DISCOVER-AQ WORKSHOP

14-16 FEB 2012

Millersville University
Location: Edgewood, MD

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Millersville University **A**tmospheric **B**oundary **L**ayer **(MABL)** Facility

MABL Components:

1) **Tethered balloon (met/chem/particles)**
2) Rawinsonde (GPS) System
3) **Micropulse LiDAR (MPL4)**
4) **MFAS Acoustic Sodar w/RASS**
5) **10-meter flux tower**
6) **Surface trace gases**
7) **Surface aerosol scattering**

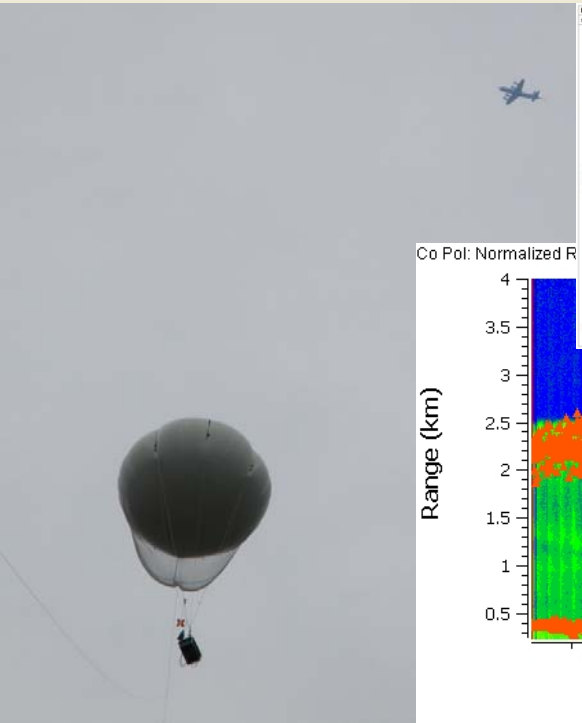
MABL was employed in DISCOVER-AQ to:

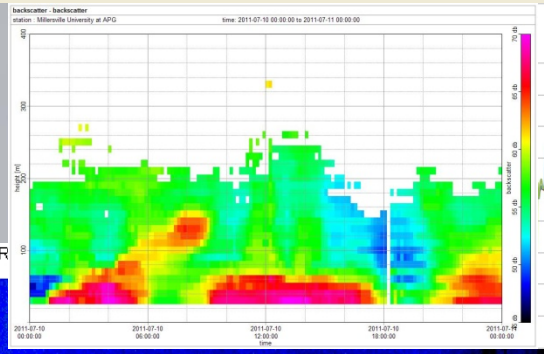
✓ **Determine variables T, p, Rh, wind velocity, O_3, NO, NO_X, and PM2.5 as a function of height and time**

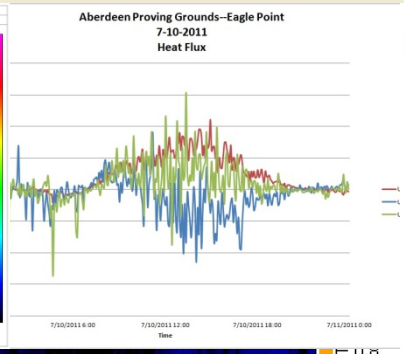
✓ **Provide detailed characterization of local and regional circulations, especially for those with high spatial and temporal variability**

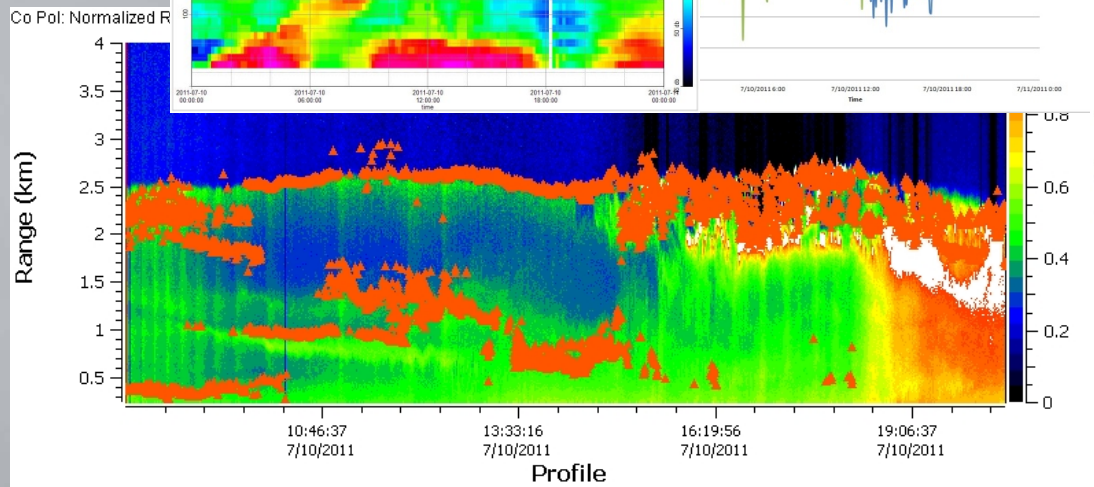
✓ **Connect the surface measurements to the lowest altitude flown by the NASA aircraft (our profiles extended to 700 meters; aircraft passes to 300 meters)**

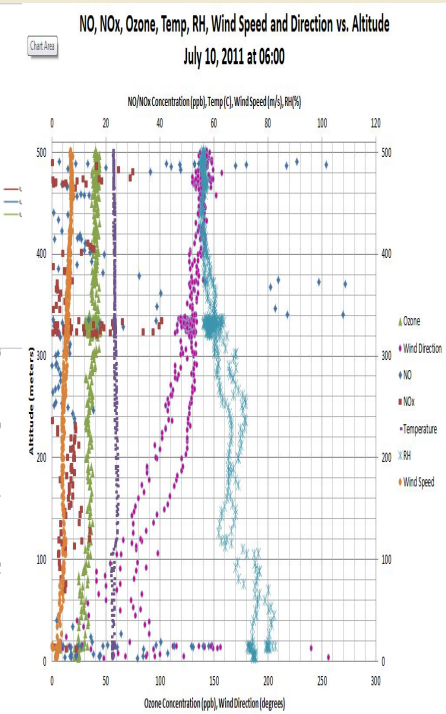
✓ **Capture characteristics of the ABL that would otherwise go undetected by both platforms**







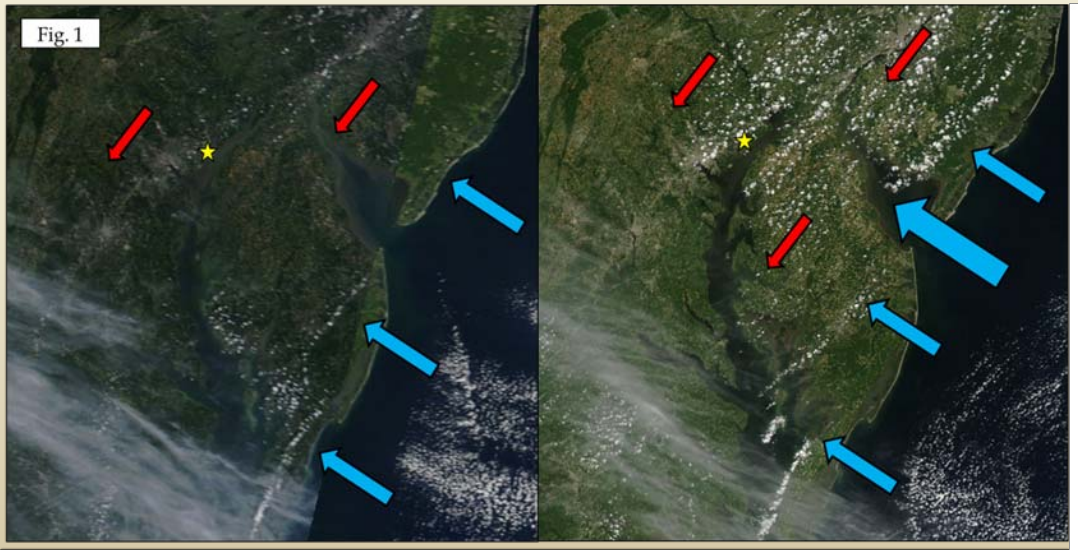




14 JULY 2011 Sea Breeze (Preconditions)

✓Weak early northeasterly synoptic-scale flow over the research area changing to southwesterly at noon; not conducive for elevated pollution

✓Clear changing to scattered sky conditions throughout the day; evidence of cloud streets (linear organization); good conditions for land/sea differential heating; good conditions for ozone production



Comparison of high resolution MODIS Terra (left, 15:00 UTC) and Aqua (right, 17:00 UTC) imagery of Sea and Bay breeze development over the Delmarva Peninsula and other regions of interest.

14 JULY 2011 (Sea Breeze)

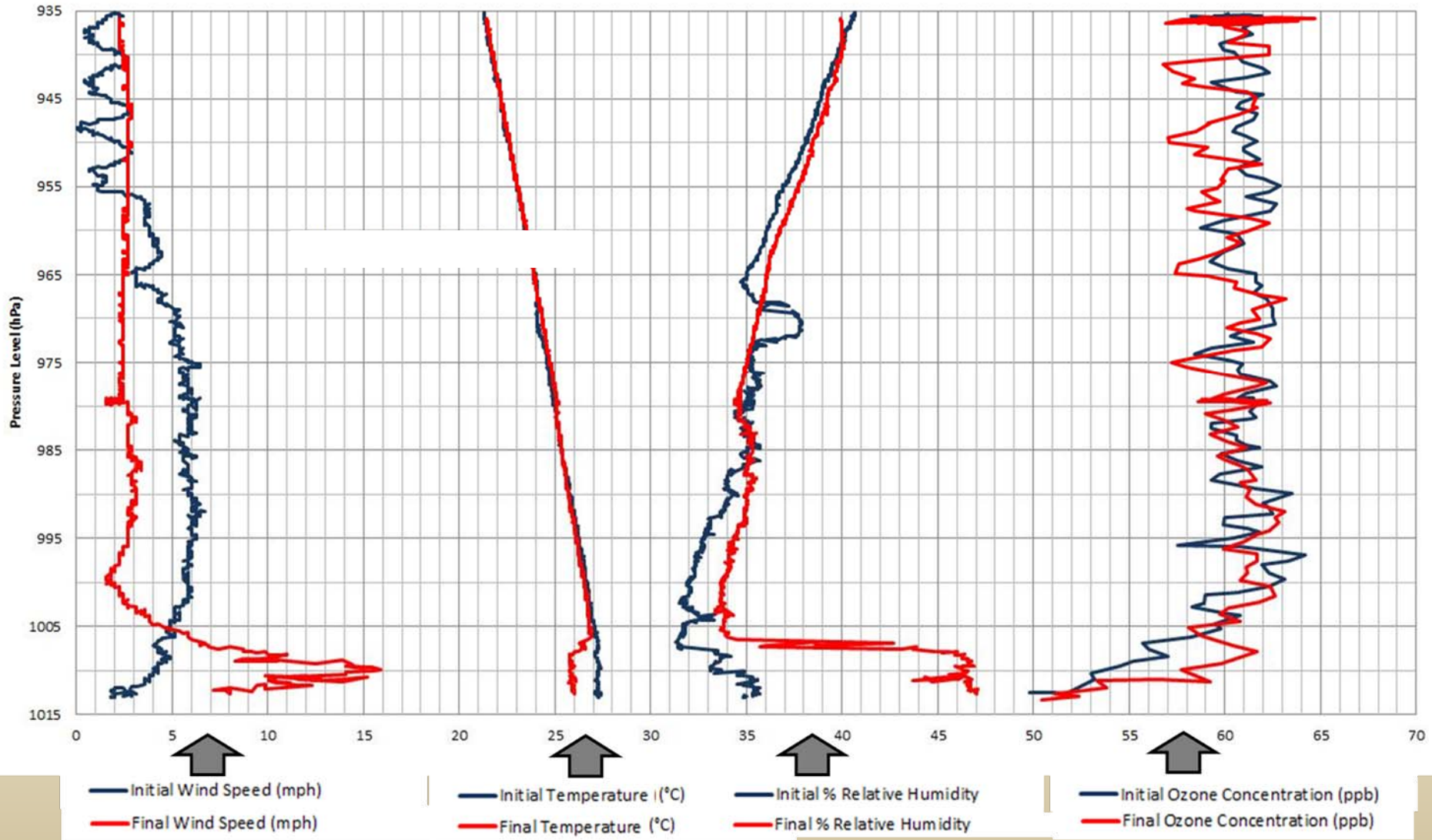
✓Sea breeze front formed over NJ about 1245 EDT and propagated across the state.

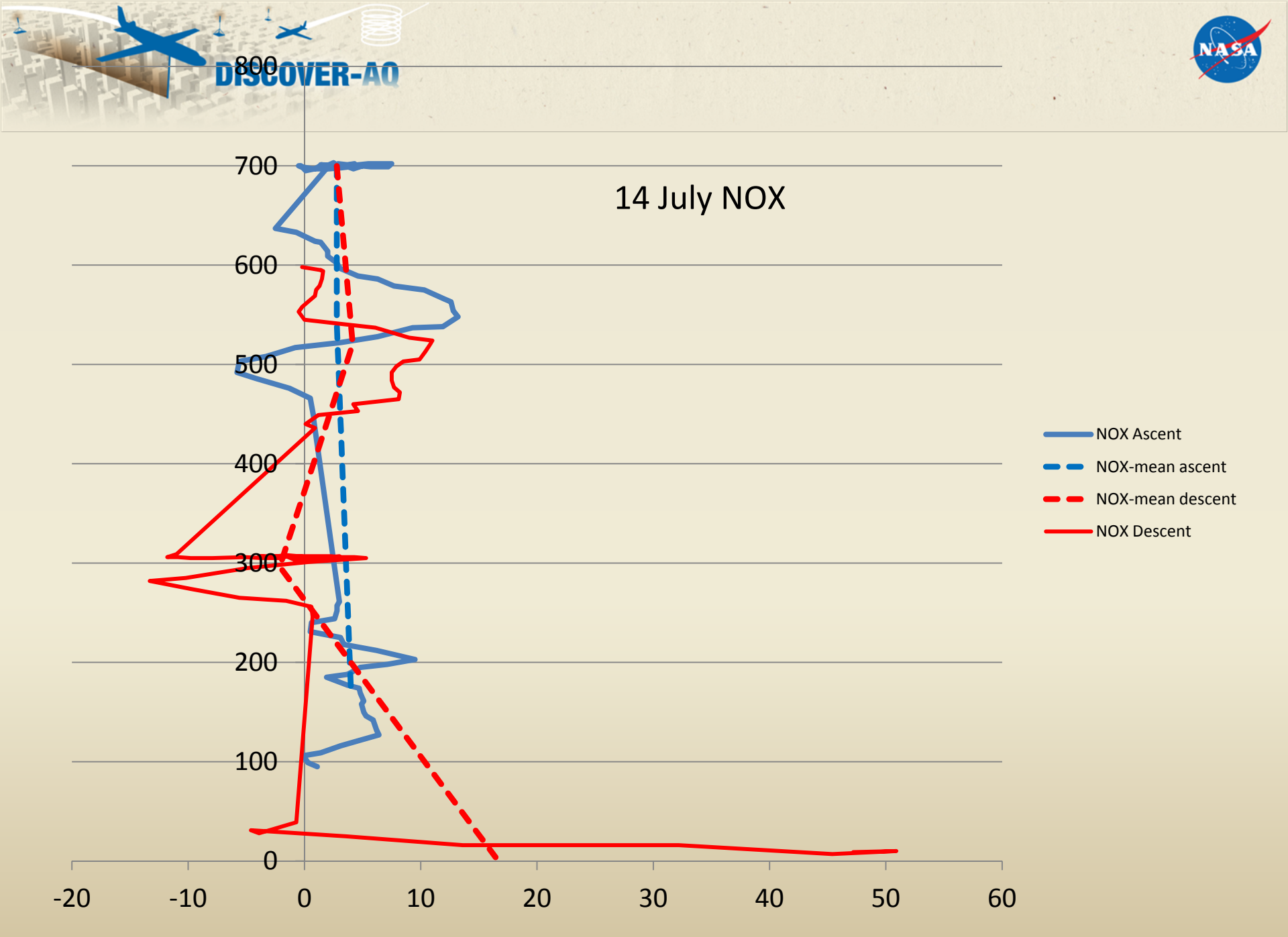
✓SB front strengthens over Delaware Bay but portion of front over NJ dissipates while stronger front over bay is influenced by northeasterly flow and rotates cyclonically

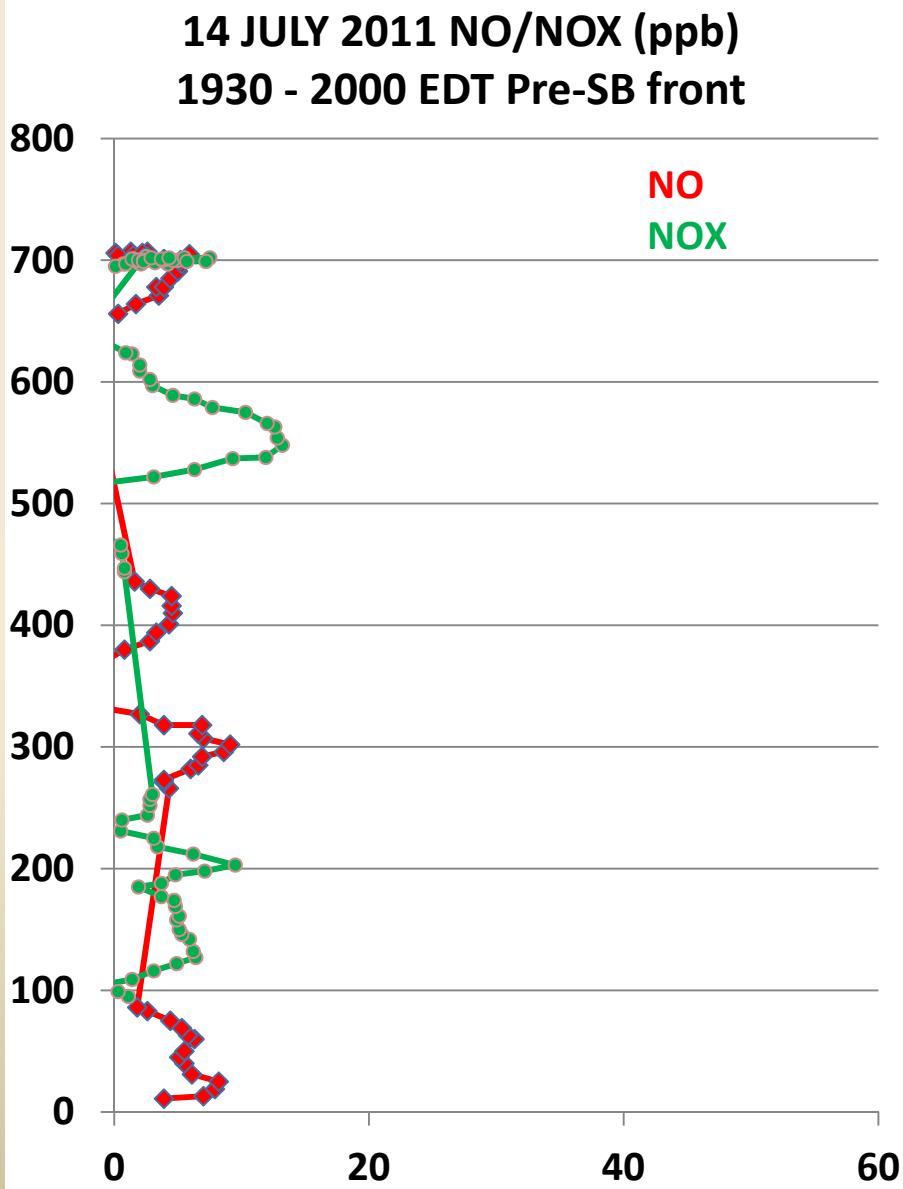
✓ SB front weakens but reaches Edgewood MD site around 2000 EDT.

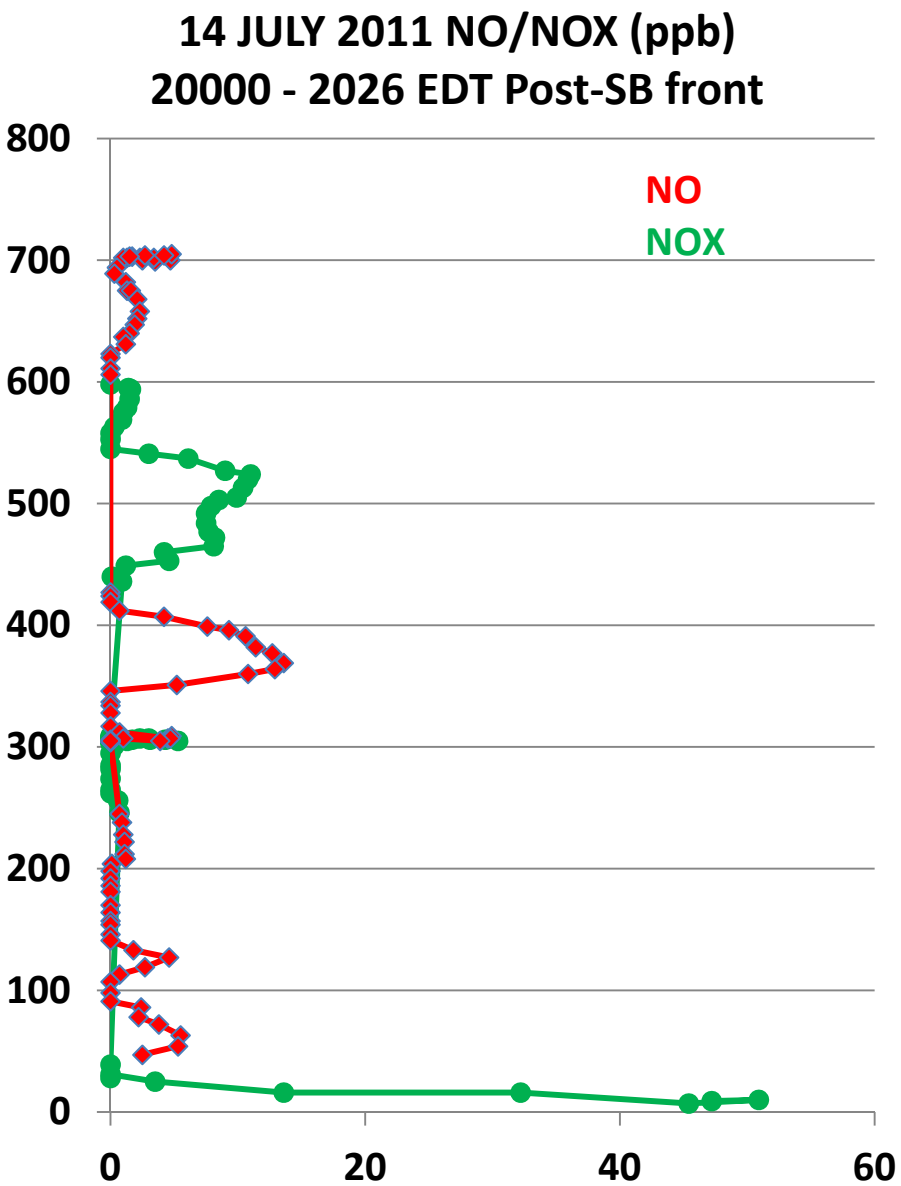
✓Instrumented balloon ascended to 935 hPa (~ 750 m) from 1930-2000 EDT before FROPA; descended from 2000-2030 EDT after FROPA

7.14.11 Boundary Layer Sounding Comparison
Before and After (19:30 UTC to 20:30 UTC) Shallow Bay/Seabreeze Passage

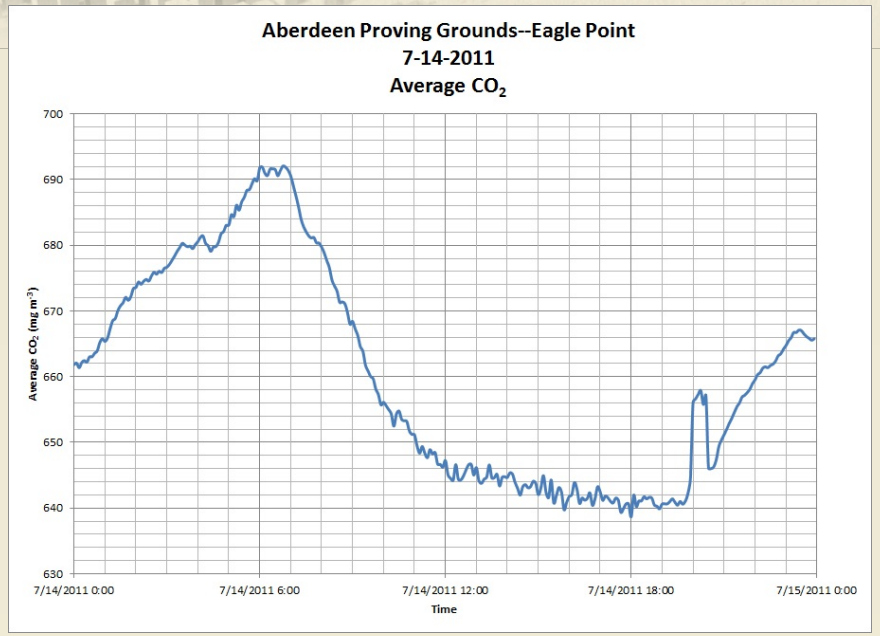


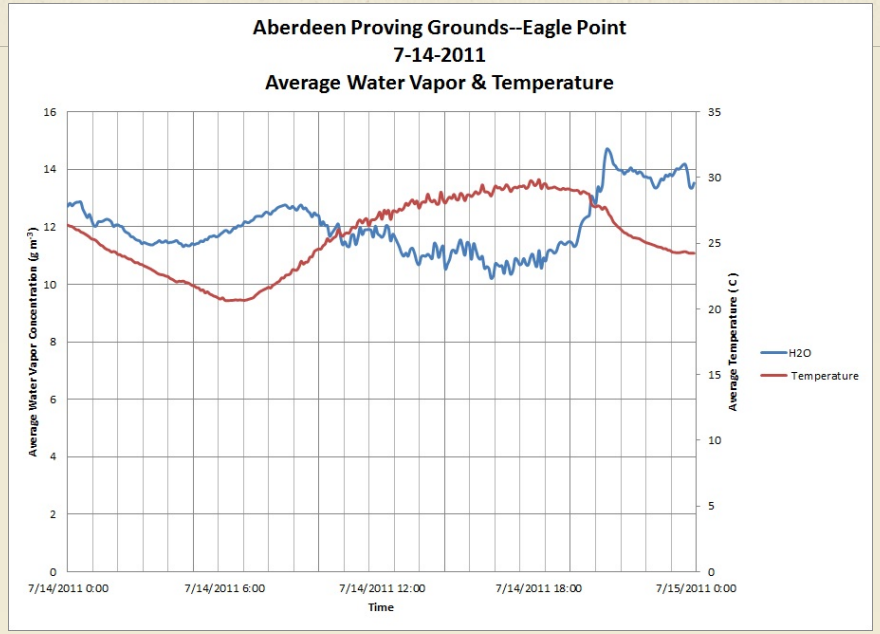

DISCOVER-AQ
NASA
14 July NOX
800
700
600
500
400
300
200
100
0
-20
-10
0
10
20
30
40
50
60
NOX Ascent
NOX-mean ascent
NOX-mean descent
NOX Descent

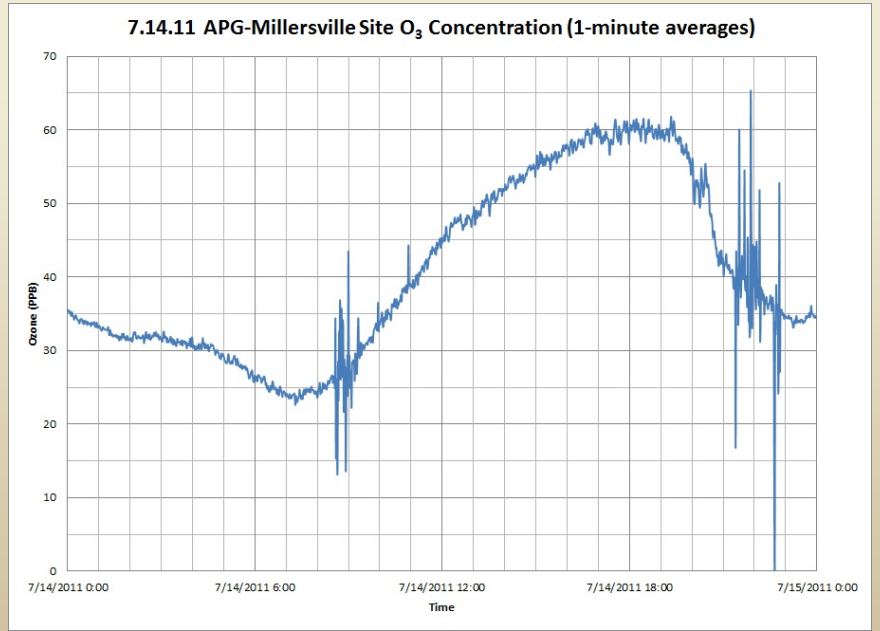

14 JULY 2011 NO/NOX (ppb)
1930 - 2000 EDT Pre-SB front
NO
NOX
800
700
600
500
400
300
200
100
0
0
20
40
60

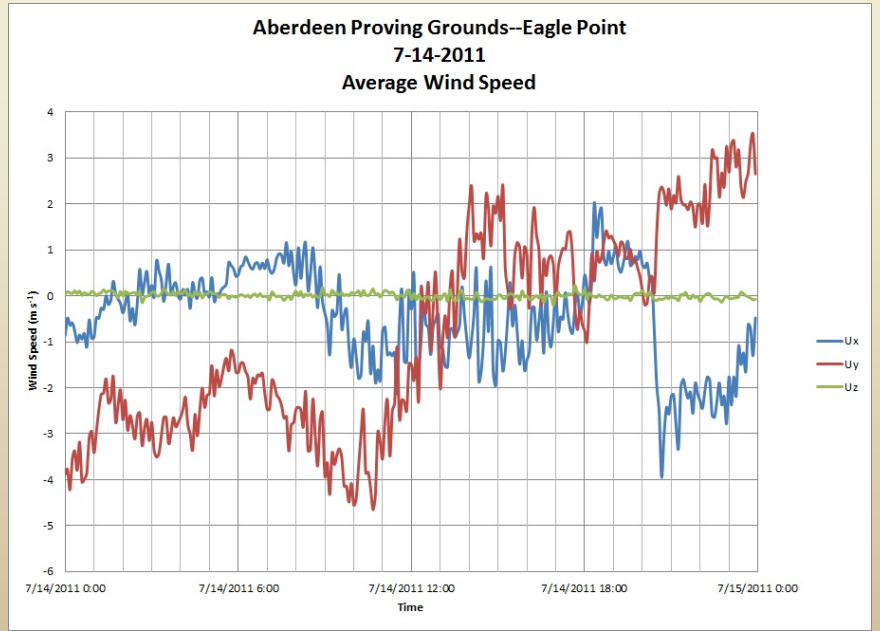

14 JULY 2011 NO/NOX (ppb)
20000 - 2026 EDT Post-SB front
NO
NOX
800
700
600
500
400
300
200
100
0
0
20
40
60

14 JULY 2011 (Mean quantities)



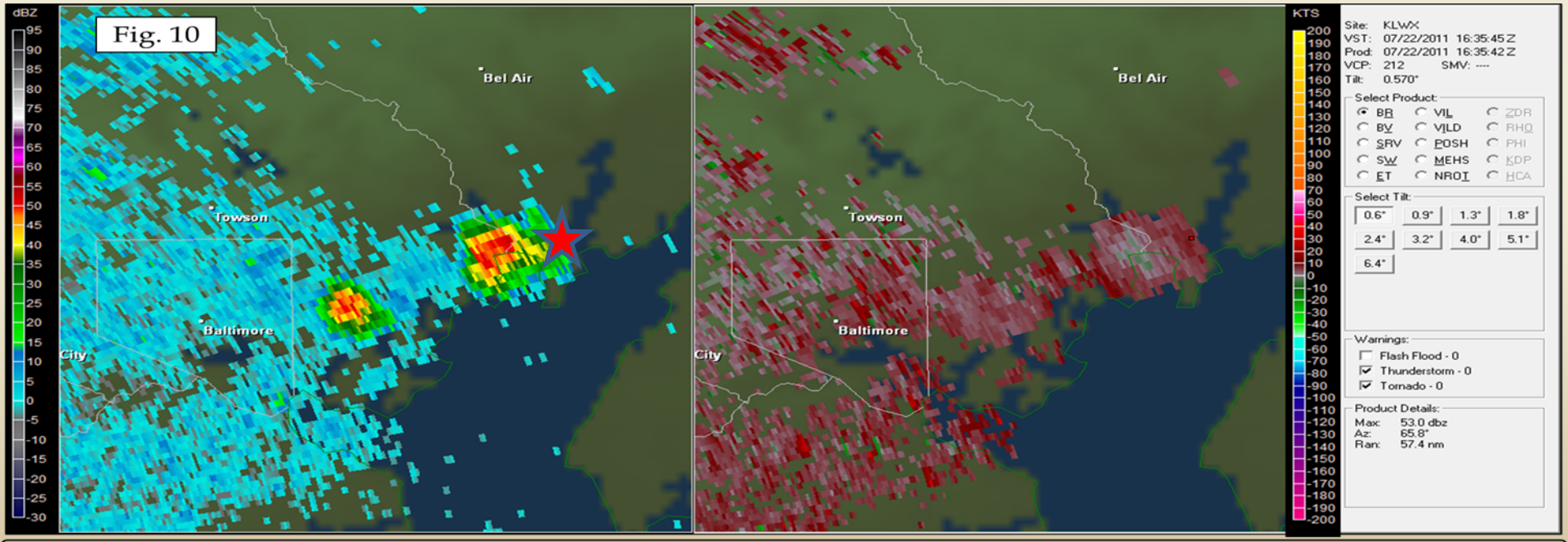






22 July 2012 (Convective Outflow Boundary) Preconditions

- ✓ Large high pressure air mass over the east coast
- ✓ Weak convergence zones formed over the northern Chesapeake
- ✓ Isolated convective elements formed to the west-southwest of Edgewood



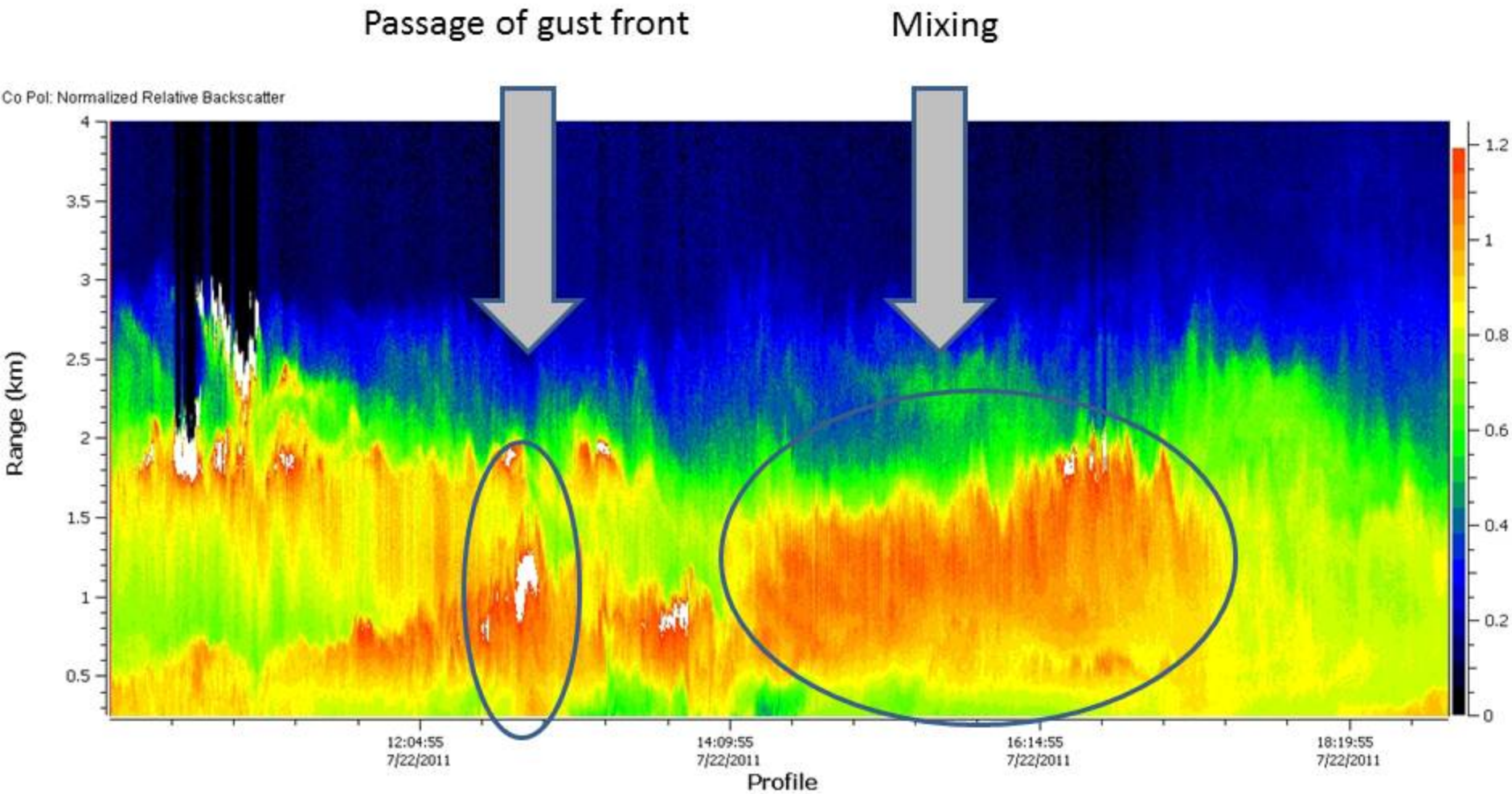
KLWX radar image on 7/22 at 16:35 UTC over the research site, indicated by the star. This image shows the 0.6 degree reflectivity (left) and velocity (right) scans at the time of interest.

22 July 2012 (Convective Outflow Boundary) Event

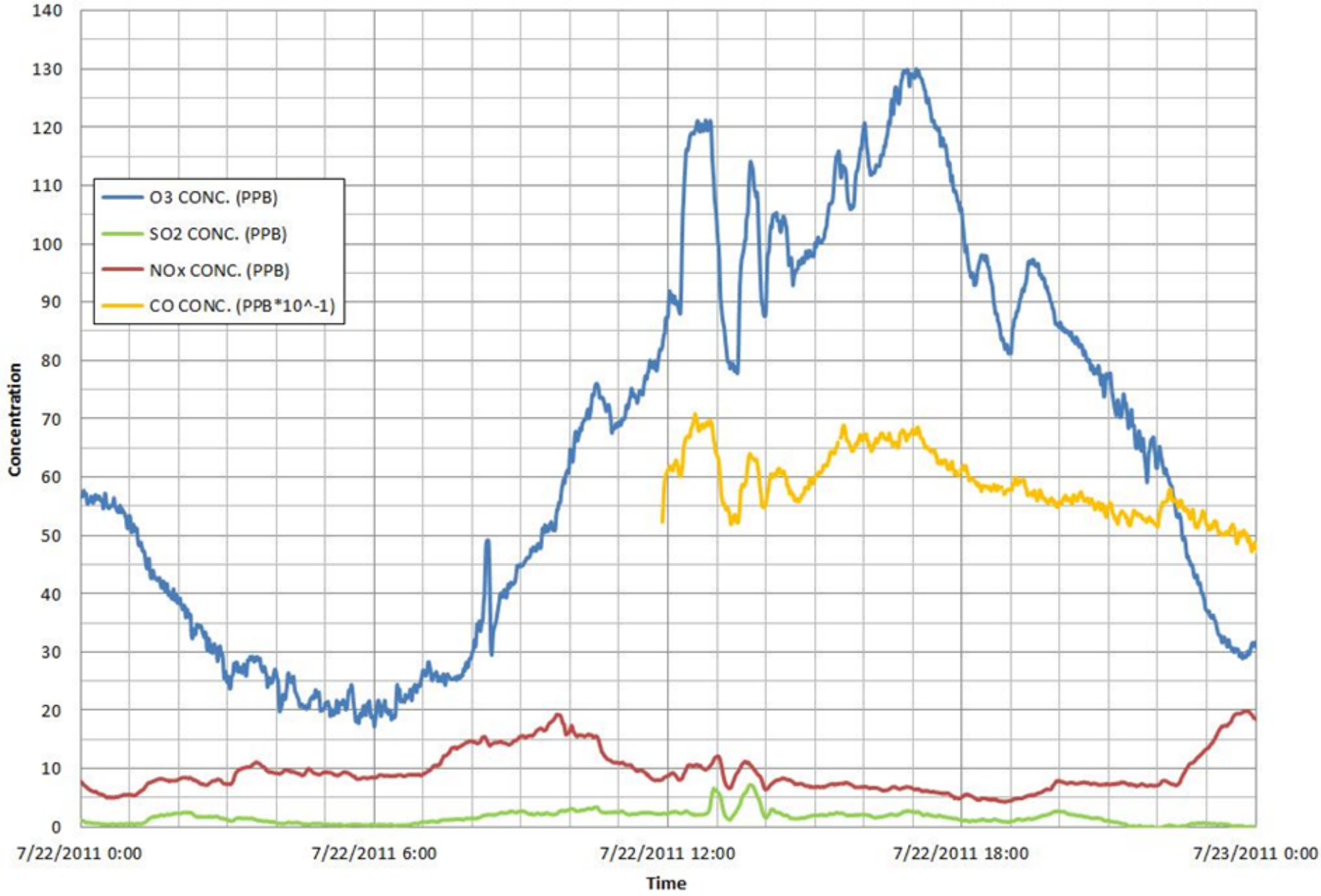
✓ Cool, moist outflow boundary propagated from the convective system

✓ By the time the outflow boundary made it to the site it was a slightly cooler and relatively dry gravity current

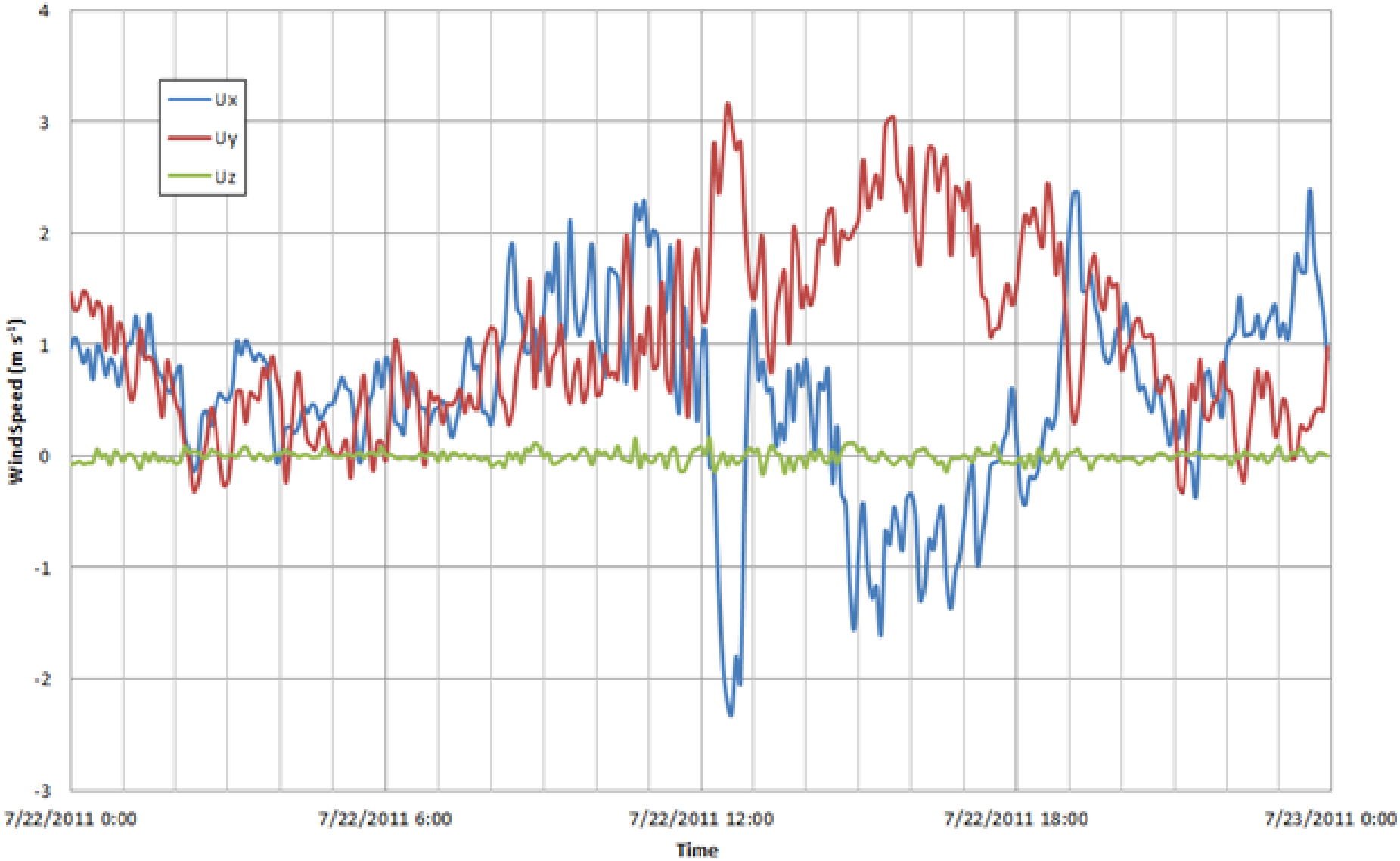
✓ The boundary focused the convergence zone resulting in elevated trace gas concentrations in the Edgewood area.


Passage of gust front
Mixing
Co Pol: Normalized Relative Backscatter
Range (km)
4
3.5
3
2.5
2
1.5
1
0.5
12:04:55
7/22/2011
14:09:55
7/22/2011
16:14:55
7/22/2011
18:19:55
7/22/2011
Profile
1.2
1
0.8
0.6
0.4
0.2
0

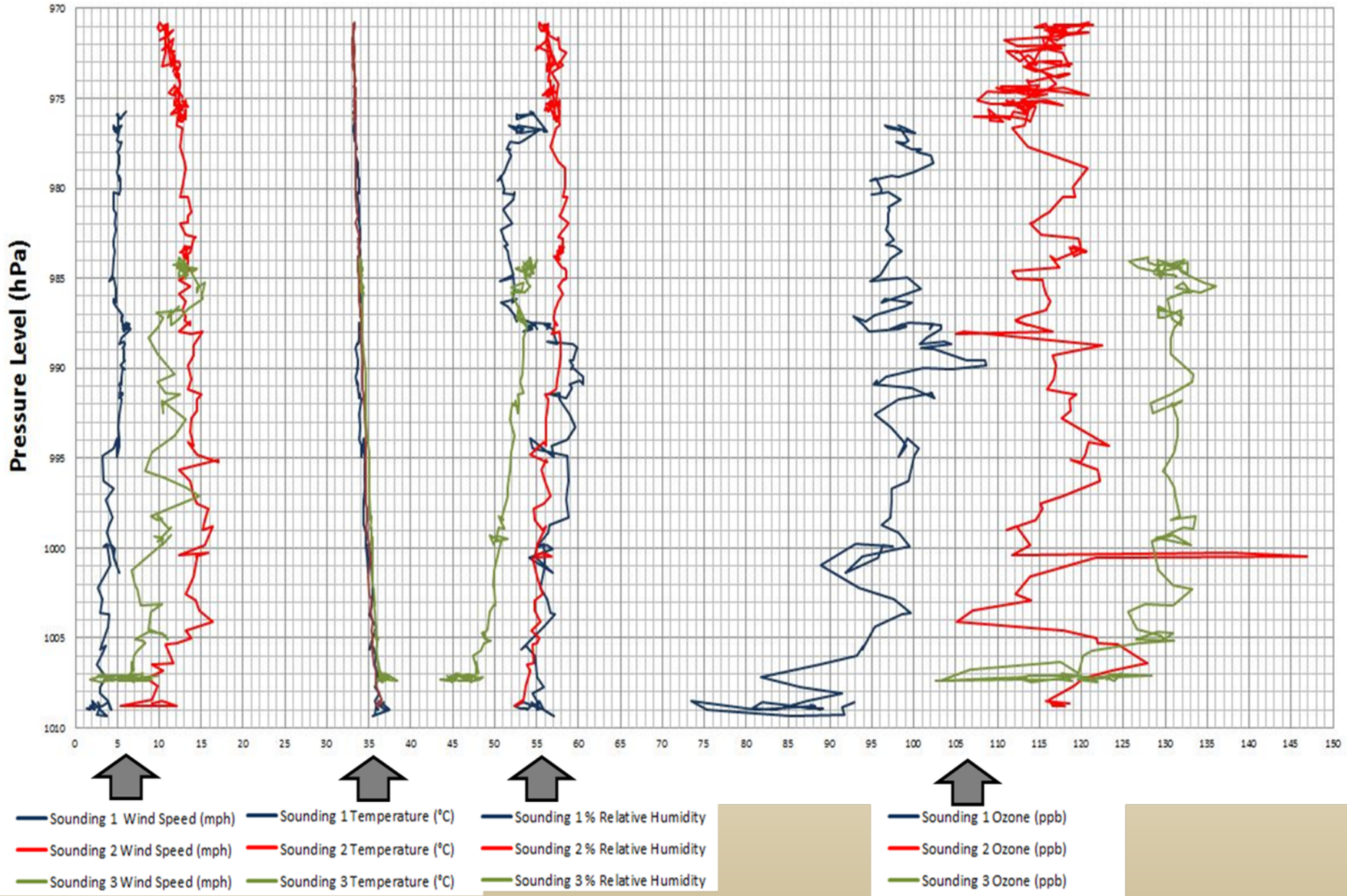
7.23.11 Trace Gasses at Millersville Site @ APG

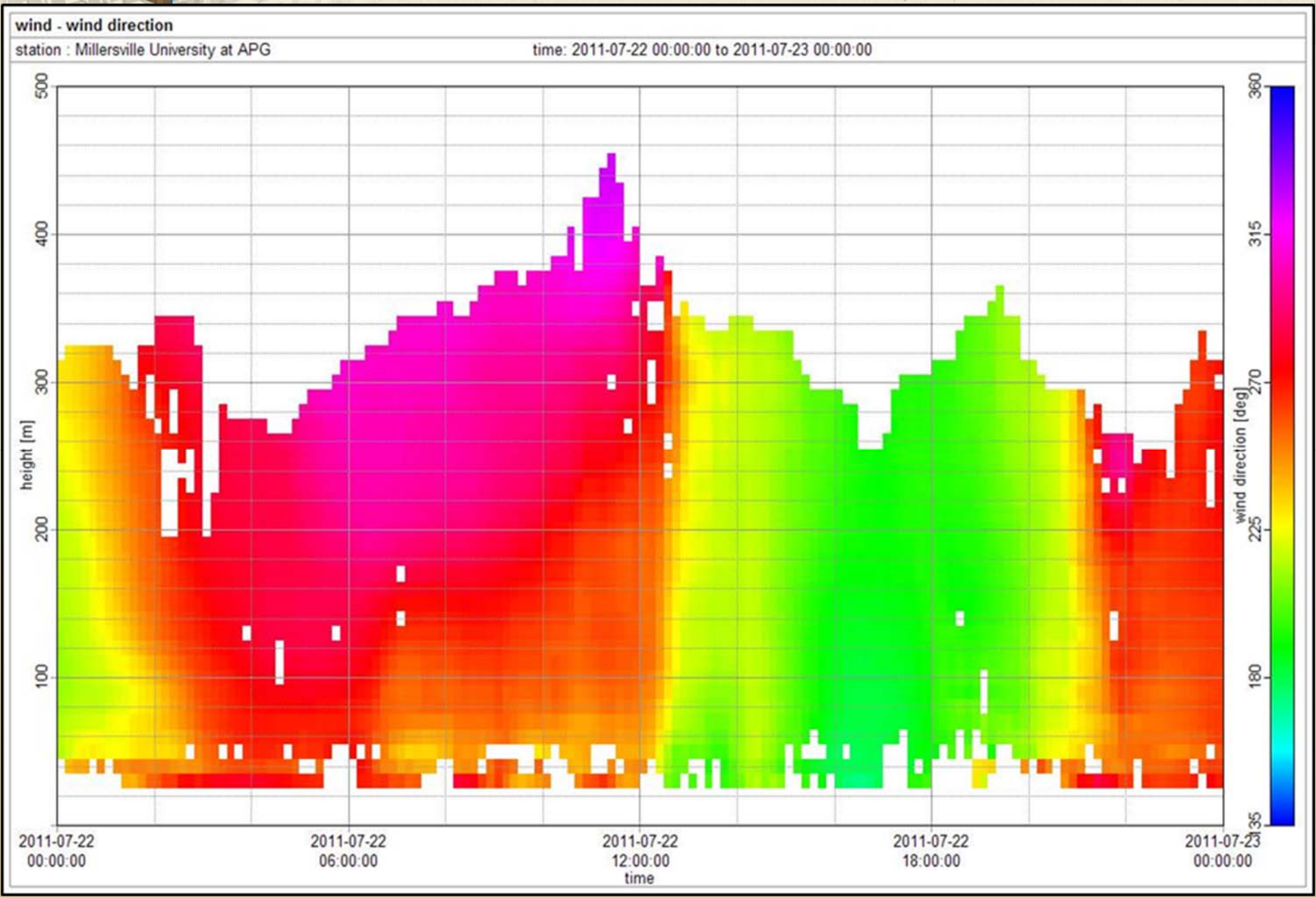


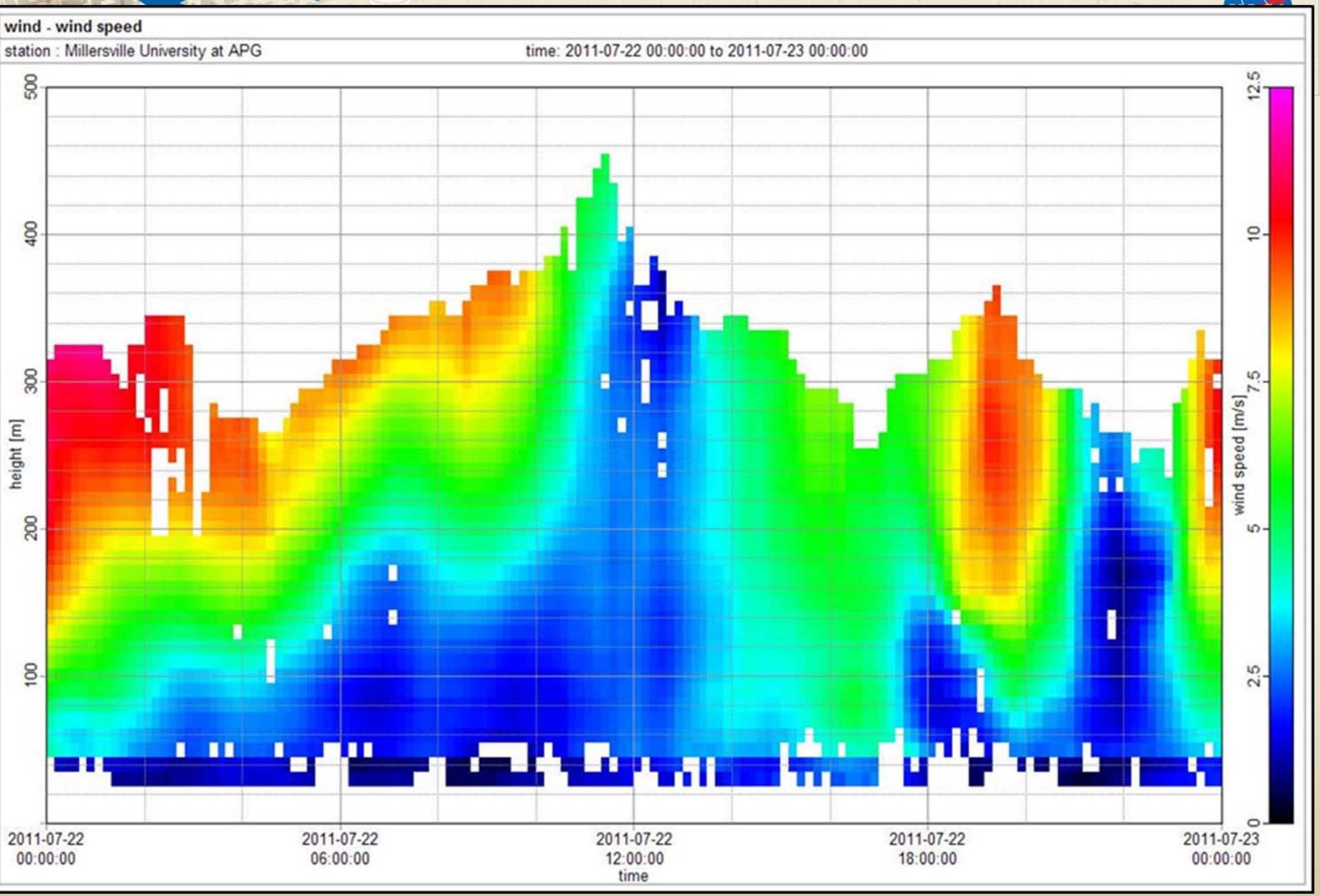
Aberdeen Proving Grounds--Eagle Point
7-22-2011 Average Wind Speed



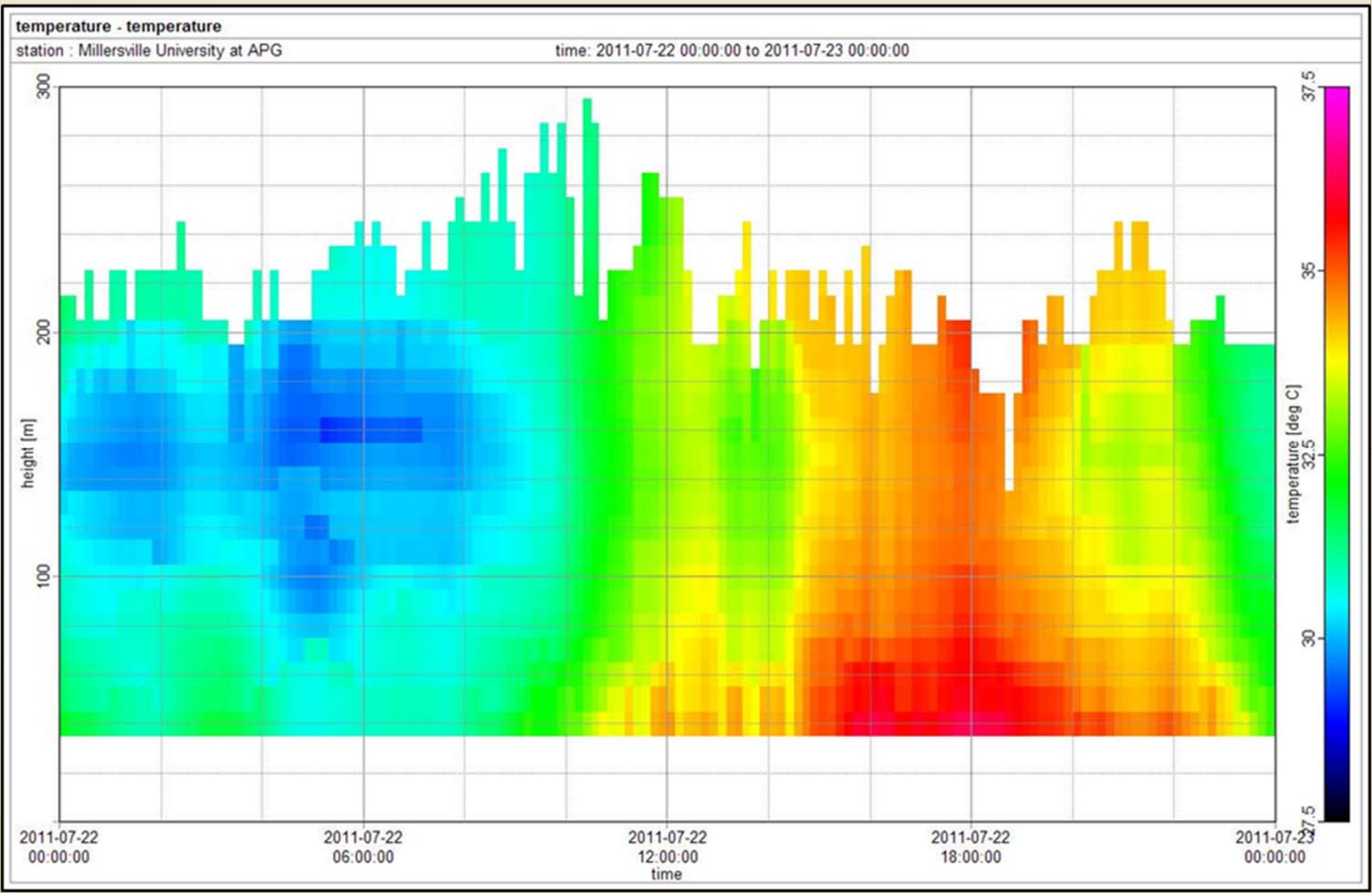
7.22.11 Boundary Layer Outflow Passage Sounding Comparison
Before (11:45 AM in Blue), During (12:15 PM in Red), and After (1:00 PM in Green)



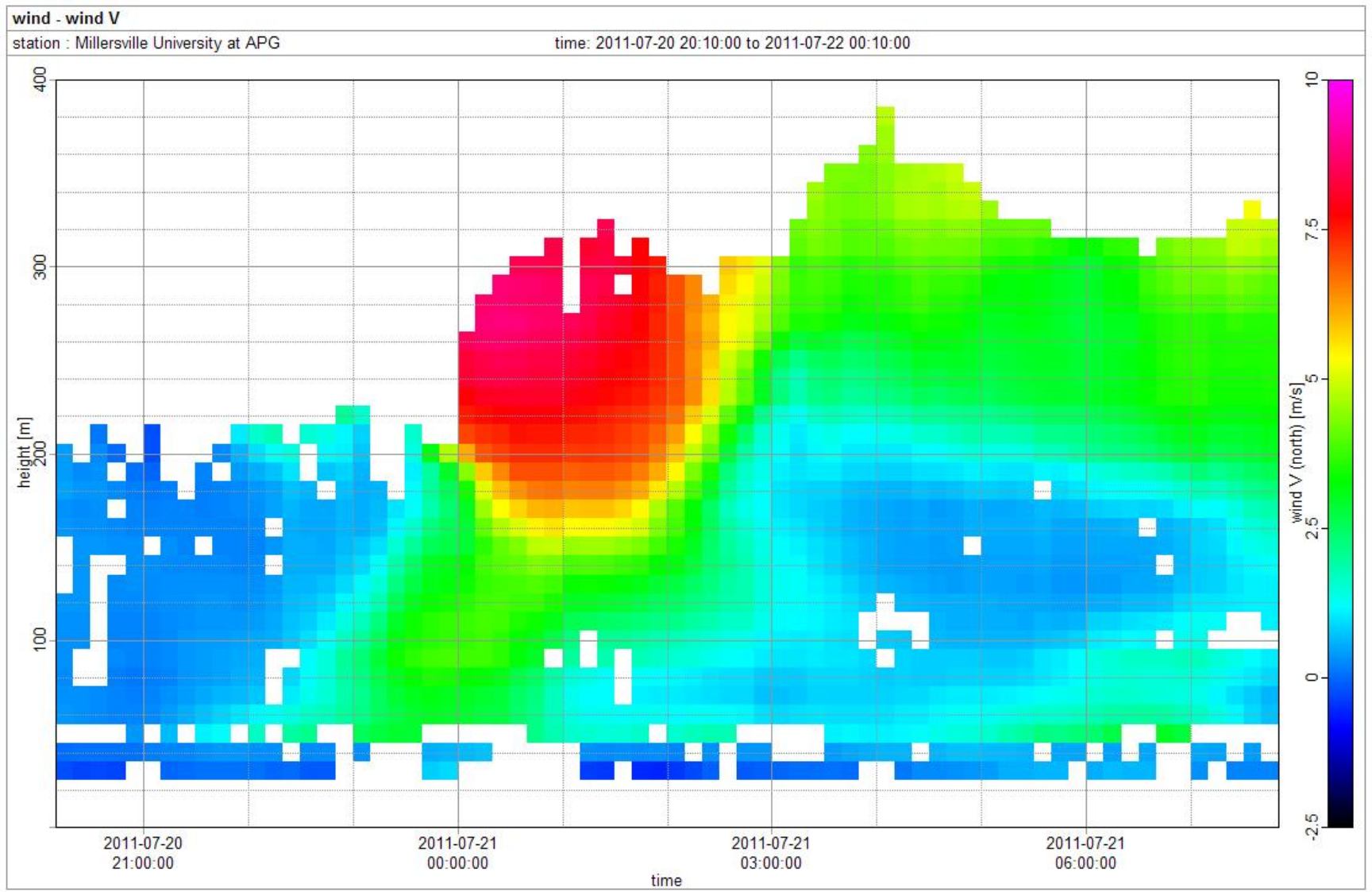

wind - wind direction
station : Millersville University at APG
time: 2011-07-22 00:00:00 to 2011-07-23 00:00:00
height [m]
500
400
300
200
100
2011-07-22 00:00:00
2011-07-22 06:00:00
2011-07-22 12:00:00
2011-07-22 18:00:00
2011-07-23 00:00:00
time
wind direction [deg]
360
315
270
225
180
135


wind - wind speed
station : Millersville University at APG
time: 2011-07-22 00:00:00 to 2011-07-23 00:00:00
height [m]
500
400
300
200
100
2011-07-22 00:00:00
2011-07-22 06:00:00
2011-07-22 12:00:00
2011-07-22 18:00:00
2011-07-23 00:00:00
time
wind speed [m/s]
12.5
10
7.5
5
2.5
0

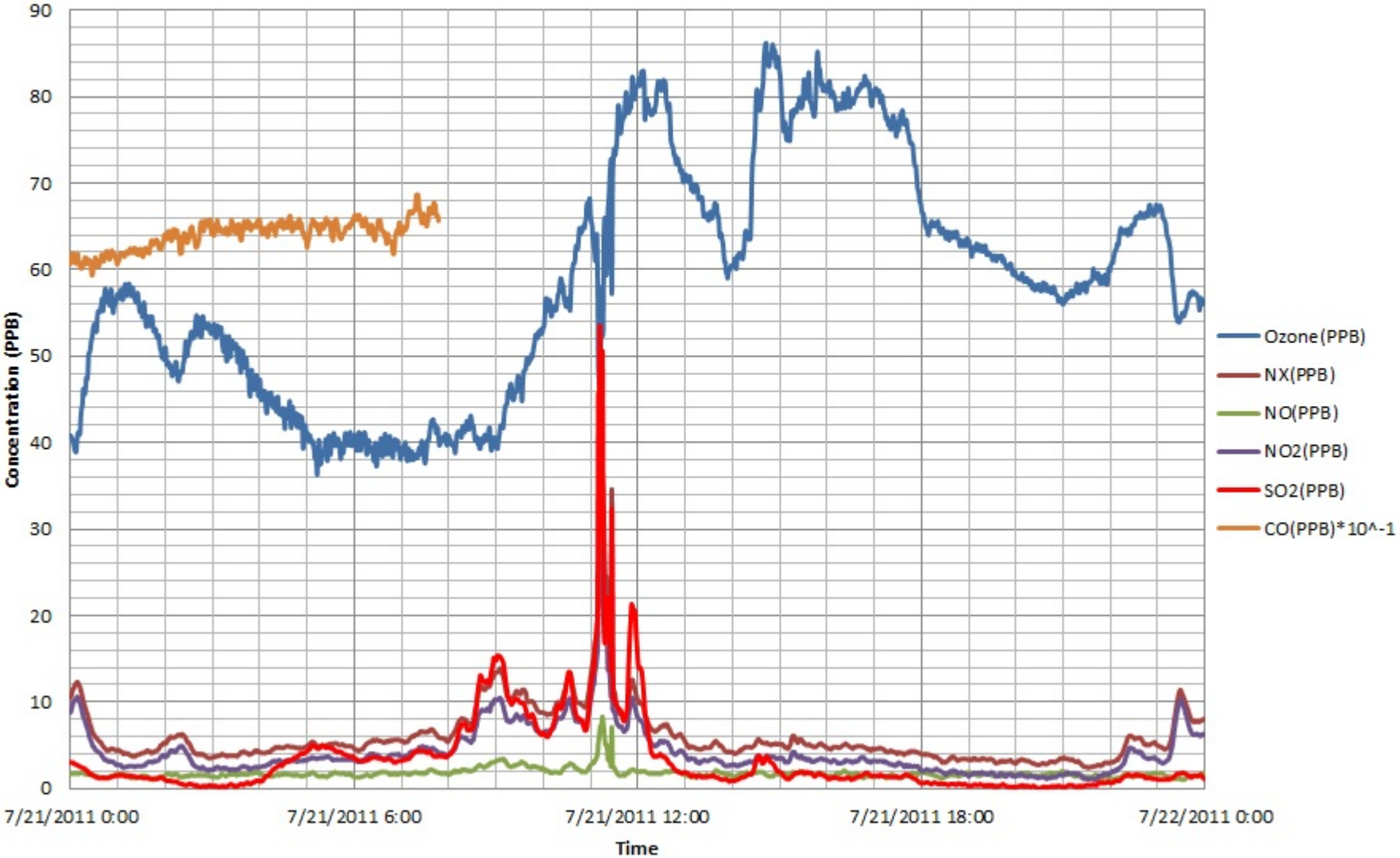
DISCOVER-AQ

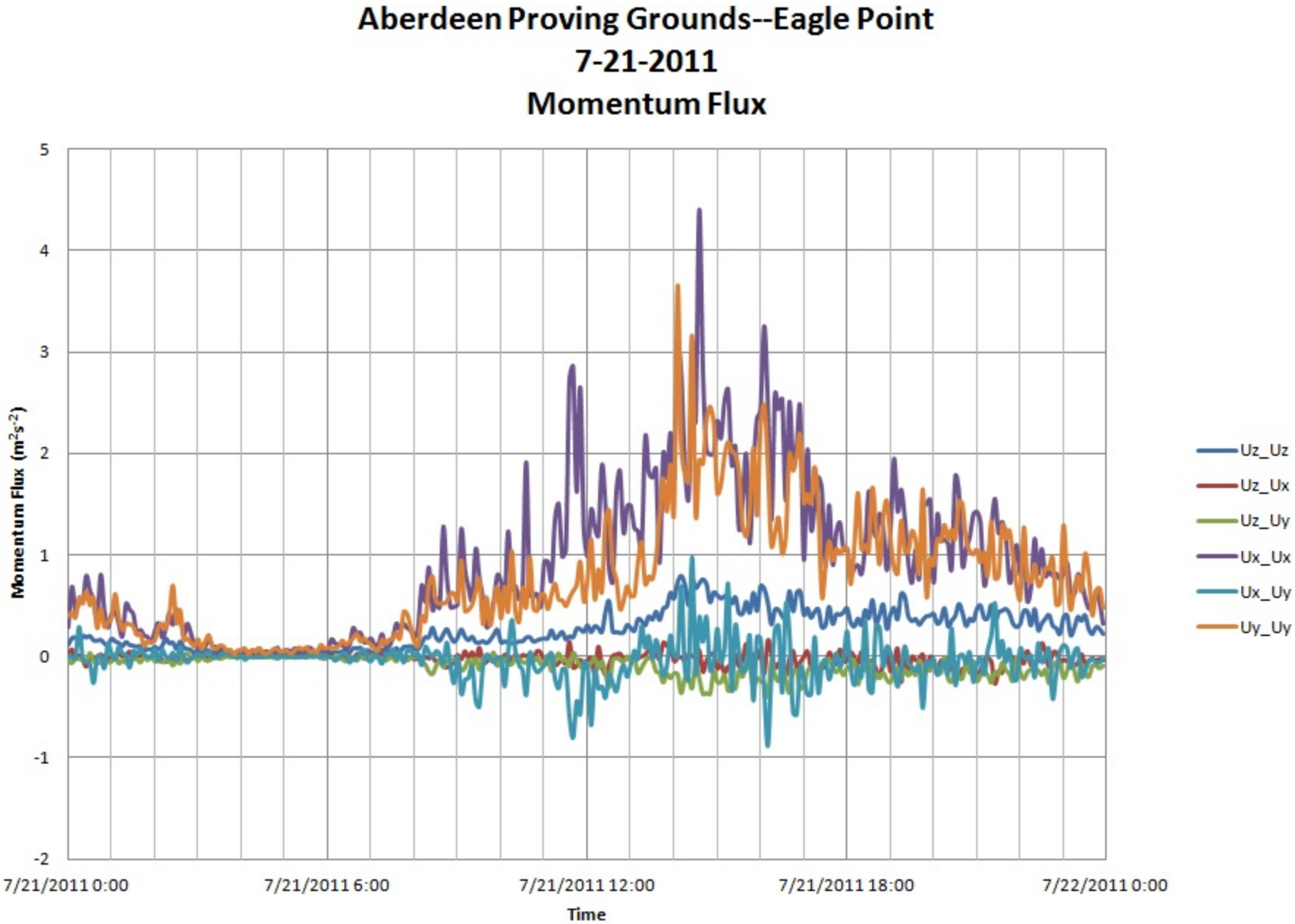

temperature - temperature
station : Millersville University at APG
time: 2011-07-22 00:00:00 to 2011-07-23 00:00:00
height [m]
300
200
100
2011-07-22 00:00:00
2011-07-22 06:00:00
2011-07-22 12:00:00
2011-07-22 18:00:00
2011-07-23 00:00:00
time
temperature [deg C]
37.5
35
32.5
30
27.5

21 July 2011 (Nocturnal low-level jet)



7.21.11 Edgewood-Eagle Point-Millersville Site
Trace Gas Concentrations (1-minute averages)
O_3(PPB), NO/NO_2/NOx(PPB), SO_2(PPB), CO(PPB*10^{-1})




Aberdeen Proving Grounds--Eagle Point
7-21-2011
Momentum Flux
Momentum Flux (m2s-2)
5
4
3
2
1
0
-1
-2
7/21/2011 0:00
7/21/2011 6:00
7/21/2011 12:00
7/21/2011 18:00
7/22/2011 0:00
Time
Uz_Uz
Uz_Ux
Uz_Uy
Ux_Ux
Ux_Uy
Uy_Uy

Summary

✓ Local and regional circulations can have a significant effect on the evolution of the kinematic and thermodynamic structure of the ABL

✓Air chemistry can be strongly influenced by the passage of a sea/bay breeze front, outflow boundary, and low-level jet.

✓ Many of these events are sub-grid-scale yet can modify the BL without being detected by the observational network or adequately modeled by even high resolution modeling systems.

Next Steps

✓ Complete the data analysis and interpretation

✓ Integrate this data with surface measurements and aircraft data