



OCEAN CARBON & BIOGEOCHEMISTRY (OCB) OCEAN ACIDIFICATION COURSE

November 2-13, 2009

Woods Hole, MA USA

MBL Swope Cafeteria Meal Times (highlighted in blue)

Breakfast: 7:00-8:30 am (before course begins each morning)

Lunch: 12:00-1:00 pm

Dinner: Served until 7:00 pm (start times vary, see daily schedule)

Don't forget your MBL ID card!!

Coffee Breaks

All **coffee breaks** will take place in the lobby just outside MBL Speck Auditorium in the Rowe Building. We have the MBL Speck Auditorium for the entire duration of the course. Please feel free to use this space during down time to check email, work, convene smaller meetings, etc.

MBL Wireless Access

Wireless network: MBL-guest

Username: mblguest

Password: mblguest

Important Email Addresses and URLs

Course instructors: **ocb-acid-inst@whoi.edu**

Course participants: **OA-students@whoi.edu**

OCB Ocean Acidification Course Website: **<http://www.whoi.edu/courses/OCB-OA>**

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Lectures

All lectures will take place in MBL's Speck Auditorium (Rowe building). There are restrooms on the 1st and 3rd floors of the Rowe Building. Please bring your MBL ID card, laptops, notebooks, syllabus, and writing utensils. **Please remember that there will be very few outlets for charging laptops available in the Speck Auditorium, so it is your responsibility to come with a fully charged battery each day.**

Labs

Labs will take place in multiple locations on the WHOI and MBL campuses. See detailed schedule. All buildings have been highlighted on your MBL and WHOI maps. Please bring your MBL ID

card, syllabus, lab coats, lab notebooks, and writing utensils to labs. Please exercise common sense when working in the labs. This means no food/drink, no open-toed shoes, wear long pants, wear your lab coats at all times, wear goggles and nitrile gloves when appropriate (we'll provide these in the labs), be aware of waste disposal protocols (i.e. don't flush hazardous substances, including mercury-poisoned seawater down the drain), and take notice of safety features (building evacuation routes, emergency showers, eye wash stations, and first aid kits). There will be a lab safety briefing on Monday 11/2 from WHOI and MBL officials. Each lab will also have a binder containing important safety information, including MSDSs for all chemicals we're using.

Lab Groups

Participants (36 total) are divided among three groups of 12 throughout the course: **A/B/C for Segment 1 CO₂ sampling; D/E/F for Segment 1 chemistry measurements; G/H/I for Segment 2 experiments.** Group makeup will change throughout the course to distribute participant experience in different areas and provide maximum interaction among participants. **Please see syllabus and/or your nametag for your group assignments.**

Emergency Phone Numbers

MBL campus: Dial 9911

WHOI campus: Dial 2911

Falmouth Hospital Emergency Services: 508-457-3524

Dr. Lee's Falmouth walk-in medical center: 508-540-6790

Transportation

We will provide shuttle service between the WHOI and MBL campuses. **All shuttle activity is highlighted in red.** Several participants and instructors may also have rental cars. Please try to share rides when possible. The MBL shuttle stop will be in front of the Swope building (see MBL campus map). WHOI shuttle drop-off and pick-up locations will be in front of the buildings in which activities are occurring (Clark, McLean, ESL, etc.).

If you miss the OCB/OA Course shuttle between MBL and WHOI

You can walk to the **WHOI shuttle stop** in the parking lot next to Coffee Obsession in Woods Hole village (WHOI shuttle stop is marked on your Woods Hole village map) or in front of the Clark building on the WHOI Quissett Campus. The shuttle is a navy blue van and says "Woods Hole Oceanographic Institution" on it. It is free – if they ask, just tell them you're attending a scientific conference/course at WHOI. The shuttle runs daily between the hours of 8:00 am and 5:40 pm (last shuttle from Woods Hole village to the WHOI Quissett campus). The ride between Woods Hole village and Quissett Campus only takes ~5 minutes, and the schedule is as follows:

Departs Woods Hole village every 20 minutes on the :00, :20, :40

Departs Clark Building (Quissett campus) every 20 minutes on the: 10, :30, :50

If you need help, please don't hesitate to call

Heather Benway 508-289-2838* (office), 541-760-3825 (cell)

Sarah Cooley 508-289-3859* (office), 706-338-6209 (cell)

Mary Zawoysky 508-289-2310* (office)

***If on WHOI campus and using a WHOI phone, just dial last four digits**

Monday, November 2, 2009

Lectures, lab safety talks, sampling, and underway pCO₂ demonstration

Morning

Time	Activity
8:15 am	Introductory remarks (Benway/Cooley)
8:30 am	Lecture. Overview of the ocean CO ₂ system (Sabine) MBL Speck Auditorium
9:00 am	Lecture. Introduction to CO ₂ chemistry in seawater media (Dickson) MBL Speck Auditorium
9:40 am	Lecture. Analytical parameters, and current measurement techniques (Dickson) MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Lecture/Hands-on. Introduction to CO ₂ SYS (Sabine) MBL Speck Auditorium – bring laptops
11:15 am	Lecture/Hands-on. Introduction to seacarb (Gattuso) MBL Speck Auditorium – bring laptops
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon

Time	Group A	Group B	Group C
1:15 pm	Lecture. WHOI/MBL Chemical Safety training, MBL Speck Auditorium (Poisson - WHOI, Marcello - MBL)		
2:00 pm	Lecture/Video. MBL Speck Auditorium: 1) CO ₂ water sampling movie (Dickson) 2) Introduction to underway pCO ₂ system (Wang)		
2:30 pm	Lab. CO ₂ water sampling, Rowe 423/424 (Dickson, Sabine, Cooley)	Break	Shuttle MBL to McLean
3:00 pm			Lab. Underway pCO ₂ demo (Wang) (1 hour)
3:30 pm	Shuttle MBL to McLean	Lab. CO ₂ water sampling, Rowe 423/424 (Dickson, Sabine)	Shuttle McLean to MBL
4:00 pm	Lab. Underway pCO ₂ demo (Wang/Cooley) (1 hour)		Shuttle MBL to McLean
4:30 pm	Break/Shuttle McLean to MBL (if desired)	Lab. Underway pCO ₂ demo (Cooley) (1 hour) – then walk to Clark	Lab. CO ₂ water sampling, Rowe 423/424 (Dickson, Sabine)
5:00 pm	Shuttle MBL to Clark (if needed)		Shuttle MBL to Clark
5:30 pm			
6:00-8:00 pm	Welcome reception/poster session (WHOI, Clark 507)		
8:00 pm	Shuttles from Clark to MBL		

Tuesday, November 3, 2009

Lectures, pH and DIC measurements, and video/discussion of coulometric DIC setup

Morning

Time	Activity
8:30 am	Lecture. pH and Alkalinity (Dickson) MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Remote Lecture. Overview of biogeochemical feedbacks (Hutchins) MBL Speck Auditorium
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon

Time	Group D	Group E	Group F	
1:15 pm	Shuttle MBL to McLean	Lab. pH measurements in Rowe 423/424 (Yates/DuFore at-sea system and electrodes with Sabine/McCorkle)	Break	
1:30 pm	Lab. Spectrophotometric pH measurements (Wang) and infrared gas analyzer DIC measurements (Langdon) (McLean 203)		Shuttle MBL to McLean	Lab. pH measurements in Rowe 423/424 (Yates/DuFore at-sea system and electrodes with Sabine/McCorkle)
2:00 pm				
2:15 pm				
2:30 pm	Shuttle McLean to MBL	Lab. Spectrophotometric pH measurements (Wang) and infrared gas analyzer DIC measurements (Langdon) (McLean 203)	Shuttle MBL to McLean	
3:00 pm	Lab. pH measurements in Rowe 423/424 (Yates/DuFore at-sea system and electrodes with Sabine/McCorkle)			
3:30 pm			Shuttle McLean to MBL	Lab. Spectrophotometric pH measurements (Wang) and infrared gas analyzer DIC measurements (Langdon) (McLean 203)
4:00 pm	Break	Break		
4:30 pm				
4:45 pm	Discussion/Video: Care and startup of a coulometric DIC system (Cooley/Dickson); MBL Speck Auditorium			
5:30 pm	Dinner (Swope Cafeteria, MBL)			

Wednesday, November 4, 2009

Lectures, TA and DIC measurements

Morning

Time	Activity
8:30 am	Lecture. Quality control of analytical measurements of CO ₂ parameters (Dickson) MBL Speck Auditorium
9:00 am	Discussion. Advantages and disadvantages of current analytical approaches? How well can you control the CO ₂ system in your experiment? (Wang) MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Lecture. Implications of uncertainties in equilibrium constants and analytical measurements (Dickson) MBL Speck Auditorium
11:00 am	Discussion. Choosing the optimal parameters for a particular ocean acidification experiment and learning how well you need to measure the parameters you choose (Sabine) MBL Speck Auditorium
12:00 pm	Lunch (Swope Cafeteria, MBL)

See Wednesday afternoon schedule on next page

Time	Group D	Group E	Group F
1:15 pm	Lab. TA measurements in Rowe 423/424 (Yates/DuFore and Langdon systems)	Lab. Coulometric DIC demo (Erickson, MBL Envir. Sciences Center 117)	Shuttle MBL to McLean
1:30 pm			Lab. Open-cell TA measurements (Wang) (McLean 203)
2:15 pm	Walk to MBL Envir. Sciences Center	Shuttle MBL to McLean	
2:30 pm	Lab. Coulometric DIC demo (Erickson, MBL Envir. Sciences Center 117)	Lab. Open-cell TA measurements (Wang) (McLean 203)	Lab. Small volume open-cell TA measurements (McCorkle/Holcomb) in McCorkle lab (McLean 113)
3:00 pm			Shuttle McLean to MBL
3:15 pm			Lab. TA
3:30 pm	Shuttle MBL to McLean	Lab. Small volume open-cell TA measurements (McCorkle/Holcomb) in McCorkle lab (McLean 113)	measurements in Rowe 423/424 (Yates/DuFore and Langdon systems)
3:45 pm	Lab. Open-cell TA measurements (Wang) (McLean 203)		
4:00 pm			Shuttle McLean to MBL
4:15 pm		Lab. TA measurements in Rowe 423/424 (Yates/DuFore and Langdon systems)	
4:30 pm	Walk to MBL Envir. Sciences Center	Lab. Coulometric DIC demo (Erickson, MBL Envir. Sciences Center 117)	
4:45 pm			
4:45 pm	Lab. Small volume open-cell TA measurements (McCorkle/Holcomb) in McCorkle lab (McLean 113)		
5:15 pm	Shuttle McLean to MBL		
5:30 pm	Dinner (Swope Cafeteria, MBL)		
7:00-8:30 pm	Lecture. Overview on experimental design. (Langdon) MBL Speck Auditorium		

Thursday, November 5, 2009

Lectures, moored pCO₂ instrument demo, CO₂SYS experiments, and larval mollusk experimental setup

Morning

Time	Activity
8:30 am	Lecture. Approaches, tools to manipulate carbonate chemistry (Gattuso) MBL Speck Auditorium (1 hour plus 15 mins for questions/discussion)
9:45 am	Coffee Break
10:15 am	Lecture/Demo. Sabine's moored CO ₂ instrument demo (MBL Rowe – auditorium for lecture, then to Rowe 423/424 to cycle participants through instrument demo)
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon

Time	Group G	Group H	Group I
1:15 pm	Shuttle MBL to Clark	Shuttle MBL to ESL	Break
1:30 pm	Lab. Theoretical CO ₂ SYS experiments (Yates, WHOI Computer Group Training Facility, Clark 141)	Lab. Exp't setup (each group does 3 ambient, 3 enriched) for larval mollusk experiment (McCorkle/White, ESL 10)	
2:00 pm			Shuttle MBL to Clark
2:30 pm	Walk Clark to ESL	Break/Walk ESL to Clark	Lab. Theoretical CO ₂ SYS experiments (Yates, WHOI Computer Group Training Facility, Clark 141)
2:45 pm	Lab. Exp't setup (each group does 3 ambient, 3 enriched) for larval mollusk experiment (McCorkle/White, ESL 10)		
3:30 pm		Lab. Theoretical CO ₂ SYS experiments (Yates, WHOI Computer Group Training Facility, Clark 141)	Walk Clark to ESL
3:45 pm	Shuttle ESL to MBL		Lab. Exp't setup (each group does 3 ambient, 3 enriched) for larval mollusk experiment (McCorkle/White, ESL 10)
4:00 pm	Break		
4:30 pm		Shuttle Clark to MBL	Shuttle ESL to MBL
4:45 pm			
5:00 pm	Dinner (Swope Cafeteria, MBL)		

Friday, November 6, 2009

Lectures, coral calcification experimental setup, larval mollusk inoculations, lab tour

Morning

Time	Activity
8:30 am	Lecture. Algal culturing overview. (Iglesias-Rodriguez). MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Lecture. Calcification overview, measurements, and background for biological experiments (Cohen/Miller)
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon/Evening

Time	Group G	Group H	Group I	
1:15 pm	Shuttle MBL to ESL	Break	Shuttle MBL to Watson	
1:30 pm	Lab. Coral calcification exp't setup (Holcomb, ESL 10)		Shuttle MBL to ESL	Tour. Joan Bernhard's lab – CO ₂ enrichment exp'ts with benthic foraminifera and other exp'ts (Watson 230)
2:15 pm				
2:30 pm	Walk to Watson lab	Lab. Coral calcification exp't setup (Holcomb, ESL 10)	Break/Walk to ESL	
2:45 pm	Tour. Joan Bernhard's lab – CO ₂ enrichment exp'ts with benthic foraminifera and other exp'ts (Watson 230)			
3:30 pm	Shuttle Watson to MBL	Break/Walk to Watson lab	Lab. Coral calcification exp't setup (Holcomb, ESL 10)	
3:45 pm				
4:00 pm				
4:30 pm	Break	Tour. Joan Bernhard's lab – CO ₂ enrichment exp'ts with benthic foraminifera and other exp'ts (Watson 230)	Shuttle ESL to MBL	
5:00 pm				
5:15 pm	Dinner (Swope Cafeteria, MBL)			
7:00 pm	Shuttle MBL to ESL	Break	Break	
7:15 pm	Lab. Take T1 samples for coral* (Holcomb, ESL 10);			Shuttle MBL to ESL
8:00 pm				

	inoculate mollusk larvae (White/McCorkle, ESL 10)		
8:15 pm	Shuttle ESL to MBL Done for evening	Lab. Take T1 samples for coral* (Holcomb, ESL 10); inoculate mollusk larvae (White/McCorkle, ESL 10)	
8:30 pm			Shuttle MBL to ESL
9:00 pm			
9:15 pm		Shuttle ESL to MBL	Lab. Take T1 samples for coral* (Holcomb, ESL 10); inoculate mollusk larvae (White/McCorkle, ESL 10)
9:30 pm		Done for evening	
10:15 pm		Shuttle ESL to MBL	

***Coral T1-T4 (Fri-Sun) sampling: this will involve a subgroup of 3 from each group (G/H/I) so that each person gets a chance to sample**

Saturday, November 7, 2009

Lectures, monitoring coral and larval mollusk experiments

Morning

Time	Activity
8:45 am	Shuttle MBL to ESL
9:00 am	Lab. T2 sampling for coral and monitor pH of mollusks (3 person subgroups of Groups G, H, I) (Holcomb, ESL 10)
10:00 am	Shuttle ESL to MBL
10:30 am	Lecture. Radioisotope Techniques for measuring coccolithophore calcification (Balch) and PIC methods for quantifying calcification (Iglesias-Rodriguez), MBL Speck Auditorium
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon

Time	Activity
1:15 pm	Shuttle MBL to ESL
1:30 pm	Lab. T3 sampling for coral (3 person subgroups of Groups G, H, I) (Holcomb, ESL 10)
2:30 pm	Shuttle ESL to MBL
2:45 pm	Break
4:00 pm	Lecture. Measuring calcification in the field. (Langdon). MBL Speck Auditorium
5:30 pm	Dinner (Swope Cafeteria, MBL)

Sunday, November 8, 2009

Monitoring coral and larval mollusk experiments

Morning Free

Afternoon

Time	Activity
1:15 pm	Shuttle MBL to ESL
1:30 pm	Lab. T4 sampling for coral and monitor pH of mollusks (3 person subgroups of Groups G, H, I), end coral exp't (Holcomb, ESL 10)
3:30 pm	Shuttle ESL to MBL
3:45 pm	Break
5:00 pm	Dinner (Swope Cafeteria, MBL)

Monday, November 9, 2009

Larval mollusk harvesting, lectures, MBL Marine Resources Center tour

Morning

Time	Group G	Group H	Group I
8:15 am	Shuttle MBL to ESL	Break	Break
8:30 am	Lab. Harvest mollusks (Cohen/Rose, ESL 10)		
9:15 am		Shuttle MBL to ESL	
9:30 am		Lab. Harvest mollusks (Cohen/Rose, ESL 10)	
10:00 am			
10:15 am	Break		Shuttle MBL to ESL
10:30 am			Lab. Harvest mollusks (Cohen/Rose, ESL 10)
11:00 am		Shuttle ESL to MBL	
11:15 am		Break	
12:00 pm			Shuttle ESL to MBL
12:15 pm	Lunch (Swope Cafeteria, MBL)		

Afternoon

Time	Activity
1:30-3:00 pm	Lecture/Demo/Hands-on. Ocean Data View (Schlitzer, MBL Speck Auditorium)
3:00 pm	Shuttle MBL to Watson (for Tour 2 at 3:15 pm)
3:15-4:00 pm	Tour 1* MBL Marine Resources Center (Ed Enos, MRC)
3:15-4:15 pm	Tour 2. Algal Culturing Lab (John Waterbury, WHOI Watson 102)
4:00-4:15 pm	Shuttle MBL to Watson (for Tour 2 at 4:15 pm)
4:15-4:30 pm	Shuttle Watson to MBL
4:15-5:15 pm	Tour 2. Algal Culturing Lab (John Waterbury, WHOI Watson 102)
5:15-5:30 pm	Shuttle Watson to MBL
5:30 pm	Dinner (Swope Cafeteria, MBL)

Notes:

***Tour 1 will only be conducted once, so if you would like to do both tours, you will need to catch the 4:00 pm shuttle to WHOI and do the 4:15 pm tour of the Waterbury lab.**

Tuesday, November 10, 2009

Lectures, cellular pH regulation experiment, and larval microscopy

Morning

Time	Activity
8:30 am	Lecture. Biogeochemical modeling introduction (Doney) MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Lecture. Physiology (Seibel) MBL Speck Auditorium
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon

Time	Group G	Group H	Group I
1:15 pm	Shuttle MBL to Clark	Break	Shuttle MBL to ESL
1:30 pm	Lab. Larval mollusk microscopy (Cohen/Rose, Clark 120)		Shuttle MBL to ESL
2:15 pm			
2:30 pm		Break/Walk Clark to ESL	Lab. Set up and begin cellular pH experiment (Seibel, ESL 10)
2:45 pm	Lab. Larval mollusk microscopy (Cohen/Rose, Clark 120)		
3:00 pm		Walk ESL to Clark	
3:30 pm	Lab. Set up and begin cellular pH experiment (Seibel, ESL 10)	Lab. Larval mollusk microscopy (Cohen/Rose, Clark 120)	Shuttle Clark to MBL
4:00 pm			Break
4:15 pm			
4:30 pm	Shuttle ESL to MBL		
4:45 pm	Break	Shuttle Clark to MBL	
5:15 pm			
5:30 pm	Dinner (Swope Cafeteria, MBL)		

Wednesday, November 11, 2009

Lectures, respirometry demo, cellular pH regulation experiment, hands-on modeling

Morning

Time	Activity
8:30 am	Lecture. Large databases (Key). MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Lecture. Genomics applications to ocean acidification research. (Fangue). MBL Speck Auditorium
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon

Time	Group G	Group H	Group I
1:15 pm	Shuttle MBL to ESL	Break	Shuttle MBL to Clark
1:30 pm	Lab. Respirometry demo and conclude cellular pH experiment (Seibel, ESL 10)		Shuttle MBL to Clark
2:15 pm			
2:30 pm		Break/Walk ESL to Clark	Lab. Hand-on Modeling (Doney, WHOI Group Training Facility, Clark 141)
2:45 pm	Lab. Respirometry demo and conclude cellular pH experiment (Seibel, ESL 10)		
3:30 pm		Lab. Hand-on Modeling (Doney, WHOI Group Training Facility, Clark 141)	Break/Walk Clark to ESL
4:00 pm	Training Facility, Clark 141)	Lab. Respirometry demo and conclude cellular pH experiment (Seibel, ESL 10)	Shuttle ESL to MBL
4:15 pm			
4:30 pm	Shuttle Clark to MBL		
4:45 pm	Break	Shuttle ESL to MBL	
5:15 pm			
5:30 pm	Dinner (Swope Cafeteria, MBL)		

Thursday, November 12, 2009
Lectures and experimental wrap-up

Morning

Time	Activity
8:30 am	Lecture. Introduction to Data Management and Better Practices for Shipboard Data Management (Chandler). MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Lecture. Biogeochemical Modeling Part II (Doney) MBL Speck Auditorium
12:00 pm	Lunch (Swope Cafeteria, MBL)

Afternoon

Time	Activity
1:30 pm	Discussion. Experimental synthesis and discussion (Langdon lead). MBL Speck Auditorium
3:30 pm	Coffee Break
4:00 pm	Discussion. Experimental synthesis and discussion cont'd (Langdon lead). MBL Speck Auditorium
6:00 pm	Farewell Dinner, MBL

Friday, November 13, 2009

Lecture, course wrap-up and evaluations

Time	Activity
8:30 am	Lecture. Data Reporting (Kozyr) MBL Speck Auditorium
10:00 am	Coffee Break
10:30 am	Discussion. Course evaluations and wrap-up (Benway/Cooley) MBL Speck Auditorium
12:00 pm	Lunch (Swope Cafeteria, MBL)

End of course.