Calibration and data processing of BB3-551
Deployment: NASA SABOR EN542
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SENSOR NAME: WET Labs BB3
S/N: 551

1) Introduction and Summary

The WET Labs BB3 is a scattering sensor. It measures the volume scattering function (VSF) at three wavelengths and one angle. It uses three individual light emitting diodes (LEDs) as sources with the corresponding detectors at the same angle. The path lengths and chi factors to convert a VSF measurement to a backscattering coefficient are the same for each source-detector pair. The specific characteristics are listed below:

Specification	
Wavelength, λ (nm):	469, 529, 652
Angle, θ (deg):	124
Path length, ℓ(m):	0.015
Chi factor, χ[1]	1.076

2) Calibration/Maintenance

2.1) Manufacturer calibrations/coefficients

The calibration applied to this data set was performed on June 10, 2014 at WET Labs, Inc. research department in Narragansett, RI. It was done using 0.1 µm NIST-traceable polystyrene microspheres. The results of this calibration are shown below:

Wavelength–Angle	**Scaling Factor**	**Dark Offset**
λ = 469 nm – θ = 124°	1.288e-05	56.4
λ = 529 nm – θ = 124°	8.204e-06	53.3
λ = 652 nm – θ = 124°	3.645e-06	49.9

2.2) Self calibration methods and results

The WET Labs BB3 does not require field calibration.

3) Deployment

3.1) Measurement methods

Measurements were made with this instrument at each station. All measurements were made in the same manner.

3.2) Package design

This instrument was attached to the instrument cage in a location that was protected from “seeing” any part of the cage or other instruments. It was connected to a WET Labs DH-4 that acted as power distributor and data collection device. The package was powered through the DH-4 by batteries.

4) Data processing

4.1) Data analysis

Data processing began by binning the raw data to 1 m depth bins by averaging all points occurring within that bin. Further processing of the data required the corresponding temperature and salinity values from the CTD and the absorption and scattering coefficients of Gelbstoff + particles from the ac-9 S/N ac90271. All calculations are performed for each of the 3 wavelength-angle pairs. The processing steps and the equations used are listed below:

1. The scattering coefficient and volume scattering function of water, b_w and VSF_w, were calculated[2,3] for the measured water temperature and salinity and included in the data set as bb30551_bw and bb30551_VSFw.

2. The fully corrected absorption coefficient of Gelbstoff + particles, a_{gp}, and the scattering coefficient of particles, b_p, from ac90271 were interpolated to match the wavelengths of bb30551 and included in the data set as bb30551_agp and bb30551_bp.

3. The dark offsets obtained in the secondary cast were applied to the raw counts to obtain the corrected data, the scaling factors were applied, and the interpolated values of a_{gp} and b_p were used to correct for absorption along the path[1] to obtain the total volume scattering function. This is included in the data set as bb30551_VSF.

$$VSF = ((counts - dark) * scaling\_factor) * e^{(\ell + a_{gp})}$$

4. The calculated volume scattering function of seawater, VSF_w, was subtracted from the total volume scattering function, VSF, to obtain the volume scattering function of particles, VSF_p, which is included in the data set as bb30551_VSFp.

$$VSF_p = VSF - VSF_w$$

5. The volume scattering function of particles, VSF_p, used with an angle-specific chi factor to obtain the backscattering coefficient of particles, b_{bp}, which is included in the data set as bb30551_bbp.

$$b_{bp} = 2\pi * VSF_p * \chi$$

6. One half of the calculated scattering coefficient of seawater, b_w, was added to the backscattering coefficient of particles, b_{bp}, to obtain the total backscattering coefficient, bb, which is included in the data set as bb30551_bb.

$$b_{bt} = b_{bp} + \frac{1}{2} b_w$$

7. The backscattering coefficient of particles, b_{bp}, was divided by the scattering coefficient of particles, b_p, to obtain the backscattering ratio, which is included in the data set as bb30551_bbp_bp.

4.2) Quality control

Processed data was reviewed by eye for any evidence of contamination by bubbles or potential interference from the instrument package and suspect data was replaced with a null value.

5) References

1. Sullivan, J., M. Twardowski, J.R.V. Zaneveld, and C. Moore. 2013. Measuring optical backscattering in water, *In*: A. Kokhanovsky (Ed), *Light Scattering Reviews 7: Radiative Transfer and Optical Properties of Atmosphere and Underlying Surface*, Springer Praxis Books, DOI 10.1007/978-3-642-21907-8_6, pp. 189-224.

2. Twardowski, M., X. Zhang, S. Vagle, J. Sullivan, S. Freeman, H. Czerski, Y. You, L. Bi, and G. Kattawar (2012), The optical volume scattering function in a surf zone inverted to derive sediment and bubble particle subpopulations, J. Geophys. Res., 117, C00H17, doi:10.1029/2011JC007347.

3. Zhang, X., L. Hu, and M. He, "Scattering by pure seawater: Effect of salinity," Opt. Express 17, 5698-5710 (2009).