Measurements of ozone, CO, NO, NO₂, NOₓ, and photolysis frequencies at the Moody Tower

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1.0 Abstract

Ozone is a recognized tropospheric pollutant which leads to reductions in agricultural yields and is a respiratory irritant. Measurements of ozone, CO, NO, NO₂, NOₓ, actinic flux, and meteorological parameters were made on the roof of the North Moody Tower on UH main campus as part of the TexAQS II Radical Measurement Project (TRAMP). The data presented here was collected between August 13 and October 2, 2006. Spatial and temporal dependencies of ozone and precursors are examined as well as the variability in photolysis frequencies under varying sky conditions.

2.0 Methods

2.1 Site Description: The University of Houston, located approximately 4 km southwest of Downtown Houston, hosted TRAMP on the roof of the North Moody Tower at the southeast corner of campus as indicated by the red circle in Figure 1. The data presented here were collected from atop of a 10 m tower mounted on the balcony.

2.2 Chemical measurements: Ozone and CO were measured with standard TEI 49c and 48c-TLE instruments, respectively. Measurements of NO, NO₂, and NOₓ were made with a TEI 42c-TL instrument coupled with a NO₂ specific photolytic converter from Droplet Measurement Technology. Data was collected every 10 seconds with a PC based data acquisition system using Azotech’s DAQFactory software.

2.3 Meteorological measurements: Measured parameters included temperature, pressure, relative humidity, wind speed and direction, and rainfall. These data were collected at a 10 second interval by a Campbell Scientific CR1000 data acquisition system and stored to a PC hard drive every 5 minutes.

2.4 Scanning Actinic Flux Spectroradiometer (SAFS): Solar actinic flux radiation was sampled with a quartz light collector with a 2 ± 0.5° field of view. The main components of the SAFS instrument are an optical collector, a custom UV fiber optic bundle, a computer controllable double monochromator, a low dark current photomultiplier tube, a custom four channel signal amplifier, and a rack mounted data acquisition and control system. The monochromator, photomultiplier tube, and amplifier are temperature stabilized at 312 K. The full-width at half-maximum of the CVI CM112 double monochromator used in this instrument is 1.0 nm using 2400 g/mm gratings and 600 micron entrance and exit slits. The acquisition time for a 280 nm to 420 nm spectrum was 10 seconds.

2.5 Photolysis Frequency Calculation: Photolysis frequencies were calculated using recent absorption cross section and quantum yield recommendations from JPL and USRAC.

\[ \phi = \frac{dF}{d\lambda} \int \sigma(\lambda) d\lambda \]

where:
- \( \phi \) = quantum yield
- \( \sigma(\lambda) \) = absorption cross section
- \( dF/d\lambda \) = total photon intensity

\[ \lambda \]

3.0 Results and Discussion

3.1 Day versus night: For the chemical analyses the data was split into day and night to examine the diurnal variability of the measurements. The time between 8:00 am CST (9:00 am local) and 8:00 pm CST was selected as day time and corresponds to the time when the boundary layer is active. This definition also places the sunrise/morn hour into the night time portion of the data. This data is presented in two ways, histograms and polar plots versus wind direction.

- Nighttime NO shows groupings pointing to the southwest towards the Parrish EGU and southeast towards Texas City. Nighttime CO shows the same southwesternly grouping but not the southeasterly group.

Above left: Morning rush hour CO:NO ratio is 4.10 ± 0.029 with a background CO value of 156 ± 2 ppbv.
Above right: O₃ vs. NOₓ plot, all points included, indicates that the highest O₃ values occurred when NOₓ was between 10 and 30 ppbv.

3.2 Night time histograms:

- No ozone values above 80 ppbv were measured at night because of titration with NO, generally resulting in very low ozone concentrations at night relative to the day.

- Very low ozone concentrations were often measured at night.

3.3 Polar plots: The first set of plots below shows the frequency of occurrence of wind direction (where the wind is coming from). The subsequent plots indicate the wind directions associated with pollutant concentrations measured during day and night periods. Plots with white backgrounds are included for clarity and include scaled, the plots overlaid on Google Earth maps provide spatial orientation.

- Nighttime NO shows groupings pointing to the southwest towards the Parrish EGU and southeast towards Texas City. Nighttime CO shows the same southwesternly grouping but not the southeasterly group.

3.4 Future work:

- Run Langley Research Center Photochemical 0-D and 1-D STAP breathing 3-D models with the TRAMP merged dataset.

4.0 Future work:

- Future work includes running the models with the merged dataset.

5.0 Acknowledgements:

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