Spring 2020 Syllabus
MSL 461/660: Chemical Oceanography
Class meeting times: T,Th 09:45-11:15
Location: O'Neil 214
Prerequisites: Graduate Standing
3 credits

Instructor:
Dr. William Burt
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Office Hours: M,W 1:30-3:00 or by appointment

Course Description: An integrated study of the chemical, biological and physical processes that determine the distribution of chemical variables in the sea. This course covers core concepts of chemical oceanography, and focuses on oceanographic applications that will assist students in their future research. Core concepts include: the major and minor constituents of sea water, controls on the ocean's chemical composition, box models, particulate fluxes and diagenesis, gas exchange and the cycling of dissolved gases, nutrient cycling, the carbon cycle and the influence of the oceans on atmospheric composition including CO_2 levels. Additional topics may include (subject to student's needs): chemical tracers, redox chemistry, hydrothermal systems, radiochemical dating and tracer methods, stable isotope studies. Chemical oceanography is an essential part of the interdisciplinary knowledge necessary to understand the ocean.

Course Goals: The ocean is central to the climate system and the natural resources of our planet. The goal of the course is to provide ocean literacy that will enable understanding of the ocean as a system and its intrinsic role in the biogeochemical cycling of elements. Additional goals include the improvement of critical thinking, and the improvement of written and oral science communication skills.

Learning Objectives:
At the end of this course students should be able to:
- *Identify the processes at ocean boundaries that control the chemical composition of seawater*
- *Understand the role of circulation and source/sinks on controlling the spatial and temporal distributions of chemical species within the world's oceans*
- *Integrate concepts of physical, biological and chemical processes to describe nutrient, dissolved gas and chemical cycling in the ocean, particularly the carbon cycle*
- *Use chemical distributions to infer information about physical and biological processes within the oceans*
- *Understand the key chemical processes and factors that influence the ocean's role with respect to ongoing global environmental change*

Expected preparation for the course: Undergraduate degree in science, or a background that includes similar undergraduate courses, is necessary. Competence in algebra is necessary; introductory calculus and differential equations are useful for some topics but are not required. One year of general chemistry and biology at the college level are necessary; organic chemistry, inorganic chemistry and biochemistry are helpful. Biological and physical oceanography are also helpful. If you have not taken a background course described as "helpful", you will probably benefit from doing some extra reading to familiarize yourself with the basics. For example, an introductory general oceanography text will be useful for students who have not had this background.

Instructional Methods: Various instructional methods will be used during the course, including lectures, reading assignments, class discussion, hands-on practice through homework assignments, literature research, and student presentations**.** BlackBoard will be used to distribute class information, updates and changes. Distance delivery through video conferencing will be available to students located outside Fairbanks.

Note: This is a stacked 400/600 level course. The material covered will be the same for both versions of the course, but the grading will differ. Graduate students will have to answer additional questions in both homework assignments and exams, and will be expected to lead class discussions at a higher level than undergrad students. Oral presentations by graduate students will also be graded more critically compared to undergraduate students.

Course Components:

Class Participation	8%
Problem Sets 3 x 8%	24%
Oral presentations. 2 x 6%	12%
Midterm 1	16 %
Midterm 2	16 %
Final Exam	24%

Grading:

>90 %	=	A
80-89	=	B
70-79	=	C
60-	=	D
< 59	=	F

Grades for each category will be weighted as shown above to obtain an overall grade from all possible class points. There will be no extra credit assignments. Your overall grade will be rounded to the nearest whole percentage before final grades are assigned. Only whole letter grades will be assigned (no plus (+) and minus (-) grading system).

Text: *Emerson and Hedges:* ***Chemical Oceanography and the Marine Carbon Cycle****. Cambridge University Press. (referred to as "E&H" below.)*
Assigned readings from other texts/articles will be provided in class or via the library.
Additional texts you might find useful:

- *Libes:* ***An Introduction to Marine Biogeochemistry****. Wiley.*
- *Pilson:* ***An Introduction to the Chemistry of the Sea****. Cambridge University Press.*
- *Berner and Berner:* ***Global Environment: Water, Air and Geochemical Cycles****. Prentice-Hall.*

Course Policies: Lecture **attendance** and active **participation** in class is expected from all students. If you must be absent due to illness, conference travel, field work, or other important reasons, please notify the instructor **as early as possible** and arrange to make up missed material or assignments.

Lack of academic integrity including plagiarism is not acceptable and will result in a failed grade. Consult the UAF Student Conduct guidelines and expectations found on line.

Three **homework assignments** will be given. Homework sets consist of multi-part questions that include a combination of quantitative and qualitative problems. Homework sets are designed to enhance your understanding of complex oceanographic processes and to provide hands-on experience in calculating chemical parameters. Collaboration among students is encouraged. However, each student is expected to submit their own work. Late homework assignments will not be accepted, unless arrangements have been made in advance with the instructor.

Oral presentations of current peer-reviewed articles (2, but subject to change) will be given throughout the semester. Student groups will choose papers/dates in advance, and will be responsible for presenting the main findings of the paper to the class (~ 10 minutes), and leading the discussion (~20 minutes). The number of students in each group will depend on the number of students enrolled in the class.

Support, Advising and Disability Services: At UAF, the Office of Disability Services (203 WHIT; 474-5655; TTY 474-1827; fydso@uaf.edu) ensures that students with physical or learning disabilities have equal access to the campus and course materials. If you have specialized needs, please contact this office or the instructor to make arrangements. There is also an academic advising center, see https://www.uaf.edu/advising/, and student support services https://www.uaf.edu/sss/ should you require academic assistance, advising, or support.

Course Schedule: (SUBJECT TO CHANGE)

14-Jan	Intro, Chemical Species	Read up on ocean circulation (pp3-17)	
16-Jan	Chem Species Discussion + Seawater Chemistry	Read E&H 33-50	
21-Jan	What is Saliniity and Why is the Sea Salty?		
23-Jan	Mass Balance + Hydrothermal		Homework #1 Assigned
28-Jan	Isotopes + in-class homework (zoom lecture)		
30-Jan	2Box Mass Balance	Paper Discussion Broeker and Peng (ME)	
4-Feb	2Box Mass Balance Cont'd		
6-Feb	Biogenic Fluxes		Homework #1 DUE
11-Feb	What happens at the bottom: Diagenesis		
13-Feb	**MIDTERM#1**		
18-Feb	Paper discussion (Martin et al 1987 & Boyd et al., 2019)		
20-Feb	OSM (NO CLASS)		Homework #2 Assigned
25-Feb	Air-Sea Flux		
27-Feb	Oxygen		
3-Mar	Oxygen Activity		
5-Mar	Paper discussion (wanninikof, CraigHayward, Bushinsky etc)		Homework #2 DUE
10-Mar	SPRING BREAK (NO CLASS)		
12-Mar	SPRING BREAK (NO CLASS)		
17-Mar	Nitrogen		
19-Mar	Phosphorus		Homework #3 Assigned
24-Mar	Paper Discussion and Debate: Nitrogen vs.? Phosphorus		
26-Mar	**MIDTERM#2**		
31-Mar	**Spare Lecture (topic TBD)**		
2-Apr	Micronutrient/Iron (Paper Discussion)		Homework #3 Due
7-Apr	Silica		
9-Apr	Paper Discussion (Iron Fertilization)		
14-Apr	CO2		
16-Apr	Carbonate System		
21-Apr	AnthroCO2		
22-Apr	Re-scheduled FINAL EXAM (time and place TBD)		
23-Apr	NO CLASS (due to fieldwork overlap)\		
28-Apr	Scheduled Final exam (moved due to fieldwork overlap)		