Abstracts for the AGU Ocean Sciences Meeting 11–15 February 2002

Ocean Sciences

OS11A HC: Hall III Monday 0830h

Reforming Education in the Ocean Sciences for All Citizens I

Presiding: **D A McManus,** University of Washington**; J Cherrier,** Florida A & M UniversityUniversity

OS11A-01 0830h POSTER

Using Oceanographic Themes to Improve the Science and Mathematics Content Knowledge and Pedagogical Skills of Preservice Elementary School Teachers

Frank R Hall[1] ((504) 280-6325; frhall@uno.edu)

Wendell Thompson[1] ((504) 280-6325; ashflow99@yahoo.com)

Cory Buxton[2] ((504) 280-7048; cbuxton@uno.edu)

[1]Dept. of Geology & Geophysics, University of New Orleans 2000 Lakeshore Dr., New Orleans, LA 70148, United States

[2]Dept. of Curriculum & Instruction, University of New Orleans 2000 Lakeshore Dr., New Orleans, LA 70148, United States

Improving the science and mathematics content knowledge and pedagogical skills of elementary school teachers is of critical importance in the United States. National and state standards and high-stakes testing of students requires that these teachers have broad knowledge of these subjects. Moreover, they must be able to present this information in a hands-on, minds-on classroom environment that emphasizes critical thinking skills. The Colleges of Sciences and Education at the University of New Orleans have created a unique collaboration that focuses on preparing preservice elementary school teachers in science. The "Physical Science for Elementary School Teachers I, II, and III" classes and the "Materials and Methods in Elementary School Science" class are being aligned along a common theme: Lake Pontchartrain.

Lake Pontchartrain is a brackish-water, well-mixed estuary in southeastern LA. Saltwater from the Gulf of Mexico mixes with fresh water from bayous, rain, and urban run-off. The City of New Orleans rests between Lake Pontchartrain and the Mississippi River with the University of New Orleans on the south-shore of the lake providing easy access from anywhere on campus.

In all of these classes, students are taught science content and pedagogy as it relates to Lake Pontchartrain. Instruction is activity-based using the same kind of methods that we want these future teachers to use. Field and laboratory analyses of Lake Pontchartrain and the Mississippi River not only reinforce the content of the courses, but also makes the subjects relevant to the lives of these students. Mathematical concepts are reinforced as the students must create simple models of the data that they collect within the context of the environment of the region. Moreover, internet and other computer-based lessons required of the students improve their self-efficacy in regards to using technology in the classroom. Anecdotal responses of students who have completed this program suggests to us that, not only does the students' science and mathematics content improve, but also their self-esteem and desire to teach science.

OS11A-02 0830h POSTER

Consortium of Oceanographic Activities for Students and Teachers: Putting Interactive Learning on Target (COAST:PILOT)

Sharon H. Walker[1] (228-374-5550; sharon.walker@usm.edu)

Mary Alyce Lach[2] (920-403-3063; mary.lack@snc.edu)

R. Dan Brook[3] (662-325-3226; rdb1@Ra.MsState.Edu)

[1]University of Southern Mississippi, 115 Beach Blvd., Biloxi, MS 39530, United States

[2]St. Norbert College, 100 Grant St., DePere, WI 54119, United States

[3]Mississippi State University, 306 Bost Bldg., Mississippi State, MS 39762, United States

The three primary COAST:PILOT partner institutions, USM, SNC, and MSU are ideally suited to and experienced in delivering programs of the highest caliber to K-12 science educators and in forming partnerships which leverage their resources to enhance and expand their educational successes. The J.L. Scott Marine Education Center and Aquarium (MEC&A), administered by USM, has been a regional and national leader in providing pre- and inservice opportunities for science educators since its 1972 inception. SNC, in De Pere, Wisconsin, has a widely-respected teacher-education program and has increasingly developed partnerships to teach science and technology and to reach underserved populations. The Engineering Research Center at MSU uses state-of-the-art, computational science and visualization tools in demonstrating and helping solve ocean sciences problems.

The principal goal of COAST:PILOT is to strengthen professional development opportunities in ocean and coastal processes sciences for cadres of teachers from across the nation-to include underrepresented and underserved districts-supported by instructional and communications technologies to enhance the efforts of these precollege teachers. To support this principal goal, two basic components of this educational effort include: a two-week Institute which has and will continue to provide a learning experience for up to 54 (over three summers) teachers at two major universities and an oceanographic research facility. Teachers increase their technological skills through extensive computer use in Internet searches, web page development, digital photography, and multimedia development. The application-offered through MSU-will be used to reinforce the teachers' content knowledge. The second week is offered at the MEC&A and offers more in-depth content knowledge in science, mathematics, and technology and focuses on Plate Tectonics, Deep Sea Technologies, Marine/Aquatic Habitats, Marine/Aquatic Resources, Physical Parameters, and Marine/Estuarine Pollution.

The second COAST:PILOT component is represented by the Sea Scholars Program which facilitates broad-based education by sending teachers to sea on US Navy TAG-60 oceanographic survey ships. This partnership is between COAST and the Naval Meteorology and Oceanography Command and the Naval Oceanographic Office. Teachers begin and end their voyage by participating in two days of land-based activities focusing on the interface between land and sea. This component offers a web-based resource for the participants, including a virtual tour of the survey ships, curricular materials, and trip-specific resources. Two trips are scheduled each year, in the spring and summer with a maximum of 24 teachers participating annually.

The evaluation plan for COAST:PILOT is designed to be continuous and dynamic, includes multiple data sources, is based on program objectives, is the result of a collaborative effort, and provides formative and summative results for all stakeholders in the program. Primary data are comprised of the pre- and posttests, attitudinal surveys, 12-18 month post-surveys, and classroom observations. Attend this session to hear the "rest of our story!"

OS11A-03 0830h POSTER

SEARUN: A Multi-disciplinary Investigation of Coral Bleaching Using Teams of Undergraduate Students

Gisele Muller-Parker (1-360-650-7400; gisele@biol.wwu.edu)

Dept of Biology and Shannon Point Marine Center, Western Washington University, 1900 Shannon Point Rd, Anacortes, WA 98221, United States

Environmental stress effects on corals were investigated with teams of undergraduates with diverse backgrounds (majors in science education, biology, chemistry, physics, engineering technology and environmental science) working with three scientists with expertises in optics, photosynthetic pigments, and symbiosis. The presentation will highlight how we succeeded in completing an ambitious field-intensive research program that served the students' educational needs, produced publishable research, and contributed to the development of K-12 curriculum and teacher preparation.

URL: http://www.wwu.edu/~gisele

OS11A-04 0830h POSTER

The Ocean Inquiry Project: Win-win for the Learning and Research Communities

Jill L. Schmidt[2] ((805)892-2529; schmidt@nceas.ucsb.edu)

Christian P. Sarason[1] ((206)789-3020; cpsarason@oceaninquiry.org)

Frederick R. Stahr[1] (stahr@oceaninquiry.org)

Scott Veirs[3] ((206)685-1947; scottv@ocean.washington.edu)

[1]National Center for Ecological Analysis & Synthesis, University of California, Santa Barbara 735 State Street, Suite 300, Santa Barbara, CA 93101, United States

[2]Ocean Inquiry Project, P.O. Box 23189, Seattle, WA 98102, United States

[3]School of Oceanography, University of Washington, Box 357940, Seattle, WA 98195, United States

The Ocean Inquiry Project (OIP) is a non-profit organization that exemplifies how strategies for reforming education in the ocean sciences may be implemented. The mission of OIP is to enable students and researchers to inquire together about Puget Sound, Washington. Motivated by their own questions and the questions posed in established research and monitoring projects, OIP students collect high-quality data during oceanographic cruises on Puget Sound. The experience expands their horizons, fostering an appreciation for the environment and for human impacts on the oceans. As the same time, students record observations that are archived on the OIP web site (www.oceaninquiry.org). These data are subsequently accessed by both local researchers and OIP students for analysis and further inquiry. A successful pilot program took out community-college and university students, collecting data that was provided to the Washington State Department of Ecology and to University of Washington researchers. Recently, an official partnership among these groups was established and funded by the National Oceanographic Partnership Program. Improvements to the OIP web site will include tools to facilitate data exchange and data-rich curricula for educators not located near Puget Sound. Our hope is that others can build upon the OIP model to develop similar programs in additional locations.

URL: http://www.oceaninquiry.org

OS11A-05 0830h POSTER

Ocean Science Education with a Focus on Regional Research and Exploration: Project Oceanica

Leslie R. Sautter[1] (843-953-5586; sautterl@cofc.edu)

Steven Vettese[2] (843-953-7263; vetteses@cofc.edu)

[1]Dept. of Geology and Environmental Geosciences, Univ. of Charleston, 66 George St., Charleston, SC 29424, United States

[2]Project Oceanica, Lowcountry Hall of Science and Math, Univ. of Charleston, 66 George St., Charleston, SC 29424, United States

Making science relevant and interesting is a challenge common to all educators. Motivating students to learn is more easily accomplished when they are engaged in the content and are active rather than passive learners. Ocean science is a natural catalyst to spark the interest and participation of educators and students, particularly in coastal states where access to the ocean is possible. In August 2001, we founded Project Oceanica at the Univ. of Charleston, with the purpose of developing and implementing education products, resources and programs that are directly related to new exploration and research activities taking place within South Atlantic Bight (SAB) - the v-shaped coast and adjacent continental margin from Cape Hatteras, NC to the southern tip of Florida. Project Oceanica serves as the education "arm" of SEaCOM, the SouthEast Coast and Ocean Margin Program that was recently organized to generate collaborative multi-disciplinary ocean studies in the SAB. At present, both SEaCOM and Oceanica are funded by the NOAA National Ocean Service.

One of the signature programs offered by Oceanica,"At Sea!," provides exciting opportunities for high school and undergraduate students, and K-12 teachers, to participate on a research cruise aboard a NOAA vessel. At Sea! ship time is dedicated solely to the program and, during the day-long cruise all participants (as many as 20) are completely engaged in and responsible for data collection, recording, and preliminary

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descriptions. Participants attend pre-cruise and post-cruise workshops and collect, analyze and ultimately present results on a variety of biologic, geologic, physical data. Data are entered onto Project Oceanica's At Sea! web site, adding to a growing database. This new, active hands-on research-oriented ocean science experience has already shown to be highly successful in motivating student learning in the classroom. Students with no previous marine science background have successfully demonstrated an understanding of the scientific data and concepts encountered in the one-day cruise. We are currently working toward expansion of At Sea! to more NOAA vessels and for longer cruises, along with the development of the curriculum, materials and assessment instruments. It is just one example of Project Oceanicas mission of using research as an educational tool for teaching ocean science.

URL: http://www.cofc.edu/oceanica

OS11A-06 0830h POSTER

NSF Graduate Teaching Fellows in K-12 Education at the University of Maine: Ocean Science Activities

Matthew Cyr[4] (207 827-3900; matthew.cyr@umit.maine.edu); Melissa Borden[1] (207 581-2927; melissa.borden@umit.maine.edu); Richard D. Glueck[3] (207 866-4916; rglueck@orono-ms.u87.k12.me.us); Sarah L. Kirn[1] (207 581-4348; Sarah.Kirn@umit.maine.edu); Christopher Lage[1] (207 581-1862; clage@maine.edu); Damaris H. Virtue[2] (207 866-4916; dhvirtue@mint.net); Danielle Oakes[2] (207 866-4916; danielle_o_science@yahoo.com)

[1]University of Maine, College Avenue, Orono, ME 04469, United States

[2]Orono High School, 14 Goodridge Drive, Orono, ME 04473, United States

[3]Orono Middle School, 14 Goodridge Drive, Orono, ME 04473

[4]Leonard Middle School, 151 Oak Street, Old Town, ME 04468, United States

The University of Maine's NSF K-12 Fellows provide active learning for K-12 students and professional development for teachers in limnology, marine biology, oceanography, and coastal geology. University graduate students work directly with 22 teachers and 1000 students in 4 school districts. Examples of program activities enriching learning in K-12 students include: 1) intertidal field trips, where students sample invertebrates and algae (e.g., collecting size-frequency and abundance data), 2) analyses of water masses of different densities, 3) monitoring of the local hydrological cycle, and 4) discussion of issues such as exotic species. Placements provide professional mentoring by K-12 teachers for Fellows to improve their communication skills with K-12 learners of varied abilities and to develop age-appropriate scientific explorations.

OS11A-07 0830h POSTER

Working With Industry to Enhance Undergraduate Ocean Science Education and Training

Nicole L Crane (831-646-4127; ncrane@marinetech.org)

Monterey Peninsula College, Marine Advanced Technology Education Center, 980 Fremont St, Monterey, CA 95076, United States

The ocean sciences cover a wide range of scientific disciplines, and encompass a tremendous diversity of careers. Recent advances in technology have increased our ability to work at depths not feasible only a short time ago, increasing further the opportunities in the field. These advancements in technology require scientists and technicians to be technologically competent, knowledgeable about the ocean, and prepared for a diverse work environment. The challenge for our educational system is to offer classes and programs that excite and attract students, provide them with knowledge and skills which prepare them well for advanced education and/or for jobs and careers, and which meet the needs of employers and research in the new century. Given the financial and programmatic constraints of many academic institutions, the Marine Advanced Technology Education (MATE) Center (an NSF funded ATE Center, located at Monterey Peninsula College), has looked to innovative program development which relies on industry collaborations to meet program academic goals. Programs utilize industry collaborations (and collaborations with research institutions) for: 1) directed student internships at sea or in shore labs; 2) access to scientists and technicians to help inform and shape student projects 3) State of the art equipment to introduce students to technology and provide them with key skills 4) support and sponsorship for a national remotely operated vehicle student competition, and 5) information about what students should know and be able to do to be successful in a variety of fields. Industry collaborations are central to ensuring student success, and help shape the academic programs to best meet student needs and interests in the ocean sciences. This model can be applied to a variety of ocean science programs at the college and pre-college level, and provides a win-win-win situation for employers, educators and students.

OS11A-08 0830h POSTER

Linking Undergraduate Geoscience and Education Departments

Frank Ireton (301-867-2034; frank_ireton@sesda.com)

Science Systems and Applications, Inc., 10210 Greenbelt Road Suite 500, Lanham, MD 20706, United States

In many colleges and universities students who have declared a major in one of the geosciences are often ineligible to take the education courses necessary for teacher certification. In order to enroll in education courses to meet the state's Department of Education course requirements for a teaching credential, these students must drop their geoscience major and declare an education major. Students in education programs in these universities may be limited in the science classes they take as part of their degree requirements. These students face the same problem as students who have declared a science major in that course work is not open to them. As a result, universities too often produce science majors with a weak pedagogy background or education majors with a weak Earth and space sciences background.

The American Geophysical Union (AGU) formed a collaboration of four universities with strong, yet separate science and education departments, to provide the venue for a one week NSF sponsored retreat to allow the communication necessary for solutions to these problems to be worked out by faculty members. Each university was represented by a geoscience department faculty member, an education department faculty member, and a K-12 master teacher selected by the two faculty members. This retreat was followed by a second retreat that focused on community colleges in the Southwest United States.

Change is never easy and Linkages has shown that success for a project of this nature requires the dedication of not only the faculty involved in the project, but colleagues in their respective schools as well as the administration when departmental cultural obstacles must be overcome.

OS11A-09 0830h POSTER

The Digital Library for Earth System Education: Opportunities for Collaboration and Contribution

Holly Devaul[1] (303-497-2653; devaul@ucar.edu)

Mary R. Marlino[1] (303-497-8350; marlino@ucar.edu)

[1]DLESE Program Center, University Corporation for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307-3000, United States

Over the past two years, the Earth system science community has articulated a vision for, and begun the development of the Digital Library for Earth System Education (DLESE). DLESE is envisioned as a community-owned and governed electronic library offering easy access to high-quality resources that facilitate a systems approach to learning about the Earth at all educational levels. Our community debut in the summer of 2001 included a searchable collection of 1000 resources, a web-based cataloging tool and the beginnings of a community center to facilitate sharing and collaboration among educators, scientists and students. Embracing the concept of users as contributors, DLESE is continually growing though individual contributions from educators, learners, and resource creators as well as through formal and content-specific collections efforts. It is also being designed to support resource discovery across a diverse, federated network of holdings, including the Alexandria Digital Earth Prototype (ADL/ADEPT), NASA education collections, and other developing National SMETE Digital Library (NSDL) projects. Preliminary discussions regarding a formal partnership with the Centers for Ocean Sciences Education Excellence (COSEE) are already underway, building on our common goals to disseminate quality ocean science education resources to an even wider audience of educators and learners. Ongoing library development is manifold, including resource alignment with National Science Education Standards and AAAS Benchmarks as a searchable field and interface. Geospatial referencing of resources will allow educators to find resources that pertain to specific areas of the globe by name and coordinates, and will allow datasets that may have no common naming convention to be accessible in a standardized way. Recognizing the importance of integrating data exploration to the learning of ocean and earth science, we will focus on the task of providing classroom-friendly datasets, tools, and supporting educational activities to the library. Ocean sciences offer a natural setting for the interdisciplinary, integrated science learning that DLESE seeks to support and promote. We look to the COSEE initiative, as well as individual educators, for guidance in identifying and expanding access to high quality ocean science education materials. In short, our common goals set the stage for a variety of collaborative ventures in the future as well as the opportunity to contribute to DLESE in the immediate.

URL: http://www.dlese.org

OS11A-10 0830h POSTER

Teaching Ocean Wave Dynamics and Forecasting with Computer-aided Animation

Dennis J Whitford (410-293-6552; whitford@usna.edu)

U.S. Naval Academy, Oceanography Department 572M Holloway Road, Annapolis, MD 21402, United States

Ocean waves are the most recognized phenomena in oceanography. Unfortunately undergraduate study of linear ocean wave dynamics and forecasting involves mathematics and physics and therefore can pose difficulties with some students because of the subject's interrelated dependence on time and space, along with its mixture of linear, hyperbolic, and trigonometric functions in its equations. Verbal descriptions and two-dimensional illustrations are often insufficient for student comprehension. Computer-generated visualization and animation, accompanied by oral explanation, have been shown to be a pedagogical improvement to more traditional methods of instruction.

MATLAB software programs were written to compute, visualize, and animate:

(1) water particle orbital paths, displacements, velocities and accelerations; static, dynamic and total sub-surface pressures; and velocity potentials and streamlines,

(2) development and comparison of wave spectra, wave interference, and forecasting of sea conditions, and

(3) group speed, frequency dispersion, angular dispersion, propagation, and wave height forecasting of deep water ocean swell waves.

Example output from the programs will be presented.

Students are far more interested in studying animation of these difficult topics than studying their traditional two-dimensional depictions. Writing computer code for scientific animation is an example of non-traditional research which attracts undergraduate students. Teachers may use these interactive visualizations and animations without requiring an extensive background in computer programming.

OS11A-11 0830h POSTER

The Undergraduate Oceanography Program at the University of Washington: Curricular Changes and new Strategies for Recruitment, Retention, and Timely Graduation

Mark L Holmes (1-206-543-7313; mholmes@u.washington.edu)

University of Washington, School of Oceanography Box 357940, Seattle, WA 98195-7940, United States

The School of Oceanography's undergraduate program (75 students) has undergone recent changes designed to 1) improve the sequencing of the School's core courses, 2) expand opportunities for undergraduates to participate in laboratory and field research, 3) involve the entire faculty in the student advising process, 4) provide more time during the senior year for the student's independent thesis research, and 5) expand opportunities for field (shipboard) experience to non-majors. These changes will aid students in completing the comprehensive program requirements for a Bachelor of Science degree and will also increase the visibility of the program as a premier interdisciplinary environmental science curriculum.

The principal goal of the program is to produce graduates who are capable of applying the scientific method to complex problems not easily solved using simple reductionism. The field of Oceanography, embracing as it does the full spectrum of environmental problems, provides the ideal framework to accomplish this goal. A key element of the curriculum is research experience at sea. Shipboard field experience begins in sophomore year as team investigations in which the cruises are organized by the faculty and the students select from a menu of research topics. The three-quarter-long capstone course sequence taken during senior year equips the students to identify their own research problem and plan and execute the necessary sample and data collection aboard the R/V Thomas G. Thompson during a week-long voyage in Puget Sound. The instructional activities preceding the cruise result in comprehensive research proposals from each student; as a group they also prepare a detailed cruise and logistics plan that provides for the needs of each student

investigator. The students thus meet and solve a full spectrum of challenges from operational to scientific. The experience provides the students with the knowledge and skills needed to carry out multi- and interdisciplinary research, and to communicate the results of that research to colleagues and the public.

OS11B HC: Hall III Monday 0830h

Oceanic Time-Series Measurements: Assessment of the Past and Planning for the Future I

Presiding: **N R Bates,** Bermuda Biological Station for Research, Inc.,**; L Campbell,** Texas A & M University

OS11B-12 0830h POSTER

Seasonal and Interannual Dynamics of Phytoplankton Community Structure in the Subtropical Oligotrophic Ocean: a Comparison of the Hawaii Ocean Time-Series and the Bermuda Atlantic Time-Series Stations.

Lisa Campbell[1] (979-845-5706; lcampbell@ocean.tamu.edu)

Michele D DuRand[2] (709-737-3465; mdurand@mun.ca)

Robert J Olson[3] (508-289-2565; rolson@whoi.edu)

[1]Texas A & M University, Dept. Oceanography 3146 TAMU, College Station, TX 77843, United States

[2]Memorial University of Newfoundland, Ocean Sciences Centre, St. John's, NF A1C 5S7, Canada

[3]Woods Hole Oceanographic Institution, Biology Department MS#32, Woods Hole, MA 02543, United States

Phytoplankton play a key role in the biogeochemistry of the ocean as the principal components of the biological pump of CO2 into the ocean interior. Results from the Hawaii Ocean Time-Series (HOT) and the Bermuda Atlantic Time-Series (BATS) have provided extended data sets from which we can begin to compare the seasonal and interannual dynamics of the phytoplankton communities in the North Pacific and Atlantic. Both HOT and BATS represent oligotrophic regions of the ocean where the phytoplankton community structure is dominated by the picoplankton. Biomass contributed by the prokaryotes, unicellular cyanobacteria *Prochlorococcus* (*Pro*) and *Synechococcus* (*Syn*), often exceeds the contribution by small eukaryotic algae. The contribution of *Pro* and *Syn* to total photosynthetic biomass is greater at HOT (60-85 %) than at BATS (20-58 %). At HOT *Pro* is 100-fold more abundant than the other picophytoplankton groups and remains the dominant component of the phytoplankton biomass (50 - 80 %) year-round, with *Syn* contributing only a small fraction (2 %). In contrast, the two groups alternate in abundance at BATS with *Pro* contributing up to 50 % of the photosynthetic biomass in summer months and *Syn* contributing an average of 20 % in Winter-Spring. Significant differences are also evident in the timing of the seasonal succession in abundance patterns of the three picoplankton groups and interannual variations, which may be related to ENSO events at HOT. Differences are also evident in the relationship between the percentage of the total phytoplankton carbon in the picoplankton fraction (% *Pro+Syn*) and primary productivity (PP). Although the overall range in PP is similar at the two sites (200 - 1000 mgC m^{-2} d^{-1}), at BATS there is a significant negative correlation between phytoplankton composition (% *Pro+Syn*) and integrated PP: the % *Pro+Syn* ranges from 20 - 60 % and is a larger component of the biomass when total integrated PP is lower. At HOT, however, the % *Pro+Syn* varies between 60 - 80 % and is not significantly correlated with PP. The differences in nutrient dynamics between HOT and BATS are also consistent with observed community structure dynamics.

OS11B-13 0830h POSTER

A spatial and temporal study on long-term variability of phytoplankton community structure at the Bermuda Atlantic Time-series Study (BATS) site and Bermuda to Puerto Rico transect based on pigment analyses using the 'CHEMTAX' matrix

Vivienne C Lochhead[1] (441-297-1880 x302; vivienne@bbsr.edu); Michael W Lomas[1] (441-297-1880 x303; mlomas@bbsr.edu); Paul J Lethaby[1] (441-297-1880 x304; paul@bbsr.edu); Rodney J Johnson[1] (441-297-1880 x300; rod@bbsr.edu); Nick R Bates[1] (441-297-1880 x210; nick@bbsr.edu); Anthony H Knap[1] (441-297-1880 x244; knap@bbsr.edu)

[1]Bermuda Biological Station for Research, Inc., 17 Biological Lane Ferry Reach, St. George's GE01, Bermuda

Upper ocean algal chlorophyll and carotenoid distributions have been measured monthly at the BATS site (31 40.00' N, 64 10.00' W) since December 1989 using high-performance liquid chromatography (HPLC) analysis. The 'CHEMTAX' program was used, using ratios calculated specifically for BATS, to interpret the HPLC data from December 1989 to February 2000 and calculate the abundance of diatoms, dinoflagellates, haptophytes, prasinophytes, chlorophytes (+ prochlorophytes), and cryptophytes throughout the time series. The protocol we employ does not permit the resolution of Chl b and divinyl Chl b and therefore our chlorophyte group likely includes prochlorophytes. Results indicate the presence of a phytoplankton community structure seen throughout the upper 80 m that is dominated by chlorophytes (+ prochlorophytes) (>50 percent) from 1991 to 1997 and 1999 to 2000 and a loss of the chlorophyte (+ prochlorophyte) (<20 percent) population from 1997 to 1999. From 1997 to 1999, the community structure was dominated by the cyanobacteria (> 40 percent) and the haptophytes resembling such species as Emiliania huxleyi (30 percent). Data from 1989 to 1990 hint at a similar shift on community structure. Macro-climate indices such as North Atlantic Oscillation (NAO) and Southern Oscillation Index (SOI) are being investigated as to their role in the biogeochemical change and indirectly the community structure. A negative NAO during the time period of 1997 to 1999 caused deeper mixing in the water column. In 1991, the NAO was positive but was close to zero and deeper mixing was observed in February, possibly due to eddy circulation. The change in species composition was coincident with a change in the pattern of Dissolved Organic Matter (DOM) cycling. Spatial variability in September 2000 and October 2001 was also studied. Results will be discussed along with comaprisons to temporal variability.

OS11B-14 0830h POSTER

Spatial and Temporal Dynamics of Virioplankton in the North Atlantic in the Vicinity of the Bermuda Atlantic Time-series Study Site.

Rachel J. Parsons[1] (441-297-1880; rparsons@bbsr.edu)

Christina M. Van Hilst[1] (441-297-1880; chrissy@bbsr.edu)

Paul J. Lethaby[1] (441-297-1880; paul@bbsr.edu)

Benjamin R. Wheeler[2] (302-645-4288; jaywh@udel.edu)

Craig A. Carlson[3] (805-893-2541; carlson@lifesci.ucsb.edu)

[1]Bermuda Biological Station for Research, Ferry Reach, St. Georges, BDA GEO1, Bermuda

[2]College of Marine Studies , University of Delaware 700 Pilottown Road, Lewes, DE 19958, United States

[3]University of California, Santa Barbara, Department of Ecology, Evolution and Marine Biology, Santa Barbara, CA 93106, United States

Viruses have been shown to play an important role in bacterial mortality. Viral infection and mortality of microbes (both bacterioplankton and phytoplankton) can potentially affect microbial trophic structure and in turn the biogeochemical cycling of nutrients and energy in pelagic ecosystems. However, little is known regarding the dynamics of viruses in oceanic gyres. We initiated a study to assess the spatial and temporal variability of virus-like particles (VLP) at the Bermuda Atlantic Time-series Study (BATS) site. Monthly profiles of were collected in the surface 400 m of the BATS site since January 1999, stained with SYBR Green II, and enumerated using image analysis.

Concentrations of VLP ranged from 0.5 - 7 E+9 particles / l. whereas concentrations of bacterioplankton ranged from 0.1 - 3 E+9 cells / l within the euphotic zone of the BATS site. Over the three year time-series VLP dynamics demonstrated a regular seasonal pattern. During winter, VLP concentrations were low (0.5 - 2E+9 particles /l) and were homogeneously distributed throughout the surface mixed layer. After stratification of the water column in late spring and early summer, a strong subsurface maximum in VLP concentration (4 to 7 E+9 particles / l) developed between 80 and 150 m. The VLP subsurface maximum persisted at elevated concentrations throughout the summer and early autumn before returning to background concentrations in late autumn-early winter. The summer subsurface VLP maximum was located deeper in the water column than the subsurface maximum for bacterioplankton (40 to 60 m) and was not well correlate with the deep Chl a maximum. We will present these dynamics and relate these trends to other biogeochemically relevant parameters such as bacterioplankton biomass, productivity, Chl a, and primary productivity and pigment tracers of specific phytoplankton taxa.

OS11B-15 0830h POSTER

Abundance trends of Calanus finmarchicus in the Gulf of Maine, Scotian Shelf, western and eastern North Atlantic (Z - line)

Doug Sameoto[1] (902 426 3272; sameotod@mar.dfo-mpo.gc.ca)

Jack Jossi[2] ((401)782-3200; Jack.jossi@noaa.gov)

[1]Bedford Institute of Oceanography, P.O. Box 1007, Dartmouth, NS B2 Y 4A2, Canada

[2]NOAA, National Marine Service, Northeast Fisheries Science Center, Narragansett, RI 02882-1199, United States

Yearly changes in Calanus finmarchicus populations were measured with the Continuous Plankton Recorder (CPR) in the western and eastern North Atlantic, Scotian Shelf and Gulf of Maine. There were close similarities in abundance trends in the four regions. It was possible to use Gulf of Maine data to fill in missing years (1977 to 1990) of data on the Scotian shelf. Analyses of CPR plus net sample data from the Scotian shelf suggested the period, between 1977 and 1990, was one of high abundance of C. finmarchicus on the Scotian Shelf and the numbers declined about 10x in the late 1990s. The seasonality of C. finmarchicus stages 1 – 4 on the western and eastern North Atlantic, Scotian shelf and the Gulf of Maine were distinctly different. The Atlantic populations showed seasonal peaks in July and August, the Scotian shelf and Gulf of Maine populations had peaks between May and June. These data suggest that C. finmarchicus populations in the four regions had different reproductive patterns with the Gulf population showing a much higher level of abundance than the other regions.

OS11B-16 0830h POSTER

Characterization of DOC Dynamics and Subsequent Response by Microbial Assemblages in Mesocosm Experiments Performed at the Bermuda Atlantic Time-Series Study Site

Stuart J. Goldberg[1] (805-893-8087; s_goldbe@lifesci.ucsb.edu)

Craig A. Carlson[1] (805-893-2541; carlson@lifesci.ucsb.edu)

Kurtis N. Gray[1] (805-893-8087; gray@lifesci.ucsb.edu)

Norman B. Nelson[2] (805-893-3202; norm@icess.ucsb.edu)

[1]University of California Santa Barbara , Department of Ecology, Evolution and Marine Biology , Santa Barbara, CA 93106, United States

[2]University of California Santa Barbara , Institute for Computational Earth System Science , Santa Barbara, CA 93106, United States

In autumn 2000 and spring 2001 experiments using water isolated from the northwestern Sargasso Sea were conducted to trace the dynamics of DOC production and subsequent microbial response in mesocosms. Seawater was amended with NO3, PO4 and SiO4 and incubated in constant light over the course of 12-18 days. The resulting primary production within the mesocosms was dominated by picoeukaryotes and cyanobacteria. In the spring 2001 experiment, primary production and Chl a concentrations reached maxima of 6 uM C/day and 9.03 ug/L respectively by day 5. Cyanobacterioplankton abundances increased 3-fold and correlated well with primary production. 14-C labeled DOC

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