WINTERTIME TETHERED BALLOON MEASUREMENTS OF METEOROLOGICAL VARIABLES AND AEROSOLS IN SUPPORT OF MANE-VU 2004

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A total of 18 students while classes were in session

Funded by the Northeast States for a Coordinated Air Use Management (NESCAUM)
• Introduction
• Data Collection
• Overview of Winter 2004
• Case Studies
• Key Elements
• Conclusions
• Future Work
Introduction: Why study the wintertime boundary layer?

• Studies of the WBL and its chemistry are rare; long-duration aloft measurements are virtually non-existent
• Dynamics and thermodynamics are very different than summertime
• Synoptic gradients can easily overwhelm local and regional effects, but…
• Strong static stability can lead to stratification and a rapid enhancement of local and regional effects
• There is a need for high resolution wintertime profiles for modeling comparison and validation
Data Collection

- 6 Weeks from 3 January – 14 February 2004
- Lat. 39° 59.43’ N; Lon. 076° 23.16’ W; Elev. 100 m MSL
- Class I visibility area in the MANE-VU domain located 16.2 km SW of the Lancaster, PA airport
- Semi-rural, agricultural setting typical of the region
- Pittsburgh 300 km to the west, New York City 150 km to the northeast, and Baltimore and Philadelphia with a 100 km radius to the south and east respectively. Lancaster, PA (pop. 50,000) 9 km east of the site
- Representative of the mid-Atlantic piedmont area about halfway distant between the Atlantic coastal plain and the Appalachian Mountains
Data Collection: Platforms

- Two 12 m³ balloons each with 7.5 kg payload capacity
- Blimp (top) used for vertical profiling to 750 m AGL
- Balloon (bottom) used for constant altitude time series at designated “altitudes of interest.”

Graphs showing daily number of vertical profiles and constant altitude time aloft during MANE-VU 2004:

- 120 profiles
- 87 hours
# Data Collection: Instruments

## Table 1: BLIMP (VP) Sensor Specifications

<table>
<thead>
<tr>
<th>Variable or Instrument</th>
<th>Method</th>
<th>Range</th>
<th>Resolution</th>
<th>Response Time</th>
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<th>Response Time</th>
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<th>Sampling Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Capacitive wire</td>
<td>-50° to +60°C</td>
<td>0.1°C</td>
<td>0.2 s</td>
<td>0.1°C</td>
<td>0.2 s</td>
<td>1°C</td>
<td>1 second</td>
</tr>
<tr>
<td>Humidity</td>
<td>Thin-film capacitor</td>
<td>0% to 100%</td>
<td>0.1%</td>
<td>&lt; 0.5 s</td>
<td>0.1%</td>
<td>&lt; 0.5 s</td>
<td>2%</td>
<td>1 second</td>
</tr>
<tr>
<td>Pressure</td>
<td>Silicon sensor</td>
<td>500 to 1000 hPa</td>
<td>0.1 hPa</td>
<td>N/A</td>
<td>0.1 hPa</td>
<td>N/A</td>
<td>0.4 hPa</td>
<td>1 second</td>
</tr>
<tr>
<td>Wind speed</td>
<td>3-cup anemometer</td>
<td>0.1 to 20 m/s</td>
<td>0.1 m/s</td>
<td>N/A</td>
<td>0.1 m/s</td>
<td>N/A</td>
<td>N/A</td>
<td>1 second</td>
</tr>
<tr>
<td>Wind direction</td>
<td>Digital compass</td>
<td>0° to 360°</td>
<td>1°/min</td>
<td>N/A</td>
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<td>N/A</td>
<td>N/A</td>
<td>1 second</td>
</tr>
<tr>
<td>PM10 Conc. (DustTrak Model 8520) Temp range 0° to 50°C</td>
<td>Laser-diode photometer</td>
<td>1.7 L/min</td>
<td>0.001 ... 100ng/m²</td>
<td>± 1% of reading or 0.001 ng/m²</td>
<td>10 second</td>
<td>1 second till 1/2/04</td>
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<td>Condensation Particle Counter (TSI Model 3007) Temp range 0° to 50°C</td>
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<tr>
<td>TSI-3 wave-length Neutron-Meter Model 9533 Scattering-coef f/ airborne particles</td>
<td>Optical integrating nephelometry</td>
<td>Flow Rate 1.0 ppm</td>
<td>0.01 ... 1.0 µm</td>
<td>&gt; 50% of reading or 0.001 ng/m²</td>
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<td>2004</td>
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## Table 2: BLIMP (CA) Sensor Specifications

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<tr>
<td>PM2.5 Conc. (DustTrak Temp range 0° to 50°C</td>
<td>Laser-diode photometer</td>
<td>Flow Rate 1.7 L/min</td>
<td>0.001 ... 100ng/m²</td>
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## Table 3: Surface-Based Instrument Specifications

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<td>1 particle/cm²</td>
<td>N/A</td>
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## TSI-3 wave-length Neutron-Meter Model 9533 Scattering-coef f/ airborne particles | Optical integrating nephelometry | Flow Rate 1.0 ppm | 0.01 ... 1.0 µm | > 50% of reading or 0.001 ng/m² | 1 second | 2004 | 3 seconds after 2004 | 1 minute |

## Sensitivity

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LOW PASS AT MANOR KNOLL LANDING STRIP

FERRY FROM UMD TO MU

RETURN TO MU SITE; START PROFILE

PROFILING BALLOON DESCENDS SIMULTANEOUS WITH AIRCRAFT ASCENT

2-3 FLY-BYS

PROFILE TO 9,500 FEET

DESCENT TO START PROFILE

RETURN TO UMD
January was the 10th coldest on record in the mid-Atlantic region with a -6 F departure from normal. The month was also the wettest January on record with precipitation 3.5 in above normal and the snowiest January on record. From 3 January - 14 February 2004, the site experienced temperature departures of -6.6 F from normal and 9.6 mm above normal precipitation. The January thaw was absent in 2004 in the mid-Atlantic region.
Difference in synoptic pattern between early and late periods

**Early**
- January characterized by progressive wave short pattern
- Rapid exchange of air masses
- Influx of air from the Canadian Provinces
- Coupling of the subtropical and polar jets
- Strong baroclinicity

**Late**
- Significant pattern change in late January (~ 27th)
- Mean trough established in Midwest
- Influx of air from south-central US and Gulf of Mexico
- Temperature and moisture more seasonal
- Strong baroclinicity continues
Case Studies: 2 FEB 2004 (daytime progressive anticyclone)
Case Study: 2 FEB 2004

Temperature Descent
2 February 2004, 0911-0943 EST

Temperature Ascent
2 February 2004, 1119-1159 EST

Total Particle Count Descent
2 February 2004, 0911-0943 EST
TSI CPC Model 3007

Total Particle Count Ascent
2 February 2004, 1119-1159 EST
TSI CPC Model 3007
Case Studies:
2 FEB 2004
Surface Quantities
Case Studies: 5 FEB 2004 (nighttime stratification)
Case Study: 5 FEB 2004

Temperature Descent
5 February 2004, 0103:00 EST

Specific Humidity Descent
5 February 2004, 0103:00 EST

Wind Speed Descent
5 February 2004, 0103:00 EST

Wind Direction Descent
5 February 2004, 0103:00 EST

PM1.5 Concentration Descent
5 February 2004, 0103:00 EST
TID Dustfall Model 9518

Temperature Descent
5 February 2004, 0313:00 EST

Specific Humidity Descent
5 February 2004, 0313:00 EST

Wind Speed Descent
5 February 2004, 0313:00 EST

Wind Direction Descent
5 February 2004, 0313:00 EST

PM1.5 Concentration Descent
5 February 2004, 0313:00 EST
TID Dustfall Model 9518
Case Studies: 5 FEB 2004
Case Studies: 5 FEB 2004
Case Studies: 5 FEB 2004
Surface Quantities
Case Studies: 5 FEB 2004

Surface Meteorology
Thank you
Questions?

Meteorology Drives Everything!