Introduction

(Welcome!)

OCN 623 – Chemical Oceanography

Course Philosophy

Every oceanographer needs to have a basic understanding of all of the disciplines of oceanography. This is not just because we desire to turn out well-rounded oceanographers -- it is extremely important to your career:

• Like any science, the most interesting discoveries are often waiting to be made at the interface between disciplines; it is the application of knowledge in one area to problems in another that frequently leads to fundamental improvements in our understanding.

• Further, tools from one branch of oceanography are often highly useful to research efforts in the other branches.

• Finally, all of us need to know enough about the other fields of oceanography so that we are literate in them and are thus capable of understanding the literature in those areas and able to talk to other researchers.
Each of the other oceanographic sub-disciplines can use chemical oceanography:

- **Physical oceanography** uses the chemical parameters to provide information on the origin and circulation of the water masses

- **Geological oceanography** is highly influenced by oceanic chemical cycles and ocean-seafloor interactions

- **Biological oceanography** is highly affected by chemical-biological interactions

Therefore, it is the goal of this course to provide:

- A general overview of chemical oceanography
- A knowledge of the basic concepts necessary to be “literate” in chemical oceanography
- A variety of tools that will be useful to practicing oceanographers

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**Course Structure**

- **Basic concepts** – Reactions, oxidation-state/redox, thermodynamics/equilibrium, ion speciation (review your general chemistry!!)

- **Chemical species** – Major ions, dissolved gases, pH, alkalinity, the CO₂/carbonate system, trace elements, organic matter, isotopes

- **Geochemical reservoirs and fluxes** –
  - Concept of separate identifiable geochemical reservoirs, and cycling of materials within and between these reservoirs
  - Fluxes of materials between the oceans and:
    - Land
    - Sediments
    - Crust
    - Atmosphere
• **Biogeochemical transformations** – These are the fundamental processes (input, removal and recycling) that govern the behavior of chemicals in sea water. We will look at:

  • The **distributions** of these chemicals, which will help us understand the **processes** that produce them
  
  • The **sinks** of chemical materials in the oceans
  
  • The biogeochemical processes that occur in **estuaries**, and their role in modifying the fluxes of materials from the continents to the oceans
  
  • The feedback mechanisms that exist between the oceans and **atmosphere**
  
  • The importance of these feedbacks to **global climate** and the evolution of the **chemical cycles**
  
  • The role that these cycles have played in maintaining the temperature and other conditions at the surface of the Earth over **geologic time**
  
  • Lessons that can be learned from these cycles in terms of predicting the **future climatic consequences** of anthropogenic activity

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### Course Outline

Chemical Oceanography (OCN 623) Course Outline -- Spring 2013

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Instructor</th>
<th>Class Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-Jan</td>
<td>Introduction to course</td>
<td>syllabus</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>10-Jan</td>
<td>Balancing reaction equations, oxidation state, redox reactions</td>
<td>Handout</td>
<td>FS</td>
<td></td>
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<tr>
<td>15-Jan</td>
<td>Gibbs Free Energy and chemical equilibrium</td>
<td>S (1st half)</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>17-Jan</td>
<td>Redox and pE-pH diagrams</td>
<td>L ch 7</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>21-Jan</td>
<td>Ion speciation</td>
<td>S (2nd half), L ch 5</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>24-Jan</td>
<td>Chemical composition of sea water: major constituents</td>
<td>L ch 2, 3, 4</td>
<td>FS</td>
<td></td>
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<tr>
<td>29-Jan</td>
<td>Dissolved gases other than carbon dioxide in sea water</td>
<td>L ch 6 (1st half)</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>31-Jan</td>
<td>Carbon dioxide, alkalinity and pH</td>
<td>L ch 15</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>5-Feb</td>
<td>Nutrients; Aerobic carbon production and consumption</td>
<td>L ch 8 &amp; 9</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>7-Feb</td>
<td>Biogeochemical production, carbonate saturation and sediment distributions</td>
<td>L ch 15 &amp; 16</td>
<td>BB</td>
<td></td>
</tr>
<tr>
<td>12-Feb</td>
<td>Aerobic to anaerobic diagenesis in sediments</td>
<td>L ch 12</td>
<td>BB</td>
<td></td>
</tr>
<tr>
<td>14-Feb</td>
<td>Organic compounds in sea water</td>
<td>L ch 22, 23</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>19-Feb</td>
<td>Fluxes from high temperature reactions along the mid-ocean ridge axis</td>
<td>L ch 19</td>
<td>MM</td>
<td></td>
</tr>
<tr>
<td>21-Feb</td>
<td>Fluxes from diagenesis deep in sediments and basement</td>
<td></td>
<td>MM</td>
<td></td>
</tr>
<tr>
<td>26-Feb</td>
<td>*** Mid-Term Exam (includes Jan 10 - Feb 21 lectures, readings, and homework) ***</td>
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<td>AO</td>
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### OCN 623 - STUDENT LEARNING OUTCOMES

Upon successful completion of the course, students are expected to be able to:

1. Explain the underlying principles of chemical and biogeochemical cycling in marine systems;
2. Identify marine chemical and biogeochemical processes that impact the student’s areas of oceanographic interest, and know how to access and understand information on these processes;
3. Use written and oral communication to clearly explain marine chemical and biogeochemical processes and related contemporary research.

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**Class:** Tuesday & Thursday, 10:30 - 11:45 am, MSB 315

**Course Coordinator:** Frank Sansone, MSB 533, 956-8370, sansone@soest.hawaii.edu
Office hours: 12-1 pm on days he lectures; email to make appointments for other times

**Instructors:** Frank Sansone, David Ho, Mike Mottl, Becky Briggs, Arisa Okazaki (TA)

**Teaching assistant:** Arisa Okazaki, MSB 213A, okazakia@hawaii.edu

**Readings:**
- L = Libes, Marine Biogeochemistry, 2nd Ed. (course text);
- S = Snoeyink and Jenkins;
- H = Handout

**Final grade:** 25% final exam; 25% mid-term exam; 25% term paper, first draft, and oral presentation; 25% problem sets and class participation

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<tbody>
<tr>
<td>28-Feb</td>
<td>Oceanic water mass tracers</td>
<td>L ch 10 &amp; 24</td>
<td>DH</td>
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<tr>
<td>5-Mar</td>
<td>Stable isotopic tracers</td>
<td>H</td>
<td>DH</td>
<td></td>
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<tr>
<td>7-Mar</td>
<td>Radio-isotopic tracers</td>
<td>H</td>
<td>DH</td>
<td></td>
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<tr>
<td>12-Mar</td>
<td>Air-sea exchange</td>
<td>L ch 6 (2nd half)</td>
<td>DH</td>
<td></td>
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<tr>
<td>14-Mar</td>
<td>Atmosphere, the water cycle, and climate change</td>
<td>DH</td>
<td></td>
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<tr>
<td>19-Mar</td>
<td>Student presentations - previews</td>
<td>FS</td>
<td></td>
<td>First draft of bibliography due</td>
</tr>
<tr>
<td>21-Mar</td>
<td>Trace elements in sea water - I</td>
<td>L ch 11</td>
<td>FS</td>
<td></td>
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<tr>
<td>26-Mar</td>
<td>Spring break - no class</td>
<td>FS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28-Mar</td>
<td>Spring break - no class</td>
<td>FS</td>
<td></td>
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<tr>
<td>2-Apr</td>
<td>Trace elements in sea water - II</td>
<td>FS</td>
<td></td>
<td>Peer reviews of drafts due</td>
</tr>
<tr>
<td>4-Apr</td>
<td>Estuaries: classification and mixing processes</td>
<td>H</td>
<td>FS</td>
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<tr>
<td>9-Apr</td>
<td>Estuarine and coastal biogeochemistry</td>
<td>FS</td>
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<tr>
<td>11-Apr</td>
<td>Oceans and climate change</td>
<td>L ch 25</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>16-Apr</td>
<td>Evolution of oceanic chemical cycles - I</td>
<td>H</td>
<td>FS</td>
<td></td>
</tr>
<tr>
<td>18-Apr</td>
<td>Evolution of oceanic chemical cycles - II</td>
<td>H</td>
<td>FS</td>
<td>Final draft of bibliography due</td>
</tr>
<tr>
<td>25-Apr</td>
<td>Student presentations - I</td>
<td>FS</td>
<td></td>
<td></td>
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<tr>
<td>30-Apr</td>
<td>Student presentations - II</td>
<td>FS</td>
<td></td>
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<tr>
<td>9-May</td>
<td>Final Exam, 9:45-11:45 am</td>
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Homework: The homework will give you a chance to develop 1) chemical skills used in oceanography, and 2) critical thinking about chemical oceanographic issues.

Assignments are due one week after they are assigned (e.g., homework assigned on Tuesday is due at the start of class on the following Tuesday). If homework is not handed in by the deadline, you will not get credit for it.

An optional homework discussion session will be run by the TA each week. We will choose a day and time for this session at the beginning of the semester. The topics discussed will be determined by the questions of those attending each discussion session.

Readings are important! They are listed on the Course Outline. DO expect reading material to be covered on the exams, even if it isn’t specifically covered in the lectures!!

Lectures: Nominally they are from 10:30 - 11:45, but realize that classroom discussion can cause the end of class to extend to 11:50. Please plan accordingly.

Exams: The mid-term and final exams will focus on the lectures from the first and second halves of the course, respectively, but not exclusively so: the use of knowledge gained in the first half of the course may be required to answer questions on the final exam. Both exams will be “open book” — you can bring any written material you wish, along with a simple calculator.

COURSE PROJECT INSTRUCTIONS

Each student will be required to write an annotated bibliography on a topic of their choice, and to give two oral presentations (a short preliminary one, and a longer final one).

Why??
- Makes concepts covered in the course more “concrete”
- Provides experience in finding the results of current oceanographic research
- Helps you develop your skills in scientific written and oral communication

Topics:
- You are free to choose a topic that interests you. You must choose your topic by February 12.
- It must be a topic of current interest in Chemical Oceanography
- Unfortunately, research from Station ALOHA and HOT is generally not acceptable -- because the relevant papers are all listed on the ALOHA/HOT web sites. (These convenient lists prevent you from showing that you can dig into the scientific literature and find relevant papers.)
- It can NOT be the primary topic of your thesis/dissertation research. (We hope you will expand your scientific horizons.)
- Topics used in the past three years cannot be used
Requirements for the annotated bibliography:

• The bibliography should start with an introductory paragraph describing the topic to be covered.
• You must find and discuss 10-12 recent papers from the primary scientific literature. Review papers, books, and online sources do not qualify.
• Each paper must be summarized in a paragraph of well-written text.
• Please use a spell-checker – they are a part of all word processors!

First draft:

Three printed copies of the first draft are due March 19. This draft should be as complete and well-written as possible. The score for the draft will be given approximately the same weight as an individual homework assignment.

Peer reviews of drafts:

• Each student will then be assigned a fellow student’s draft bibliography to anonymously review; the instructor and the TA will also review each draft bibliography.
• Your peer review is due April 2.

Final draft:

• You will have until April 23 to revise and complete your bibliography, addressing the comments of the three reviews you received.

Grading of the bibliographies will be based on the following criteria:

• Comprehensive coverage of the topic
• Appropriateness of the papers selected
• Quality of the written summaries

Presentations:

• Short presentations will be given on March 19 -- these will be introductions to the topics
• Longer presentations will be given on April 25 & 30 -- these will be much more detailed explanations what was learned about the topic
Grading of the presentations will be based on the following criteria:

- Quality and comprehensiveness of the material covered
- Organization of talk, including the quality of the conclusions given
- Quality and use of figures
- Keeping within the allotted time
- Quality of speaking style
- Participation in discussions

QUESTIONS??