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

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A total of 18 students while classes were in session

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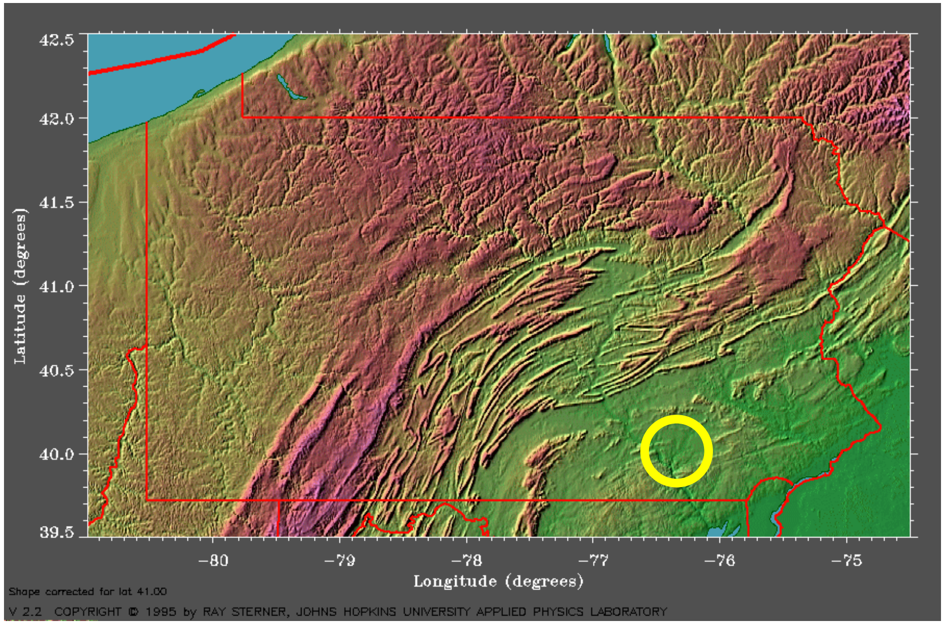
- Introduction
- Data Collection
- Overview of Winter 2004
- Case Studies
- Key Elements
- Conclusions
- Future Work

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

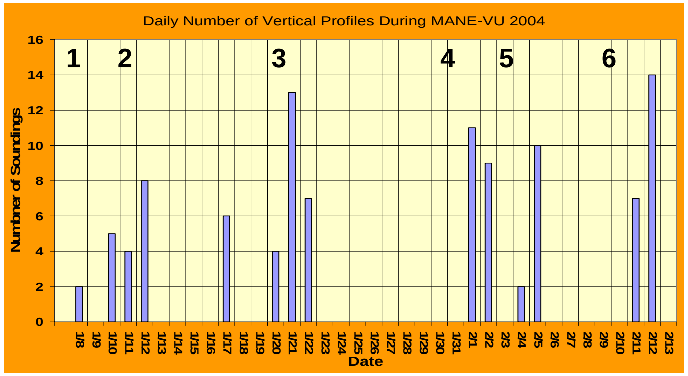
Data Collection



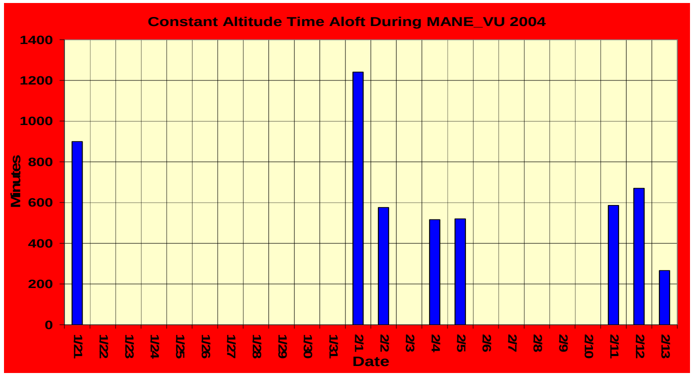
- 6 Weeks from 3 January – 14 February 2004
- Lat. 39° 59.43' N; Lon. 076° 23.16' W; Elev. 100 m MSL
- Class I visibility area in the MANE-VU domain located 16.2 km SW of the Lancaster, PA airport
- Semi-rural, agricultural setting typical of the region
- Pittsburgh 300 km to the west, New York City 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

<u>Data Collection:</u> Platforms

- Two 12 m^3 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."



120 profiles



87 hours

Data Collection: Instruments

TABLE 1: BLIMP (VP) SENSOR SPECIFICATIONS

Variable or Instrument	Method	Range	Resolution	Response Time	Repeatability	Sampling Frequency
Temperature	Capacitive wire	-50 … + 60 C	0.1 C	0.2 s	0.10 C	1 second
Humidity	Thin film capacitor	0 …100%	0.1%	< 0.5 s @ 20 C	2%	1 second
Pressure	Silicon sensor	500 … 1080 hPa	0.1 hPa	N/A	0.4 hPa	1 second
Wind speed	3-cup anemometer	0 … 20 m/s	0.1 m/s	N/A	N/A	1 second
Wind direction	Digital compass	0 … 360 deg	1 deg	N/A	N/A	1 second
PM2.5 Conc (DustTrak Model 8520) Temp range 0 – 50 C (Calibrated for standard ISO 12103-1, A1 test dust)	90 deg Laser-diode photometry Flow Rate 1.7 L/min	0.001 … 100 mg/m^3	± .1% of reading or 0.001 mg/m^3			10 second thru 1/22/04 1 second after 1/22/04
Condensation Particle Counter (TSI Model 3007) Temp range 0 – 50 C	Cloud chamber w/ optical scatterometer Flow Rate 700 cc/min	0.01 … 1.0 µm; 0 …100,000 cm^{-3}	1 particle cm^{-3}			1 second

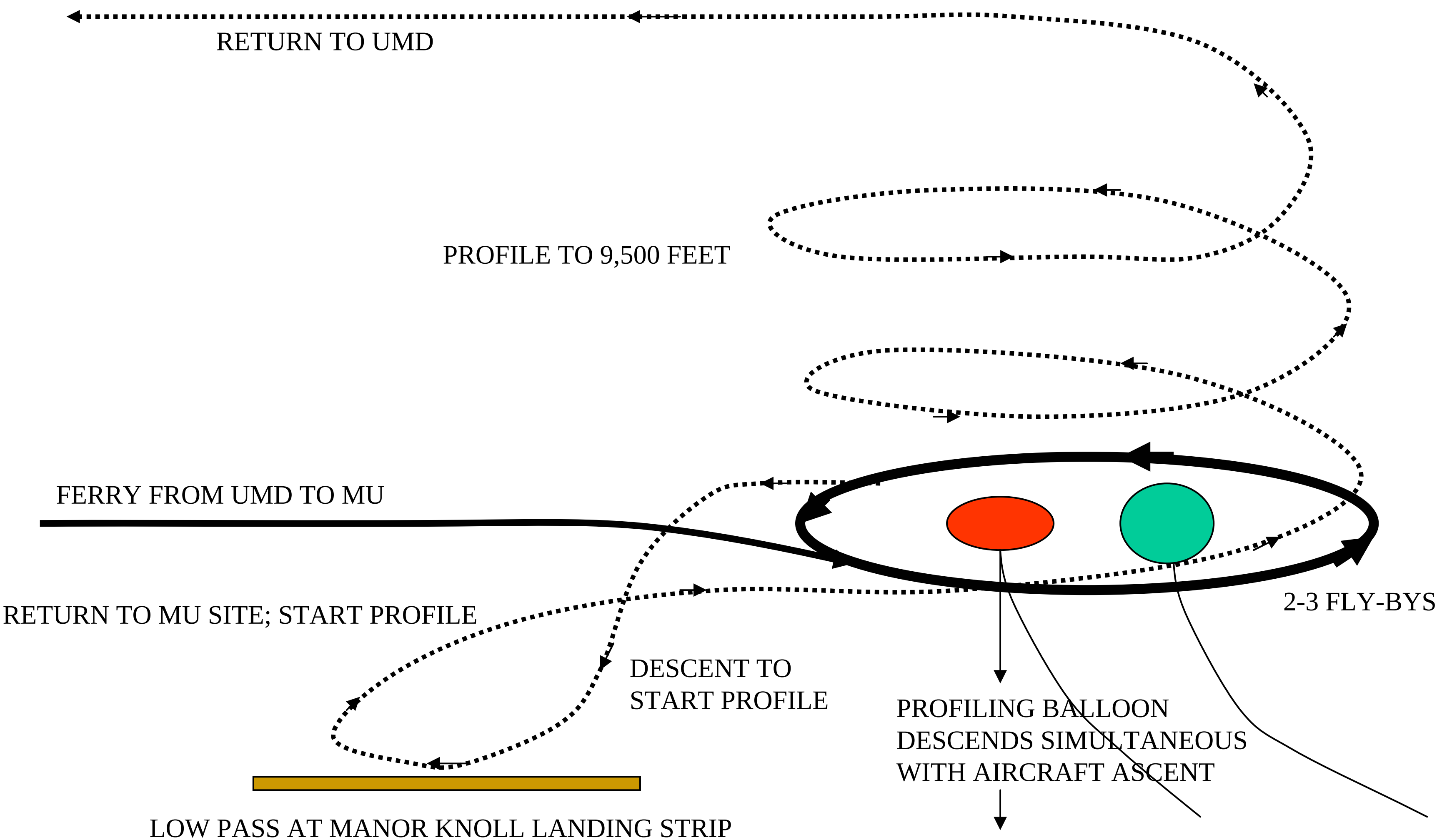
TABLE 2: BLIMP (CA) SENSOR SPECIFICATIONS

Variable or Instrument	Method	Range	Resolution	Response Time	Repeatability	Sampling Frequency
PM2.5 Conc (DustTrak) Temp range 0 – 50 C (Calibrated for standard ISO 12103-1, A1 test dust)	90 deg Laser-diode photometry Flow Rate 1.7 L/min	0.001 … 100 mg/m^3	± .1% of reading or 0.001 mg/m^3	N/A	N/A	1 second thru 2/2/04 3 seconds after 2/2/04
SKC Personal Environmental Monitors for integrated filter samples	Inertial separation/impaction Gravimetric analysis Flow Rate 4 L/min	< 2.5 µm (2.5 µm size cut)	N/A	N/A	N/A	Integrated sample, 4 hours min; 10 hours max.

TABLE 3: SURFACE-BASED INSTRUMENT SPECIFICATIONS

Variable or Instrument	Method	Range	Resolution	Response Time	Repeatability	Sampling Frequency
Temperature	Capacitive wire	-50 … + 60 C	0.1 C	0.2 s	0.10 C	1 minute
Humidity	Thin film capacitor	0 …100%	0.1%	< 0.5 s @ 20 C	2%	1 minute
Pressure	Silicon sensor	500 … 1080 hPa	0.1 hPa	N/A	0.4 hPa	1 minute
Wind speed	3-cup anemometer	0 … 20 m/s	0.1 m/s	N/A	N/A	1 minute
Wind direction	Digital compass	0 … 360 deg	1 deg	N/A	N/A	1 minute
PM2.5 Conc (DustTrak Model 8520) Temp range 0 – 50 C	90 deg Laser-diode photometry Flow Rate 1.7 L/min	0.001 … 100 mg/m^3	± .1% of reading or 0.001 mg/m^3	N/A	N/A	5 minute (ave)
Condensation Particle Counter (TSI Model 3007) Temp range 0 – 50 C	Cloud chamber w/ optical scatterometer Flow Rate 700 cc/min	1.01 … 1.0 µm; 0 …100,000 cm^{-3}	1 particle cm^{-3}	N/A	N/A	5 minute (ave)
SKC Personal Environmental Monitors for integrated filter samples	Inertial separation/impaction Gravimetric analysis Flow Rate 4 L/min	< 2.5 µm (2.5 µm size cut)	N/A	N/A	N/A	Integrated sample, 4 hours min; 10 hours max.
TSI 3-wavelength Nephelometer Model 3563 Scatter-coef of airborne particles	Optical integrating nephelometry; 450 nm (blue), 550 nm (green), 700 nm (red). Flow Rate 20-200 L/min	Sensitivity Blue/green 1.0 x 10^{-7} m^{-1} Red/IR 3.0 x 10^{-7} m^{-1}	Drift Less than 2.0×10^{-7} m^{-1} at 30-sec ave time	< 10 sec		5 minute (ave)
CO conc API model 300A	Gas filter correlation RFNA-0193-093	0-1 ppm 0-1000 ppm	< 0.5 % of reading per EPA definition	< 10 sec per EPA definition	N/A	1 minute (ave)
SO_2 conc API model 100A	Fluorescence EQSA-0990-077	0-50 ppb / 0-20 ppm auto ranging	0.4 ppb RMS	< 20 sec per EPA definition	N/A	1 minute (ave)
NO_x conc API model 200A	Chemiluminescence RFNA-1194-099	0-5 ppb / 0-2000 ppb user selectable	0.4 ppb RMS	< 20 sec per EPA definition	N/A	1 minute (ave)

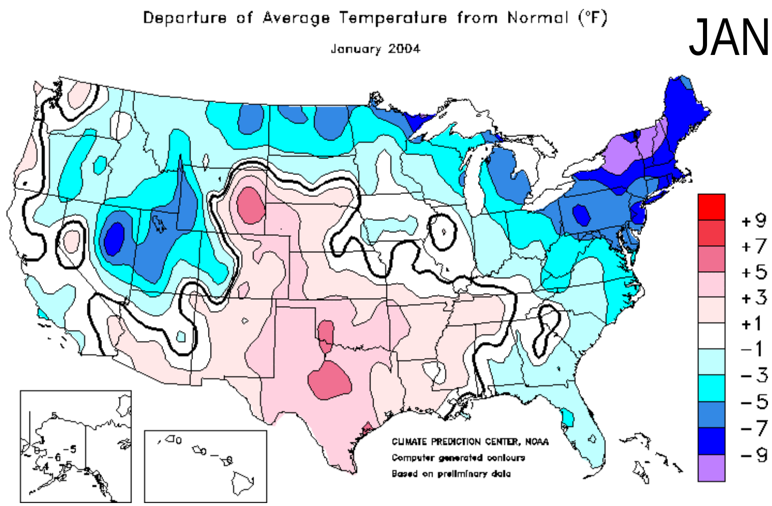
UMD-MU COMPARISON

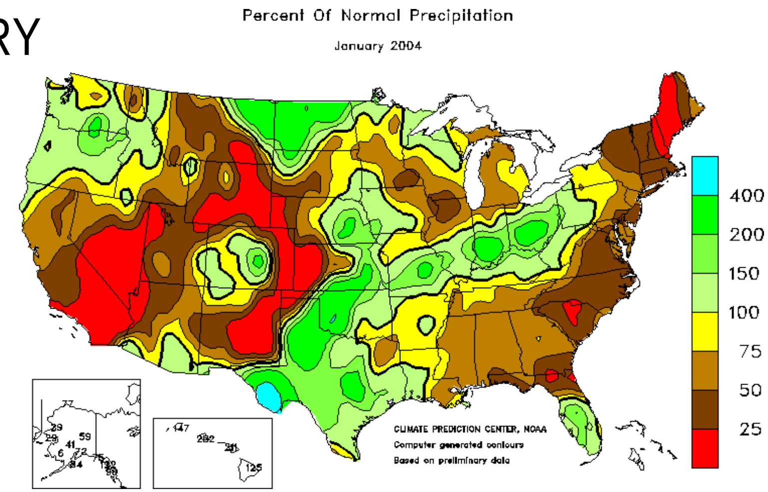


Overview of Winter 2004 Climatology

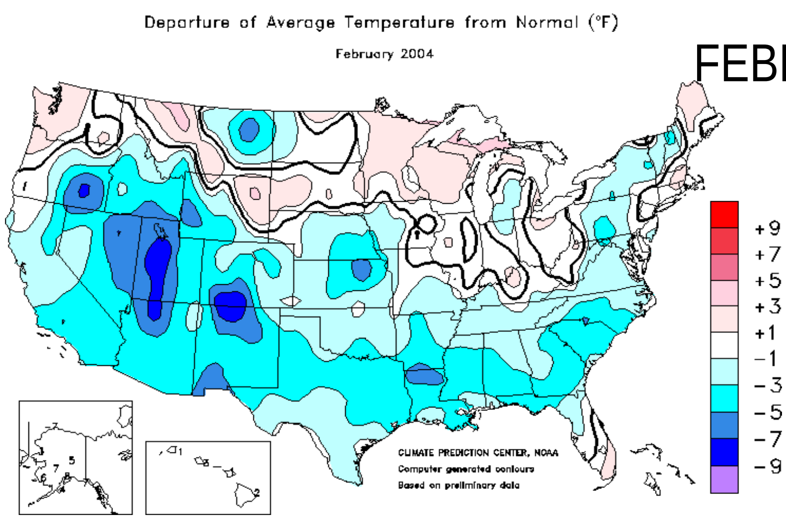
From 3 January - 14 February 2004 the site experienced temperature departures of -6.6 F from normal and 9.6 mm above normal precipitation

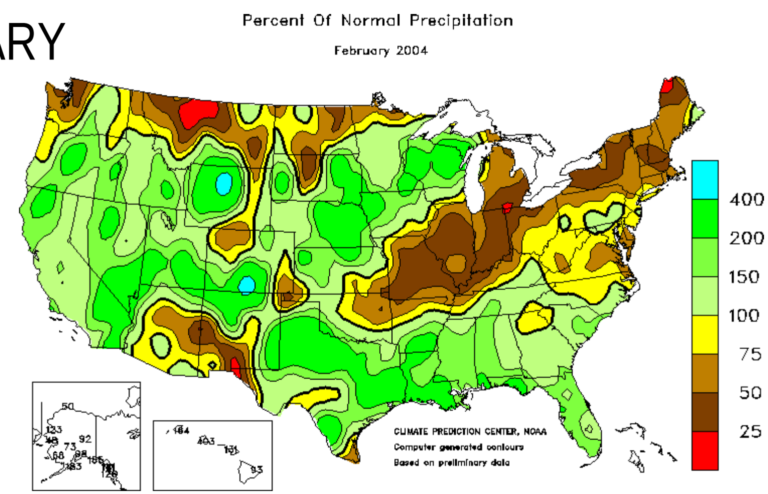
JANUARY





FEBRUARY

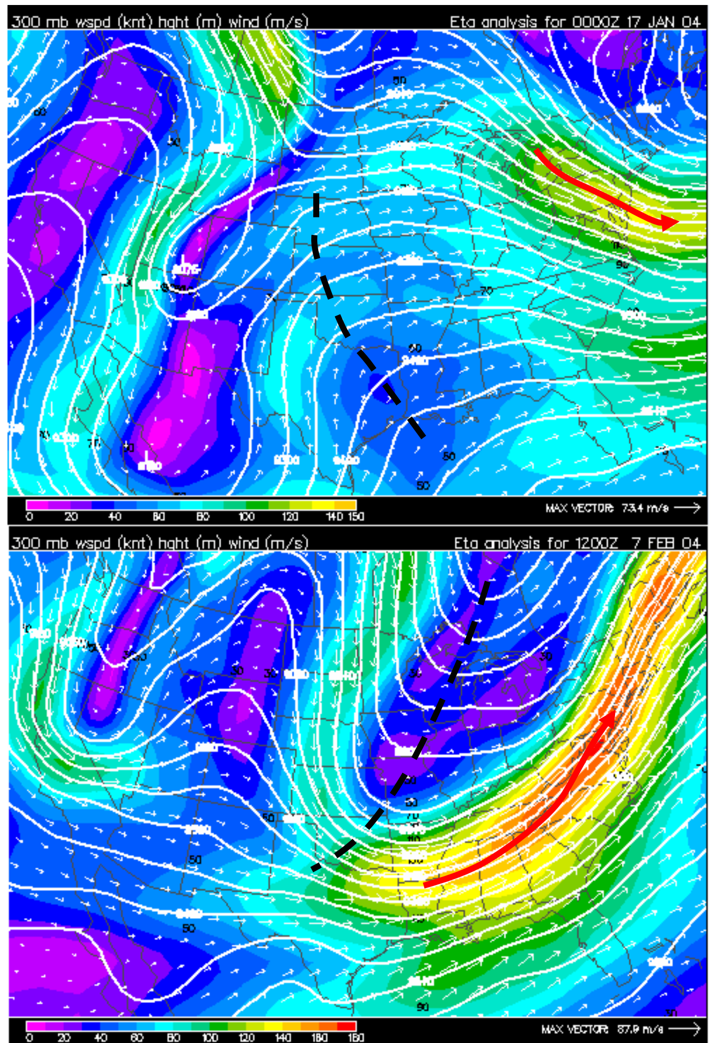




Difference in synoptic pattern between early and late periods

Early

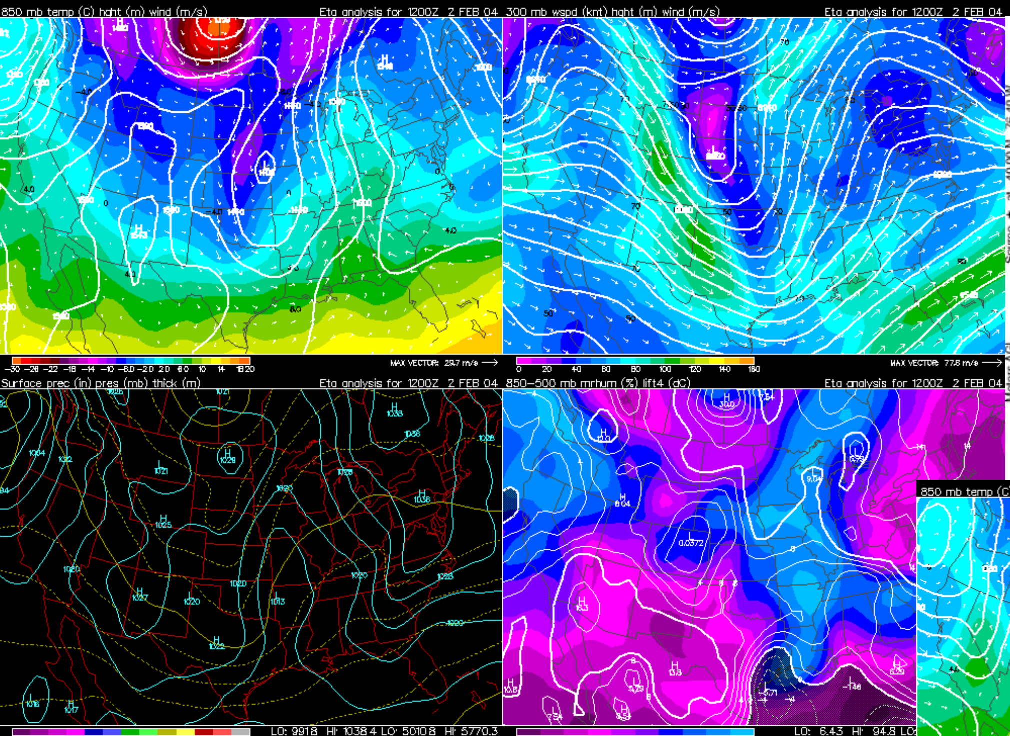
- January characterized by progressive wave short pattern
- Rapid exchange of air masses
- Influx of air from the Canadian Provinces
- Coupling of the subtropical and polar jets
- Strong baroclinicity

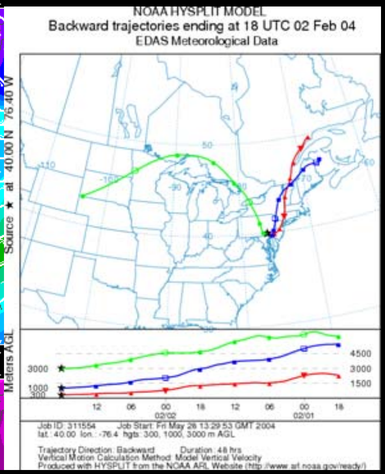


Late

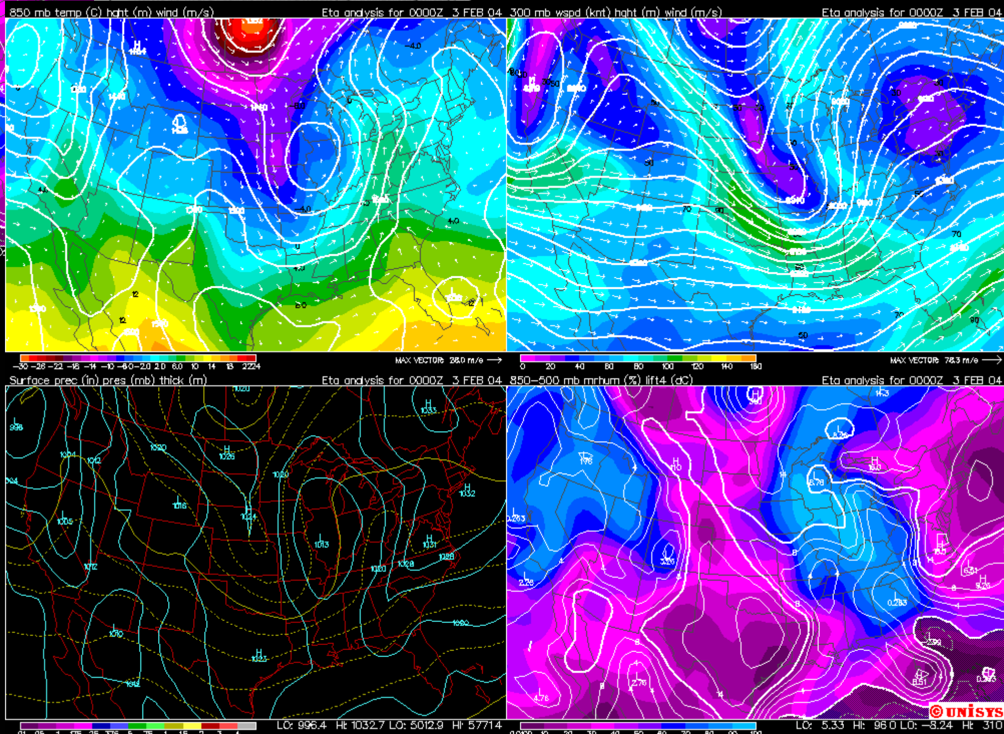
- Significant pattern change in late January (~ 27th)
- Mean trough established in Midwest
- Influx of air from south-central US and Gulf of Mexico
- Temperature and moisture more seasonal
- Strong baroclinicity continues

Case Studies: 2 FEB 2004 (daytime progressive anticyclone)



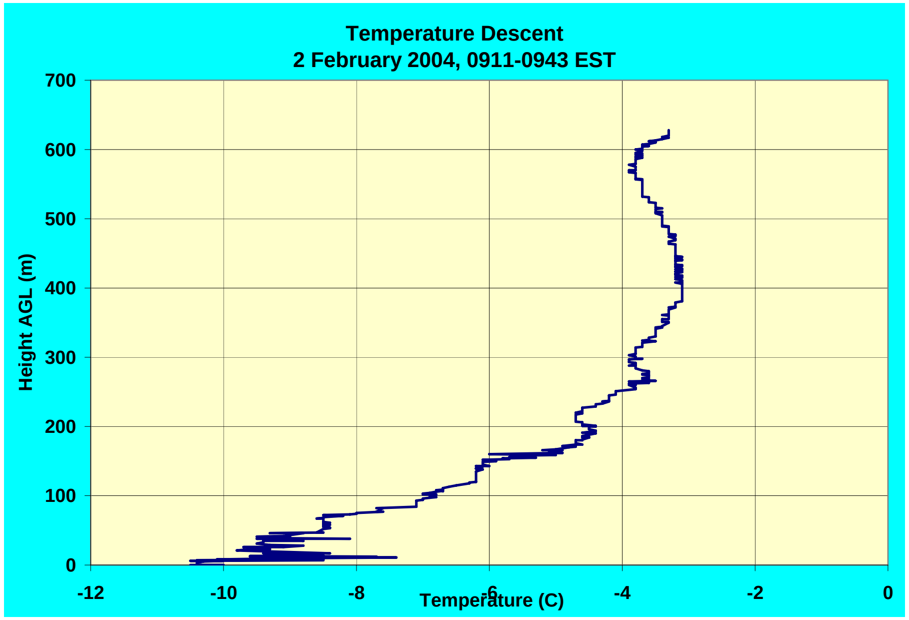


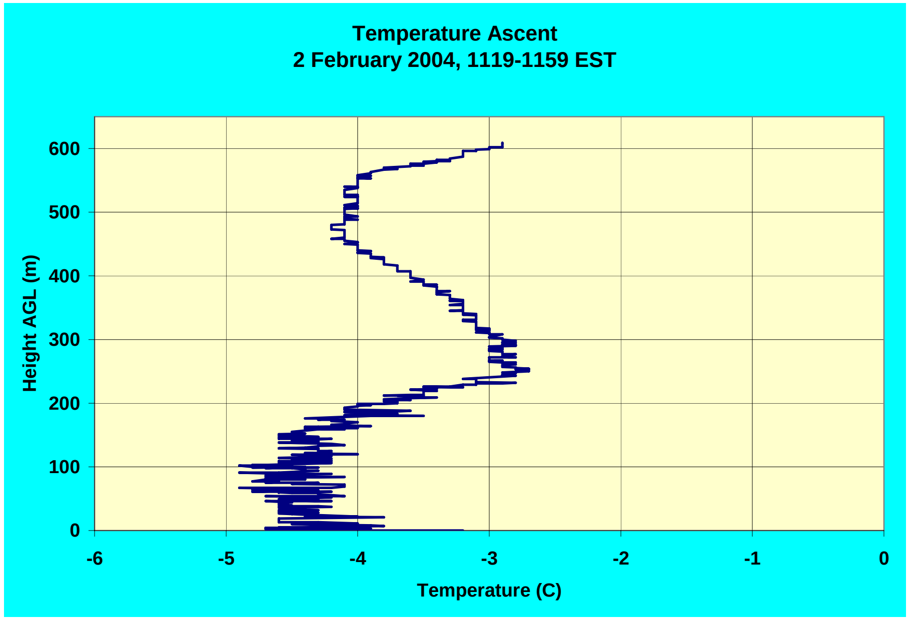
00Z 3 FEB 04

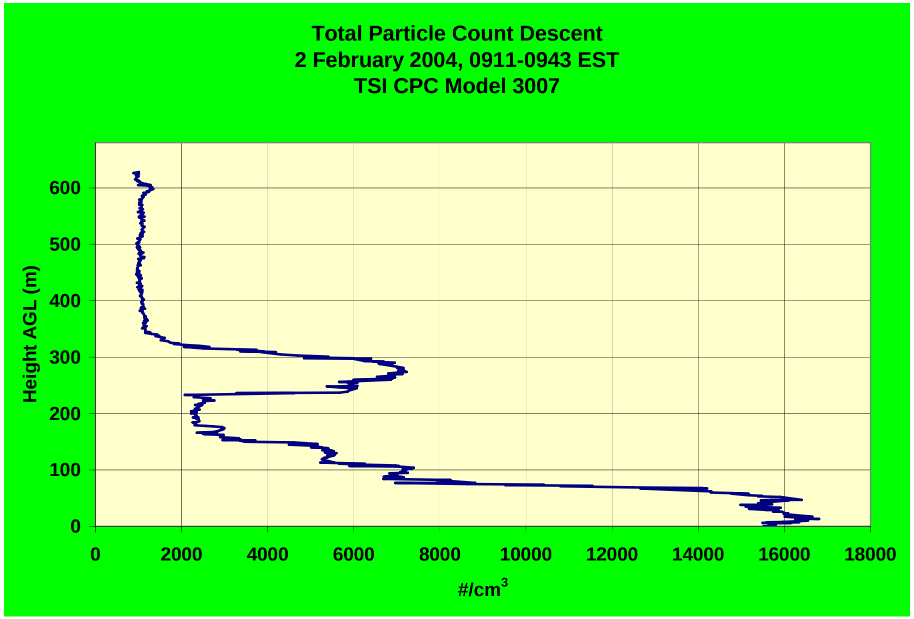


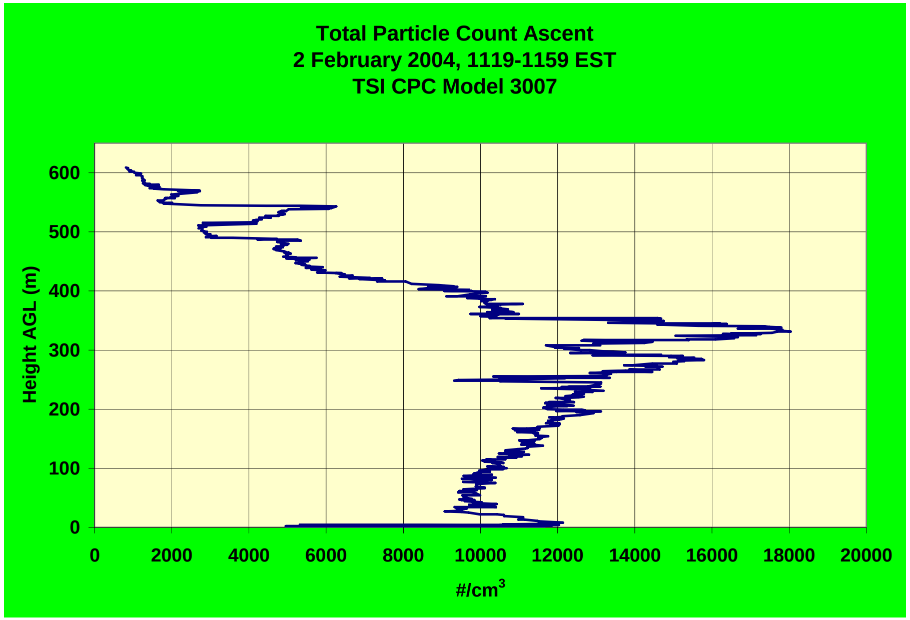
12Z 2 FEB 04

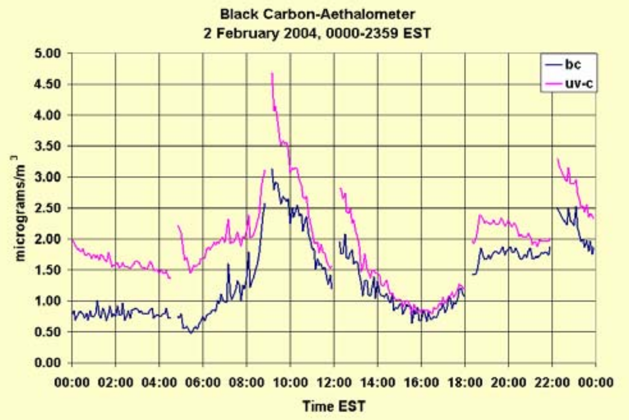
Case Study: 2 FEB 2004

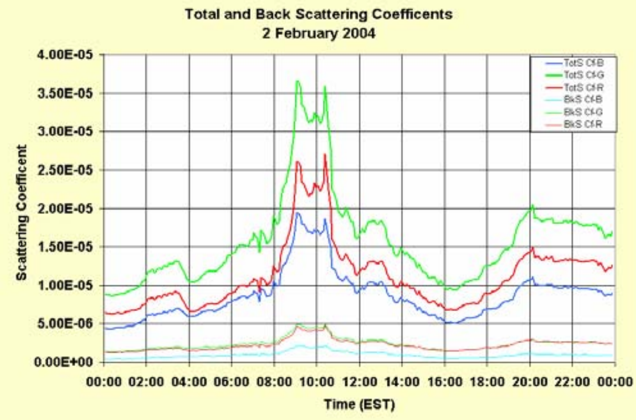






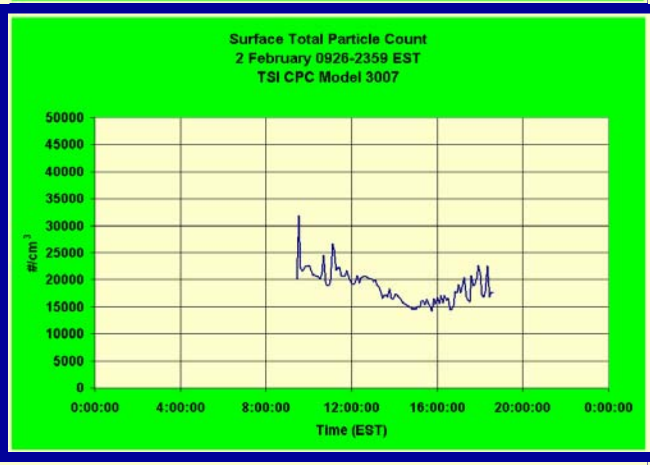


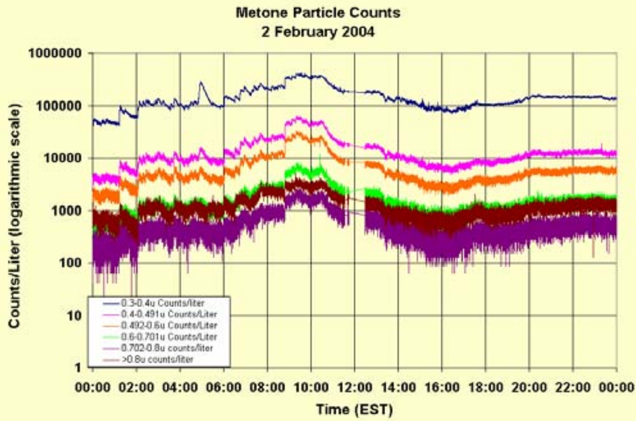


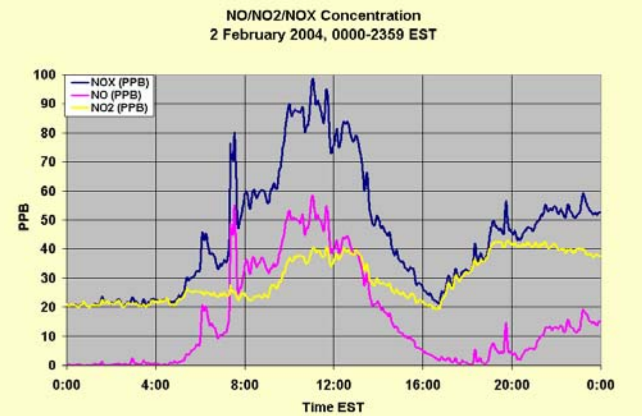


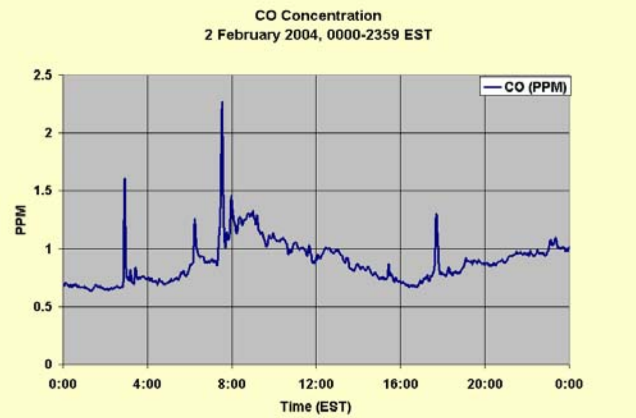
Case Studies:
2 FEB 2004

Surface Quantities

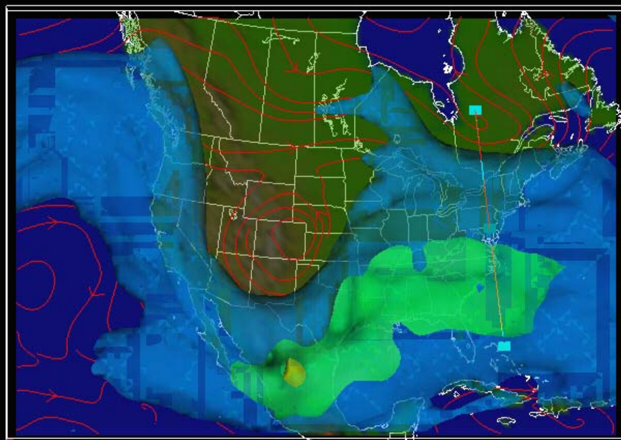


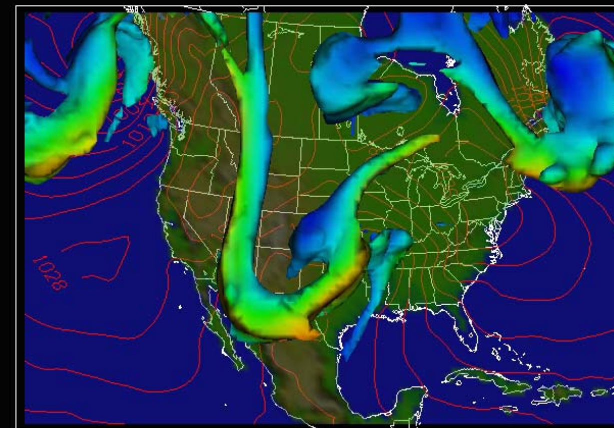


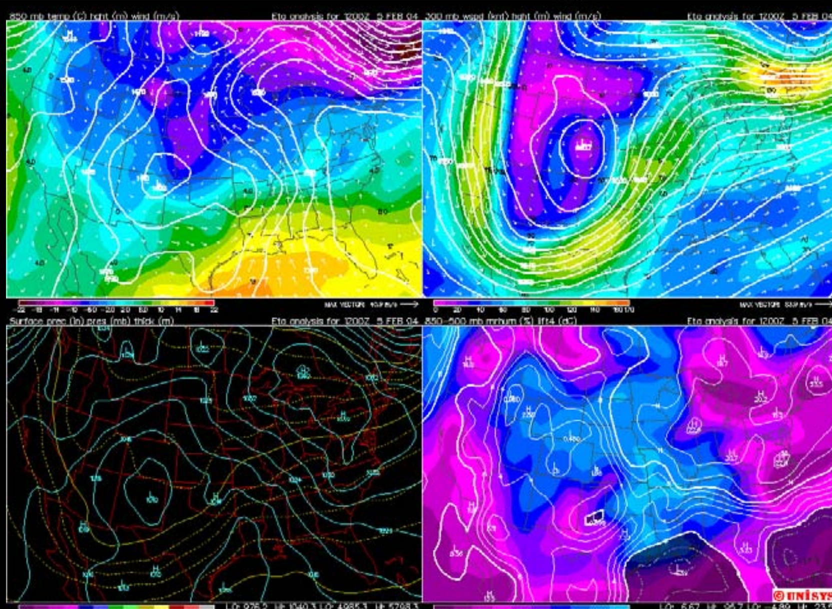


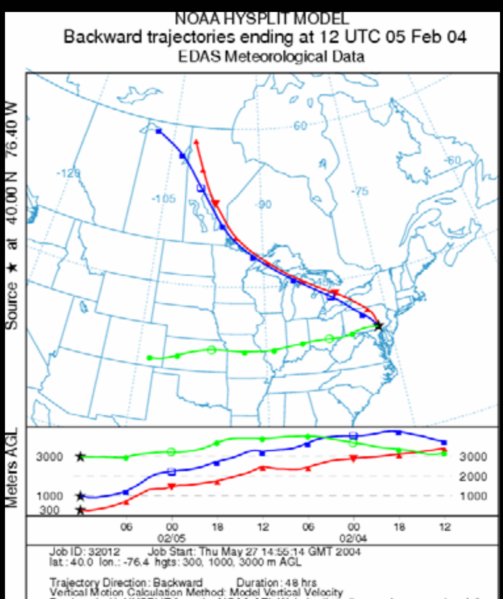


Case Studies: 5 FEB 2004 (nighttime stratification)

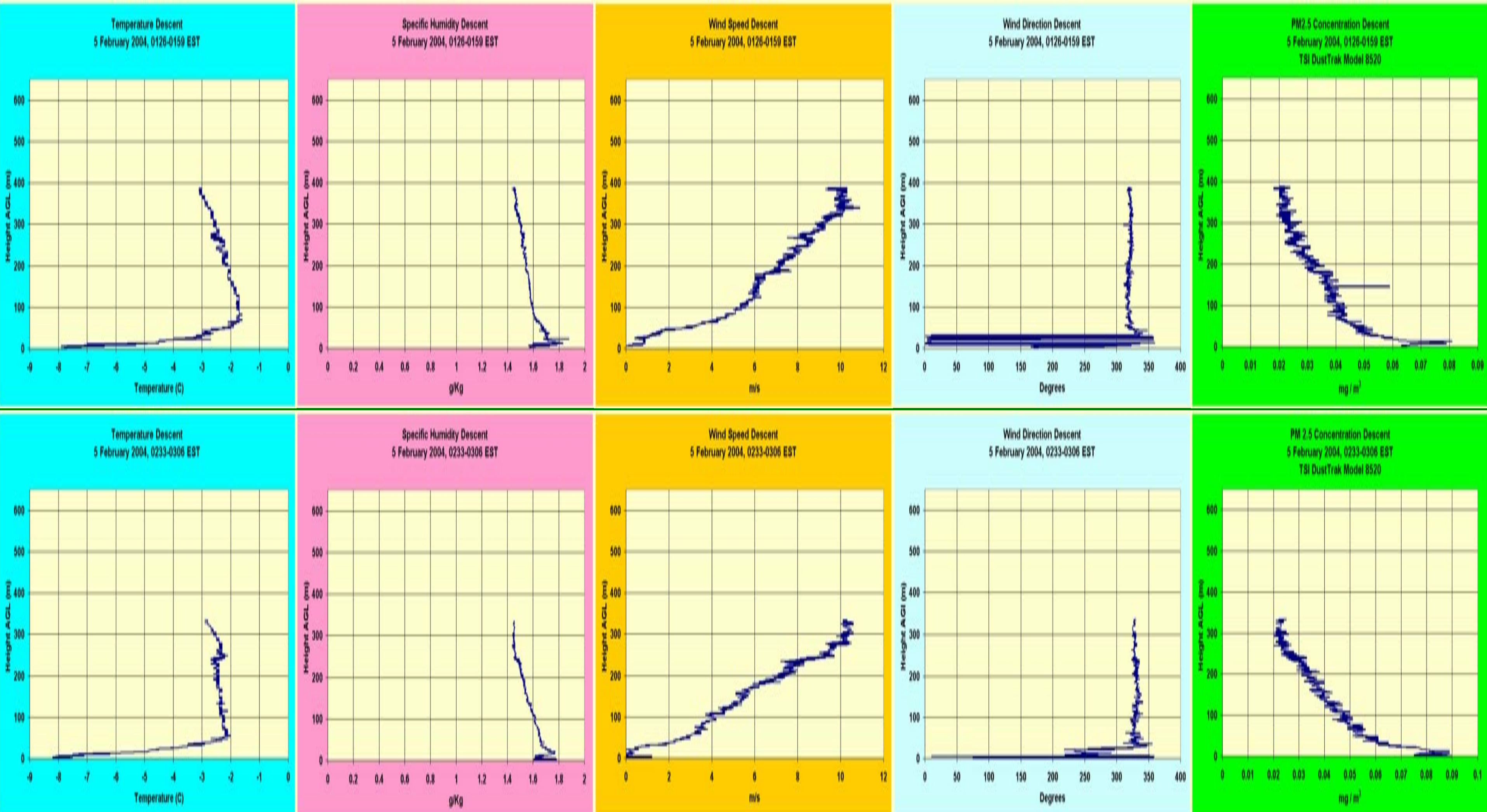




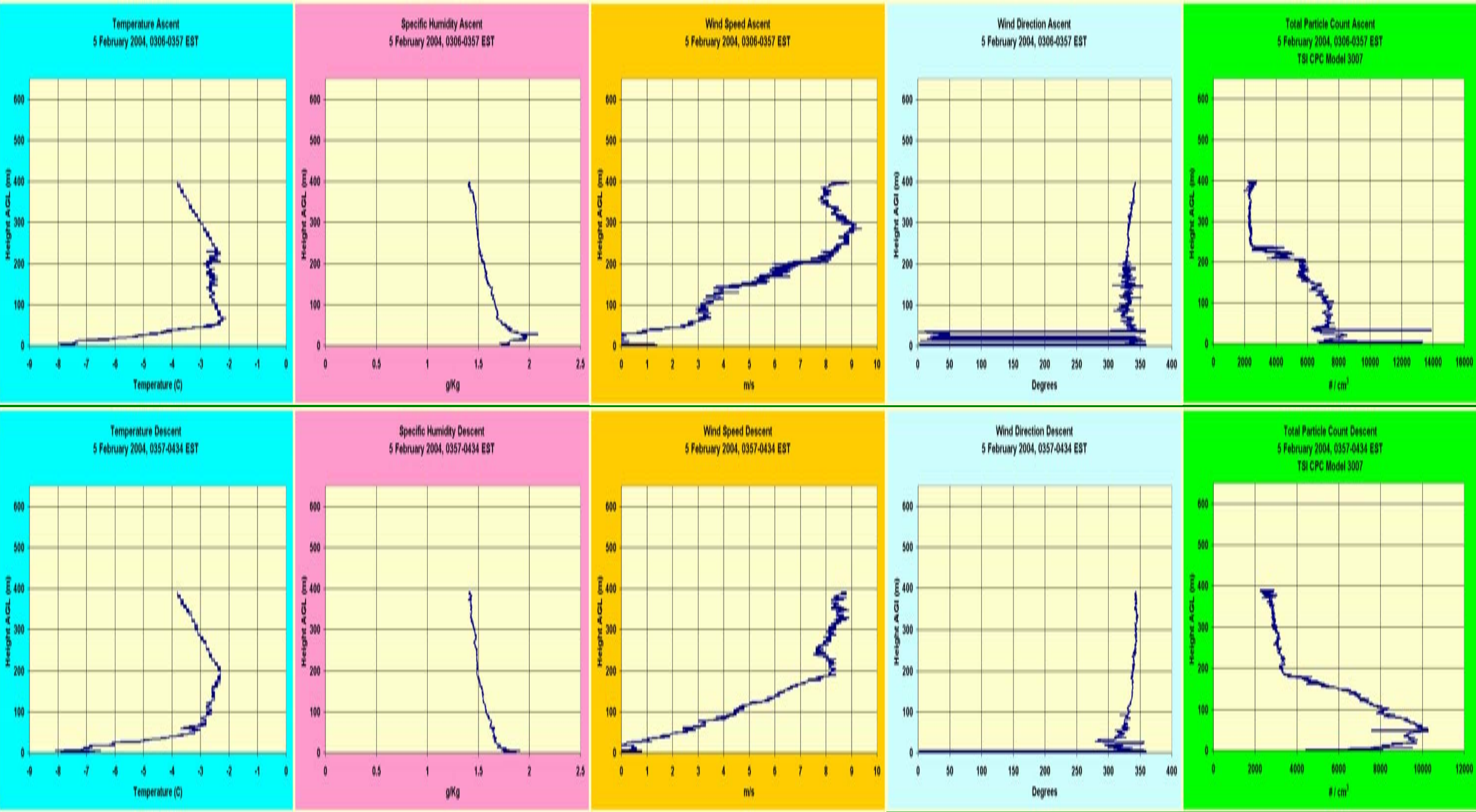




Case Study: 5 FEB 2004



Case Studies: 5 FEB 2004



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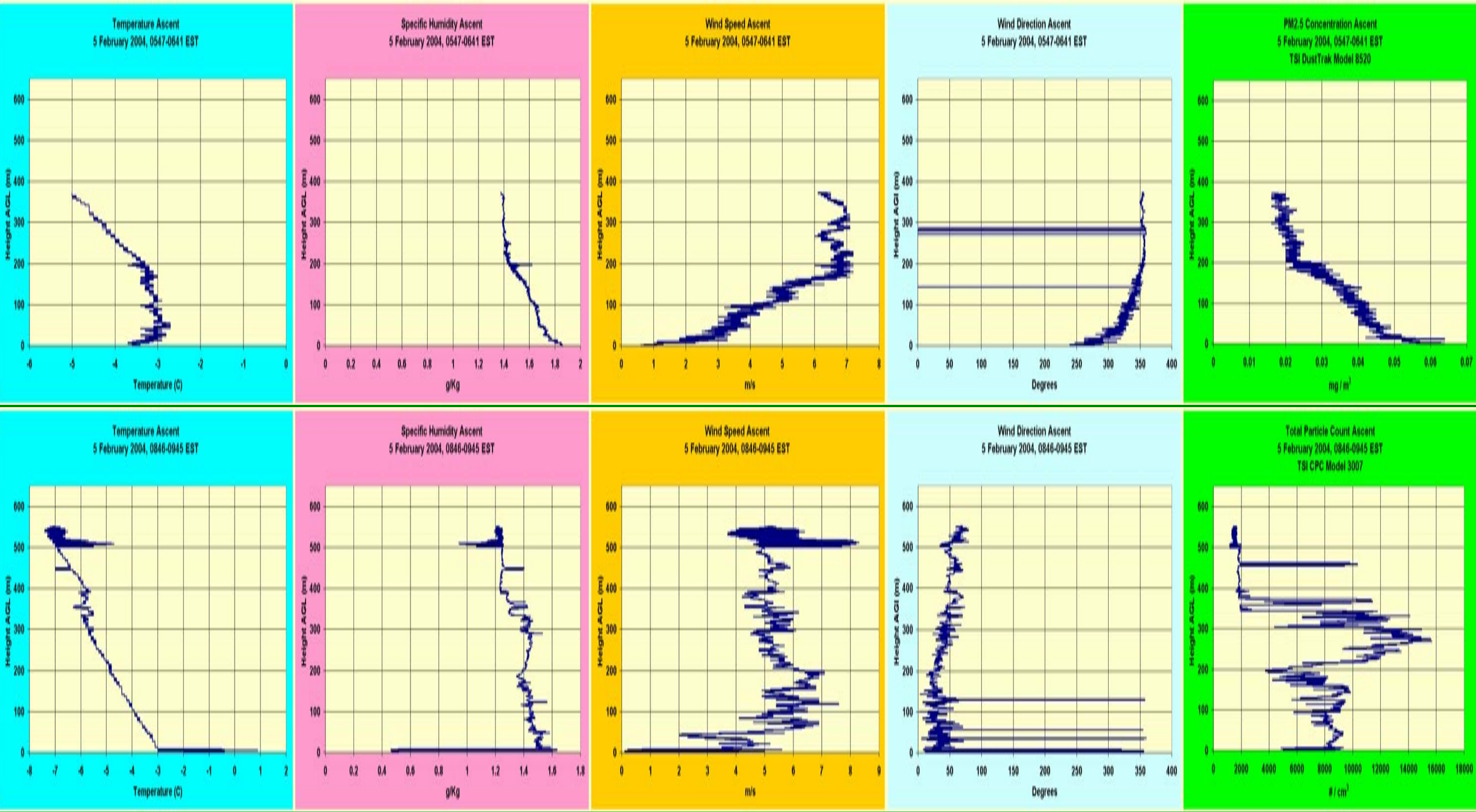

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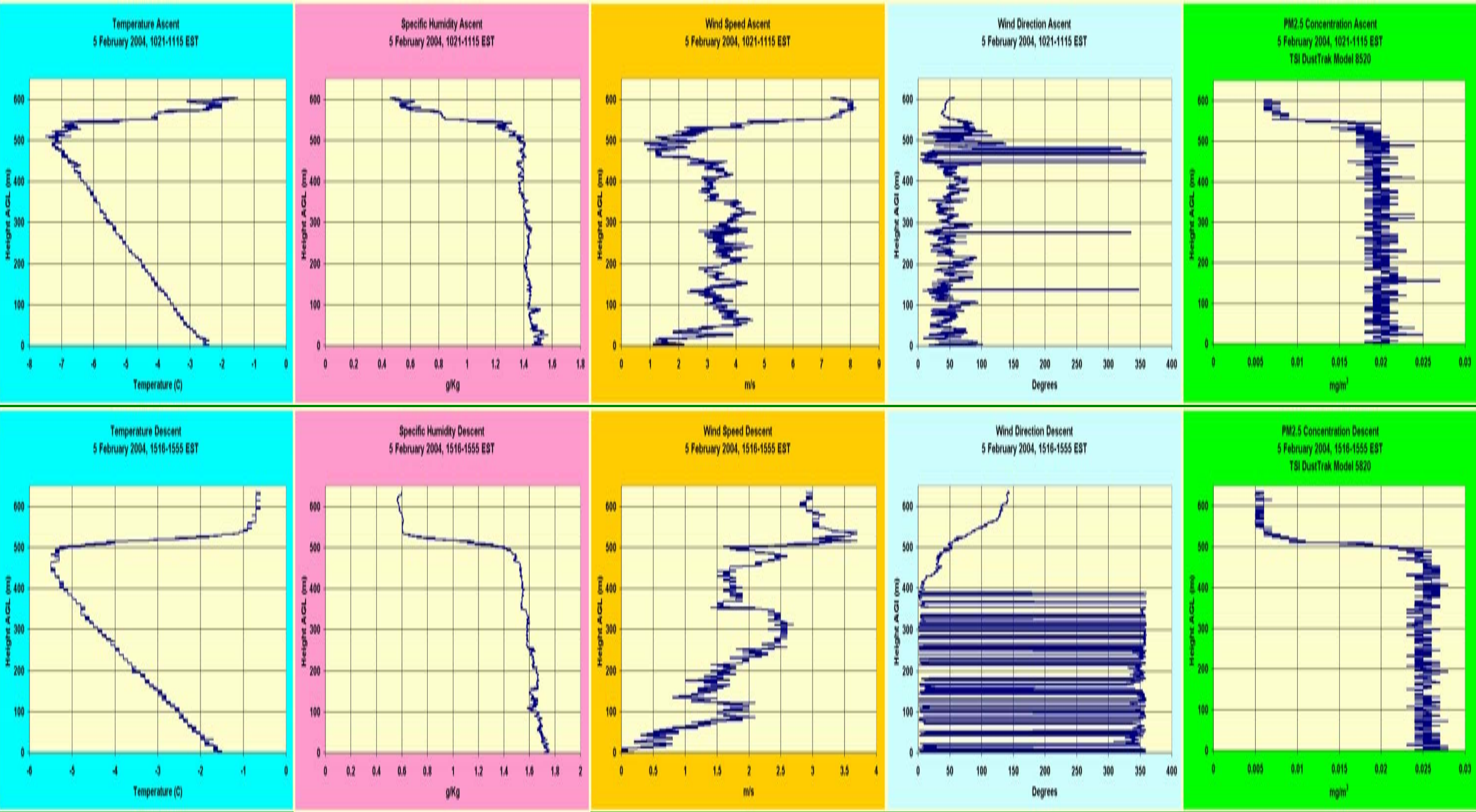
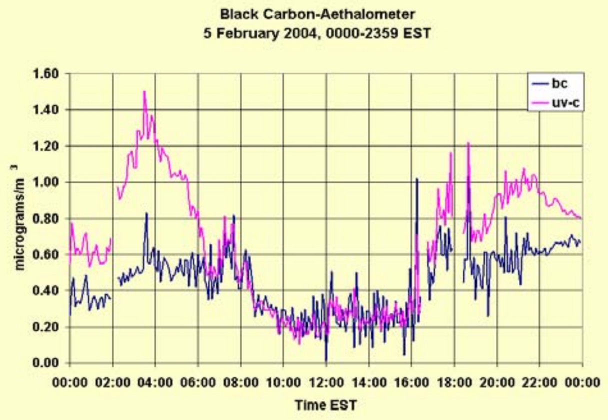
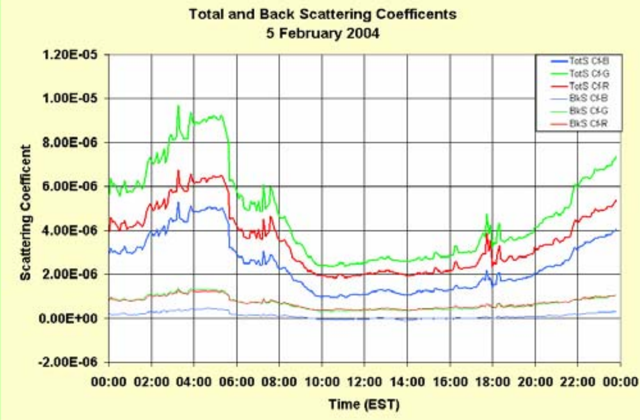


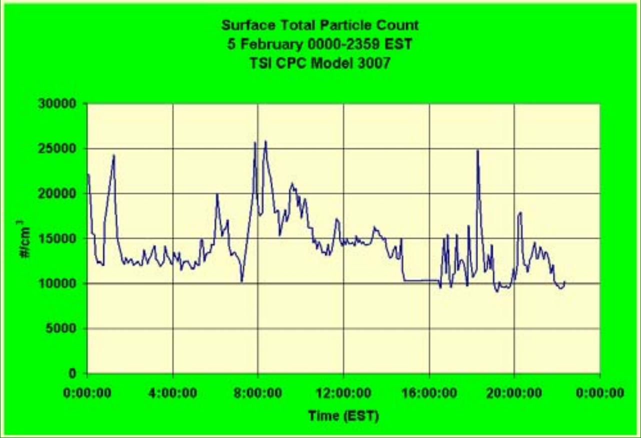


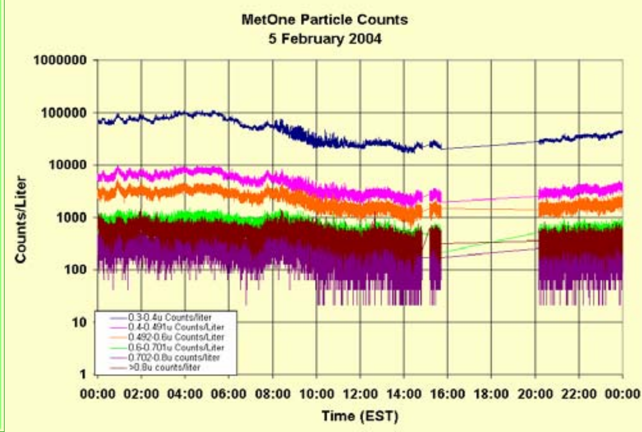


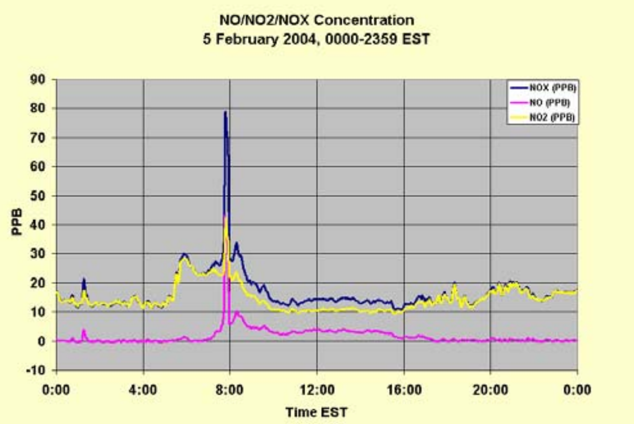
Case Studies:

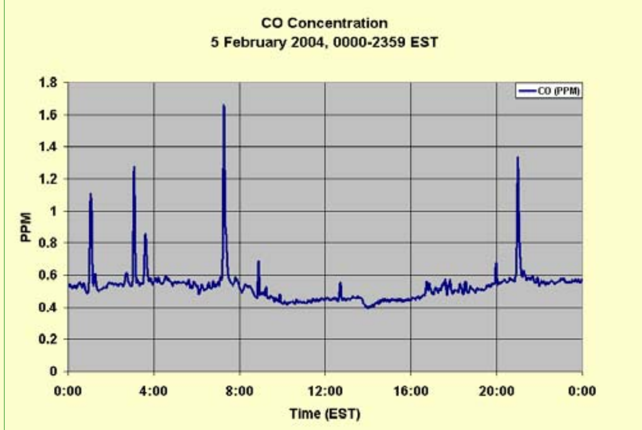
5 FEB 2004

Surface Quantities



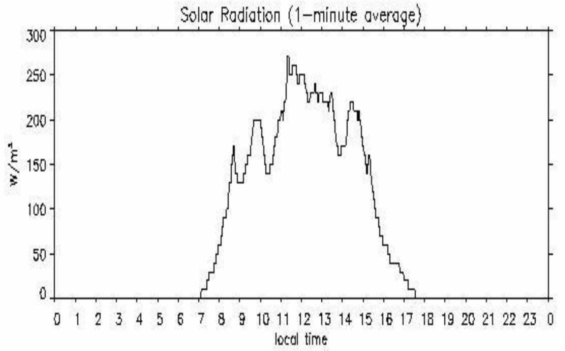


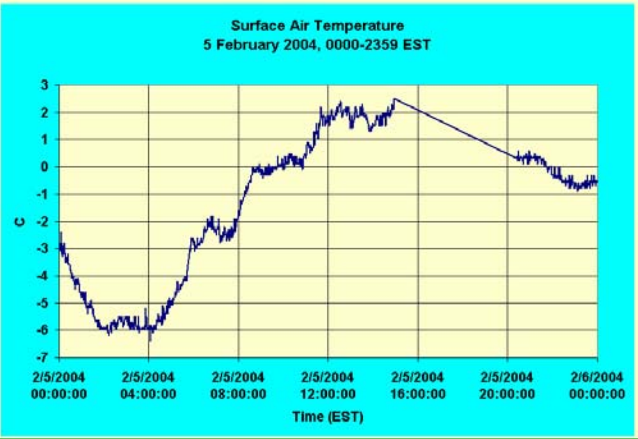


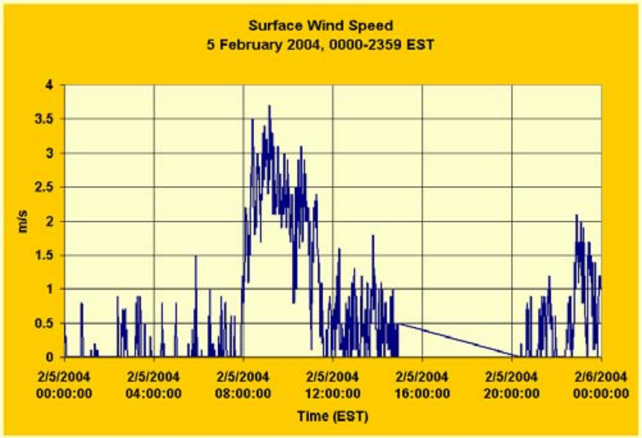


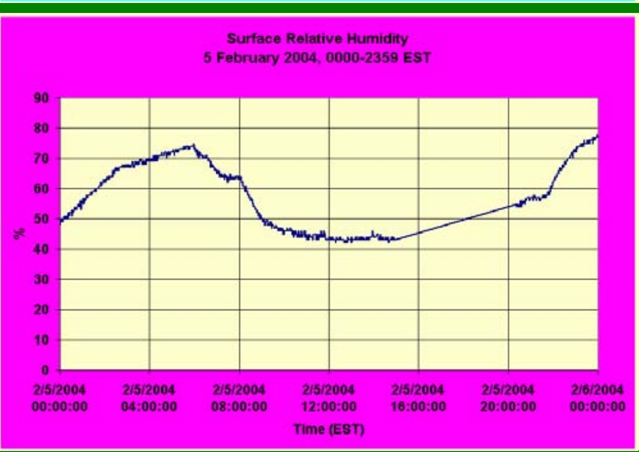
<u>Case Studies:</u>
5 FEB 2004

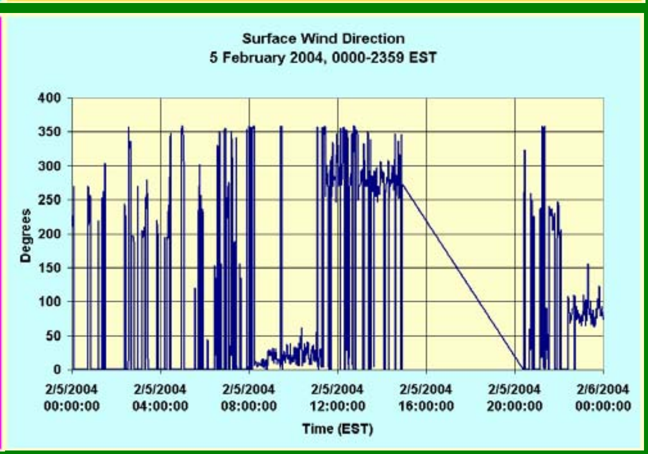
Surface Meteorology











Meteorology Drives Everything!

Thank you
Questions?