Methods and data processing report for Wirewalker deployments during EXPORTSNP

Instrument name: Wirewalker
Serial number: 2015001
Purchase date: Spring 2015

Dr. Melissa Omand
Graduate School of Oceanography
University of Rhode Island
215 South Ferry Road
Narragansett, RI 02882
momand@uri.edu

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I) Introduction

The Wirewalker is an autonomous, wave-powered profiler. The buoyant profiler uses wave energy to walk down a 500 m long wire to a weight and then floats up the wire to the surface buoy approximately every 40 minutes. The package carries a battery-powered CTD (RBRmaestro, RBR), a dissolved oxygen optode (RINKO III, JFE Advantech), a combined chlorophyll fluorometer, CDOM fluorometer, and 700-nm backscattering sensor (ECO BBFL2, WETLabs), a 650-nm beam transmissometer (C-Star, WETLabs), and a PAR sensor (DEFI2-L, JFE Advantech) (Table 1). Lat-Lon position of the Wirewalker buoy are obtained through Iridium communication approximately every 20 minutes.

Parameter	λ (nm)	Model	S/N	Manufacturer	Cal. date
Dissolved oxygen		RINKO III ARO-CAV	0322	JFE Advantech	10-Aug-2017
Temperature (for DO)		RINKO III ARO-CAV	0322	JFE Advantech	29-Sep-2017
Chlorophyll fluorescence	470/695	ECO BBFL2	BBFL2SSC-1309	WetLABS	27-May-2015
CDOM fluorescence	370/460	ECO BBFL2	BBFL2SSC-1309	WetLABS	27-May-2015
Backscatter	700	ECO BBFL2	BBFL2SSC-1309	WetLABS	27-May-2015
Beam transmission	650	C-Star	CST-1811PR	WetLABS	1-Dec-2016
PAR		DEFI2-L	0AAO036	JFE Advantech	7-Jul-2016

Table 1. Sensors installed on the Wirewalker platform.

II. Calibration / Maintenance

Optical data have the manufacturer calibration applied. Manufacturer calibration coefficients and equations are provided here for reference. Self-calibrated data will be provided in an update to this dataset when platform intercomparison is complete. Preliminary dissolved

oxygen data are not yet available. The sensor data exhibited abnormal behavior and we are working with the manufacturer (RBR and JFE Advantech) to resolve. If the data can be corrected, it will be provided as an update to this dataset.

A. Chlorophyll, CDOM

The manufacturer calibration coefficients and equations were applied to convert raw instrument output to uncorrected concentration (Table 2).

	CHL	CDOM	BB700
Dark counts	49	32	48
Scale factor	0.0121	0.0899	3.070E-06

Table 2. Manufacturer calibration coefficients for ECO BBFL2SSC-1309.

CDOM [ppb] = Scale Factor * (Output – Dark Counts)
CHL [mg/m^3] = Scale Factor * (Output – Dark Counts)

B. Backscatter

The manufacturer calibration coefficients and equations were applied to convert raw instrument output to volume scattering coefficient (Table 2). The in-water centroid angle of the ECO BBFL2 is 124°.

$\beta(124°,700\ nm)\ [m^{-1}\ sr^{-1}]$ = Scale factor * (Output – Dark counts)

The volume scattering of seawater was subtracted from the total volume scattering coefficient to obtain the volume scattering of particles:

$\beta_p(124°,700\ nm)\ [m^{-1}\ sr^{-1}] = \beta(124°,700\ nm) - \beta_{sw}(124°,700\ nm)$

β_{sw} was calculated using the 'betasw_ZHH2009' Matlab function with $\delta = 0.039$ (Zhang 2009). The backscattering coefficient of particles, $b_{bp}(700\ nm)$, is estimated as:

$b_{bp}(700\ nm)\ [m^{-1}] = 2\pi\chi\beta_p(124°,700\ nm)$
$\chi = 1.1$ for 124° (from Boss and Pegau 2001)

C. Beam transmission

The manufacturer calibration coefficients and equations were applied to convert raw instrument output to percent transmission and beam attenuation coefficient (Table 3). The transmissometer pathlength is 0.25 m.

	Analog output (V)	Digital output (counts)
V_d	0.002	0
V_{air}	4.794	15771
V_{ref}	4.699	15458

Table 3. Manufacturer calibration coefficients for CST-1811PR.

$Tr\ [\%] = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})$
$c\ [1/m] = -\ln(Tr)/0.25$

C. PAR

A	9.511952E+03
B	-1.466265E-01

Table 4. Manufacturer calibration coefficients for DEFI2-L 0AAO036.

$PAR\ [\mu E\ cm^{-2}\ s^{-1}] = [A + (B * Output)] / 10000$

III) Deployment / Sample collection

A goal of the EXPORTS field campaigns is to characterize export over operationally-defined time periods, termed “epochs”, equivalent to the time necessary for sinking particles to exit the euphotic zone and enter sediment traps in the upper 500 m. The Wirewalker was deployed for three 8-day epochs during the cruise.

IV. Data processing

Chlorophyll fluorescence, CDOM fluorescence, backscatter, beam transmission, and PAR data have been factory calibrated. Self-calibrated data will be provided in an update to this dataset when platform intercomparison is complete. Epoch 1 data are formatted as a time-series binned to 10-minute intervals because the Wirewalker remained near the surface for the majority of the deployment. Profiles from Epochs 2 and 3 were depth-binned at 1-m intervals and downcasts were removed. Position and PAR were linearly interpolated to match the time-series of the sensor platform.

V. Additional information

Cautionary notes

Epoch 1: The Wirewalker remained at about 5-10m depth, without profiling, for the majority of the deployment.

References

Boss, E., Pegau, W.S., 2001. Relationship of light scattering at an angle in the backward direction to the backscattering coefficient. Appl. Opt. 40, 5503-5507. http://doi.org/10.1364/AO.40.005503.

Zhang, X., 2009. Scattering of pure seawater. Retrieved June 7, 2018. http://www1.und.edu/faculty/zhang-xiaodong/_files/docs/programs/betasw_zhh2009.m.