Teaching Oceanography through the Research Experience

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SSV *Corwith Cramer*

SSV *Robert C. Seamans*

Introduction to SEA Semester

SEA Semester is a college-level, multidisciplinary 12-week program in which students study the ocean while living and working aboard a traditional sailing vessel equipped for oceanographic research. During the first half of the semester on our Woods Hole campus, each student takes an oceanography course that combines traditional classroom learning with the development of an oceanography research project. Students are required to formulate a research question, conduct a thorough literature search, propose hypotheses, and describe a specific data collection and analysis plan to be carried out at sea. During the six-week sea component students participate in all aspects of data collection, analysis, and interpretation aboard one of our two sailing school vessels. Before returning to port each student presents the results of their research project in both an oral presentation and a written research paper.

The Research Platform

134-foot steel brigantines designed for oceanographic research under sail

SSV Corwith Cramer

- Launched in 1987
- Operates in western Atlantic and Caribbean

SSV Robert C. Seamans

- Launched in 2001
- Operates in Pacific

Lab on *Corwith Cramer*

Labs on *Robert C. Seamans*

Carousel deployment

Gravity core deployment and analysis

Tucker Trawl deployment and analysis

Final presentations

Student Research Projects

Student research projects span the four major disciplines of oceanography – physical, biological, chemical and geological oceanography. Data for each project are collected and analyzed by the students at sea. In addition, some projects incorporate data from SEA's 30+ year archive for long time series analysis.

Eddies in the Caribbean Sea

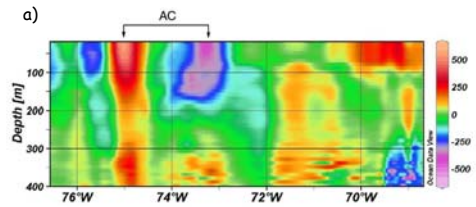

Figure 1: Data collected in several eddies south of Hispaniola in March 2004. a) Vertical section of ADCP northward velocity (mm/s). AC indicates anticyclonic eddy sampled close to its center, with strong northward then southward velocities. b) Vertical profiles of *in situ* fluorescence, indicating depression of the deep chlorophyll-*a* maximum in the center of the eddy. Student authors: Kate Gerth, Matt Moretti, Rhiannon Rognstad, Lizzy Shephard; Chief scientist: Dr. Kara Lavender.

Phytoplankton size and nutrient availability

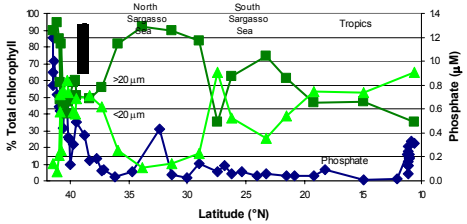

Figure 2: Phytoplankton size and phosphate availability in the western North Atlantic. Large phytoplankton (>20 µm) dominate coastal (north of 40°N) and Sargasso Sea waters, while small phytoplankton (<20 µm) are prevalent in the Gulf Stream and tropics. Phytoplankton size does not closely track nutrient availability. Student author: Amber Martin; Chief scientist: Dr. Sara Harris.

Sub-bottom profiling of the Cedros trench

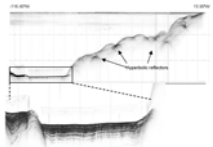

Figure 3: CHIRP trace of the Cedros trench, an inactive subduction zone off of the Baja peninsula. Upper trace shows trench axis and wall; lower trace shows expanded view of possible turbidites. Student authors: Mindy Goldstein, Darcy McKeon; Chief scientist: Dr. Lisa Graziano.

Diel variation of *in vivo* fluorescence vs. plant biomass

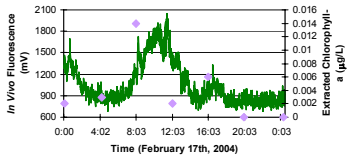

Figure 4: Continuously-measured *in vivo* fluore--scence (line) and extracted chl-*a* (symbols) from surface waters north of the Bahamas. Diel variation seems to be largely due to changes in phytoplankton biomass. Student author: Hilde Schmitt; Chief scientist: Dr. Kara Lavender.

Cruise Tracks and Data Archive

SEA cruise tracks are repeated every year, resulting in an expanding 30+ year data archive in the western Atlantic and Caribbean and 5 year archive in the Pacific. These data are available to students and outside research scientists, upon request.

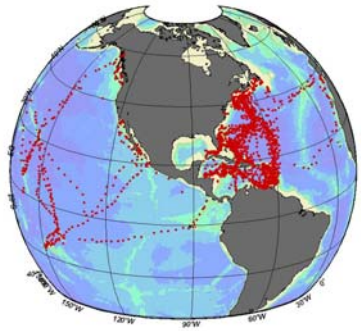

Figure 5: Locations of approximately 2500 CTD profiles collected on SEA cruises since 1988. Typical cast depth is 1000 m, with some casts to 3300 m depth. Figure courtesy of Meg Estapa, SEA.

Major Oceanographic Equipment

- Hull-mounted ADCP (RDI Ocean Surveyor, 75KHz)
- Multi-frequency CHIRP bottom and sub-bottom profiler (Benthos CHIRP II 3.5 KHz)
- Hydrographic winch (Markey, 4000 m wire)
- Rosette water sampler with 12 Niskin bottles, Auto Fire Module, and CTD
- Clean seawater flow-through system
- *In situ* fluorometer and transmissometer
- Multiple plankton nets (63-2000 µm mesh)
- Multiple opening and closing Tucker Trawl net
- Winkler apparatus for oxygen analysis
- Spectrophotometer for nitrate, phosphate, and silicate analyses
- VideoRay ROV with 175 m umbilical
- Shipek sediment grab
- Gravity core
- Onboard wireless network and datalogger

The **Sea Education Association (SEA)** is a non-profit educational institution, founded in 1971 and located in Woods Hole, MA. SEA is a partner in the scientific community of Woods Hole, and is a nationally-recognized leader in education under sail.