2009 LTER Science Council Meeting
May 13-14, 2009; San Diego – La Jolla Shores Hotel

Tuesday, May 12

Travel day for SC
Executive Board meets (9am – 5pm) La Jolla, breakout room - Aztec

Wednesday, May 13

9:00 Opening Plenary – Acapulco Room
Welcome and Introduction to the Science Program
Update on ISSE and Decadal Plan – Phil Robertson
9:15 Connectivity Overview (Deb Peters)
9:35 Working Group Intros and Status (20 min each + 15 min break in middle)
A. Climate effects on coastal ecosystems (Merryl Alber / Chuck Hopkinson)
B. The disappearing cryosphere (Hugh Ducklow / Mark Williams)
C. Altered Precipitation and Soil Moisture Regimes: Opportunities for Continental-Scale LTER Research (John Blair / Alan Knapp)
D. Land change & urbanization (David Foster)
E. Species change (Steward Pickett)
11:30 Cross-site Support Activities (2008 workshops) (15 min each)
A. Demonstration of new "collaborative project database" (Margaret Obrien/Corinna Gries)
B. Long-Term socioecological research in the LTER Network: Results of a workshop." (Jess Zimmerman)
12:00 Lunch
1:00 Afternoon - CCE Site Tour and reception
~7:00 Dinner

Thursday, May 14

8:30 Charge to Working Groups - Acapulco Room
Working Group Breakouts
A. Climate effects on coastal ecosystems (Merryl Alber / Chuck Hopkinson) – Acapulco South
B. The disappearing cryosphere (Hugh Ducklow / Mark Williams) – La Jolla North
C. Altered Precipitation and Soil Moisture Regimes: Opportunities for Continental-Scale LTER Research (John Blair / Alan Knapp) – La Jolla South
D. Land change & urbanization (David Foster /) – Acapulco North
E. Species change (Scott Collins / Steward Pickett) - Aztec Room
12:00 Lunch
Working Group Breakouts, cont.
4:00 Plenary Working Group Reports and Discussion – 15 min each
5:30 Science Meeting Adjourns
Departures for 2nd Site Representatives
6:30 SC Business Meeting – Dinner – Aztec Room
9:30 Adjourn

Friday, May 15

Departures

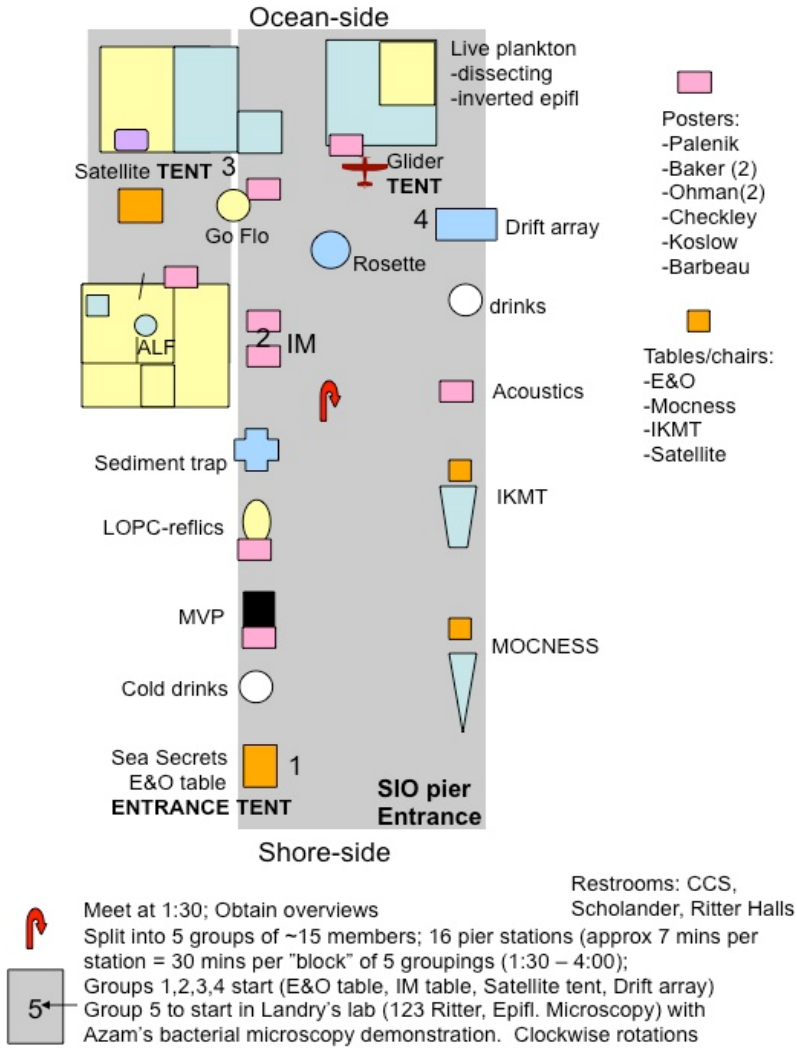
Organizing Committee:

Peter Groffman (chair), Merryl Alber, David Foster, Nancy Grimm, Deb Peters, Phil Robertson (ex officio)

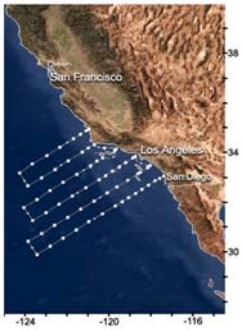
LTER Science Council Meeting
May 13-14, 2009
San Diego – La Jolla Shores Hotel
Hosted by California Current Ecosystem (CCE) LTER

Featuring:
LTER Plenary Session
LTER Working Groups
LTER Steering Committee Business Meeting
CCE Site Tour: A Pier Walk

Scripps Institution of Oceanography Pier
CCE Exhibit Arrangements



The *California Current Ecosystem* (CCE) LTER site welcomes you to our simulated "field trip" on the Scripps pier. We hope to acquaint you with some of the methods and approaches we use at sea, and some of the added challenges of ecological research in the 4-dimensional fluid environment of the ocean water column.



CCE focuses on *ecosystem state changes* in the California Current coastal pelagic ecosystem. We have previously identified relatively abrupt temporal changes in plankton and fish assemblages, based on 6 decades of context provided by the CalCOFI program. CCE is testing four hypotheses to explain these ecosystem transitions, in order to understand the mechanisms underlying long-term ecosystem variability.

Bear in mind that you will be seeing only part of CCE's site science today.

Please visit the CCE web site: http://cce.lternet.edu/

CCE-LTER Program Elements

- **Experimental Process Cruises**
  Rate processes and at-sea experimental manipulations
  (Lagrangian parcel-tracking)

- **Time Series Measurements**
  Augmented CalCOFI (4 times yr^{-1})
  Satellite remote sensing
  Spray ocean gliders
  Sta. M deep-sea benthic flux site
  SIO pier and Dana Pt. nearshore stations

- **Modeling**
  Coupled bio-physical models
  Conceptual process models
  Control volume property fluxes

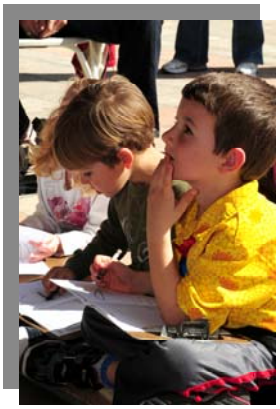
- **Ocean Informatics**

- **Education and Outreach**

Education and Outreach

Beth Simmons

CCE LTER has a comprehensive Education and Outreach (E/O) program benefiting from its location and partnership with Scripps Institution of Oceanography. This partnership extends to the local resources of the Birch Aquarium at Scripps as a platform to showcase Schoolyard LTER projects like our recent cross-site children's book, "*Sea Secrets: Tiny Clues to a Big Mystery"*. We have invested in a range of opportunities for educators to grow professionally, including our Research Experiences for Teachers (RET) program. For example, our process cruises afford educators the unique experience to work alongside scientists and graduate students aboard research vessels in the field. Our partnership with Ocean Institute in Dana Point also serves as a means to combine education with long-term scientific research and data collection. We extend such opportunities to undergraduate students with our Research Experience for Undergraduates (REU) program and encourage our graduate students to participate in opportunities through the Scripps Fellows Program (http://scc.ucsd.edu). Collectively, our program components aim to reach out to share the science of the California Current Ecosystem LTER to the "K through gray" community.



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CCE Information Management

Karen Baker lab

The CCE LTER initiated at SIO in 2004 enabled launch of "Ocean Informatics", a new approach to design of information infrastructure in support of interdisciplinary science. CCE works synergistically with Palmer Station LTER and with California Cooperative Oceanic Fisheries Investigations (CalCOFI) at Scripps and at NOAA Southwest Fisheries Science Center. Major activities of the CCE LTER Information Management to date have been to develop an information environment that includes: a) a cross-project, open source framework that provides collaborative tools and activities; b) a project web site (http://cce.lternet.edu) with dynamic elements such as personnel and bibliography modules; c) an information system (http://oceaninformatics.ucsd.edu/datazoo) serving as a local data repository providing both data access and integration; d) a multi-component architecture anchored by data dictionaries and metadata; and e) a suite of resources supporting local data handling, analysis, and visualization. Local informatics research focuses on discursive practices, sociotechnical systems design, and the semantic work required at the human-information interface while network activities include participation in a dictionary working group,governance working group, and the Databits Newsletter.


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Iron limitation of Primary Production

Kathy Barbeau lab

Iron is an important micronutrient for almost all forms of life. In marine systems, iron can often be in short supply because dust and/or sedimentary sources of iron may be scarce in offshore regions. In the CCE LTER site, iron supply can potentially influence the growth and size distribution of the phytoplankton community, with implications for higher levels of the food web. As part of the CCE LTER program, Kathy Barbeau's group studies the distribution, cycling, and ecological role of iron in the Southern California Current System. The image below shows a sampling device, a **GO Flo bottle**, used to collect uncontaminated water samples for the determination of seawater iron concentrations. Such

sampling at sea can be challenging, because sources of iron contamination abound on ship (see rusty cleat in foreground). Our studies indicate that the primary iron supply to the CCE LTER region appears to be upwelling from the continental shelf and bottom boundary layer around Point Conception. Moving offshore, dissolved iron concentrations decrease more rapidly than upwelled nitrate. This can result in iron limitation of phytoplankton in some offshore areas during spring and summer.

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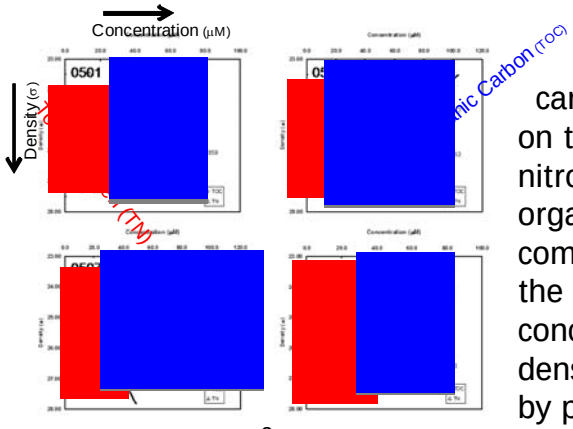
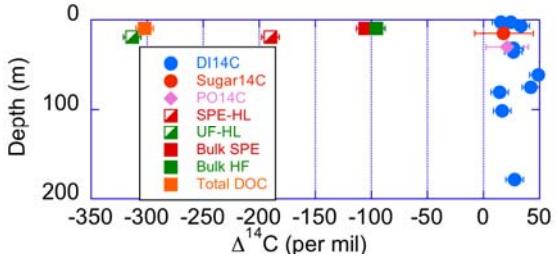
Organic Matter Quantity, Composition and Reactivity

Lihini Aluwihare Lab



Within CalCOFI and CCE LTER we measure spatial and temporal variability in the quantity of organic carbon (TOC) and organic nitrogen to identify controls on their inventory. A mass balance of carbon and nitrogen in marine systems requires quantification of all organic forms (*dissolved* and particulate). Here we compare the variability of TOC/TN and density within the CaCOFI grid during 4 months in 2005. TOC concentrations are highest at the surface (lower density). In winter and fall, TOC is distributed primarily by physical processes (i.e. strong correlation between density and TOC; r^2 = 0.8 and 0.7). In spring and summer, density and TOC are not as well correlated, consistent with strong biological controls on surface TOC inventory during these seasons. TN is correlated with density most of the year since this variable is dominated by inorganic nitrogen. Summer and fall data show distinct TN-density relationships.

We are also interested in determining the chemical composition and residence time of components within each reservoir. We determine residence time, using radiocarbon measurements (D14C) of dissolved organic carbon (DOC) fractions within the CalCOFI grid. Sugars have a relatively short residence time in surface waters. Dissolved hydrophobic compounds (UF-HL and SPE-HL) have longer residence times in seawater. We are in the process of identifying the composition and source of the latter components.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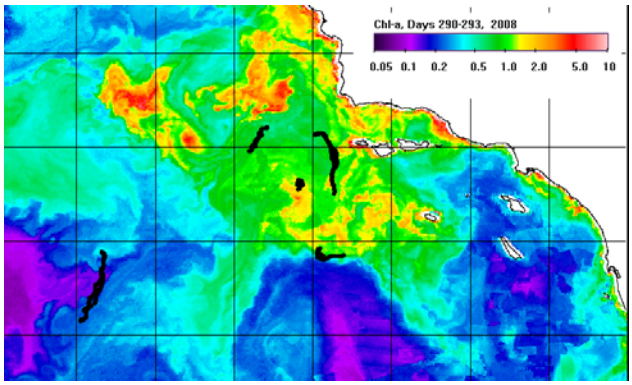
Satellite support of CCE LTER cruises, and primary production modeling using satellite data

Mati Kahru and B.Greg Mitchell

Various satellite data are collected and analyzed in near-real time concurrently with CCE LTER cruises in order to create the spatial context of the ship-board and glider/drifter measurements. The position of the ship as well as those of the gliders/drifters are overlain in near-real time on the most recent satellite images in order to facilitate choosing of the measurement stations relative to hydrographic features such as fronts and eddies.



Satellite data from several sensors (SeaWiFS, MODIS-Aqua, MODIS-Terra, MERIS) are routinely collected, remapped to a standard projection of the California Current. Merged composites (daily, 5-day, 15-day, monthly) of Chl-a and SST are made available through the web.

A revised algorithm for calculating net primary production (NPP) using satellite data has been created using in situ NPP data collected by CalCOFI and applied to the time series of all available satellite data. A trend of increasing chlorophyll and NPP was detected along the California coast as well as off some other eastern boundary currents. (Kahru et al. 2009 J. Geophys. Res. 114)

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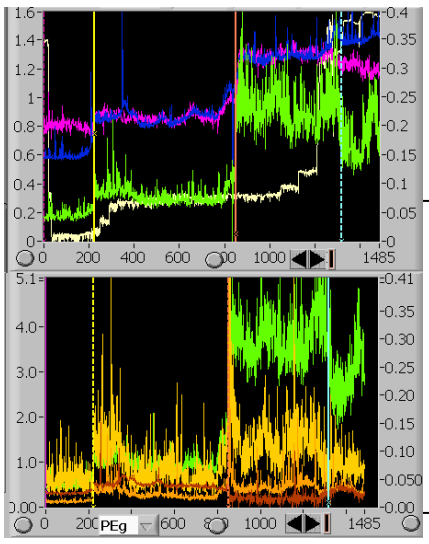
Phytoplankton characterization using Advanced Laser Fluorometry (ALF)

Alexander Chekalyuk

The ALF technique (Chekalyuk and Hafez, 2008. L&O Methods 6:591) uniquely combines high-resolution spectrally and temporally resolved measurements of the laser-stimulated emission (LSE). Real-time LSE provides assessments of key bio-geochemical variables, including chlorophyll-a (Chl-a), phycobiliprotein pigments, and chromophoric dissolved organic matter (CDOM). Three spectral types of phycoerythrin (PE) are discriminated for detection and characterization of PE-containing phytoplankton and cyanobacteria for characterization of the mixed phototrophic populations. Spectrally corrected pump-during-probe (PDP) measurements of variable fluorescence ($F_v/F_{m)}$ assess phytoplankton photosynthetic capacity and biomass. An extensive series of ALF deployments in diverse water types during the CCE LTER cruises have demonstrated the utility of ALF utility as an integrated tool for continuous characterization of phytoplankton communities.



Examples of ALF underway measurements of horizontal variability during the CCE LTER student cruise (1 May 2009).
Upper panel: sharp changes across the frontal zones were detected in key ALF variables, including Chl-a (green), CDOM (blue), phytoplankton photo-physiology index (Fv/Fm, pink). White: PAR.
Lower panel –Group-specific phycoerythrin pigments (light-yellow: cryptophytes; dark-yellow - green-water cyanobacteria; brown - blue-water cyanobacteria) Green: Chl-a.
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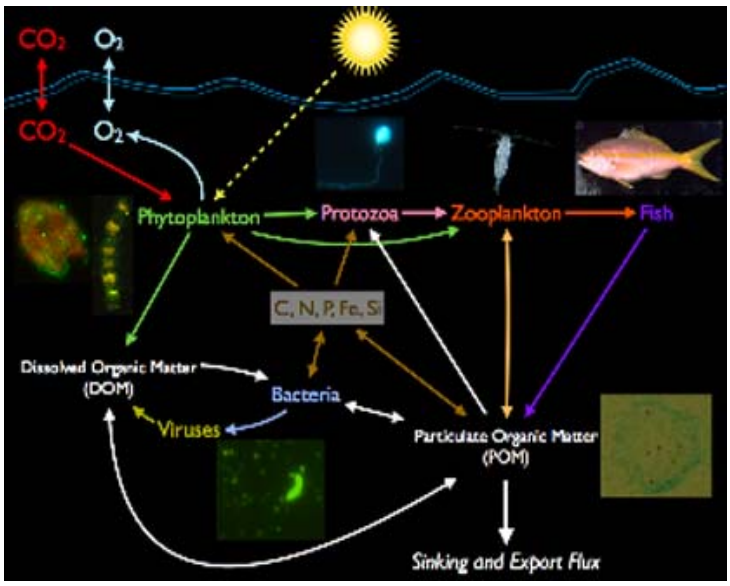
Microbial Oceanography in the CCE

Farooq Azam lab (Ty Samo, Byron Pedler)

Using a variety of microscopic, biochemical, and molecular approaches, our lab is studying the influence of marine bacteria on ocean biogeochemistry within the California Current Ecosystem. We are addressing specific quantitative and mechanistic questions on the role of microbial processes in the regulation of carbon fluxes in the ecosystem. These questions are integrated within the overall goals of the CCE/LTER.



What is the abundance, community composition and spatial-temporal variations of bacteria and viruses and their biogeochemical activities? How do microbial interactions with the non-sinking and sinking organic matter phases influence microbial distribution and activities at scales from micrometer to millimeter? (We are particularly interested in a class of transparent particles that we recently discovered to be abundant in seawater; their biogeochemical role is only beginning to be clarified.).

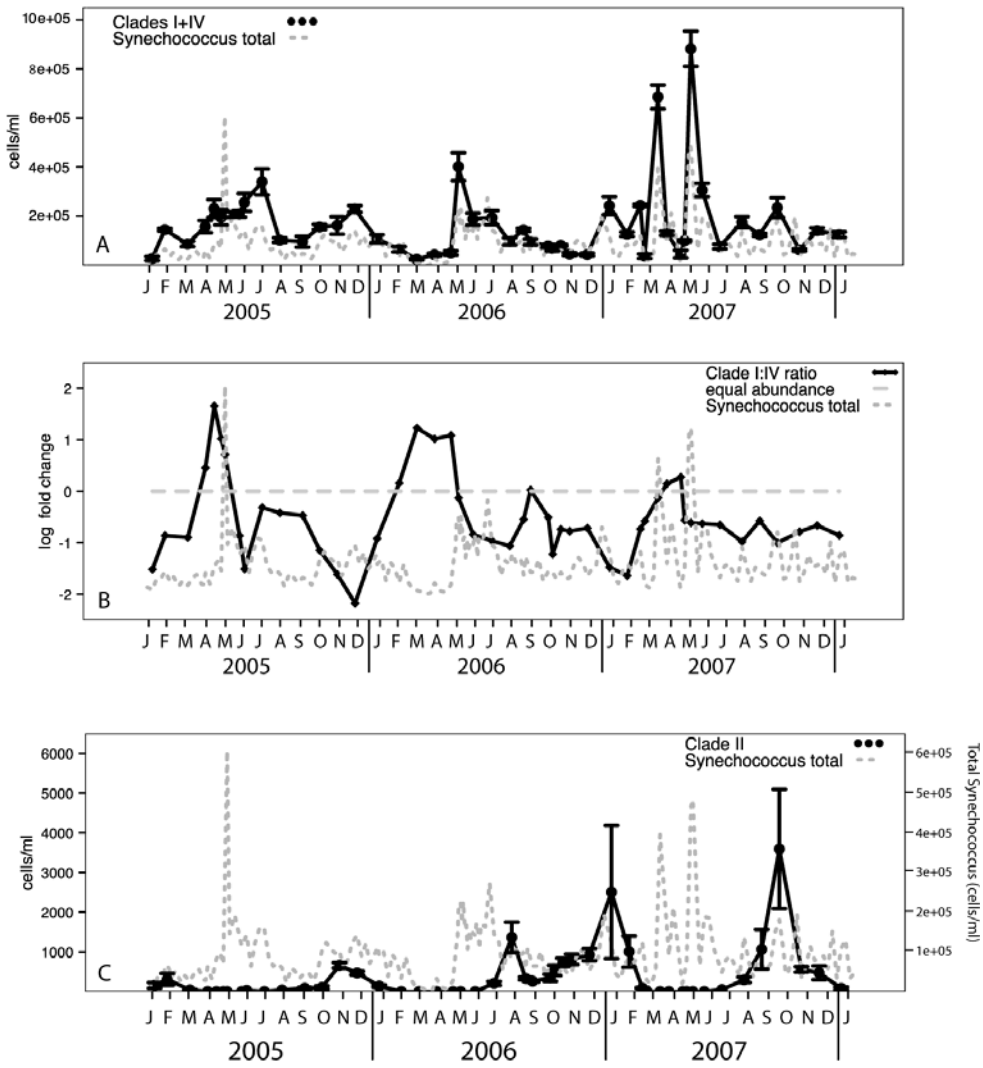
How do we go about doing all this? We do a lot of microscopy to measure microbial abundances and their associations with other organisms and organic matter. Carbon flux measurements are quantified with radiotracers. Metabolic activities are measured by targeting individual "digestive" enzymes of bacteria, using chemicals that fluoresce intensely in proportion to enzyme activity. Also, we use DNA fingerprinting and sequencing methods to find out the types of bacteria at some of the CCE stations.

Seawater samples obtained at sea are processed for analysis at Scripps. We capture microbes on polycarbonate filters at sea and bring them back for analysis by several advanced microscopy tools: transmitted light, epifluorescence, laser scanning confocal, and atomic force microscopy. We quantify microorganisms and image their microenvironment. While at sea we concentrate microbes on filters and extract their DNA to create a community DNA fingerprint and clone libraries. This allows us to compare community composition and how it varies in the study area. The DNA is archived; so, one day one could look back to ask how the communities of microbes have changed e.g. in response to ecosystem change. Ideally, we want to be able to predict how the CCE ecosystem might change because of shifts in microbial community composition and in situ performance.

Temporal dynamics of *Synechococcus* diversity from the coastal Southern California Bight

Vera Tai and Brian Palenik

Marine cyanobacteria from the genus *Synechococcus* are found throughout the world's oceans and are important contributors to global primary productivity and carbon cycling. To understand the seasonal dynamics of *Synechococcus* diversity, we have developed quantitative PCR (qPCR) and Luminex high-throughput hybridization strategies using the gene encoding a subunit of DNA-dependent RNA polymerase (*rpoC1*) and applied them to a time series of surface samples from the Scripps pier (La Jolla, CA). Using both methods we have shown that *Synechococcus* from clades I and IV were dominant throughout the time series and correlated with total *Synechococcus* abundance (Figure A). QPCR is a more precise method and using qPCR we can demonstrate that the relative abundance of these two dominant clades showed evidence of a seasonal cycle. *Synechococcus* from clade IV were typically more abundant. However, those from clade I dominated during periods just prior to the annual spring bloom of *Synechococcus* (Figure B). *Synechococcus* from clades II and III were absent during spring and early summer, but appeared at low abundances in late summer and winter possibly due to changes in circulation in the Southern California Bight (Figure C). As the first long term time-series describing *Synechococcus* population diversity, these temporal dynamics were used to interpret the genetic/genomic diversity observed in the environment and the potential factors regulating their distribution.

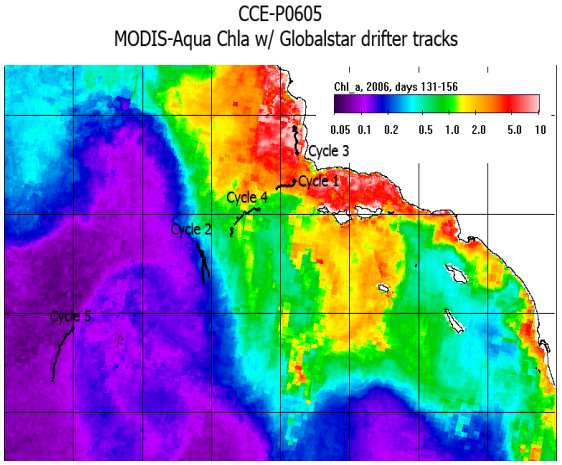


Temporal dynamics of *Synechococcus* clade diversity from surface samples off the SIO pier

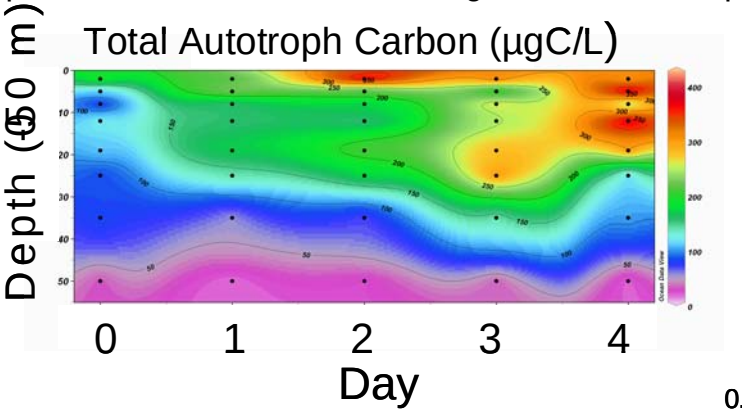
In situ measurements of growth and grazing

Mike Landry lab (+collaborators)

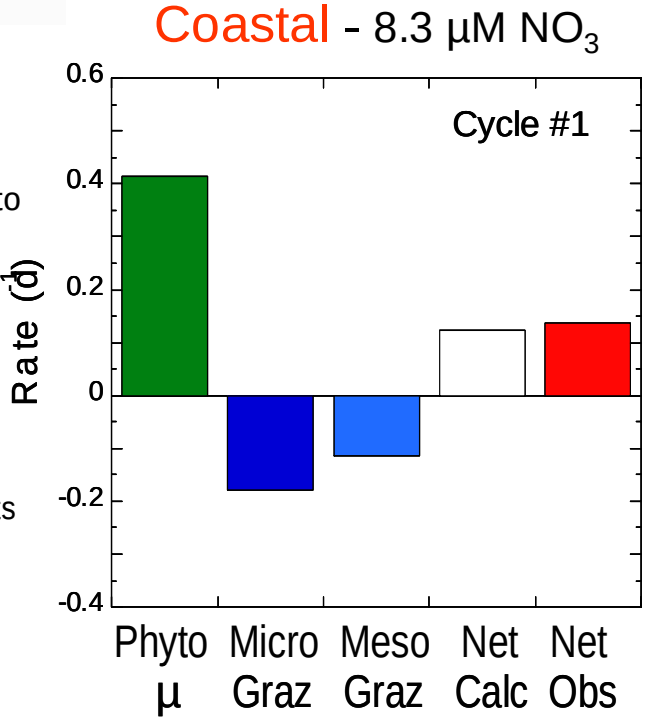
Lagrangian-designed experimental studies of plankton dynamics are conducted on CCE Process cruises using satellite-tracked drifters to follow discrete water parcels. This figure shows the drifter tracks for 5 experiments on our first cruise in May 2006 overlaid on a composite satellite image of surface chlorophyll a. This illustrates the relatively large distances that water parcels can be advected over ~4 days of study as well as the variability in the CCE biomass conditions, the equivalent of major transitions in terrestrial ecosystems with many order of magnitude differences in the relative sizes of dominant primary producers.



For process experiments, primary production and community manipulation (dilution) experiments are set-up daily and incubated *in situ* on a line underneath the drifter, and other observational and experimental studies are done daily in waters adjacent to assess net community changes and to quantify rate processes of larger animals (mesozooplankton). By comparing individually measured rate processes to the net *in situ* change in the ambient phytoplankton community, these experiments have tested the hypothesis that phytoplankton growth and grazing processes determine, to first order, the local dynamics of phytoplankton in our system. The left panel shows, as an example, the net increase in phytoplankton biomass (approximately one doubling) observed over 4 days in the Cycle 1 experiment.



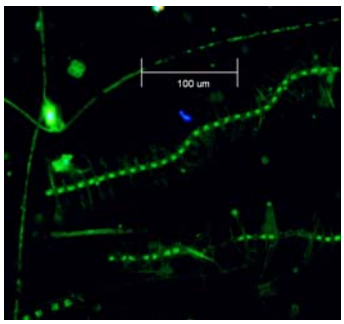
The panel to the right shows for Cycle 1 the individual instantaneous rate estimates for phytoplankton growth (µ), the grazing losses to microzooplankton and mezozooplankton, the calculated difference between growth and grazing, and the observed net change of the ambient phytoplankton. Overall, measured growth and grazing rates have explained 86% of the variability observed in phytoplankton biomass trajectories under variable field conditions on two cruises. Efforts are underway to look more closely at how the dynamics of growth and grazing processes relate to changes in community com position and size structure.



Plankton community structure assessed with digital epifluorescent microscopy

Daniel Wick

For semi-automated enhanced digital epifluorescent microscopy we preserve and stain samples at sea, filter them onto Polycarbonate filters, and image them using a Carl Zeiss 200M compound epifluorenscence microscope equipped with 5 different filters:



transmitted light, DAPI (binds to DNA), FITC (binds to proteins), chlorophyll (autofluorescent) and phycoerytherin (autofluorescent). We use a combination of 3 or 4 of these channels to make a final image that we then analyze by mostly automated procedures. These digital images provide us with accurate measurements of biomass, community composition, and size structure. These results are complimented with flow cytometry, which allows the rapid measurement of picoplankton (cells smaller than 2-um). At left is an image taken using our epifluorescent scope aboard the R/V *Melville* during the CCE process cruise in Oct. 2008. Green is FITC channel (protein), red is chlorophyll and blue is DAPI (DNA).

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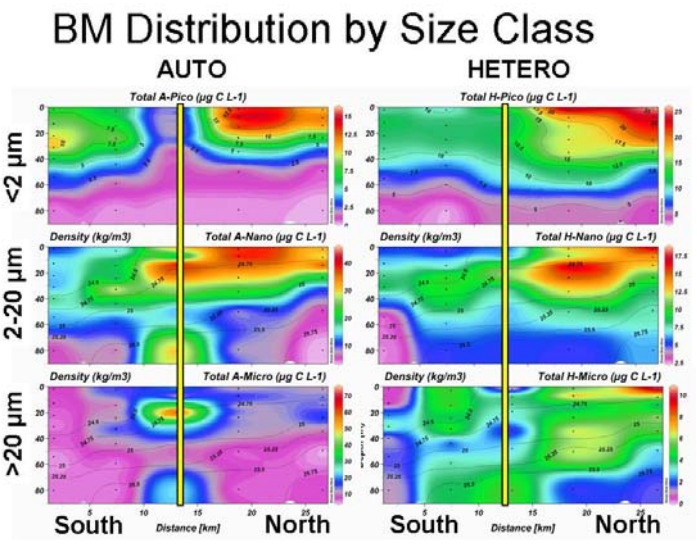
Microplankton communities in the CCE analyzed by flow cytometry and enhanced digital epifluorescence microscopy

Andrew Taylor

To quantify the biomass, composition and size-structure of the microplankton we employ a combination of flow cytometry (FCM) and enhanced digital epifluorescence microscopy. Our high-throughput, semi-automated digital epifluorescence microscopy system allows us to quantify the biomass, size-structure and composition of six different eukaryotic plankton functional classes: Diatoms, autotrophic flagellates, autotrophic dinoflagellates, prymnesiosphytes, heterotrophic flagellates, and heterotrophic dinoflagellates. With these two complementary methods we are able to quickly and accurately process samples that help to elucidate the complex and dynamic microbial communities found throughout the CCE.



Left: Contour plots of the pico- (0.2-2.0 µm), nano- (2.0-20 µm) and micro- (20-200 µm) plankton biomass of autotrophic and heterotrophic groups across a front (yellow line) encountered during the October, 2008 CCE-LTER cruise. The front was defined by a cold and eutrophic water parcel to the north (right side of figure), and a warm and oligotrophic water parcel to the South (left side of figure). The biomass of all size classes of heterotrophic and autotrophic microplankton were elevated in the colder, more nutrient rich area of the front.
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Particle transport: sediment trap arrays and Thorium-234 deficiency

Mike Stukel

I have been studying the role of plankton in transporting carbon from the surface to the deep ocean, and hence sequestering this carbon in a region inaccessible to the atmosphere. On CCE Process cruises I measure carbon export using two independent methods: Drifting sediment trap arrays that collect particles sinking across the 100-m depth horizon and Th-234 disequilibrium, which approximates carbon export by calculating the deficiency of Th-234 relative to its parent isotope U-238. Preliminary measurements of carbon export from the May 2006 Process cruise show strong correlation between my export measurements and an ecological model that approximates mesozooplankton fecal production (one of the primary sources of sinking organic carbon) from measurements of phytoplankton growth and grazing rates made by other scientists on the cruise.

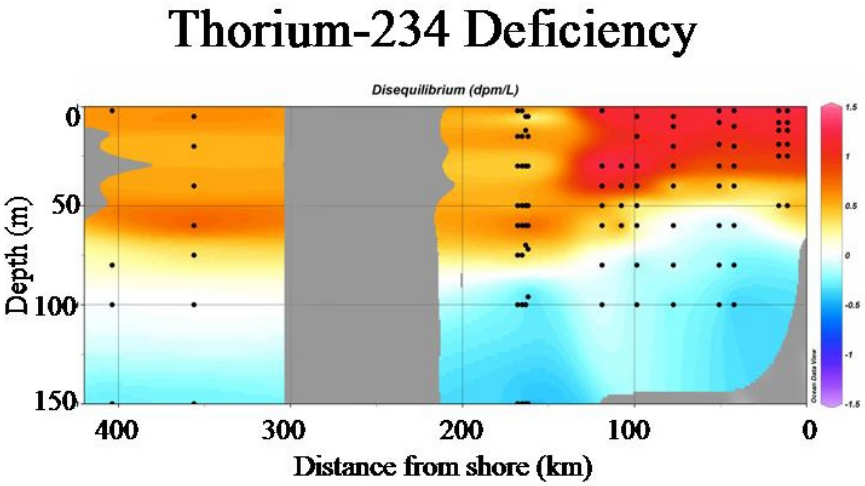


Fig. The deficiency of Th-234 relative to its parent isotope (U-238) is indicative of the removal of Th-234 from the upper ocean when it scavenges onto particles that sink out of the euphotic zone. General patterns of carbon export in the CCE can be seen in this figure from CCE-P0605. Throughout the region, net remineralization typically begins just below the depth of the euphotic zone. Nearshore there is high export near the surface that decreases rapidly with depth. Offshore the deficiency is less pronounced but extends throughout the deeper euphotic zone and includes a subsurface maximum that corresponds to a subsurface maximum in C-14 measured primary productivity.

Mesozooplankton Grazing

Moira Decima

My research in CCE focuses on the trophic dynamics of two dominant species of mesozooplankton: *Euphausia pacifica* and *Calanus pacificus*. I conducted bottle incubations on the LTER process cruises in order to quantify their diet and grazing impact on both the hetero- and autotrophic components of the microplankton. These species exert variable grazing pressure on different microzoo- and phytoplankton groups, which can vary as a function of the respective concentrations in the water column. The results from these incubations, however, represent merely a snapshot of the trophic history of these organisms. We also use an independent method to elucidate both the mean trophic position as well as the lower frequency temporal variations of diet, using the amino acid nitrogen stable isotope signature in the tissues of these organisms from past CalCOFI samples. The ultimate purpose is to quantify the trophic position and the grazing impact on lower trophic levels of these dominant zooplankters, in this highly spatial and temporally variable region.

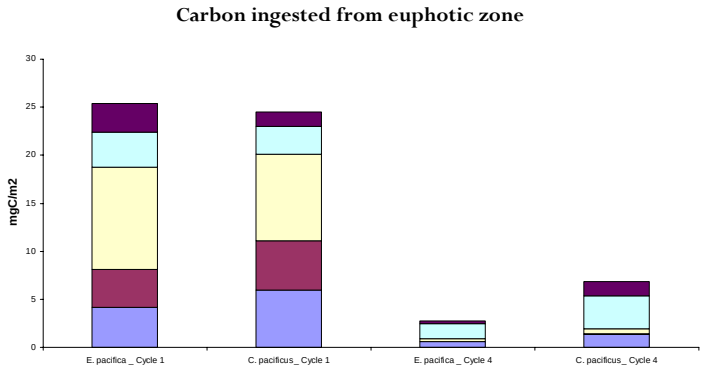
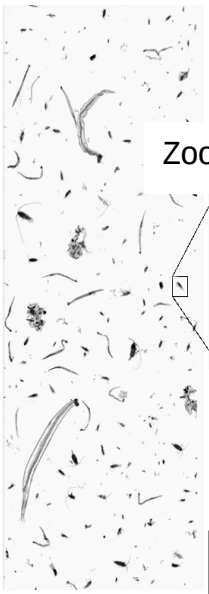


Fig.1: Carbon removed from the euphotic zone by *E. pacifica* and *C. pacificus* at two experimental cycles on CCE cruise P0704.

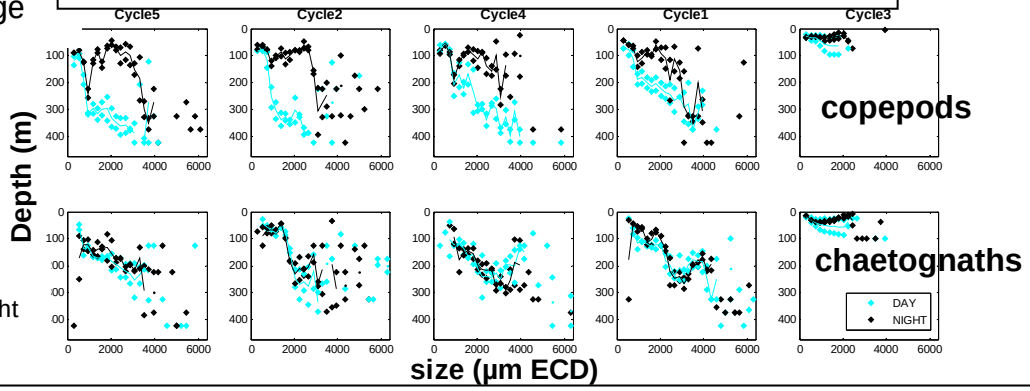
Zooplankton Vertical Habitats assessed by digital image analysis

Mark Ohman lab (Jean-Baptiste Romagnan, Alison Cawood)

We are evaluating spatial differences in vertical habitats occupied by mesozooplankton in relation to optical properties of the water column, predation risk, and food availability. We analyze vertically stratified samples taken with a Mocness (Multiple-Opening Closing Net and Environmental Sensing System), using Zooscan digital scanning and digital image analysis.



Size-dependence of DVM in two major zooplankton taxa

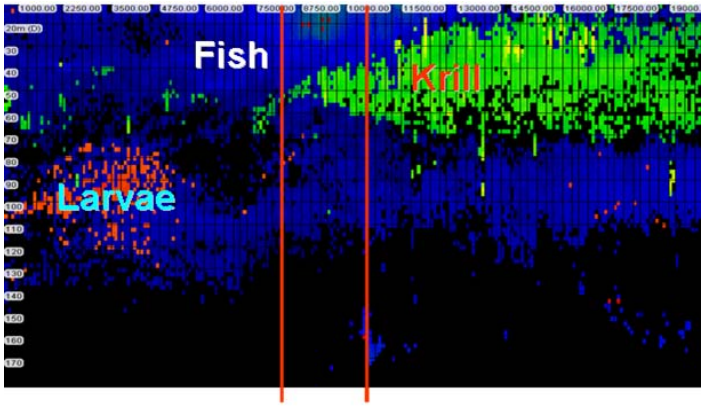


Intermediate-sized copepods show the strongest DVM (diel vertical migration), but DVM varies with distance offshore. Chaetognaths do not show size-dependent DVM.

Bioacoustic measures of plankton and micro-nekton communities

Tony Koslow lab

Multi-frequency acoustics (38, 70, 120, and 200 kHz) are used in combination with midwater trawl sampling with a 5 m^2 mouth-opening net to characterize the larger plankton and micro-nekton communities in the CCE region. The figure shows the distribution of key faunal groups across a frontal zone (vertical red lines), based on subtracting the acoustic backscatter from the 38 and 120 kHz transducers. At 38 kHz, there is strong backscattering from fish with small air-filled swimbladders and weak returns from large plankton, whereas krill (euphausiids) dominate the acoustic backscattering at 120 kHz. Krill (green) predominate in the cool water north of the front, and small fish (blue), probably anchovy or sardine, are seen concentrated at the front itself and elsewhere. An aggregation of fish (red) with very small swimbladders, larvae or juveniles, is seen below the surface layer south of the front. This interpretation of the acoustic data is consistent with net tows, which sampled high concentrations of krill north of the front. The acoustic transect was taken in daylight hours, and layers of myctophids and cyclothonids were observed in deeper water, below the effective sampling depth of the 120 kHz sounder.



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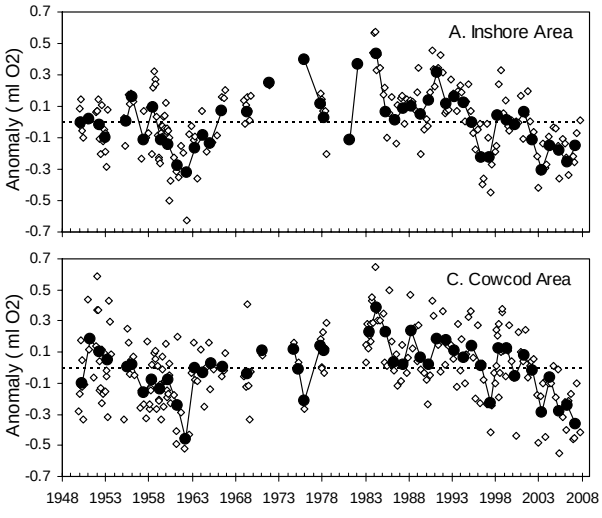
Long-term trends in dissolved oxygen in the CCE region

Ralf Goericke lab

We carried out a retrospective analysis of the CalCOFI data to determine the degree to which 2 areas important to fisheries are impacted by a decline in dissolved oxygen over the past 3 decades, and to determine whether periods of low oxygen had been observed previousliy (McClatchie et al, submitted). The areas studied are a narrow band along the coast of Southern California (Inshore Area) and an area in the Southern California Bight which is a designated fisheries management area (Cowcod Area). Concentrations of oxygen in these areas at one density surface (the 26.6 isopycnal, see figure) have indeed been declining over the last few decades. This decline in oxygen concentrations and the decreasing depth where oxygen concentrations reach levels of 1.5 ml/L (data not shown) imply a reduction of available habitat for a variety of species in the SCB.



However, the recent declines in concentrations of oxygen are not unprecedented. During the 1950's similarly low concentrations of oxygen were observed in these areas (figure). We are currently studying historical data on larval and adult fish abundance to determine if time series of these responded to the drop in concentrations of oxygen.
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Autonomous ocean measurements: *Spray* ocean gliders

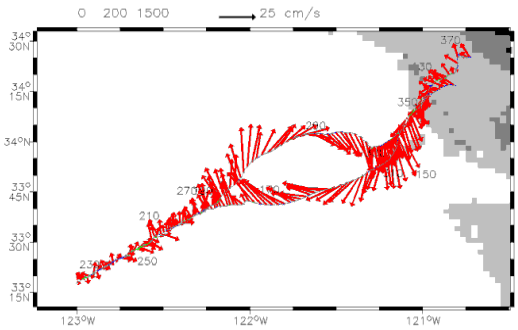
Russ Davis and Mark Ohman labs

In addition to shipboard and other time series measurements made by CCE scientists in collaboration with CalCOFI, autonomous underwater vehicles are being used to make continuous measurements of the ocean water column. We are using the *Spray* ocean gliders, designed and built by the Instrument Development Group at Scripps. We deploy gliders along CalCOFI lines 80 and 90, in order to resolve cross-shore variations in ocean currents and vertical current shear, hydrographic structure, phytoplankton biomass, and zooplankton biomass (via acoustic backscatter). The *Spray* gliders, as currently instrumented for CCE, include a pumped CTD (Conductivity-Temperature-Depth sensor), SeaPoint fluorometer, and Sontek Acoustic Doppler Profiler (750 kHz). Buoyancy is regulated by pumping mineral oil from an internal to an external bladder, thereby altering density. The gliders descend from the surface to 500 m depth, record all variables on ascent, then once at the surface, telemeter the data ashore via the Iridium satellite network. We have 2-way communications and can sample adaptively. With our current payload we deploy the gliders for 100 days at a time. We have occupied lines 80 and 90 since late 2005/early 2006.

An anticyclonic eddy and associated bio-physical fronts

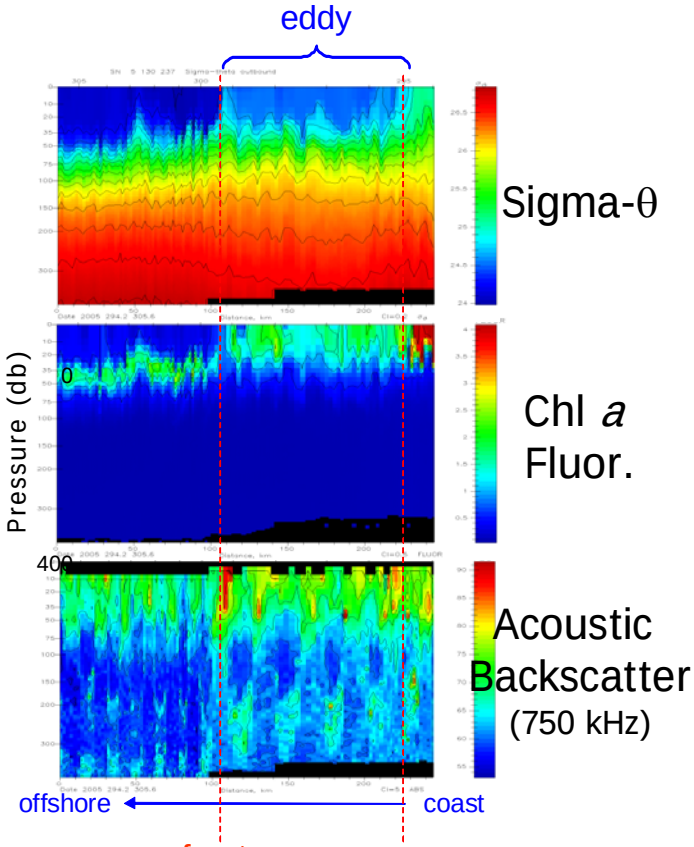
Among many features resolved by the high spatial resolution glider data, one example is a pronounced anticyclonic eddy that had sharply delineated physical and biotic fronts at the inshore and offshore boundaries. One CCE graduate student is currently investigating whether such fronts are enhanced sites of predator-prey interactions.

Off Pt. Conception , Oct-Nov 2005



Average velocity, 0-400 m

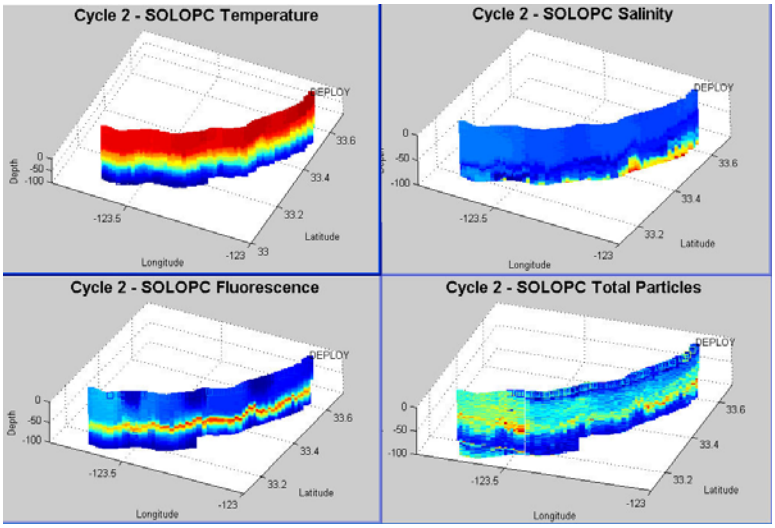
Spray glider



The SOLOPC: Autonomous measurements of particles and plankton

Dave Checkley lab

Within CCE LTER, I am focusing on the measurement and characterization of particles and plankton using optical methods and on the spawning habitat and population dynamics of anchovy and sardine. The former focus includes assessment of particles and plankton (~ 0.1 to 10 mm) by the use of the Laser Optical Plankton Counter (LOPC) in standard plankton net use in CalCOFI and on the SOLOPC, a semi-Lagrangian, autonomous profiling float with LOPC and Ecopuck. The latter focus includes the use of data from the Continuous Underway Fish Egg Sampler (CUFES) and ship and satellite observations of the environment.



Left: Data from the SOLOPC deployment in Cycle 2 of the April 2007 CCE LTER Process Cruise. This was a 4-day deployment with a profile every hour. Cycle 2 was offshore in oligotrophic water. Notable are (a) the persistent deep chlorophyll maximum layer, (b) diel variation in chlorophyll *a* fluorescence in the overlying water, (c) particle maximum above the chlorophyll *a* maximum, and (c) particles within and above the chlorophyll *a* maximum. These data are consistent with other SOLOPC data from the region showing diel variation in particle production and loss, increasing particle size with depth, and a conceptual model of daytime primary production, aggregation, and sinking loss (Checkley et al. 2008.L&O. 53: 2123)

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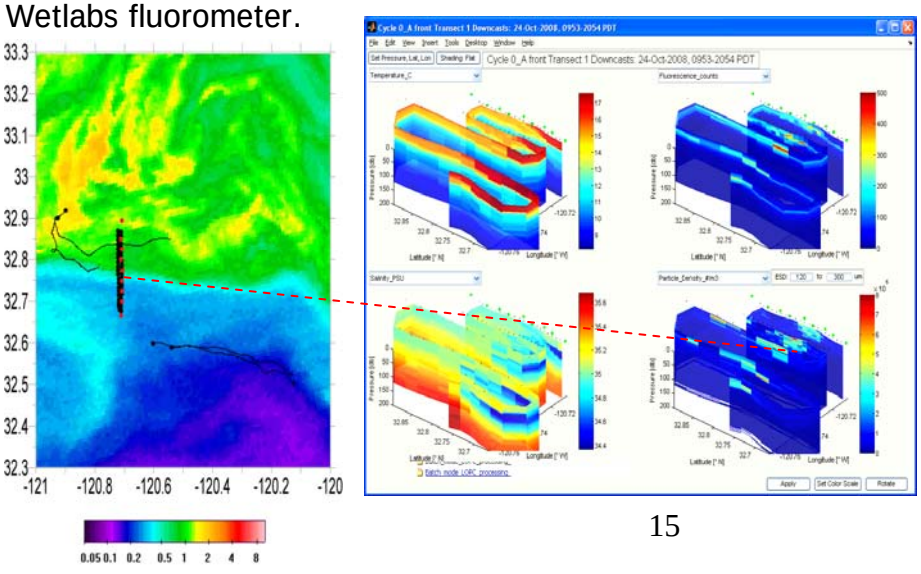
Moving Vessel Profiler

Mark Ohman lab

We are using a Moving Vessel Profiler (MVP) to markedly increase our ability to resolve spatial structure in plankton communities. The MVP incorporates a free-fall sampler with computer-controlled winch and recovery system that profiles the ocean water column from 0-200 m depth while the research vessel is underway at 12 kts. Our MVP includes an LOPC (Laser Optical Plankton Counter), CTD (Conductivity-Temperature-Depth sensor), and Wetlabs fluorometer.



The MVP has been instrumental in guiding our selection of water parcels to track during our experimental Lagrangian process cruises, and in identifying ocean fronts (**left**).

Satellite image courtesy of M. Kahru. MVP sections, Oct. 2008, CCE-P0810.
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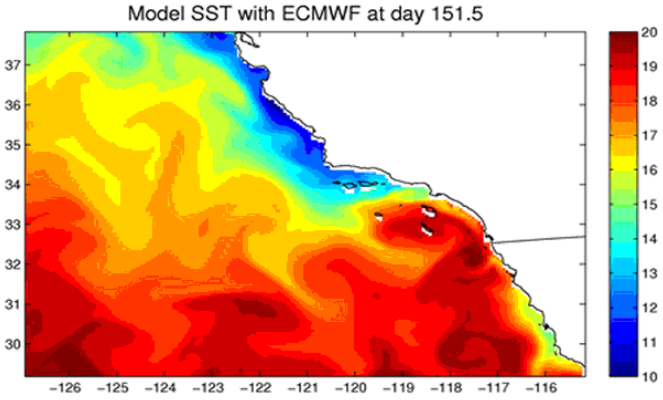
Bio-physical modeling

Art Miller lab

Changes in the physical oceanic environment are a major factor influencing biological variability. So it is vital to understand the physical processes occurring during the LTER cruises that measure biological changes. Since sampling of the physical environment is sparse in space and time, we use numerical models of ocean physics to help dynamically interpolate and interpret those measurements. Ocean model runs during the LTER cruise time periods (figure at left) are first made using smoothed versions of the available ocean data and surface atmospheric forcing. These runs are then corrected, using inverse methods of four-dimensional data assimilation, to find optimal initial conditions and forcing functions that allow the model to more correctly reproduce the physical observations. The best "fit" can then be analyzed to determine the dynamical processes that control the flow evolution. It can also then be used to drive ecosystem models to help interpret the biological observations.



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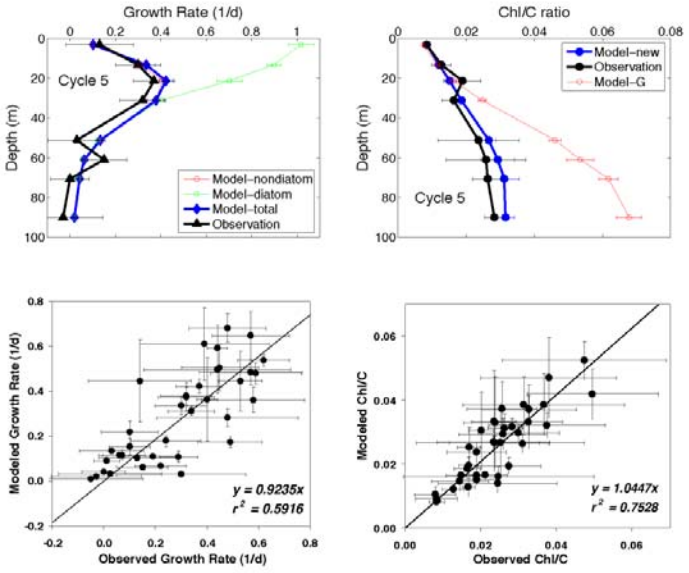
Ecosystem modeling

Peter Franks lab (Qian Li, Heidi Fuchs, collaborator Pascal Rivière)

We are developing planktonic ecosystem models to use as platforms for synthesizing, analyzing and simulating data gathered during the CCE-LTER program. Shown below are four panels from one such model, a modification of the NEMURO ecosystem model. The model can be forced with irradiance, nitrate concentration, and temperature, to generate vertical profiles of the growth rate of two phytoplankton types: diatoms and non-diatoms (upper left panel). Comparison of the model to all the growth rate data from a recent LTER cruise shows that the model accounts for almost 60% of the variability in growth rate in our region (lower left). Our modification of the model also allows it to predict the Chlorophyll-carbon ratio (upper right), which is an essential quantity for model-data comparison. Our model accounts for over 75% of the variability in this ratio within the CCE-LTER domain (lower right). Models such as this will be embedded in three-dimensional physical models from Art Miller's group (above) to simulate the effects of long-term climate change on planktonic ecosystem dynamics in the CCE-LTER region, and the North Pacific Ocean.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