Optical Characterization of dissolved Organic Matter in Maine Rivers

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Introduction

Disolved Organic Matter (DOM) is comprised of carbon- and hydrogen-rich molecules of biological origin (Coble, 2007). Recently, scientists have begun to use fluorescent properties to measure and discriminate between fractions of DOM. The major components of fluorescent DOM are humic-like, pigment-like, and protein-like. Based on which fluorophores are present and their relative concentrations, one can deduce the sources of DOM and the processes taking place either in the watershed or in the aquatic systems. Here, fluorescence is used to identify the DOM components present in water samples collected from four rivers in New Hampshire, Maine and New Brunswick, Canada (Figure 1): the Androscoggin, Penobscot, Kennebec, and St. John. The watersheds of the four rivers combined have 39,120 mi² of drainage area. They also have an average combined discharge of 39.79 billion gallons into the Gulf of Maine (GoM) each day (Rivers, 2013). The results of this analysis will help to explain the different sources of materials and the processes that affect the transport of carbon from terrestrial systems, via rivers and into the coastal waters. It may also provide insight into how this may change in the future.

Objective

This research was a part of the NASA Three Rivers Project that began in 2011. This project was designed to identify how different components of DOM move down through the various watersheds and the composition and concentration of DOM that is exported into the Gulf of Maine.

Sampling Locations

Figure 1. The locations of sampling sites on each river with the Penobscot sites depicted with red pins, Androscoggin with blue, and St. John with grey. The darker shaded pins indicate that the site is on the river’s mainstem, while lighter shades depict sites on tributaries.

Methods

Gathering Samples:
- From April 2011-July 2013, samples were collected monthly during ice-free periods from 69 sampling stations along the mainstem and tributaries of the Androscoggin, Kennebec, Penobscot and St. John rivers.
- Samples were filtered on site through a 0.7 µm filter, then stored in cold and dark glass bottles for transfer to the lab.

Fluorescence analysis in the Lab:
- Samples were run through a Cary Eclipse 3 fluorescence spectrophotometer (Varian Instruments).
- Fluorescence intensities were compiled, creating an Excitation-Emission Matrices (EEMs). Figure 2 with excitation at 5 nm intervals and emission at 1 nm resolution.
- Daily lamp scans and distilled Nanopure water scans were performed.

Calculating flux of DOM components into the GoM:
- Samples were filtered on site through a 0.7 µm filter, then stored in cold and dark glass bottles for transfer to the lab.
- Daily lamp scans and distilled Nanopure water scans were performed.

Results

- Figure 3: A typical EEM 2-D contour plot displaying fluorescence intensity as a function of excitation and emission wavelengths. There are two distinct fluorophores emitting at approximately 450 nm, due to scattering on the diffraction grating.

- Table 1: Fluorescence properties of major DOM components

Future Directions

In the future, I hope to obtain the land use analysis of the four watersheds done by scientists at Michigan Tech (who are working in collaboration with Bowdoin on this project) to further explain why specific compounds were found in some areas and not others. I hope to combine the information from this analysis with other aspects of the project to identify and understand the sources and sinks of these compounds down the rivers and into the Gulf of Maine. I would also like to like to follow this data further out to sea by comparing the flux of DOM into the GoM with DOM measured at offshore buoy sites.

Special Thanks

A special thanks to my Faculty Mentor, Dr. Collin Roesler, for all of her patience and wisdom. Thank you to Dr. Philip Camill, Dr. John Lichter, Susan Drapau, Anna Bourakovsky, Kit Hamley, Alana Menendez, Hugh Ruscitti and Kari Ransohort without their help none of this would have been possible. Also to NASA for funding this project.

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Future Directions

- Peaks 1, 3, and 4 (the humic materials) are the most prevalent components at the river mouths, accumulating along the river due to run off
- The relative intensity of the humic materials also increased from the Androscoggin to the St. John suggesting a geographic progression in source material likely related to land coverage
- Peak 2 (forsyline) was extremely rare in all samples while peak 7 (tryptophan) was always present suggesting ubiquitous aquatic biological activity (protein production)
- While seasonal variability in concentration was observed, it was masked by the seasonal variations in river discharge
- The seasonal flux of fluorescent materials was very similar between the Penobscot and the Kennebec in terms of magnitude and pattern
- The flux of all DOM components was highest during the spring freshet, with a secondary peak during fall precipitation maxima and lowest during August, due to decreased rainfall.

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