# 2017
## Biogeochemistry

CIE 457 & 657
3 credit hours

Time: Monday and Wednesday 2:15 to 3:35
Place: 152 Link Hall

Instructor:
C.T. Driscoll
*ctdrisco@syr.edu*

Office Hours: Monday and Wednesday 1:00-2:15

## Text:

The required text for this course:

William H. Schlesinger and Emily S. Bernhard (2013). Biogeochemistry: an Analysis of Global Change. Third Edition. ISBN-10: 0123858747, Academic Press, San Diego, CA.

ISBN-10: 0123858747, Academic Press, San Diego, CA, Soft-cover, $99.95; you can also purchase this book in eBook format; see: http://tinyurl.com/elsevier-PRF13) or as a Kindle version on Amazon. This book places special attention on global biogeochemical cycles.

In this course several case studies will be used as examples for demonstrating biogeochemical principals. One site of notable importance is the Hubbard Brook Experimental Forest (HBEF; https://hubbardbrook.org/). This site has one of the longest records of biogeochemical data in North America including an extensive record of research and publications. The site characteristics are similar to those found in much of the northern hardwood forest found in eastern North America including portions of New York State. For additional information on the HBEF see: http://www.hubbardbrook.org. Other case study examples will include Onondaga Lake http://www.ongov.net/wep/we15.html, the Everglades (www.sfwmd.gov/science-data) and the Adirondacks http://www.adirondacklakessurvey.org/.

## Please also download/see file and read the articles relevant to linkage between climate change and biogeochemistry:

NECIA. 2006. Climate Change in the U.S. Northeast. UCS Publications, 2 Brattle Square, Cambridge, MA 02238-9105. 35 pages. See Blackboard for file

2012 State of the Climate Report:
For a summary see:
http://www.climate.gov/news-features/understanding-climate/state-climate-2012-highlights

For the complete report see:

http://www.ametsoc.org/2012stateoftheclimate.pdf

IPCC report (summary for policy makers):
http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf

National Climate Assessment (highlights):
http://admin.globalchange.gov/sites/globalchange/files/NCA3_Highlights_LowRes-small-FINAL_posting.pdf

Additional information on biogeochemistry will be provided in the lectures and supplemental readings. Students will be expected to read assigned articles and be prepared to discuss them. Lectures and discussion will cover the general area of element cycling emphasizing those processes that are important in regulating fluxes and transformations. We will also have three class sessions devoted to specific topics associated with biogeochemical analyses and will be in the form of "workshops" that will include problem solving exercises that will need to be completed by each student working independently.

The lecture presentations and supplemental readings will be posted on Blackboard to download.

## Course Description:

Biogeochemical processes and phenomena are a unifying concept for ecological systems. In this course students will learn about patterns, processes and cycles of water, and major and trace elements, including carbon, nitrogen, sulfur, and phosphorus among others at global and local ecosystem scales. The interface between the abiotic and biotic components of ecosystems will be explained using examples from both terrestrial and aquatic environments. Linkages among element cycles will be highlighted. Recurrent biogeochemical patterns and processes will be used to help develop an understanding of similarities and differences among ecosystem types. Tools and instrumentation necessary to study biogeochemistry will be discussed. Conceptual models will be employed to describe element dynamics of ecosystems. Several case studies will be used as examples for demonstrating biogeochemical principles, including ocean acidification, restoration of Onondaga Lake and the Everglades, and disturbances to the northern forest, such as acid and mercury deposition and climate change.

The unique role of humans in altering element fluxes will be detailed, including the application of biogeochemistry within the context of environmental management. A particular focus will be given on the influence of atmospheric pollutants and climate change on biogeochemical processes

## Course Objectives:

1. To discuss the principles of biogeochemical pattern and process in ecological systems.
2. To acquaint students with the methodologies and approaches to understand the science and conduct research in biogeochemistry.

## Excused absence due to observation of religious holidays:

If you need to be absent from class due to a religious observance, please let me know as soon as possible so that any needed adjustments can be made.

**Approach to Classes:** We will generally use a "flipped" class approach. Most lecture have been taped which students can access on Blackboard. Students need to view lectures in advance of the class. Students will be required to submit 1-3 questions on the lecture material before 12 noon the day of the lecture by email. There will be a short "quiz" on the material at the start of the class. The class period will be used for a general discussion on the lecture material, the student questions and the quiz.

## Biogeochemistry Project:

Each student students will be required to develop report which involves analysis and interpretation of biogeochemical data. This exercise with be conducted in several phases. Students will develop a proposal for evaluating a question related to biogeochemistry using existing data available to the student including information available on the web (e.g., NADP, LTER, IPCC). An oral presentation of this proposal will occur early in the semester. Following the oral proposal presentation, written version of the proposal (maximum length two pages) will be provided to the instructor.

A final oral presentation of report will be given (~ 10 minutes) during a symposium toward the end of the semester. Also, a written report will be provided to the instructor on the last day of classes. The maximum length of the report will be approximately 10 pages of text.

## Exams:

Students will be evaluated with midterm and final take-home examinations, the proposal, problem sets, class discussion and final report. Examinations will be different for undergraduate and graduate students. It is expected that in answering the exam questions that students will provide literature citations including the class readings that support their answers. *Students are not allowed to exchange information with anyone in any manner in mid-term and final examinations.*

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| **Evaluation:** | Participation in Class Discussions, Quizzes | 10% |
| | Workshop problem sets | 15% |
| | Report Proposal | 5% |
| | Final Oral Report Presentation | 10% |
| | Final Written Report | 20% |
| | Midterm | 20% |
| | Final | 20% |
| | **Total** | **100%** |

# CLASS SCHEDULE

| | | | READINGS | | |
|---|---|---|---|---|---|
| **Date** | **Topic** | **Assignment** | **SCHLESINGER AND BERNHARD** | **Digital Edition** | **Other (Subject to Change)** |
| Mon., Aug. 28 | Introduction to Course – and lecture on Climate Change Impacts | | | | (NECIA 2006)<br>(Campbell et al. 2009)<br>(Melillo et al. 2014)<br>(Reilly 2015)<br>(Jackson et al. 2015) |
| Wed., Aug 30 | Chemical Evolution of the Earth | Introduction to student projects and presentations.<br><br>Important due dates for student projects | Chapter 2, 15-47 | | (Zamora 2014)<br>(Falkowski and Isozaki 2008)<br>(Falkowski and Godfrey 2008)<br>(Falkowski 1997)<br>(The Story of the Earth, Hazen, 2012) |
| Mon., Sept. 4 | Labor Day, No Class | | | | |
| Wed., Sept. 6 | Major pools and processes in Biogeochemistry | | | | (Berner and Berner 1996)<br>(Matthews et al. 2008)<br>(Doney 2006) |
| Mon., Sept. 11 | Major pools and processes in Biogeochemistry (cont) | | | | |
| Wed., Sept. 13 | Atmospheric Processes; workshop on units and atmospheric deposition | **ASSIGNMENT** - Problem Set 1 | Chapter 3, 49-89 | | (Selections from Guide for International System of Units (SI))<br>(Chapter 7 Units and Measurements)<br>(USGS 2011) |
| Mon., Sept. 18 | Global Water Cycle | | Chapter 10, 399-416 | | (Jones et al. 2012)<br>(Rodell et al. 2011) |
| Wed., Sept. 20 | Lithosphere | **DUE** - Preliminary project topics for student proposals | | p. 93-131 (Chapter 4) | |
| Mon., Sept. 25 | Approaches for Biogeochemistry Study: the Hubbard Brook Ecosystem Study and research on climate change effects. | | Chapter 1, p. 3-14<br>p. 255-270<br>Chapter 9, p. 365-368 | Chapter 1, p. 14-26<br><br>p. 254-269<br>Chapter 9 – p. 365-368 equivalent in digital | (Groffman et al. 2012) |
| Wed. Sept. 27 | Instrumentation and Approaches for Biogeochemistry Studies. | | | | (Mitchell et al. 2001)<br>(Knapp et al. 2012) |

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| Mon., Oct. 2 | Biogeochemistry of Carbon | **DUE** – Problem Set 1<br><br>Directions for oral presentation and final written proposal for class project. | p. 55-59, 65, (Chapter 5)135-171, 224-225, 290-304, 352-368, (Chapter 11) 419-443 | p. 68-69, Chapter 5 (139-172, 230-231, 289-301, 348-364, (Chapter 11) 411-439 | (Fahey et al. 2005)<br>(Falkowski et al. 2000)<br>(Bauska et al. 2015)<br>(Schmidt et al. 2011) |
| Wed., Oct. 4 | Carbon (Continued) | | | | (Luo 2007)<br>(Magnani et al. 2007)<br>(Stavins and Richards 2005)<br>(Aufdenkampe et al.2011)<br>(Raymond et al. 2016)<br>De la Rocha, C.L.<br><br>Additional Reference Material (Optional Readings)<br>(Creyts et al. 2007)<br>(Bales and Clay 2008) |
| Mon., Oct. 9 | Student Proposals | | | | |
| Wed., Oct 11 | Biogeochemistry of Nitrogen | **ASSIGNMENT DUE** – Final Written Proposals | p. 63-64, 200-210, 223-224, 304-305, 445-462 | p. 74-76, 201-213, 228-229, 303-304, 440-455 | (Yanai et al. 2013)<br>(Rabalais 2002)<br>(Schlesinger 2009) |
| Mon., Oct. 16 | Biogeochemistry of Nitrogen (Continued) | | | | (Driscoll Charles T. et al. 2003)<br>(Galloway James N. et al. 2003)<br>(Cloern 2001)<br>(Thomas et al. 2010)<br>(Fenn et al. 2003) |
| Wed., Oct. 18 | Workshop on Hydrological Measurements<br><br>David Chandler (Guest Lecturer) | **ASSIGNMENT** – Problem Set 2 | | | |
| Mon., Oct. 23 | Phosphorus | **ASSIGNMENT -** Midterm Directions for Oral Presentation for Class Symposium | p. 106-111, 334-336, 462-465 | p. 113-117, 322, 456-460 | (Walker and Syers 1976)<br>(Carpenter et al. 1998)<br>(Conley et al. 2009)<br>(Schindler 2012) |
| Wed., Oct. 25 | No Class | | | | |
| Mon., Oct 30 | Sulfur | **DUE** – Midterm<br>(to be emailed to ctdrisco@syr.edu by 11:59pm | p. 86-87, 211-213, 307-308, 390-391, 469-482 | p. 94, 214-216, 306, 385-387, 465-478 | (Smith et al. 2011)<br>(Likens et al. 2002)<br>(Galloway J. N. 2001)<br>(Rice et al. 2014) |

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| Wed., Nov. 1 | Stoichiometry<br><br>Kim Schulz<br>*(Guest Lecturer)* | | | | Required:<br>(Elser et al. 2000)<br>(Moe et al. 2005)<br><br>Optional:<br>(Frost et al. 2002)<br>(Sterner and Hessen 1994)<br>(Allgeier et al. 2017) |
| Mon., Nov 6 | Cations | **ASSIGNMENT DUE** –<br>Problem Set 2 | | p. 102-113, 126-133 | (Cronan and Schofield 1990)<br>(Driscoll Charles T. et al. 2001)<br>(Battles et al. 2014)<br>(Greaver et al. 2012)<br>(Leys et al. 2016) |
| Wed., Nov. 8 | Cations; acid deposition (Continued) | | | | |
| Mon., Nov. 13 | Symposium Talks | | | | |
| Wed., Nov. 15 | Workshop on Ecosystem Pools and Fluxes/Critical Loads | **ASSIGNMENT**<br>Problem Set 3 (Soils/Streams) | | | (Burns et al. 2008)<br>(Porter et al. 2005) |
| Mon., Nov. 20-24 | **Thanksgiving Break** | | | | |
| Mon., Nov. 27 | Biogeochemistry & Stable Isotopes: Analyses of Trophic Relationships<br>Mark Teece<br>*(Guest Lecturer)* | | | | (Sulzman 2007) |
| Wed., Nov. 29 | Mercury | **ASSIGNMENT DUE –**<br>Problem Set 3 (Soils/Streams) | p. 482-484 | p.478-481 | (Munthe et al. 2007)<br>(Evers et al. 2011)<br>(Driscoll C. T. et al. 2013)<br>(Chen et al. 2012)<br>(Lavoie et al. 2013)<br>(Demers et al. 2013) |
| Mon., Dec. 4 | Mercury (*continued*) or to be decided | | | | |
| Wed., Dec. 6 | Final Take Home Examination Given to Students<br><br>Last day of class | – FINAL EXAM<br><br>**DUE –**<br>Project | | | |
| Wed. Dec. 13 | | **DUE –**<br>FINAL EXAM<br>To be emailed to ctdrisco@syr.edu by 4:30pm | | | |

**References:**


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Climate Change. Paul and Amy talk about recents events with weather and their views on the matter. Your browser does not support the audio tag. Script.Â  Paul: I've read quite a lot about it. And yes, there is a science to support it but there's also a lot of science to â€” not to deny it but there's definitely a lot of questions that aren't answered yet. It's a very sort of complex issue. I mean, these global systems of weather and you've got all these like organic processes going on that we just don't really understand. And then trying to explain all these complex events by saying it's climate change, it'sâ€¦ I mean, what worries me is that by denying it, it seems to also be a sort of justification for