Trace Element and Isotope Analysis of Aerosol Samples from the CLIVAR/Repeat Hydrography Program

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Introduction

The CLIVAR/Repeat Hydrography program consists of re-occupations of long ocean sections (WOCE lines) to quantify the invasion of anthropogenic carbon dioxide into the oceans. We are funded by NSF to study the chemistry and input of trace elements and isotopes from atmospheric aerosols. We emphasize bio-active trace elements, since aerosol input is the major source for trace elements including manganese, iron, and cobalt that are required for efficient phytoplankton productivity. We also collect filtered and unfiltered rain samples when possible on the research cruises to quantify the wet deposition of these elements.

High-resolution ICPMS is required to measure many of the trace elements of interest, and allows us to calculate the deposition flux of these important materials to the open ocean.

Experimental

Replicate aerosol samples are collected daily on research cruises and subjected to solubility leaching using ultrapure water and freshly collected surface seawater. Those sample leachates are returned to FSU for analysis. High-resolution ICPMS (Finnigan Element-I) was used to measure the soluble fraction of 40-50 trace elements on the ultrapure water solubility leachates and the rain samples. Seawater leachates are first extracted using an 8HQ column technique that we developed, and analyzed for dissolved Fe, Ni, Cu, Zn, Cd, and Pb by isotope dilution using the Element-I ICPMS. In addition, Al, Mn and Co are analyzed on the same extracts using the method of standard additions. All nine elements are analyzed on each sample within 4 minutes (this includes time to regularly monitor instrument sensitivity and reagent blanks).

Results and Discussion

We have used these methods to analyze aerosol samples from CLIVAR cruises in 2003, 2004, 2006, 2006, and 2007. The solubility of aerosols in ultrapure water mimics the chemistry of filtered rain samples, demonstrating that the solubility leaching treatment we developed is a good analog for wet deposition scavenging of aerosols during rain events. Since wet deposition is believed to account for about 50% of total atmospheric aerosol deposition, this is a very important finding since the technique is relatively simple and is easily reproduced by other workers. The seawater solubility treatment is designed to mimic the instantaneous solubility of aerosols that are dry-deposited to the surface ocean. Although we still have many seawater leachate samples to analyze, we are beginning to see a pattern where the aerosol solubility in seawater is about 50% of the solubility in ultrapure water. This is also a very important finding, since it suggests that we can estimate the dry deposition of soluble aerosol trace elements to the surface ocean from the ultrapure solubility measurement.

Conclusions

Our conclusions are still being developed, and several journal articles are being submitted to a special issue of Marine Chemistry on aerosol deposition and chemistry.

Acknowledgements

This research was funded by NSF awards OCE-0223378, OCE-0550317 and OCE-0649639 (to WML).

References

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