

Calibration and data processing of ac9-270
Deployment: NASA SABOR EN542
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SENSOR NAME: WET Labs ac-9
S/N: 270

1) Introduction and Summary

The WET Labs ac-9 is an absorption and attenuation meter. It makes concurrent measurements of absorption and attenuation through the use of dual 25 cm flow tubes. Each flow path has a separate light source and detector. The two paths share a filter wheel that contains nine filters at wavelengths from 412 nm to 715 nm (see calibration table for a complete list). A more detailed description of the optics, use, and data processing of the ac-9 can be found in the WET Labs ac-9 User's Guide (WL_ac-9_User's_Guide.pdf) and the WET Labs ac Meter Protocol Document (WL_ac_Meter_Protocol_Document.pdf).

2) Calibration/Maintenance

2.1) Manufacturer calibrations/coefficients

The manufacturer provides an instrument-specific device file that contains a temperature correction and clean water offset calibration performed at the factory. The most recent factory calibration for this instrument was performed on October 30, 2012. The device file is provided as ac90270_device_file.dev.

2.2) Self calibration methods and results

Multiple calibrations were performed prior to, during, and after the cruise, following the procedure described in the ac Meter Protocol Document. The values were then normalized to a reference temperature of 12°C to account for the dependency of pure water absorption on temperature, using the values from Sullivan et al. (2006) multiplied by the coefficient $\frac{0.0029}{0.0042}$. After thorough analysis of all applicable calibrations, the best calibration for this cruise was determined to be a hybrid of an absorption calibration on August 4, 2014 and an attenuation calibration on July 22, 2014. The results of the calibration, as applied to the complete data set, are shown below:

Wavelength (nm)	Absorption "a" calibration	Attenuation "c" calibration
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412	0.0084770265	0.009151267694033
440	-0.0007001390	0.014764630228086
488	-0.0024640145	0.024944779926286
510	-0.0020293925	0.026163915789755
532	-0.0015224320	0.034457638213771
555	-0.0030080415	0.031185540569414
650	-0.0047172295	0.028653844613001
676	-0.0052762160	0.026942926125741
715	-0.0281650755	0.000615125260403

3) Deployment

3.1) Measurement methods

Two types of measurements were made with the ac-9 during this deployment: unfiltered and filtered casts. For the unfiltered casts, both the a-tube and c-tube paths had separate intakes with a coarse mesh screen to exclude large particles (~ > 1 mm) from entering and clogging the flow path. For the filtered casts, the a-tube and the c-tube had a 0.2 µm Pall capsule filter on the sample intake path. A Sea-Bird Electronics pump was used to induce flow through the instrument.

3.2) Package design

The instrument was placed in an instrument cage in a vertical position. The sample flow path, from intake to outflow of the pump, was oriented to ensure that any air present would be able to escape from the flow path.

4) Data processing

4.1) Data analysis

Data processing began during the initial extraction using WET Labs Archive Processing (WAP) software. WAP uses the device file to convert the raw binary data to engineering units and apply the factory calibration. The data was then binned to 1 m depth bins by averaging all points occurring within that bin. Processing the ac-9 data required the corresponding temperature and salinity values from the CTD. All calculations are performed for each of the nine wavelengths. The processing steps and equations used are listed below:

1. The field water calibration and temperature and salinity¹ corrections were applied to the binned data.

$$a = a_m - ((T - T_{ref}) * \Psi_T) - (S * \Psi_{Sa}) - a_w$$

$$c = c_m - ((T - T_{ref}) * \Psi_T) - (S * \Psi_{Sc}) - c_w$$

where:

a_m and c_m are measured a and c from the ac-9

T and S are measured temperature and salinity from the CTD

a_w and c_w are the field water calibration

T_{ref} is the reference temperature, 12 °C

Ψ_T , Ψ_{Sa} , and Ψ_{Sc} are the temperature and salinity corrections

For the filtered casts, the resulting absorption and attenuation coefficients of Gelbstoff, a_g and c_g , are included in the data set as ac90270_ag and ac90270_cg.

4.2) Quality control

Following the application of the field water calibration and the temperature and salinity corrections, the ac-9 data was visually reviewed. The bins whose shape or value differed significantly from the bulk of the data, indicative of bubbles or other contamination in the flow cell, were replaced with a null value.

5) References

1. Sullivan, J.M., M.S. Twardowski, J.R. V. Zaneveld, C.M. Moore, A.H. Barnard, P.L. Donaghay and B. Rhoades, "Hyperspectral temperature and salt dependencies of absorption by water and heavy water in the 400-750 nm spectral range," Applied Optics 45:5294-5309 (2006).