CCE Moorings

Moored Climate, Carbon, Biogeochemical, and Ecosystem Observations in the Southern California Current System

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1. Project Summary

The California Current is a region of large ecological significance and known sensitivity to climate forcing. Climate processes, complex physical systems, carbon and nutrient chemistry, and ecosystem dynamics all interact to create a rich, societally important, and scientifically fascinating ocean environment off the west coast of the US. The CCE mooring project has established a unique highly multidisciplinary timeseries presence in the southern California Current, to complement ship-board observations from LTER and CalCOFI, glider and remote sensing observations, and the flow and transport monitoring system that has been initiated under CORC, and to start building a comprehensive continuous real-time monitoring system for this region.

The two moorings now operating, called CCE(California Current Ecosystem)-1 and CCE-2, are located in the offshore core and the coastal upwelling regime of the California Current along CalCOFI line 80, respectively and measure

- **atmospheric conditions** (x(CO_2), wind, temperature, humidity, precipitation, irradiance),
- **upper ocean conditions** (temperature, salinity, p(CO_2), O_2, pH, currents, point and integrated measures of phytoplankton chlorophyll content over the euphotic zone, and nitrate supply),
- **multi-frequency active-acoustic observations** of zooplankton and fish biomass.

Most of the data are telemetered in real-time and publicized via websites to other researchers, agencies, and the public.

The CCE moorings are intended to serve as an example and nucleus for enhanced autonomous observations of the California Current climate system, carbon cycle, ocean acidification processes, and ecosystem changes. They also represent a real step toward a recognized need in the sustained ocean climate observing system – techniques and implementations of observing infrastructure that jointly addresses the societal challenges driving the climate, biogeochemical and ecosystem community. This capability was clearly identified as a major need at the OceanObs09 conference in Venice. The merging of many new technologies, the highly

collaborative nature, and merging of several funding sources, is a promising example of how to enable such observations in the future.

The supported activities include operation of the two highly instrumented real-time moorings along CalCOFI line 80 and preliminary processing of the data. The activities include construction of moorings, execution of cruises, servicing and calibration of sensors, upgrading of technology, QA/QC of data streams, and participation in west coast wide ocean acidification research.

The anticipated products and outcomes include:

- long records of the processes and variability in the physical, biogeochemical, and ecosystem conditions in the southern California Current System
- data sets to develop and validate biogeochemical models
- integration of the data with other OA and ecosystem programs along the US west coast.

The users/applications include the carbon, OA, ecosystem, and fisheries research communities and agencies, modeling centers, fisheries management programs, as well as commercial fishermen (see letter of support in Appendix C). The data complement and add value to the regular ecosystem and stock assessment ship surveys along the west coast.

2. Scientific and Observing System Accomplishments

a) Field Work and Data Holdings

The FY2013 funding was used for the recovery and new installation of two nearly identical moorings CCE1 and CCE2 along CalCOFI line 80, in the same locations as in past years. In September 2012, CCE1 was serviced and re-deployed from RV "New Horizon." Immediately after anchor drop we lost real-time inductive connection to the controller in the 40m load cage with a suite of biogeochemical sensors. Since all instruments and the controller had passed all tests until minutes before deployment, it was concluded that the most likely scenario was just a problem with the inductive link and that the sensors and controller are still running and recording data. Due to extremely difficult weather conditions we had also run out of time at sea, and had no option to recover, diagnose, and re-deploy the mooring (in addition, given the weather, the risk of damaging something else far outweighed the real-time data loss).

On April 10, 2013, CCE2 was recovered and re-deployed from RV "New Horizon". Everything functioned after deployment and data were being streamed to SIO.

On April 12, 2013, CCE1 was struck by a large vessel (despite our Notice to Mariners and presence of radar reflectors) and we lost inductive communication to all instruments below the surface buoy, but the mooring remained in place. Apparently, at that time, the wire was damaged sufficiently that on May 15 the mooring broke loose and started drifting. An emergency recovery was staged on RV "New Horizon" and on May 21 the drifting buoy was recovered. It was severed not far below the buoy so all other equipment is presumed still attached to the anchor.

It took until September 2013 to free up manpower, place orders, build a new mooring, and arrange ship time, for re-deploying the CCE1 mooring. In addition, we could only get the much-too-small RV "R.G. Sproul," and to make up for the lack of lab space it was possible to arrange for a lab van from the NSF pool (since this cruise was co-funded by the NSF LTER program).

This took away from valuable deck space and made operations much more cumbersome. In spite of rough weather, we managed to get a 36hr window with calmer winds, and got the new CCE1 mooring deployed. Unfortunately, the remainder of the broken CCE1 mooring, in particular with the 40m cage and controller (which is pressure rated to 6000m and should survive falling to the seafloor), could not be recovered since the nylon rope seems to have been entangled around the anchor. The acoustic release did lift by a few hundred meters but then stopped, being held my something caught around the anchor. We will try to dredge for the mooring parts in 2014.

Both new deployments of CCE1 and CCE2 were highly successful, all deployed sensors are operating at the time of writing, and telemetering data, as visible also on the CCE website (http://mooring.ucsd.edu/CCE). The present configuration of the moorings is the most comprehensive yet, with PMEL having added, in addition to their Map-CO_2 system, a surface SAMI-pH sensor and a surface Seacat with oxygen/fluorescence sensors to both moorings. Also, the SWFSC/Demer acoustic AOS are operating on both moorings and sending data. Further, both surface buoys carry acoustic modems for telemetering data from bottom-mounted PIES (bottom pressure plus inverted echosounder) at the same locations.The current total data holdings are shown in figures A1 and A2 in appendix A, including the current data being telemetered.

b) Data Processing and Scientific Analyses

Data processing is taking place in the teams of the respective collaborators, i.e. in the labs of PMEL, Martz, Demer, Ohman, and Send. To the extent that funding allows, effort is going into calibration and quality control efforts of the data. We are also working within the NOAA OA program to contribute to its efforts and adhere to its protocols. Figure 1 documents the high quality of the data we are generating now, by comparing moored timeseries of oxygen, pH, nutrients, and chlorophyll fluorescence with quarterly ship samples from CalCOFI cruises.

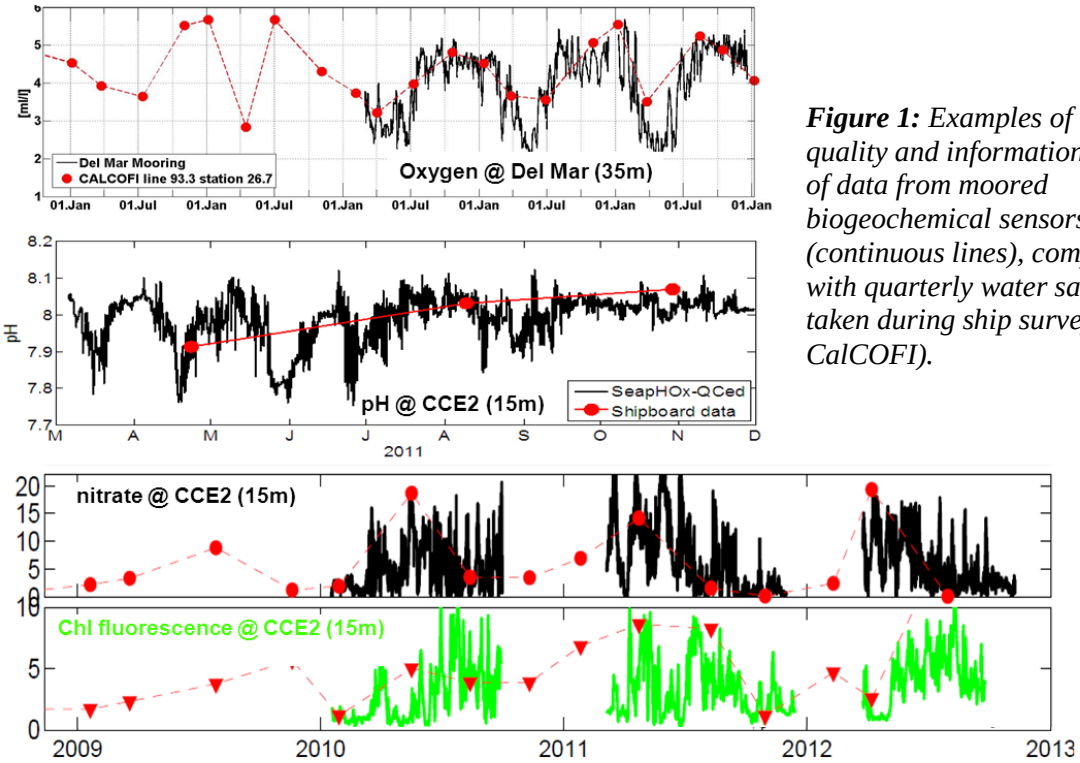

Figure 1: *Examples of the quality and information content of data from moored biogeochemical sensors (continuous lines), compared with quarterly water samples taken during ship surveys (here CalCOFI).*

For the scientific analyses, our multiple, copmlementary efforts are starting to pay off. This includes physical observations from CORC, glider sections from CORC and IOOS, data from the Del Mar mooring, and ship surveys (CalCOFI, LTER, recent student cruises).

The goals of the CCE mooring program are to contribute continuous observations needed for addressing physical control of carbon/OA and ecosystem processes and variability, from short timescales (semidiurnal and upwelling events) to interannual changes. Improved understanding of these connections will enable us ultimately to forecast impacts, manage resources, and develop/validate/control numerical models. Some examples for analyses and results for these different timescales are show below.

Semidiurnal processes

The moored instruments allow analysis of high-frequency processes and their impact on biogeochemical and ecosystem conditions. We have found at the CCE moorings that sometimes there is a coincidence of high internal tidal energy (large vertical displacements of layers) with vertical gradients in a properties like nitrate which our instruments can measure. This permits a calculation, from hour to hour, of the correlation of, e.g., nitrate with vertical displacement. If it were truly passive, the same nitrate concentration would go up past the sensor and then come down again. We sometimes find however a net correlation, i.e. a rectification, meaning that higher concentrations go up than come down afterwards. This suggests that some nutrients have been consumed in the upper layer, resulting in a net vertical pumping of nitrater.

One such example is shown in figure 2. In mid to late March 2011 we infer that an eddy at CCE1 lifted the isopycnals and thus the nutricline higher than usual (red colors at 50m while normally at 70m in the upper plot). Higher frequency, semidiurnal displacements of order 10m are seen in the isopycnals. Translating this into a vertical velocity w, we can calculate $w'NO_3'$ (the product of the fluctuating components) and its average $\langle w'NO_3' \rangle$ over, e.g., 6-day intervals. The NO_3 timeseries and the timeseries of $w'NO_3'$ are shown in the lower panel. Integrating over 6-day intervals yields a net NO_3 input into the upper 41m layer equivalent to 13µmol/kg (over 6 days), which is a substantial flux. It thus appears that our moorings have the capability to directly observe and calculate the semidiurnal pumping of nutrients into the euphotic zone.

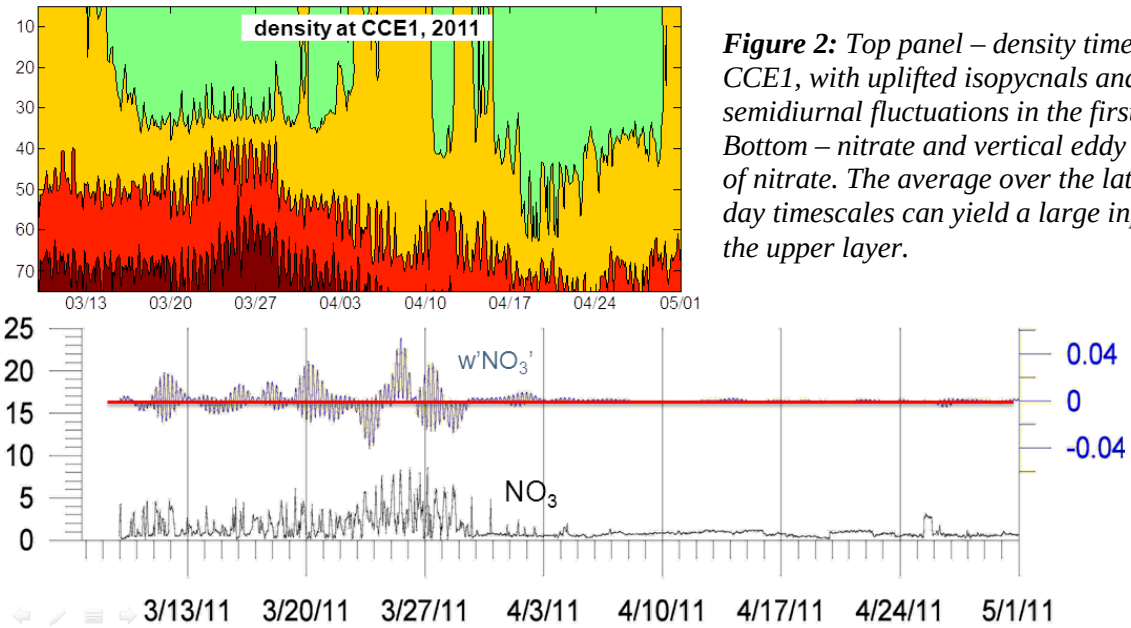

Figure 2: *Top panel – density time series at CCE1, with uplifted isopycnals and large semidiurnal fluctuations in the first 2 weeks. Bottom – nitrate and vertical eddy advection of nitrate. The average over the latter on 6-day timescales can yield a large input into the upper layer.*

Event-scale processes

The physical, biogeochemical, and ecosystem variability off Southern California are strongly affected by upwelling events, which bring low-pH, low-oxygen, high-CO_2, high nutrient water to the surface, usually triggering blooms. We are developing better indices for quantifying the upwelling variability in the CCE and CalCOFI region. One traditional measure is the so-called "Bakun" or UPI index which is calculated from surface pressure fields and available for downloads from NOAA on a 3x3° or 1x1° grid. We have found that this classic index does not represent local upwelling well (correlation around 0.3) and also is not closely related to local wind stress. Hence, we also estimated Ekman transport (based onwind stress) from the NCEP North American Regional Analysis (NARR) reanalysis product. This also had an unsatisfying correlation with the upwelling observed at CCE2 (correlations of 0.4-0.5). Thus we developed a new index that takes into account not only local wind stress, also but remote forcing and propagation via coastally trapped waves (CTW). Our index is based on the cumulative effect of winds to the south, time-lagged with approximate CTW speeds, with amplitudes determined via an optimal fit. This index yields correlations with density, temperature, and even nutrient timeseries up to 0.7 (for the year 2011) with both surface density and 15m nutrient concentrations. Figure 3 shows the agreements founds for 2011 (compare CTW index with mooring measurements); in other years it is generally more difficult to reproduce the upwelling variability and we are working on the issue. More generally, our plan is to also define an in-situ upwelling index (from density and/or nutrient data) and report this to the community on a regular basis.

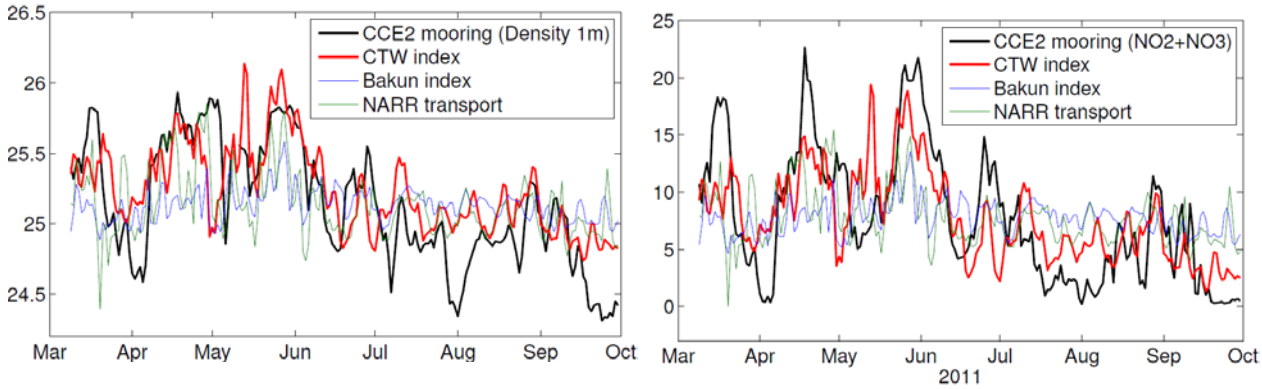

Figure 3: *Timeseries at CCE2 of 1m density (top) and 15m nitrate (bottom) in black. Thin blue and green lines show the Bakun upwelling index at the nearest grid point, and the Ekman transport (essentially wind stress) from NCEP regional reanalysis winds. The "coastally trapped wave" index we derived from accumulated wind stress forcing to the south (red) has much better correlation with both density and nutrient concentration.*

The observations at CCE2 also allow us to causally and quantitatively relate the physical upwelling variability with biogeochemical and biological changes. Figure 4 show a set of upwelling events, where the repeated sequence is clearly visible, in whiche isopycnal uplifting brings low-pH, low-oxygen, high-CO_2, high-nutrient water into the upper layer (pink shading), which then leads to a chlorophyll bloom (gray shading). We are in the process of analyzing the nutrient budgets and carbon budgets for these events.

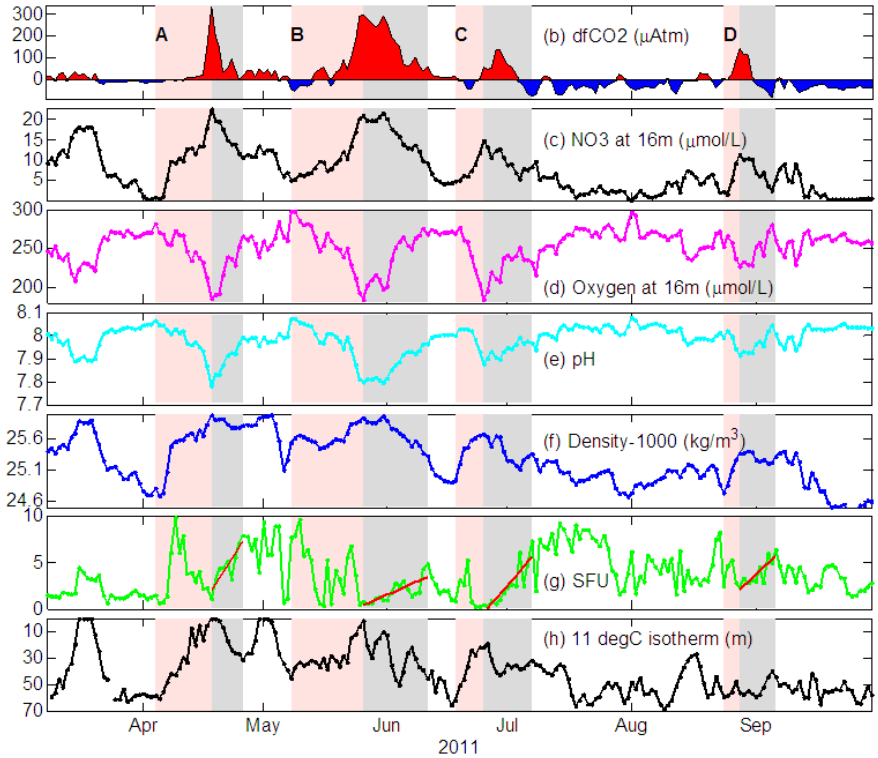

Figure 4: *Upwelling events at CCE2 visible in (top to bottom) CO2, nitrate, oxygen, pH, density, chlorophyll fluorescence, and isotherm depth. Pink shading shows onset of even until peak amplitude, gray shows subsequent blooms.*

Undercurrent variability

We are working along several lines to document and understand the water mass variability which results from advection of southern, more subtropical water via the California Undercurrent. This water normally is found at depths between 150 and 250m but can spread vertically and laterally, and the Undercurrent can be more or less pronounced. Due to its different characteristics (high salinity, high nutrient, low oxygen) it is believed to have important controls on the oxygen/pH variability in the upwelling regime, to affect euphotic zone productivity, and influence habitat conditions for marine fishes. A good measure for water of southern origin is spiciness π (high temperature and high salinity;orthogonal to density in the T-S diagram). We have started to analyze spiciness more systematically from moorings and gliders in the region. Much of this work is done as part of the CORC project, but we have also applied it to our moorings at CCE2 and Del Mar, since this is where upwelled water enters the euphotic layer and near-shore zone. Figure 5 shows a contour plot of spiciness in time-density space, at CCE2. The higher values intruding from below are instances where the Undercurrent starts to affect the upper 75m sampled by CCE2.

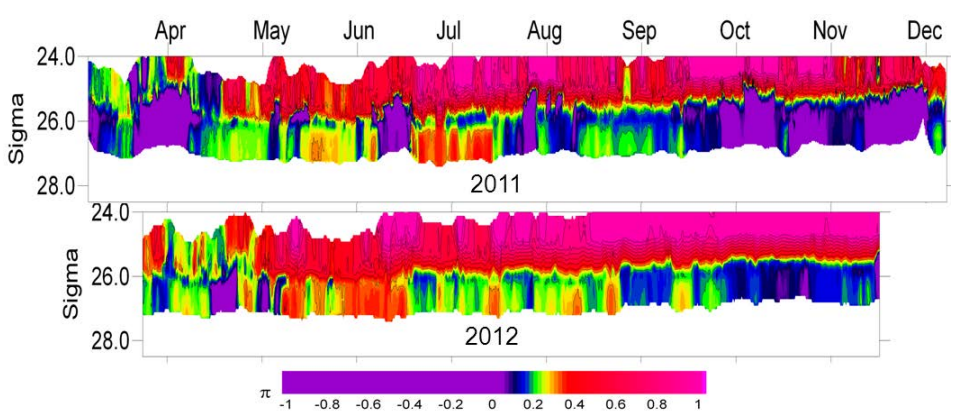

Figure 5: *Spiciness at CCE2 on a vertical density coordinate. The green/ yellow red values in the deepest part are influences of Undercurrent water from the south, reaching close to the surface (here 75m and above), thus potentially influencing the euphotic zone and ecosystem processes in this upwelling area.*

Integration of moorings (temporal resolution) with Spray gliders (spatial resolution)
The co-location of the CCE-1 and CCE-2 moorings along CalCOFI line 80 not only permit quarterly shipboard calibration measurements, but also permit integration of mooring measurements with the *Spray* glider observations along line 80. Some of these gliders now measure dissolved oxygen and, together with the proxy relationship developed for the region by Alin et al. (2012), it is possible to convert hydrographic measurements (O_2, temp, salinity) from both the moorings and gliders to accurately estimate aragonite saturation state (Ω_{arag}), figure 6.

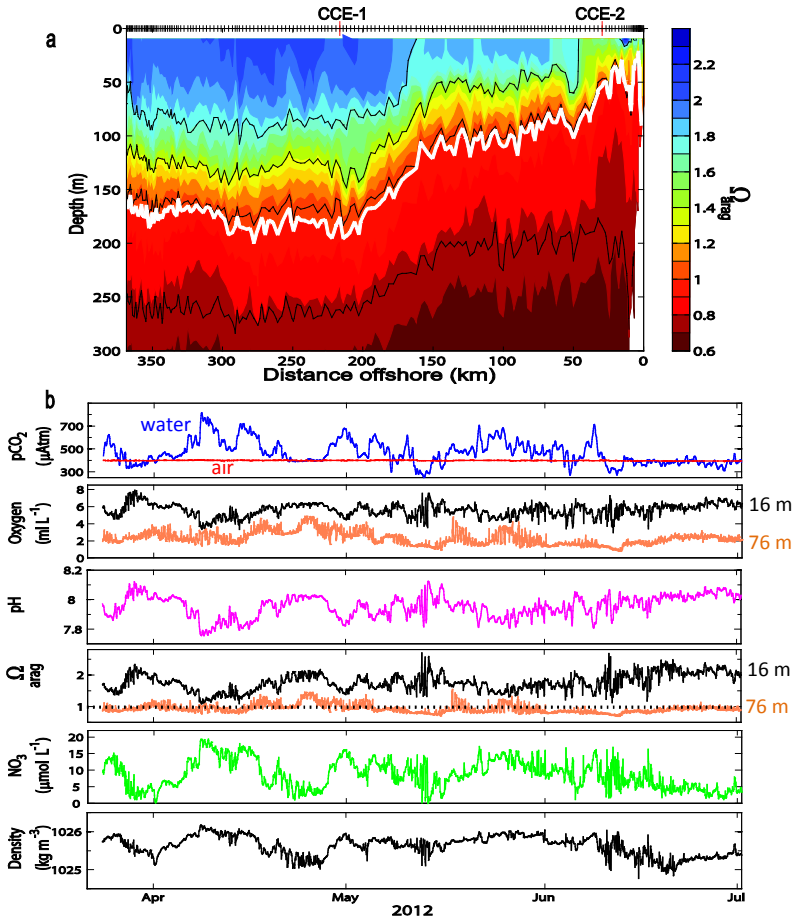

Figure 6: *Variations in Ω_{arag} in an Upwelling Ecosystem (Ohman et al. 2013). Top: Spatial Variations - Spray ocean gliders show that during the upwelling season, the depth where (Ω_{arag} = 1.0 (white line) shoals from 200 m in the offshore region to <30 m at the coastal boundary. Bottom: Temporal Variations - Concurrent high frequency mooring measurements at CCE-2 reveal episodic upwelling events of ~6-14 day duration during which efflux of pCO_2 to the atmosphere is accompanied by decreased O_2, pH, , Ω_{arag} and elevated NO_3. At 76 m, but not at 16 m, Ω_{arag} decreases below a threshold of 1.0 during these upwelling events.*

Interannual variability
Our mooring timeseries are becoming long enough to identify unusual years, especially when combined with CalCOFI sampling at the mooring locations. Figure 7 below shows (in the top panel) nutrient data from the offshore mooring CCE1, where normally nitrate is low. However, in June 2012 our sensor indicated very large values which were first suspected to be artifacts. Looking at 30 years of CalCOFI samples at that site, however, revealed that such extreme values can be found, but rarely (purple crosses). The high CO_2 of the water at that time together with the elevated chlorophyll, suggest that this is upwelled water from near the coast which was advected far offshore in this year. The summer was remarkably cloudy that year, so that no ocean color satellite images are available at all for this season. However, an altimeter analysis shows that this year was unusual in terms of removing large volumes of near-shelf water to far offshore. Figure 8 shows example backward trajectories from the CCE1 location, highlighting some periods where water that flowed past CCE1 originated near the coast (red lines).

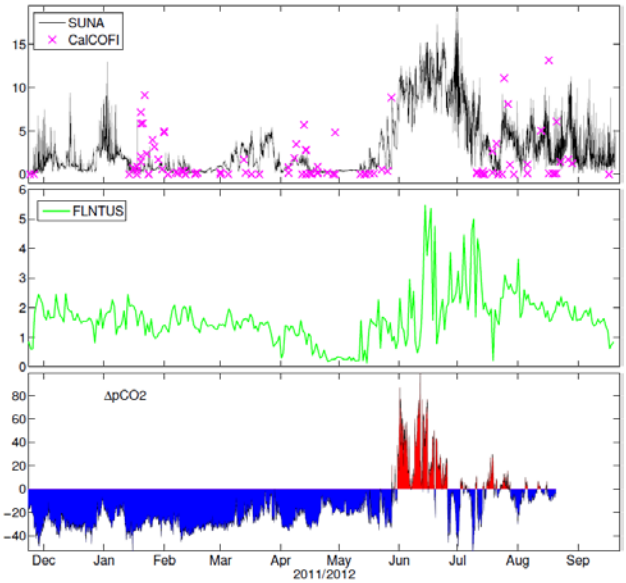

Figure 7: *Top – nitrate at CCE1 (black) showing unusually high values in June, and 30 years of CalCOFI nitrate samples at same location/depth. Middle – chlorophyll fluorescence, and bottom – delta pCO2, showing upwelled origin of the water.*

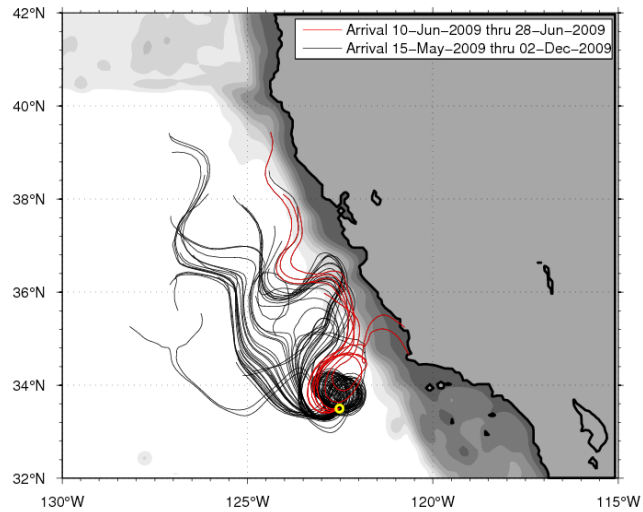

Figure 8: *Back-calculated trajectories ending up at CCE2 of surface flow using AVISO altimeter data. The red trajectories show periods where water originated from near the coast.*

We have extended this satellite source-water tracking algorithm to a multi-year analysis. Calculate the fraction of the area in a box around CCE1 that is occupied by water that had been on the continental shelf or slope a short time before, shows that 2012 is a highly unusual year (figure 9). We speculate that this anomalous influx of cool, coastal water led to the large cloud cover and the high nutrients at CCE1.

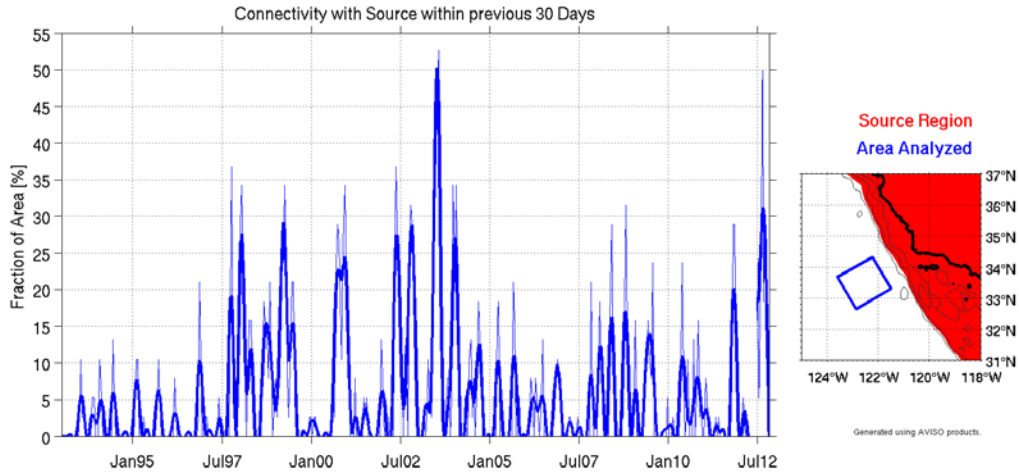

Figure 9: *The blue line in the left panel shows the fraction of the area of the blue box box (right panel) which is occupied by water that has come from (passed through) the red area on the map. The method is the back-trajectory calculation from figure 8. This is meant as an index for the amount of upwelled water that has reached CCE1.*

Acoustic backscatter data for fish and zooplankton
The acoustic AOS sensors are now routine on both CCE moorings and telemeter approximate data for echogram views and analyses, as shown on the CCE mooring website. After recovery, the full acoustic information is available for analysis, and various filters can be applied, e.g. to detect the presence of fish. One example is show in figure 10, where a filter to detect coastal pelagic fish species (CPS) has been applied, and then weekly averages were formed for acoustic volume backscattering strength Sv as a measure for the abundance of fish. The first quick-look of these data seems to show some relation to the density, even on event timescales.

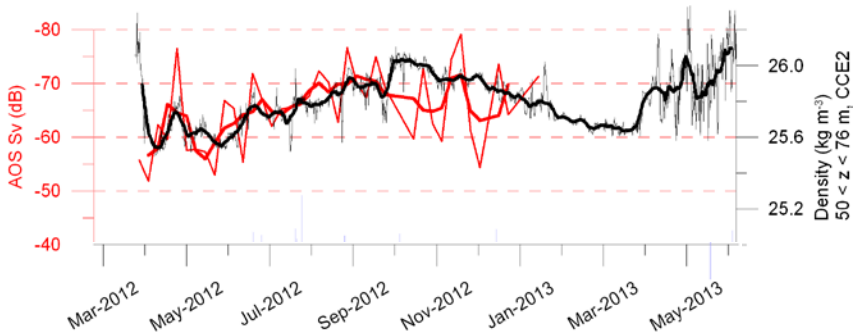

Figure 10: *Weekly AOS averages of acoustic backscatter as a measure of CPS (red, inverted scale), and density at 50-75m depth (black) at the CCE2 mooring.*

c) Data Management

All raw data are archived and made available to all collaborators on the server of the Send group. The calibration information for all sensors is collected and shared via the Ohman group Wiki site. Realtime data are displayed on the website http://mooring.ucsd.edu/CCE. Within the available resources we make a best effort at quality controlling the CCE mooring data set.

The data are not distributed on the GTS.
Data from the CO_2 instruments operated by NOAA PMEL reside on their computers, with plots available on their website. Raw data from the bio-sonar are preserved on an institutional server, and passed on to the PI at NOAA SWFSC. The other real-time data reside on an institutional server at SIO, which is connected to a backup system. Plots of the data are available online on an institutional website. We are working on making real-time data available via OceanSITES.

Delayed-mode data from the CO_2 instruments operated by NOAA PMEL reside and are available from the CDIAC websites (until 10/2010). Data from the bio-sonar are with the PI at NOAA SWFSC. The other delayed-mode data reside on an institutional server at SIO, which is connected to a backup system. Temperature and salinity data (delayed-mode) are publicly available through OceanSITES until 10/2010. We will make an effort to also distribute biogeochemical and ecosystem data via OceanSITES.

The backup of the institutional server is run daily. Transfer of processed data to OceanSITES occurs as processing is completed, approximately yearly.

The websites for the data are
ftp://data.ndbc.noaa.gov/data/oceansites/DATA/CCE1/
ftp://data.ndbc.noaa.gov/data/oceansites/DATA/CCE2/
http://www.pmel.noaa.gov/co2/story/CCE+1
http://cdiac.ornl.gov/oceans/Coastal/CCE1_122W_33N.html

http://cdiac.ornl.gov/oceans/Moorings/CCE2.html
http://mooring.ucsd.edu/projects/cce/cce_intro.html

We have successfully retrieved our program's data from the OceanSITES Data Assembly Center where the data reside.

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The lack of resources/funding is a definite constraint in the data management activity.
A draft data management plan is given in Appendix B.

Summary Information:

a. Project deliverables serving the observing system's program deliverables

- Long timeseries with high temporal resolution of the physical conditions, processes and forcing, representing controls of the carbon and ecosystem in the California Current
- Long timeseries with high temporal resolution of components of the carbon system and ocean acidification processes in the California Current, enabling climate impact research
- Long timeseries with high temporal resolution of ecosystem variability and processes, yielding the response to changes in the physical and biogeochemical conditions

b. Achievements during FY2012

- Continued operation of two equivalent highly instrumented realtime moorings across the California Current ecosystem with physical, chemical, carbon, and ecosystem sensors
- First real-time sustained telemetry of acoustic backscatter from up/downlooking sensors at 150m depth
- Improvements in sensor calibration and data quality control techniques, allowing intercomparisons with other data sets (e.g. CalCOFI)
- Analyses of carbon (DIC) budgets
- analyses of climate anomalies in subsurface oxygen
- quantification of carbon events in timeseries

c. Scientific advances made and/or facilitated through the project activities

- Understanding of time variability and events in the processes governing the biogeochemical and ecosystem
- Impact of climate variability on the carbon and ecosystem in the California Current
- Integration of high temporal resolution CCE mooring measurements with spatial coverage from *Spray* gliders, to understand both time- and space-variability of aragonite saturation state.
- Analyses of the offshore boundary conditions affecting the shelf regime through upwelling transport of low oxygen/pH water into near-shore regimes
- The AOS on CCE moorings allow real-time monitoring of the coastal pelagic fish, their essential oceanographic habitat, and their seasonal dynamics. An array of such moorings could serve as a monitoring toll gate, perhaps allowing estimations of CPS-stock biomasses by measuring fish densities as they pass (e.g., Brierley et al. 2006).

d. Significance of these advances

- The results allow evaluations of the carbon cycle role and impact in the California Current
- The observations allow assessments of the magnitude, duration, and frequency of "event-scale" ocean acidification events in the region

- Understanding of ecosystem controls and improvement of forecasts, including fisheries management
- Improvement of biogeochemical and ecosystem models, and model validation
- Real-time monitoring of coastal pelagic fish, their habitat, and migrations could serve fisheries surveys, management, and conservation efforts.

e. Information jeopardized due to a lack of funding, lack of instrumentation, or inability to carry out the work

- Due to the IDC rate change at SIO and due to reduced funding for this project in FY2012, the CCE mooring program currently operates at a loss and needs voluntary free contributions from several collaborators and borrowed equipment. This is not sustainable.
- Lack of a duplicate set of hardware for two moorings (buoys, sensors) means we cannot service both moorings on a single cruise. This means increased need of shiptime (which we do not have) and/or gaps in the mooring timeseries (when we bring hardware to shore for service)
- The instrument array must be larger to span the migration route of coastal pelagic fish and should use several frequencies, which is not possible with present funding. Insufficient funding for data integration/analysis has limited applications of this valuable data resource.
- Data management and calibration efforts are behind and lacking funding, especially the QC and dissemination of biogeochemical and ecosystem sensors.

f. Web sites for the program

- http://mooring.ucsd.edu/CCE

3. Outreach and Education

The CCE mooring effort will be presented via multiple presentations at the ASLO/Ocean Sciences Conference in Honolulu in February 2012. Some recent results were communicated during an invited oral presentation at the fall AGU meeting in December 2012. The CCE mooring consortium also made several presentations at the Third international symposium on the Ocean in a High CO2 World, Monterey, CA. The program is communicated to the public via various websites and also contributes to the CCE LTER program.
Three young scientists and several graduate students are being trained via work on the CCE program and data. Wherever possible, we invite students to participate in CCE cruises. In our teaching, and during visits of prospective students, CCE is used as a demonstration of exciting and relevant research. Many potential new students contact us as a result of their interest in the CCE mooring program as explained on our websites.

4. Related Publications by Principal Investigators

Send, U., and S. Nam (2012): Relaxation from Upwelling: the effect on dissolved oxygen on the continental shelf. J. Geophys. Res. VOL. 117, C04024, doi:10.1029/2011JC007517

Ohman, M.D., Rudnick, D.L., Chekalyuk, A., Davis, R.E., Feely, R.A., Kahru, M., Kim, H.-J., Landry, M.R., Martz, T.R., Sabine, C., Send, U., 2013. Autonomous ocean measurements in the California Current Ecosystem. *Oceanography* 26: 18-25 doi 10.5670/oceanog.2013.41.

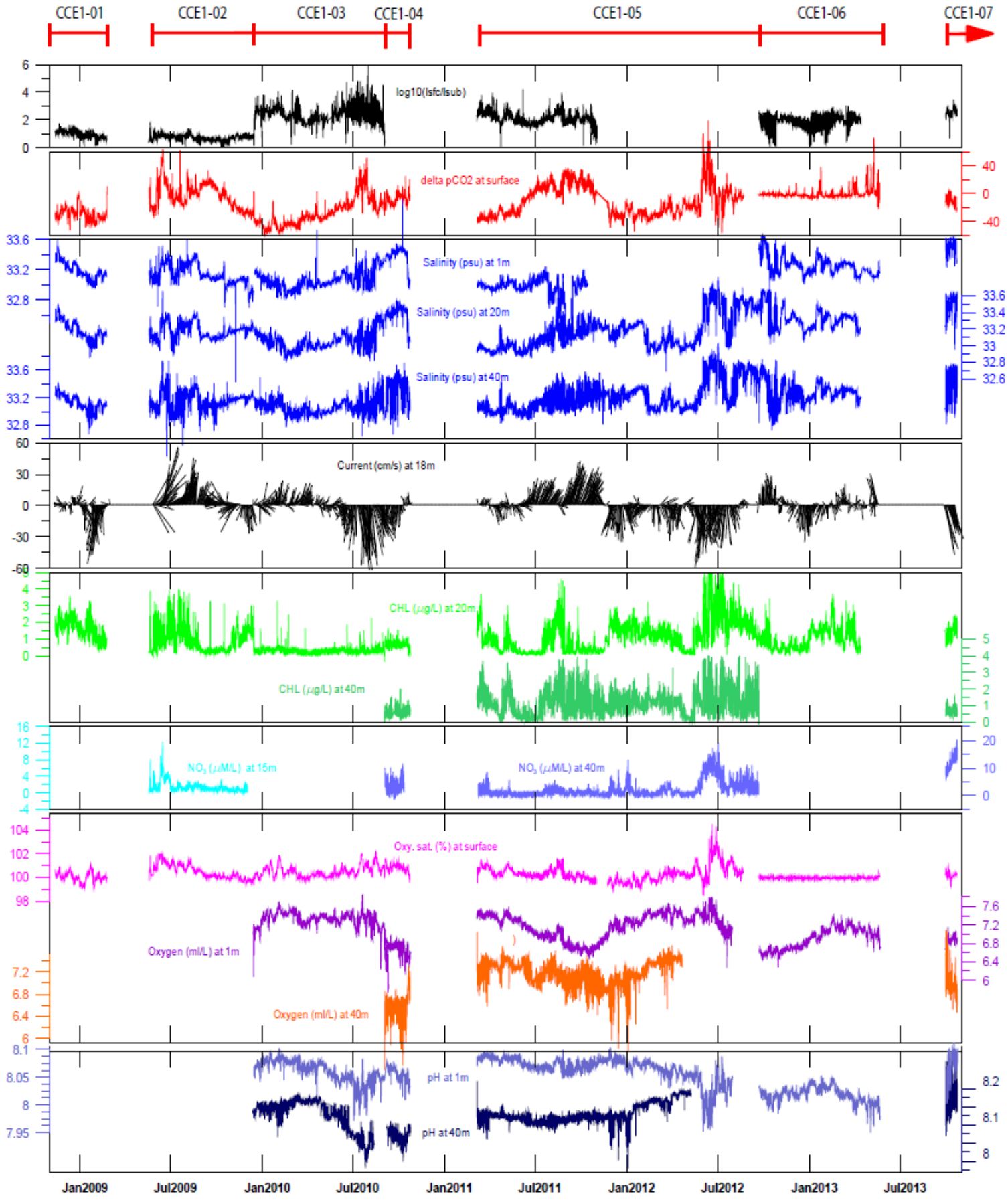
Send, U. H.-J. Kim, S.Nam, M.D. Ohman, T. Martz, R. Feely, 2013: Upwelling events observed with simultaneously with a large suite of multi-disciplinary variables. Deep-Sea Res, in preparation.

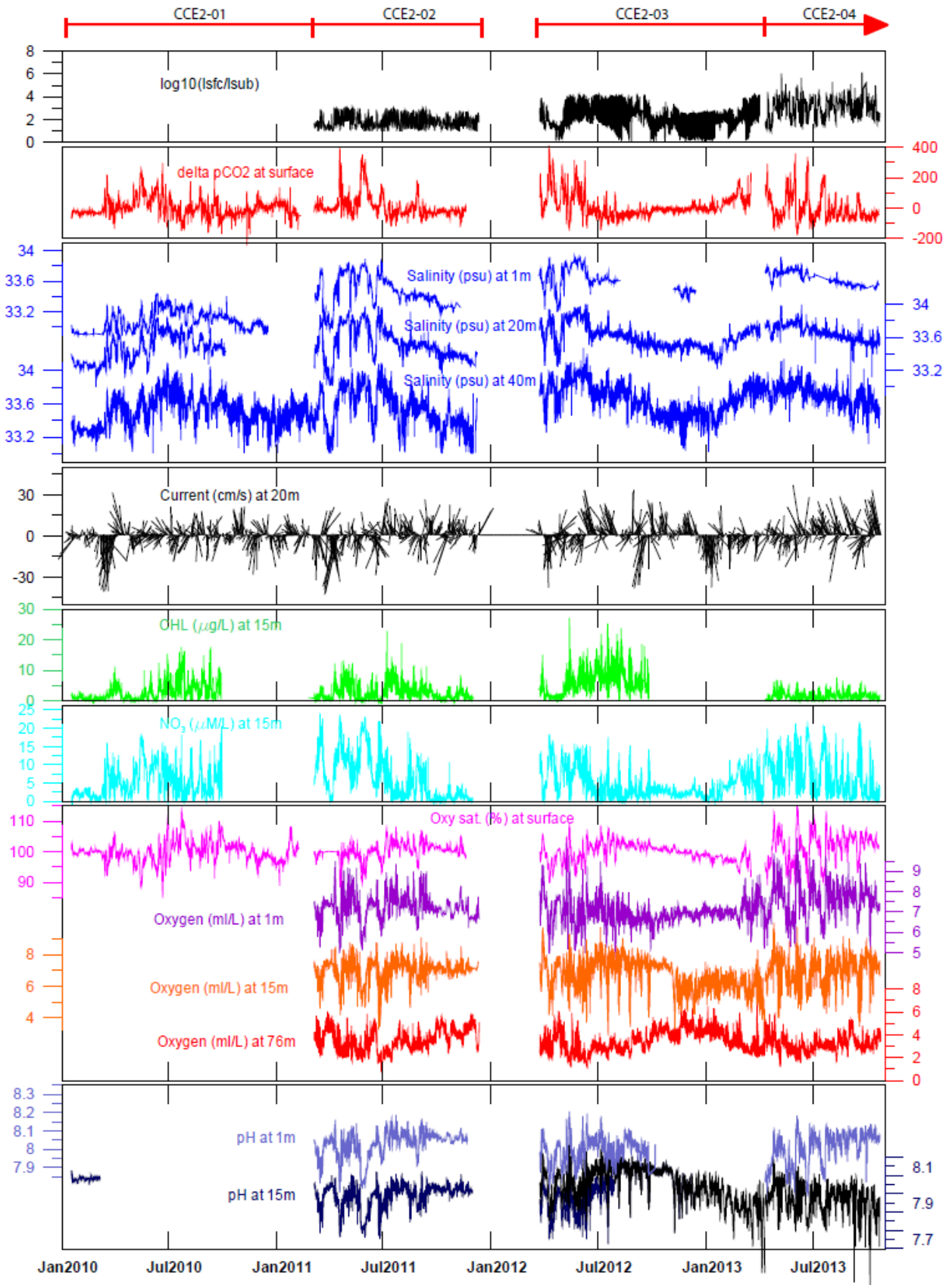
Wilson, S., U. Send, and B. G. Mitchell. Chlorophyll timeseries in the California Current System measured through wavelength-specific optical attenuation. In preparation.

Appendix A:

Figure A1 *(next page): Available data from all CCE1 mooring deployments for: surface-subsurface radiometers (showing a logarithmic ratio), water-air pCO2 difference (PMEL sensors), some of the T/S sensors (showing salinity), currents at 20m (mostly from an ADCP covering the upper 500m),chlorophyll estimates, nitrate concentration, dissolved oxygen data from several dephs, and pH readings from two depths. All data are raw with factory calibration.*

Figure A2 *(page after next): Same as figure A1 but for the CCE2 mooring.*


CCE1-01
CCE1-02
CCE1-03
CCE1-04
CCE1-05
CCE1-06
CCE1-07
log10(Isfc/Isub)
delta pCO2 at surface
Salinity (psu) at 1m
Salinity (psu) at 20m
Salinity (psu) at 40m
Current (cm/s) at 18m
CHL (μg/L) at 20m
CHL (μg/L) at 40m
NO3 (μM/L) at 15m
NO3 (μM/L) at 40m
Oxy. sat. (%) at surface
Oxygen (ml/L) at 1m
Oxygen (ml/L) at 40m
pH at 1m
pH at 40m
Jan2009
Jul2009
Jan2010
Jul2010
Jan2011
Jul2011
Jan2012
Jul2012
Jan2013
Jul2013


CCE2-01
CCE2-02
CCE2-03
CCE2-04
log10(lsfc/lsub)
delta pCO2 at surface
Salinity (psu) at 1m
Salinity (psu) at 20m
Salinity (psu) at 40m
Current (cm/s) at 20m
CHL (μg/L) at 15m
NO3 (μM/L) at 15m
Oxy sat. (%) at surface
Oxygen (ml/L) at 1m
Oxygen (ml/L) at 15m
Oxygen (ml/L) at 76m
pH at 1m
pH at 15m
Jan2010
Jul2010
Jan2011
Jul2011
Jan2012
Jul2012
Jan2013
Jul2013

Appendix B:

Draft Data Management Plan

Types of data:

The project will obtain data from meteorological and oceanographic instruments and sensors mounted on the moorings. All of these data are represented as numeric values of some measured or derived properties. Subsets of data will be telemetered ashore and are referred to as "real-time data", in contrast to "delayed-mode data" which are retrieved after physically recovering the instruments. Additional information and documentation about data will be provided and referred to as "metadata." Real-time data are not fully quality-controlled, and do not have final calibration information applied. Delayed-mode data will be quality-controlled and have final calibration information applied. Metadata will accompany the data to describe the anticipated data quality and data provenance.

Standards to be used for data and metadata format and content:

The project will adhere to the format and content requirements set forth by the "CF metadata conventions" and "OceanSITES". In cases where these do not cover the data types produced, the project will work with these groups to expand their definitions accordingly. Responsibility for format and content is with the principal investigator associated with the instrument producing the data.

Policies for access and sharing:

The project will make real-time data publicly available as soon as they are received. The project will make delayed-mode data publicly available after processing is complete. The desired time frame for this is one year after physical recovery of the instrumentation. Data will be made accessible through the OceanSITES ftp servers. Responsibility for sharing is with the principal investigator associated with the instrument producing the data.

Policies and provisions for re-use, re-distribution, and the production of derivatives:

All project data are made available subject to the Creative Commons Attribution-ShareAlike 3.0 Unported License:
http://creativecommons.org/licenses/by-sa/3.0/deed.en_US

Plans for archiving data and for preservation of access to them:

Incoming data are stored on institutional computers that are connected to a disk backup system. The OceanSITES ftp servers are the primary access points. These servers will be routinely backed up to an archive facility at NOAA.

Appendix C: Letter of Support from Santa Barbara Fishermen

Commercial Fishermen of Santa Barbara

Commercial Fishermen of Santa Barbara, Inc. 6 Harbor Way, #155 Santa Barbara, CA 93109 www.cfsb.info

To Whom It May Concern:

This is a letter of support for Scripps Institution of Oceanography California Current Ecosystem (CCE) Buoy Program.

Many of the fishermen fishing out of Santa Barbara Harbor use this data on a daily basis to guide them in their fishing activities. The drift gillnet fleet and the black cod long line fleet use the real time data of wind speed and current direction to make their fishing activities significantly safer as they fish in the immediate area around the CCE 1 and CCE2 buoys. I am a black cod fisherman and have often found myself sitting off Pt Conception waiting for the weather to break checking on the CCE buoy data to advise me when the weather has changed. These are the only buoys providing current data in the Pt Conception Bite.

This program is of real value to the commercial fishermen of Santa Barbara and we wholeheartedly support it.

Sincerely,

Stephanie Mutz

John Colgate
CFSB Black Cod Representative

Stephanie Mutz, President