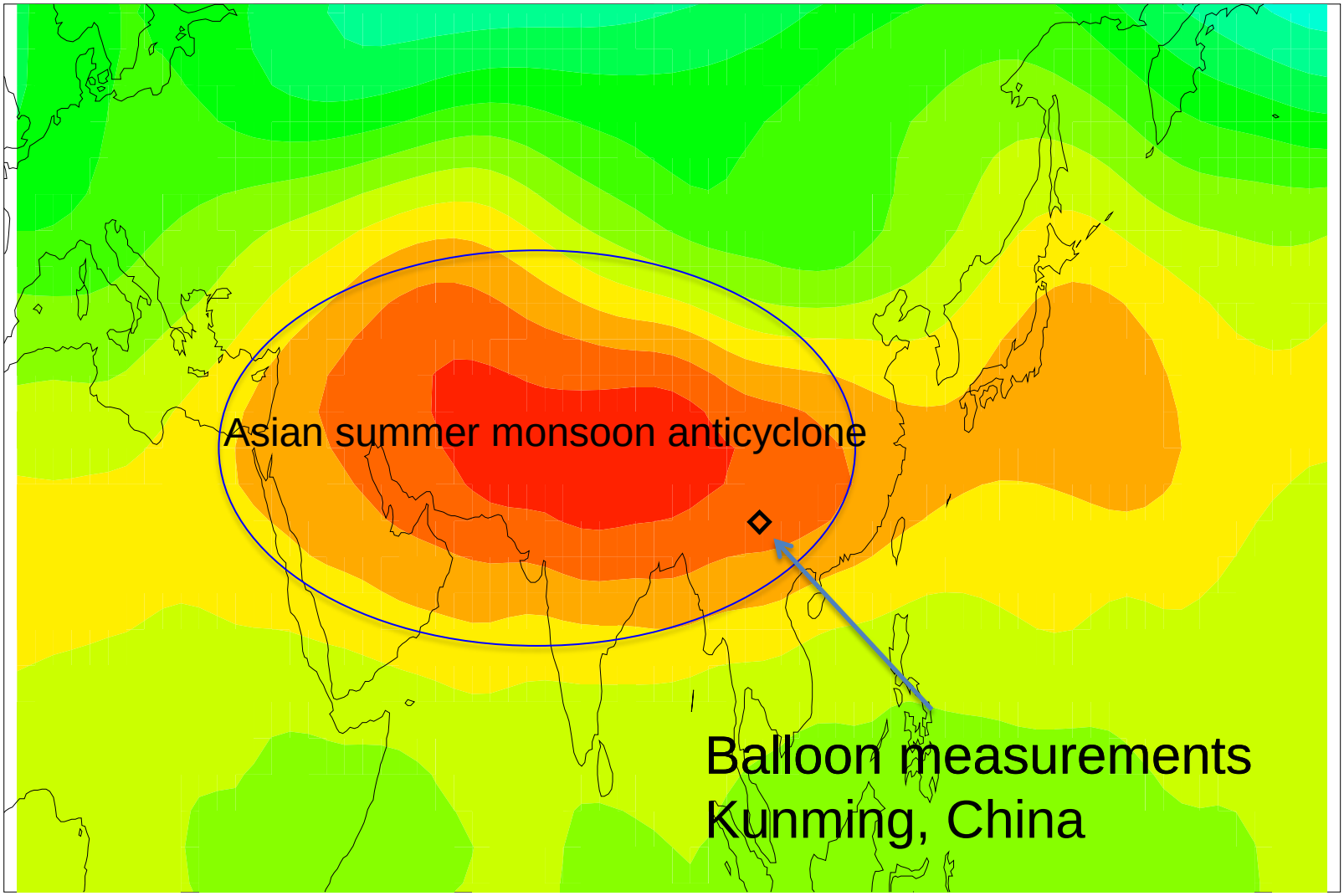
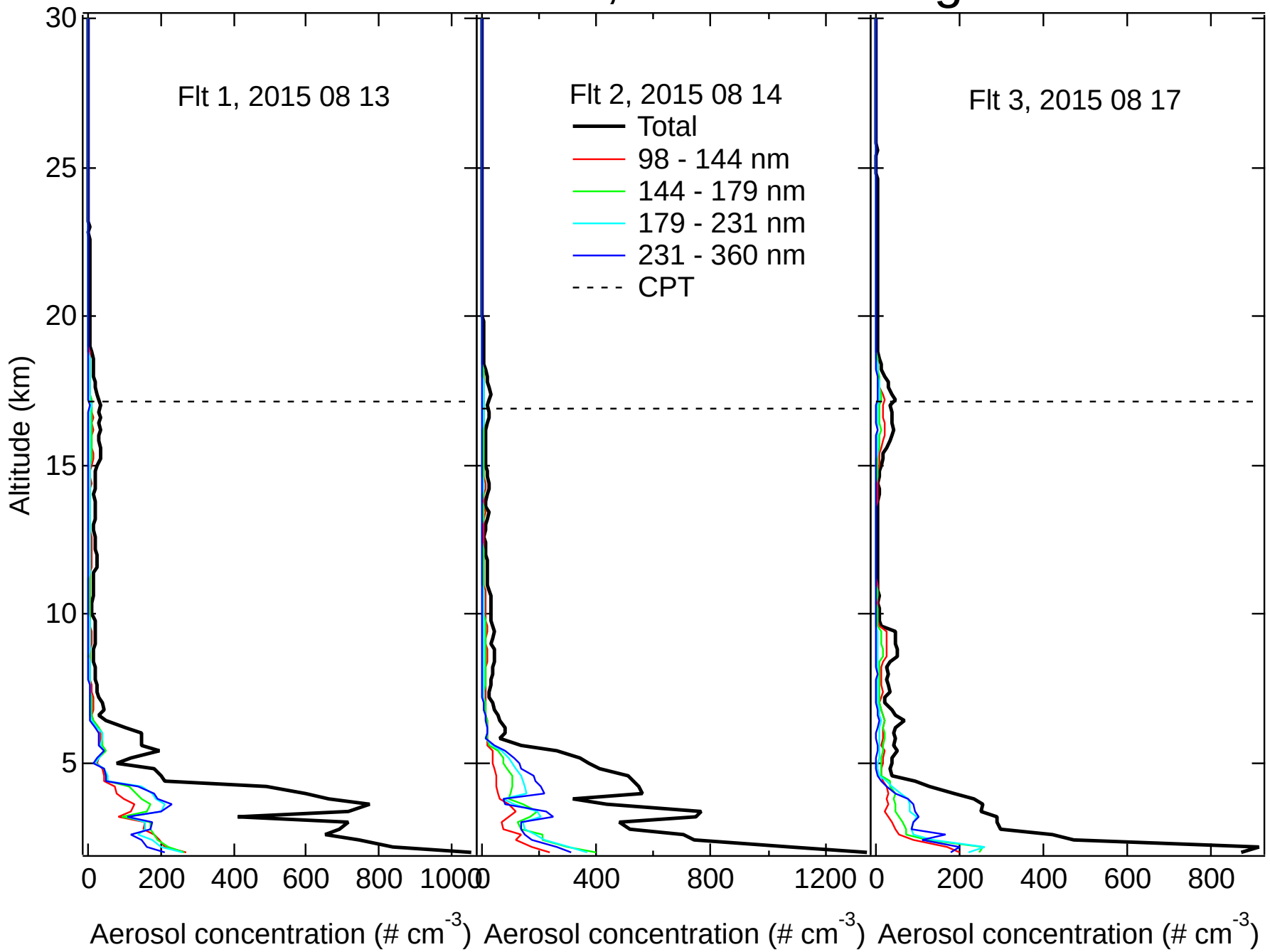
Ozone Depletion
IT IS THE BUYERS'
WITH ALL APPLICABLE

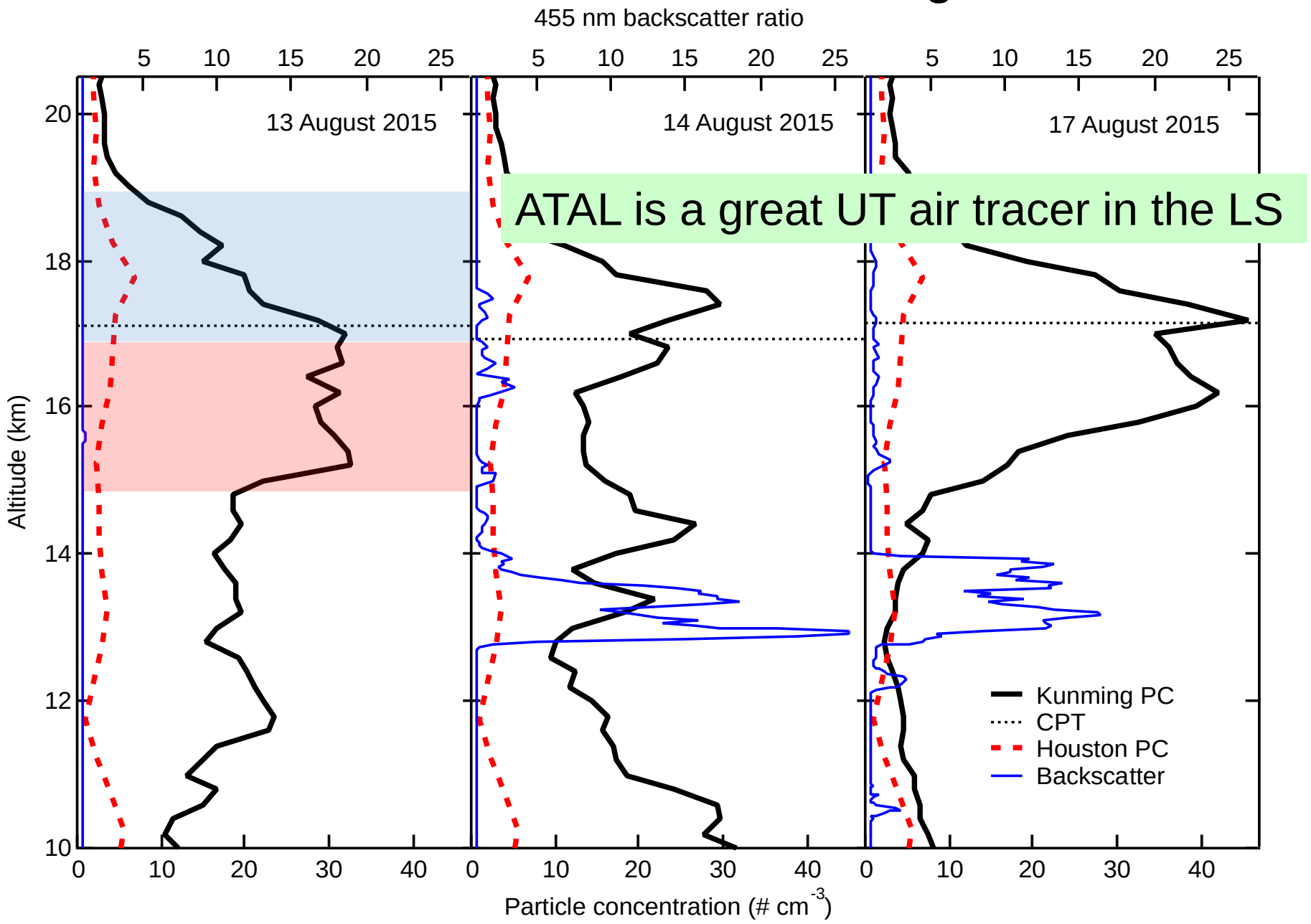


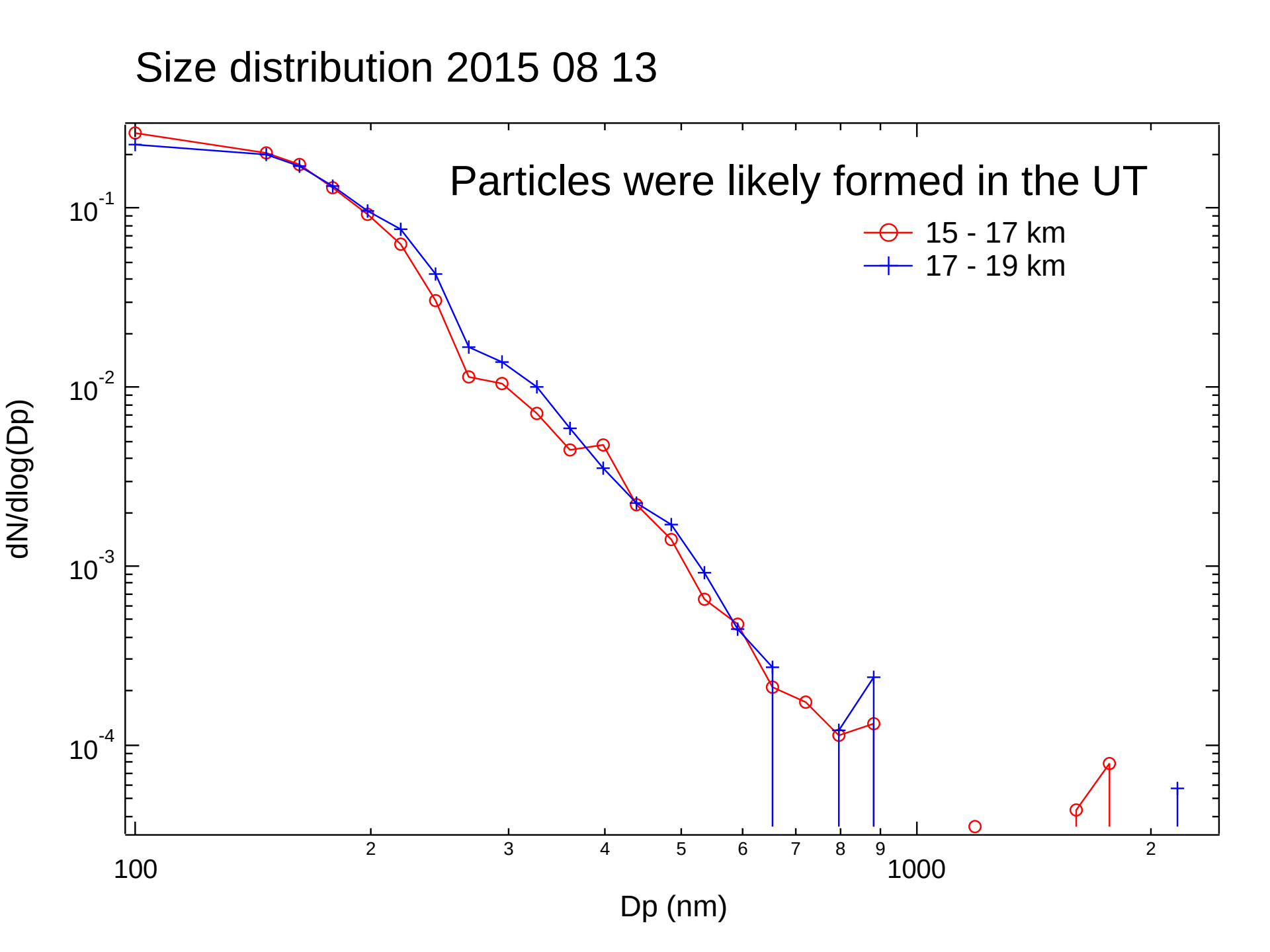
Aug 17, 2015: NCEP 100 mb hgt



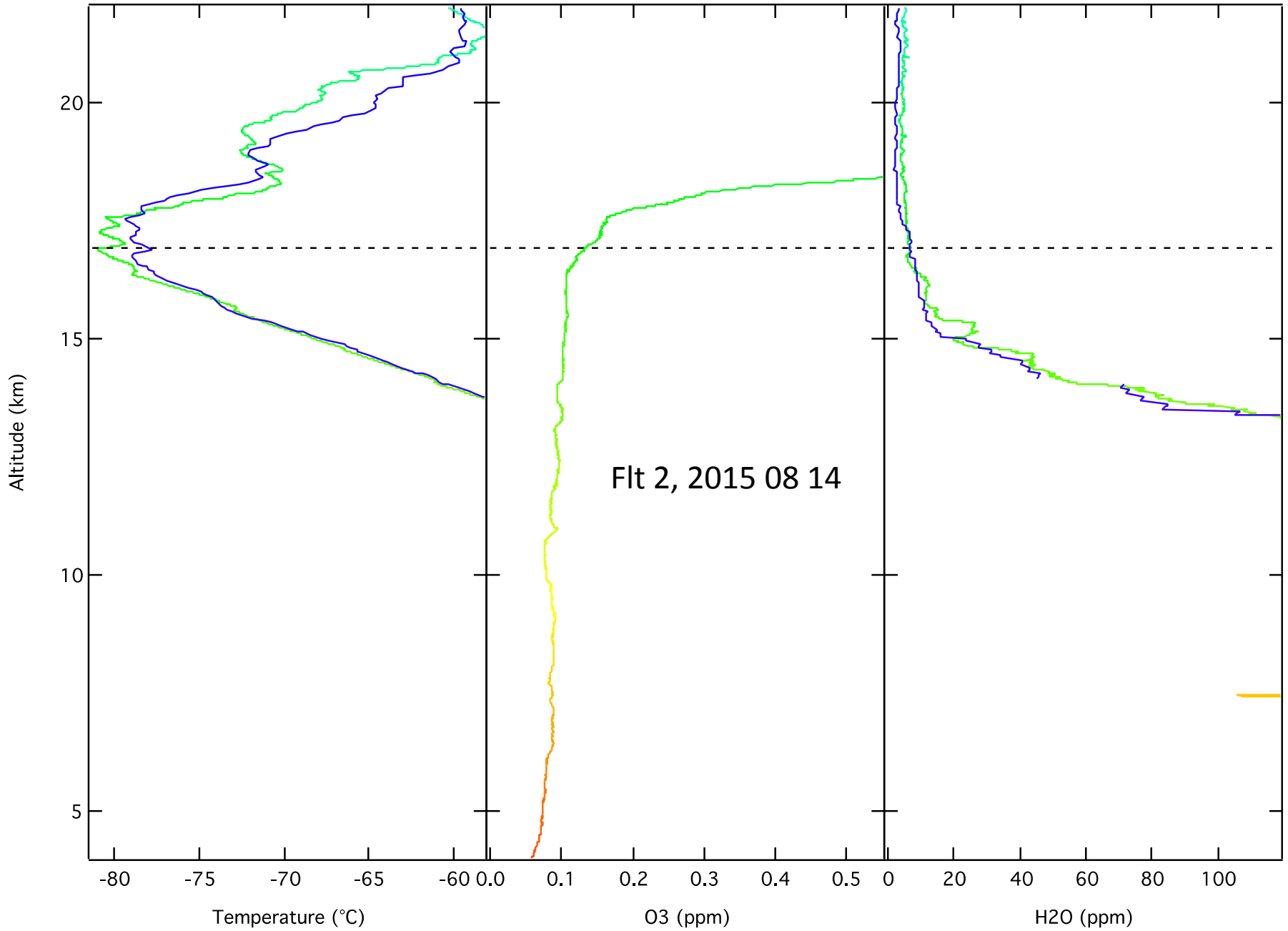

Ascent data, 200-m average
Flt 1, 2015 08 13
Flt 2, 2015 08 14
Flt 3, 2015 08 17
Total
98 - 144 nm
144 - 179 nm
179 - 231 nm
231 - 360 nm
CPT
Altitude (km)
30
25
20
15
10
5
0
200
400
600
800
1000
1200
Aerosol concentration (# cm-3)
Aerosol concentration (# cm-3)
Aerosol concentration (# cm-3)

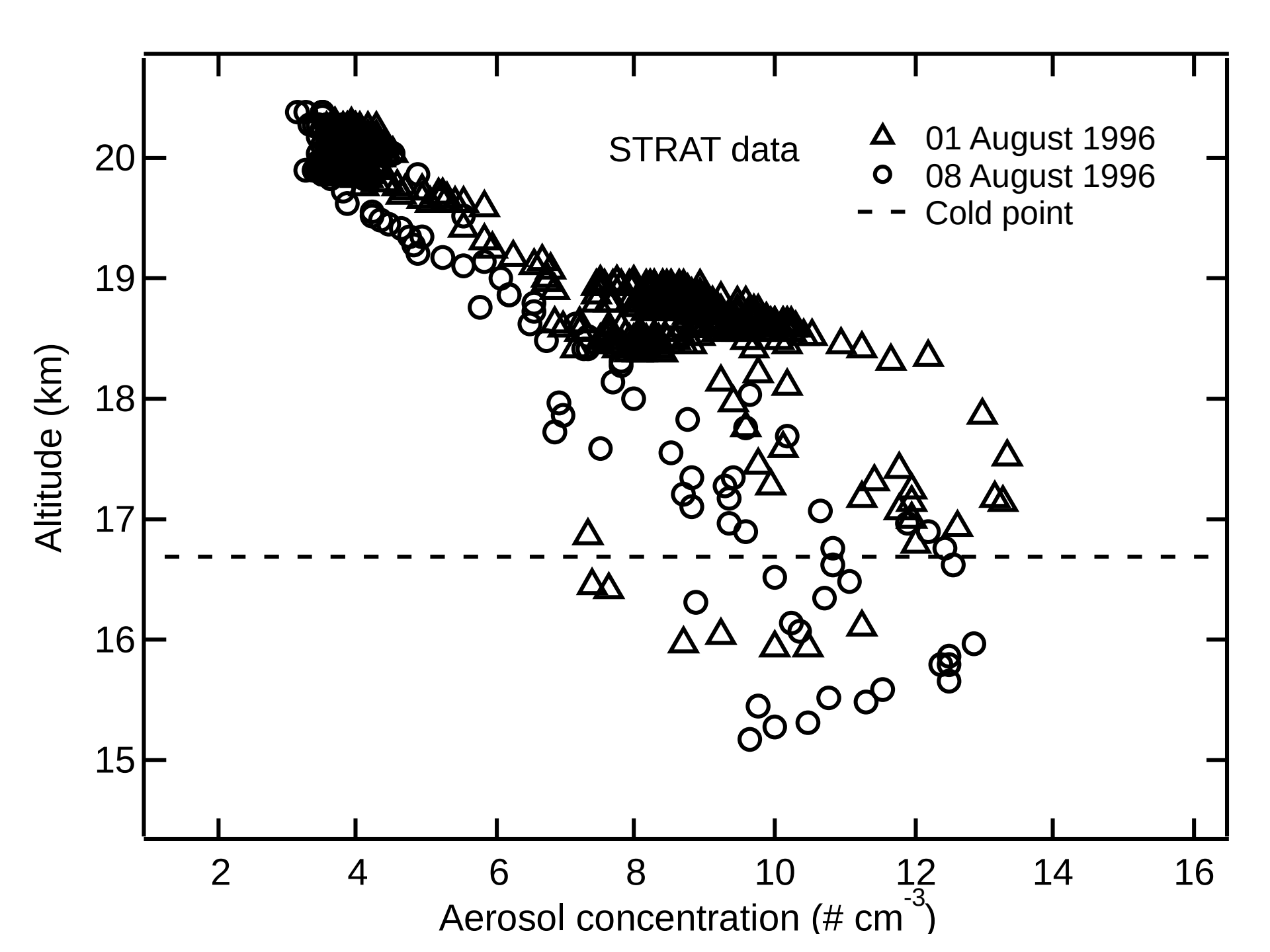
Ascent data, 200-m average

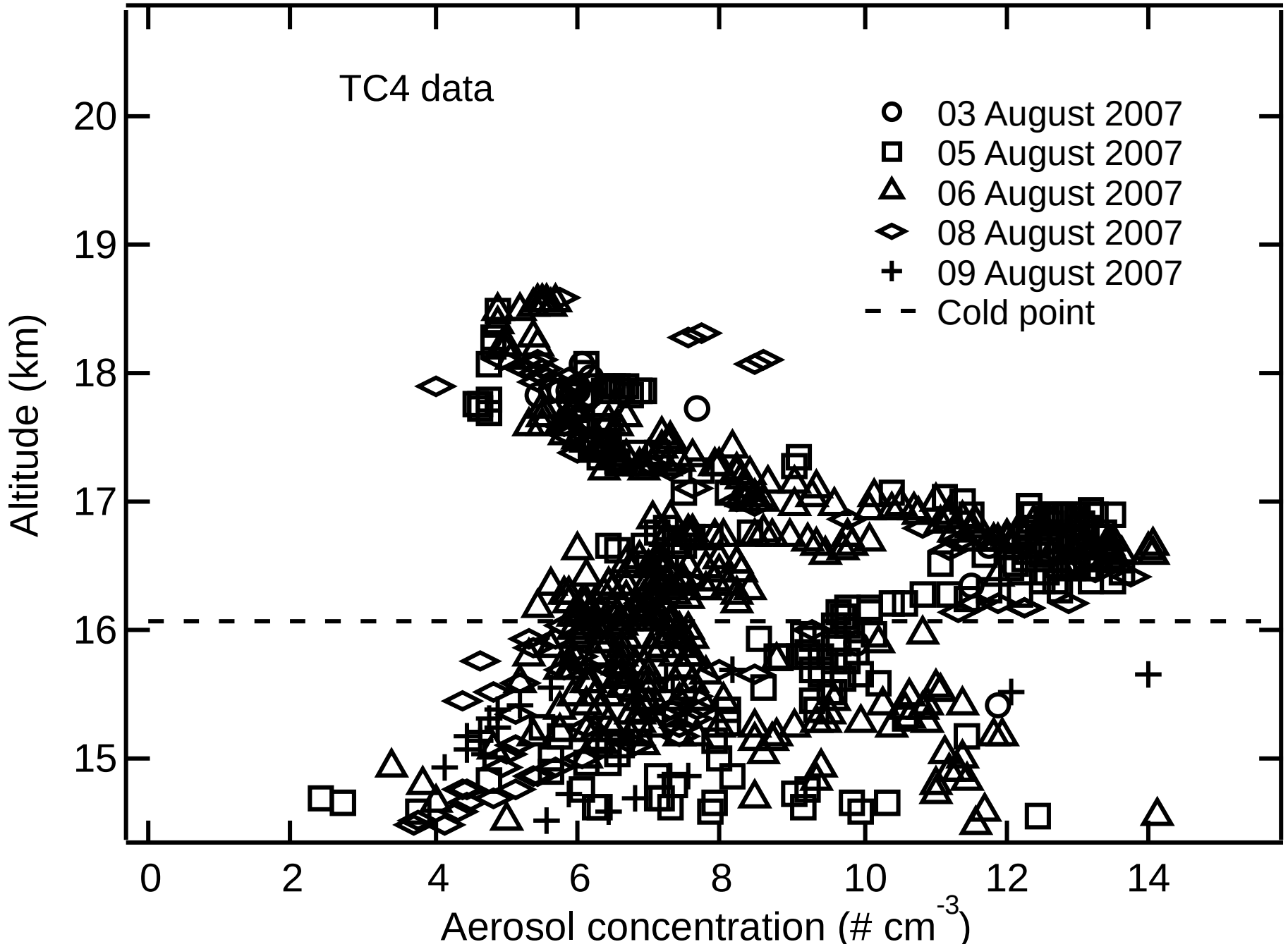



Size distribution 2015 08 13
Particles were likely formed in the UT
15 - 17 km
17 - 19 km
dN/dlog(Dp)
10-1
10-2
10-3
10-4
100
2
3
4
5
6
7
8
9
1000
2
Dp (nm)

T, O_3, and WV


Altitude (km)
20
15
10
5
Flt 2, 2015 08 14
-80
-75
-70
-65
-60
Temperature (°C)
0.0
0.1
0.2
0.3
0.4
0.5
O3 (ppm)
0
20
40
60
80
100
H2O (ppm)


STRAT data
01 August 1996
08 August 1996
Cold point
Altitude (km)
20
19
18
17
16
15
2
4
6
8
10
12
14
16
Aerosol concentration (# cm-3)

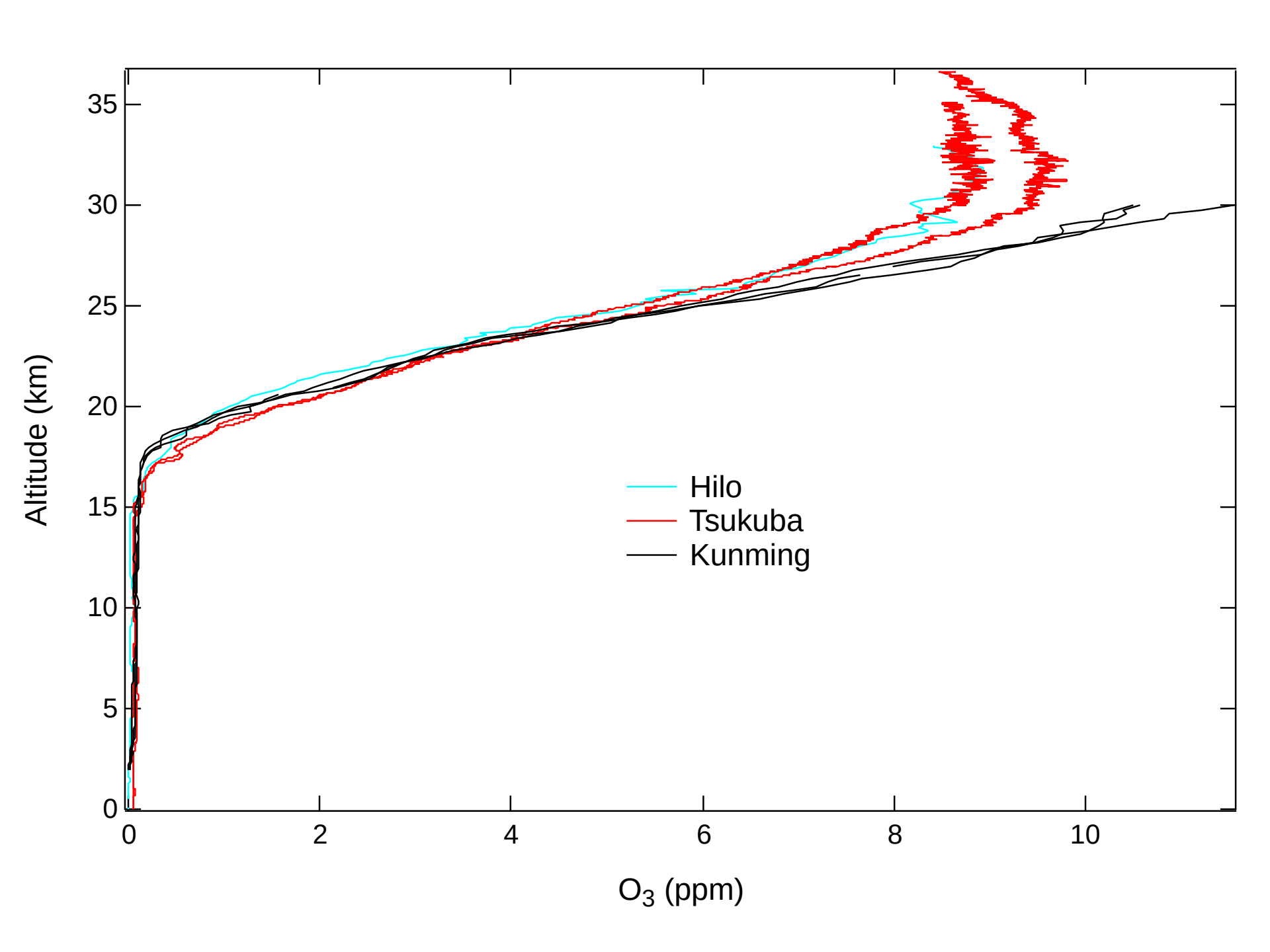

TC4 data
03 August 2007
05 August 2007
06 August 2007
08 August 2007
09 August 2007
Cold point
Altitude (km)
20
19
18
17
16
15
0
2
4
6
8
10
12
14
Aerosol concentration (# cm-3)

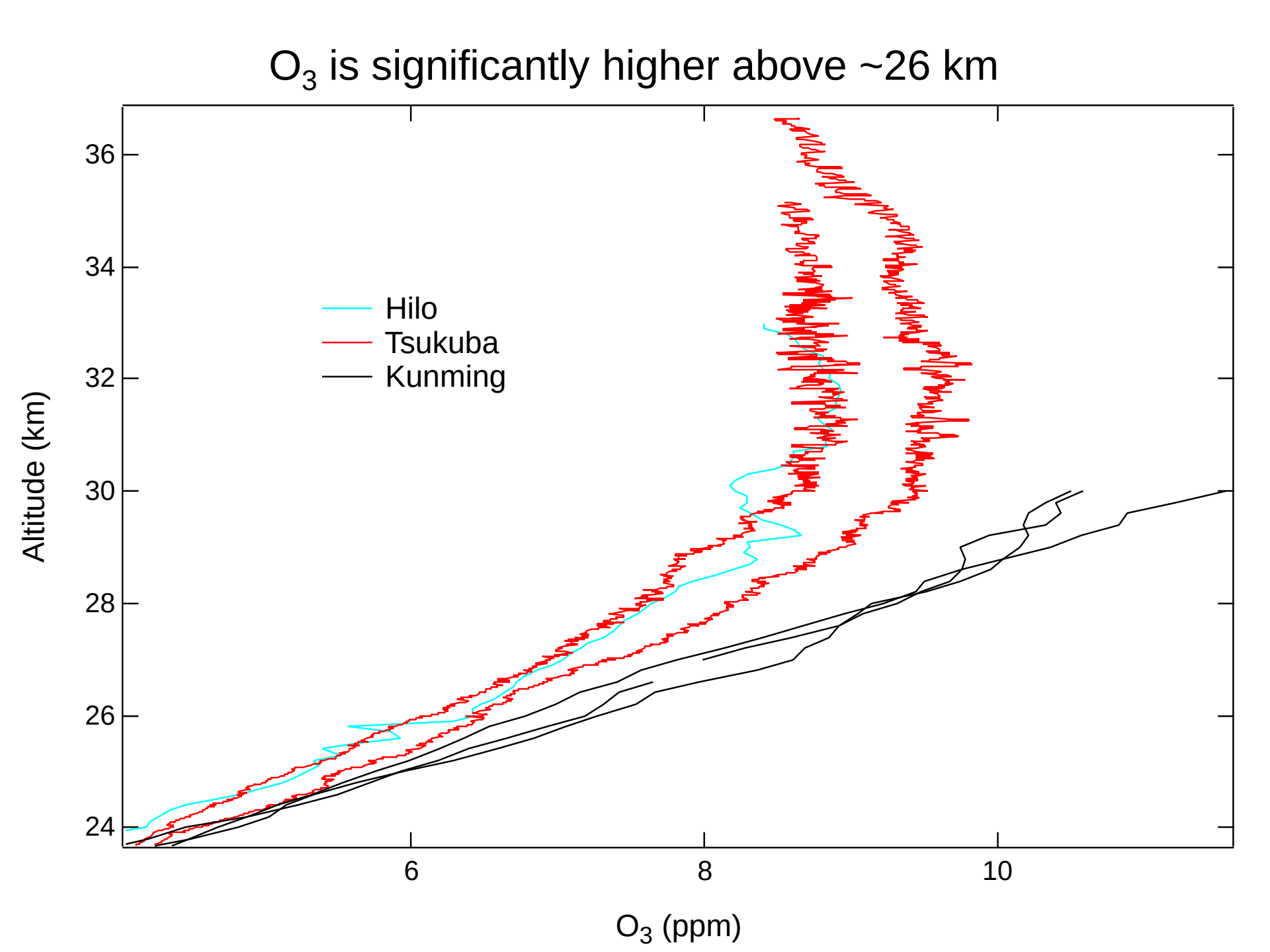
• In a general sense the ATAL is NOT unique!
    - Brock et al., *Science* (1995)

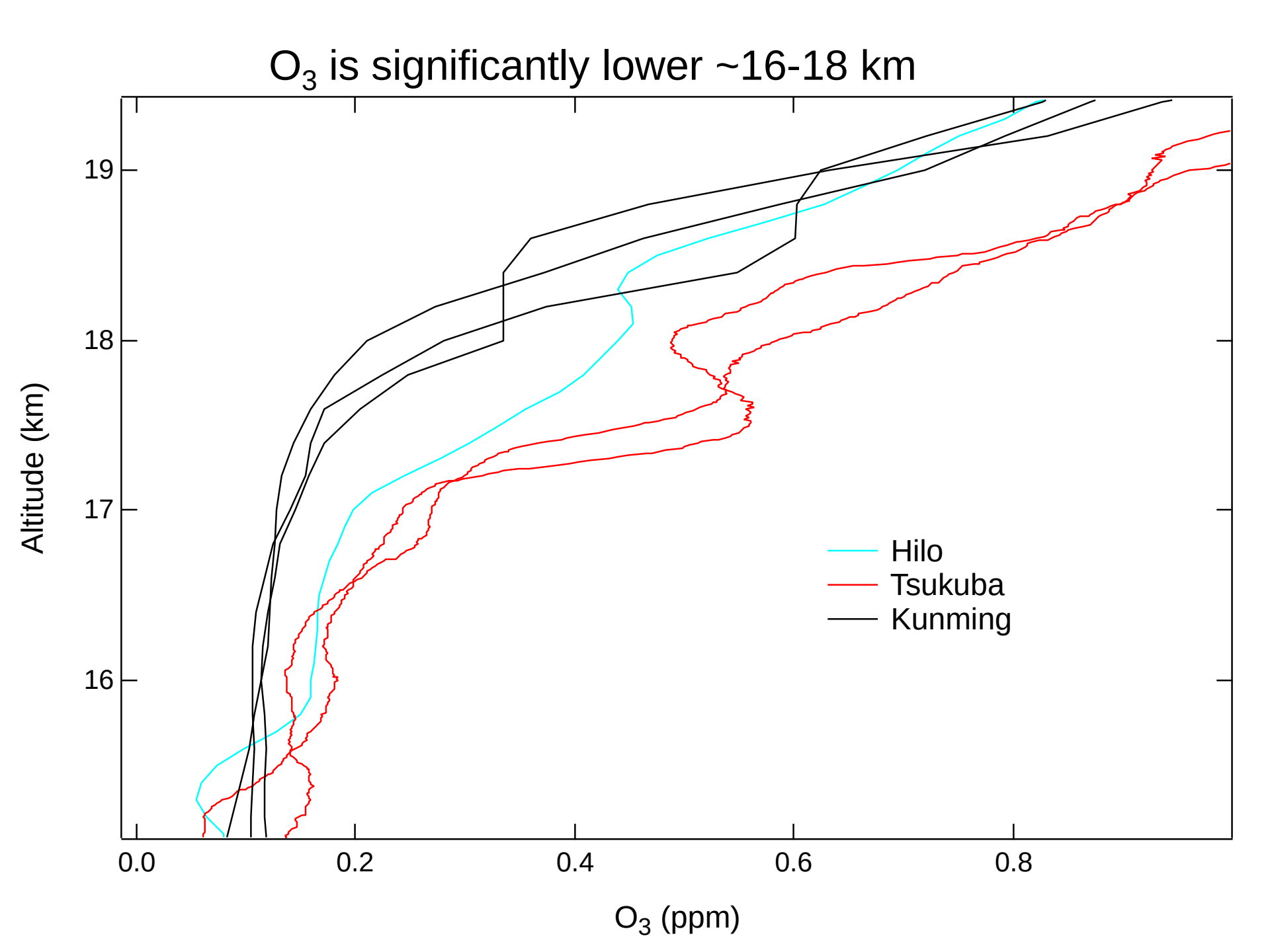
• The air in the ASMA, similar to the air in the tropics, is trapped and moving upward slowly.

• Condensables have sufficient time to form new particles or condense on existing particles.

• Tropical aerosol layer too thin to be detected by satellites?


Altitude (km)
0
5
10
15
20
25
30
35
0
2
4
6
8
10
O_3 (ppm)
Hilo
Tsukuba
Kunming

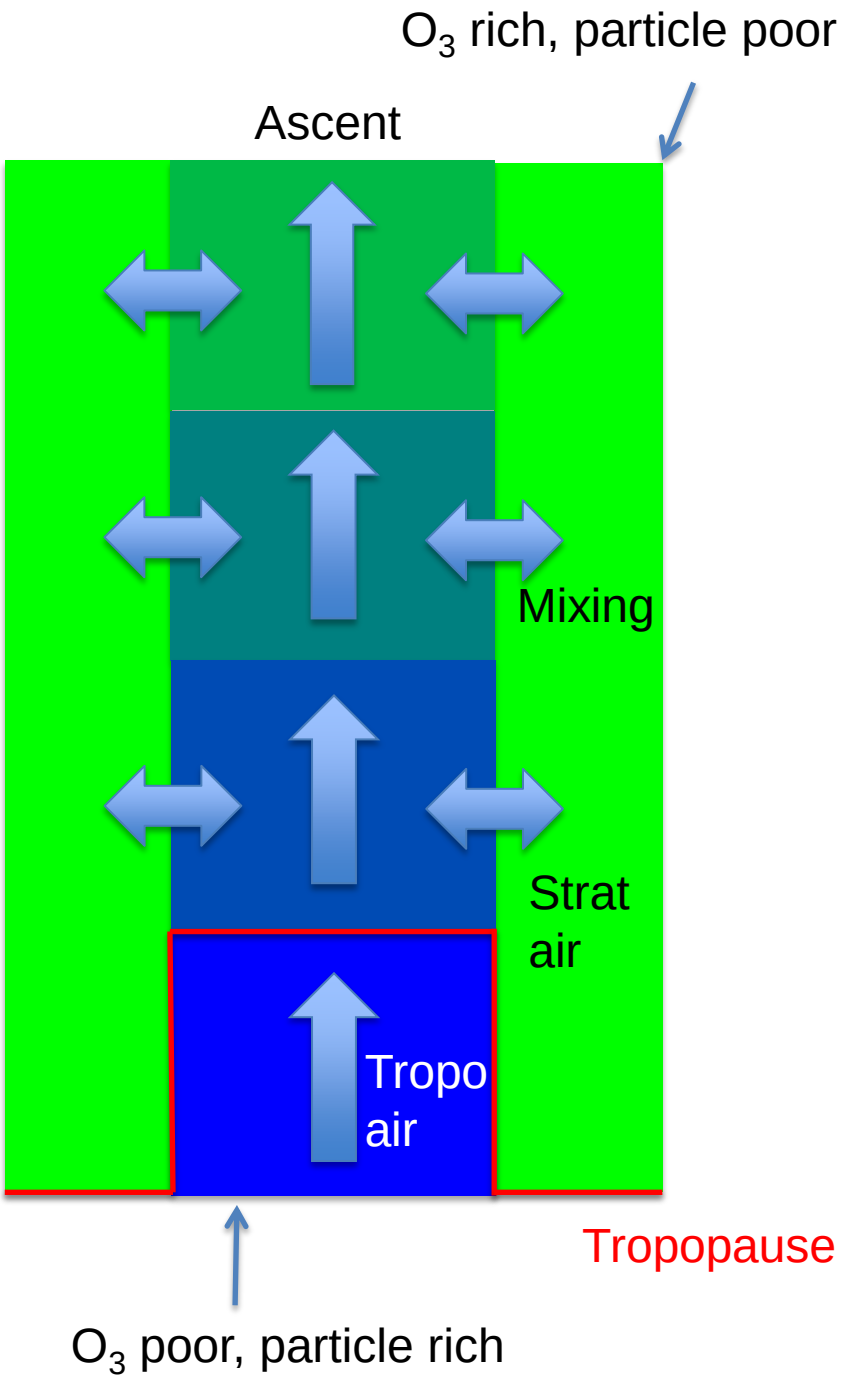

O_3 is significantly higher above ~26 km
Hilo
Tsukuba
Kunming
Altitude (km)
36
34
32
30
28
26
24
6
8
10
O_3 (ppm)


O_3 is significantly lower ~16-18 km
Altitude (km)
19
18
17
16
0.0
0.2
0.4
0.6
0.8
O_3 (ppm)
Hilo
Tsukuba
Kunming

A crude mixing model:

- Ascent rate determined by the local heating rate and local thermal structure
- Particles = Trop. tracer
- O_3 = Strat. tracer
- Mixing in strat can be derived from these three.

(Arguably ascent is easier to calculate than mixing)



Conclusions

1) ATAL appears to be robust feature

2) The particle enhancement has implications (additional heating)

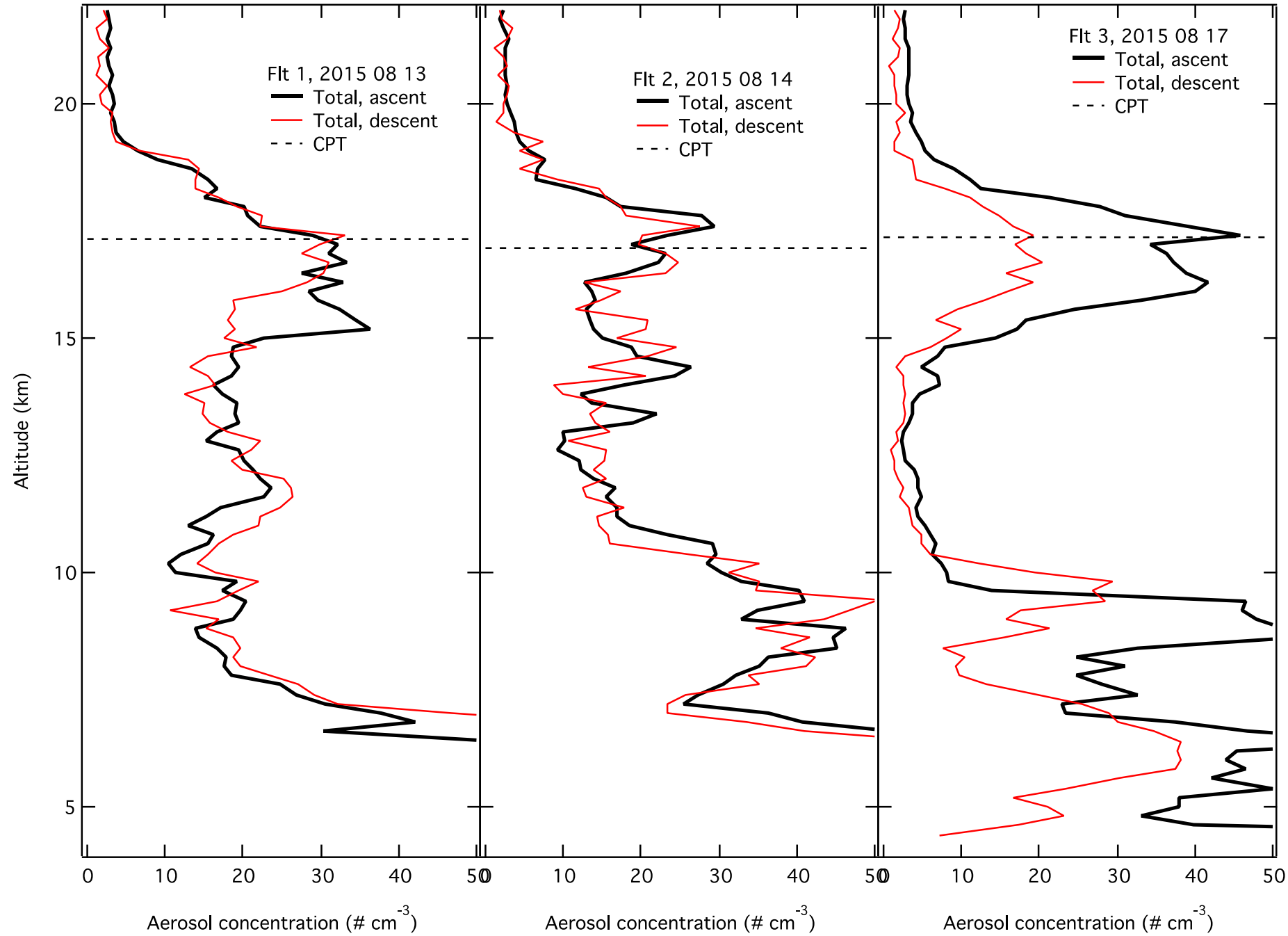
3) In the ASMA LS these particles are a good tracer of the tropospheric air

- Size distributions suggest formation/growth in UT
- Tropospheric air is moving up into stratosphere

4) ATAL is similar to the tropical aerosol layer

5) Measureable mixing tracers: O_3 and aerosol

6) A crude model may be useful for LS mixing rate


Flt 1, 2015 08 13
Total, ascent
Total, descent
CPT
Flt 2, 2015 08 14
Total, ascent
Total, descent
CPT
Flt 3, 2015 08 17
Total, ascent
Total, descent
CPT
Altitude (km)
20
15
10
5
0
10
20
30
40
50
Aerosol concentration (# cm-3)