

Investigating Stability of Ozone Samples: Ogawa Holding Time Experiment in Seattle, WA

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Introduction

Ozone is a naturally occurring gas in the atmosphere. Stratospheric ozone (the "ozone layer") protects life from the damaging effects of solar radiation. However near to Earth's surface, ozone is created by chemical reactions between sunlight and emissions from automobiles and industrial facilities such as nitric oxide, and is toxic in high concentrations.

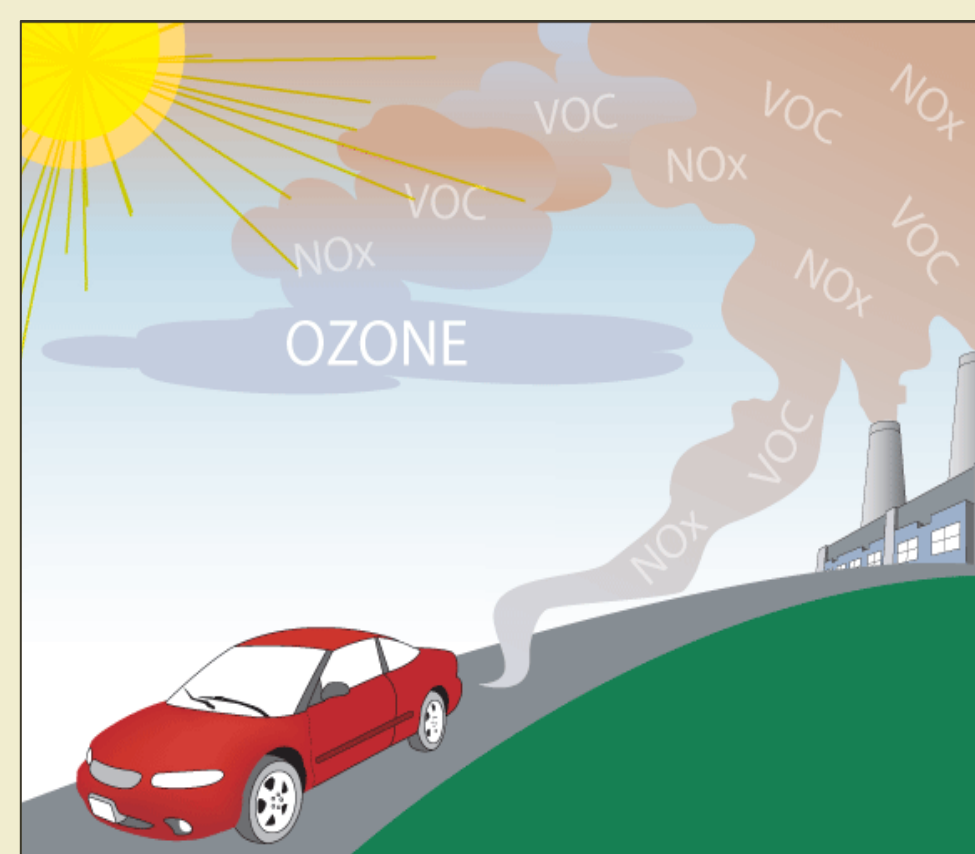


Figure 1. Vehicles and industrial emissions, are major sources of nitrogen oxides and volatile organic compounds[1].

The Ogawa passive sampler was developed by Ogawa & Co. for collecting nitrogen oxides (NO_x), ozone and SO₂. The passive sampler consists of a barrel body containing two filters coated with sodium nitrite, which, when exposed to ozone in air, oxidizes to nitrate:
 $\text{NO}_2^- + \text{O}_3 \rightarrow \text{NO}_3^- + \text{O}_2$ [2].

Objectives: To assess the effect of immediate badge extraction versus badge extraction on the day of analysis by:

1. Testing the stability of exposed filters
2. Testing the stability of filter extracts

Methods

Eighteen double sided Ozone Ogawa passive samplers were exposed to ambient air in Seattle for 2 weeks. Samplers were protected by a cover during exposure. After 2 weeks, all samplers were retrieved. 4 badges were immediately extracted into water and analyzed using ion chromatography (IC) (e.g. Time 0).

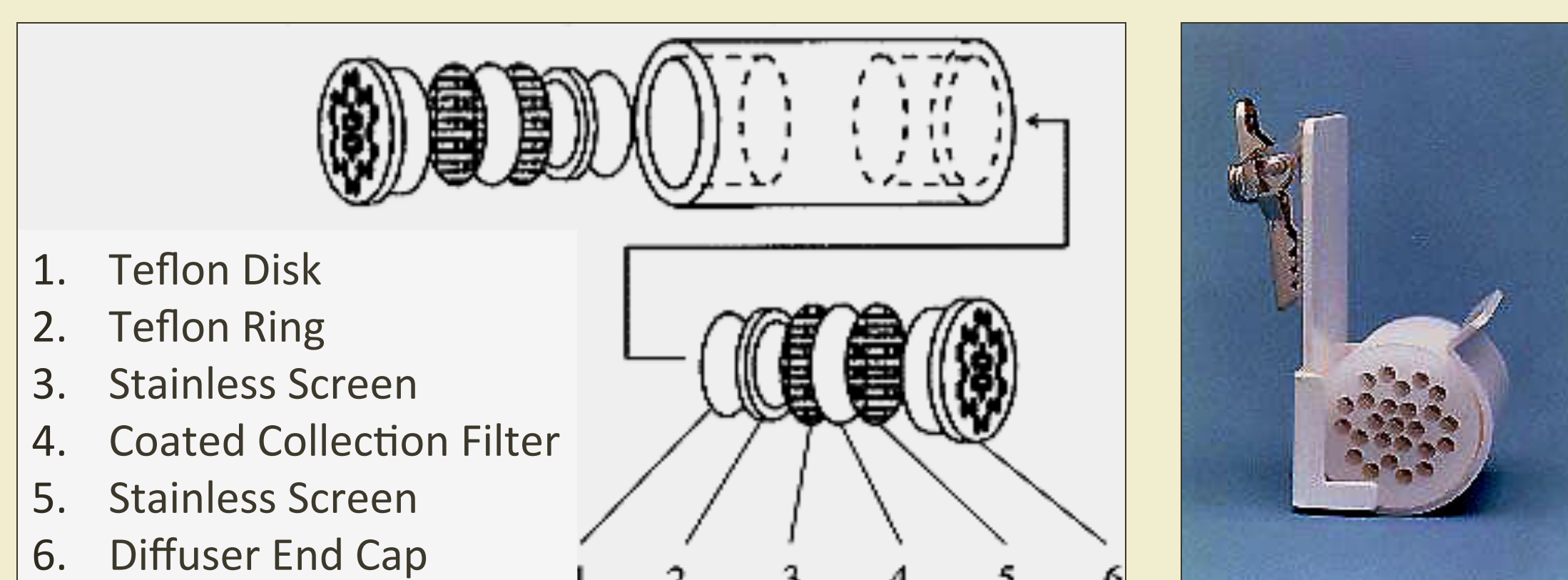


Figure 2. Ogawa passive sampler assembly.

Methods

1. In one experiment, we tested the stability of **exposed filters**: 16 of the retrieved badges were immediately stored at 2-4°C
2. In another experiment, testing the stability of **filter extracts** : The remaining 16 badges were immediately extracted into water and stored at 2-4°C.



Figure 3. Ogawa badge samplers hanging in Seattle.

After one, two, four, and eight weeks of storage, four exposed samplers were extracted and analyzed using IC, along with four of the stored extracts.

Results

Storage (weeks)	O ₃ [mg/sample]	
	Filter	Extract
0	1.53	1.53
	1.43	1.43
	1.59	1.59
	1.65	1.65
1	1.14	2.39
	1.53	1.75
	1.51	1.72
	1.55	1.55
2	0.982	1.58
	1.10	1.34
	1.57	1.25
	1.30	1.28
Average	1.41	1.59
Std. Dev.	0.22	0.30
%CV	16%	19%

Table 1. Ozone concentrations from both experiments after two weeks.

Lab blanks from both experiments were analyzed for nitrate along with all other samples. The mean concentration of these filters was 0.259 µg/sample, with 0.18 being the limit of detection (LOD) where the LOD is the nitrate concentration per sample of the 2.5 calibration standard - 0.25µg/sample. On average, the spike recoveries over the three time point analysis was 2.83 µg/mL. Results have not been corrected for lab blanks or spike recoveries.

	Filter O ₃ [mg/sample]		
	0 week	1 week	2 weeks
Average	1.55	1.43	1.24
Std. Dev.	0.09	0.20	0.26
%CV	5.9%	13.8%	20%

Table 2. Exposed filter ozone concentrations over 2 weeks.

	Extract O ₃ [mg/sample]		
	0 weeks	1 week	2 weeks
Average	1.55	1.60	1.36
Std. Dev.	0.09	0.17	0.15
%CV	5.9%	10%	11%

Table 3. Filter extract ozone concentrations over 2 weeks.

Results

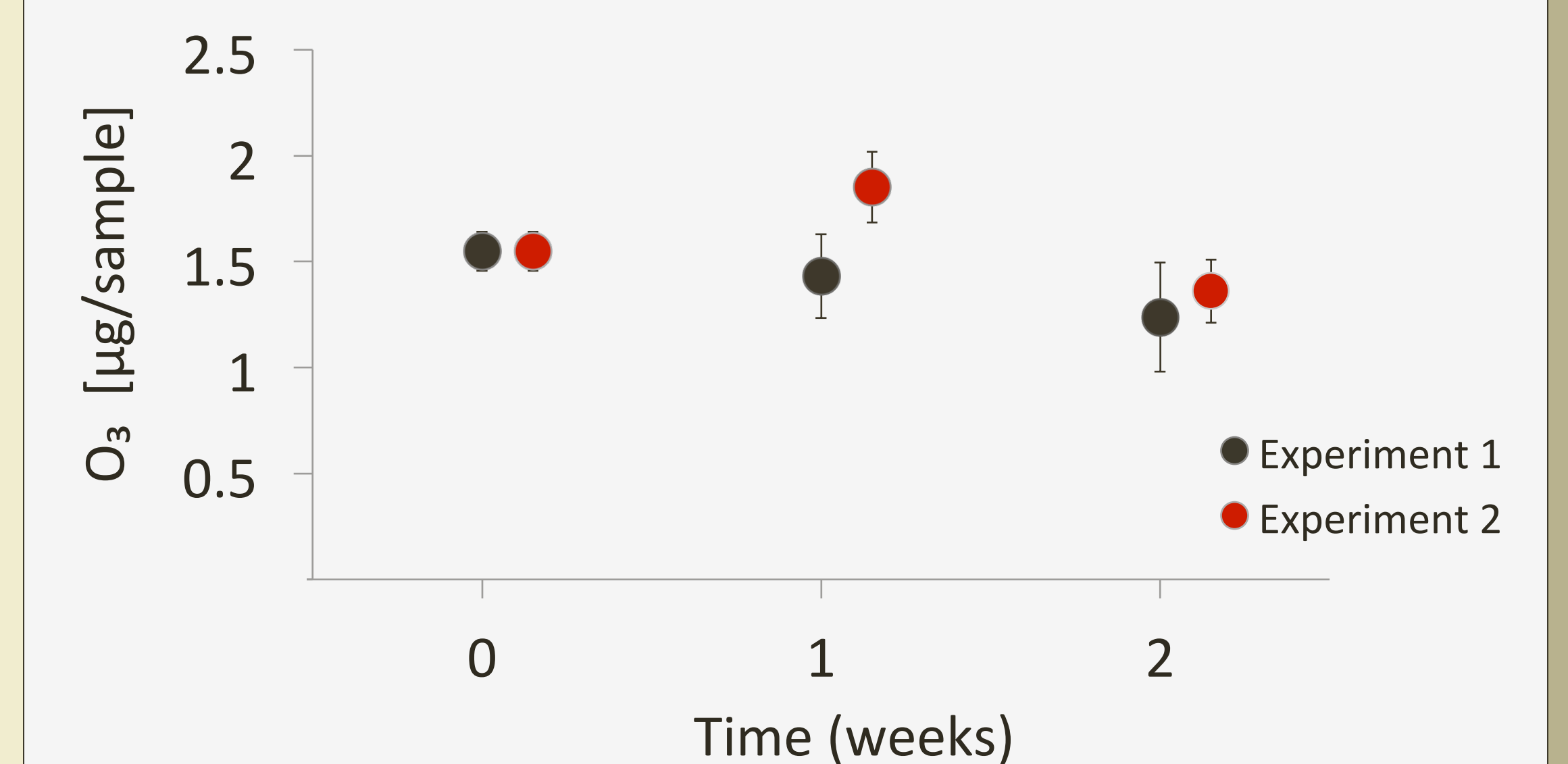


Figure 4. Scatter plot of ozone concentrations from the exposed filter experiment and the filter extract experiment over the course of 2 weeks.

The P-value for the exposed filters experiment was calculated to be 0.129, implying that our data is statistically significant in showing no difference in the mean ozone concentration over the course of 2 weeks. The P-value for the filter extracts experiment was calculated to be 0.086, implying that our data is statistically significant in showing no difference in the mean ozone concentration over the course of 2 weeks. The P-value for both experiments was calculated to be 0.42. Therefore the results can be interpreted to mean that over the course of 2 weeks, the mean concentration of ozone on an Ogawa sampler badge will not be affected by extraction.

Conclusion

Our data demonstrate that exposed Ozone Ogawa samplers can be safely stored up to 2 weeks with or without extraction. Our experiment will continue for a total of 8 weeks and we anticipate similar results.

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References:

1. United States Environmental Protection Agency, "Ground-Level Ozone." Accessed August 3, 2012. <http://www.epa.gov/glo/basic.html>.
2. Petros Koutrakis et al., "Measurement of Ambient Ozone Using a Nitrite-Coated Filter," *Analytical Chemistry*, 65 (1993): 209-214.