Original transmitted-light imagery and processed attenuance images of sinking particles observed by autonomous Carbon Flux Explorers deployed 100-500m in the California Current Regime, during the CCE-LTER process study (P1706) between June 2 and July 1, 2

Website: https://www.bco-dmo.org/dataset/825076
Data Type: Other Field Results
Version: 1
Version Date: 2020-09-17

Project
» California Current Ecosystem Long Term Ecological Research site (CCE LTER)
» Carbon Sedimentation In the Ocean Watercolumn (C-SNOW): Calibration (C-SNOW)
» Carbon Flux Explorer Development (C-SNOW Development)

Programs
» Long Term Ecological Research network (LTER)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
Bishop, James K.B.	University of California-Berkeley (UC Berkeley)	Principal Investigator, Contact
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Original transmitted-light imagery and processed attenuance images of sinking particles observed by autonomous Carbon Flux Explorers deployed 100-500m in the California Current Regime, during the CCE-LTER process study (P1706) between June 2 and July 1, 2017.

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Coverage

Spatial Extent: **N**:35.2 **E**:-120.8 **S**:33.5 **W**:-123.5
Temporal Extent: 2017-06-10 - 2017-06-26

Dataset Description

Original transmitted-light imagery and processed attenuance images of sinking particles observed by autonomous Carbon Flux Explorers deployed 100-500m in the California Current Regime, during the CCE-LTER process study (P1706) between June 2 and July 1, 2017.

These data will be submitted with the following manuscript:

Hannah L. Bourne, James K. B. Bishop, Elizabeth J. Connors, Todd J. Wood. Carbon Export and Fate Beneath a Dynamic Upwelled Filament off the California Coast.

Acquisition Description

The expedition followed a newly formed filament of upwelled water in a region bounded by 33.5N, 123.5W and 35.2N, 120.8W.

Sample attenuance calculation. Transmitted light color images were normalized by an in-situ composite image of the clean sample stage following Bishop et al., 2016 yielding a map of fractional transmission corrected for inhomogeneities of the light source. Attenuance (ATN) values were then calculated by taking the -log10 of the normalized image. Results were saved as bmp formatted images in attenuance units where counts in each 8- bit (red, green, blue) color plane are scaled so that 100 counts = 1 attenuance unit.

The Carbon Flux Explorer is built on a standard ARGO style float, called the Sounding Oceanographic Lagrangian Explorer (SOLO and SOLO-II). The float is the buoyancy engine for the CFE and also manages all satellite communication of data from the CFE. The top of the float has an integrated Seabird CTD system. Temperature, pressure, and salinity data are read in bursts at 10 minute intervals as the CFE is monitoring flux at depth. These data are merged with the imagery meta data.

Processing Description

The software package ImageJ 1.52 (IJ, National Institutes of Health) was used for particle size analysis. Fortran codes were written for secondary data processing.

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Data Files

File	Version
Jim_Bishop_CFE001_20170610_ATN.tgz (Octet Stream, 353.53 MB) MD5:039da382a5a6ae3bc79f605d24f180d2 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER process study (P1706) on 2017-06-10*	1
Jim_Bishop_CFE001_20170610_BCK.tgz (Octet Stream, 615.28 MB) MD5:e7354e57678a20e2662172c9b1062ce3 *Transmitted light color images acquired by carbon flux explorer 001 during the CCE-LTER study P1706 on 2017-06-10.*	1
Jim_Bishop_CFE001_20170613_ATN.tgz (Octet Stream, 381.69 MB) MD5:7ae4a2268f3f5bed2e275bbbe43fe304 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER process study (P1706) on 2017-06-13.*	1

File	Version
Jim_Bishop_CFE001_20170613_BCK.tgz (Octet Stream, 1.27 GB) MD5:51edd59887e383cf6e134ab4fac53a2e *Transmitted light color images acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER study P1706 on 2017-06-13.*	1
Jim_Bishop_CFE001_20170619_ATN.tgz (Octet Stream, 77.61 MB) MD5:7094d1f4ec81061a1914cc0ffc29c309 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER process study (P1706) on 2017-06-19*	1
Jim_Bishop_CFE001_20170619_BCK.tgz (Octet Stream, 306.18 MB) MD5:e1241bff09335ad4f2388d199597c16c *Transmitted light color images acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER study P1706 on 2017-06-19*	1
Jim_Bishop_CFE001_20170621_ATN.tgz (Octet Stream, 131.30 MB) MD5:910e1b774f95467bf996fdaded1ab8ba *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER process study (P1706) on 2017-06-21.*	1
Jim_Bishop_CFE001_20170621_BCK.tgz (Octet Stream, 531.97 MB) MD5:5d7093e7364b263f3a250dc985fbc48a *Transmitted light color images acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER study P1706 on 2017-06-21.*	1
Jim_Bishop_CFE001_20170623_ATN.tgz (Octet Stream, 317.29 MB) MD5:7ba713619ce3b66385f113620ccdf56c *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 001 during the CCE-LTER process study (P1706) on 2017-06-23*	1
Jim_Bishop_CFE002_20170609_ATN.tgz (Octet Stream, 116.53 MB) MD5:c0371d0a1c07f01ac076f290eab4bf08 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER process study (P1706) on 2017-06-09.*	1
Jim_Bishop_CFE002_20170611_ATN.tgz (Octet Stream, 76.92 MB) MD5:2cc5b8d095830123ab82caa4c07dec37 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER process study (P1706) on 2017-06-11*	1
Jim_Bishop_CFE002_20170611_BCK.tgz (Octet Stream, 266.29 MB) MD5:bee7d2cddc5d0cf68001dad558dcb478 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER study P1706 on 2017-06-11.*	1
Jim_Bishop_CFE002_20170614_ATN.tgz (Octet Stream, 117.29 MB) MD5:6d4a8389afb5d599a10c8a90e80035d3 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER process study (P1706) on 2017-06-14*	1
Jim_Bishop_CFE002_20170614_BCK.tgz (Octet Stream, 429.71 MB) MD5:81c367a44256c53dbf33842f4553144d *Transmitted light color images acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER study P1706 on 2017-06-14*	1
Jim_Bishop_CFE002_20170616_ATN.tgz (Octet Stream, 124.91 MB) MD5:3715becca65f62a702202815b474f1e5 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER process study (P1706) on 2017-06-16*	1

File	Version
Jim_Bishop_CFE002_20170616_BCK.tgz (Octet Stream, 517.81 MB) MD5:c2bb12a76eece2d779af39be9c00b7dd *Transmitted light color images acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER study P1706 on 2017-06-16*	1
Jim_Bishop_CFE002_20170619_ATN.tgz (Octet Stream, 93.30 MB) MD5:33db8994658e8afb556858ec12a4309e *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER process study (P1706) on 2017-06-19*	1
Jim_Bishop_CFE002_20170619_BCK.tgz (Octet Stream, 383.89 MB) MD5:c61eeea75debb3dc5beaf2e9841faad6 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER study P1706 on 2017-06-19*	1
Jim_Bishop_CFE002_20170621_ATN.tgz (Octet Stream, 89.61 MB) MD5:4110262d7df1cc4f96233093971b893c *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER process study (P1706) on 2017-06-21.*	1
Jim_Bishop_CFE002_20170621_BCK.tgz (Octet Stream, 394.05 MB) MD5:9360a2c574cc8aa750a3f39188531e2f *Transmitted light color images acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER study P1706 on 2017-06-21.*	1
Jim_Bishop_CFE002_20170623_BCK.tgz (Octet Stream, 318.03 MB) MD5:d873e407b4e35a97fbe72b4de189a62b *Transmitted light color images acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER study P1706 on 2017-06-23*	1
Jim_Bishop_CFE002_20170625_BCK.tgz (Octet Stream, 802.94 MB) MD5:319cd0a57590dd7174f51862a29034b4 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 002 during the CCE-LTER study P1706 on 2017-06-25*	1
Jim_Bishop_CFE003_20170610_ATN.tgz (Octet Stream, 185.51 MB) MD5:381c7ecca3c9a60a1cac6252a55e5322 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 003 during the CCE-LTER process study (P1706) on 2017-06-10*	1
Jim_Bishop_CFE003_20170610_BCK.tgz (Octet Stream, 401.31 MB) MD5:848d80052b50f102bf11574c570933bb *Transmitted light color images acquired by autonomous Carbon Flux Explorer 003 during the CCE-LTER study P1706 on 2017-06-10*	1
Jim_Bishop_CFE003_20170613_ATN.tgz (Octet Stream, 424.76 MB) MD5:b0f64a6ebbb9f039fce2280ebaf49726 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 003 during the CCE-LTER process study (P1706) on 2017-06-13*	1
Jim_Bishop_CFE003_20170613_BCK.tgz (Octet Stream, 1.15 GB) MD5:62627140e693a82285d2361d4a3428d3 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 003 during the CCE-LTER study P1706 on 2017-06-13*	1
Jim_Bishop_CFE004_20170613_ATN.tgz (Octet Stream, 45 bytes) MD5:cf597f32713e23b8cb165e4d2d6c2a30 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER process study (P1706) on 2017-06-13*	1

File	Version
Jim_Bishop_CFE004_20170614_ATN.tgz (Octet Stream, 110.99 MB) MD5:a2b684e282b5aa77060f72d2d3e59a2e *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER process study (P1706) on 2017-06-14.*	1
Jim_Bishop_CFE004_20170614_BCK.tgz (Octet Stream, 380.83 MB) MD5:a0ba323a38768cdf109bf6eaaee7dd81 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER study P1706 on 2017-06-14*	1
Jim_Bishop_CFE004_20170616_ATN.tgz (Octet Stream, 114.04 MB) MD5:4973be85f6cd992be9e6d1cf8a7d83fe *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER process study (P1706) on 2017-06-16*	1
Jim_Bishop_CFE004_20170616_BCK.tgz (Octet Stream, 389.28 MB) MD5:965bc96c39204c40c69605e47db11108 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER study P1706 on 2017-06-16*	1
Jim_Bishop_CFE004_20170621_ATN.tgz (Octet Stream, 74.59 MB) MD5:1398923666c920ef7a0fea70191e6c7e *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER process study (P1706) on 2017-06-21*	1
Jim_Bishop_CFE004_20170621_BCK.tgz (Octet Stream, 298.75 MB) MD5:46fe6612528f8a4213c1cf8a0bfac090 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER study P1706 on 2017-06-21*	1
Jim_Bishop_CFE004_20170623_ATN.tgz (Octet Stream, 122.83 MB) MD5:080c5cfb43b04c888b47fb7b6efadd05 *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER process study (P1706) on 2017-06-23*	1
Jim_Bishop_CFE004_20170623_BCK.tgz (Octet Stream, 362.68 MB) MD5:b4d33de9b6356a71264acd7afeb0d572 *Transmitted light color images acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER study P1706 on 2017-06-23*	1
Jim_Bishop_CFE004_20170625_ATN.tgz (Octet Stream, 208.81 MB) MD5:11380ad4bc6cc5d31e85175955e1b0db *Imagery in attenuance units acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER process study (P1706) on 2017-06-25.*	1
Jim_Bishop_CFE004_20170625_BCK.tgz (Octet Stream, 671.18 MB) MD5:5aa443249020e7c27bcba2b4f27f76da *Transmitted light color images acquired by autonomous Carbon Flux Explorer 004 during the CCE-LTER study P1706 on 2017-06-25*	1

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Related Datasets

IsSourceOf

Bishop, J. K. (2020) **Size fractionated Particulate Carbon Flux 100-500m measured by autonomous Carbon Flux Explorers deployed during the CCE-LTER process study (P1706) between June 2 and July 1, 2017 in the California Current Regime.** Biological and Chemical

Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2020-09-16 doi:10.26008/1912/bco-dmo.823408.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
cycle	CCE cycle number = our location number (range 1 to 4)	unitless
cfeid	Carbon Flux Explorer Identity (CFE00X) where X is serial number (1 through 4)	unitless
cfeno	Carbon Flux Explorer (CFE) serial number (1 through 4)	unitless
dive	CFE dive number	unitless
ISO_DateTime_UTC	Datetime of image acquisition in ISO format (yyyy-mm-ddThh:mm:ssZ) in UTC zone	yyyy-MM-dd'T'HH:mm:ss
jday	Day: Jan 1 = 1, use to correlate with satellite imagery	unitless
ddays	decimal days since Jan 1 2017 at 0000 UTC, ddays = 0.5 on Jan 1 2017 at 1200UTC, ADCP data use same time	unitless
driftdays	CTD obs decimal days since Jan 1 2017 at 0000 UTC, ddays = 0.5 on Jan 1 2017 at 1200UTC, ADCP data use same time	unitless
lon	Decimal Longitude (negative for west)	decimal degrees
lat	Decimal Latitude (negative for south)	decimal degrees
press	SOLO CTD pressure	dbar
pressflag	SOLO Data (0 - profiling or unstable; 1 during flux measurement; 4 single value for dive; 5 SOLO at surface)	unitless
temp	SOLO CTD insitu temperature	degrees Celcius
sal	SOLO CTD salinity	PSU
cm_sec	SOLO Rate of depth change over 10 minute intervals	cm s-1
diveimage_seq	dive image number	unitless
cleanflag	1 = means taken seconds after a cleaning cycle; 0 = images after cleaning; -1 means failed clean; -2 image taken at start of dive before first stage cleaning	unitless
class_ATN	UPPER CASE 'ATN' if useful OR lowercase 'bck' if non useful.	unitless
class_BCK	UPPER CASE 'BCK' if useful OR lowercase 'bck' if non useful.	unitless
illum	illumination mode (bck=transmitted light, led=darkfield illumnation, pol crosspolarized transmission, pl2=pol at longer exposure time)	unitless
sensor	CFE enginnering information: SUMIX imager serial number	unitless
exp_msec	Imager exposure time in milli seconds	s*10^-3
b_gain	Imager gain settinng blue channnel	unitless
g_gain	imager gain settinng green channnel	unitless

r_gain	imager gain setting red channel	unitless
therm	instrument temperature (C) NOT CALIBRATED	unitless
iqual	flag (1 = image is useful for flux information ; 4 = image is not useful since the CFE was profiling or was stuck at the surface)	unitless
flatflag_bck_images	flag (1 = image has been corrected for non uniformity of illumimation; 0 = no corection)	unitless
flatflag_atn_images	flag (1 = image has been corrected for non uniformity of illumimation; 0 = no corection)	unitless
filename_bck	Filename of BCK images	unitless
filename_atn_images	Filename of ATN image	unitless

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Instruments

Dataset-specific Instrument Name	SBE 41 CTD
Generic Instrument Name	CTD Sea-Bird 41
Dataset-specific Description	The CTD used with the SOLO floats is the Seabird SBE 41 CTD. Salinity ± 0.0035 psu Pressure Initial Accuracy: ± 2 dbar Temperature Accuracy: ± 0.002 °C
Generic Instrument Description	The Sea-Bird SBE 41 CTD module was originally developed in 1997 for integration with sub-surface oceanographic floats. It uses MicroCAT Temperature, Conductivity, and Pressure sensors.

Dataset-specific Instrument Name	Carbon Flux Explorer
Generic Instrument Name	Carbon Flux Explorer
Dataset-specific Description	The CFE and the operation of its particle flux sensing Optical Sedimentation Recorder (OSR) have been discussed in detail in Bishop et al. (2016). CFE has a design mission capability of 8 months of hourly operations (16 months @ 2 hours …) and has been demonstrated by deployments of 40 days; CFE design depth is 1500m and it has been proven to 1000 m. The system has demonstrated operations in high sea states. Briefly, once deployed, the CFE dives below the surface make particle flux observations at target depths as it drifts with currents. The OSR wakes once the CFE has reached the target depth. On first wake-up of a given CFE dive, the sample stage is flushed with water and images of the particle-free stage are obtained. Particles settle through a 1-cm opening hexagonal celled light baffle into a high-aspect ratio funnel assembly before landing on a 2.54 cm diameter glass sample stage. At 25-minute intervals, particles are imaged at 13 µm pixel resolution in three lighting modes: dark field, transmitted and transmitted-cross polarized.
Generic Instrument Description	The Carbon Flux Explorer (CFE) is designed to perform sustained high-frequency observations of POC and PIC sedimentation within the upper kilometer (or twilight zone) of the ocean for seasons to years and to operate in an observational context not dependent on ships. The CFE melds the concept of current-following, sample-collecting neutrally buoyant sediment traps with photographic imaging of the particles as they are deposited in a sediment trap. The CFE and the operation of its particle flux sensing Optical Sedimentation Recorder (OSR) have been discussed in detail in Bishop et al. (2016). CFE has a design mission capability of 8 months of hourly operations (16 months @ 2 hours) and has been demonstrated by deployments of 40 days; CFE design depth is 1500m and it has been proven to 1000 m. The system has demonstrated operations in high sea states. Diagram: https://datadocs.bco-dmo.org/docs/302/C-SNOW/data_docs/CFE_CFE-Cal.png Bishop, J. K. B., Fong, M. B., and Wood, T. J.: Robotic observations of high wintertime carbon export in California coastal waters, Biogeosciences, 13, 3109–3129, https://doi.org/10.5194/bg-13-3109-2016, 2016. Bourne, H. L., Bishop, J. K. B., Wood, T. J., Loew, T. J., and Liu, Y.: Carbon Flux Explorer optical assessment of C, N and P fluxes, Biogeosciences, 16, 1249–1264, https://doi.org/10.5194/bg-16-1249-2019, 2019

Dataset-specific Instrument Name	SOLO
Generic Instrument Name	Sounding Oceanographic Lagrangian Observer
Dataset-specific Description	The Carbon Flux Explorer is built on a standard ARGO style float, called the Sounding Oceanographic Lagrangian Explorer (SOLO and SOLO-II). The float is the buoyancy engine for the CFE and also manages all satellite communication of data from the CFE. The top of the float has an integrated Seabird CTD system. Temperature, pressure, and salinity data are read in bursts at 10 minute intervals as the CFE is monitoring flux at depth. These data are merged with the imagery meta data. All CFEs also report profile data when they are surfacing after completion of a dive. I can provide these separately. In addition CFE-Cals also log data as they sink to depth.
Generic Instrument Description	A standard ARGO style float, called the Sounding Oceanographic Lagrangian Explorer (SOLO and SOLO-II). SOLO floats are drifting instruments and have the ability to change their own buoyancy. After deployment it moves with the ocean currents and can, therefore, travel long distances on their own without the need of a ship or a person to handle them. They are programmed to come to the ocean surface at regular intervals to transmit their data and position to orbiting satellites. The float then sinks again, continuing the process. To control the buoyancy of the float, a small amount of oil is contained within the float. When the float is submerged, all of the oil is kept entirely within the hull. When it is time to rise to the surface, the oil is pumped into an external rubber bladder that expands. Since the weight of the float does not change but its volume increases when the bladder expands, the float becomes more buoyant and floats to the surface. Similarly, when the float is on the surface and it is time to submerge, the oil is withdrawn from the bladder into the hull of the float and the buoyancy decreases.

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Deployments

RR1710

Website	https://www.bco-dmo.org/deployment/823418
Platform	R/V Roger Revelle
Report	http://cce.lternet.edu/data/cruises/cce-p1706
Start Date	2017-06-01
End Date	2017-07-02

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Project Information

California Current Ecosystem Long Term Ecological Research site (CCE LTER)

Website: http://cce.lternet.edu/

Coverage: California coastal current from ccelter.edu The California Current System is a coastal upwelling biome, as found along the eastern margins of all major ocean basins. These are among the most productive ecosystems in the world ocean. The California Current Ecosystem LTER (32.9 degrees North, 120.3 degrees West) is investigating nonlinear transitions in the California Current coastal pelagic ecosystem, with particular attention to long-term forcing by a secular warming trend, the Pacific Decadal Oscillation, and El Nino in altering the structure and dynamics of the pelagic ecosystem. The California Current sustains active fisheries for a variety of finfish and marine invertebrates, modulates weather patterns and the hydrologic cycle of much of the western United States, and plays a vital role in the economy of myriad coastal communities. LTER Data: The California Current Ecosystem (CCE) LTER data are managed by and available directly from the CCE project data site URL shown above. If there are any datasets listed below, they are data sets that were collected at or near the CCE LTER sampling locations, and funded by NSF OCE as ancillary projects related to the CCE LTER core research themes.

Carbon Sedimentation In the Ocean Watercolumn (C-SNOW): Calibration (C-SNOW)

Website: http://oceanbots.lbl.gov

Coverage: California Current System and surrounding waters 33°N, 125°W to 39°N, 119°W

NSF Award Abstract: Carbon sedimentation (10 Pg C/year) via the ocean biological carbon pump is important to the regulation of atmospheric CO2, yet is poorly observed in space and time due to limitations of current methodology (moorings/ships), and thus is poorly understood and consequently is poorly represented in carbon cycle simulations. Current estimates of the strength of the ocean biological carbon pump are highly uncertain. The one year project will deploy and calibrate low-cost robotic ocean-profiling current-following Carbon Flux Explorers (CFEs) which is a necessary step paving the way high frequency broad scale monitoring and prediction of carbon sedimentation in the ocean. Project scientists will work with the San Francisco Exploratorium to enhance public knowledge of the ocean carbon cycle, ocean robotics. UC Berkeley undergraduate students will be exposed to this research activity in the class-room, as laboratory assistants, and in hands-on experience at sea. The CFEs represent the integration of an ocean profiling float-- similar to those widely deployed in the ocean as part of the ARGO program-- with the UC Berkeley / Lawrence Berkeley National Laboratory - developed Optical Sedimentation Recorder (OSR). The CFEs dive to depth and the OSR uses a camera and three modes of illumination to image particles over time as they accumulate in a sediment trap. Periodically the sample is removed and the imaging resumes. The use of transmitted, transmitted cross-polarized transmitted, and side illumination permits three modes of quantification sample loading as measured sample attenuance, sample cross-polarized photon yield, and sample reflectance. The project specifically aims to relate the three optical metrics of sample load to the amount of particulate organic carbon, particulate inorganic carbon (also known as calcium carbonate), and other biogenic particle phases. Thus, the development will demonstrate the ability of the Carbon Flux Explorer to measure the strength of carbon sedimentation in the ocean. In a one year project. Scientists at University of California, Berkeley and engineers at Lawrence Berkeley National Laboratory and Scripps Institution of Oceanography will build/modify 2 Carbon Flux Explorers to enable the collection of samples for their calibration. These and two other CFEs and a surface tethered OSR will be co-deployed during an oceanographic expedition in California coastal and offshore waters. Collected samples will be analyzed and compared with the optical metrics of sample load, collected at the same time. The project will thus meet its major goal of demonstrating that the CFEs can measure the strength of ocean carbon sedimentation as a function of depth, time, and ocean location, in a way here-to-fore impossible to achieve from ships.

Carbon Flux Explorer Development (C-SNOW Development)

NSF Award Abstract: The PIs request funding to complete the development of the Carbon Flux Explorer

(CFE), a fully autonomous and free robotic system designed to measure and relay in real time via Iridium satellite link the hourly/diurnal variations of particulate organic carbon (POC) and particulate inorganic carbon (PIC) flux at various depths in the upper kilometer of the ocean for seasons to year-long time scales. CFEs are the successful integration of the Sounding Oceanographic Lagrangian Observer (SOLO) float (developed at Scripps) and LBNL/UC Berkeley?s imaging Optical Sediment Trap (OST). The first prototype CFE was successfully tested at sea for 2 days to 800 m in June 2007. The proposed new work will refine and challenge the CFE design with successively longer deployments in coastal and California Current waters to evaluate and address real world issues such as biofouling and animal invasions. At the same time, engineering refinements will improve power budget and solve multiple minor system issues. On-board image processing/data reduction software will be fully established. Calibration samples (POC and PIC flux) will be obtained concurrently with CFE testing using a buoy tethered twinned OST system operating at similar depths. At the end of this project, three fully developed Carbon Flux Explorers (CFEs) will be deployed (and recovered if possible) in the open ocean for at least 3-6 months in the subarctic N Pacific. Carbon sedimentation via the bio-carbon pump of the ocean is important to the regulation of atmospheric CO2. Due to limitations of current observational methodology (moorings/ships), carbon export (or sedimentation) is poorly observed in space and time and therefore is poorly understood and parameterized in carbon cycle simulations. CFE deployments in the world?s ocean have the potential to lead to fundamentally new insights into the biology/biogeochemistry of carbon sedimentation. Broader Impacts: The potential benefits to society due to the proposed activities are important. These actives will help improve confidence in future carbon cycle predictions. The results could maybe a key to helping society deal with the potentially economically and environmentally hazardous consequences due to climate change. Through education, the proposed activities and technologies developed will make the ocean more accessible to the public in general. An improved understanding of the ocean by the public will help protect the ocean's environment. The real-time observations offered by the proposed activities will help bring about such an understanding and diminish the perceived remoteness of the ocean. The proposed activities will advance ocean related scientific teaching and education. The technology in development will help enliven the ocean in the classroom, moving from textbook knowledge to real-time interactions. The proposed activities will allow students to become more connected to the global environment. The technology will help educate the public in manner needed if society is to overcome the environmental problems humanity currently faces.

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Program Information

Long Term Ecological Research network (LTER)

Website: http://www.lternet.edu/

Coverage: United States

adapted from http://www.lternet.edu/ The National Science Foundation established the LTER program in 1980 to support research on long-term ecological phenomena in the United States. The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1800 scientists and students investigating ecological processes over long temporal and broad spatial scales. The LTER Network promotes synthesis and comparative research across sites and ecosystems and among other related national and international research programs. The LTER research sites represent diverse ecosystems with emphasis on different research themes, and cross-site communication, network publications, and research-planning activities are coordinated through the LTER Network Office. 2017 LTER research site map obtained from https://lternet.edu/site/lter-network/

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF. The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems. The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two. The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1538686

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