NAAMES IOP Package Protocol

**Cruise:** NAAMES 2

**Region:** North Atlantic

**Dates:** 12 May – 4 June, 2016

**Project Website:** <https://www.naames.larc.nasa.gov>

**Instruments:**

SBE25 CTD – Temperature, Salinity, Conductivity

Wetlabs BB9 – Particulate Backscattering Coefficient

Sequoia LISST100X – Particulate Volume Concentration

Wetlabs AC-S – Absorption and Attenuation Coefficients

Wetlabs DH4

**Cast Protocol:**

Each IOP cast consisted of a “filtered” deployment where a 0.2µm filter was attached to the intake of the AC-S absorption and attenuation tubes, and an “unfiltered” deployment without the filter. Before each cast, all instrument faces were cleaned with alcohol and lens paper and the filters were attached to the AC-S. The ~150lb package was lowered by winch to a depth of 20m for 2 minutes as a de-bubbling procedure. It was then brought up to 2 to 5m, depending on sea state, and then deployed to a depth of 100m at 30m/min. After the first filtered deployment, the AC-S filters were removed on deck and the IOP Package was deployed immediately afterward. Data was extracted from the DH4 using Wetlabs Host.

**Data Processing:**

**Sequoia LISST100X:**

As the SBE25 CTD showed artifacts in the pressure, the Sequoia LISST100X time and depth data was used to mark the downcast for each deployment. The downcast was selected as the minimum depth after the de-bubbling protocol down to the maximum depth (~100m).

To maximize signal levels in very clear waters, LISST scattering was corrected with a background file generated from LISST data with the highest transmission during the cruise. Corrected scattering data were median-binned to every 2m using a +/- 1m-window and their standard deviation was kept for reporting. Median-binned data with a transmission higher than 99% were flagged as below detection limit.

Binned corrected scattering data were inverted using both a spherical and irregular particle assumption using manufacturer-provided MATLAB scripts. The volume concentration for both files were calibrated using the manufacturer-provided Volume Conversion Constant. Standard deviations were propagated by running them through each shape inversion and calibrating them using the manufacturer-provided Volume Conversion Constant.

The associated raw files consist of the downcast unbinned transmission and corrected scattering data.

**SBE25 CTD:**

**NOTE**: For this cruise, depth measurements were made by the Sequoia LISST100X due to pressure artifacts from the SBE25 CTD. Additionally, Temperature and Salinity profiles for Stations 0-2night are unavailable due to improper instrument setup. We instead used the closest CTD Rosette downcast for the temperature and salinity calculations for the BB9 processing.

Temperature, salinity, and conductivity profiles for each deployment were mapped to the downcast determined from the Sequoia LISST100X. Both deployments for the overall cast were combined into one downcast and mean bin-averaged to every 2m using a +/- 1m-window. Standard deviations were kept for reporting.

The associated raw files consist of the downcast unbinned temperature, salinity, and conductivity data.

**Wetlabs BB9:**

Raw counts were mapped to the downcast determined from the Sequoia LISST100X. Dark measurements were made using black tape over the sensors at the beginning of the cruise. Raw counts were dark-corrected and then scaled to angular scatterance (Beta) using the factory scale factors provided with the instrument. Data from both deployments were combined into one large cast, then median bin-averaged to every 2m using a +/- 1m-window. Standard deviations were kept for reporting.

A temperature and salinity correction using the associated binned SBE25 CTD data is performed on the binned data to remove Beta\_seawater (Zhang et al., 2009). The particulate backscattering coefficient (b­­bp) is computed using χ=1.1 (nominal angle 117˚, Boss and Pegau, 2001).

The associated raw files consist of the total Beta at each wavelength at all unbinned depths, uncorrected for Beta\_seawater.

**Wetlabs AC-S:**

A calibration independent technique (Slade et al., 2010) was used to obtain particulate absorption and attenuation by subtracting the 0.2µm-filtered AC-S data from the total unfiltered AC-S data. Data for each respective deployment was first mapped to the Sequoia LISST100X time and depth to select just the downcast. To remove noise, all spectra with values greater than 1 were automatically removed. Additionally, spectra with a filter-wheel error (where half of the spectra is significantly higher than the other half) were removed.

The mismatch in spectral band positions between absorption and attenuation were corrected by interpolating all attenuation data to the absorption wavelengths. Data from each deployment was binned separately using a median filter at every 2m with a +/- 1m bin window. Standard deviations were kept for reporting.

After subtracting the filtered deployment data from the unfiltered deployment data to get particulate absorption, we use the 3rd method of Zaneveld et al., 1994, to correct for scattering with 730nm as the null wavelength while simultaneously performing a residual temperature correction. Particulate attenuation is also corrected for a residual temperature effect. The standard deviation for each binned spectrum was propagated through each of these steps.

The associated raw files consist of the uncorrected, unbinned filtered and unfiltered absorption and attenuation spectra at all depths of the downcast.

**References:**

Boss, E. and W. S. Pegau. 2001. “Relationship of light scattering at an angle in the backward direction to the backscattering coefficient,” Applied Optics, 40(30):5503–5507.

Slade, W.H, E. Boss, G. Dall'Olmo, M.R. Langner, J. Loftin, M.J. Behrenfeld, and C. Roesler, 2010. Underway and moored methods for improving accuracy in measurement of spectral particulate absorption and attenuation. Journal of Atmospheric and Oceanic Technology, 27:10, 1733-1746.

Zaneveld, J. R. V., J. C. Kitchen, and C. Moore, “The scattering error correction of reflecting-tube absorption meters,” in Ocean Optics XII, S. G. Ackleson ed., Proc. SPIE 2258, 44-55 (1994).