Evaluation of Ozone Concentrations at Different Inlet Heights

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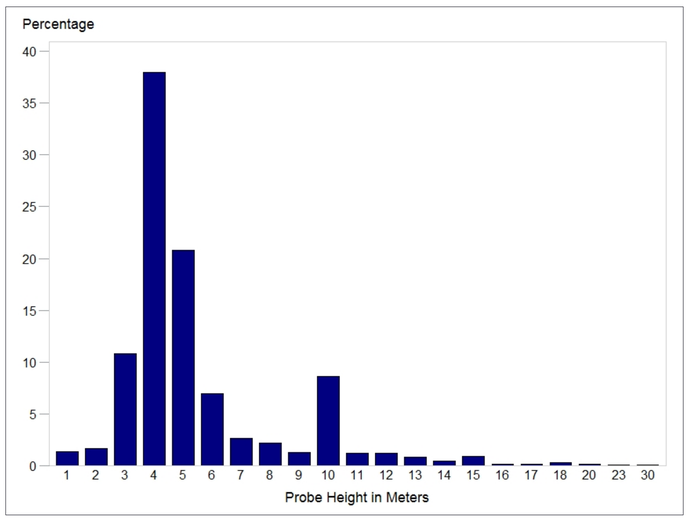
INTRODUCTION

Ozone analyzers must be contained in a temperature controlled station; therefore, monitor probe heights are typically a function of monitoring station height and sample manifold inlet height. Although siting criteria in 40 CFR part 58 allows for inlet heights between 2 and 15 meters above ground level for ozone, most of the 1300 or so monitor inlets are typically at a height of 3 to 5 meters with the exception of about 80 CASTNET sites where the probe height is 10 meters. The average probe height for 1302 ozone monitors in 2014 was 5.4 meters (Figure 1).

Recommendations from the American Petroleum Institute (API)[1] include adjustments to ozone design values (DVs) to account for ozone gradients and moving ozone probe inlets down to 2 meters. There is very little information in the literature to inform the variation in ozone concentrations with vertical height under compliance monitoring siting conditions or at heights between 2 and 10 meters.

While there is some information indicating decreasing ozone concentration with decreasing monitor probe height in vegetative flux studies,[2] there is little data under compliance monitoring network siting conditions to warrant adjustments to DVs or moving inlets to a 2 meter inlet height.

Figure 1. Distribution of Inlet Height in Meters, 2014



METHOD

Preliminary results for a 5-day period were obtained from two Teledyne API (TAPI) T265s at 2 and 6 meters. The ¼ inch outside diameter (OD) inlet lines were attached to the on-site meteorological tower at EPA's on-campus monitoring station.

A bypass pump and fixed orifices were used to ensure that the residence time for both sampling lines were the same.

Sampling lines were shielded from sunlight using gray conduit tubing.

The prevailing wind direction was considered in siting the inlets on the tower.

Both instruments were initially calibrated using a TAPI 700EU that was certified against EPA's Standard Reference Photometer (SRP).

Nightly zero and span checks were not possible with the bypass pump configuration.

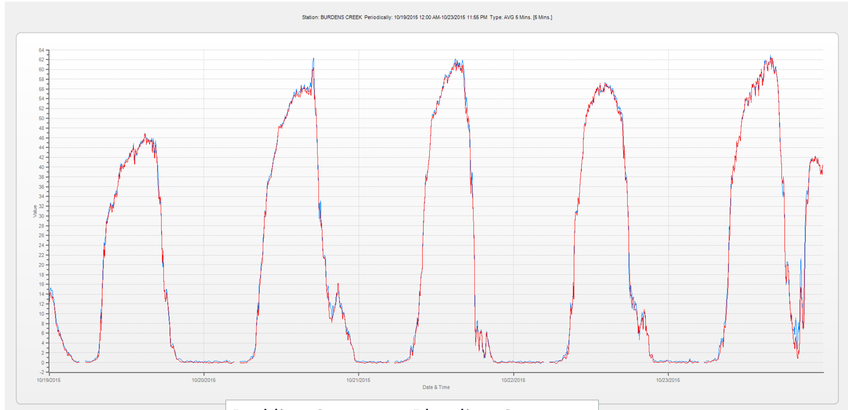
[1] Ollison W.M. Presented at the Air Quality Measurement Methods and Technology Conference, Chapel Hill, NC, March 2016; Paper #34.

[2] *Air Quality Criteria for Ozone and Related Photochemical Oxidants (2006 Final).* U.S. EPA, Washington, DC, 2006; EPA 600/R-05/004aF-cF.

PRELIMINARY RESULTS (2015)

EPA has preliminary data from measurements at 2 and 6 meters for a 5-day period in October of 2015. Preliminary results showed very little difference between the 5 minute ozone concentrations during that period (Figure 2).

Figure 2. Ozone Concentrations from two TAPI T265s at 2 and 6 Meters (October 2015)



Red line 2 meters; Blue line 6 meters;

EXPERIMENTAL DESIGN (2016)

So far in 2016, we have explored a few configurations that have not proved viable:

1) Use of three 2BTech POMs (Personal Ozone Monitors) at 2, 5, and 10 meter inlet heights.

- Laboratory experiments showed that the POMs were not stable enough over time to pursue further experiments at 2, 5, and 10 meters.

2) Differential ozone measurements using a single TAPI 400E analyzer

- Modified the 400E to bypass the scrubber and connect one sampling inlet to the reference side and the other sampling inlet to the sampling side.
- Large pressure changes produced unexpected and inconsistent results.

Currently using two ozone analyzers at 2 meter (400E) and 10 meter (T265) inlet heights on the meteorological tower (Figure 3).

- There are no major obstructions to the tower in the predominant wind direction during the ozone season (see wind rose in Figure 4 for April 1st through October 31st, 2015).
- Inlet lines (¼ inch OD) are connected to 3 way solenoid valves to allow nightly zero and span checks (see Figure 5 for a schematic). Inlet lines are of equal length and residence time.
- The old monitoring station to the southwest of the tower has been removed (Figure 6).
- Nightly zero and span checks are run at the 0 and 75 ppb levels.
- Preliminary data for daily maximum 8-hour average concentrations are presented in Table 1. We plan to continue to collect data through October 2016.

Table 1. Daily Maximum 8-hour Average, ppm

Date	TAPI 400E (2 meters)	TAPI 265 (10 meters)
07/28/2016	0.040	0.041
07/29/2016	0.043	0.041
07/30/2016	0.040	0.040
07/31/2016	0.042	0.042
08/01/2016	0.039	0.039

EXPERIMENTAL DESIGN (2016)

Figure 3. Inlets on the tower.

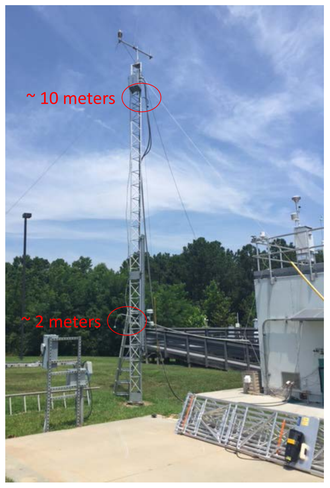


Figure 4. Predominant wind direction (April 1st through October 31st, 2015).

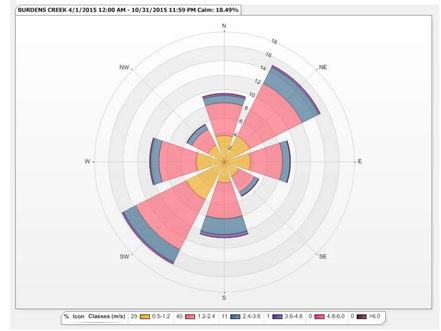


Figure 5. Schematic of the current ozone analyzer, zero/span, and inlet configuration.

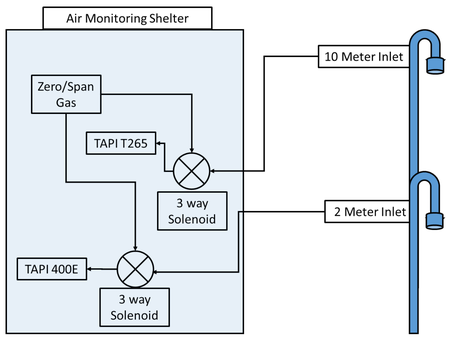
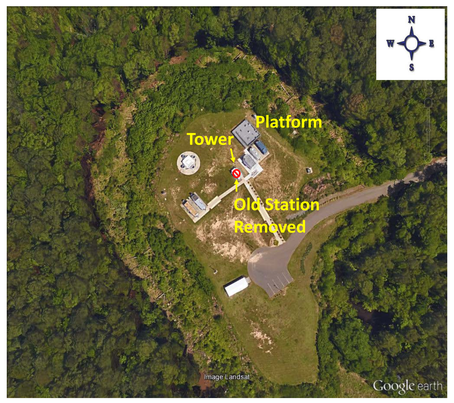


Figure 6. Google Earth view of EPA's air monitoring site (35.8893, -78.8746).



SUMMARY

It is premature to conclude that ozone design values need to be adjusted for inlet height or that inlets be moved to 2 meters.

There is not enough data under compliance monitoring network siting conditions to evaluate ozone concentrations at various inlet heights.

Initial evaluation of ozone concentrations at 2 and 6 meters and very preliminary data at 2 an 10 meters indicate no difference in 8-hour average daily maximum values.

Several experiments during the summer of 2016 resulted in the current configuration:

- Two ozone analyzers (TAPI T265 and 400E) at 2 and 10 meters with equal tubing length and residence times.
- Nightly zero and span checks.

We plan to continue to collect data through October 2016 and evaluate the results.

No changes are currently recommended to inlet requirements in compliance monitoring networks.