# Investigating Concentration and Composition of Aerosol Particles of Seawater with Different Conditions by Atomizing and Bubbling

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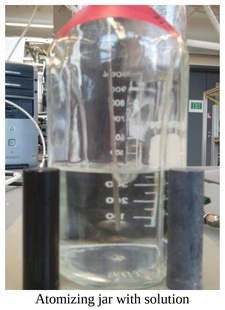
## Introduction

Climate change is impacted by both anthropogenic and natural sources. Particles in the atmosphere may increase the planetary albedo. Albedo is the fraction of shortwave radiation that is reflected from the earth back to space. Analyzing how and what particles get into the atmosphere and impact albedo is currently being studied by many groups. In the Aerosols Group, headed by Dr. Lynn Russell, which measure particles in the aerosol form, wanted techniques to sample aqueous solutions on Teflon filters. The "Marine Aerosols" project had two goals to investigate. The first goal was to use procedures developed for liquid or solid particles suspended in a gas, and test two different types of aerosol-producing instruments to collect particles from various aqueous samples and analyze their composition and concentrations. The second goal was to compare seawater sampled with the atomizer and bubbler immediately, to the results of seawater that was allowed to "age" in a freezer, a dark cabinet and in the sunlight, for two days and then sampled.



Atomizing jar with solution

Bubbler with Nitrogen being bubbled through solution

## Methods

- Carbohydrate standards and Total Organic Carbon (TOC) solutions were made to compare to collected seawater samples.
- A Clean Room was used, humidity and temperature were regulated to limit the amount of particles that could come into contact with the Teflon filters during analysis.
- Filters were Pre- and post- scanned and weighed before and after sampling different solutions. The pre- weights and scans produced baseline weights to compare to the sampled filters post- weights and scans.
- A microbalance was used to weight all 22 sets of filters.
- The atomizer uses nitrogen gas as propellant which creates a venturi effect and sprays the sampled solution into aerosol form. The particles suspended in the gas phase are then able to be collected on the filters.
- The Bubbler uses a non-reactive gas to create bubbles which burst at the surface and propel organic particles into the air column. The particles travel with the air flow and get collected on the filters.
- The filters were scanned using a Fourier Transform Infrared Spectroscopy (FTIR) to determine the absorbance in the infrared region. An automated algorithm was used to baseline, peakfit and integrate peaks at specific wavenumbers corresponding to specific functional groups, for all of the samples.

## Results

Table 1 gives the 22 sets of filters with a description of the sampled solution. Figure 1 and 2 show the IR spectrum of all sampled solutions bubbled and atomized. Figure 3 and 4 compare the four conditioned samples of seawater to the TOC standard made in the lab. Figure 5 shows phenol peaks that were measured and a reference showing what phenol peaks look like.

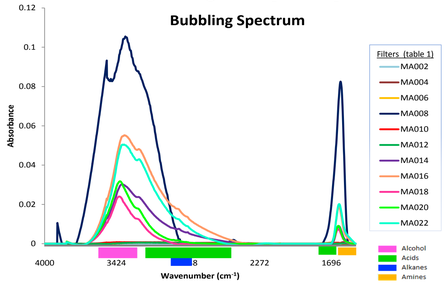



Figure 1 - Spectra from all bubbled solutions. With organic functional group absorption regions; Acids-Green, Amines-Orange, Alkane-Blue and Alcohols–Pink

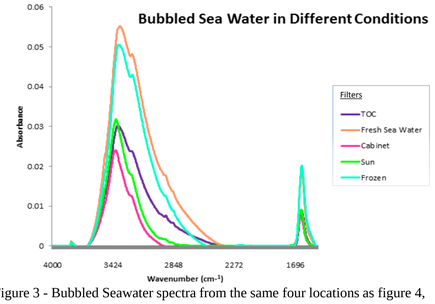
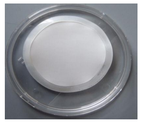



Figure 3 - Bubbled Seawater spectra from the same four locations as figure 4, compared to TOC standard. Frozen and Fresh seawater have very similar spectra where TOC has a similar absorbance to the cabinet and sun samples.

Table 2 – Total percent OM (%) for seawater samples

| Filter # | Solution Sampled | Mass on filter (mg) | Organic Mass (mg) | Bubbling OM% (OM/total$_m$) x100 | Atomizing OM% (OM/total$_m$)x100 |
|---|---|---|---|---|---|
| MA015 | Fresh Sea Water | 2611.87 | 28.84 | | 1.10 |
| MA016 | Fresh Sea Water | 54.27 | 21.16 | 39.00 | |
| MA017 | Cabinet Sea Water | 3768.57 | 81.51 | | 2.16 |
| MA018 | Cabinet Sea Water | -196.37 | 8.42 | -4.29 | |
| MA019 | Sun Sea Water | 3640.47 | 105.49 | | 2.90 |
| MA020 | Sun Sea Water | -5.60 | 11.67 | -208.33 | |
| MA021 | Frozen Sea Water | 4484.53 | 70.09 | | 1.56 |
| MA022 | Frozen Sea Water | 38.10 | 18.30 | 48.04 | |



Teflon filter used for sampling

Table 2 – Filter order and Solutions

| Atomize | Bubbling |
|---|---|
| MA001 DI | MA002 DI |
| MA003 Sucrose | MA004 Sucrose |
| MA005 Beta- D Glucose | MA006 Beta- D Glucose |
| MA007 Sea Salt DI | MA008 Sea Salt DI |
| MA011 Fructose | MA010 Fructose |
| MA009 Cellobiose | MA012 Cellobiose |
| MA013 TOC | MA014 TOC |
| MA015 Fresh Sea Water | MA016 Fresh Sea Water |
| MA017 Cabinet Sea Water | MA018 Cabinet Sea Water |
| MA019 Sun Light Sea Water | MA020 Sun Light Sea Water |
| MA021 Frozen Sea Water | MA022 Frozen Sea Water |

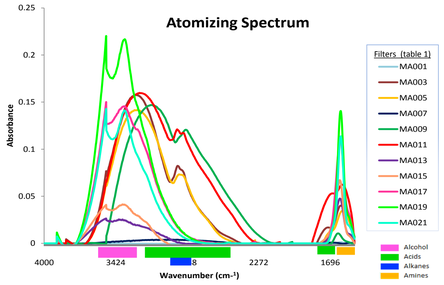



Figure 2 - Spectra from all Atomized solutions. With organic functional group absorption regions; Acids-Green, Amines-Orange, Alkanes-Blue and Alcohols-Pink

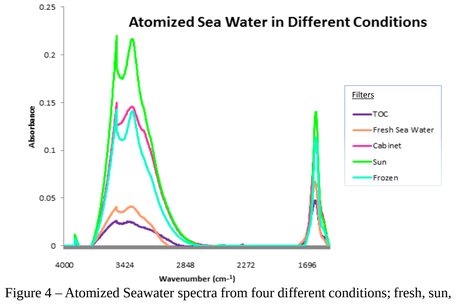
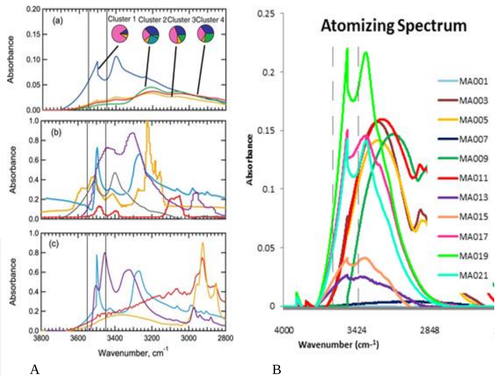



Figure 4 – Atomized Seawater spectra from four different conditions; fresh, sun, cabinet and frozen compared to TOC standard made in lab. Frozen and Sun have similar shape. Fresh and TOC standard have similar looking peaks.




A B

Figure 5 – A is a figure from (Bahadur et al., 2009) showing phenol peak in ~3500 cm$^{-1}$ wavenumber. In B the atomizing spectrum shows similar characteristics to (Bahadur et al., 2009) phenol peaks.

## Conclusion

Bubbling and Atomizing are efficient techniques to collect aqueous samples on Teflon filters. Both processes are slightly different in their approach to generating aerosol particles. Unique results were observed with the large absorbances at 3500cm$^{-1}$ in both the bubbled and atomized samples indicative of phenol functional groups. The atomizing technique is more representative of what the composition of the solutions are, and the bubbling is more representative to the actual way the bubbles are formed and burst when waves break in the oceans. The freshly atomized sampled seawater had very similar peaks and absorbance to the TOC standard made in lab, where the bubbled sun and frozen seawater samples had similar peaks and absorbance and the TOC standard had completely different looking peaks. The spectra from both the bubbled and atomized showed that reactions did occur and changed compositions of the sampled seawater, however it was not determined if it was chemical, physical or bacteria that caused the change.

Collecting seawater samples from SIO Pier

Working in clean room with FTIR

## Acknowledgments

The authors would like to thank Anita Johnson for allowing access in the cleanroom when she needed to scan hundreds of filters, and would like to thank Jane Teranes and the Russell Group for the guidance throughout the process.

Bubbles being produced by the frit

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