



center for microbial oceanography: research and education
C-MORE *linking genomes to homes*

2010 NMEA Conference

Thursday, July 22 11:15-12:15

Glenstone Lodge; Dogwood 1

Exploring the ocean conveyor belt through experiments, activities and oceanographic data

The ocean conveyor belt is the major system that transports heat and nutrients in the Earth's ocean. This session will introduce a series of lessons developed by the Center for Microbial Oceanography: Research and Education (C-MORE) designed to engage students and allow them to access the same data scientists use to understand the ocean conveyor belt. Through hands on activities, teachers will get a fast paced introduction to two lessons that involve modeling ocean structure and circulation. In addition, there will be a brief introduction to two additional lessons that involve accessing online oceanographic data. All of the lesson plans are available online, are aligned with the ocean literacy principles, and easily integrated into the classroom (http://cmore.soest.hawaii.edu/education/teachers/science_kits.htm).

The session presented at the 2010 NMEA conference will give an overview of one of C-MORE's Science Kits. C-MORE Science Kits offer lesson plans and materials for hands-on science activities in a self-contained format. They are designed for use with a range of grade levels. Each Kit provides the information and supplies necessary for educators to teach their students about a particular topic in oceanography and are free to borrow from one of our lending locations in California (Monterey), Oregon (Newport), Massachusetts (Woods Hole), or throughout Hawai'i. If you do not live near one of our lending locations, you can easily get the supplies to produce your own Ocean Conveyor Belt Kit using the following guide.

How-to make your own Ocean Conveyor Belt Kit:

Download the complete lesson materials which include teacher guides, materials photo guides, student worksheets, and pre- and post- tests for the Ocean Conveyor Belt Kit including all handouts in the session from http://cmore.soest.hawaii.edu/education/teachers/science_kits/ocean_conveyor_kit.htm

Materials: (Paper materials contained in the downloadable Ocean Conveyor Belt file are shown in **BOLD CAPS**)

The Science Kits come with the printed lesson materials laminated in a 3-ring binder and are called "binder materials" throughout the kit. The complete list of materials included with the kit is below, as well as notes indicating where materials supplied with the kit can be purchased (Table 1). The estimated cost per item was current as of March 2010 and subject to change. C-MORE does not endorse any product or vendor listed below, but the specific products and suppliers used to assemble the kit are listed below to help you reproduce the kit. Some materials are only sold by the case which would substantially increase the cost. In these situations, a substitution idea is included in italics.

Cost: The total cost to assemble the supplies for your own Ocean Conveyor Belt Kit as described in the binder materials is approximately \$595, not including tax and shipping. The activities in the Kit could be done for less than \$200 if you substitute some materials. Additionally, C-MORE offers Grants for Education in Microbial Science (GEMS) for up to \$1500 to foster awareness in microbial science (<http://cmore.soest.hawaii.edu/education/teachers/gems.htm>). A GEMS grant could be used to fund supplies to assemble your own Ocean Conveyor Belt Kit or other C-MORE Kit.

Front Binder Materials

1. CD with narrated PowerPoint presentations (also contains electronic versions of binder materials)
 - o Email kits@soest.hawaii.edu to request PowerPoint presentations

2. C-MORE *Key Concepts in Microbial Oceanography* brochure
 - Distributed at session, downloadable version available at <http://cmore.soest.hawaii.edu/education.htm>
3. C-MORE *Microbial Oceanography: Resources For Teachers* brochure
 - Distributed at session, same information available online at <http://cmore.soest.hawaii.edu/education/teachers/index.htm>

4. **TEACHER SUPPLEMENTAL INFORMATION**

Lesson 1: Water Stratification

Materials for 28–35 students to work in 7 groups of 4–5 students per group are recommended.

5. **TEACHER GUIDE – Lesson 1: Water Stratification**
6. **OCEAN CONVEYOR BELT SURVEY – Lessons 1 and 2**
7. **TEACHER ANSWER KEY to OCEAN CONVEYOR BELT SURVEY – Lessons 1 and 2**
8. **MATERIALS PHOTO GUIDE – Lesson 1: Water Stratification (Teacher Supplies)**
9. **MATERIALS PHOTO GUIDE – Lesson 1: Water Stratification (Water Containers and Student Supplies)**
10. **HOT WATER DISPENSER GUIDE – Lesson 1: Water Stratification**
11. **SALINITY METER GUIDE – Lesson 1: Water Stratification**
12. **SALINITY APPROXIMATION TABLE – Lesson 1: Water Stratification**
13. Color-coded **GROUP EXPERIMENT** cards (8)
 - Card made by printing appropriate pages of binder materials, cutting out cards and laminating
14. **STUDENT WORKSHEET – Lesson 1: Water Stratification**
15. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 1: Water Stratification**
16. **POWERPOINT SCRIPT – Lesson 1: Water Stratification**
17. Large plastic tanks with bottom and one side painted white (3)
 - Sterilite 16 quart 18" x 12" x 6" clear plastic storage box # 1644
<http://www.sterilite.com/SelectProduct.html?id=443&ProductCategory=179§ion=1>
\$5.00 each at large retail chain. Directions on how to paint are below.
18. Clip-on labels for tanks during group experiments (2)
 - Email kits@soest.hawaii.edu for file. Laminated paper labels taped to medium binder clips.
19. One large plastic re-sealable bag containing:
 - Wooden blocks (3)
 - Blocks made by cutting a standard 2" x 2" x 6' piece of lumber into 5½" lengths, sanding smooth and coating with a clear spray lacquer.
\$9.50 for lumber and spray lacquer at local home improvement store (makes 12 blocks)
 - 1500 ml Measuring Bottle (1)
 - 1500 Wide mouth Nalgene bottle from VWR (#73520-408) www.vwr.com
\$8.23 each, but only sold as case of 24 *substitution: empty beverage container*
 - 1000 ml Demonstration Water bottle (1)
 - 1000 Wide mouth Nalgene bottle from VWR (#16125-107) www.vwr.com
\$16.07 each, but only sold in packs of 6 *substitution: empty beverage container*
 - 250 ml beakers (4)
 - Beakers from VWR (#13915-103) www.vwr.com
\$11.18 each, but only sold in packs of 6 *substitution: any metric graduated measuring cup*
 - 100 ml beakers (2)
 - Beakers from VWR (#13915-089) www.vwr.com
\$6.27 each, but only sold in packs of 6 *substitution: any metric graduated measuring cup*
 - Probe Rinse Water beaker (1)
 - Beaker from VWR (#25384-156) www.vwr.com
\$1.15 each, but only sold in case of 100 *substitution: any cup with volume of about 400 ml*
 - Measuring spoon sets (¼ tsp, ½ tsp, 1 tsp) (2)
 - \$0.97 each for set of measuring spoons and cups at large retail chain

- Plastic spoons (2)
 - <\$3.00 from local grocery store or large retail chain *substitution: wash take-out spoons*
 - Small salt container (1)
 - \$0.50 each for pack of 8 Glad Ware mini-rounds, fill with salt from grocery store
 - 4 colors of food dye: Red, Yellow, Green, and Blue (2 each)
 - \$2.50 per 4-color set at local grocery store or large retail chain
20. Oakton SALT 6 Salinity Meter (1)
- \$288.00 from Omni Controls (WD-35606-20) <http://www.omnicontrols.com> and 1.7 Liter Really Useful box (\$3.99) from <http://www.reallyusefulproducts.co.uk> or local office supply store for meter storage
substitution: thermometer and copy of SALINITY APPROXIMATION TABLE – Lesson 1: Water Stratification
21. Small plastic tanks (7)
- Sterilite 6 quart 13" x 8" x 4" clear plastic storage box # 1642; \$1.50 at large retail chain
<http://www.sterilite.com/SelectProduct.html?id=442&ProductCategory=179§ion=1>
22. Small plastic re-sealable bags (7), each containing:
- Wooden block (1)
 - Blocks made by cutting a standard 2" x 2" x 6' piece of lumber into 5½" lengths, sanding smooth and coating with a clear spray lacquer.
\$9.50 for lumber and spray lacquer at local home improvement store (makes 12 blocks)
 - 100 ml beaker (1)
 - Beakers from VWR (#13915-089) www.vwr.com
\$6.27 each, but only sold in packs of 6 *substitution: any metric graduated measuring cup*
 - Measuring spoon set (¼ tsp, ½ tsp, 1 tsp) (1)
 - \$0.97 each for set of measuring spoons and cups at large retail chain
 - Plastic spoon (1)
 - <\$3.00 from local grocery store or large retail chain *substitution: wash used take out spoons*
 - Small container filled with ~ ½ cup of salt (1)
 - \$0.50 each for pack of 8 Glad Ware mini-rounds, fill with salt from grocery store (\$1.00)
 - 2 colors of food dye: Red and Blue (1 each)
 - \$2.50 per 4-color set at local grocery store or large retail chain
23. Hot water dispenser with power cord
- \$50.99 Sunpentown 5.0 L Hot Water dispensing pot (SP-5016) from <http://www.aquasuperstore.com/>
substitution: hot water from faucet or any safe means of dispensing hot water to you students throughout the day
24. Red cooler
- \$14.00 2-gal dispensing beverage cooler from large retail chain
25. Collapsible water carrier
- \$8.99 Reliance Products 5 Gallon Poly-Bagged Fold-A-Carrier Collapsible Water Carrier from amazon.com *substitution: classroom sink*
26. Extra salt for refilling small containers
- \$1.00 each from grocery store (non iodized will make less cloudy solutions), 2 containers are necessary to get started

Lesson 2: Deep Ocean Circulation

- 27. TEACHER GUIDE – Lesson 2: Deep Ocean Circulation
- 28. POWERPOINT SCRIPT – Lesson 2: Deep Ocean Circulation
- 29. STUDENT WORKSHEET – Lesson 2: Mapping Deep Ocean Circulation
- 30. MÖBIUS STRIP (Part A) – Lesson 2: Mapping Deep Ocean Circulation
- 31. MÖBIUS STRIP (Part B) – Lesson 2: Mapping Deep Ocean Circulation
- 32. BLANK WORLD MAP
- 33. TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 2: Mapping Deep Ocean Circulation
- 34. TEACHER ANSWER SHEET – Deep Ocean Circulation Map

35. **NATIONAL GEOGRAPHIC NEWS** article
36. **STUDENT WORKSHEET – Lesson 2: Ocean Circulation Article**
37. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 2: Ocean Circulation Article**
38. Laminated Möbius strip teacher answer key
 - Color Möbius strip in lesson 2 materials according to key, join two short strips into one long strip, laminate and then form complete Möbius strip as an example. *Substitution: non-laminated strip*
39. Colored pencils (14 each of red, blue, and purple)
 - Prismacolor Colored Pencils - Dahlia Purple
 - Prismacolor Colored Pencils - Denim Blue
 - Prismacolor Colored Pencils - Crimson Red
 \$0.88 each from <http://www.jerrysartarama.com/> *substitution: any red, blue or purple colored pencils or crayons.* Also included in Kit but not listed as material: zipped pencil storage bag (\$1.00) from large retail chain.
40. Scissors (7)
 - \$0.39 each Best value safety scissors from <http://www.discountsschoolsupply.com>, stored in Glad Ware Soup & Salad container *substitution: any scissors suitable for your students*
41. Transparencies of Surface Ocean Currents (7)
 - Email kits@soest.hawaii.edu for file, print on transparency

Lesson 3: Using Data to Explore Ocean Processes

42. **TEACHER GUIDE – Lesson 3: Using Data to Explore Ocean Processes**
43. **POWERPOINT SCRIPT – Lesson 3: Using Data to Explore Ocean Processes**
44. **STUDENT WORKSHEET – Lesson 3 PowerPoint: Using Data to Explore Ocean Processes**
45. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 3 PowerPoint: Using Data to Explore Ocean Processes**
46. **STUDENT WORKSHEET – Lesson 3: Graphing with HOT-DOGS**
47. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 3: Graphing with HOT-DOGS**

Lesson 4: Nutrients and Ocean Circulation

48. **TEACHER GUIDE – Lesson 4: Nutrients and Ocean Circulation**
49. **OCEAN CONVEYOR BELT SURVEY – Lesson 4**
50. **TEACHER ANSWER KEY to OCEAN CONVEYOR BELT SURVEY – Lesson 4**
51. **POWERPOINT SCRIPT – Lesson 4: Nutrients and Ocean Circulation**
52. **STUDENT WORKSHEET – Lesson 4: Nutrients and Ocean Circulation (Excel 2003)**
53. **STUDENT WORKSHEET – Lesson 4: Nutrients and Ocean Circulation (Excel 2007)**
54. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 4: Nutrients and Ocean Circulation**
55. **STUDENT INSTRUCTIONS – Lesson 4: Data Extraction (Excel 2003)**
56. **STUDENT INSTRUCTIONS – Lesson 4: Data Extraction (Excel 2007)**

Other Materials:

57. **GLOSSARY**
58. **TEACHER EVALUATION**
59. **SUPPLY CHECKLIST**
60. Manuals for Hot Water Dispenser and Salinity Meter
 - Included with purchase of each item
61. Speakers
 - \$21.99 Insignia NS-PLPTSP Laptop Travel Speakers from www.bestbuy.com *substitution: use script and give non narrated PowerPoint presentations yourself*

Materials Not Included in this Kit:

62. Water
63. Ice
64. Paper towels
65. Computer
66. Projector
67. Transparent tape
68. Computers with access to the internet (required for Lesson 3) and computers with *MS Office* Excel (required for Lesson 4)

Table 1. List of materials and quantities needed to reproduce the Ocean Conveyor Belt Kit. This list excludes materials not included with the Kit listed in lines 62–68.

	Description	Vendor	Model No.	Qty*	Unit Price	Extension
Lesson 1:						
17	Plastic water tanks: Sterilite 16 qt 18"x12"x6"	Large Retail Store	1644	3	\$ 5.00	\$ 15.00
	Spray Paint: Krylon fusion for <u>Plastic</u> (gloss white)	Local Hardware store		1	\$ 4.99	\$ 4.99
19 & 22	Wooden Blocks 1.5" x 1.5" x 6" (Start with 6' 2x2)	Local Lumber store		10	\$ 0.60	\$ 6.00
	Spray Lacquer: Clear for coating blocks	Local Hardware store		1	\$ 4.49	\$ 4.49
19	1500 ml Nalgene Wide Mouth Bottle	VWR	73520-408	1	\$ 8.23	\$ 8.23
19	1000 ml Nalgene Wide Mouth Botle	VWR	16125-107	1	\$ 16.07	\$ 16.07
19	250 ml beakers	VWR	13915-103	4	\$ 11.18	\$ 44.72
19	100 ml beakers	VWR	13915-089	9	\$ 6.27	\$ 56.43
19	probe rinse beaker: 400 ml tri-pour beaker	UH Chem Stockroom		1	\$ 1.15	\$ 1.15
19 & 22	Measuring spoon set	WalMart		9	\$ 0.97	\$ 8.73
19 & 22	Plastic spoons	Large retail store		9		\$ 1.50
19 & 22	Small container for salt: Gladware mini-round	Large retail store		8	\$ 3.50	\$ 3.50
19, 22 & 26	Salt non-iodized	Grocery Store		2	\$ 1.00	\$ 2.00
19 & 22	Food dye: 4 color set, red, yellow, blue, green	Grocery Store		9	\$ 2.50	\$ 22.50
20	Oakton SALT 6 Salinity Meter	Omni Controls Inc.	WD-35606-20	1	\$ 288.00	\$ 288.00
	1.7 Liter Really Useful box (for salinity meter)	Office supply or online		1	\$ 3.99	\$ 3.99
21	Small plastic water tanks: Sterilite 6 qt 13" x 8" x 4"	Large retail store	1642	7	\$ 1.50	\$ 10.50
23	Hot Water Dispenser: Sunpentown 5.0 L	AquaSuperstore	SP-5016	1	\$ 50.99	\$ 50.99
24	Red cooler, Igloo 2 gal cooler	Large retail store		1	\$ 12.41	\$ 12.41
25	Collapsible water carrier	Amazon.com	500013	1	\$ 8.99	\$ 8.99
Lesson 2:						
39	Prismacolor Colored Pencils Box of 12 PC1009 - Dahlia Purple	Jerry's Artarama	38142A	14	\$ 0.88	\$ 12.32
39	Prismacolor Colored Pencils Box of 12 PC1101 - Denim Blue	Jerry's Artarama	75073A	14	\$ 0.88	\$ 12.32
39	Prismacolor Colored Pencils Box of 12 PC924 - Crimson Red	Jerry's Artarama	08186A	14	\$ 0.88	\$ 12.32
	Bag for colored pencil storage	Large retail store		1	\$ 1.00	\$ 1.00
40	Scissors: Best value safety scissors	Discount School Supply	8WWPSAFE	7	\$ 0.39	\$ 2.73
	Kit box to hold supplies, Sterilite 92 qt ultra latch box	Large retail chain	1992	1	\$ 15.81	\$ 15.81
					Total	\$ 594.88

Prices as of March 2010 and are subject to change. C-MORE dose not endorse any of the vendors listed. Shipping fees not included.

* Some items are only sold by the pack or case. Price listed is the per item cost.

Instructions for painting water tanks:

The three large plastic tanks included with the Kit are partially painted white so that it is easier for the students to view the layered water system. If you are only going to use the plastic storage boxes as layered water tanks once a year, an alternative would be to place white paper or a white sheet behind the tanks to aid in viewing. Painting is the best long term way to help make the layers more visible in the classroom. Instructions for painting the water tanks:

- 1) Remove stickers from tank and mask off the area of the box that is to remain clear with masking tape and newspaper (Figure 1). Be sure to securely cover areas that are to remain clear as the spray paint will get into any holes in the masking.
- 2) Use the green scrubby side of a sponge to dull the area of the box that will be painted to ensure that the paint will adhere better (Figure 1).
- 3) Wipe off the dust generated with a damp cloth and allow box to dry completely prior to painting.
- 4) Locate an area where overspray will not cover anything valuable (houses, cars, pets, etc.).
- 5) Follow the directions on the paint can for painting. You will have much better results if you apply 7–8 thin coats a few minutes apart instead of 1–2 thick coats. It will appear as if not much paint is going onto the box during the first few coats, but be patient, you will eventually get good coverage.
- 6) Let paint dry until handling time has elapsed (listed on paint can), then remove newspaper and masking tape.
- 7) Allow to dry completely, and then remove any tape residue.



Figure 1. Storage box with masking tape borders to use as a guide for painted versus not painted areas. Arrows indicate areas that should be painted white and areas that should be masked off during painting and remain clear. A picture of a painted water tank is included in the **MATERIALS PHOTO GUIDE – Lesson 1: Water Stratification (Teacher Supplies)**.