Surface data from ABLE deployments in the upwelling region of the west coast of northern California from 2016-2018

Website: https://www.bco-dmo.org/dataset/724002
Data Type: Cruise Results
Version: 2
Version Date: 2019-01-29

Project
» Collaborative Research: Field test of larval behavior on transport and connectivity in an upwelling regime (ABLE)

Contributors	Affiliation	Role
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Abstract
Surface data from ABLE deployments in the upwelling region of the west coast of northern California from 2016-2018: GPS position locations for each ABLE unit during each deployment and other spatial data, as well as common fields describing the ABLE unit, deployment, and other identifiers for that data subset.

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Coverage

Spatial Extent: **N**:38.41627 **E**:-122.9741 **S**:38.07565 **W**:-123.16774
Temporal Extent: 2016-06-07 - 2018-07-07

Dataset Description

GPS position locations for each ABLE unit during each deployment and other spatial data, as well as common fields describing the ABLE unit, deployment, and other identifiers for that data subset.

Methods & Sampling

We simulated documented behaviors using the Autonomous Behaving Lagrangian Explorer (ABLE). It can be programmed to maintain depth or vertically migrate in response to *in-situ* variables, like the larvae under study. It can reveal quasi-Lagrangian transport of vertically migrating plankters that swim between water parcels at different depths. ABLE weighs 3 kg and is 36 cm tall, topped by a 15 cm antenna mast. It necessarily integrates water motions at and below its own scale. Consequently, it cannot mimic transport of individual plankters, nor diffusive processes at scales smaller than its own. ABLE best simulates the transport of the centroid of a cloud of plankters that is large relative to its own dimensions.

ABLE dynamically calculates its target depth from measurements of its immediate microenvironment and a behavioral model for the organism being simulated. It moves toward the new target depth at a biologically realistic velocity, permitting it to show transport consequences of adaptive behaviors in response to actual (not average) conditions and actual (not modeled) water movements. Because behavioral patterns are under the experimenter's control, ABLE can reveal effects of either known or hypothetical behavior patterns. ABLE has no structures outside the parcel of water in which it is embedded, hence no extraneous drag that would cause drift errors. Use of ABLE (unlike modeling) requires no a priori characterization of the system before the first data can be collected; immediately upon deployment it begins yielding information on how water and organisms in the system move.

Although ABLE has no extraneous drag, hence no drift errors, while embedded in the tracked water parcel, it must periodically leave that parcel and make excursions to the surface to obtain and transmit GPS fixes. A drift error is created by velocity differences (relative to the target parcel) at other depths multiplied by the time ABLE spends transiting each during a pop-up, which cannot be simply estimated in heterogeneous systems. A rule of thumb analogous to that for suspended-drogue drifters would be that ABLE must spend <1/40 of the time making excursions to the surface. As target (operating) depth increases, transit time to the surface increases, and hence allowable fix frequency decreases.

To facilitate tracking, it has an ultrasonic beacon that provides bearings and telemeters depth during operation at depth; when at the surface it obtains fixes from its GPS receiver and transmits the fix data by VHF radio (short range) and satellite modem (global range). The GPS fix obtained at each surface interval is logged in ABLE's data memory, even if it is not received by the Globalstar satellite system. To facilitate recovery at the sea surface, it transmits updated fixes continuously by VHF and periodically via satellite while blinking high-brightness LED beacons for visual fixes. We also command ABLE to surface for recovery by decoding ultrasonic signals while rejecting noise from surf and biota. It senses the bottom and swims up a programmed distance above the substrate.

When deployed, it uses measurements of *in-situ* variables (depth, T, S, PAR, time of day, vertical speed relative to water). It subtly adjusts buoyancy (by < 1g) to "swim" toward that target depth, maintaining a rate realistic for the organism being simulated (0 to >10 cm/s). It periodically pops to the surface to obtain a GPS fix and transmit it by VHF, ultrasonic pinger and satellite (or cell phone) modem. Along its entire trajectory, it logs *in-situ* measurements; the suite of variables and frequency of logging are user-selectable. On the bench, ABLE communicates by wireless Bluetooth with a host computer or smart phone and presents a menu for downloading logged data, testing and calibrating sensors, altering data logging parameters, or even rewriting the entire program. Endurance during deployments is about 2 wk with 7 NiMH "D" cells, depending on frequency of excursions to the surface and pumping of ballast to hoist antennas.

Data Processing Description

Data has been manually reformatted to accommodate columns and rows.
Flag descriptions:
0 – no QC,
1 – good,
2 – unreliable,
3 – bad,
4 – changed,
5 – no data.

BCO-DMO Processing:
- modified parameter names to conform with BCO-DMO naming conventions (replaced . with _);
- replaced blanks (missing data) and NA with "nd";
- converted date/time fields to ISO 8601 format;
- changed positive longitude values to negative;
- 29-Jan-2019: appended the 2018 data to 2016-2017 data.

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Data Files

File
ABLE_surface.csv(Comma Separated Values (.csv), 527.24 KB) MD5:438c630279e9fbd9b65d581e36e1e2ac Primary data file for dataset ID 724002

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Parameters

Parameter	Description	Units
Deployment	Date of deployment YY-MM-DD	unitless
name	Unique identifier used for naming individual instruments	unitless
Migration_model	Vertical swimming behavior program (DVM = Diel Vertical Migration where ABLE is at the deeper Migration_depth_2 for 14hrs45min during day and at the shallower Migration_depth_1 for 9hrs15min at night; Constant = constant depth maintained)	unitless
Migration_depth_1	Shallower (night time) migration depth in meters for DVM behaviors OR migration depth in meters for constant behaviors	meters
Migration_depth_2	Deeper (day time) migration depth in meters for DVM behaviors OR migration depth in meters for constant behaviors	meters
Fix_secs	cumulative seconds	seconds
Date_UTC	Date and time (UTC) formatted to ISO 8601 standard	unitless
Date_Local	Date and time (local; Pacific Time) formatted to ISO 8601 standard	unitless
Lat	latitude in decimal degrees; positive values = North	decimal degrees
Lon	longitude in decimal degrees; positive values = East	decimal degrees
DOP	dilution of precision for GPS quality (0.0)	unitless
Temp	temperature in degrees centigrade (0.00 °C)	degrees Celsius
PAR	photosynthetically active radiation in mol m?2 s?1 (0)	moles per square meter per second (mol m?2 s?1)
Salin	salinity in practical salinity scale (0.00 PSU)	practical salinity units
Batt_V	battery voltage (0.00 V)	volts
Report_no	Position report number for given ABLE on given deployment	unitless
fix_interval	Time difference (hours) between fixes OR default of 4 for first fix (this interval value is used to compute mean aspe, xspe, spe, dir values in subsequent columns).	hours
aspe	alongshore windspeed (meters per second, positive is North) at Bodega Marine Laboratory sensor (boon.bml.edu)	meters per second (m/s)

xspe	cross-shore windspeed (meters per second, positive is East) at Bodega Marine Laboratory sensor (boon.bml.edu)	meters per second (m/s)
spe	wind speed (meters per second) at Bodega Marine Laboratory sensor (boon.bml.edu)	meters per second (m/s)
dir	wind direction (degrees True) at Bodega Marine Laboratory sensor (boon.bml.edu)	degrees
elapsed_time	total time (hours) elapsed during deployment up to surface report	hours
d_pos_norm	change in position between current and previous position reports (meters per hour)	meters per hour (m/h)
d_drop_norm	change in position between current position report and drop location (meters per hour)	meters per hour (m/h)
d_Lat_norm	change in North-South direction between current and previous position reports (meters per hour)	meters per hour (m/h)
d_Lon_norm	change in East-West direction between current and previous position reports (meters per hour)	meters per hour (m/h)
d_cumLat_norm	change in North-South direction between current position report and drop location (meters per hour)	meters per hour (m/h)
d_cumLon_norm	change in East-West direction between current position report and drop location (meters per hour)	meters per hour (m/h)
step_dir	Compass bearing (degrees True) from previous position report to current position report	degrees
drop_dir	Compass bearing (degrees True) from drop location to current position report	degrees
Behavior	categorical identifier of behavior (DVM, Deep, or Shallow)	unitless
QA_flag	Quality assurance flag (0 means no QA done, 1 means QA pass, 2 means QA fail)	unitless

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Instruments

Dataset-specific Instrument Name	ABLE
Generic Instrument Name	Autonomous Behaving Lagrangian Explorer
Generic Instrument Description	The Autonomous Behaving Lagrangian Explorer (ABLE), designed by Tom Wolcott, is a biomimetic robotic drifter that senses in situ environmental stimuli (e.g., variations in PAR, pressure, salinity, or temperature) and can be programmed to respond to these cues with vertical migration behavior like that of the planktonic organism of interest.

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Deployments

20160616_CapeHorn

Website	https://www.bco-dmo.org/deployment/724080
Platform	R/V Cape Horn
Start Date	2016-06-16
End Date	2016-06-17

20170621_CapeHorn

Website	https://www.bco-dmo.org/deployment/724088
Platform	R/V Cape Horn
Start Date	2017-06-21
End Date	2017-06-21

20170622_CapeHorn

Website	https://www.bco-dmo.org/deployment/724092
Platform	R/V Cape Horn
Start Date	2017-06-22
End Date	2017-06-23

20160809_CapeHorn

Website	https://www.bco-dmo.org/deployment/724096
Platform	R/V Cape Horn
Start Date	2016-08-09
End Date	2016-08-10

20160707_CapeHorn

Website	https://www.bco-dmo.org/deployment/724100
Platform	R/V Cape Horn
Start Date	2016-07-07
End Date	2016-07-07

20170626_CapeHorn

Website	https://www.bco-dmo.org/deployment/724104
Platform	R/V Cape Horn
Start Date	2017-06-26
End Date	2017-06-28

20170510_CapeHorn

Website	https://www.bco-dmo.org/deployment/724109
Platform	R/V Cape Horn
Start Date	2017-05-10
End Date	2017-05-11

20160621_CapeHorn

Website	https://www.bco-dmo.org/deployment/724113
Platform	R/V Cape Horn
Start Date	2016-06-21
End Date	2016-06-22

20170627_CapeHorn

Website	https://www.bco-dmo.org/deployment/724117
Platform	R/V Cape Horn
Start Date	2017-06-27
End Date	2017-06-29

20180326_CapeHorn

Website	https://www.bco-dmo.org/deployment/754369
Platform	R/V Cape Horn
Start Date	2018-03-26
End Date	2018-03-27

20180402_CapeHorn

Website	https://www.bco-dmo.org/deployment/754373
Platform	R/V Cape Horn
Start Date	2018-04-02
End Date	2018-04-03

20180416_CapeHorn

Website	https://www.bco-dmo.org/deployment/754376
Platform	R/V Cape Horn
Start Date	2018-04-16
End Date	2018-04-18

20180419_CapeHorn

Website	https://www.bco-dmo.org/deployment/754379
Platform	R/V Cape Horn
Start Date	2018-04-19
End Date	2018-04-20

20180501_CapeHorn

Website	https://www.bco-dmo.org/deployment/754382
Platform	R/V Cape Horn
Start Date	2018-05-01
End Date	2018-05-02

20180614_CapeHorn

Website	https://www.bco-dmo.org/deployment/754397
Platform	R/V Cape Horn
Start Date	2018-06-14
End Date	2018-06-15

20180606_CapeHorn

Website	https://www.bco-dmo.org/deployment/754394
Platform	R/V Cape Horn
Start Date	2018-06-06
End Date	2018-06-07

20180522_CapeHorn

Website	https://www.bco-dmo.org/deployment/754388
Platform	R/V Cape Horn
Start Date	2018-05-22
End Date	2018-05-23

20180531_CapeHorn

Website	https://www.bco-dmo.org/deployment/754391
Platform	R/V Cape Horn
Start Date	2018-05-31
End Date	2018-06-01

20180521_CapeHorn

Website	https://www.bco-dmo.org/deployment/754385
Platform	R/V Cape Horn
Start Date	2018-05-21
End Date	2018-05-22

20180620_CapeHorn

Website	https://www.bco-dmo.org/deployment/754400
Platform	R/V Cape Horn
Start Date	2018-06-20
End Date	2018-06-22

20180626_CapeHorn

Website	https://www.bco-dmo.org/deployment/754418
Platform	R/V Cape Horn
Start Date	2018-06-26
End Date	2018-06-27

20180628_CapeHorn

Website	https://www.bco-dmo.org/deployment/754444
Platform	R/V Cape Horn
Start Date	2018-06-28
End Date	2018-06-29

20180702_CapeHorn

Website	https://www.bco-dmo.org/deployment/754447
Platform	R/V Cape Horn
Start Date	2018-07-02
End Date	2018-07-03

20180705_CapeHorn

Website	https://www.bco-dmo.org/deployment/754450
Platform	R/V Cape Horn
Start Date	2018-07-05
End Date	2018-07-06

20160606_CapeHorn

Website	https://www.bco-dmo.org/deployment/724076
Platform	R/V Cape Horn
Start Date	2016-06-06
End Date	2016-06-07

20160628_CapeHorn

Website	https://www.bco-dmo.org/deployment/724084
Platform	R/V Cape Horn
Start Date	2016-06-28
End Date	2016-06-28

20160627_CapeHorn

Website	https://www.bco-dmo.org/deployment/724121
Platform	R/V Cape Horn
Start Date	2016-06-27
End Date	2016-06-27

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Project Information

Collaborative Research: Field test of larval behavior on transport and connectivity in an upwelling regime (ABLE)

Coverage: Upwelling region, West coast of USA, Northern California

Description from NSF award abstract:
The majority of larvae of coastal marine species are planktonic and generally weak swimmers. Thus, they are thought to be dispersed widely by coastal currents. However, there is accumulating evidence that their behavior can strongly influence their transport: some remain within estuaries, while others make true migrations between adult and larval habitats, even out to the edge of the continental shelf and back. Rates and directions of larval transport are thought to be determined largely by the timing, duration, and amplitude of vertical migrations and the mean depth that larvae occupy in stratified flows. The PIs propose to provide one of the first direct tests of how behavior affects across-shelf and alongshore transport using biomimetic drifters. The study will be conducted in a region of persistent upwelling, where strong currents are widely believed to overwhelm larval swimming and limit recruitment to adult populations.

Knowledge of underlying mechanisms regulating larval transport is central to understanding ecology and evolution in the sea and anticipating the impacts of climate change on marine populations and communities. The proposed research will provide the first experimental field-test of how larval behavior affects the rates, directions and distances of transport and population connectivity in an upwelling regime. The PIs will test three hypotheses:

1. Residence below the wind-driven surface layer and vertical migrations below that layer keep larvae closer to shore compared to residence in the surface layer or larvae without depth preferences and vertical migration.

2. Residence at depth enhances northward transport near shore, and vertical migration leads to decreased alongshore mean displacement but increased variance for a group.

3. Depth preferences and vertical migrations have pronounced effects on retention and transport of plankton

in upwelling regions.

The study will compare direct measurements from mimetic drifters with observed and modeled cross-shelf larval distributions, and with modeled alongshore transport. Results will be broadly applicable to upwelling regimes along the western margins of continents, and the approach can be applied to non-upwelling systems throughout the world.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1334448
NSF Division of Ocean Sciences (NSF OCE)	OCE-1334553

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