Preliminary Cessna Data
Thursday Afternoon 21 July 2011

Russell R. Dickerson

Heather Arkinson

Lacey Brent

Hao He

Tamba Marufu

Jeffrey Stehr

The University of Maryland

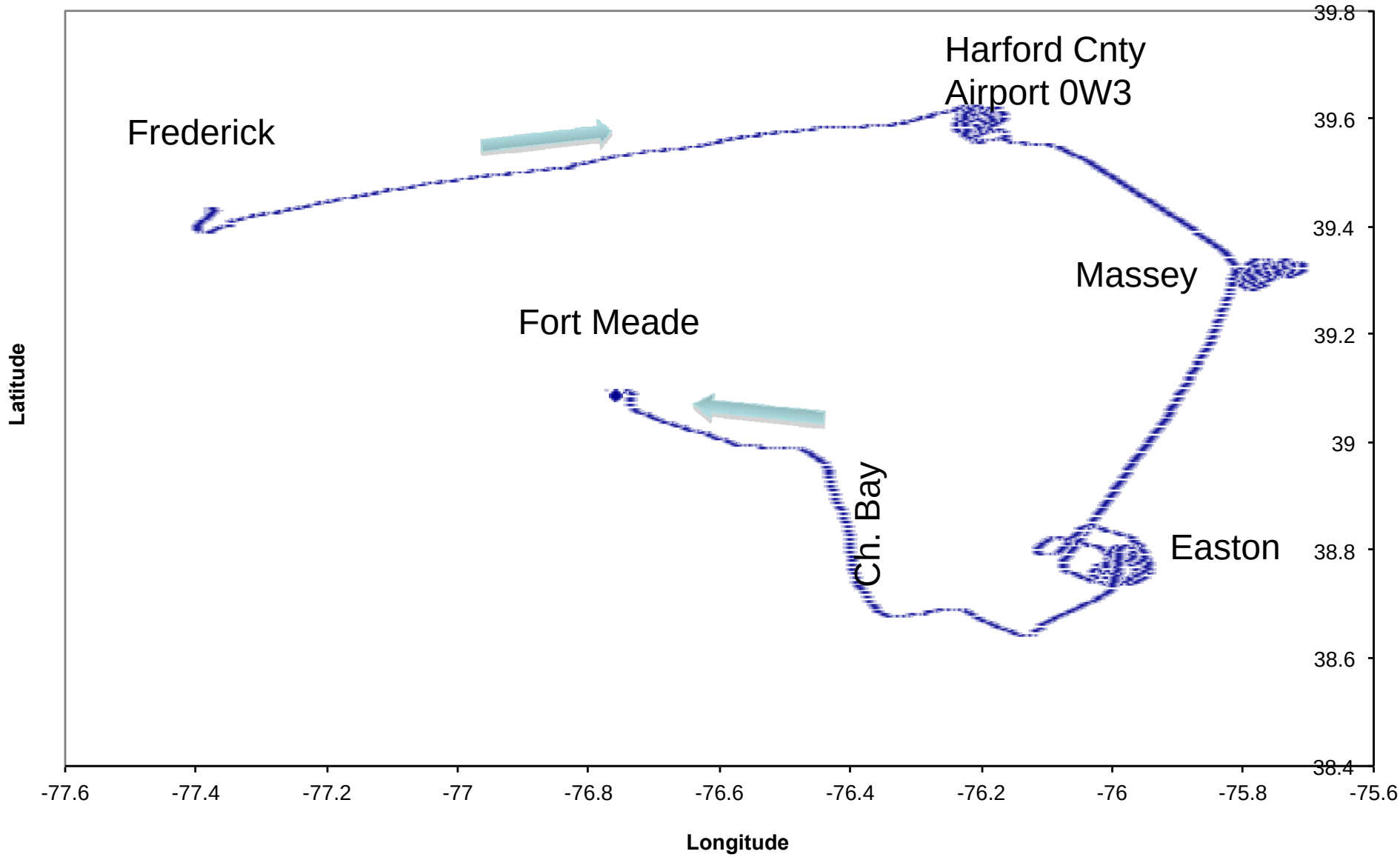
Supported by MDE, DNR, NOAA, and NASA

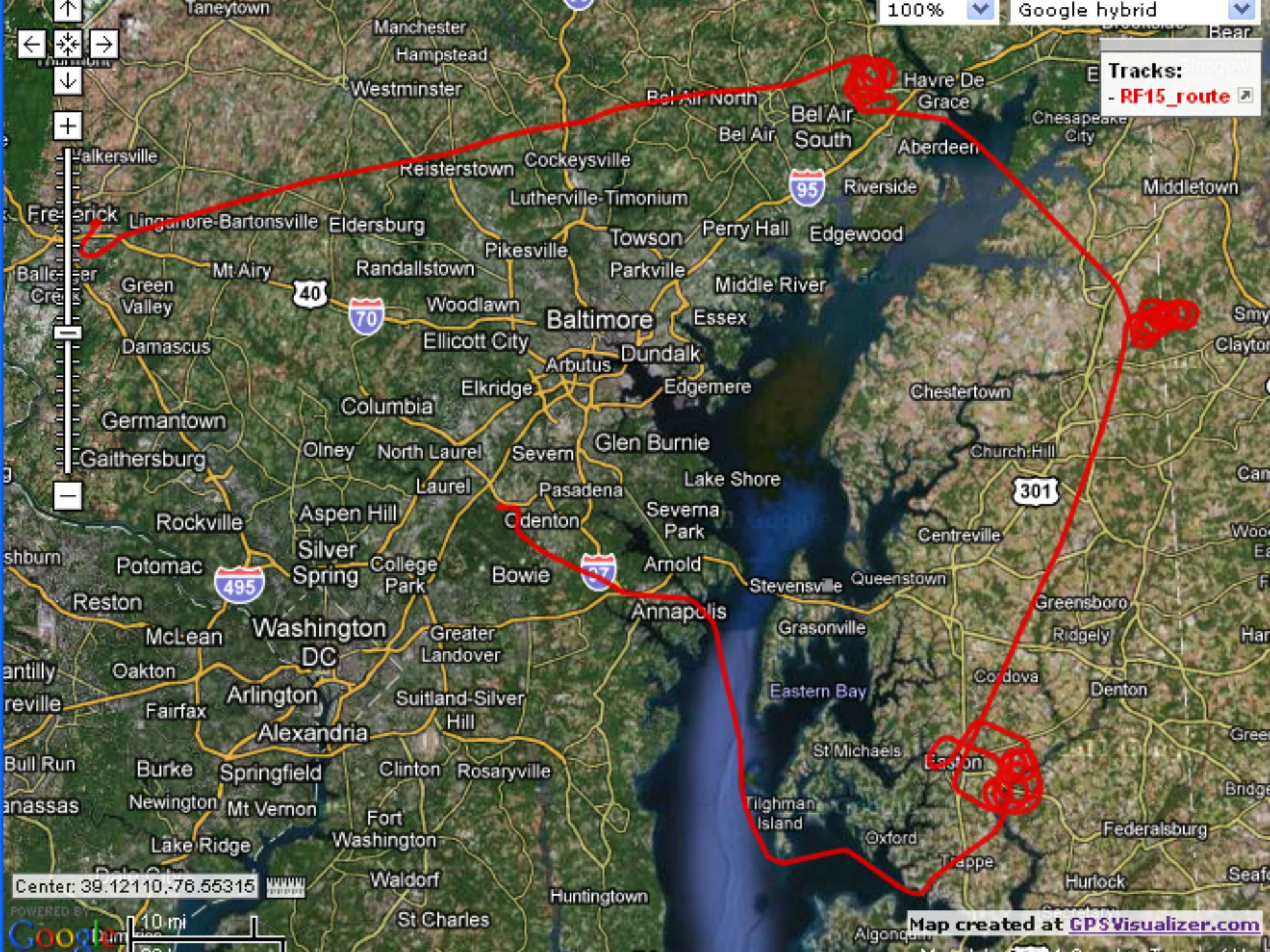
Image of Haze by J. Stehr

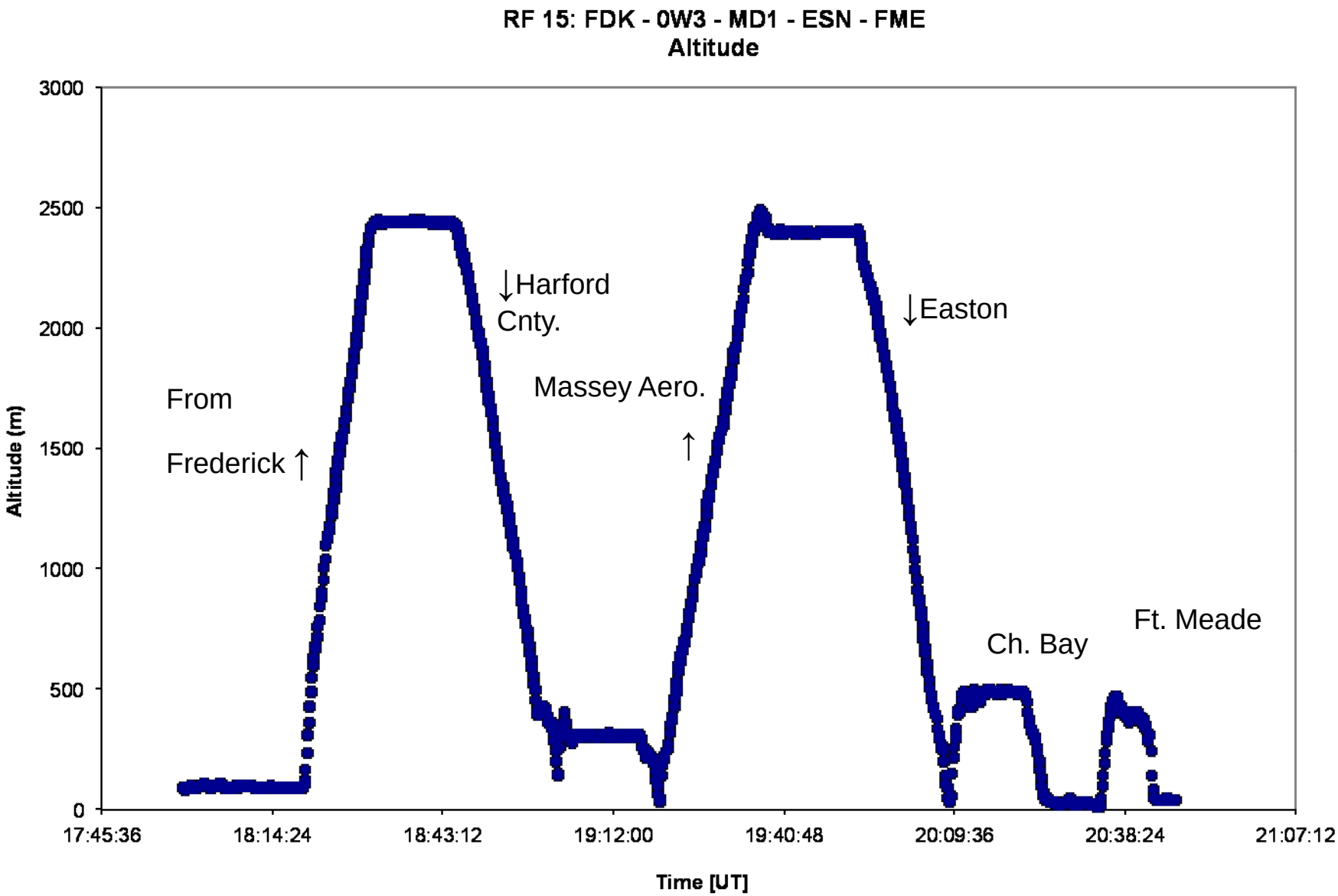
Surface Observations for MDE Sites
Preliminary Data

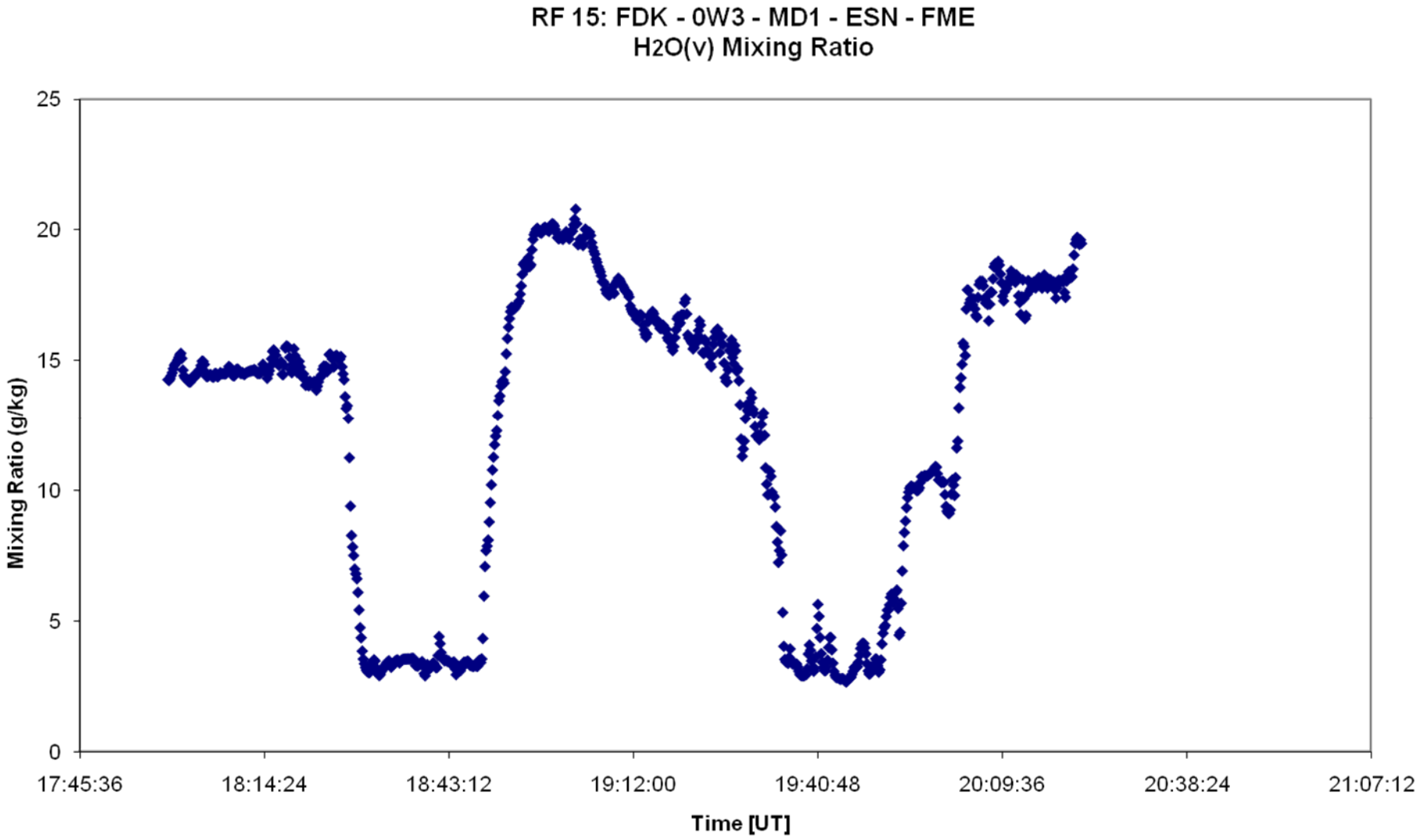
Day of July 2011	8-hr O_3 Max (ppb)	1-hr PM2.5 max ($\mu g/m^3$)	Tmax at BWI (°F) (°C)
18	88	26.2	95 (35.0)
19	76	26.7	95 (35.0)
20	86	25.8	93 (33.9)
21	83	35.3	100 (37.8)
22	97	35.3	106 (41.1)
23	91	22.5	102 (38.9)

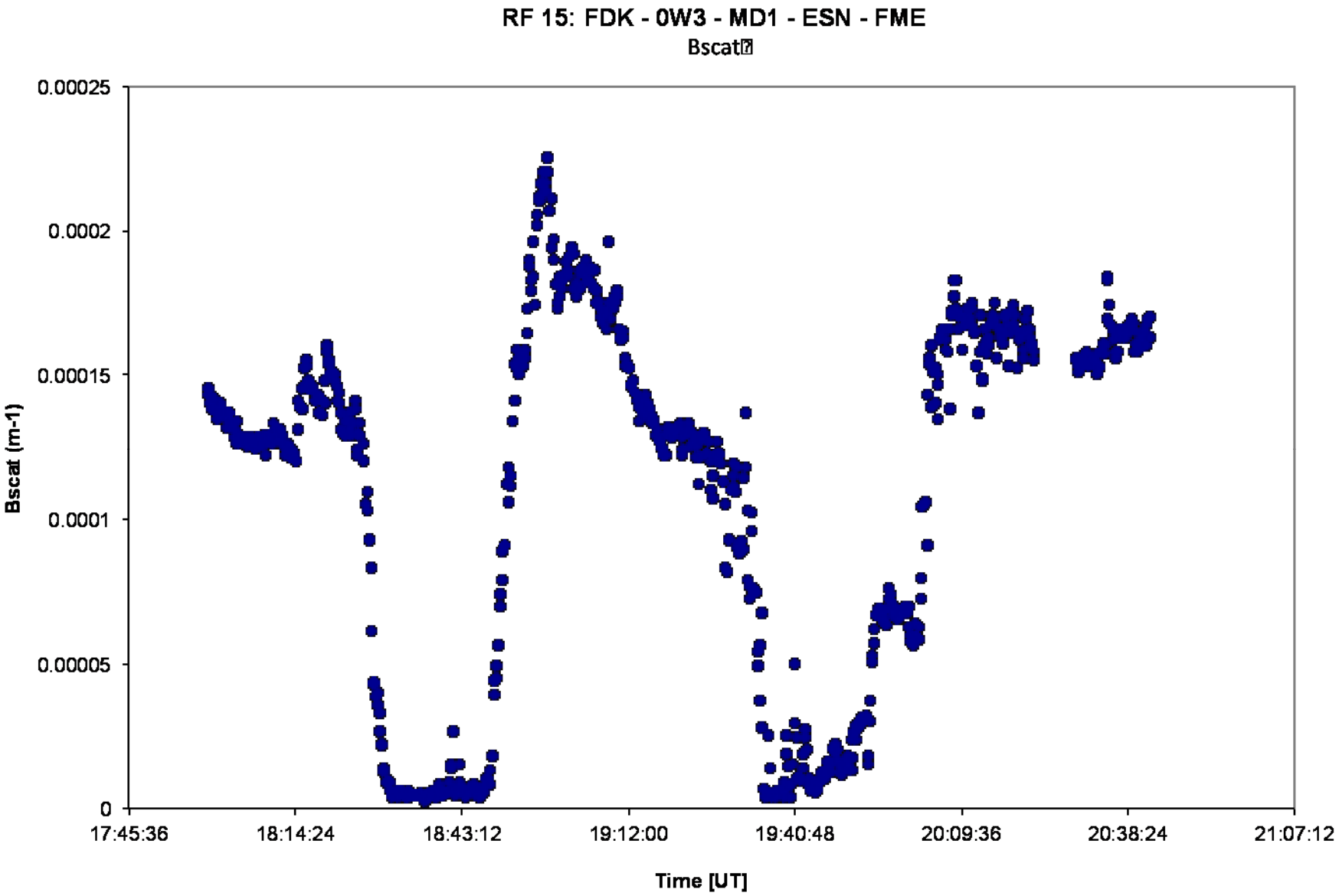
RF 15: FDK - 0W3 - MD1 - ESN - FME
Flight Route

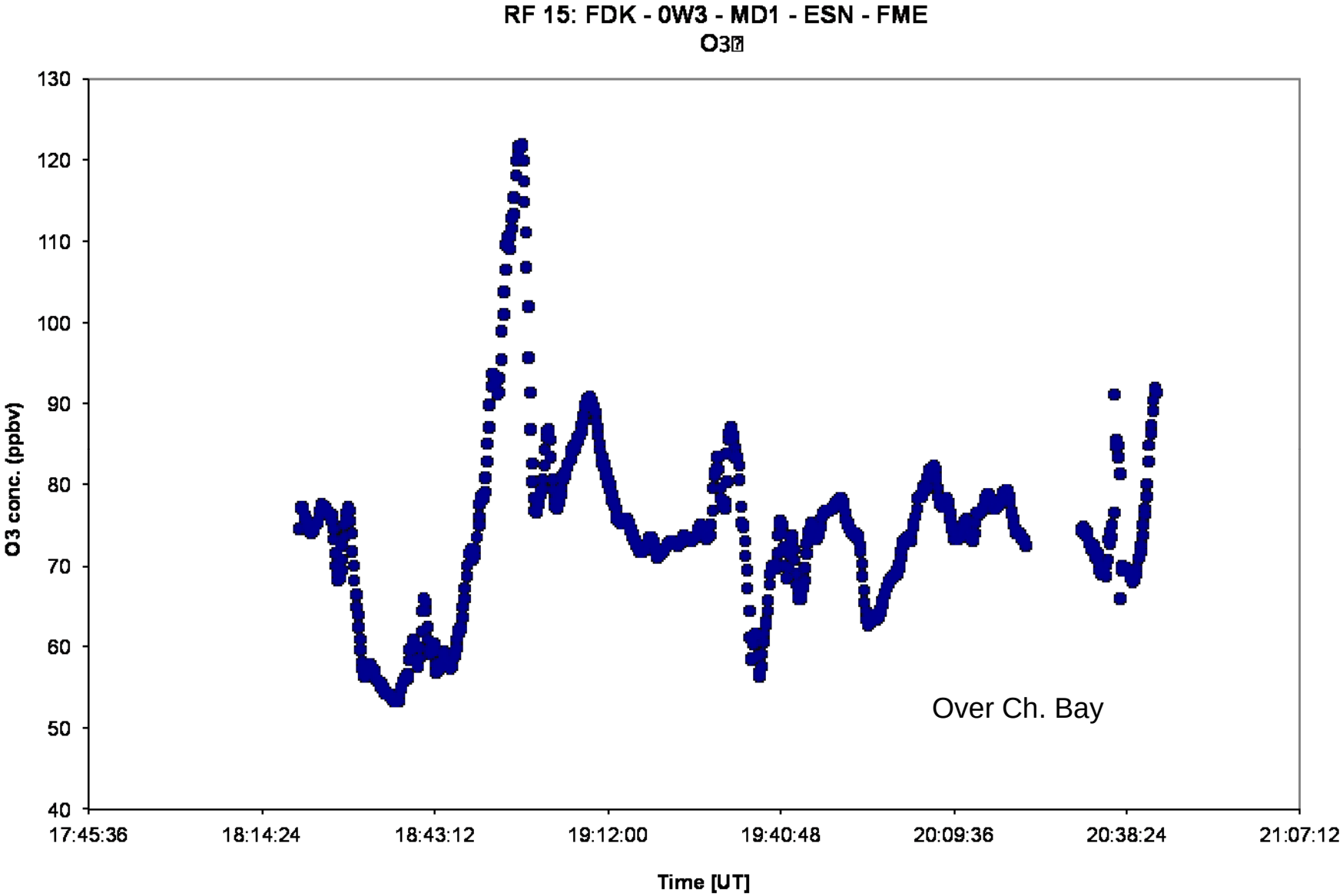


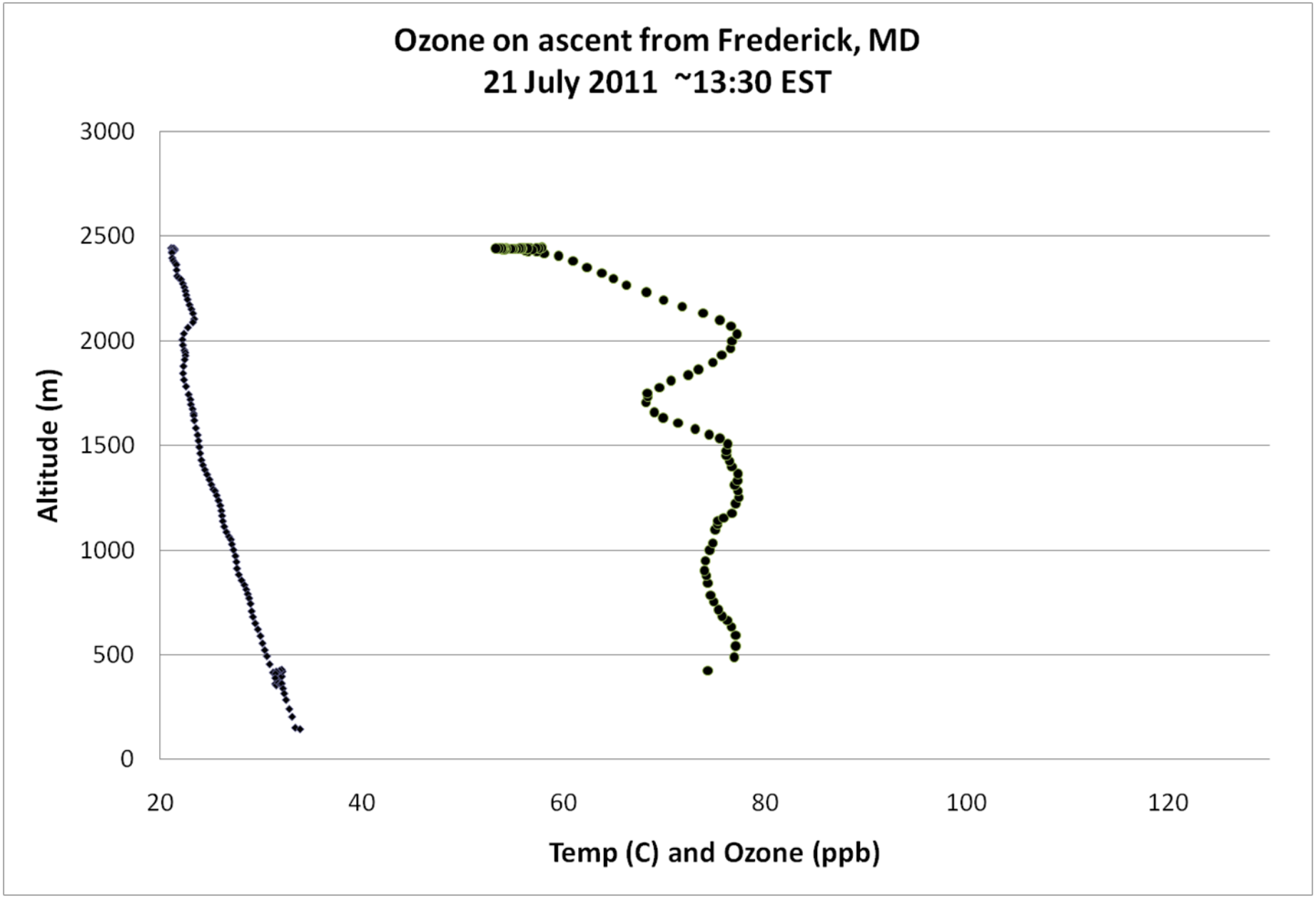

100%
Google hybrid
Tracks:
- RF15_route
Taneytown
Manchester
Hampstead
Westminster
Bel Air North
Havre De Grace
Bel Air South
Bel Air
Aberdeen
Chesapeake City
Reisterstown
Cockeysville
Lutherville-Timonium
Riverside
Middletown
Frederick
Linganore-Bartonsville
Eldersburg
Towson
Perry Hall
Edgewood
Pikesville
Randallstown
Parkville
Middle River
Mt Airy
Green Valley
Woodlawn
Baltimore
Essex
Damascus
Ellicott City
Dundalk
Arbutus
Elkridge
Edgemere
Chestertown
Columbia
Germantown
Glen Burnie
Olney
North Laurel
Severn
Gaithersburg
Laurel
Pasadena
Lake Shore
Church Hill
Rockville
Aspen Hill
Odenton
Severna Park
Centreville
Silver Spring
Potomac
College Park
Bowie
Arnold
Stevensville
Queenstown
Reston
Annapolis
Greensboro
Washington DC
McLean
Greater Landover
Grasonville
Ridgely
Oakton
Arlington
Suitland-Silver Hill
Eastern Bay
Denton
Fairfax
Alexandria
St Michaels
Easton
Burke
Springfield
Clinton
Rosaryville
Bull Run
Newington
Mt Vernon
Tilghman Island
Fort Washington
Oxford
Federalsburg
Lake Ridge
Trappe
Hurlock
Waldorf
Huntingtown
St Charles
Center: 39.12110,-76.55315
10 mi
Map created at GPSVisualizer.com

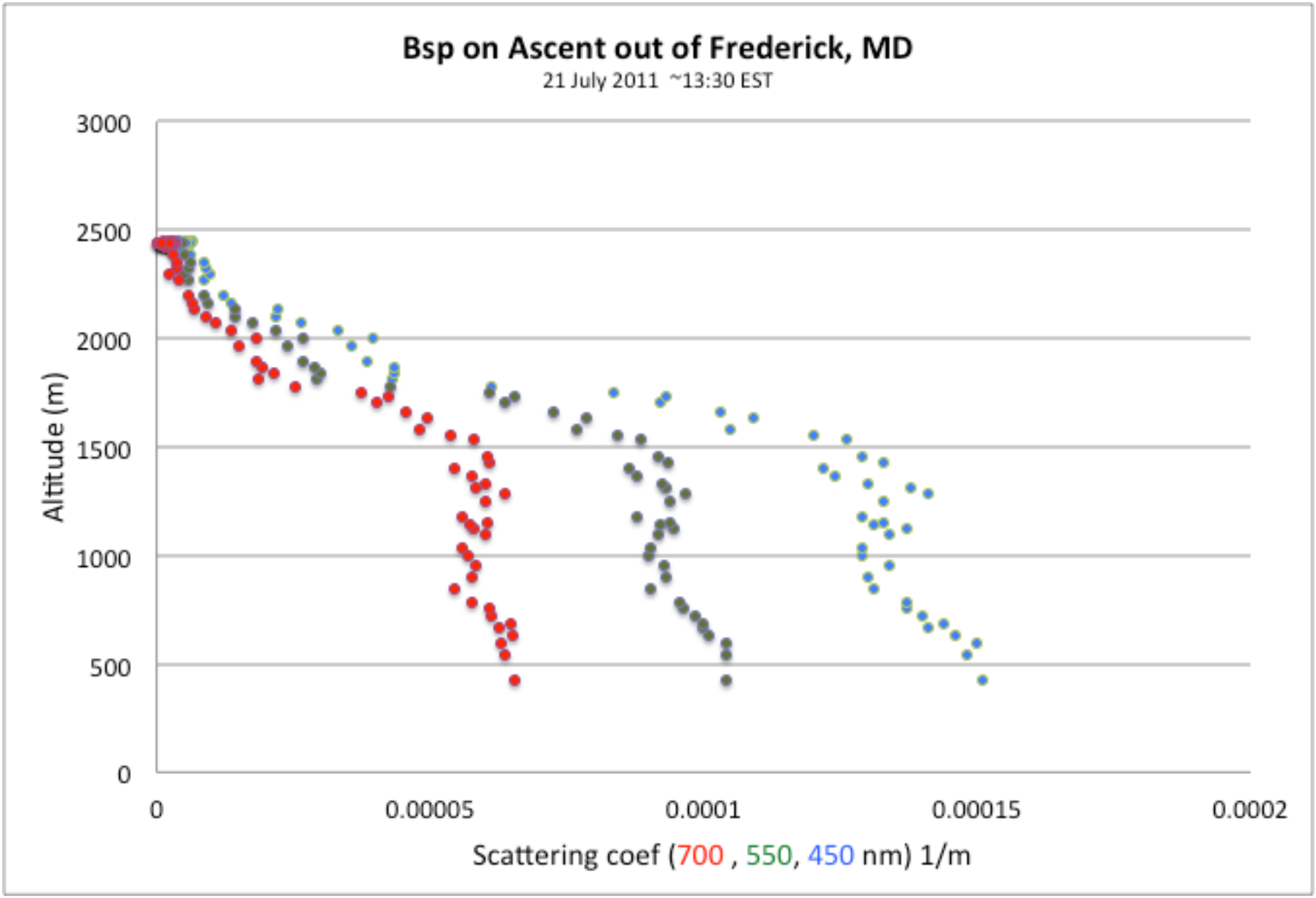

RF 15: FDK - 0W3 - MD1 - ESN - FME
Altitude
Altitude (m)
3000
2500
2000
1500
1000
500
0
17:45:36
18:14:24
18:43:12
19:12:00
19:40:48
20:09:36
20:38:24
21:07:12
Time [UT]
From
Frederick ↑
↓Harford
Cnty.
Massey Aero.
↑
↓Easton
Ch. Bay
Ft. Meade

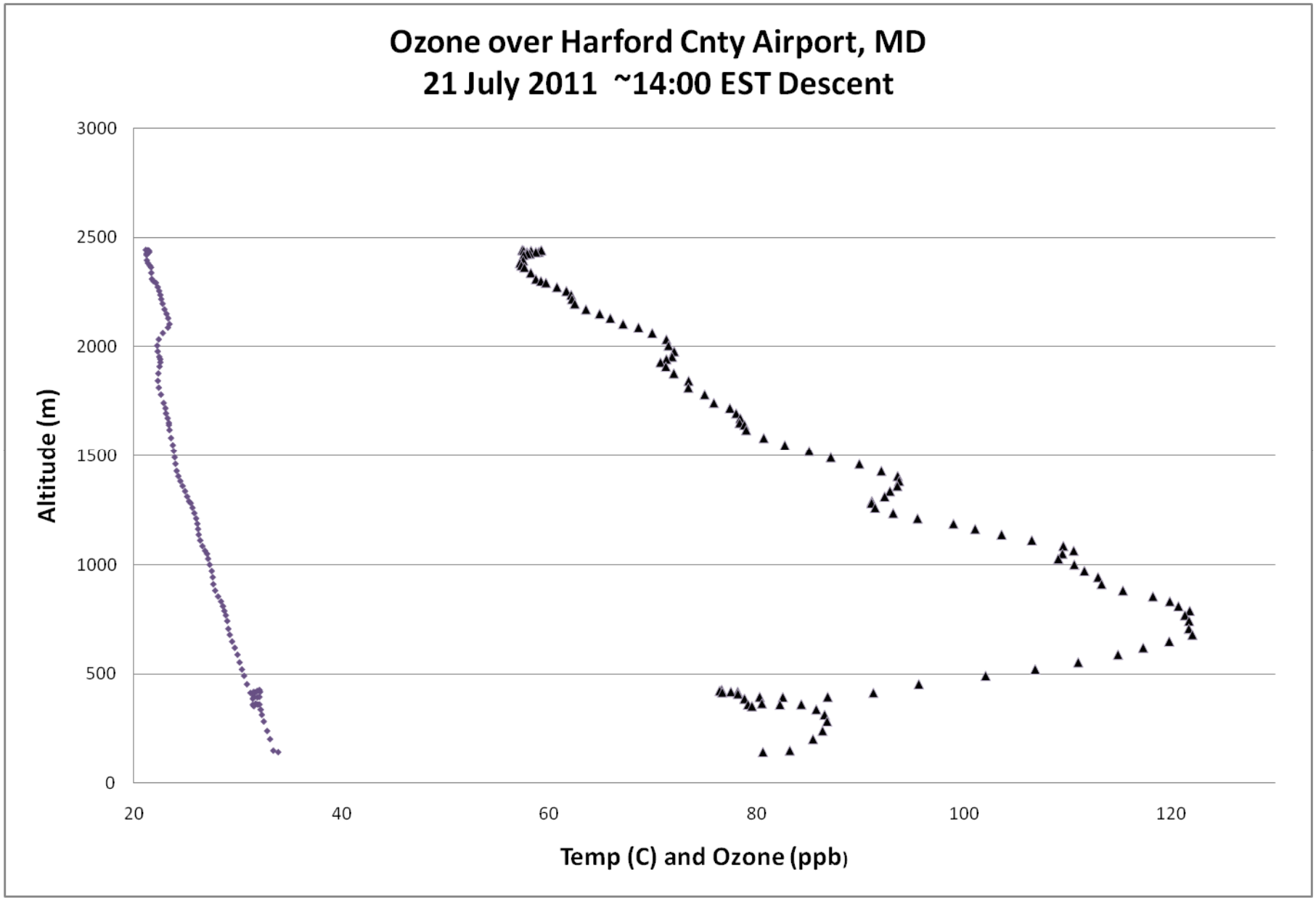

RF 15: FDK - 0W3 - MD1 - ESN - FME
H2O(v) Mixing Ratio
Mixing Ratio (g/kg)
25
20
15
10
5
0
17:45:36
18:14:24
18:43:12
19:12:00
19:40:48
20:09:36
20:38:24
21:07:12
Time [UT]

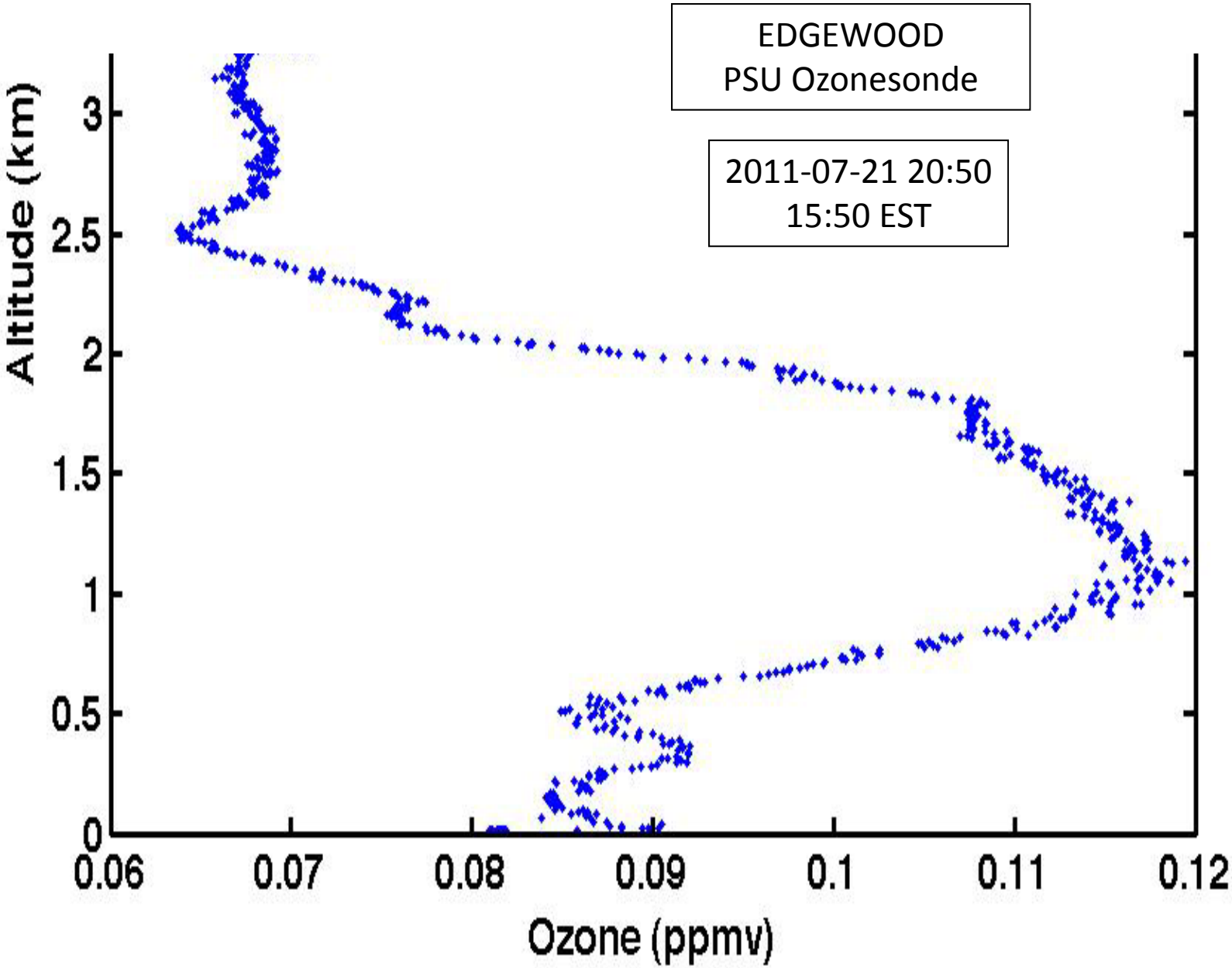

RF 15: FDK - 0W3 - MD1 - ESN - FME
Bscat
0.00025
0.0002
0.00015
0.0001
0.00005
0
Bscat (m-1)
17:45:36
18:14:24
18:43:12
19:12:00
19:40:48
20:09:36
20:38:24
21:07:12
Time [UT]

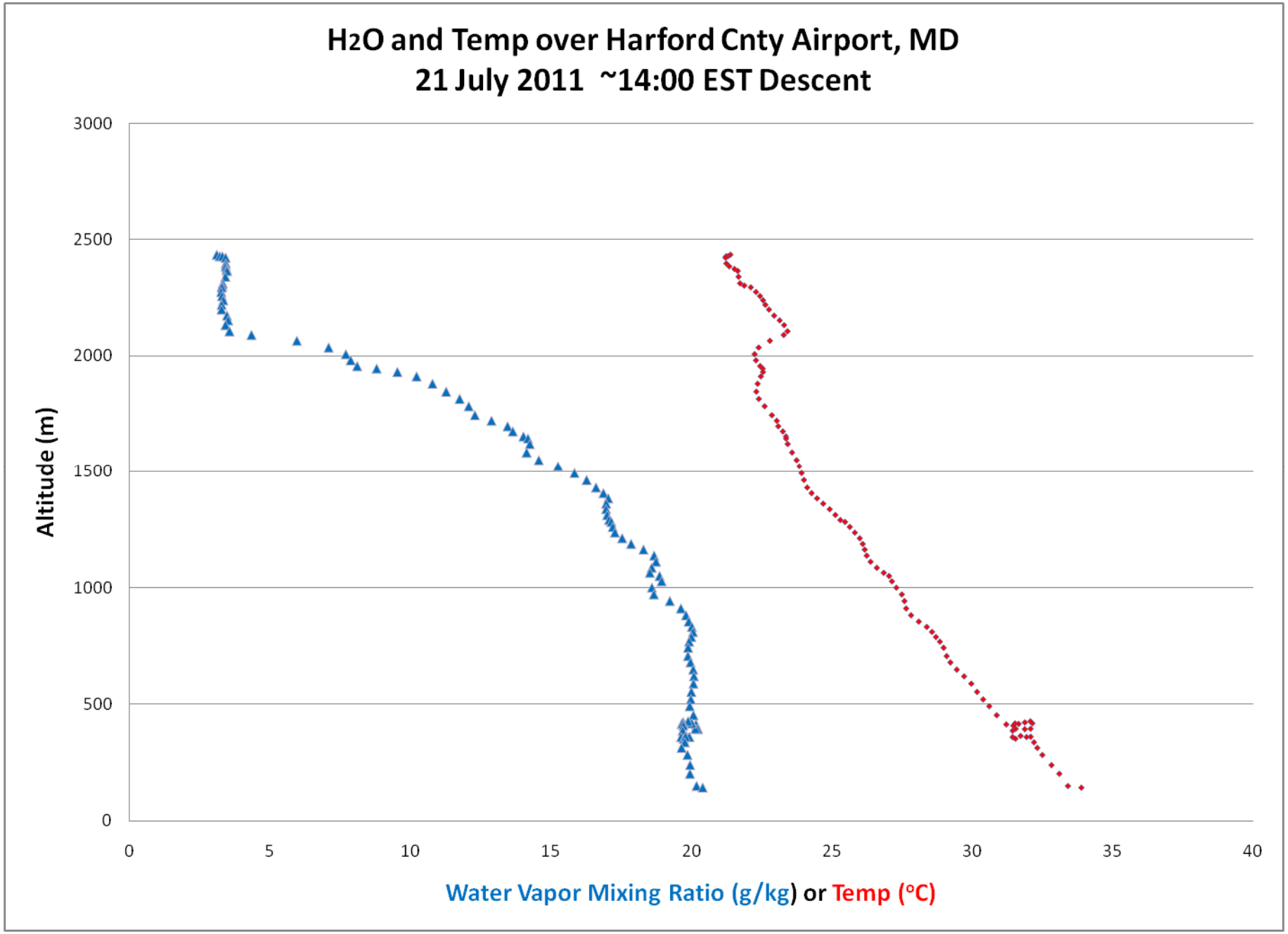

RF 15: FDK - 0W3 - MD1 - ESN - FME
O3
O3 conc. (ppbv)
130
120
110
100
90
80
70
60
50
40
17:45:36
18:14:24
18:43:12
19:12:00
19:40:48
20:09:36
20:38:24
21:07:12
Time [UT]
Over Ch. Bay

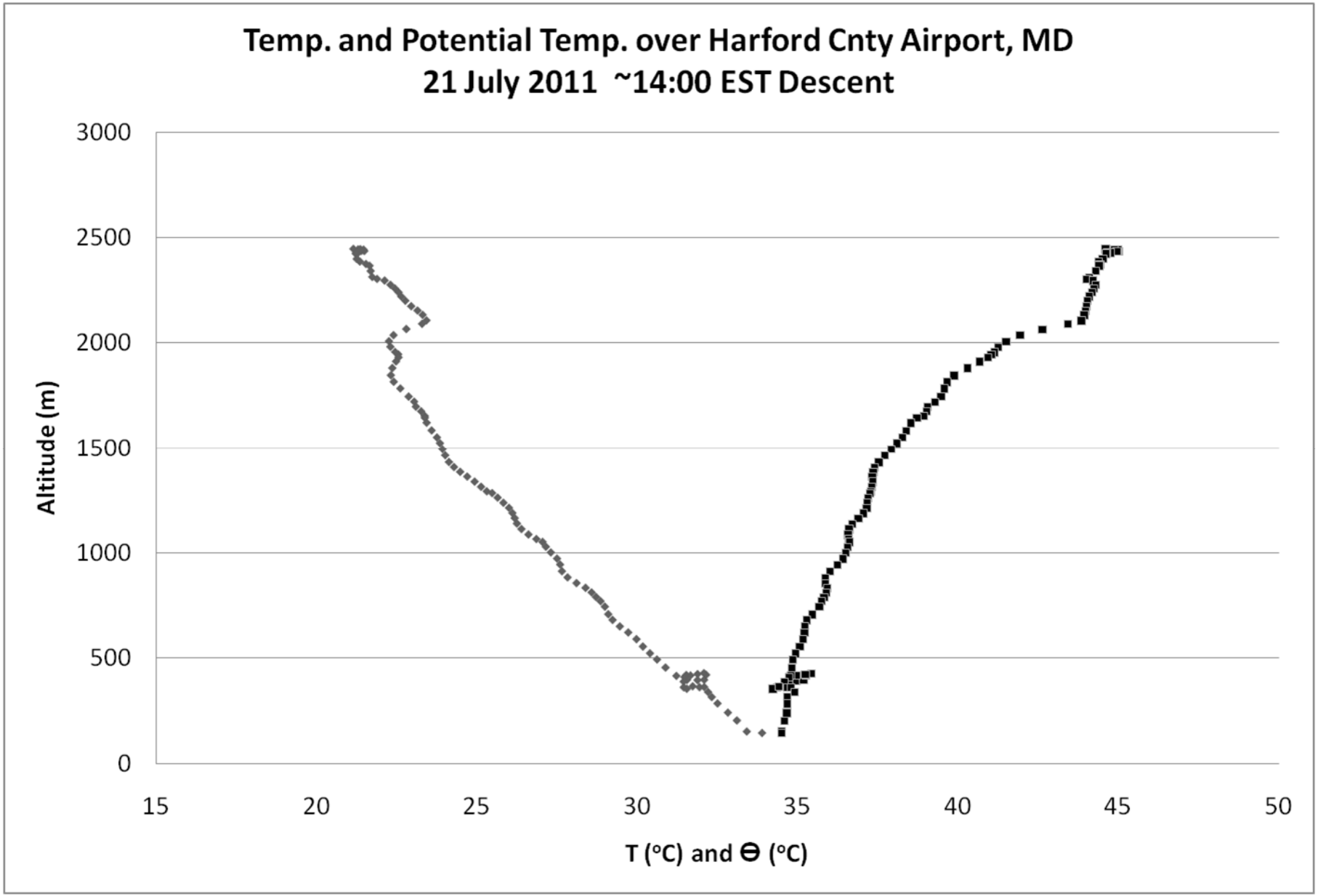

Ozone on ascent from Frederick, MD
21 July 2011 ~13:30 EST
Altitude (m)
3000
2500
2000
1500
1000
500
0
20
40
60
80
100
120
Temp (C) and Ozone (ppb)

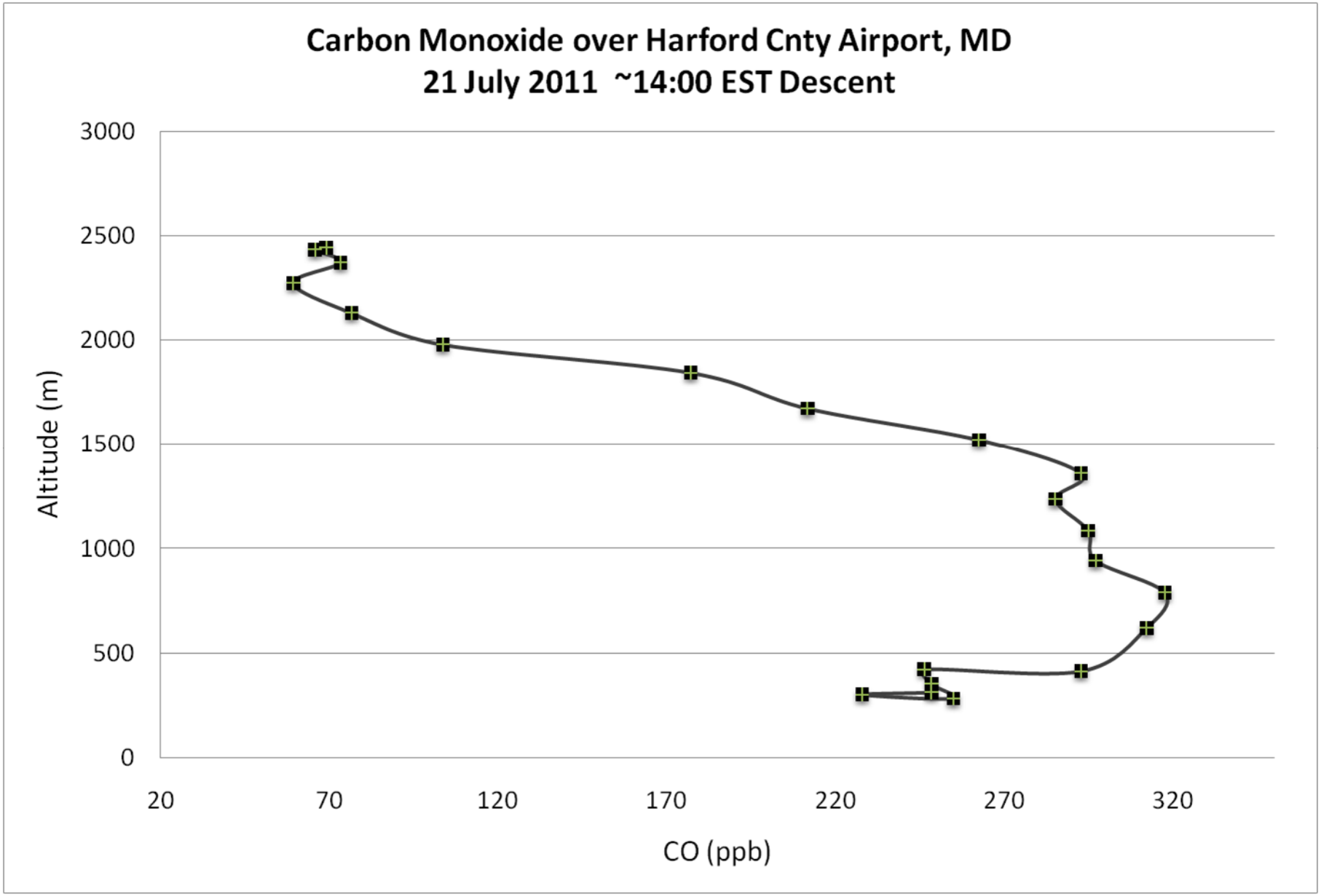

Bsp on Ascent out of Frederick, MD
21 July 2011 ~13:30 EST
Altitude (m)
3000
2500
2000
1500
1000
500
0
0
0.00005
0.0001
0.00015
0.0002
Scattering coef (700 , 550, 450 nm) 1/m

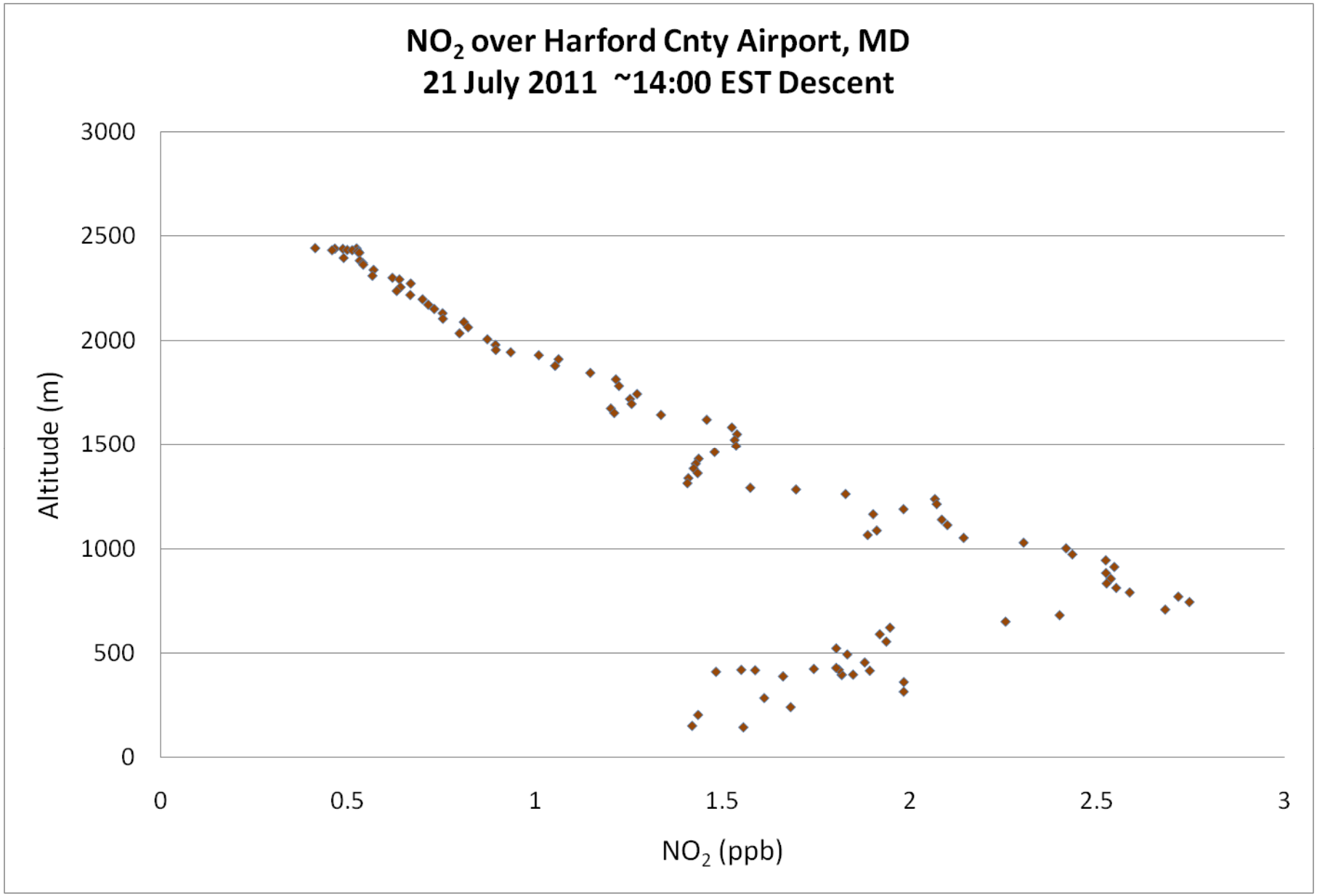

Ozone over Harford Cnty Airport, MD
21 July 2011 ~14:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
20
40
60
80
100
120
Temp (C) and Ozone (ppb)

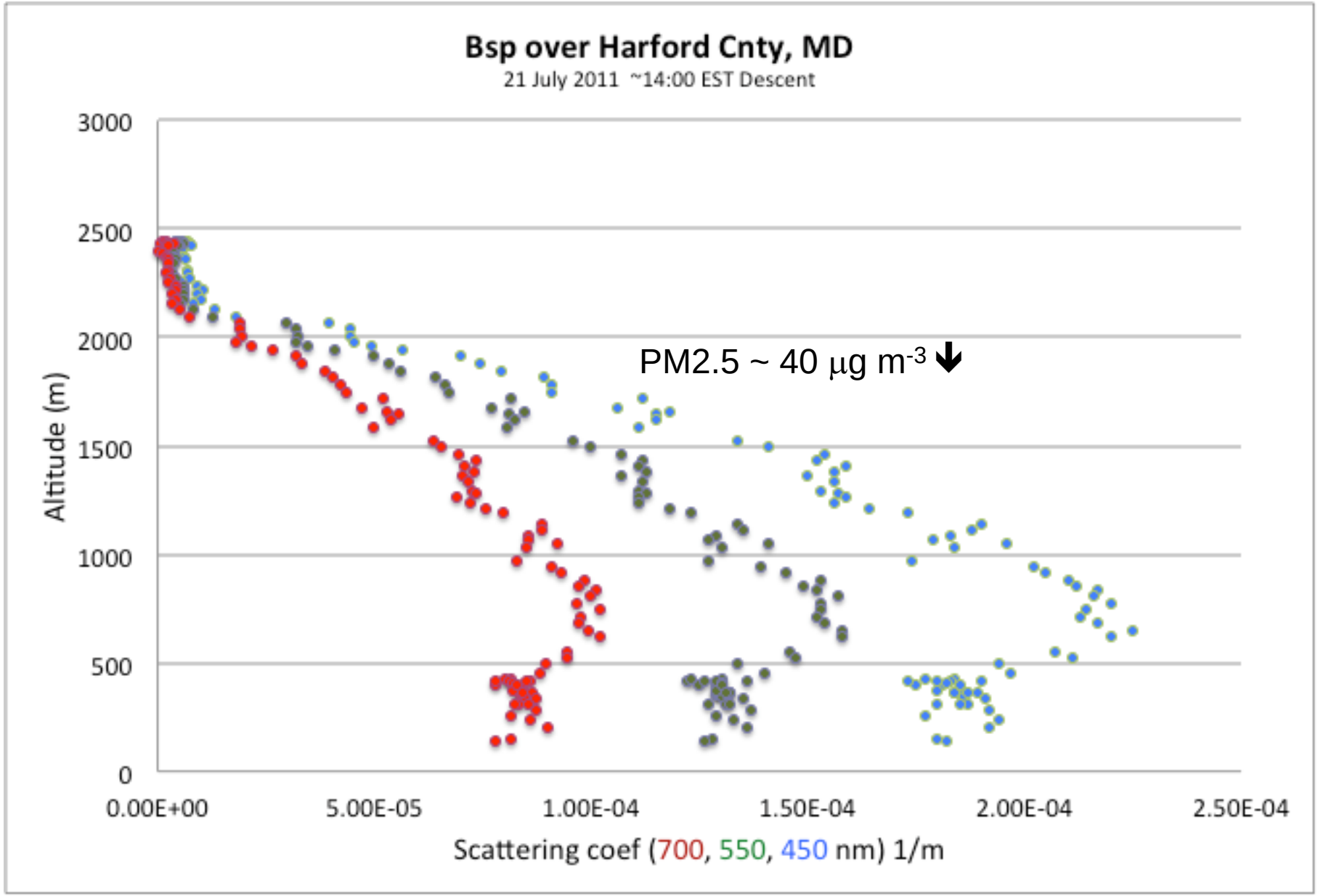

EDGEWOOD
PSU Ozonesonde
2011-07-21 20:50
15:50 EST
Altitude (km)
3
2.5
2
1.5
1
0.5
0
0.06
0.07
0.08
0.09
0.1
0.11
0.12
Ozone (ppmv)


H2O and Temp over Harford Cnty Airport, MD
21 July 2011 ~14:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
35
40
Water Vapor Mixing Ratio (g/kg) or Temp (°C)

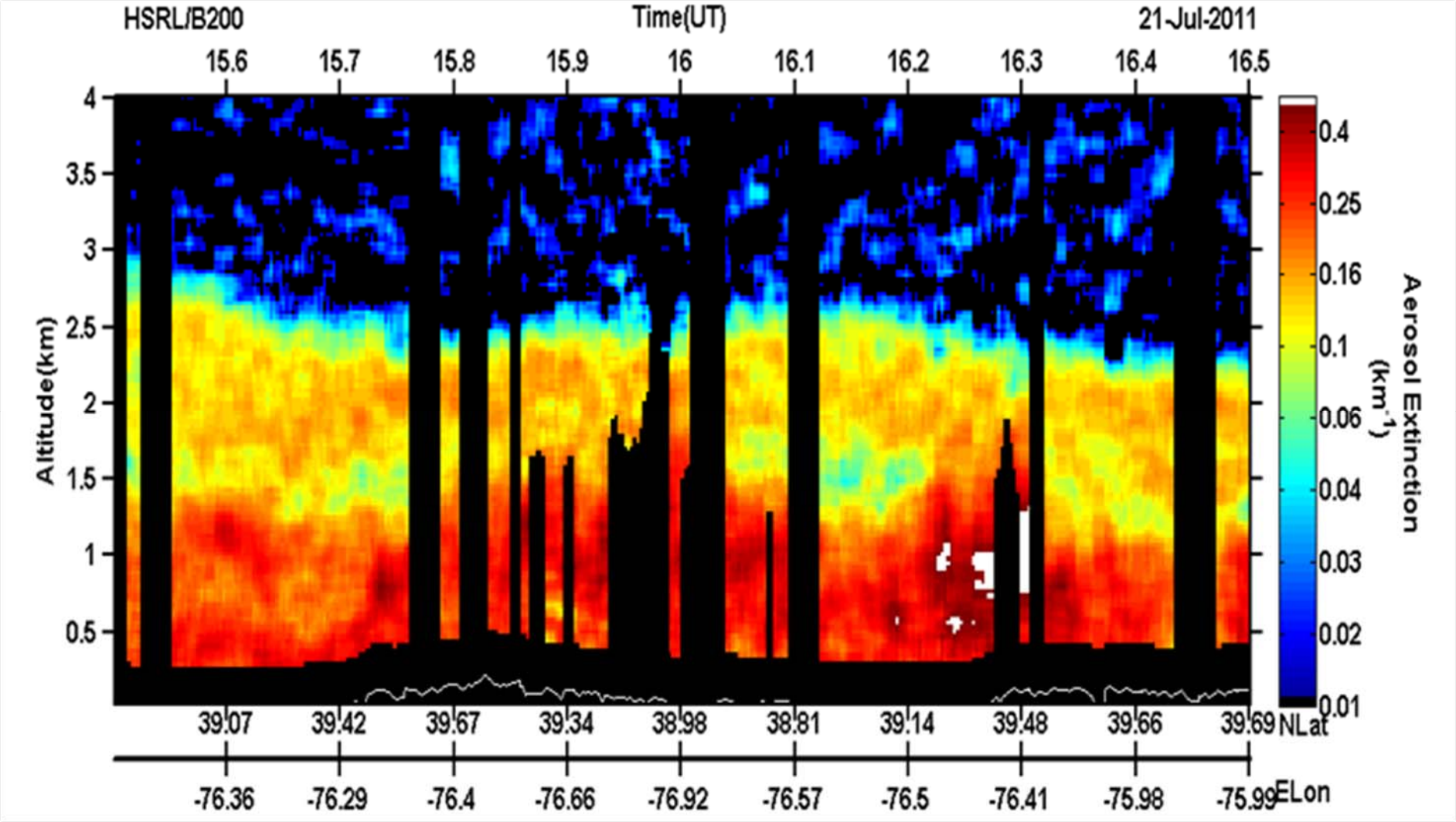

Temp. and Potential Temp. over Harford Cnty Airport, MD
21 July 2011 ~14:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
15
20
25
30
35
40
45
50
T (°C) and Θ (°C)

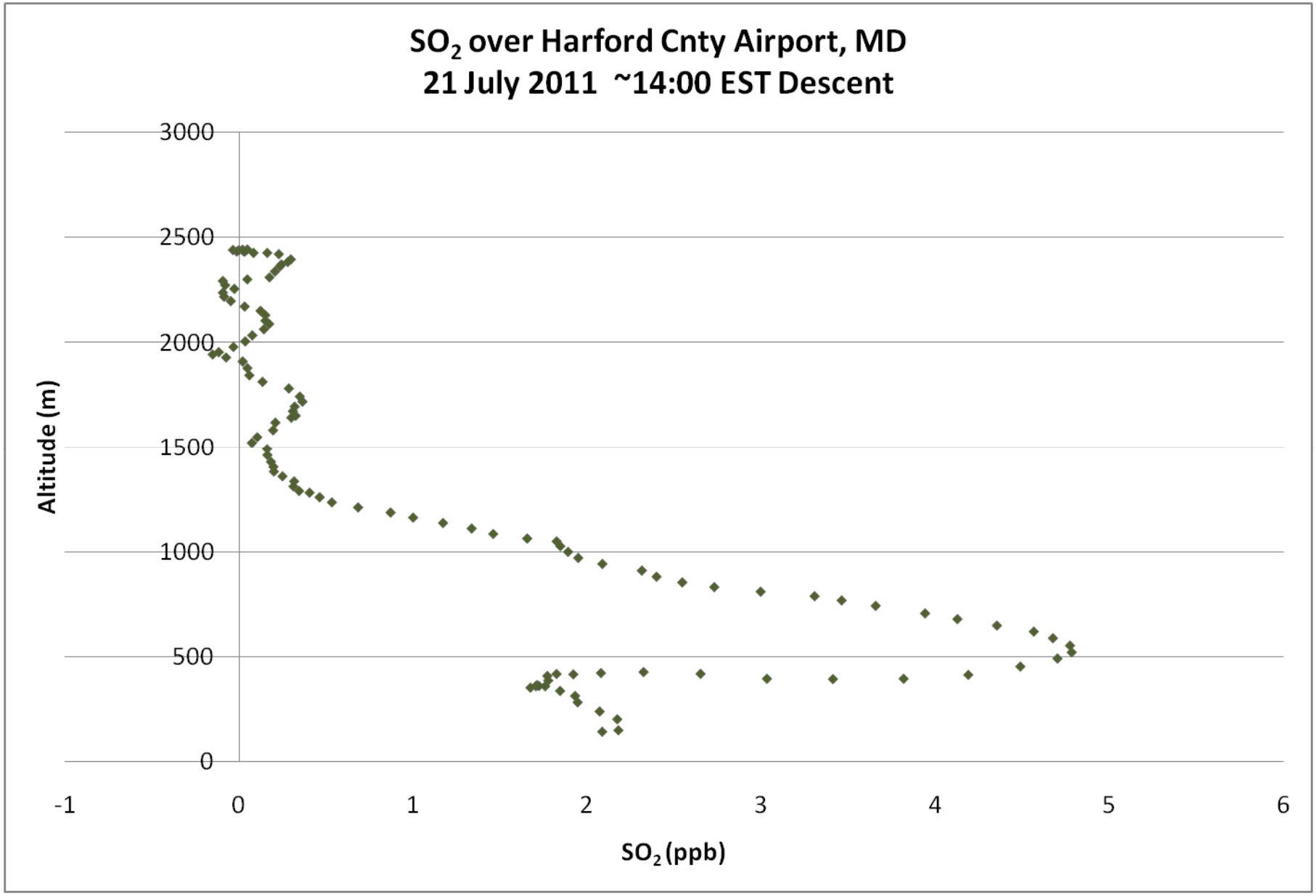

Carbon Monoxide over Harford Cnty Airport, MD
21 July 2011 ~14:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
20
70
120
170
220
270
320
CO (ppb)

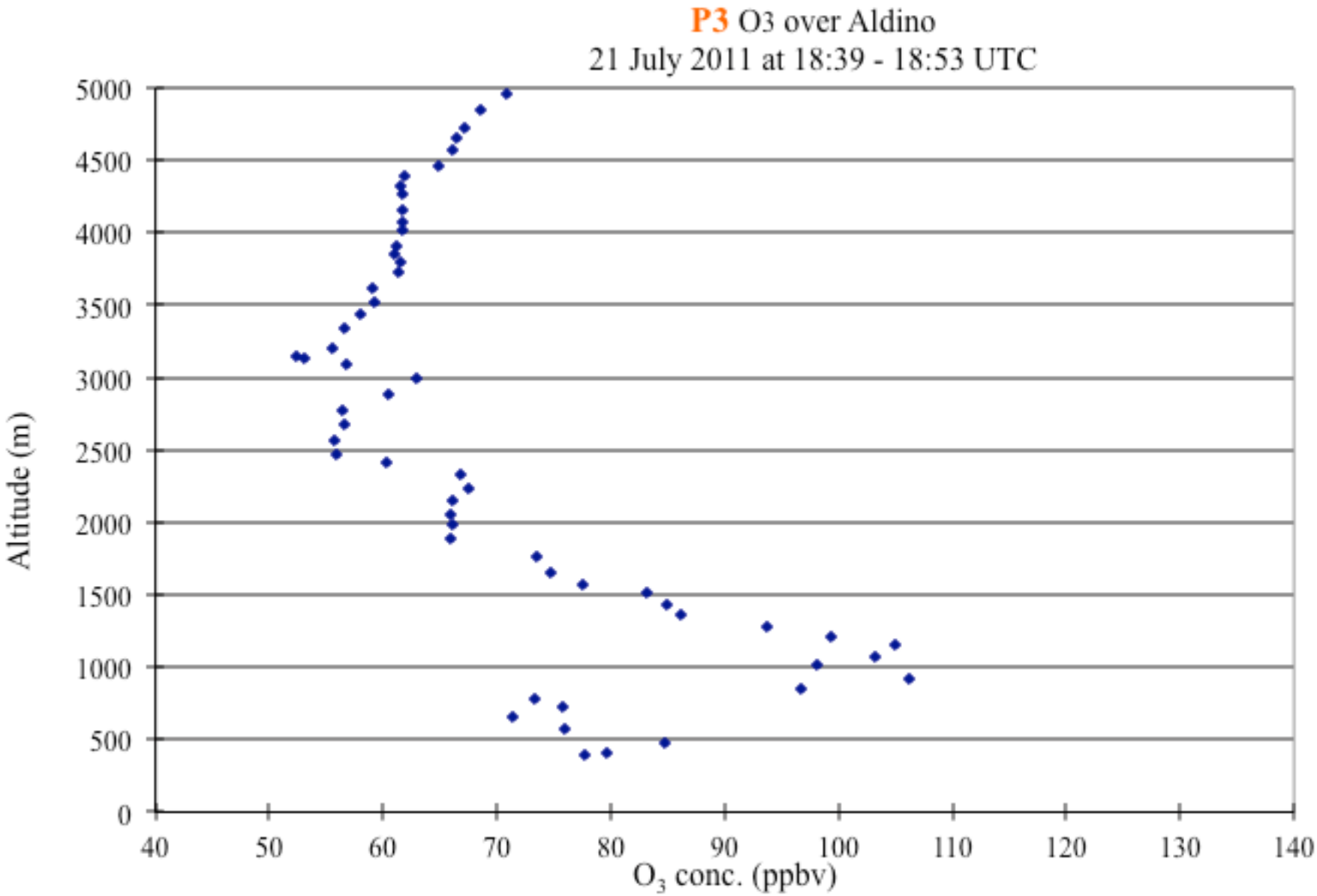

NO2 over Harford Cnty Airport, MD
21 July 2011 ~14:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
0
0.5
1
1.5
2
2.5
3
NO2 (ppb)

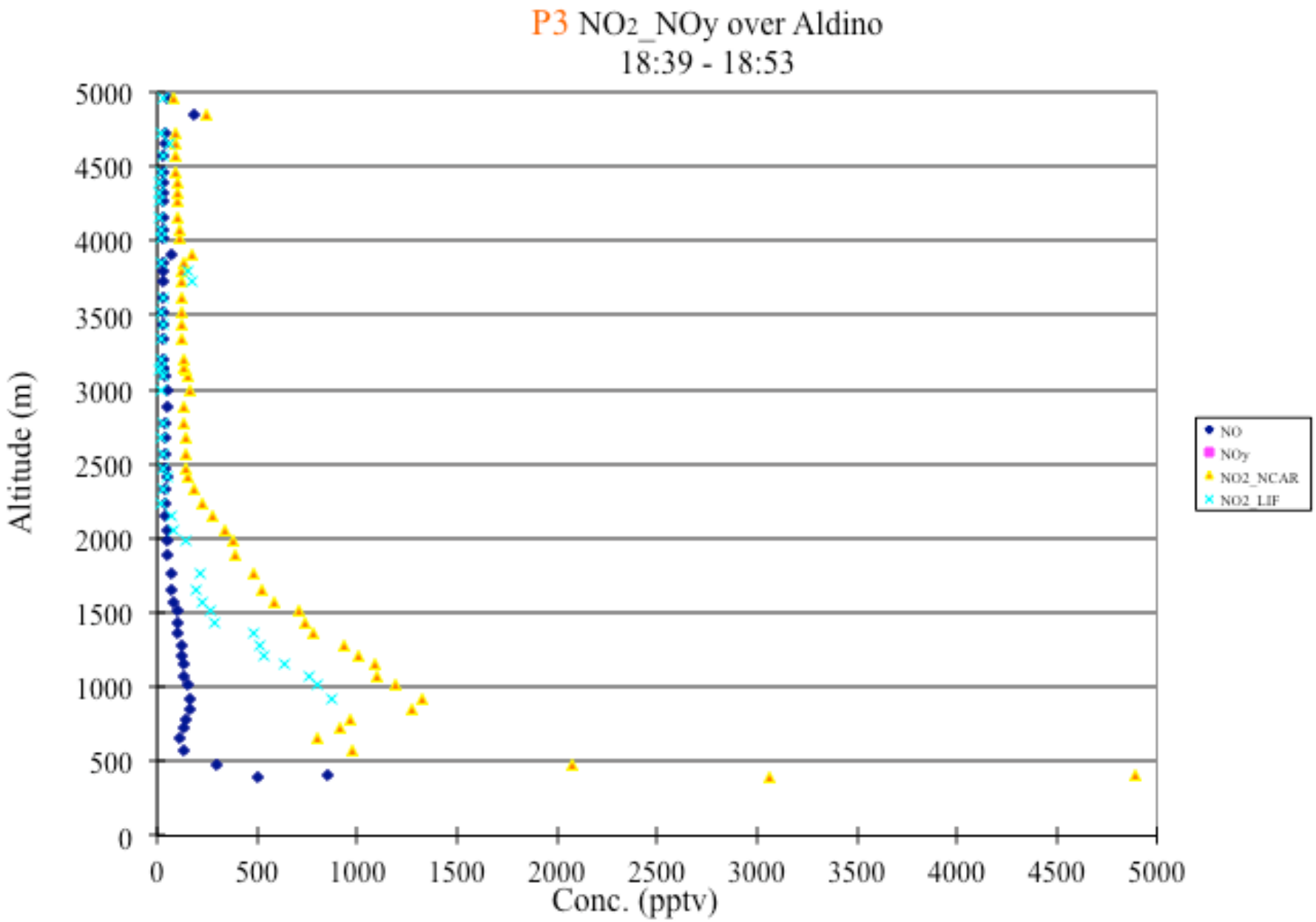

Bsp over Harford Cnty, MD
21 July 2011 ~14:00 EST Descent
3000
2500
2000
1500
1000
500
0
Altitude (m)
PM2.5 ~ 40 μg m-3
0.00E+00
5.00E-05
1.00E-04
1.50E-04
2.00E-04
2.50E-04
Scattering coef (700, 550, 450 nm) 1/m

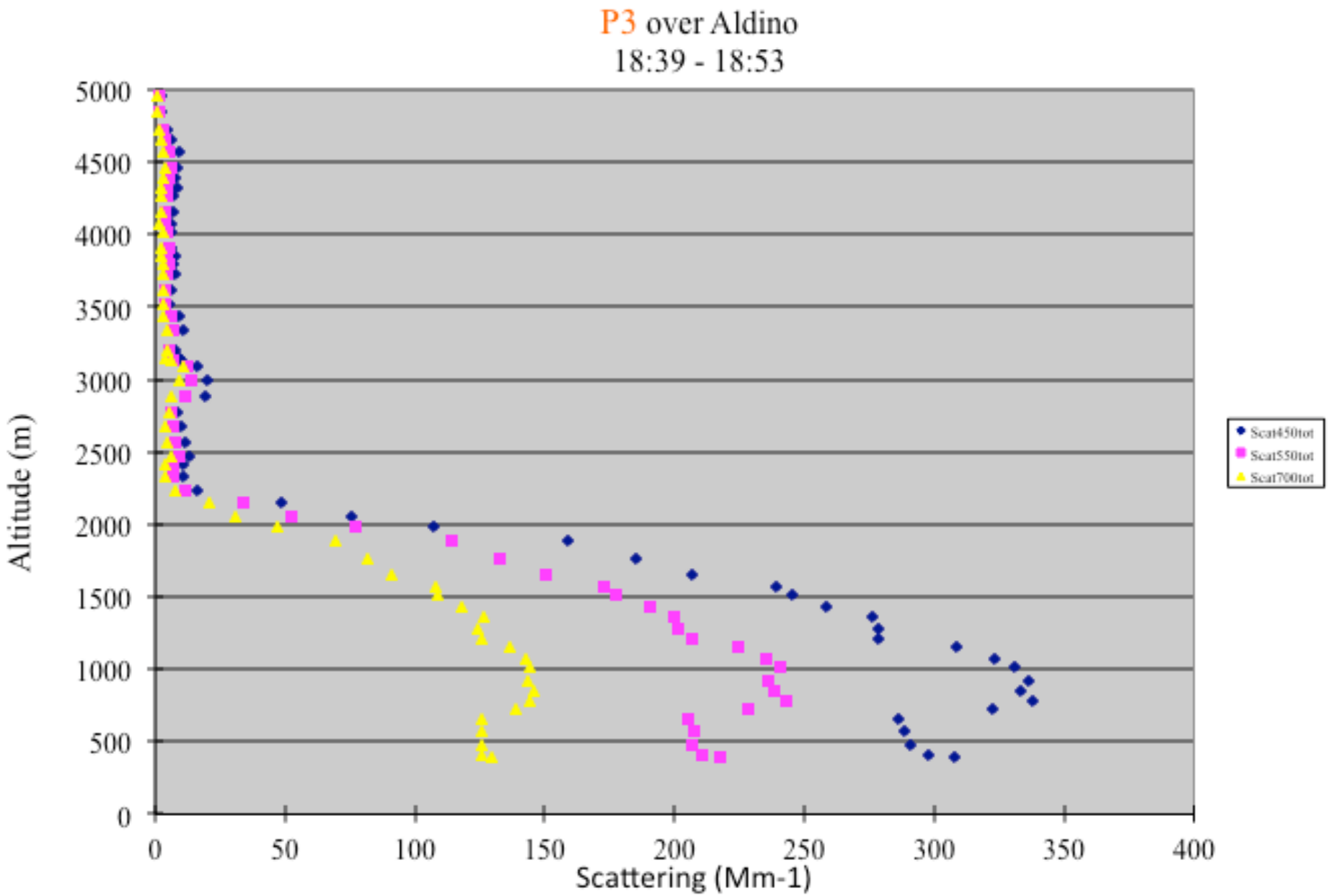
From Rich Ferrare

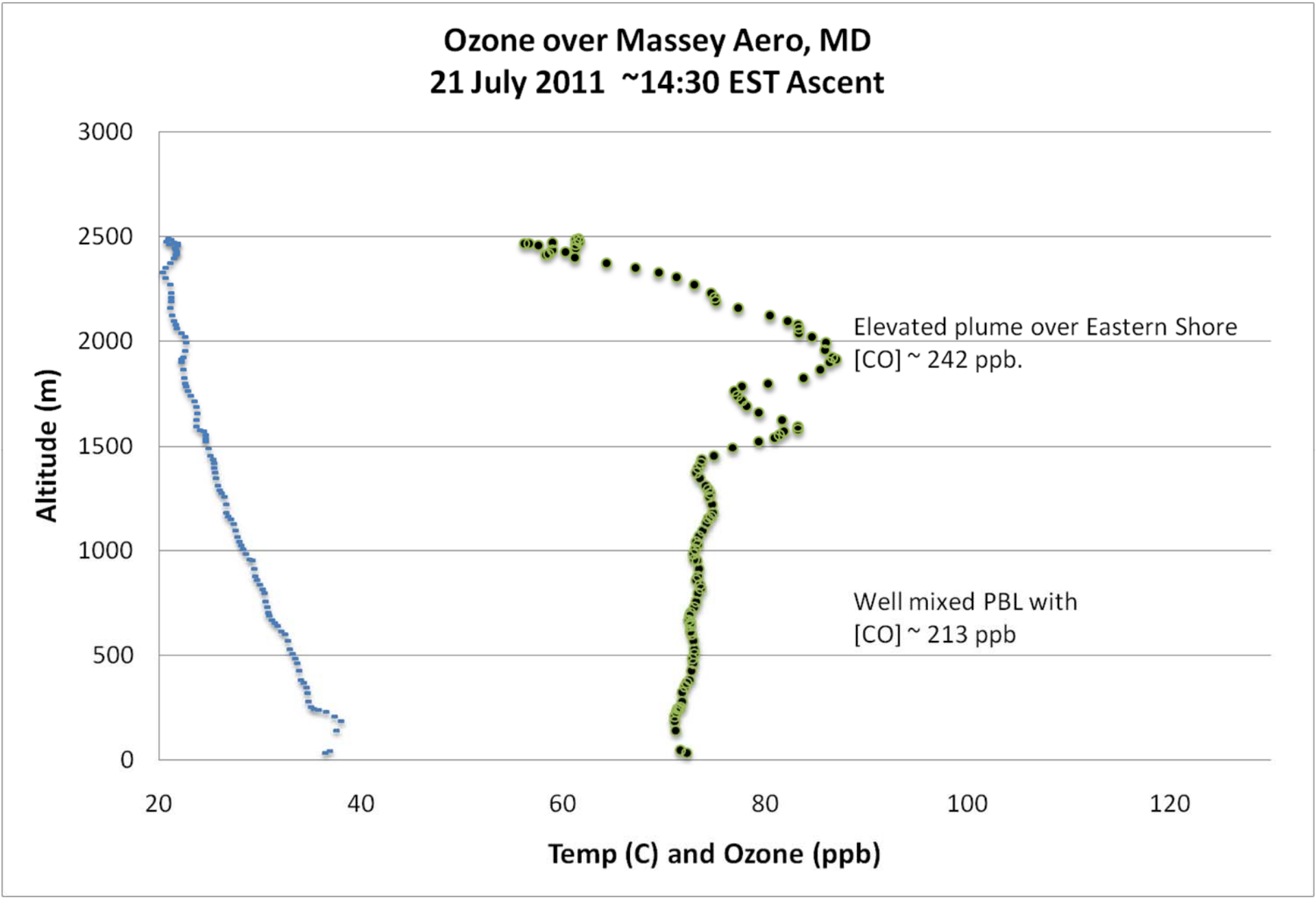


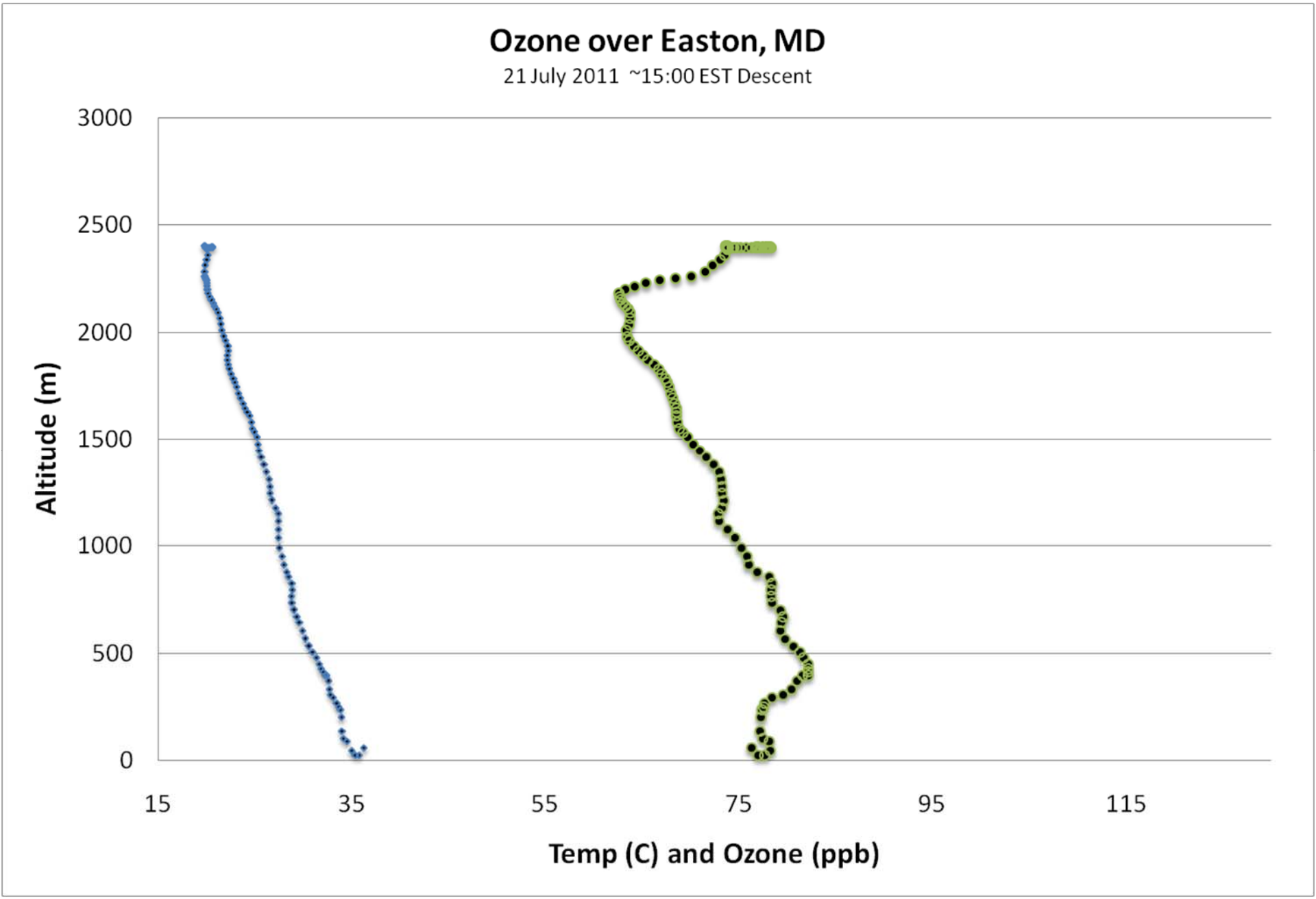

SO2 over Harford Cnty Airport, MD
21 July 2011 ~14:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
-1
0
1
2
3
4
5
6
SO2 (ppb)

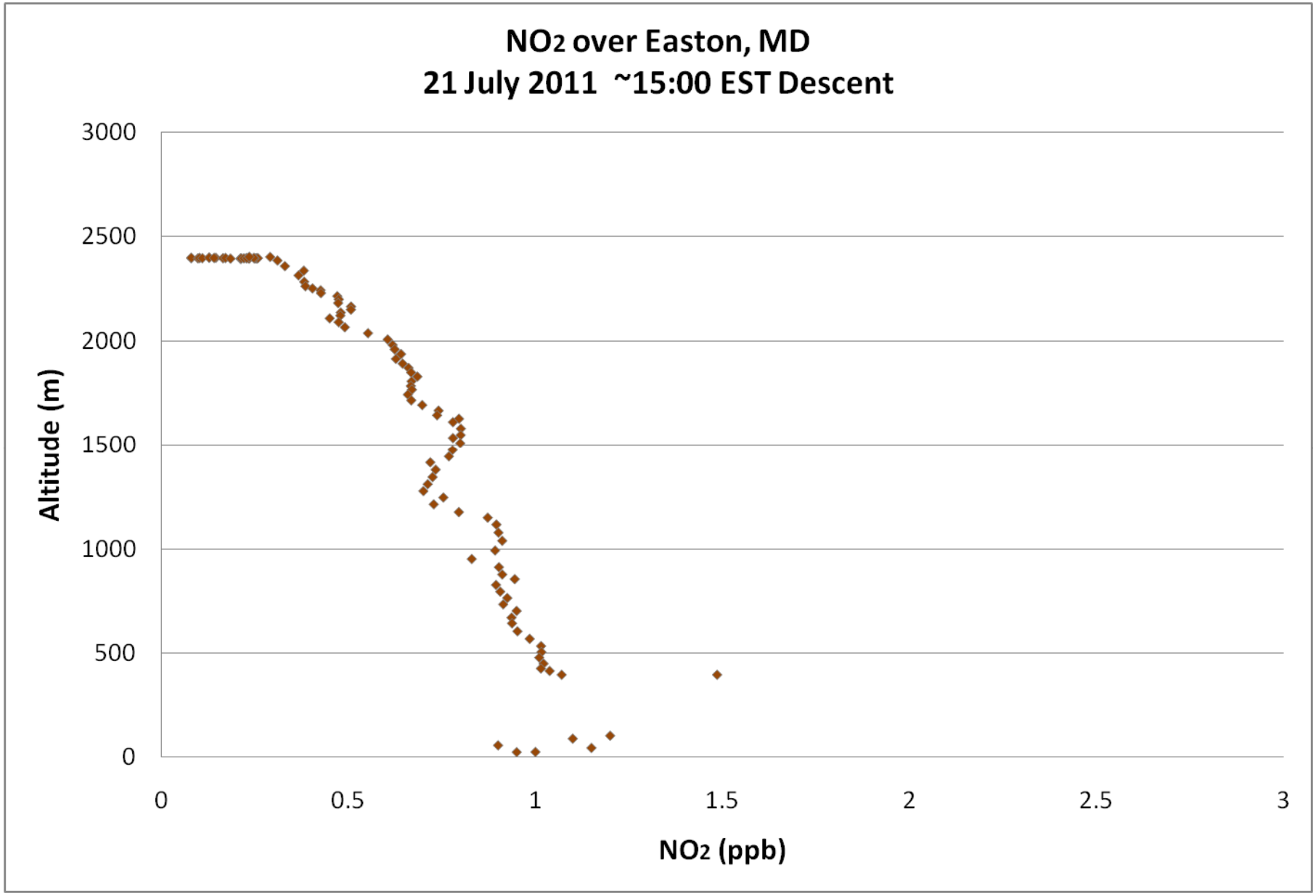

P3 O3 over Aldino
21 July 2011 at 18:39 - 18:53 UTC
Altitude (m)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
40
50
60
70
80
90
100
110
120
130
140
O3 conc. (ppbv)

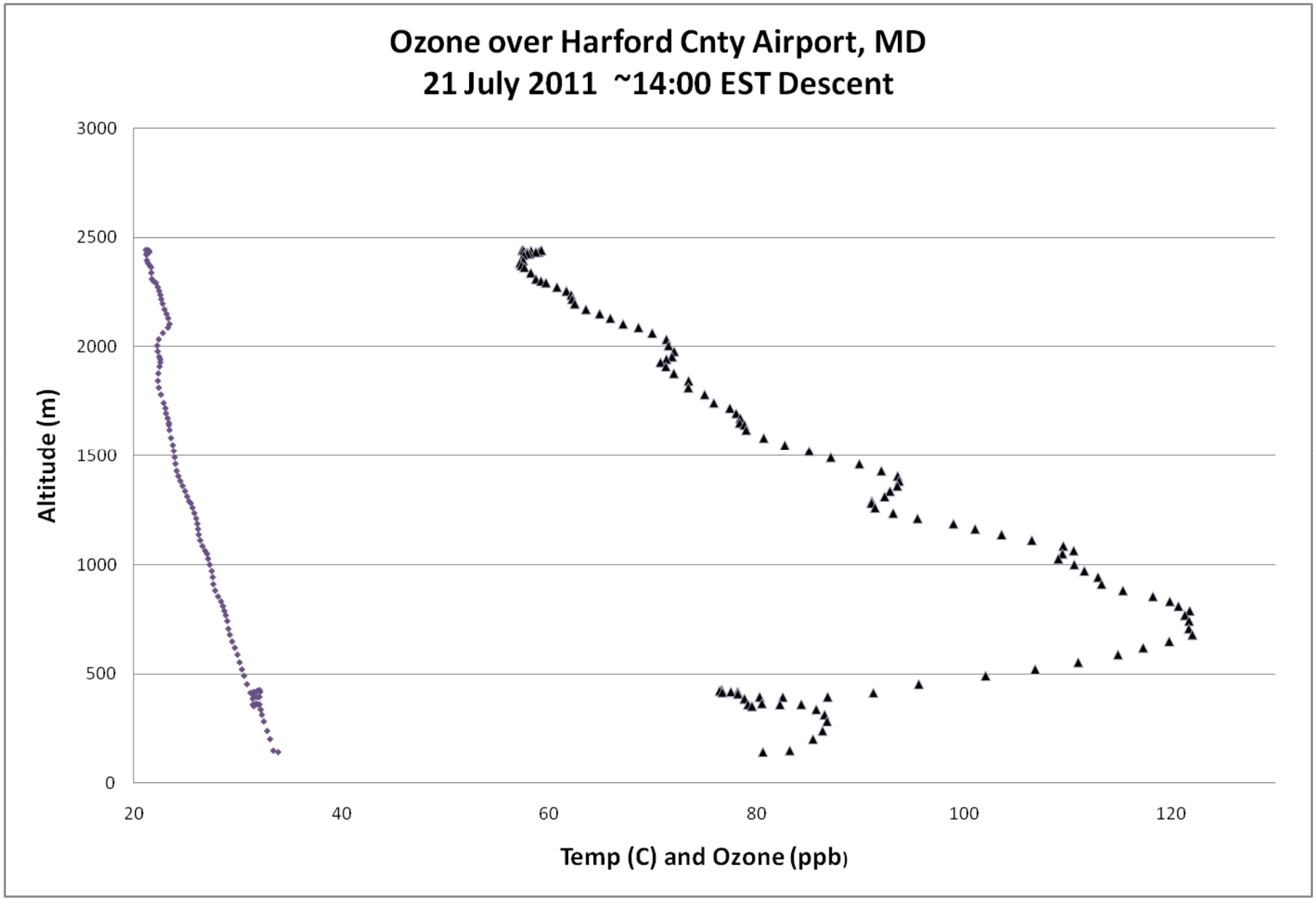

P3 NO2_NOy over Aldino
18:39 - 18:53
Altitude (m)
Conc. (pptv)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
NO
NOy
NO2_NCAR
NO2_LIF


P3 over Aldino
18:39 - 18:53
Altitude (m)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350
400
Scattering (Mm-1)
Scat450tot
Scat550tot
Scat700tot

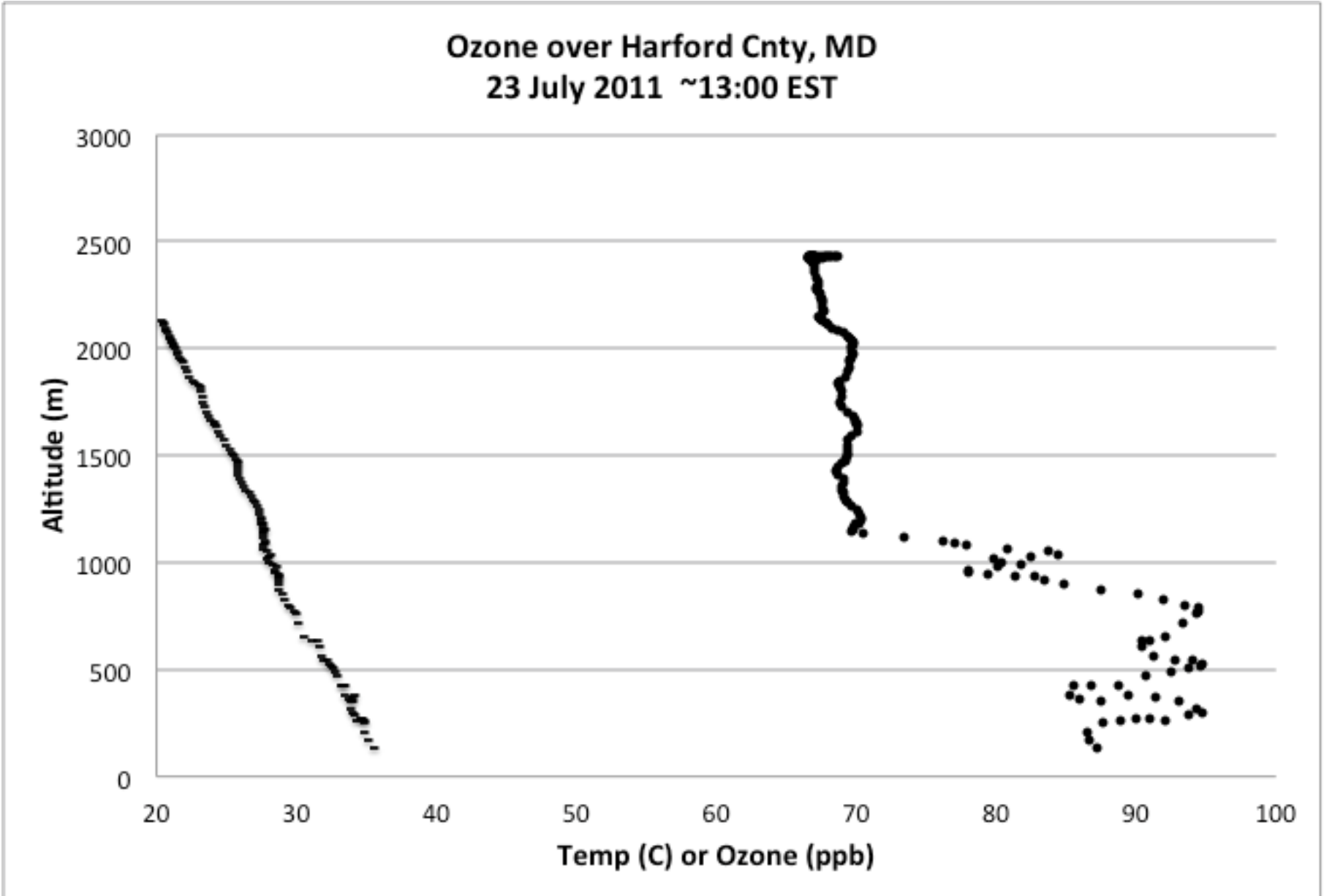

Ozone over Massey Aero, MD
21 July 2011 ~14:30 EST Ascent
Altitude (m)
3000
2500
2000
1500
1000
500
0
20
40
60
80
100
120
Temp (C) and Ozone (ppb)
Elevated plume over Eastern Shore
[CO] ~ 242 ppb.
Well mixed PBL with
[CO] ~ 213 ppb


Ozone over Easton, MD
21 July 2011 ~15:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
15
35
55
75
95
115
Temp (C) and Ozone (ppb)


NO2 over Easton, MD
21 July 2011 ~15:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
0
0.5
1
1.5
2
2.5
3
NO2 (ppb)


Ozone over Harford Cnty Airport, MD
21 July 2011 ~14:00 EST Descent
Altitude (m)
3000
2500
2000
1500
1000
500
0
20
40
60
80
100
120
Temp (C) and Ozone (ppb)

23 July 2011, Ozone has moved down.



Conclusions:

1. This was an epic 5-6 day episode.

2. The pollution layer was deep with truly clean air first seen above 2000 m altitude.

3. Highest B_{sp} and concentrations of O_3, CO, NO_2, and SO_2, were found ~750 m over Harford County Airport, near Aldino, MD; high O_3 was measured over Edgewood as well.

4. At these sites NE of Baltimore, the PBL (0-2 km) was relative stable and the pollution layer was disconnected from the surface. Possible role of Bay breeze.

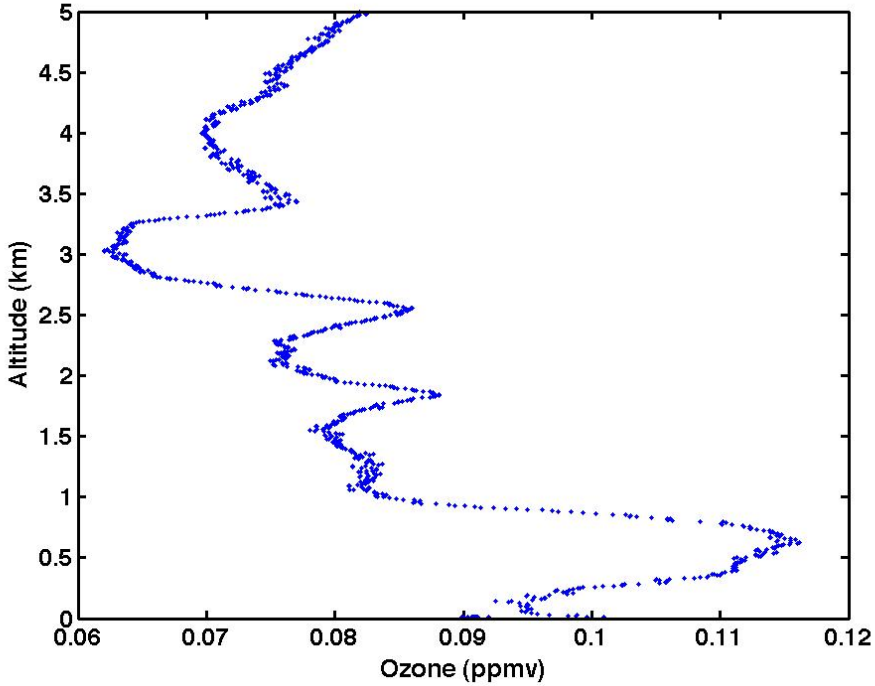
5.The ratios of CO, NO_2, and SO_2 indicate an elevated reservoir over Harford County with NOx from vehicles as well as power plants.

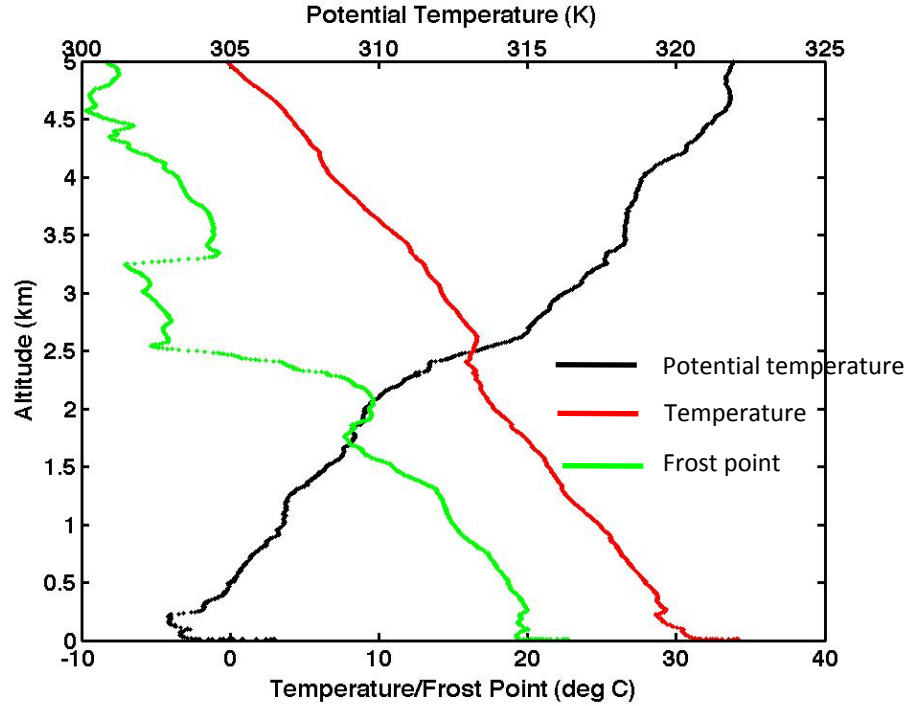
The End

Fear the Turtle!

Potential Papers

- "A Cavity ringdown NO2 detector: Measurements from aircraft" Brent, Arkinson, et al., Rev. Sci. Inst., or Atmos. Environ.,
- "Evaluation of a Luminol-based NO2 sonde" Sluis et al., RSI or ACP needs comparison of NO2 and NOy for PAN.
- "The role of an elevated reservoir in a six-day pollution event over the eastern US." Lead: Stehr, Dickerson, ?, He, Thompson, Martins, Pickering, et al.
- "Comparison of tropospheric NO2 columns observed in situ and from surface-and space-based remote sensing" Lead? Kai, Krotkov, Tzortziou, Hembeck, Salawitch, Pickering, et al., Includes aircraft, ship, PANDORA, OMI, SCIA
- "Urban/Rural NO2 ratios: comparison of CMAQ and Observations" Canty, Salawitch, Brent, et al. JGR or ACP.
- "AOD observed by sun photometers, in situ aircraft, and space-based instruments" Lead? Stehr, Shobha, Levy, et al. JGR or ACP
- "Too Hot to make Ozone: Extreme heat can reduce isoprene emissions and inhibit ozone production" Lead? Fried (H2CO), Allen, Vinnikov, et al.
- “The impact of the Chesapeake Bay and Boundary layer dynamics and pollutant concentrations during smog episodes” Goldberg, Marufu, Thorn, Loughner, et al. We see no evidence for O3 concentrating in the lowest 100 m.





EDGEWOOD
Ozonesondes

2011-07-21 16:31

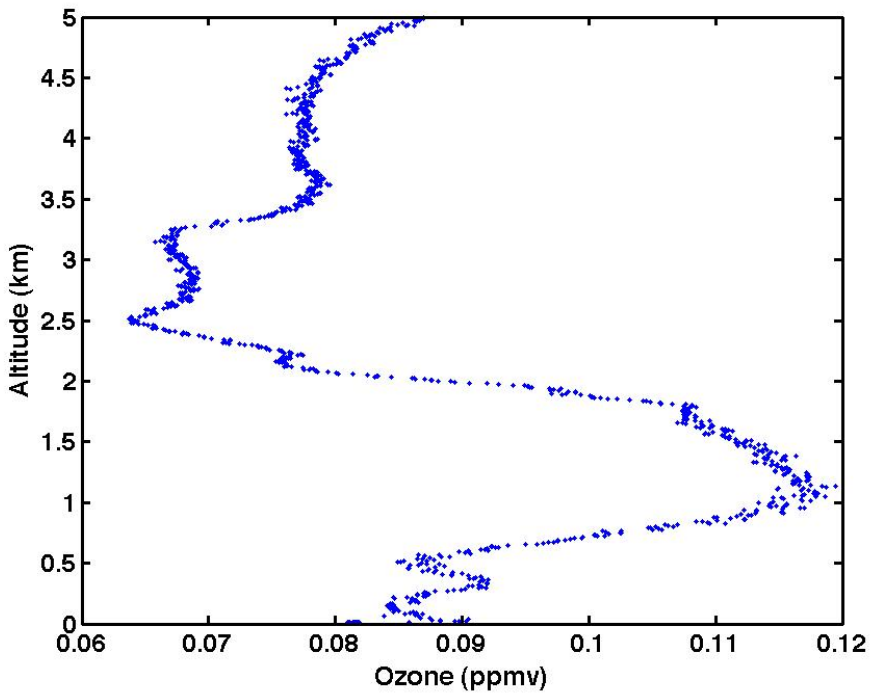
Precursors from urban flow all day produced ozone at the top of the “un-mixed layer”. Persistent subsidence (and perhaps a little maritime influence) prohibited mixing to the ground. We remained code-green all day

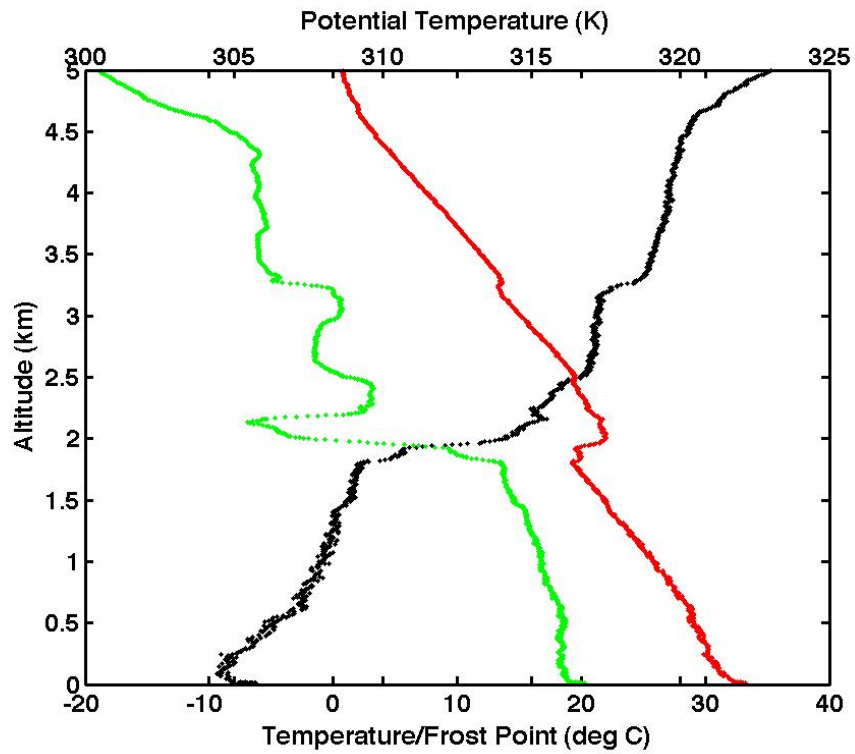
EDGEWOOD
Ozonesondes

2011-07-21 20:50
15:50 EST

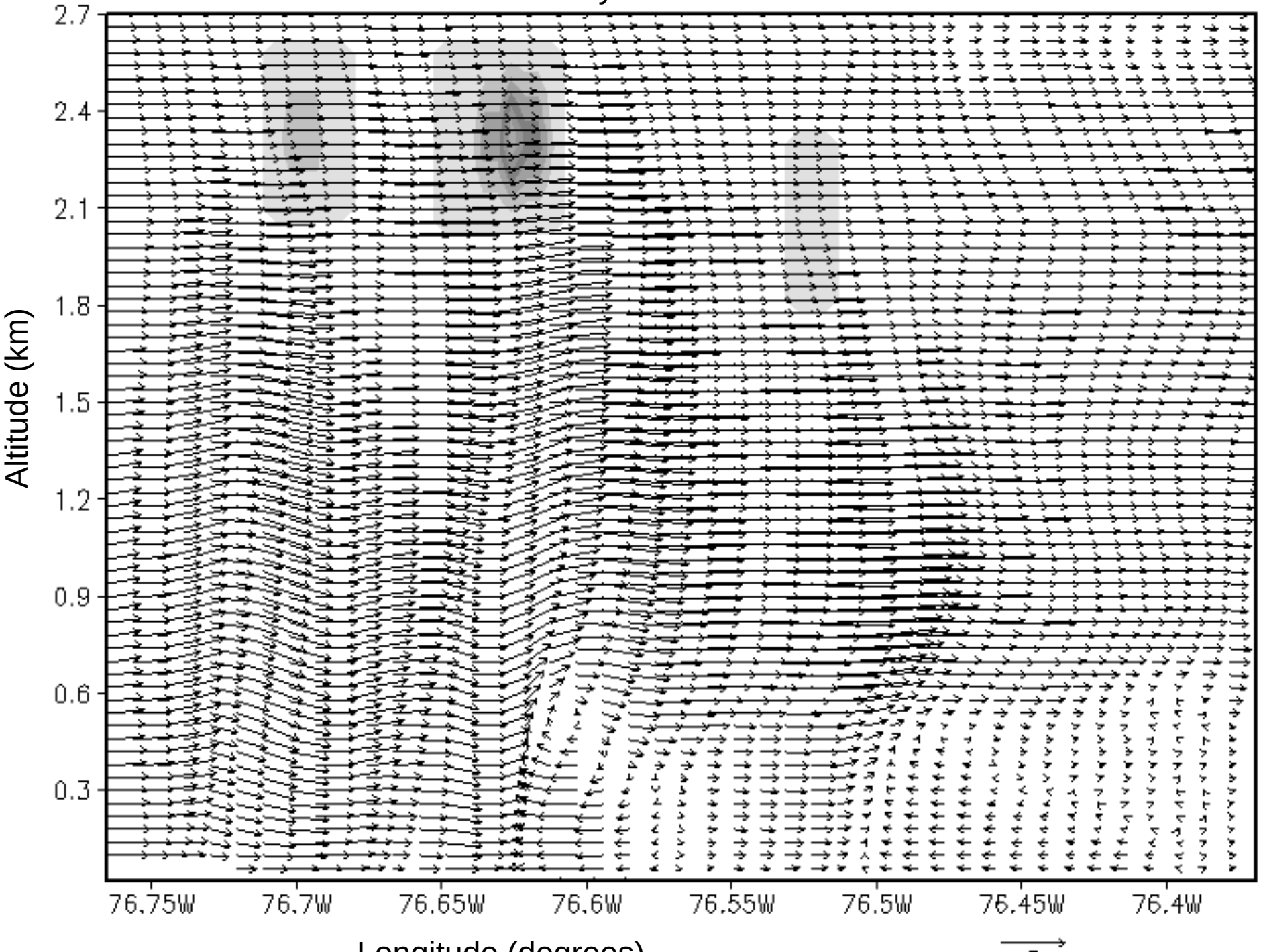
Potential temperature
Temperature
Frost point

On days like this, there should be a huge disconnect between aircraft and surface

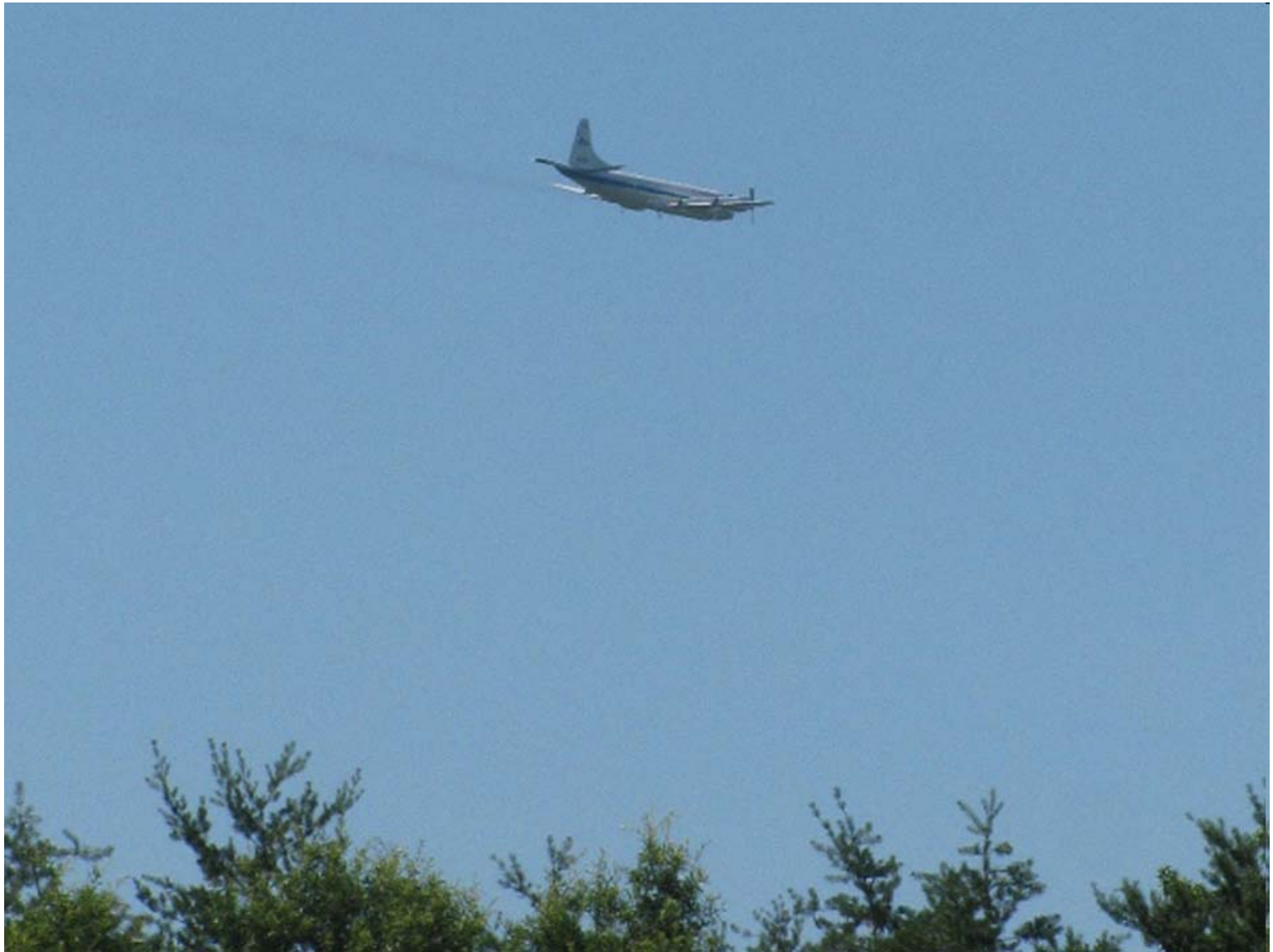




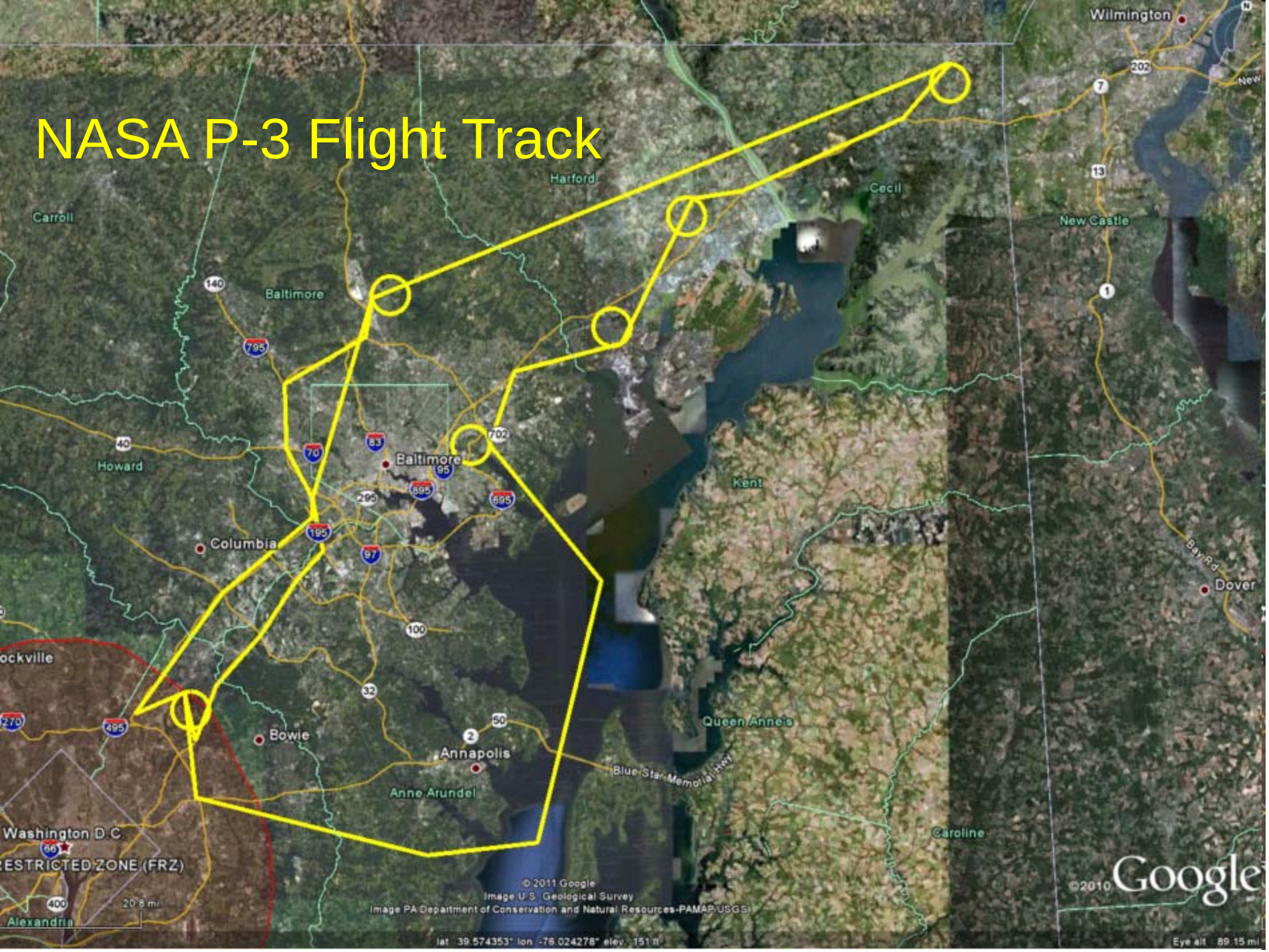
WRF-Urban multilayer model results



NASA P-3 During DISCOVER-AQ



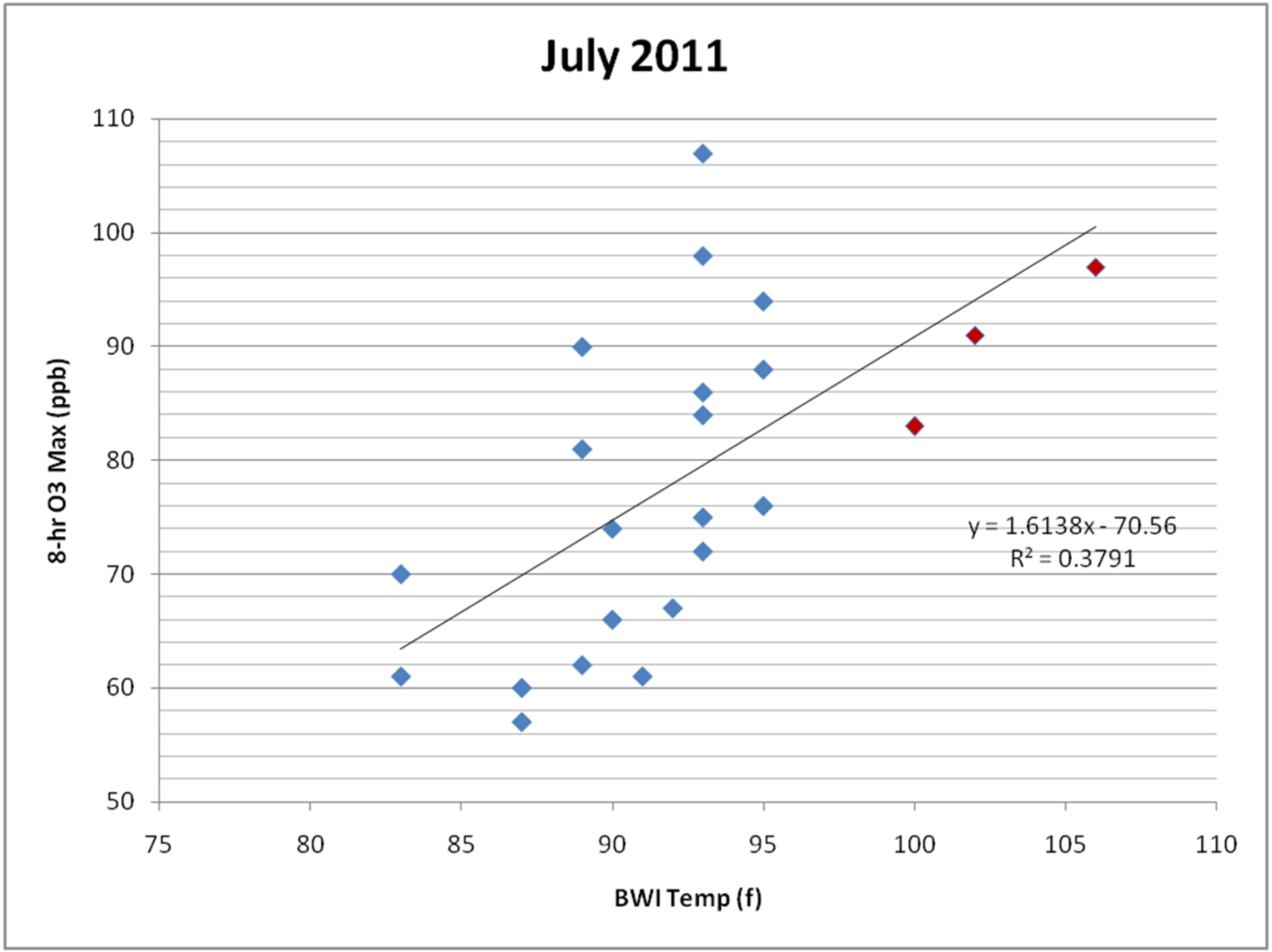
NASA P-3 Flight Track



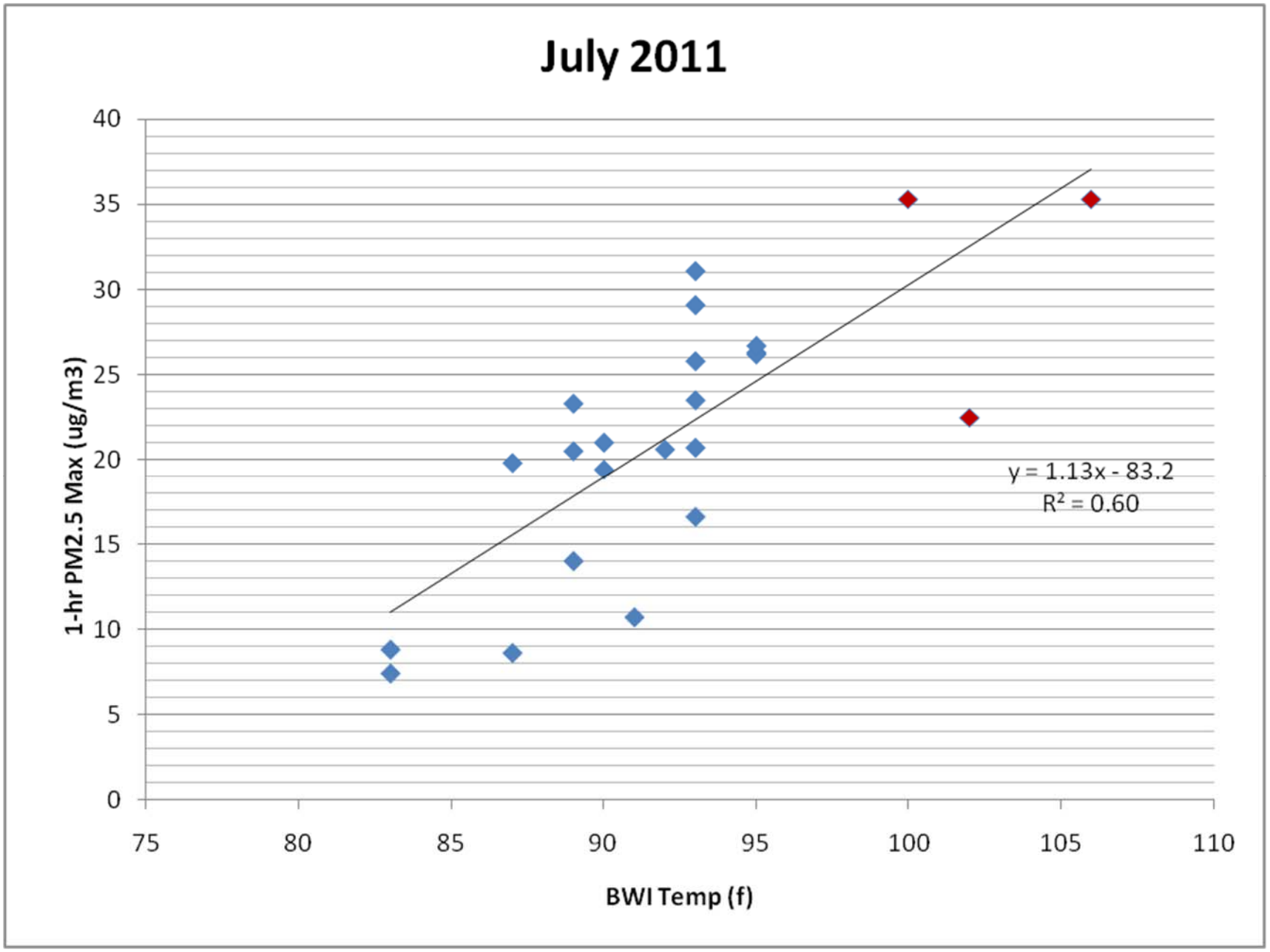
MARYLAND'S OZONE MAX 8-HOUR AVERAGE IN 2011

(Last updated 07/25/2011 Raw data, subject to change upon further verification. Design Values are 2010, preliminary and subject to change)

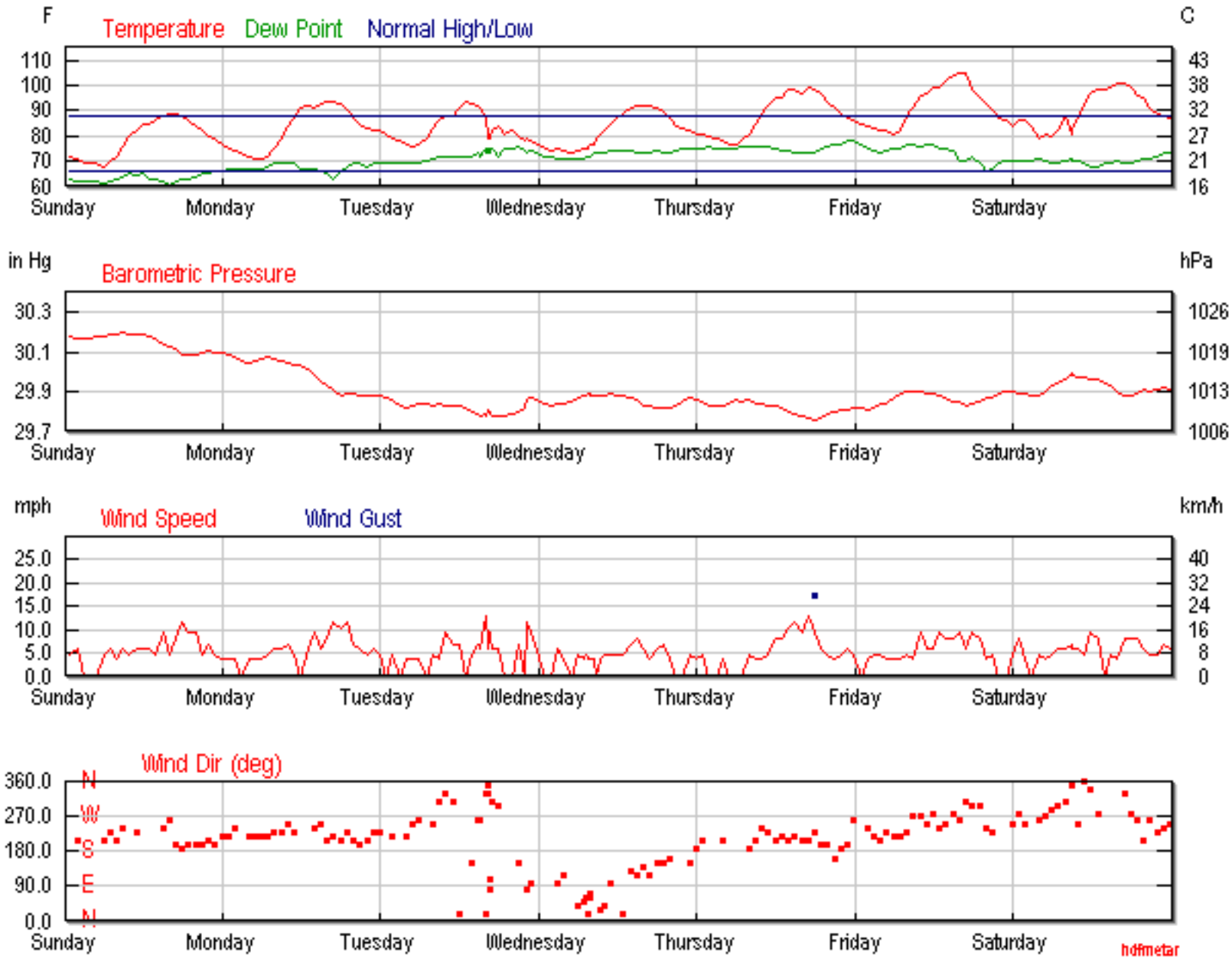
	Non-attainment Area (Group Number)																	Daily peak 8-hour ozone concentration (ppb)	Daily number of sites with an occurrence
	1							2						3	4	5	6		
	Aldino	Davidsonville	Edgewood	Essex	Furley ES, Baltimore	Padonia	So. Carroll	Calvert Cnty.	PG County Equest. Ctr.	Frederick County	HU-Beltsville	Rockville	So. Maryland	Fair Hill	Millington	Hagerstown	Piney Run		
2010 Design Value	78	79	89	78	67	77	76	77	77	75	78	74	75	80	75	72	71		
05/26/2011						76												76	1
05/30/2011								76										76	1
05/31/2011			80	79	77					77	83				76	76		83	7
06/01/2011			79											92	81			92	3
06/07/2011			89	83		76					76			89	77			89	6
06/08/2011		88	114	101	87	83	79	87	95	82	82	81	77	94	91	76		114	15
06/09/2011		87	106	83	76	82	77	93	86	76	80		86	96	100			106	13
06/10/2011		94	87	81	77	86		92	92		91		98	76	78			98	11
06/18/2011									76						76			76	2
06/28/2011									76									76	1
07/01/2011	80	80	81						80				79					81	5
07/02/2011	98	78	107	87	83	92	85	78	81	85	88	88	79			84		107	14
07/03/2011	84		78															84	2
07/05/2011		78	98	91	82				85									98	5
07/06/2011	90																76	90	2
07/07/2011	85	79	87	85	84	88	79		83	76	94	82			78			94	12
07/18/2011	88	81	82						80					86				88	5
07/19/2011		76																76	1
07/20/2011	77					86	80			78	80	85						86	6
07/21/2011	83					76					78							83	3
07/22/2011	85	92	97	84					90					88	92			97	7
07/23/2011	84		91	84					76				85					91	5
Number of occurrence days																			
2011: 22	**10**	**10**	**14**	**10**	**7**	**9**	**5**	**5**	**12**	**6**	**9**	**4**	**6**	**7**	**9**	**3**	**1**		
2010: **43**																			

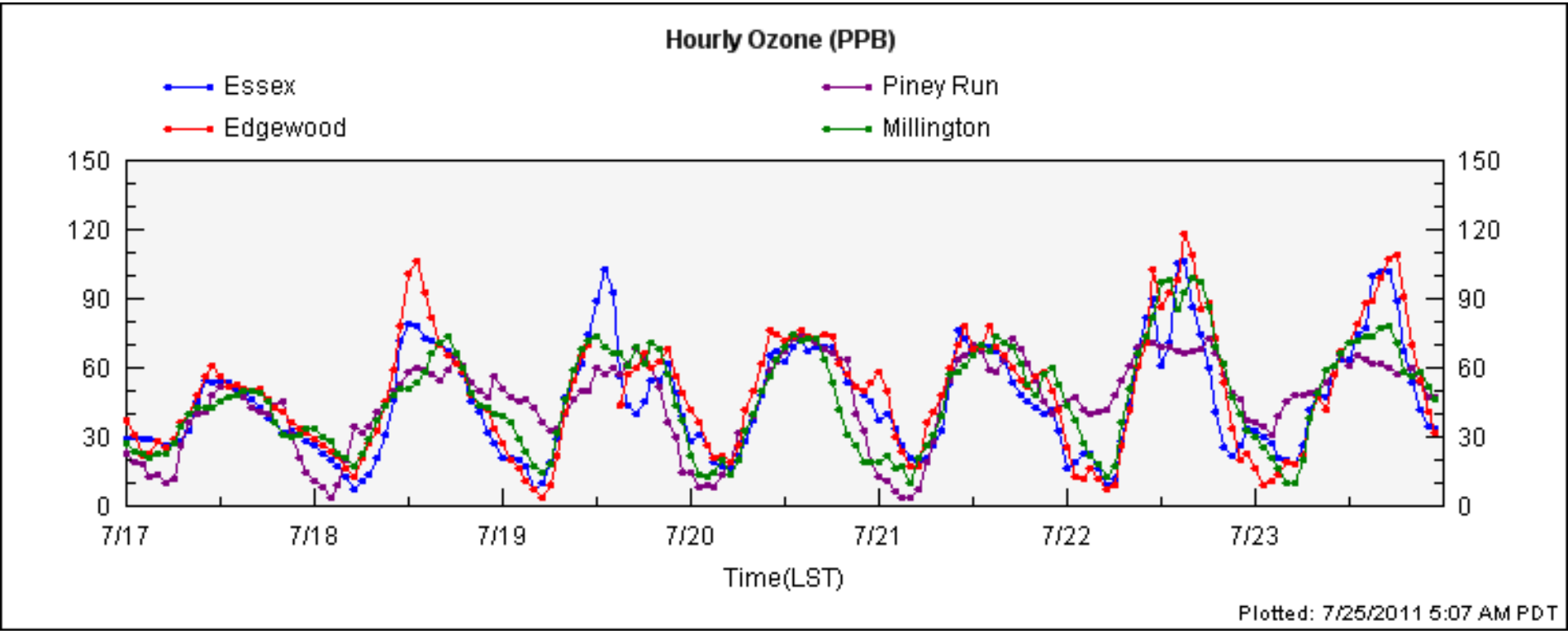


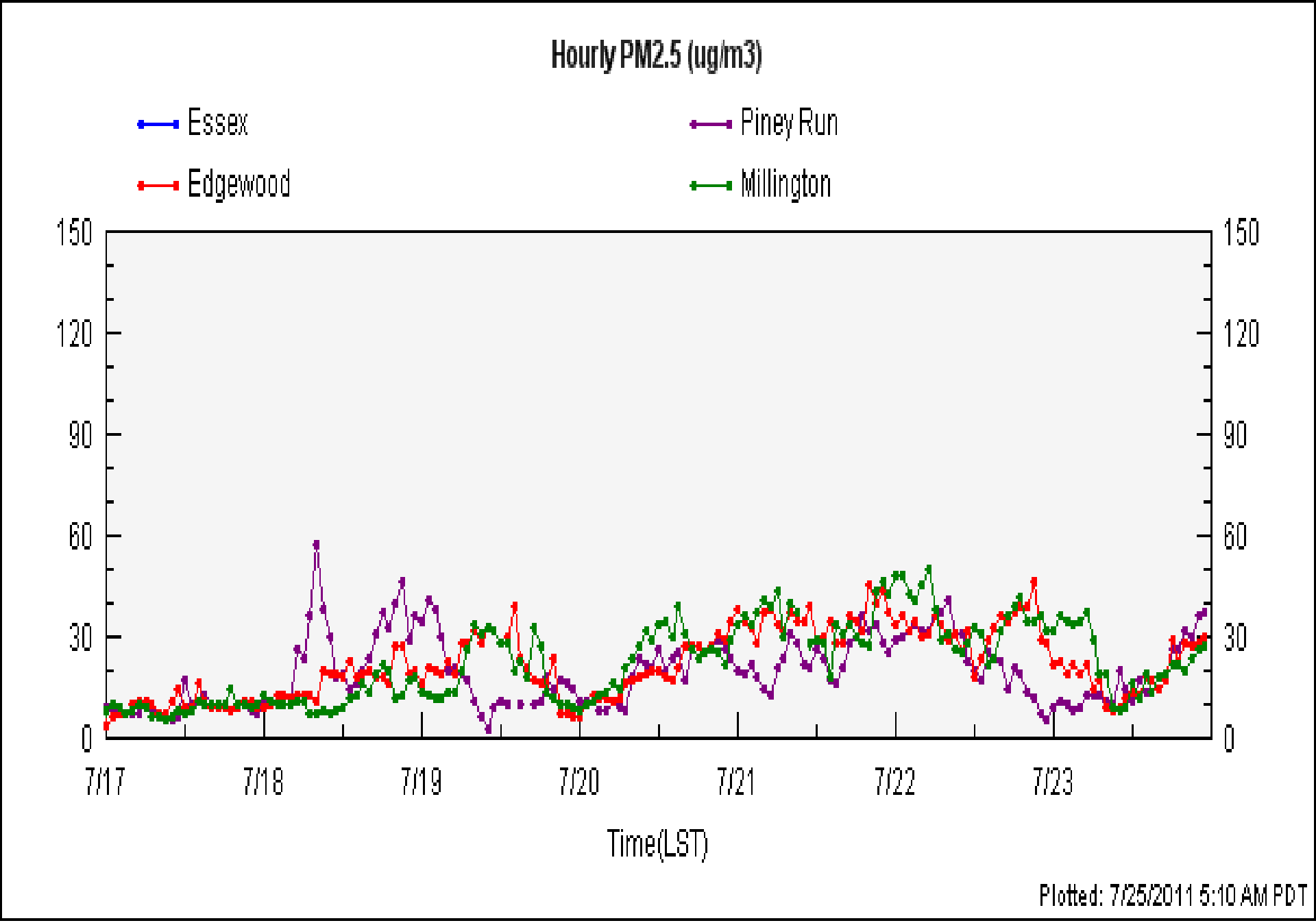
The days with T>100F have relatively low O_3.

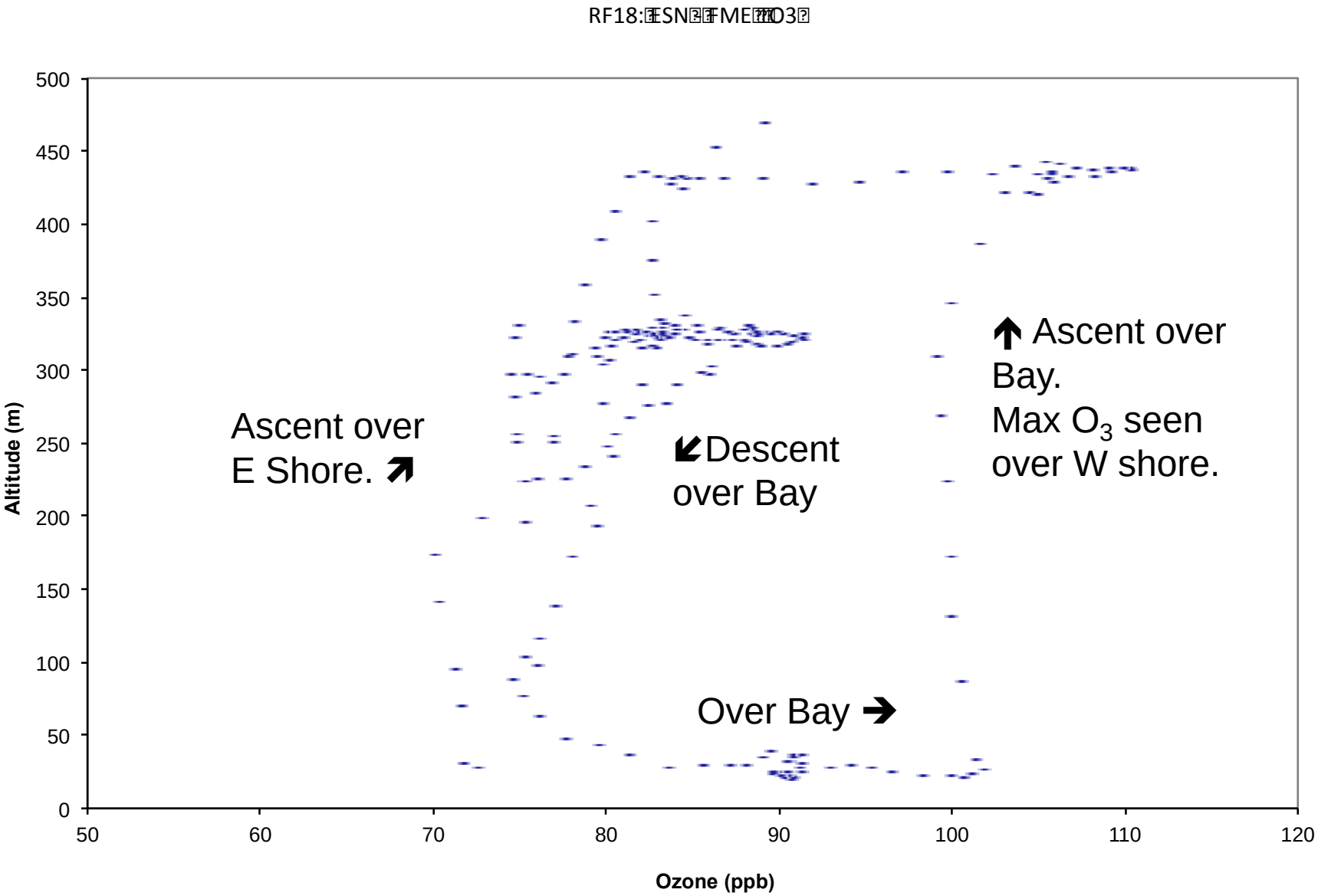

July 2011
1-hr PM2.5 Max (ug/m3)
40
35
30
25
20
15
10
5
0
75
80
85
90
95
100
105
110
BWI Temp (f)
y = 1.13x - 83.2
R² = 0.60

BWI Weather 17-23 July 2011




Hourly Ozone (PPB)
Essex
Piney Run
Edgewood
Millington
150
120
90
60
30
0
7/17
7/18
7/19
7/20
7/21
7/22
7/23
Time(LST)
Plotted: 7/25/2011 5:07 AM PDT


Hourly PM2.5 (ug/m3)
Essex
Piney Run
Edgewood
Millington
150
120
90
60
30
0
7/17
7/18
7/19
7/20
7/21
7/22
7/23
Time(LST)
Plotted: 7/25/2011 5:10 AM PDT


RF18:ESN FME O3
Altitude (m)
Ozone (ppb)
0
50
100
150
200
250
300
350
400
450
500
50
60
70
80
90
100
110
120
Ascent over E Shore.
Descent over Bay
Ascent over Bay.
Max O_3 seen over W shore.
Over Bay