Spatial Variability in Measured Urban Fine Particles

Solomon T. Bairai, Roger L. Tanner
Tennessee Valley Authority, P.O. Box 1010, Muscle Shoals, AL 35662
Menachem Luria
Hebrew University, Givat Ram, Jerusalem, 91904, Israel
Robert E. Imhoff
MCNC, P.O. Box 12889, Research Triangle Park, NC 27709

Scientific Issues

- Concentrations of trace gases (O_3, CO, SO_2, NO_y) may vary widely vertically & horizontally, especially at night.
- Knowledge of this variability at the time of nocturnal boundary layer (BL) breakup is limited.
- Formation and transport of secondary O_3 and fine particulate mass may depend strongly on this 3D structure.

Experimental Approach

- Sample an urban area during the morning BL breakup and again in the afternoon of the same day.
- Use vertical profiles to the top of the previous day's BL followed by horizontal transects upwind and downwind of the city.
- Probe both the gas-phase O_3 chemistry and the secondary aerosol properties.

Aircraft Instrument Package TVA Bell 205 Helicopter

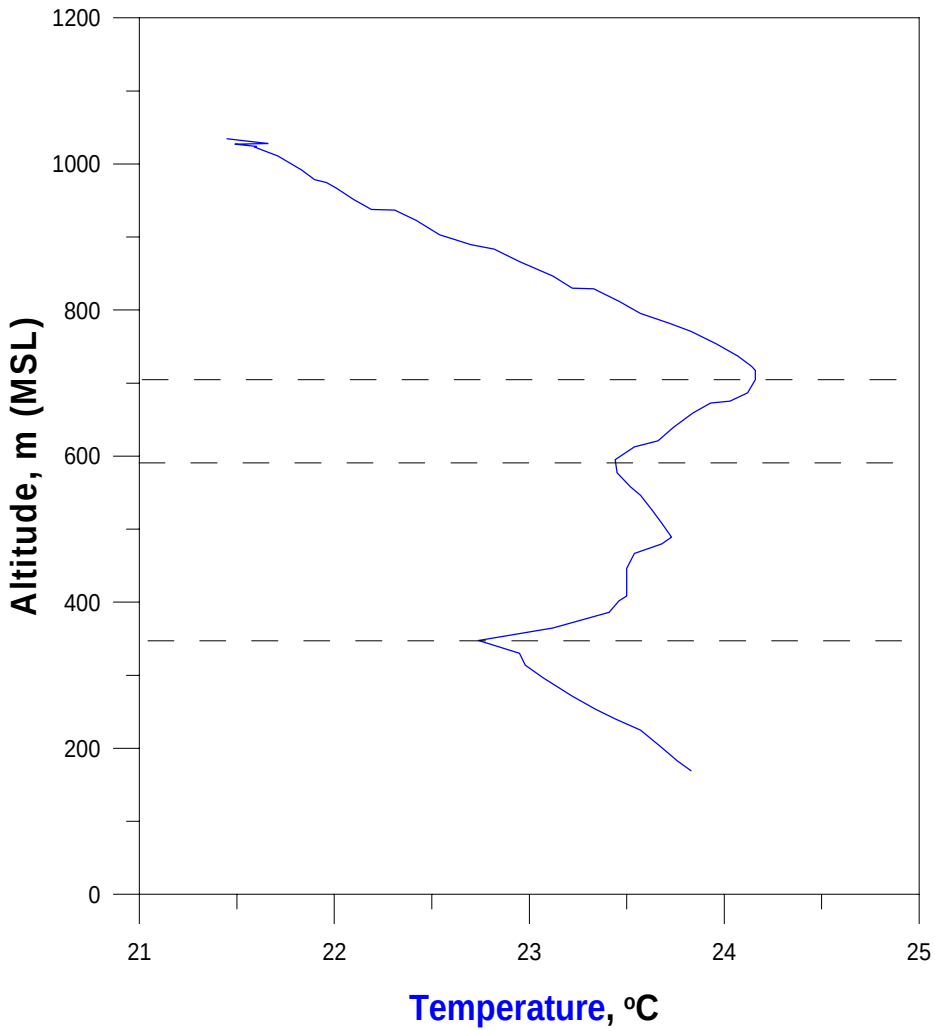
Endurance:	2 hrs
Ceiling:	2.5 km
Payload:	500 kg
Research Speed:	40-50 m/s

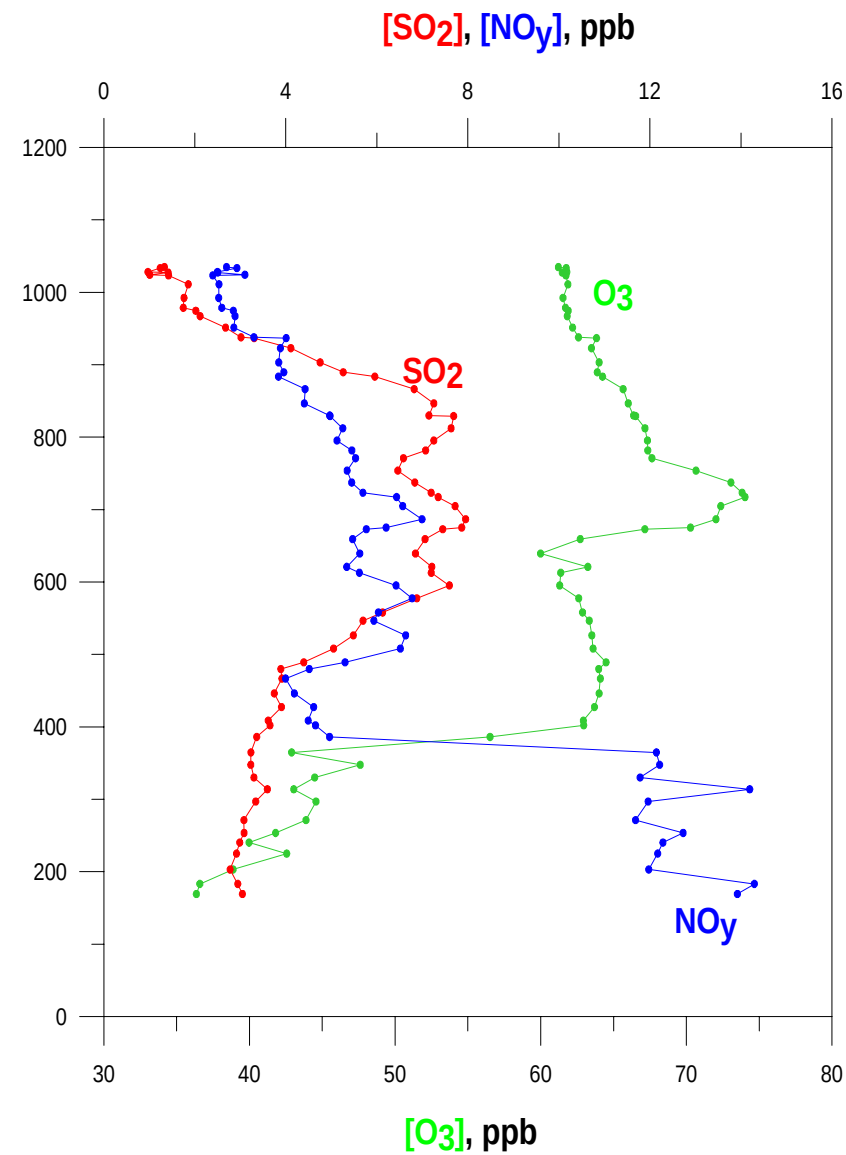
Parameter	Time Resolution	Method	Det. Limit
Ozone (O_3)	**1 s**	**NO Chemiluminescence**	**2 ppb**
Sulfur Dioxide (SO_2)	**5 s**	**UV Pulsed Fluorescence**	**0.5 ppb**
Total Nitrogen Oxides (NOy)	**1 s**	**Au Converter, NO/O_3 Chem.**	**1 ppb**
b_{scat}	**5 s**	**Nephelometer**	**< 10^{-6} m^{-1}**
Aerosol Size Distribution	**1 s**	**PCASP.**	**(0.17 - 3µm)**

Other Instrumentation

CO, NO, NO_2, NO_y^*, Air Temperature, Dew point, Altitude, Position, Air Speed, Heading

July 8, 1999 Morning Vertical Profile over Cornelia Fort (Nashville)

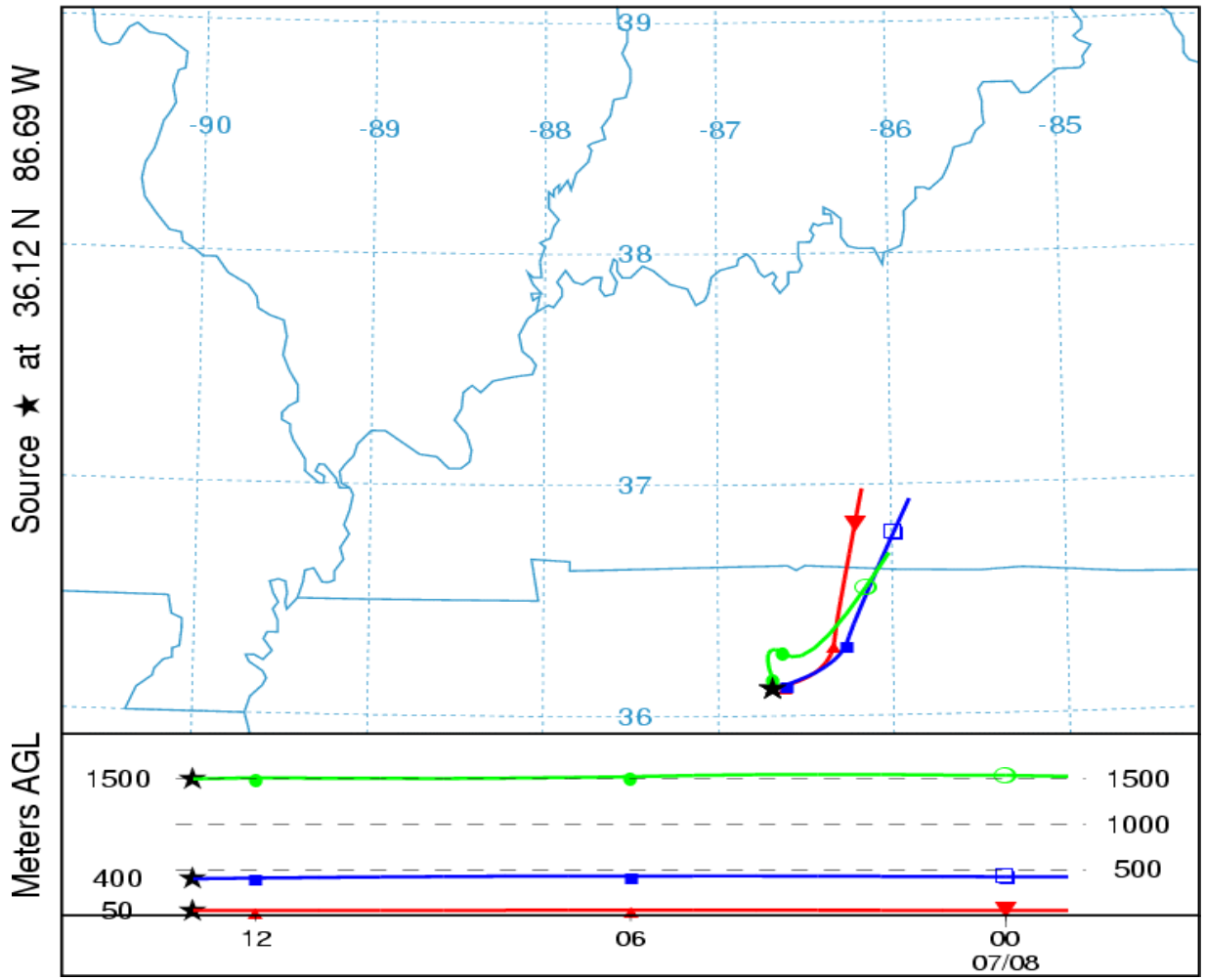




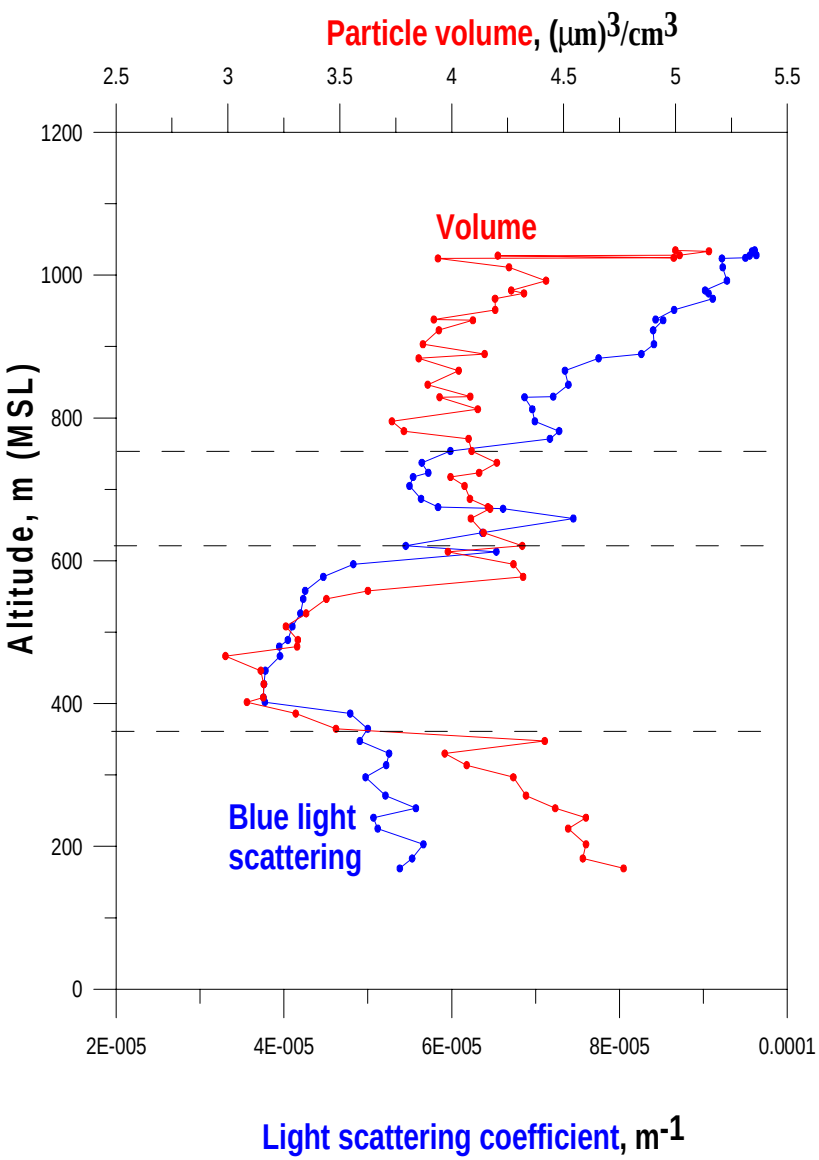
NATIONAL OCEANIC ATMOSPHERIC ADMINISTRATION

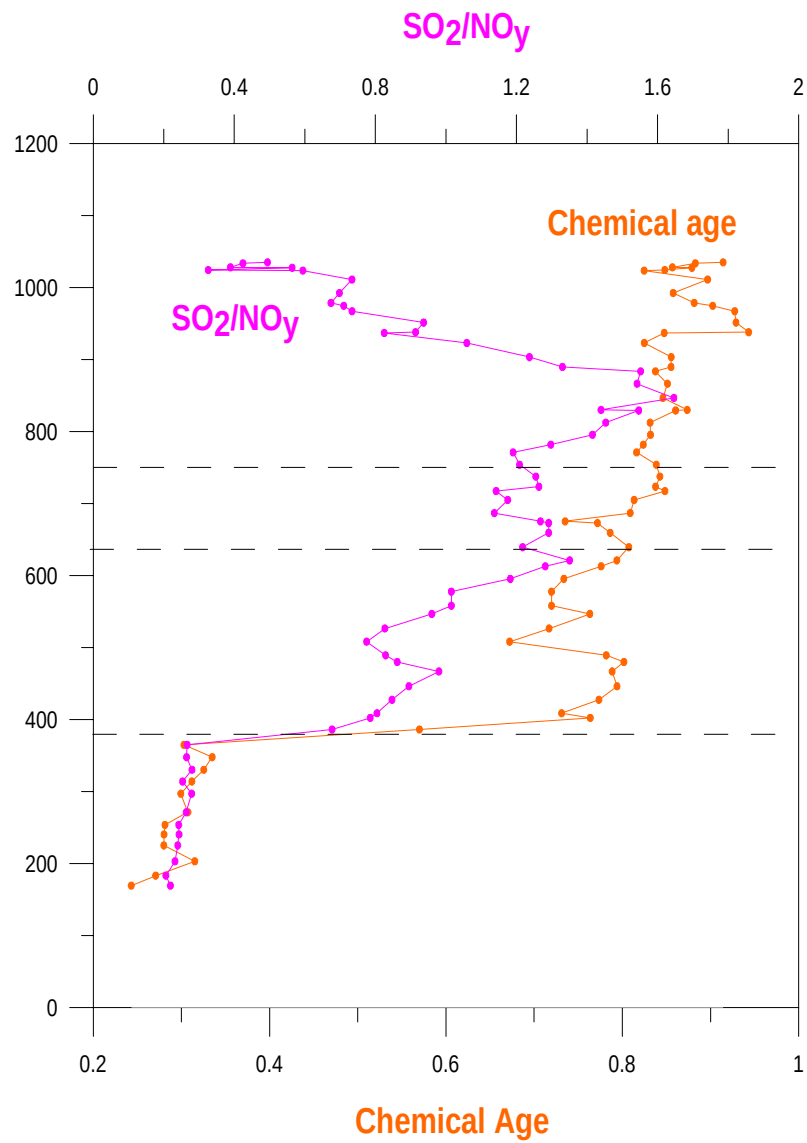
Backward trajectories ending at 13 UTC 08 Jul 99

CDC1 Meteorological Data

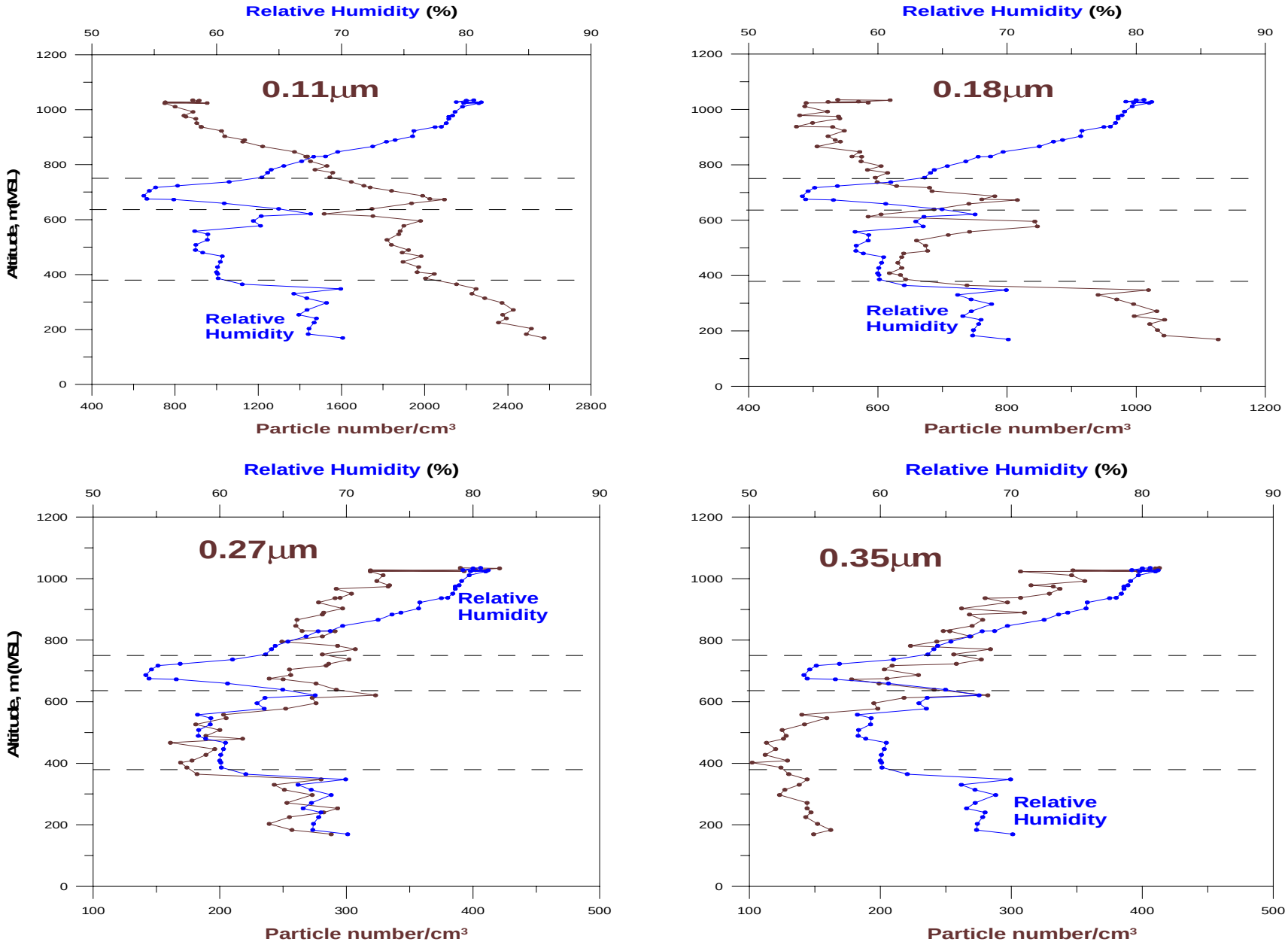


July 8, 1999 Morning Vertical Profile, Nashville

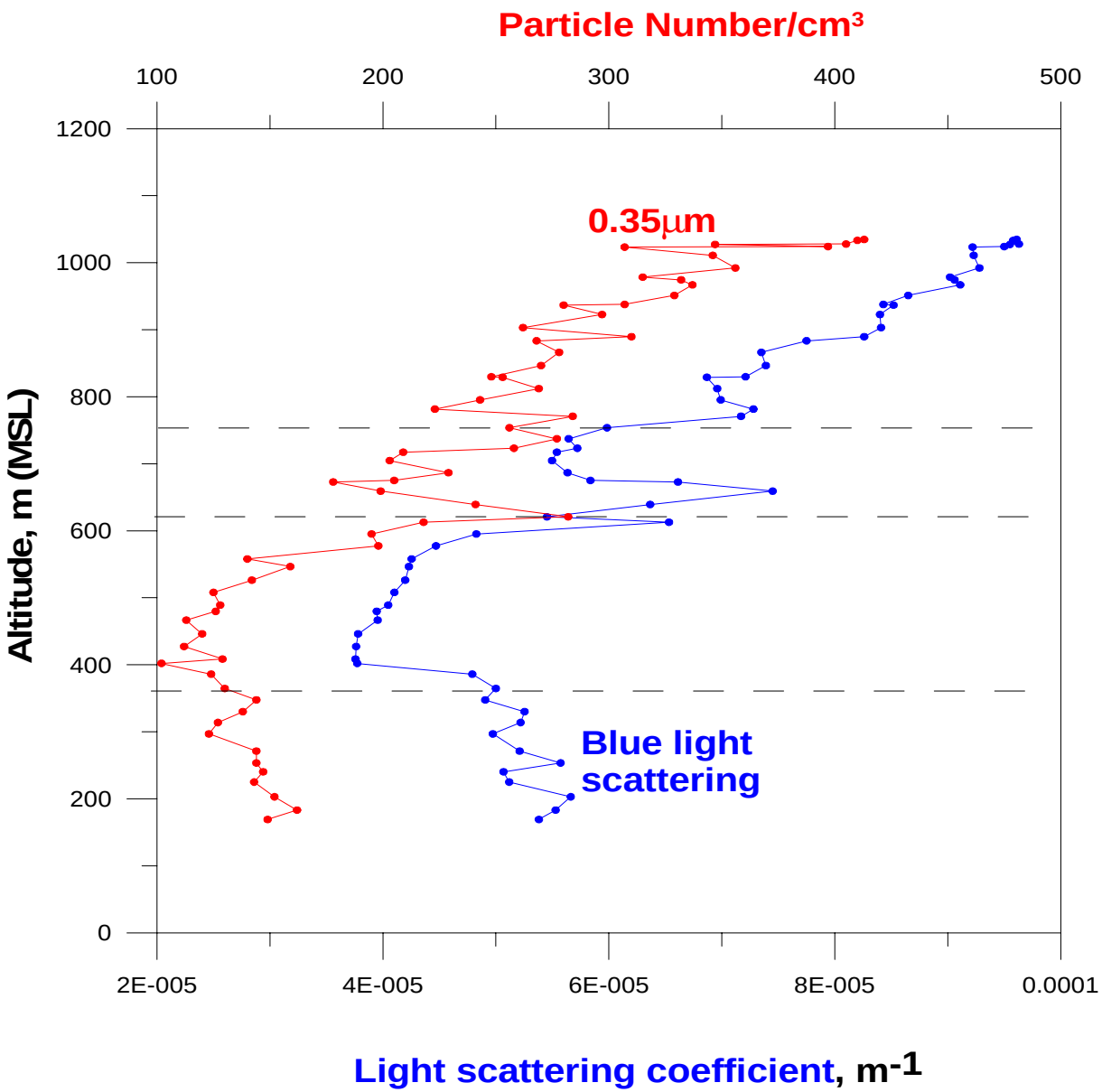




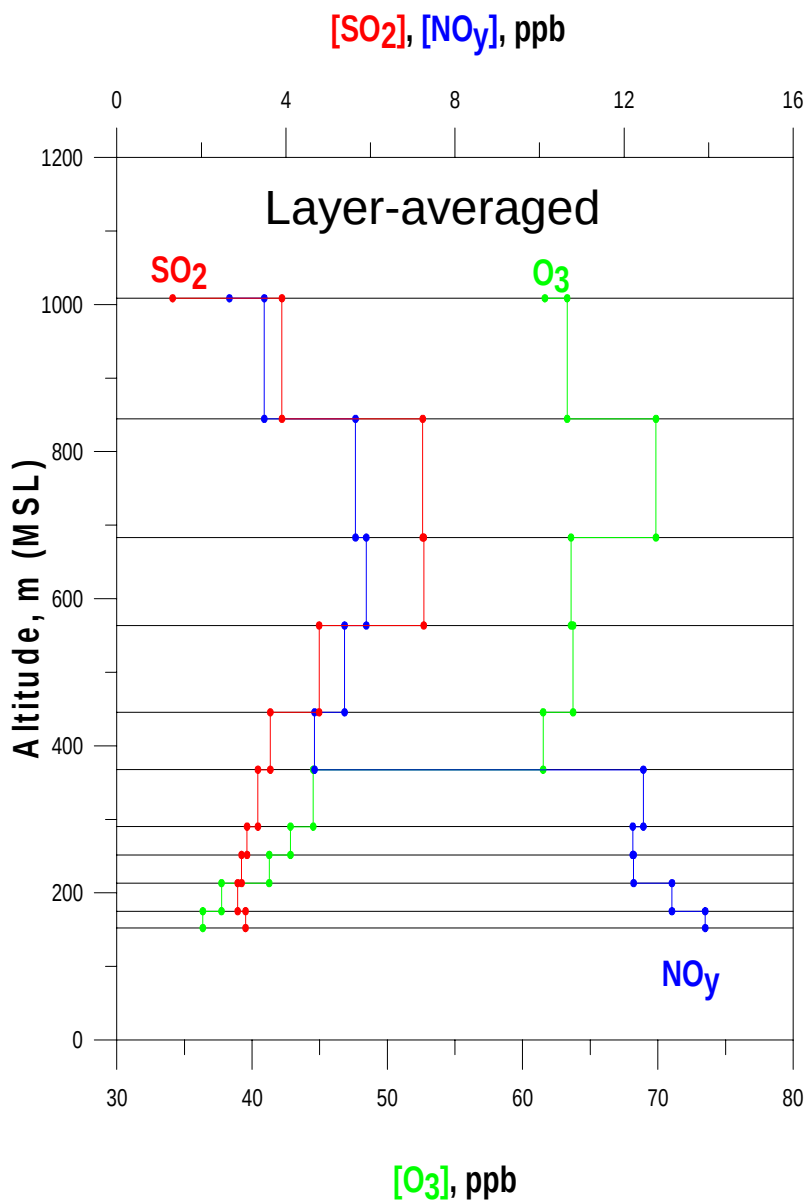
July 8, 1999 Morning Vertical Profile, Nashville

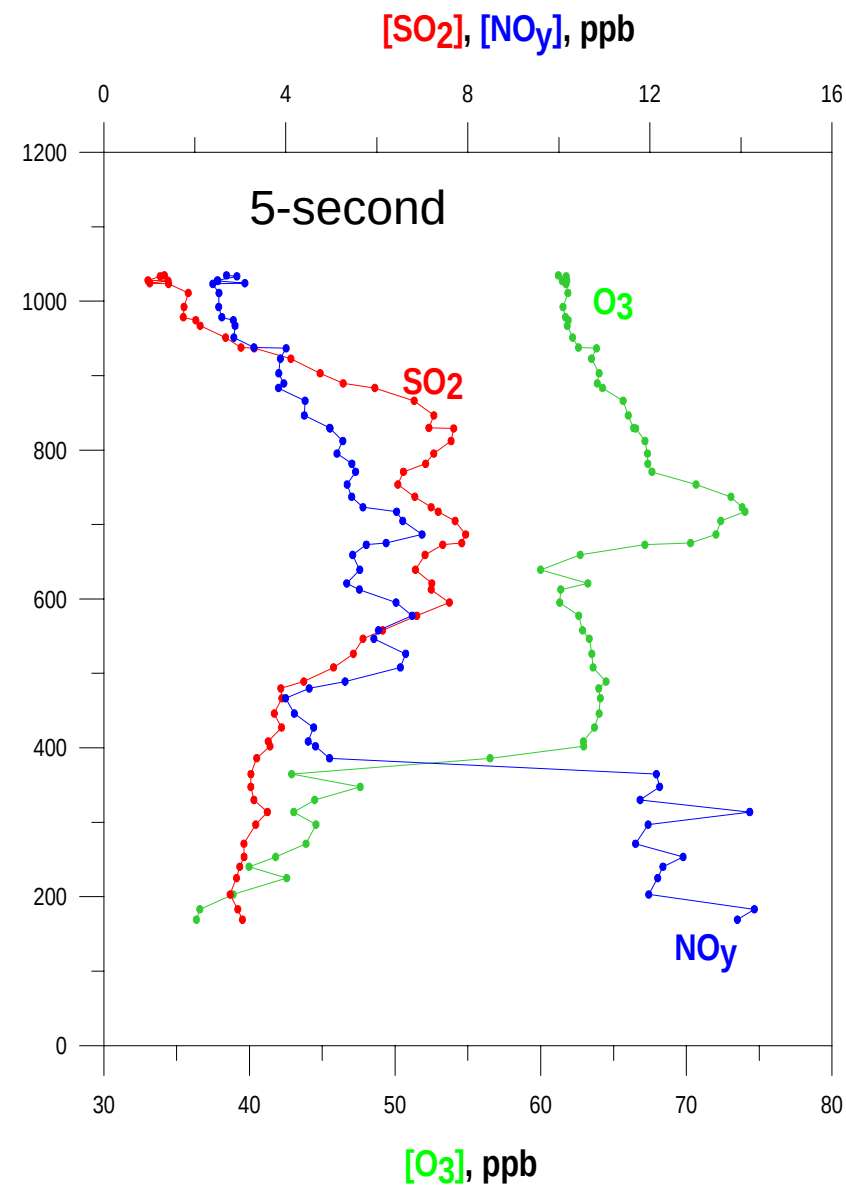


July 8, 1999 Morning Vertical Profile, Nashville

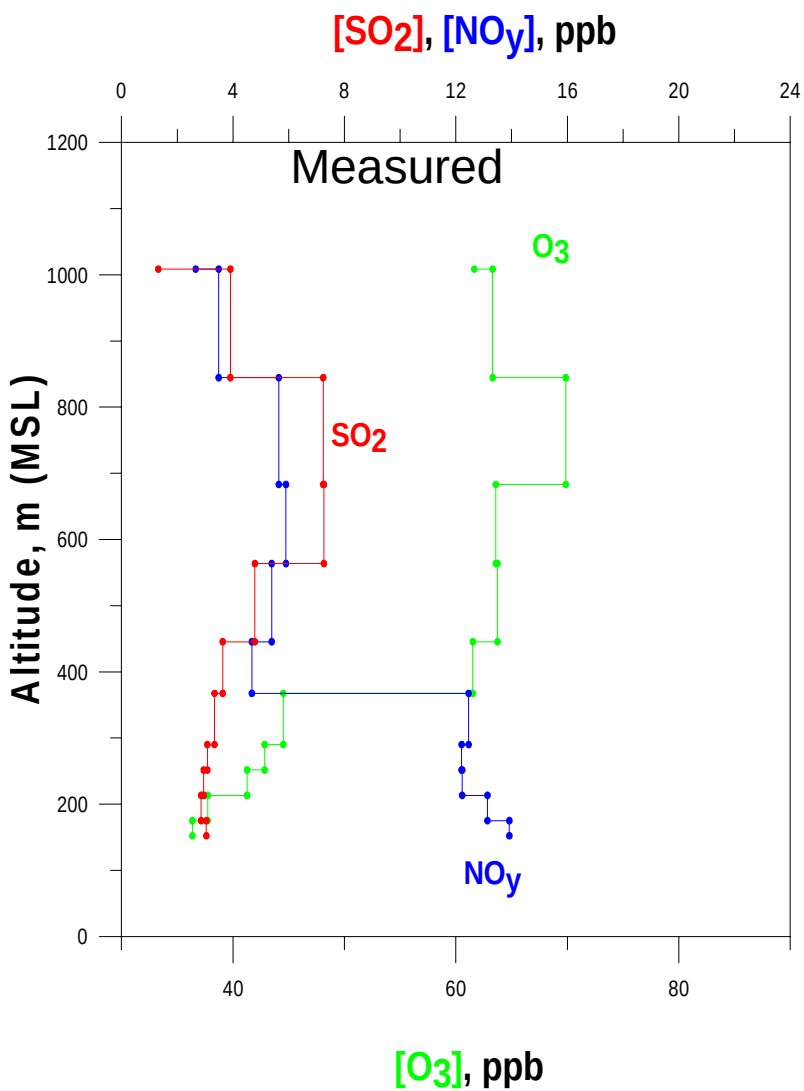


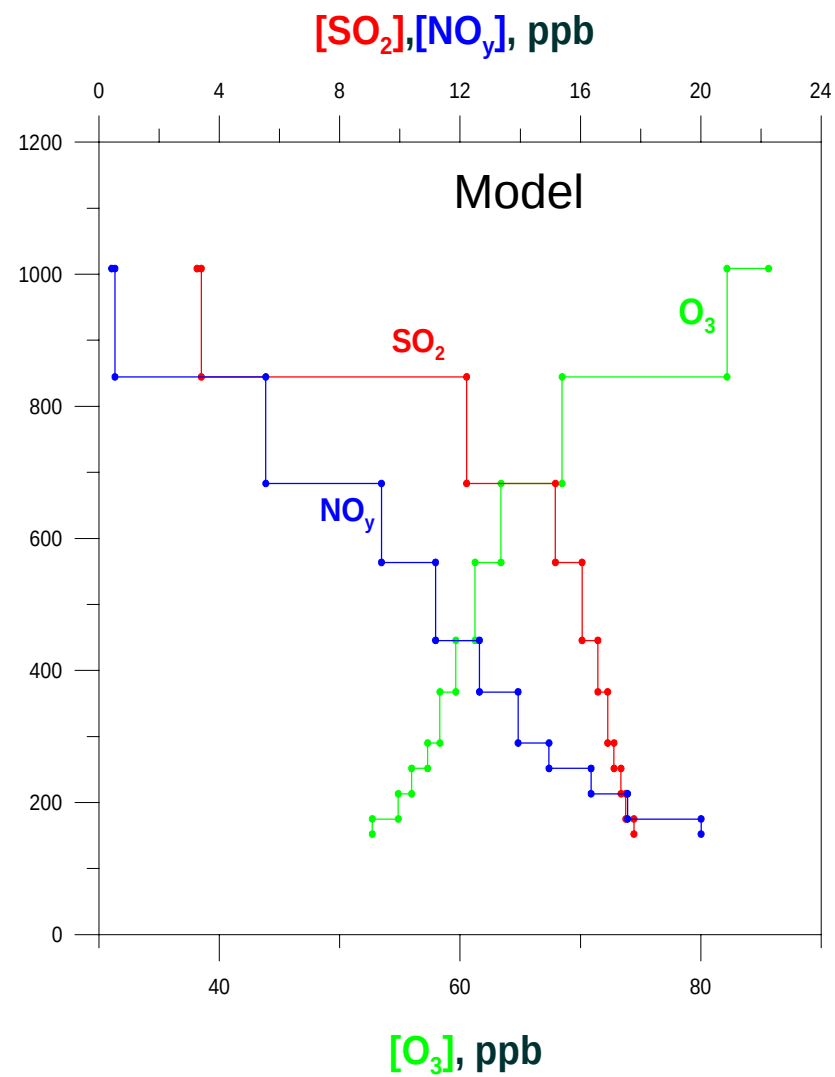
July 8 Morning 5 s measured data averaged for CMAQ layers



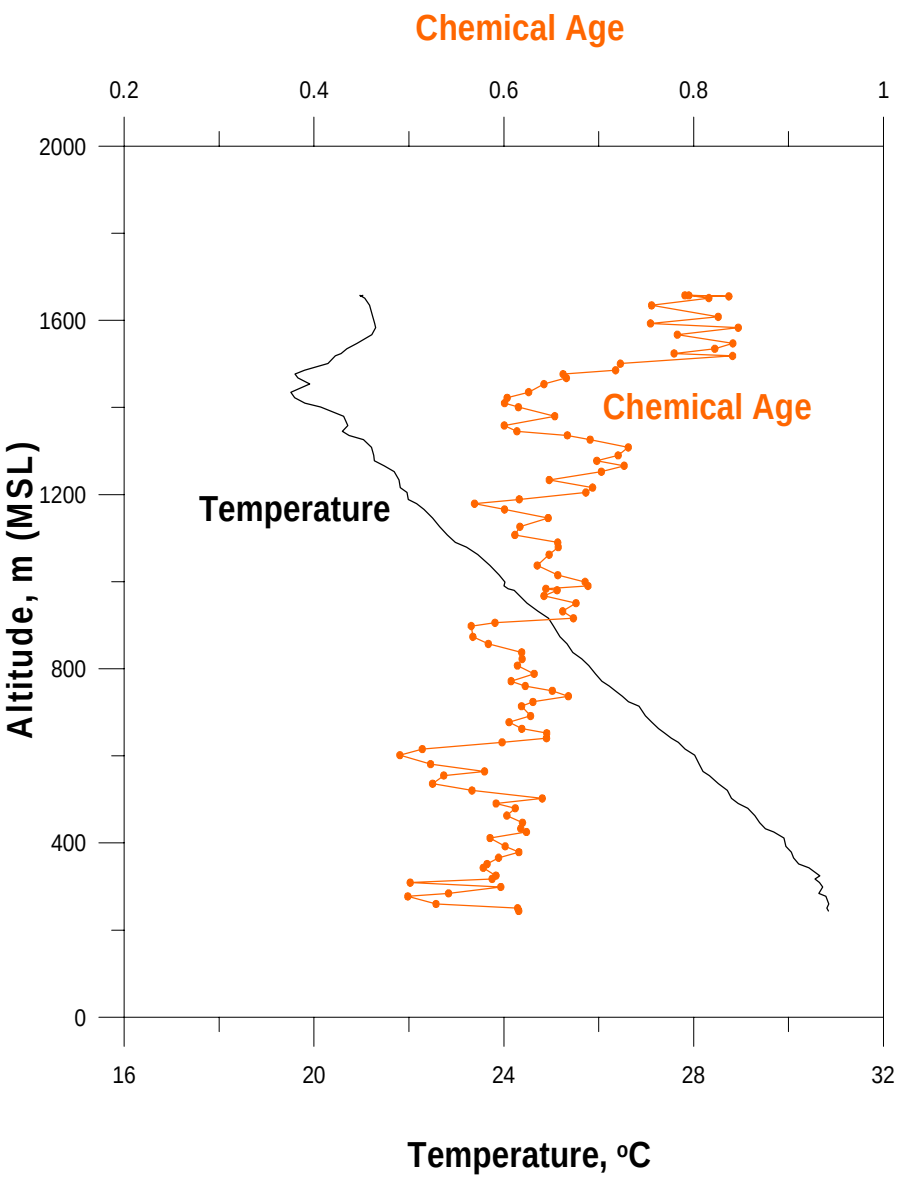


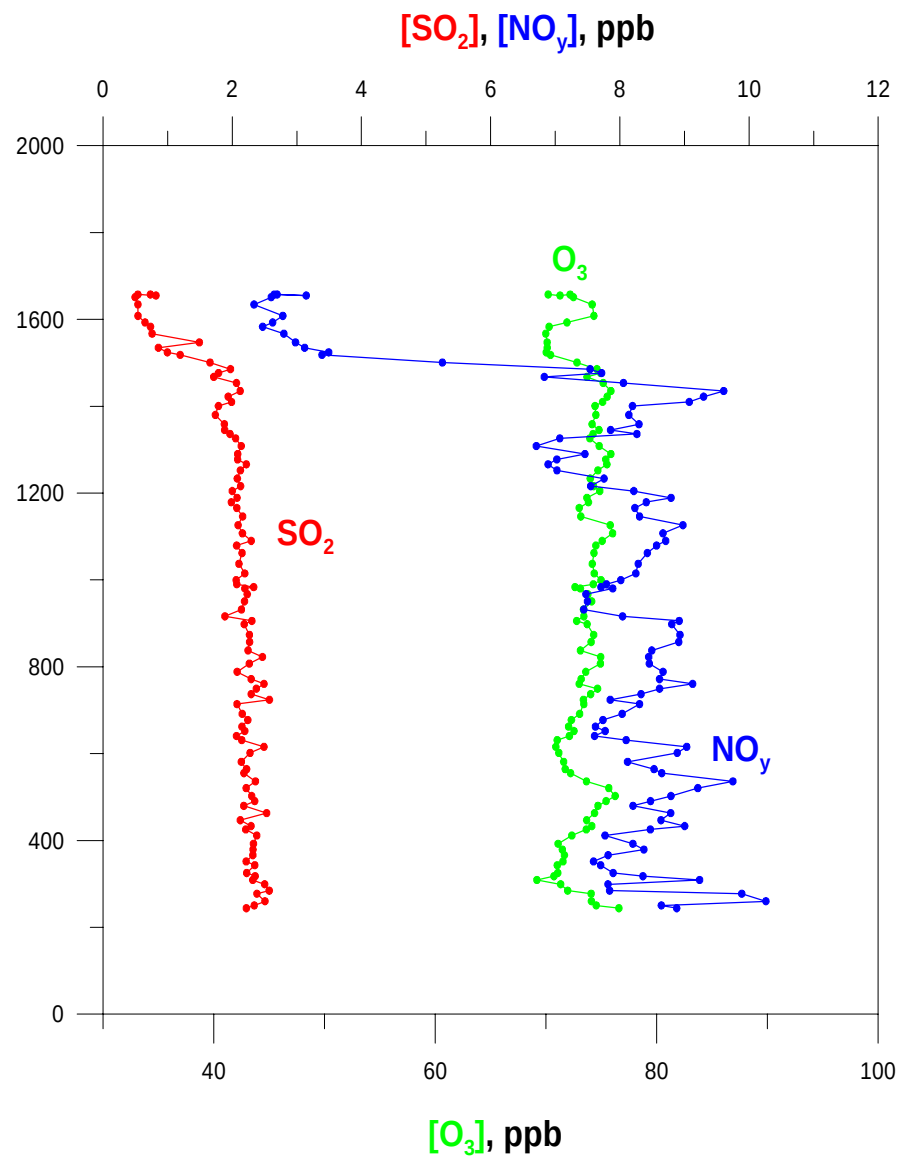
Comparison of Measured and Model vertical profiles over Cornelia Fort, Morning of July 8, 1999



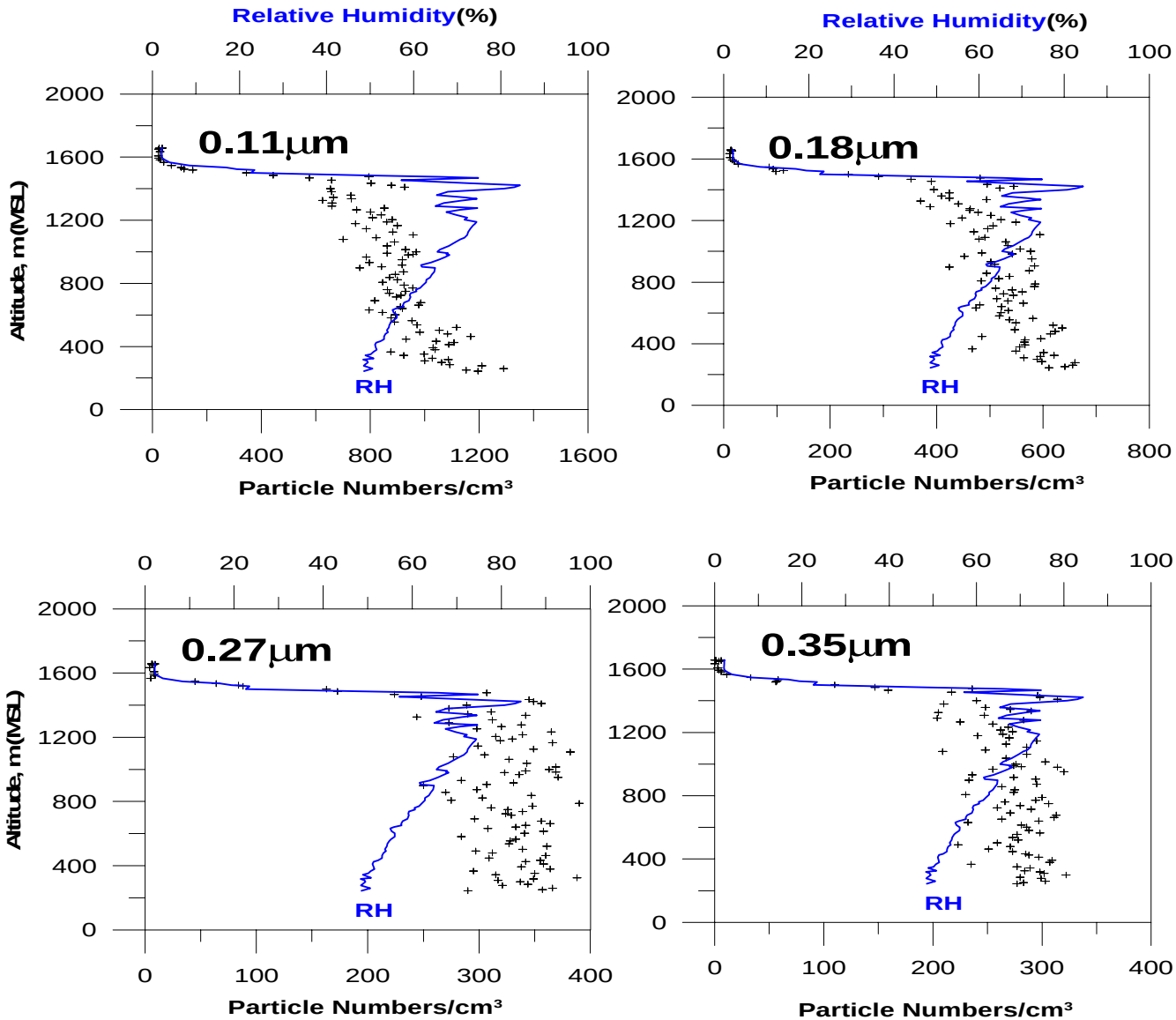


July 8 Afternoon Vertical Profile Over Nashville

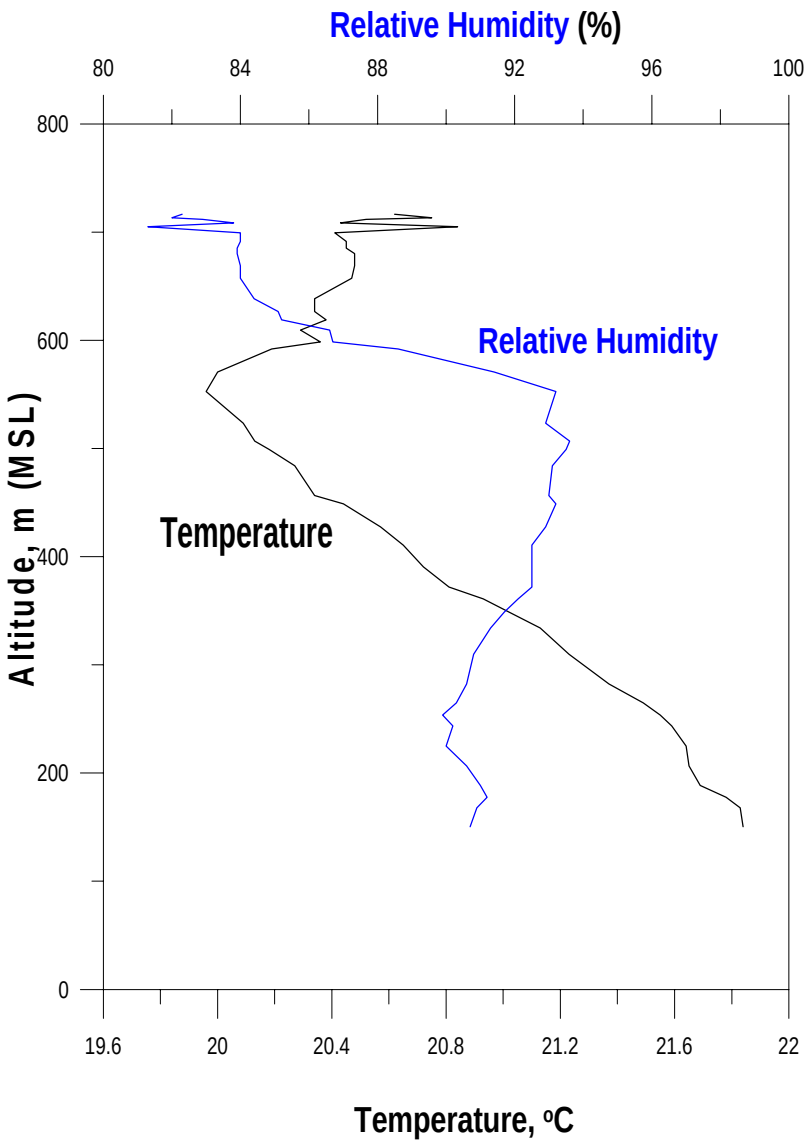


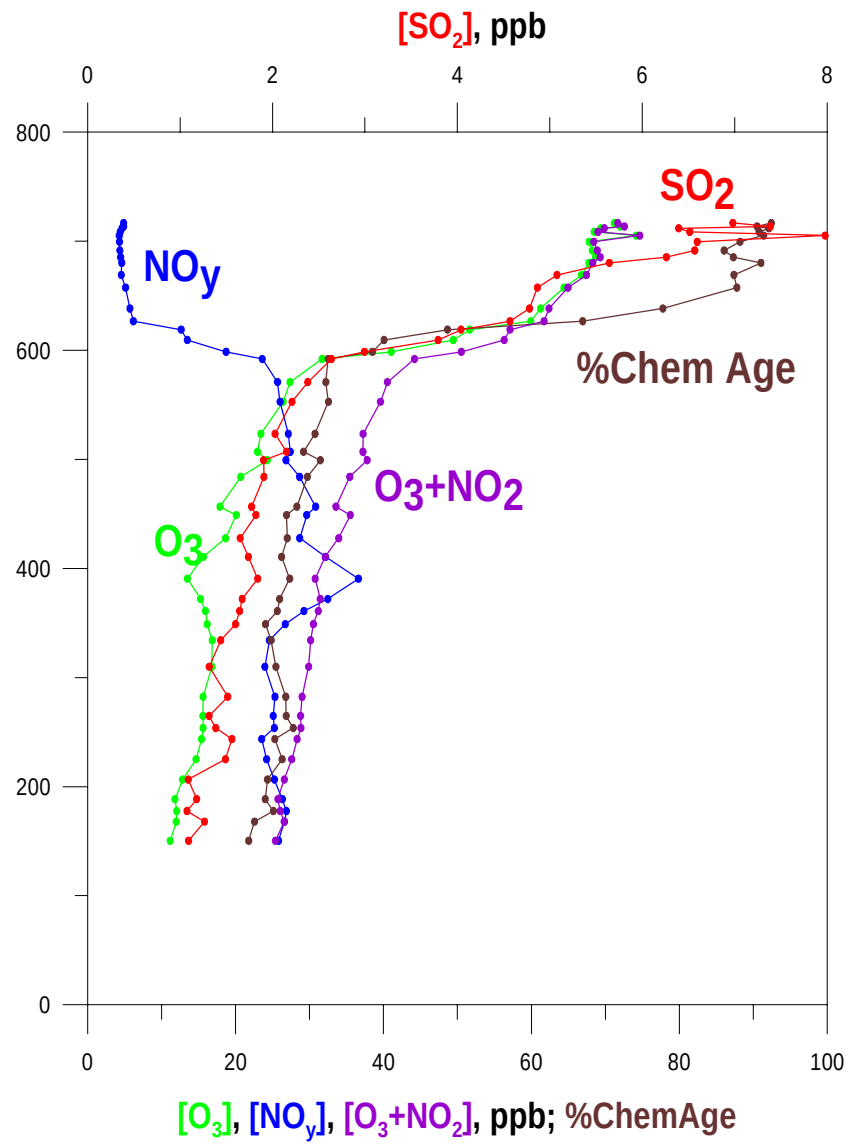


July 8, 1999 Afternoon Vertical Profile Over Nashville

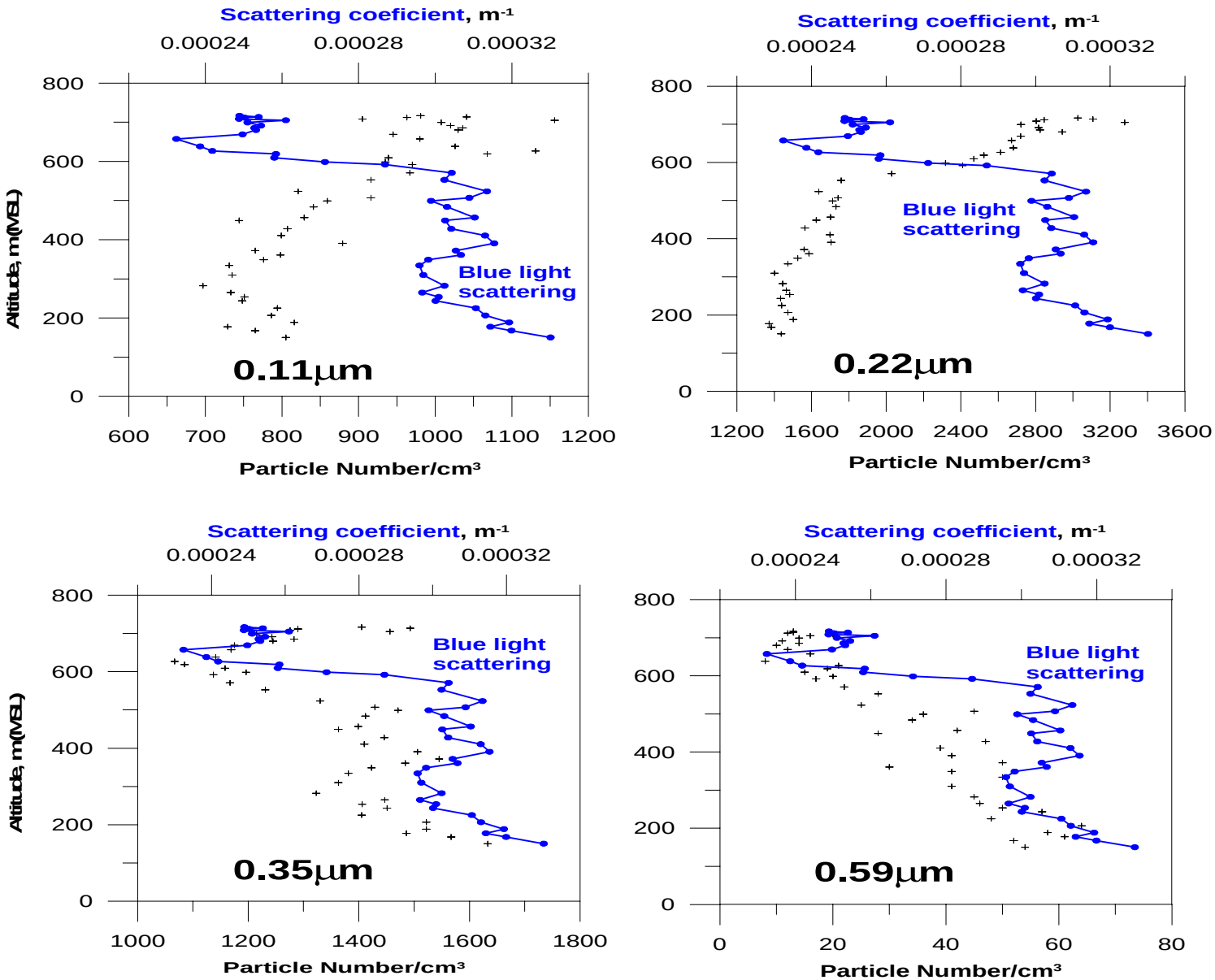


July 14, 1999 Morning Vertical Profiles Over Nashville

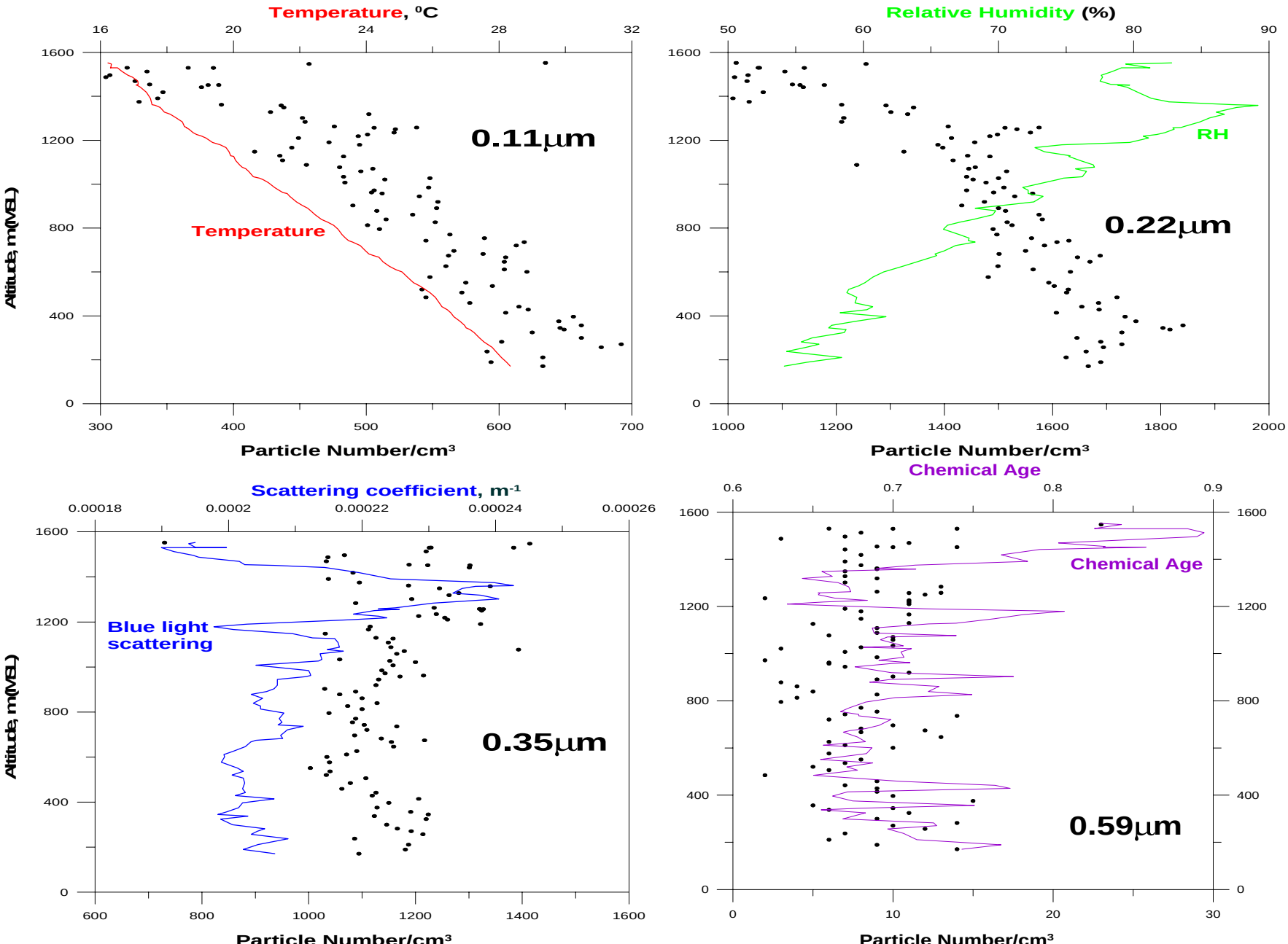




July 14, 1999 Morning Vertical Profiles over Nashville

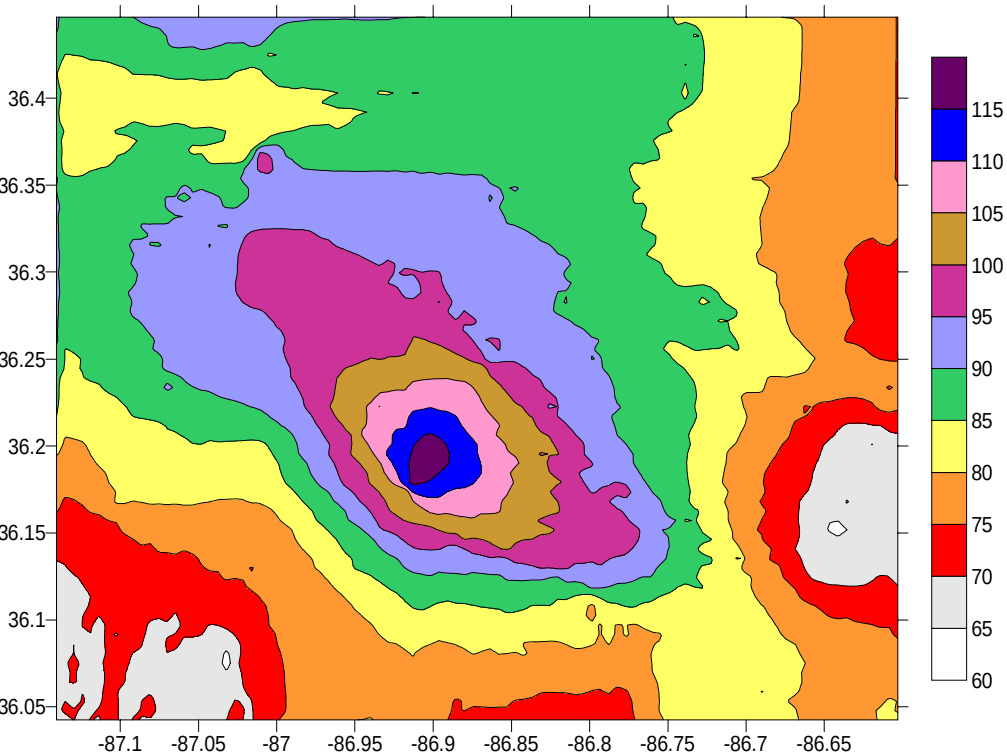


July 14, 1999 Afternoon Vertical Profiles over Nashville

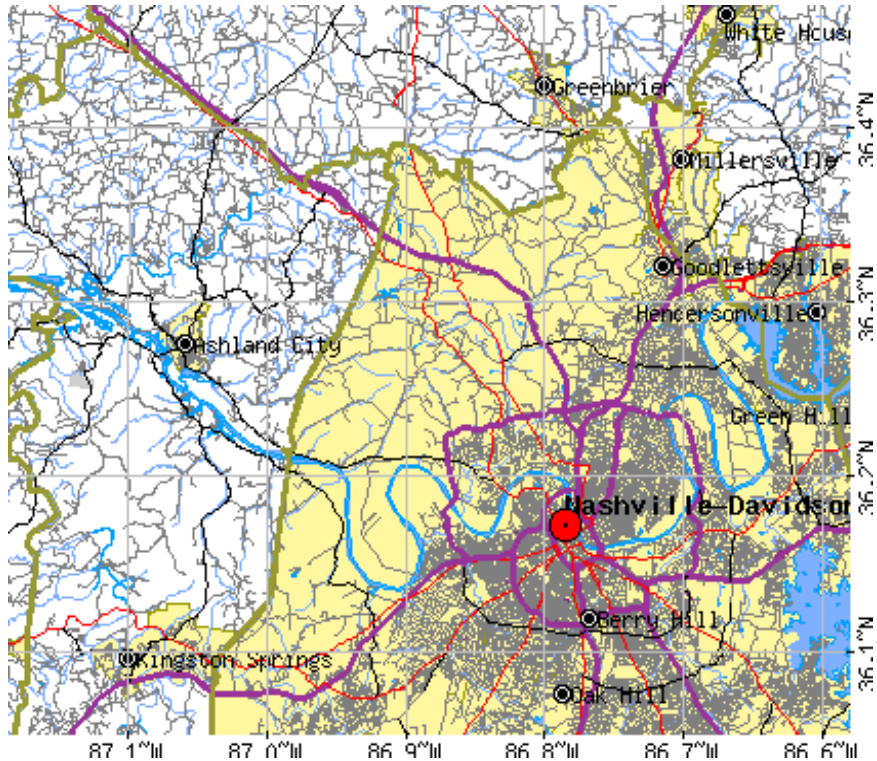


Horizontal Traverses about 350 m above Nashville
Afternoon of July 8, 1999

Ozone



Nashville & Surrounding

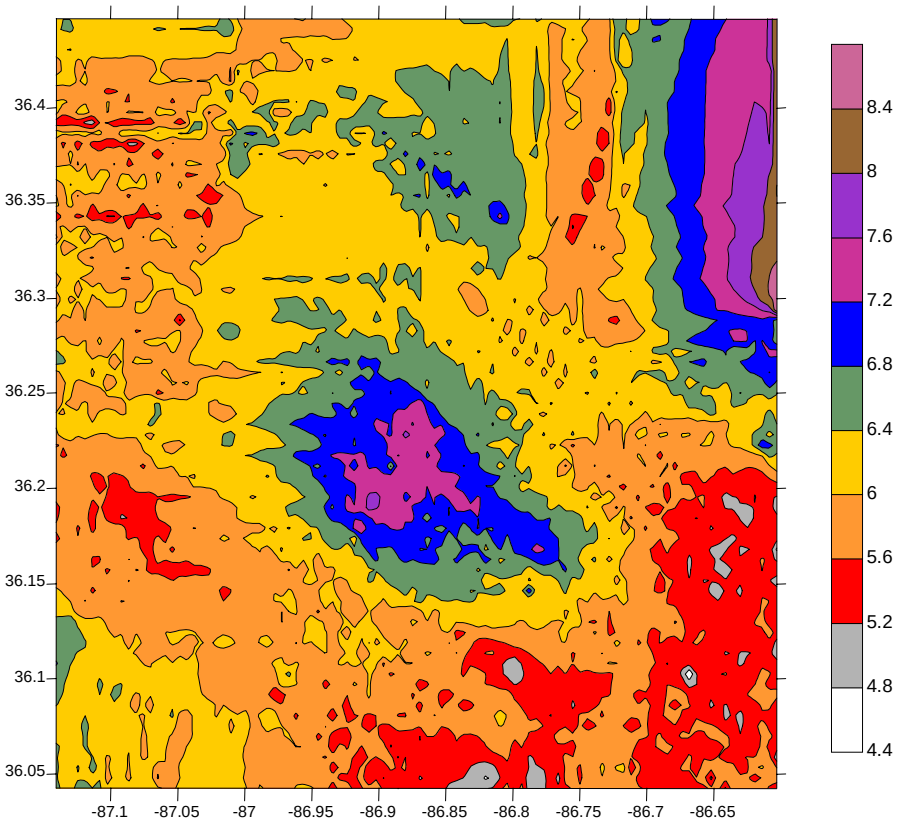


West – East (Longitude)

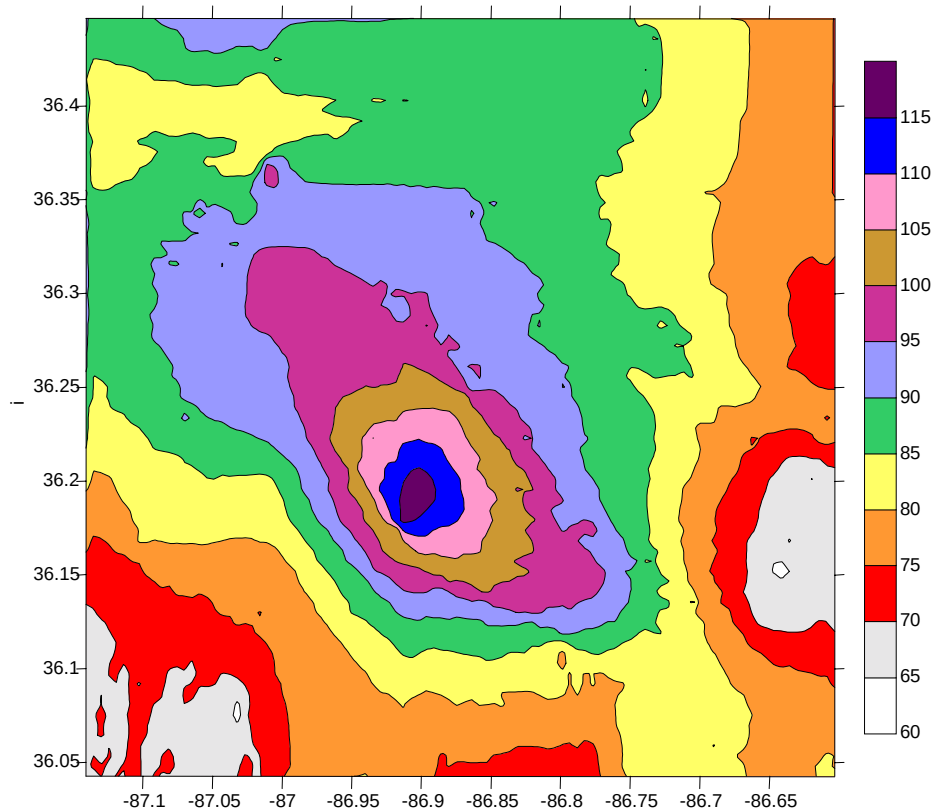
Vertical axis is North-South (Latitude)

Horizontal Traverses about 350 m above Nashville
Afternoon of July 8, 1999

Particle Volume



Ozone



West – East (Longitude)
Vertical axis is North-South (Latitude)

Conclusions

- Vertical structure of urban atmosphere is complex in space and variable in time.
- Simple models of ozone and particle formation may match observations on some days, not others.
- Nighttime transport of point source plumes may influence next-day urban chemistry.

Project Supported by:

EPA
TVA
DOE/NETL
EPRI