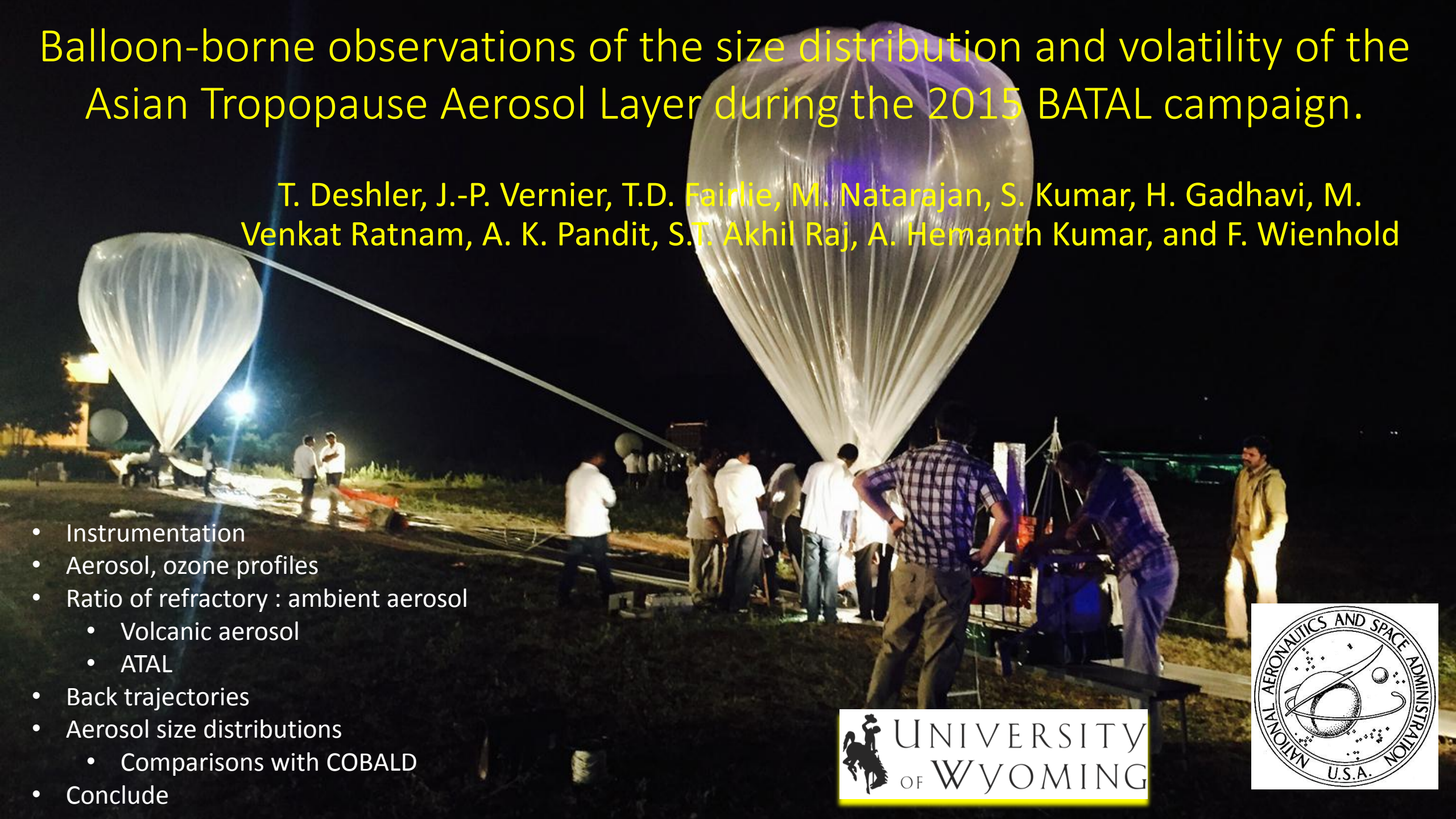
Balloon-borne observations of the size distribution and volatility of the Asian Tropopause Aerosol Layer during the 2015 BATAL campaign.

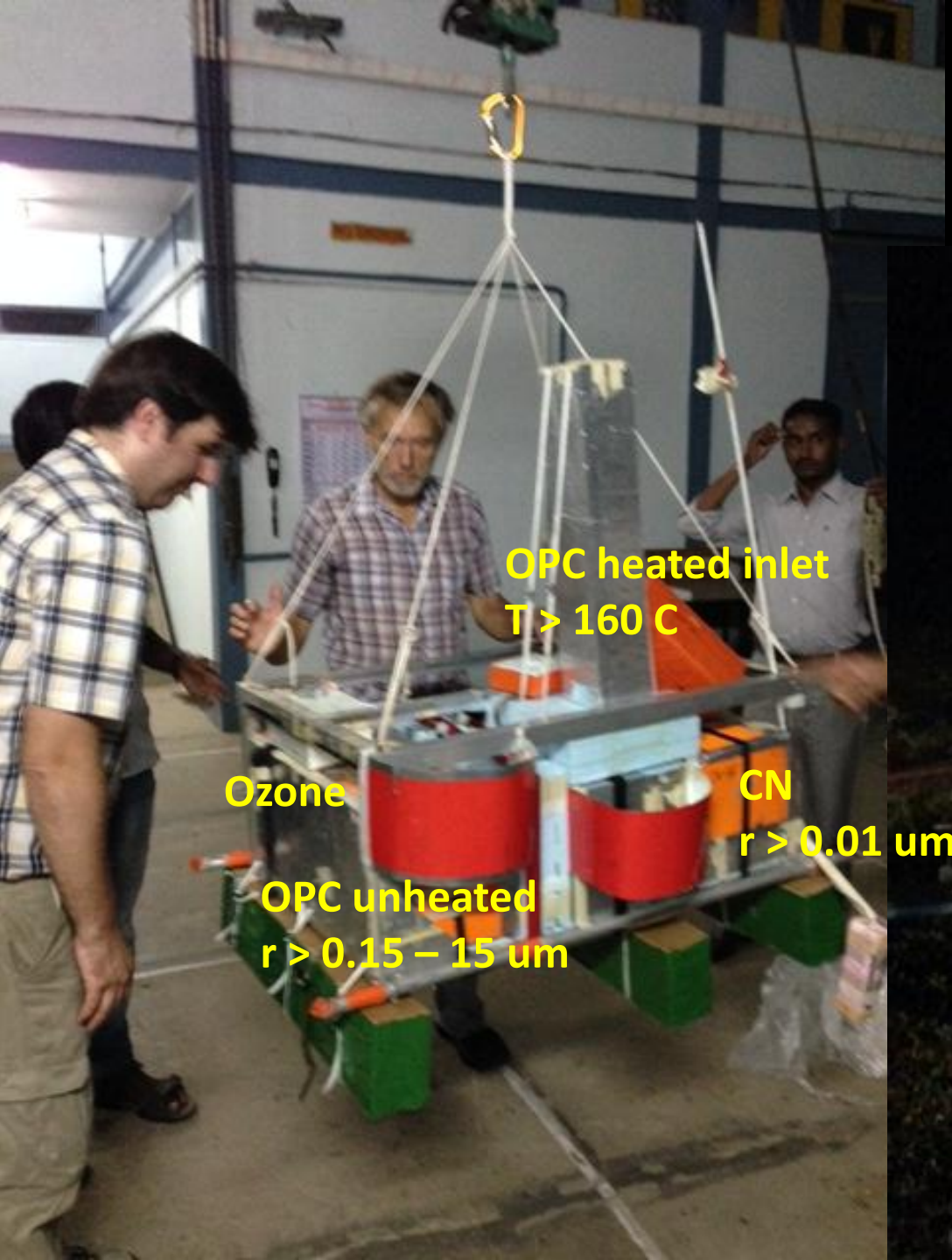
T. Deshler, J.-P. Vernier, T.D. Fairlie, M. Natarajan, S. Kumar, H. Gadhavi, M. Venkat Ratnam, A. K. Pandit, S.T. Akhil Raj, A. Hemanth Kumar, and F. Wienhold



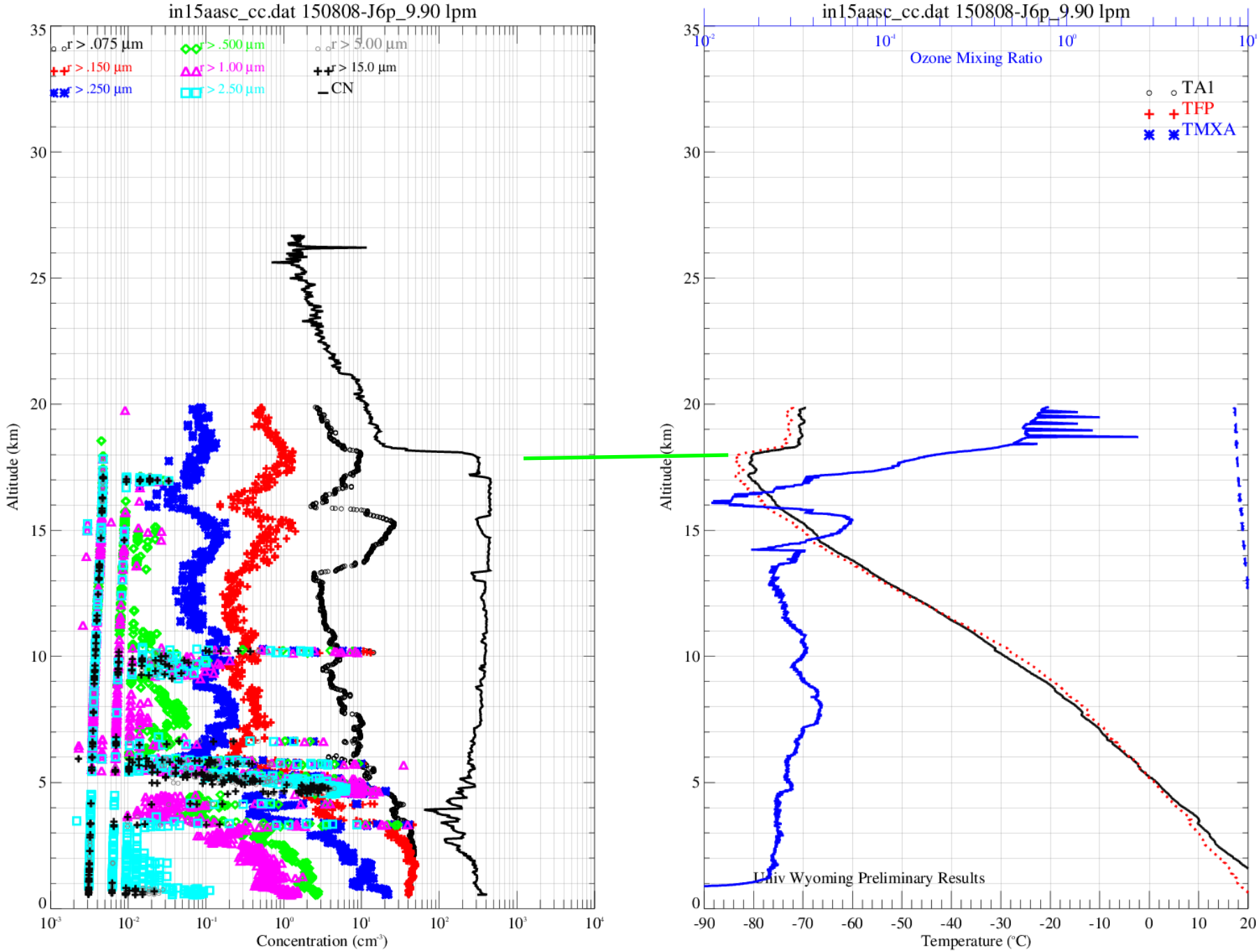
- Instrumentation
- Aerosol, ozone profiles
- Ratio of refractory : ambient aerosol
  - Volcanic aerosol
  - ATAL
- Back trajectories
- Aerosol size distributions
  - Comparisons with COBALD
- Conclude

UNIVERSITY OF WYOMING

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION U.S.A.



- Instrumentaion
- 40 kg gondola
- Two flights
  - 150808
  - 150813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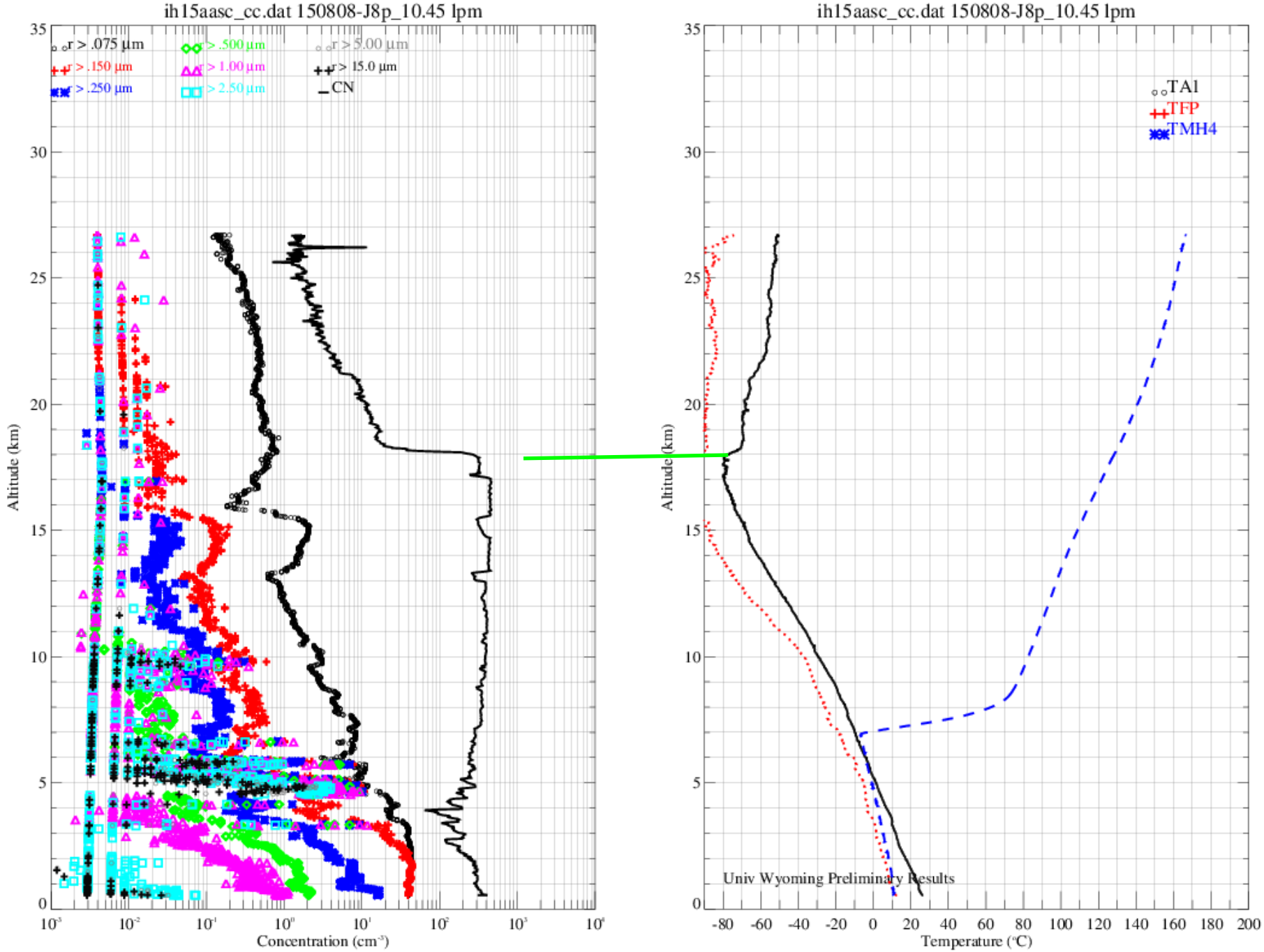
r > .075 µm
r > .150 µm
r > .250 µm
r > .500 µm
r > 1.00 µm
r > 2.50 µm
r > 5.00 µm
r > 15.0 µm
CN
Altitude (km)
Concentration (cm⁻³)
in15aasc_cc.dat 150808-J6p_9.90 lpm
Ozone Mixing Ratio
TA1
TFP
TMXA
Univ Wyoming Preliminary Results
Altitude (km)
Temperature (°C)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r > .250 µm
r > .500 µm
r > 1.00 µm
r > 2.50 µm
r > 5.00 µm
r > 15.0 µm
CN
Altitude (km)
Concentration (cm⁻³)
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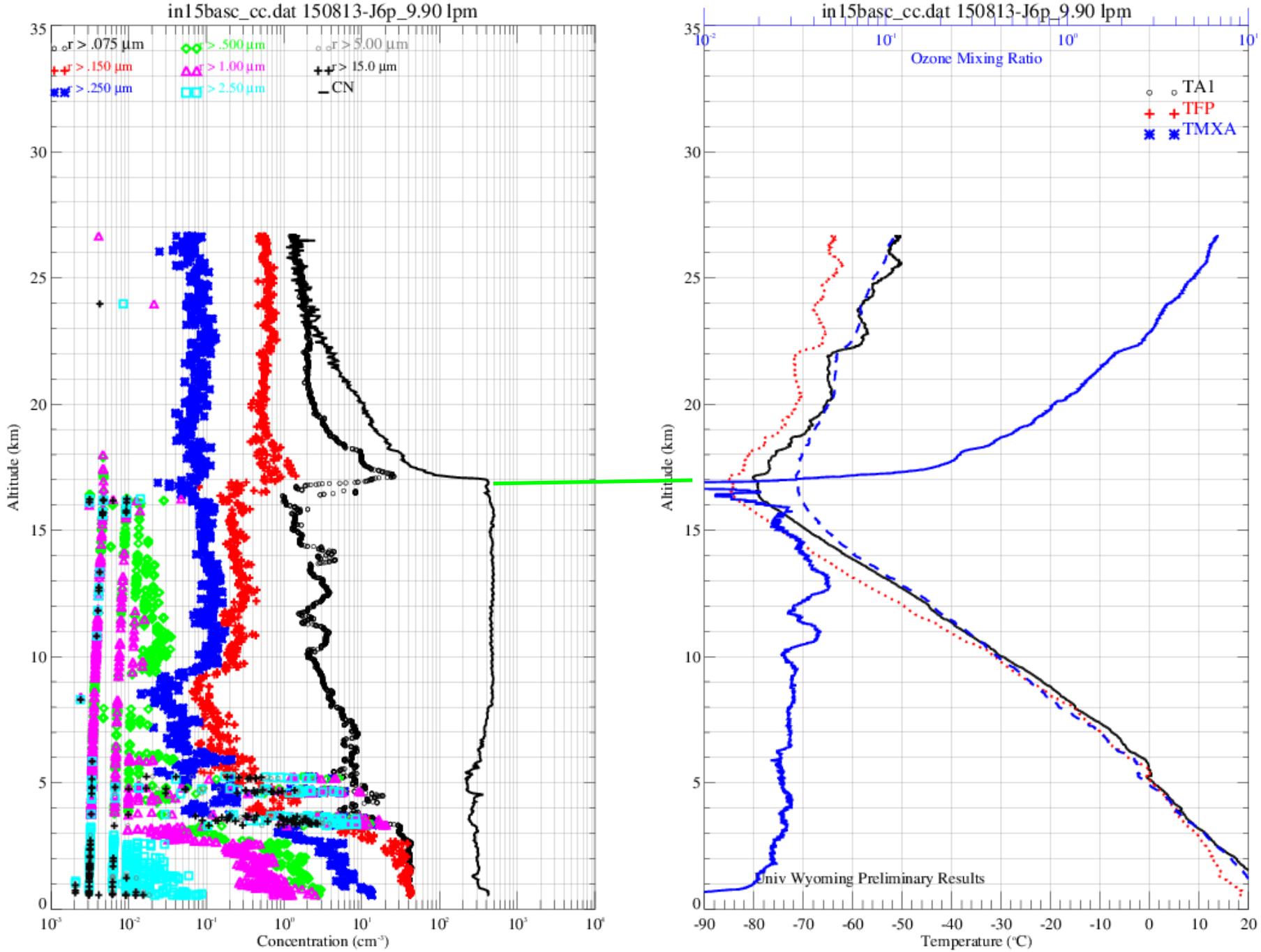
TAI
TFP
TMH4
Univ Wyoming Preliminary Results
Temperature (°C)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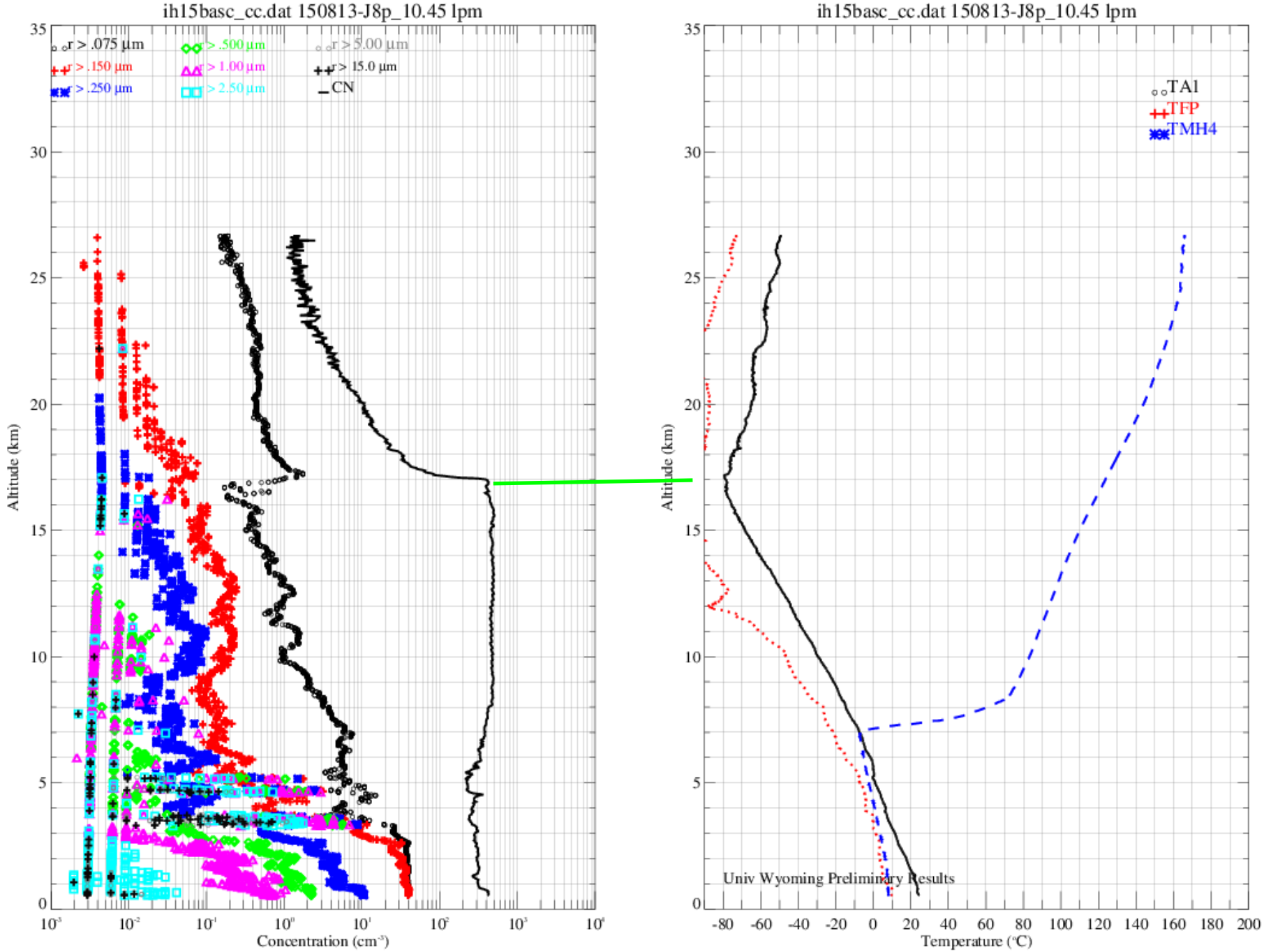
r > .500 µm
r > 1.00 µm
r > 2.50 µm
r > 5.00 µm
r > 15.0 µm
CN
Altitude (km)
Concentration (cm⁻³)
in15basc_cc.dat 150813-J6p_9.90 lpm
Ozone Mixing Ratio
TA1
TFP
TMXA
Univ Wyoming Preliminary Results
Temperature (°C)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r > .150 µm
r > .250 µm
r > .500 µm
r > 1.00 µm
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Altitude (km)
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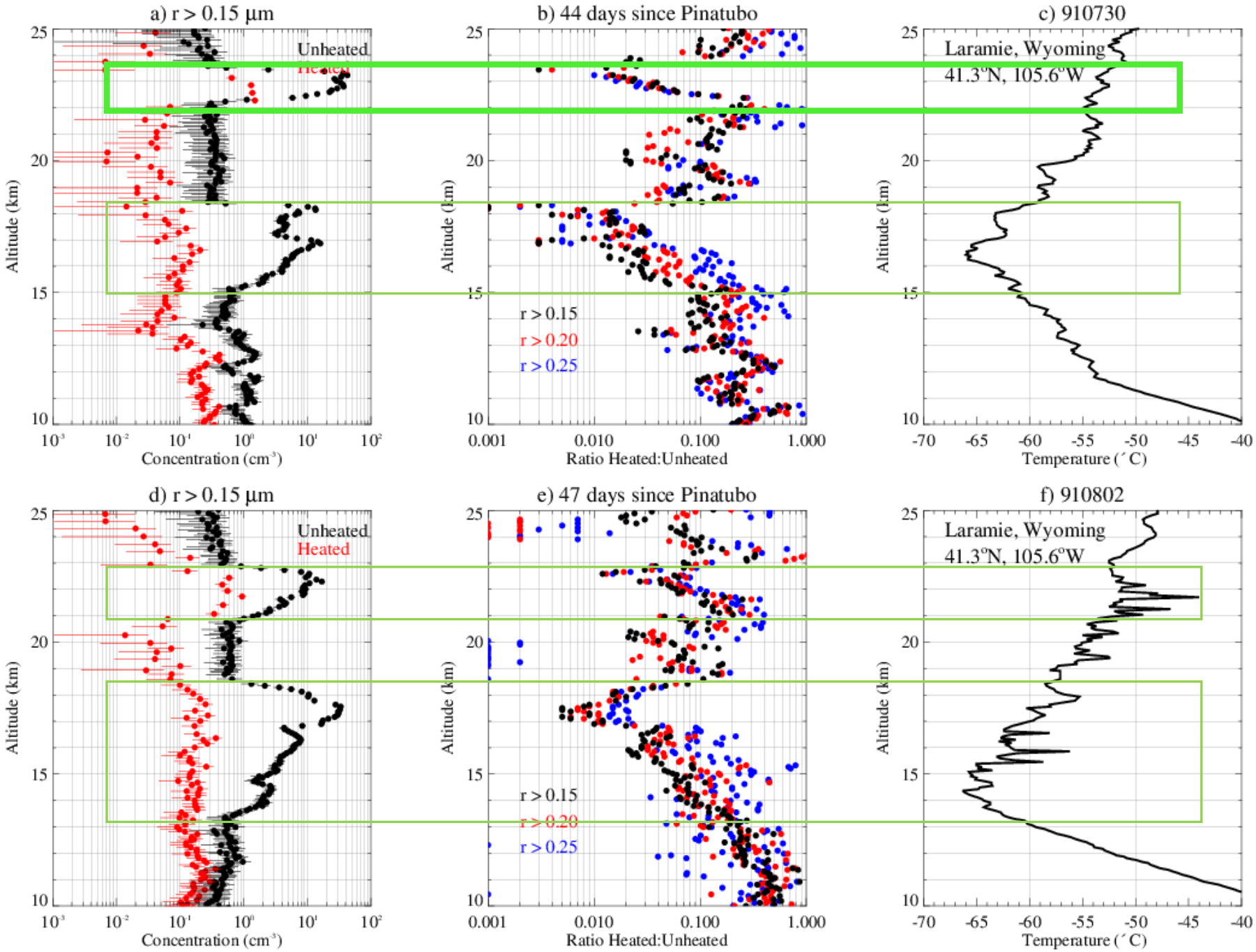
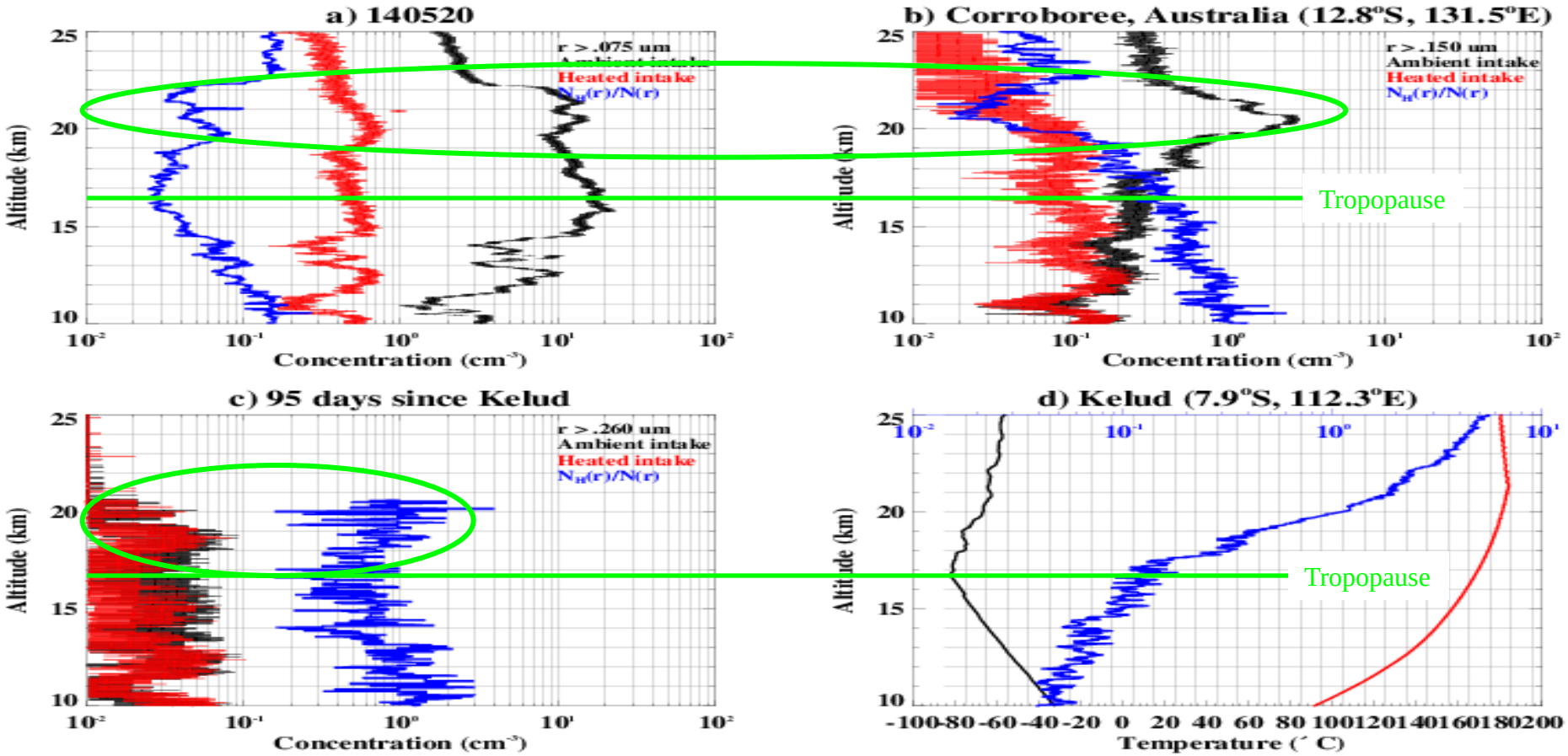
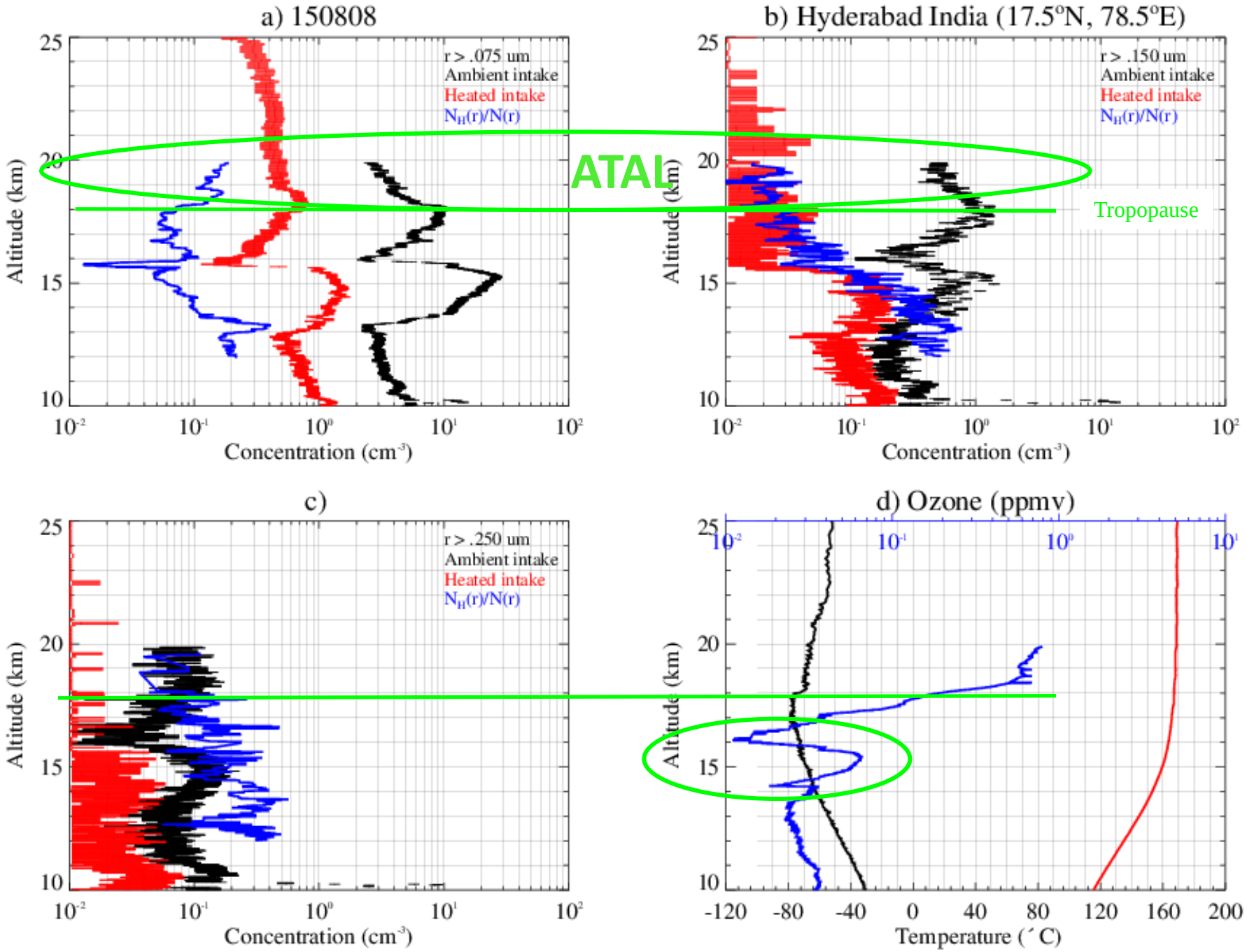
ih15basc_cc.dat 150813-J8p_10.45 lpm
TAI
TFP
TMH4
Univ Wyoming Preliminary Results
Temperature (°C)


a) r > 0.15 µm
b) 44 days since Pinatubo
c) 910730
d) r > 0.15 µm
e) 47 days since Pinatubo
f) 910802
Unheated
Heated
Laramie, Wyoming
41.3°N, 105.6°W
r > 0.15
r > 0.20
r > 0.25
Altitude (km)
Concentration (cm⁻³)
Ratio Heated:Unheated
Temperature (´C)



Kelud, 7.9 S, 112 E, 25 February 2014

Deshler, 2016, submitted, *Volcanic ash: methods of observation and monitoring*

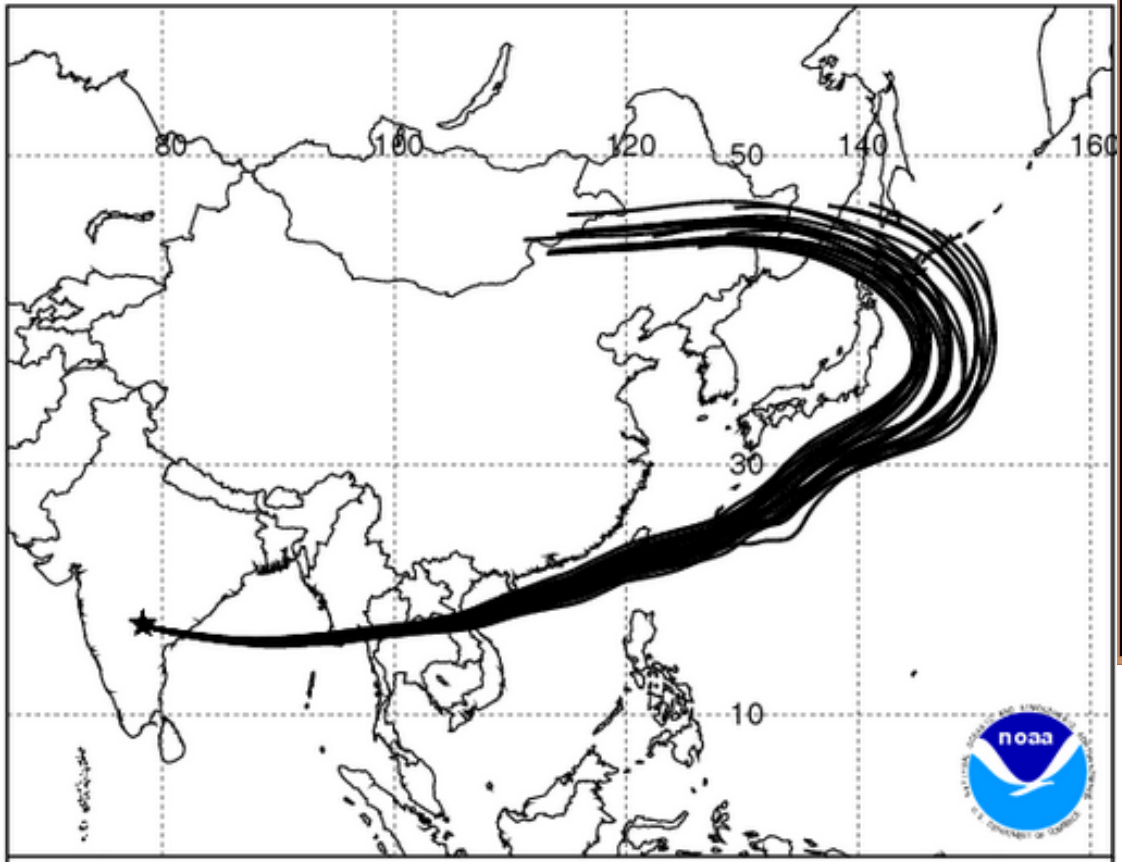

a) 150808
r > .075 um
Ambient intake
Heated intake
$N_H(r)/N(r)$
Altitude (km)
Concentration (cm^{-3})
ATAL
b) Hyderabad India (17.5°N, 78.5°E)
r > .150 um
Ambient intake
Heated intake
$N_H(r)/N(r)$
Tropopause
c)
r > .250 um
Ambient intake
Heated intake
$N_H(r)/N(r)$
d) Ozone (ppmv)
Temperature (´C)

NOAA HYSPLIT MODEL

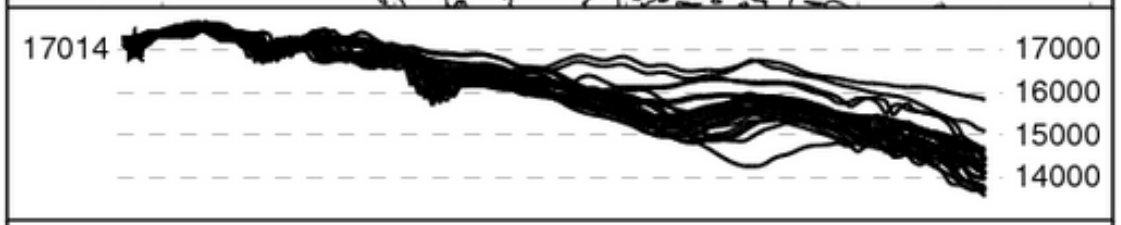
Backward trajectories ending at 0500 UTC 08 Aug 14

GDAS Meteorological Data

Source ★ at 17.41 N 78.30 E

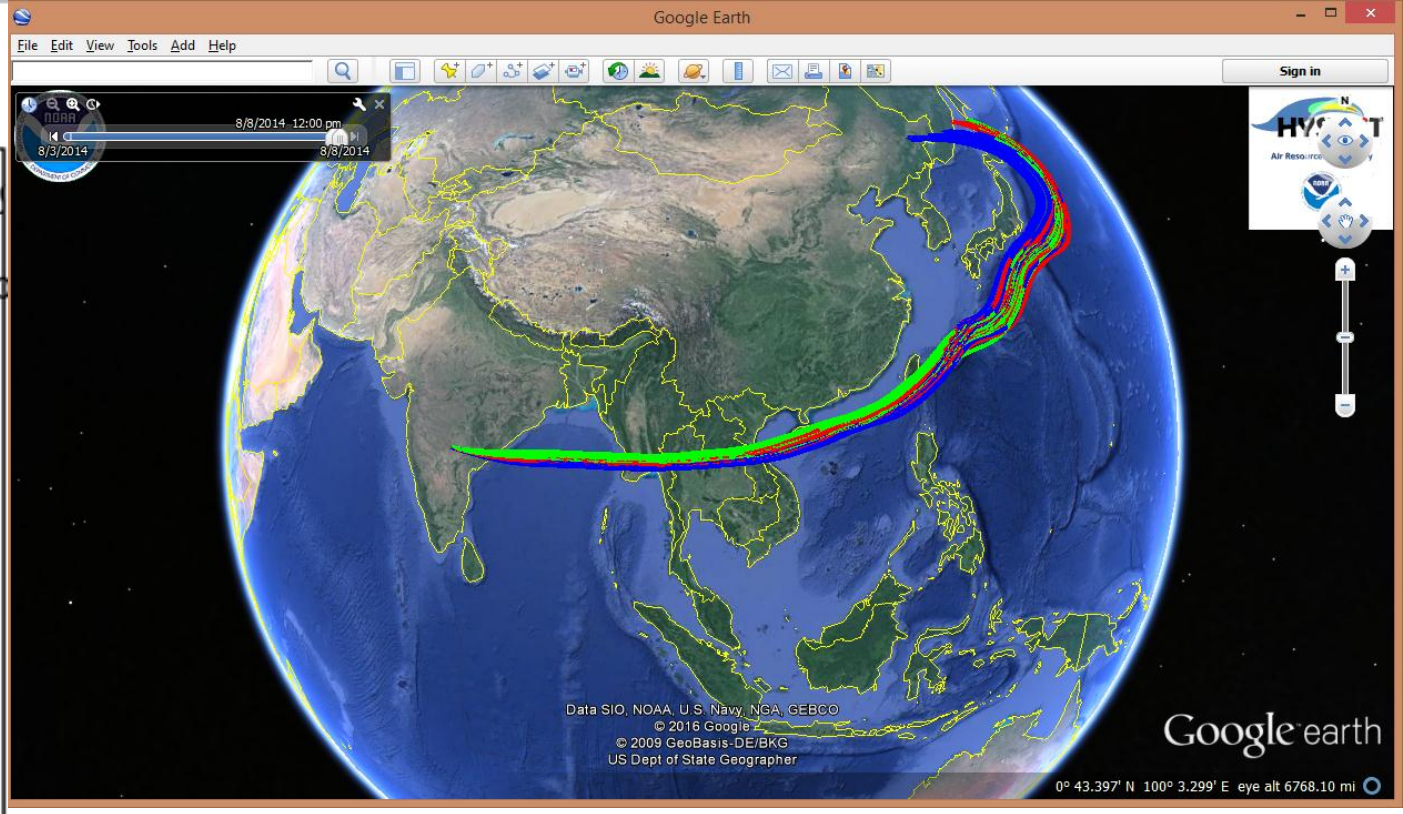


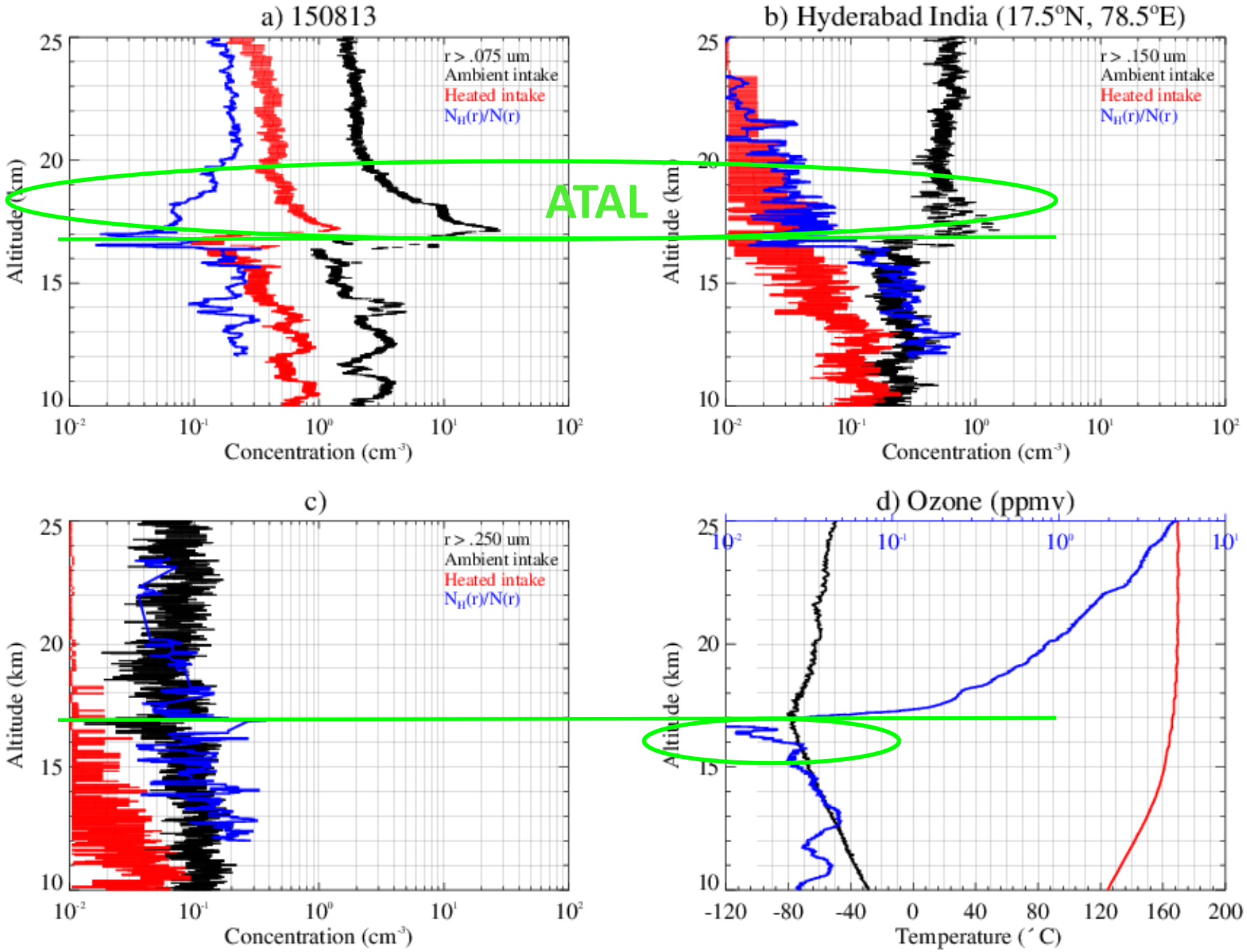
Meters AGL



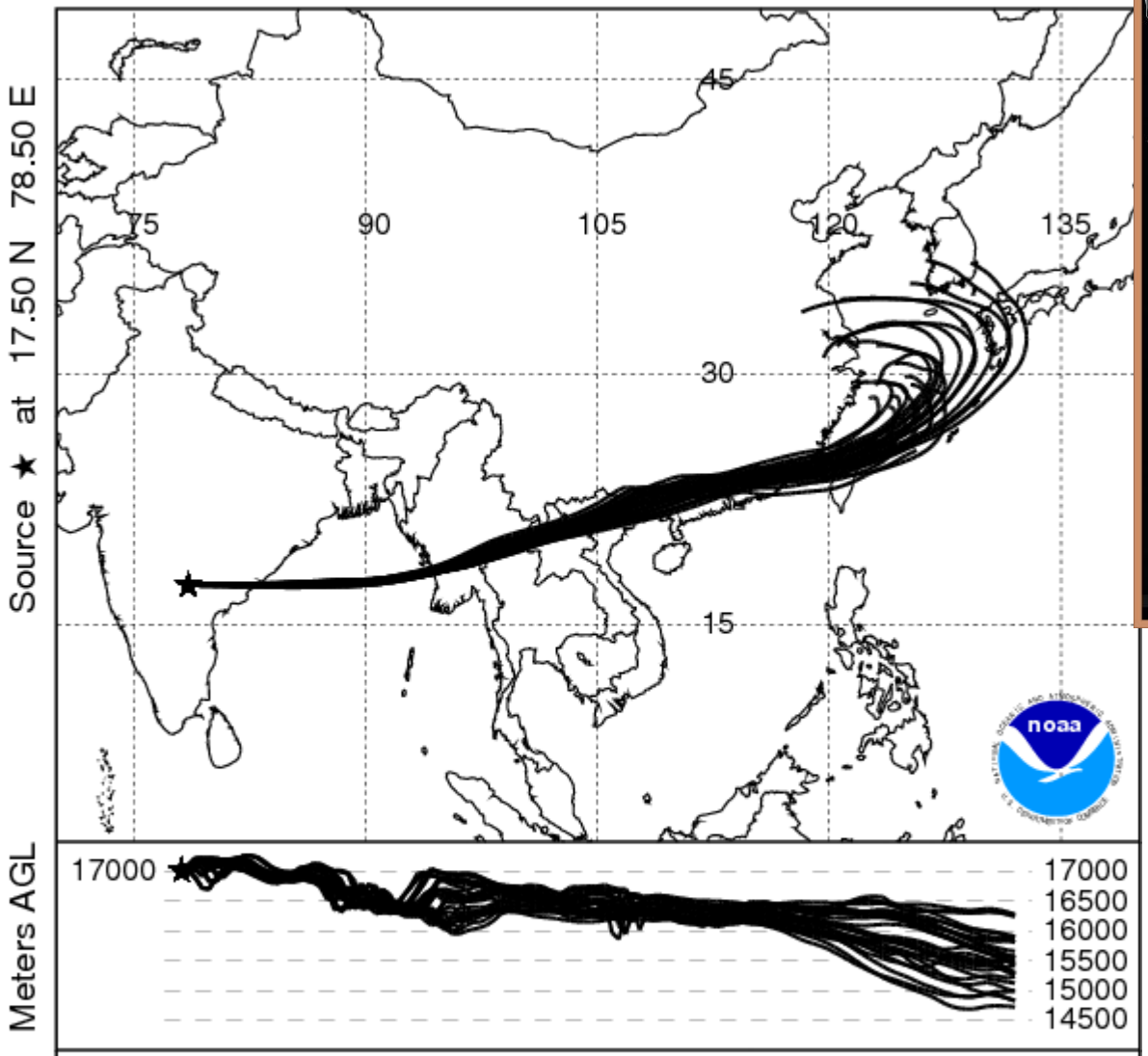
Job ID: 139096 Job Start: Wed Mar 9 05:43:35 UTC 2016
Source 1 lat.: 17.409000 lon.: 78.300000 height: 17500 m AMSL

Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 8 Aug 2014 - GDAS1



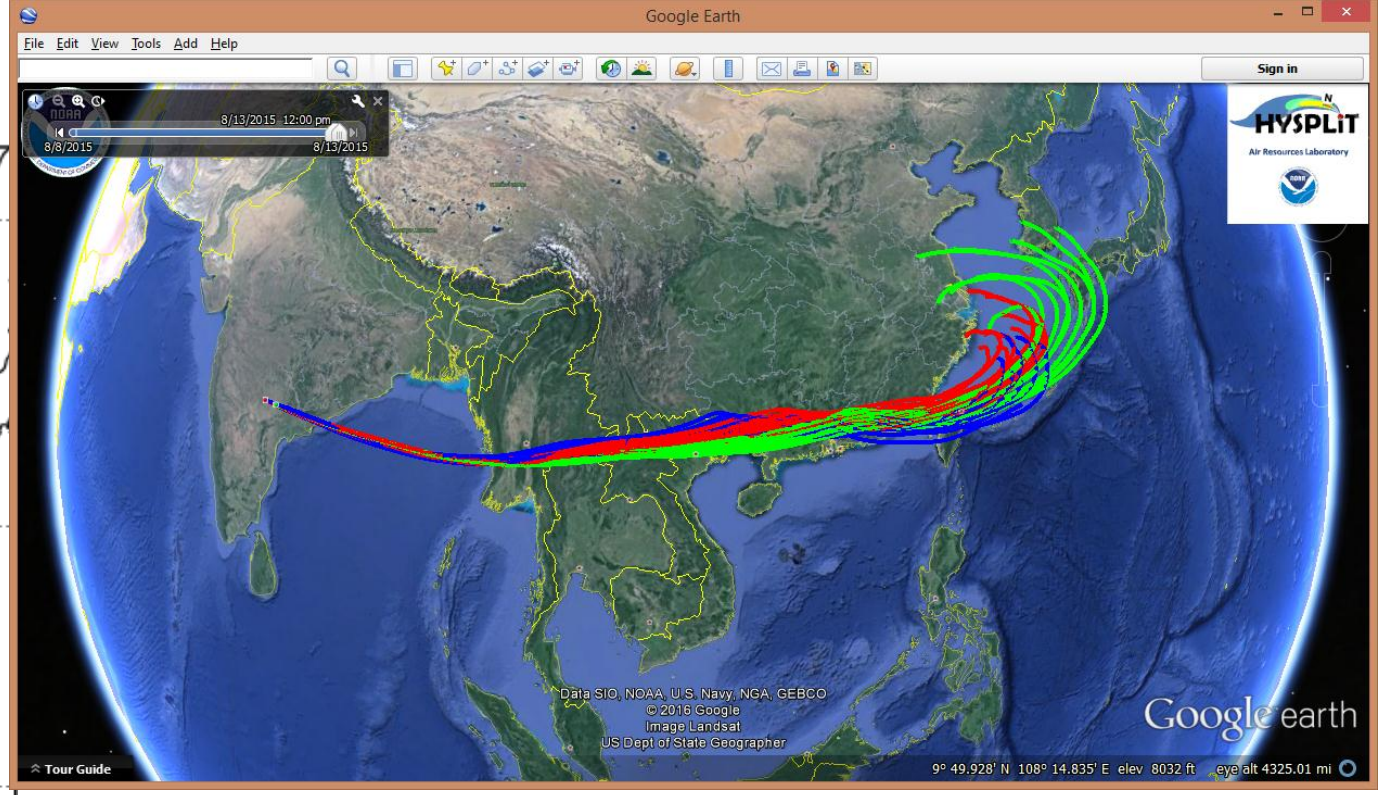

a) 150813
r > .075 um
Ambient intake
Heated intake
N_H(r)/N(r)
Altitude (km)
Concentration (cm⁻³)
b) Hyderabad India (17.5°N, 78.5°E)
r > .150 um
Ambient intake
Heated intake
N_H(r)/N(r)
Altitude (km)
Concentration (cm⁻³)
ATAL
c)
r > .250 um
Ambient intake
Heated intake
N_H(r)/N(r)
Altitude (km)
Concentration (cm⁻³)
d) Ozone (ppmv)
Altitude (km)
Temperature (´C)

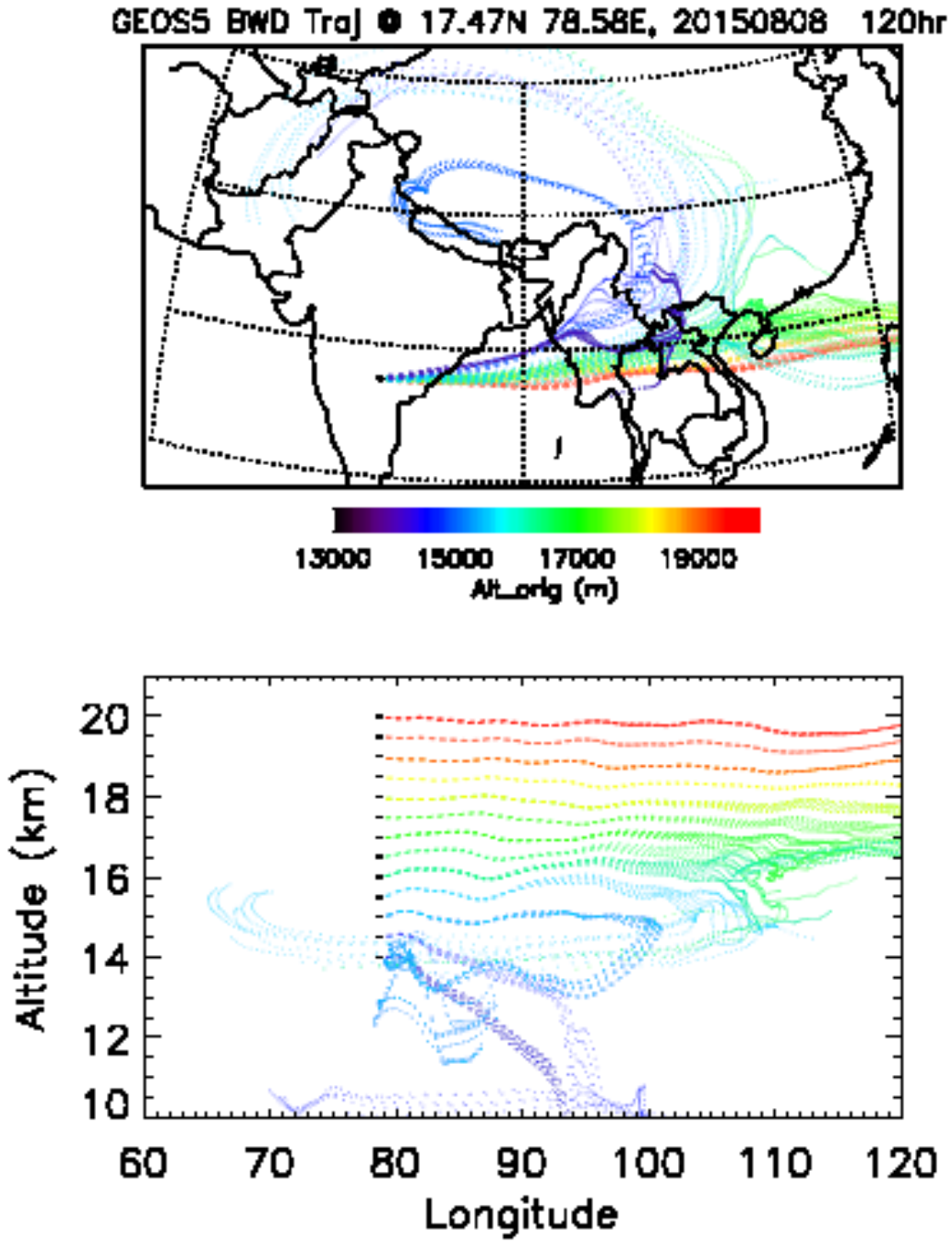
NOAA HYSPLIT MODEL
Backward trajectories ending at 1900 UTC 13 Aug 15
GDAS Meteorological Data

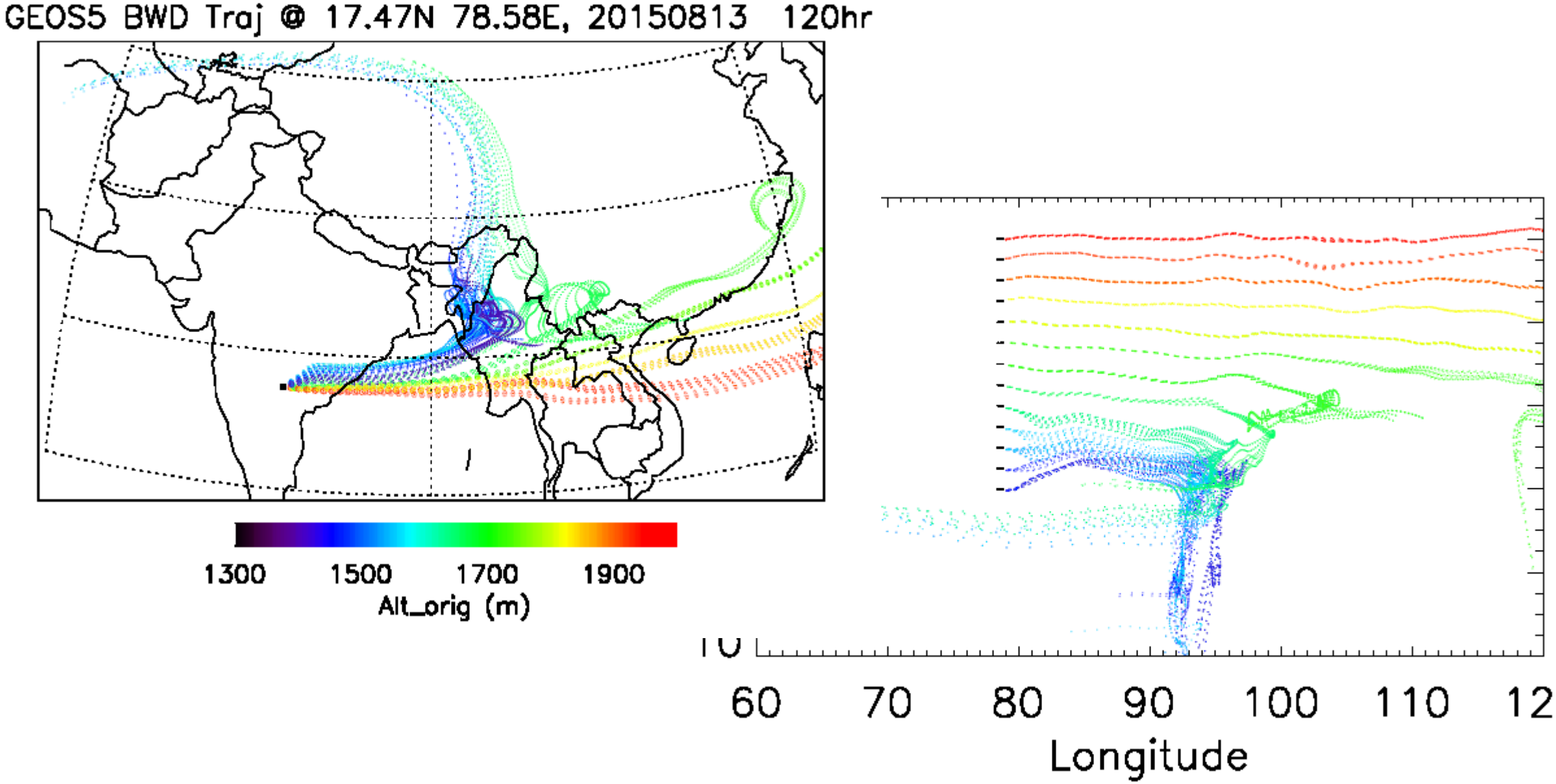


Job ID: 142260 Job Start: Wed Mar 9 07:02:05 UTC 2016
Source 1 lat.: 17.500000 lon.: 78.500000 height: 17000 m AGL

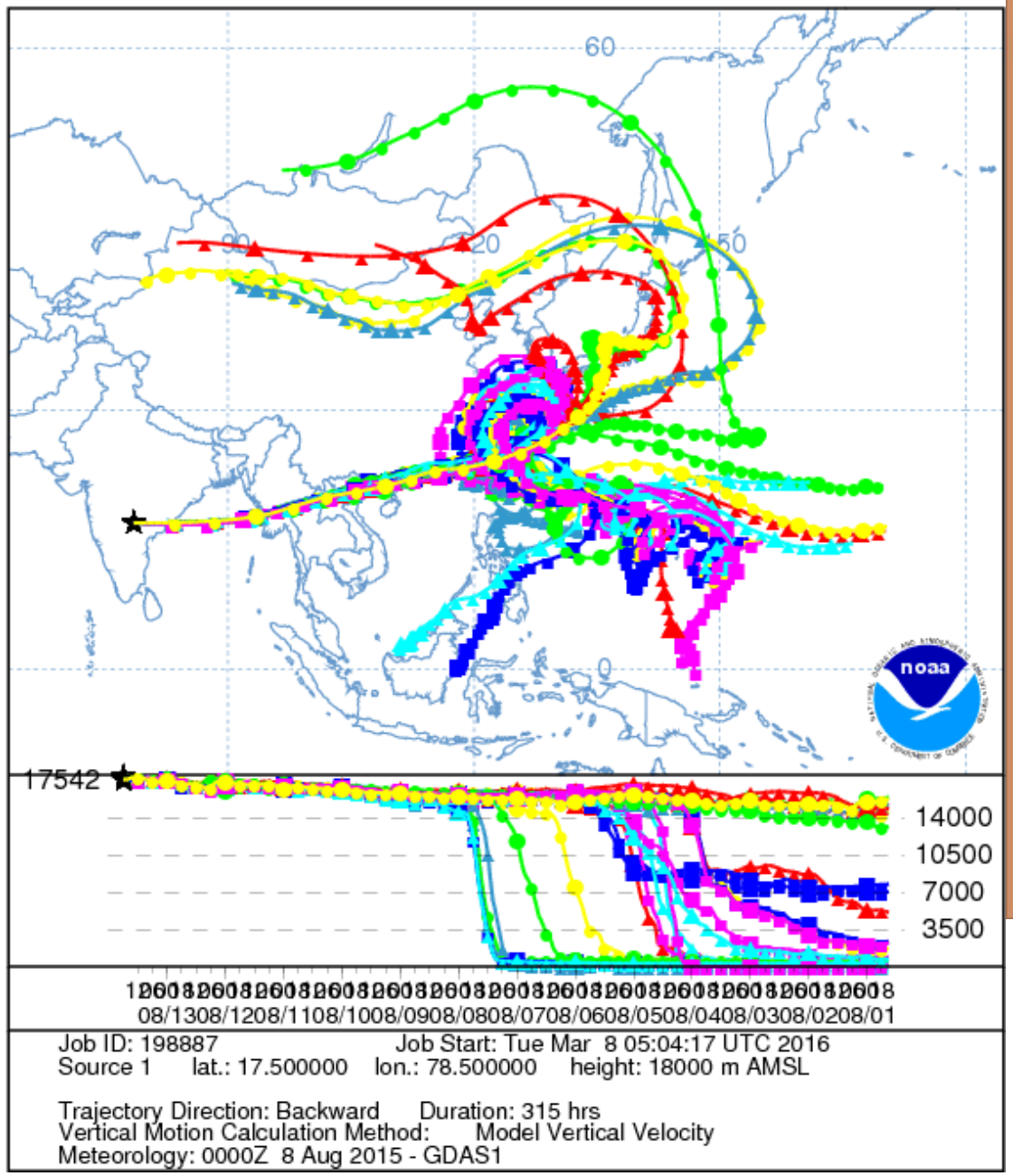
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 00UTC 8 Aug 2015 - GDAS1




GEOS5 BWD Traj @ 17.47N 78.58E, 20150808 120hr
13000
15000
17000
19000
Alt_orig (m)
Altitude (km)
20
18
16
14
12
10
60
70
80
90
100
110
120
Longitude

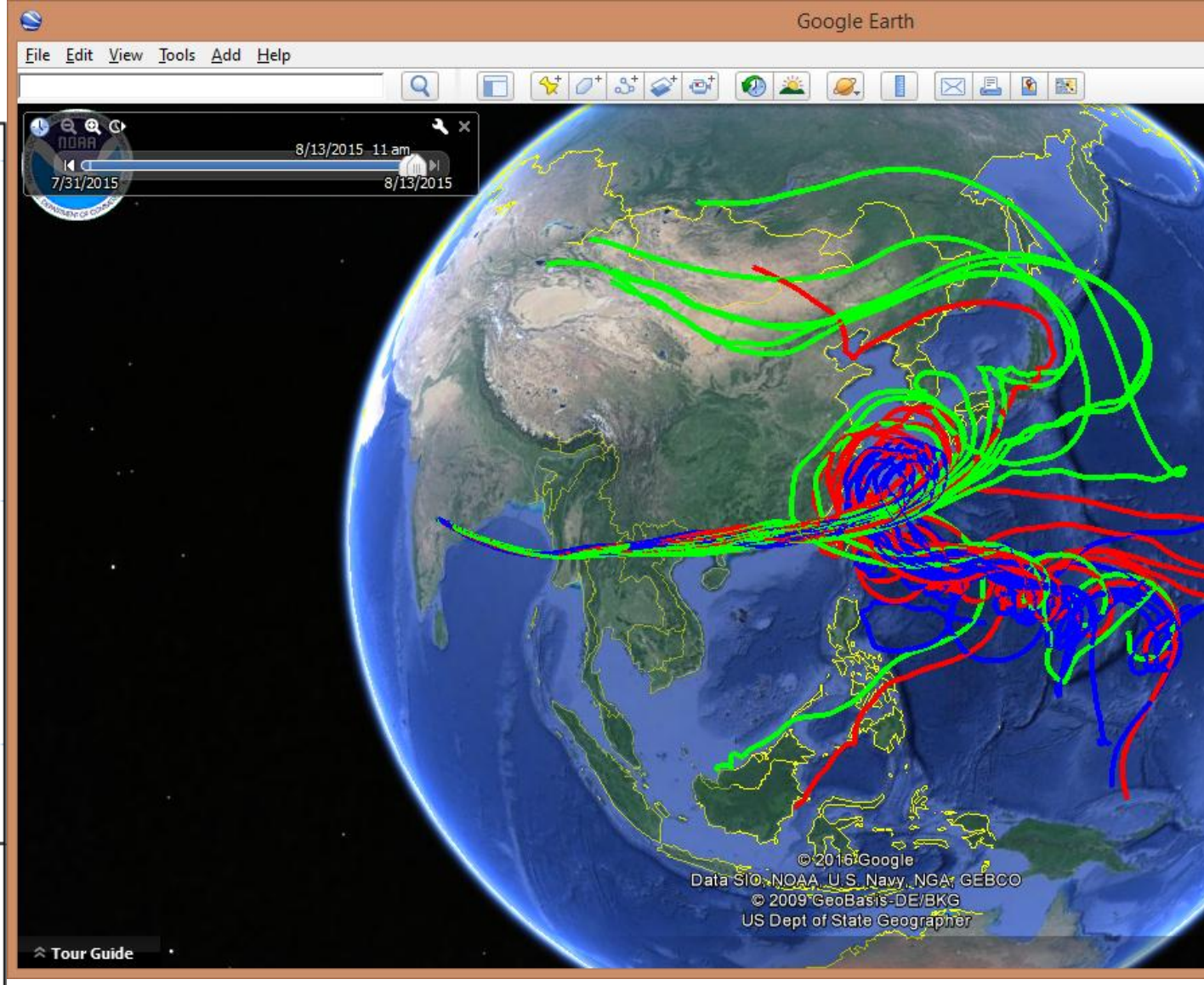

GEOS5 BWD Traj @ 17.47N 78.58E, 20150813 120hr
1300
1500
1700
1900
Alt_orig (m)
60
70
80
90
100
110
Longitude

NOAA HYSPLIT MODEL
Backward trajectories ending at 1800 UTC 13 Aug 15
GDAS Meteorological Data



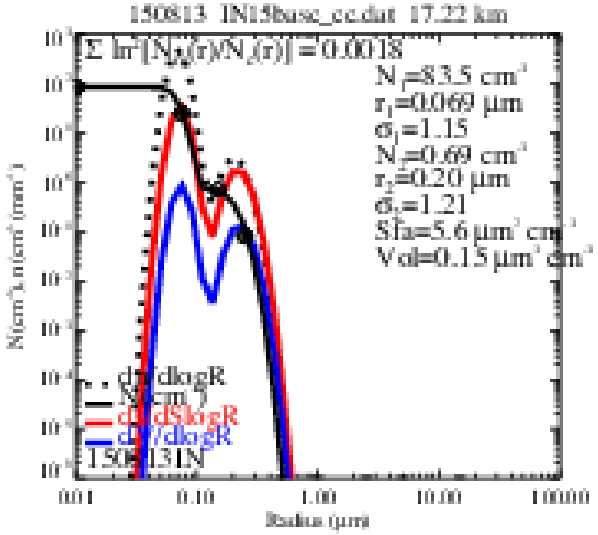
Job ID: 198887 Job Start: Tue Mar 8 05:04:17 UTC 2016
Source 1 lat.: 17.500000 lon.: 78.500000 height: 18000 m AMSL

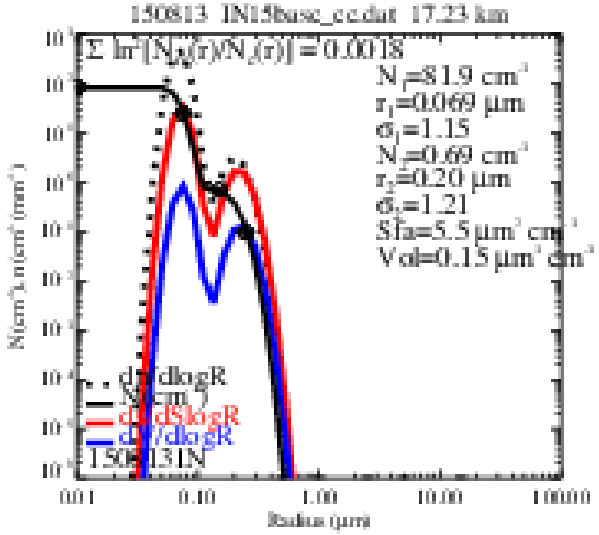
Trajectory Direction: Backward Duration: 315 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 8 Aug 2015 - GDAS1

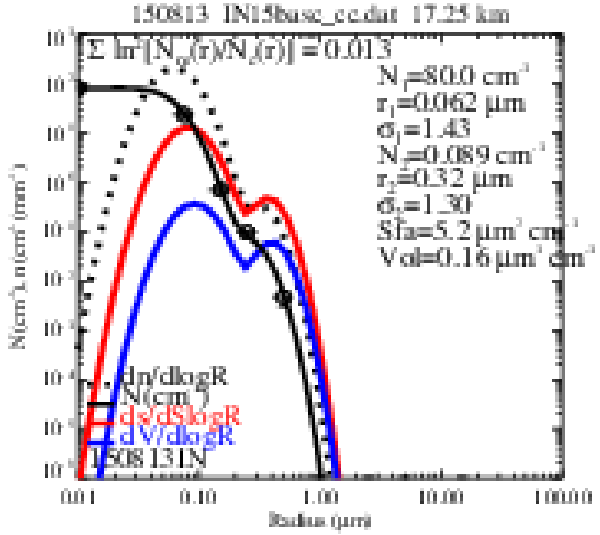


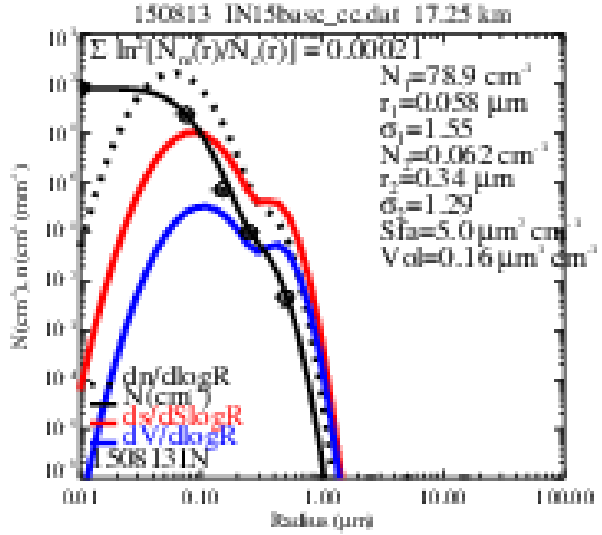
Aerosol Size distributions

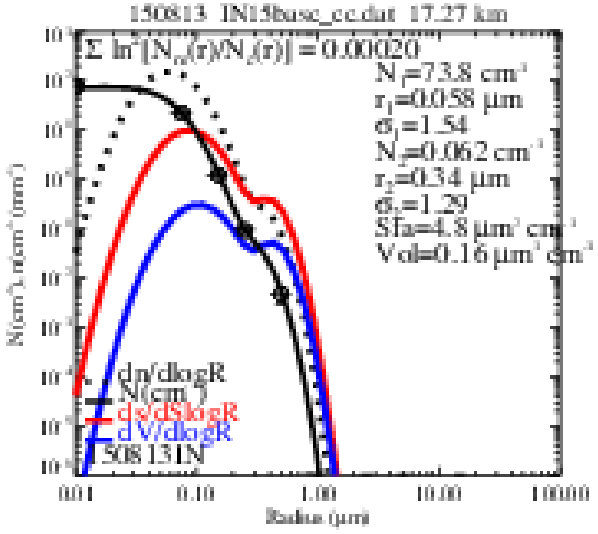
$$N(>r) = \sum_i \int_r^{\infty} \frac{N_i}{\sqrt{2\pi}\ln\sigma_i} \exp\left(\frac{-\ln^2[a/r_i]}{2\ln^2\sigma_i}\right) d\ln a$$

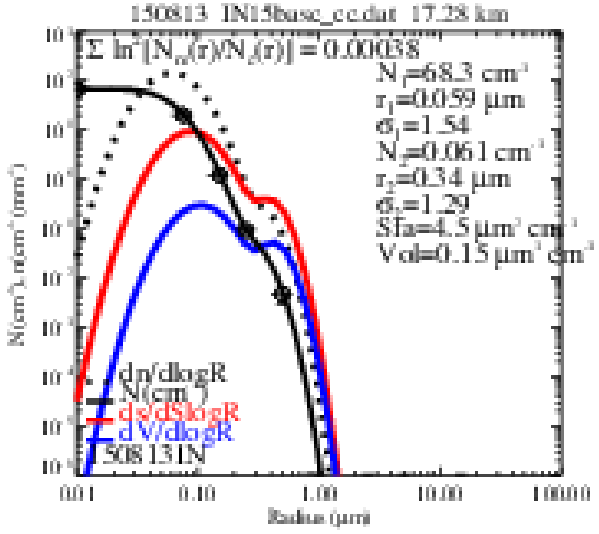


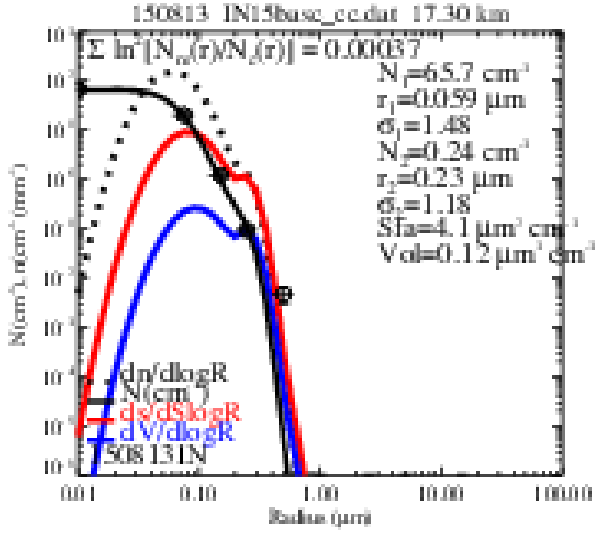


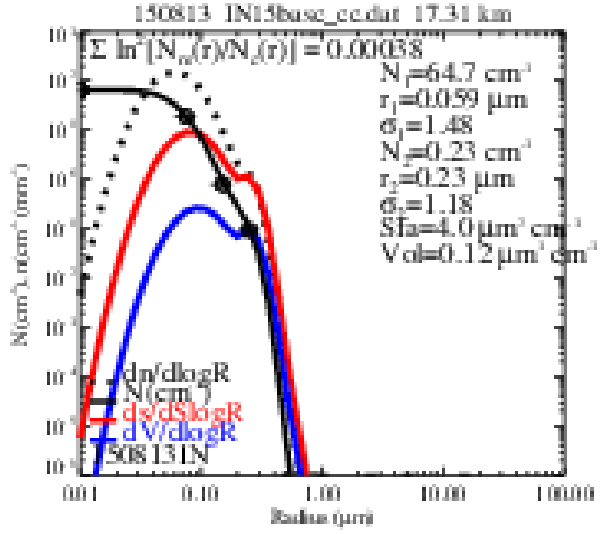




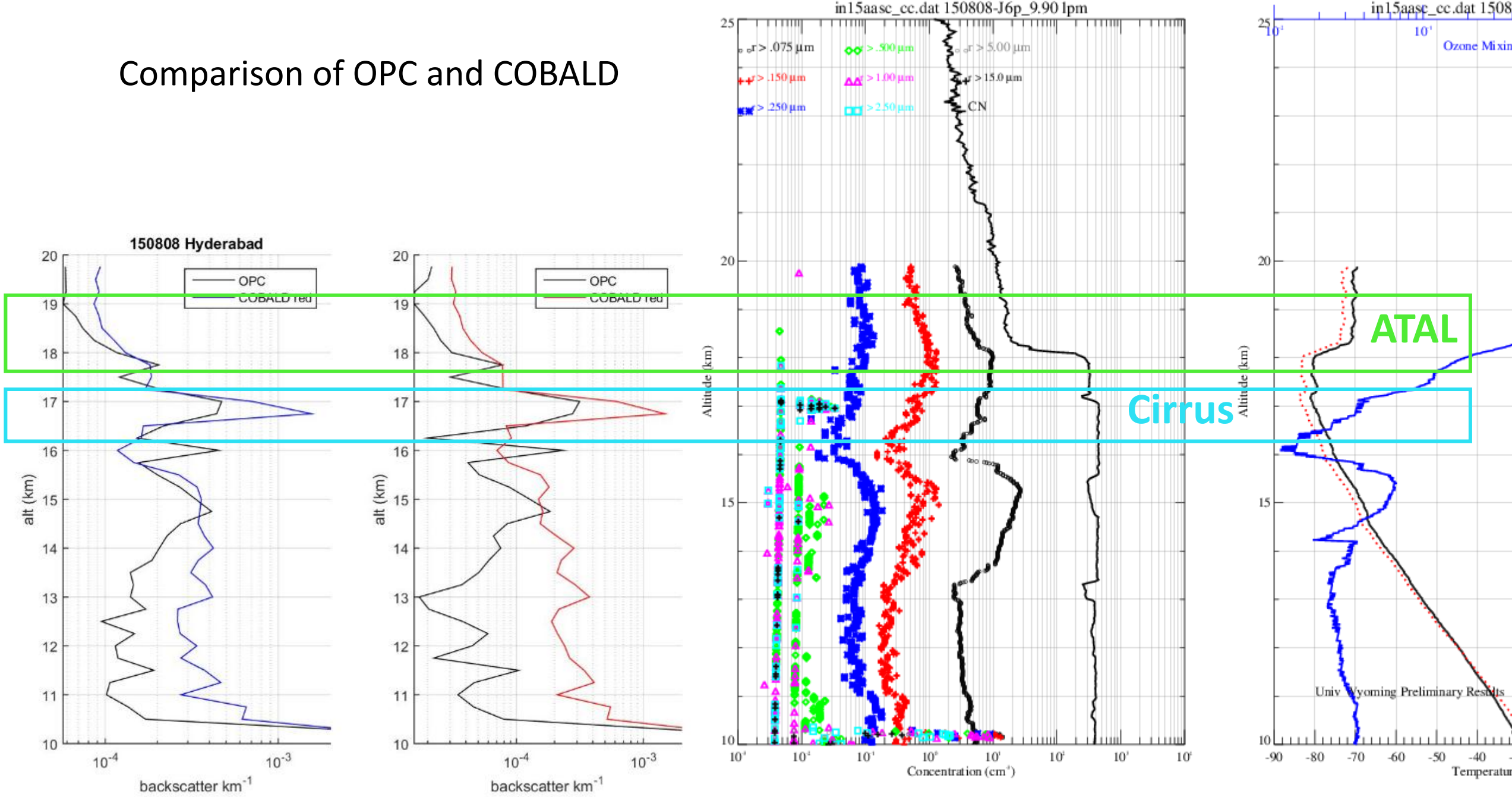




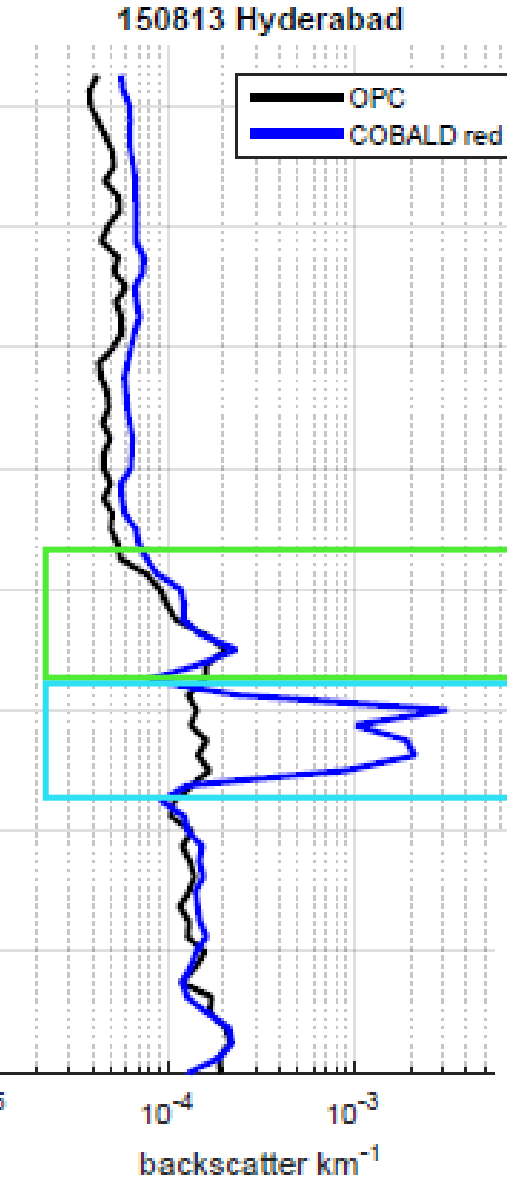


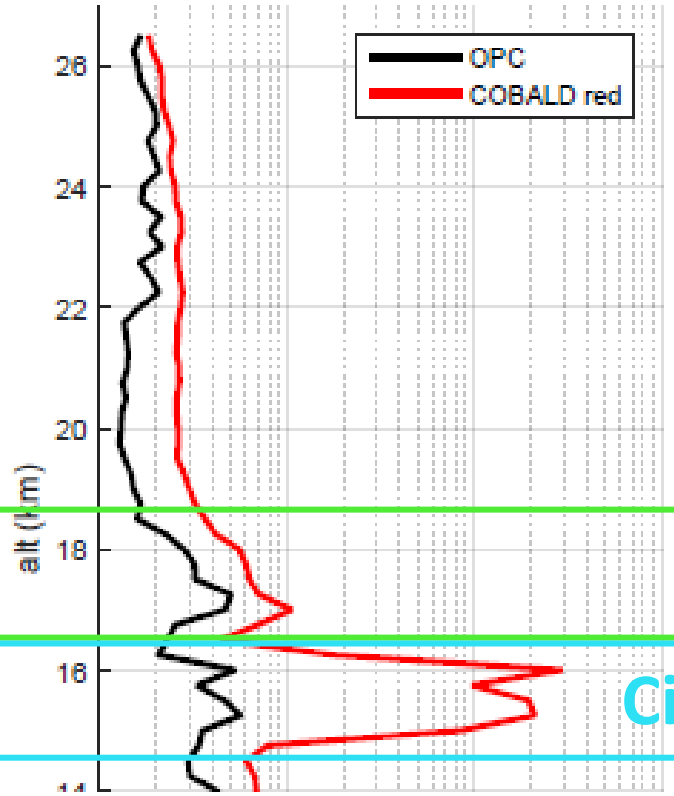


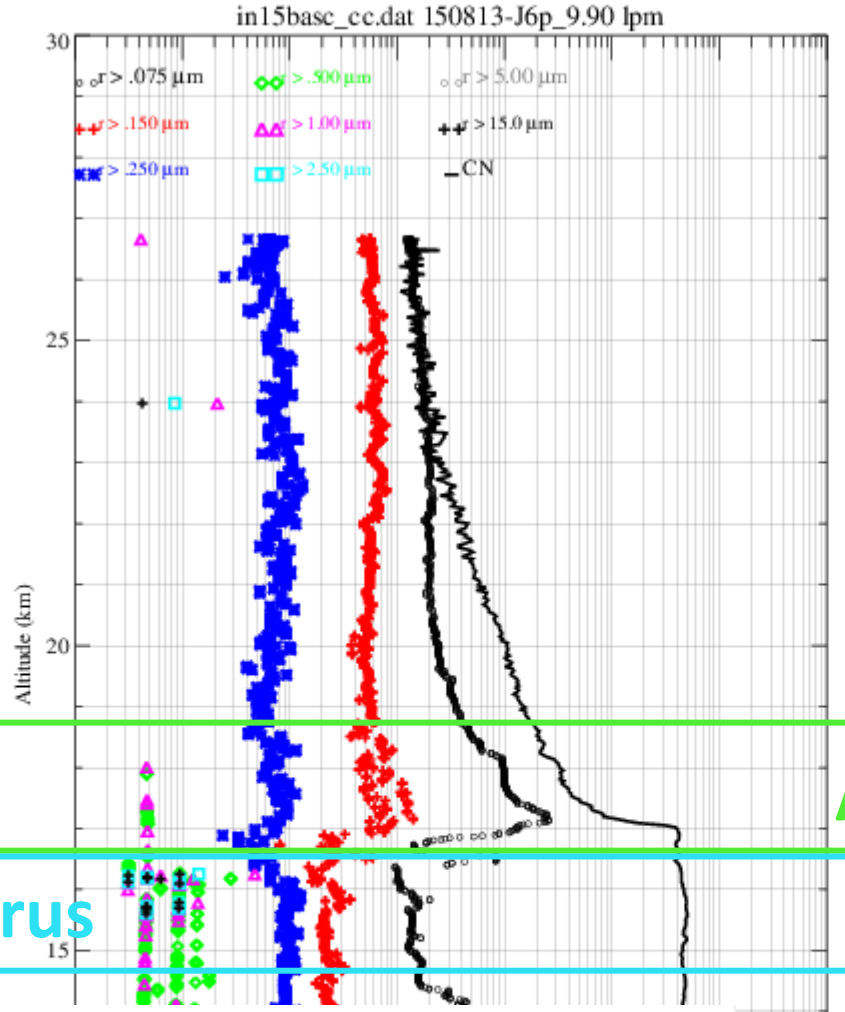
Comparison of OPC and COBALD

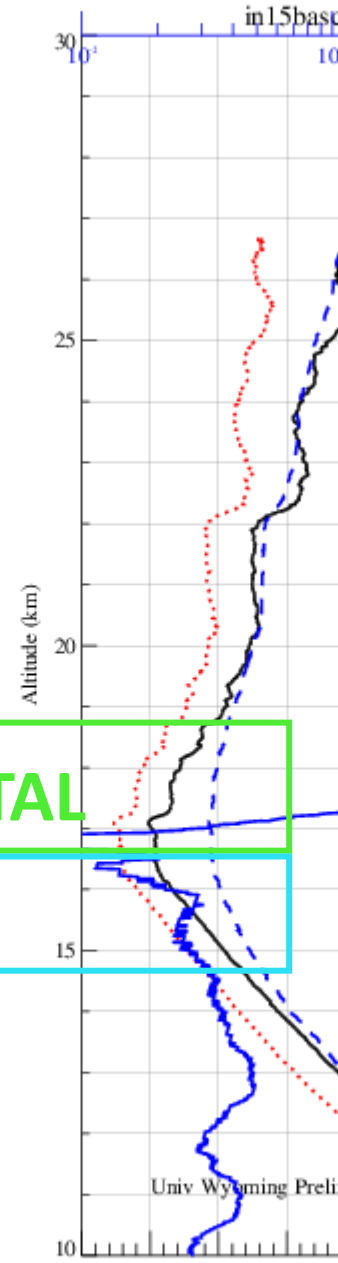


Comparison of OPC and COBALD



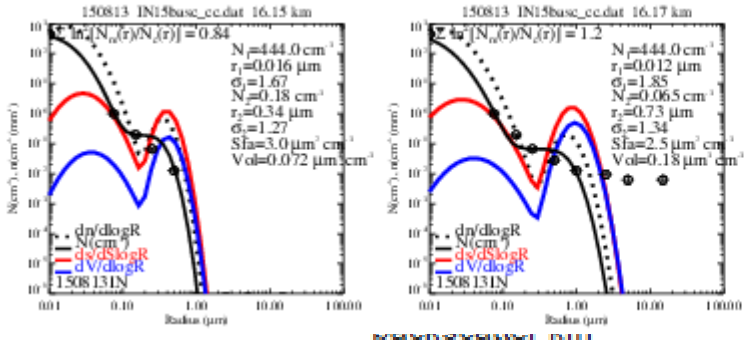


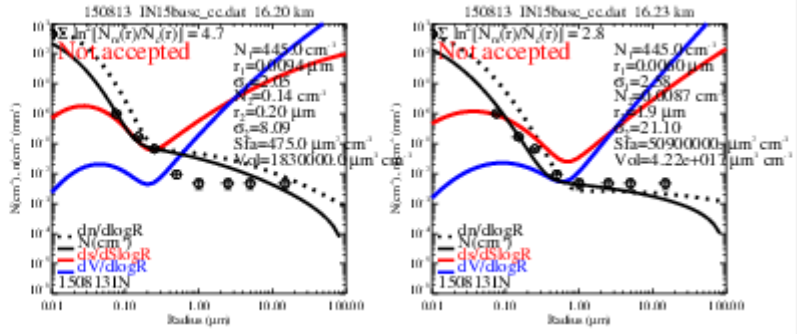




ATAL

Cirrus





Conclusions

- ATAL
  - 1-2 km deep, just above cold point tropopause
  - All particles <= 0.25 µm radius
  - No evidence of gravitational sorting at 0.07 µm
  - Weak gravitation sorting at 0.15 µm
  - Not exclusively sulfate
- Cirrus
  - Observed on both days.
  - Very narrow and only appear in large particle channels OPC
    - COBALD and OPC do not agree on cloud thickness or intensity
    - Outside of cloud, COBALD and OPC agree, more or less
- Ozone
  - Local ozone maximum just below tropopause on 150808
  - Unusual ozone minimum just below tropopause and above cirrus on 150813