NAAMES 4 ACS data processing
Nils Haëntjens and Emmanuel Boss
November 7, 2017

Cruise: NAAMES 4 – AT39-06
Region: North Atlantic
Dates: March 21, 2018 – April 12, 2018
Project website: https://naames.larc.nasa.gov

We use a calibration independent technique (Slade et al., 2010) to obtain particulate absorption (ap) and attenuation (cp) by differencing measurements with a 0.2um filter from measurements made with no filter. Dissolved absorption and attenuation are obtained by subtracting daily MilliQ run from .2um filtered measurements. Filters are exchanged weekly and flow-tubes are cleaned every day. Switching between filtered and unfiltered measurements is done every 60min (50min total, 10min dissolved). In addition, MilliQ water was run every day after the instrument cleaning through the instrument to obtain ag and cg spectrums.

Only ACS-298 with calibration file from 2017/12/15 are posted here. As the other ACS (serial number 301) used during the expedition had issues described below. The first four days of the NAAMES IV campaign ACS-301 was used to record particulate absorption and attenuation. Unfortunately, the instrument was: drifting really fast on the attenuation side (c=0.01 to 0.9 with DI water in 4 days), some temporary unexplained strong increase were seen, the shape of ap and ag spectrums sometime contained unrealistic wave, and the instrument was operating outside of its calibration temperature range. Thereafter the data is not shared here as its quality his discussable. Regarding the ACS-298, bad spectrums are removed manually and arise, generally due to bubbles going through the instrument.

For each minute, the remaining data between 15th and 75th percentiles are binned-averaged and their standard deviation is kept for reporting. The particulate bins are processed by subtracting the filtered measurements from the unfiltered measurements. Filtered values needed to obtain the particulate values are interpolated to the time of particulate measurements linearly. Dissolved bins are computed by differencing MilliQ and filtered data. The MilliQ values are linearly interpolated to match the filtered periods.

The mismatch in spectral band positions between absorption and attenuation are corrected using interpolation. We use the 3rd method of Zaneveld et al., 1994 to correct for scattering with 730nm as the null wavelengths simultaneously performing a residual temperature correction (Slade et al., 2010). Attenuation is also corrected for residual temperature effect. Then, we perform a spectral unsmoothing based on the method in Chase, A., et al., 2013. We have left spectra with negative absorption in the blue regions, as these values are not significantly different from zero.

The processing is independent from the calibration found in the device file provided here. The device file was used to read the wavelength and indicate the last service of the instrument (2017/12/15), as well as to provide the temperature compensation table used.

While the dissolved absorption and attenuation spectrums are available they must be used with caution and only a couple of hours a day might be valid due to bio-fueling of the instrument which can't be assessed with the current method. For more information please contact us (emmanuel.boss@maine.edu, nils.haentjens@maine.edu).

Additional products derived directly from the ap or cp spectrums are provided.
- Chlorophyll a (chl) is computed using the particulate absorption line height at 676 nm and the global relationship from Tara Ocean (Boss et al. 2013) retuned to the NAAMES HPLC:
  - line_height = a_p(676) - (39/65 × a_p(650) + 26/65 × a_p(715))
  - chl = 157 × line_height^1.22 (relationship NOT applied here, from Tara Ocean)
  - chl_regional = 95 × line_height ^1.06 (relationship applied here, specific to NAAMES)
- The particulate organic carbon (POC) is computed using the particulate attenuation at 660 nm Using the global relationship from Gardner et al. (2006):
  - POC = 380 × c_p(660)
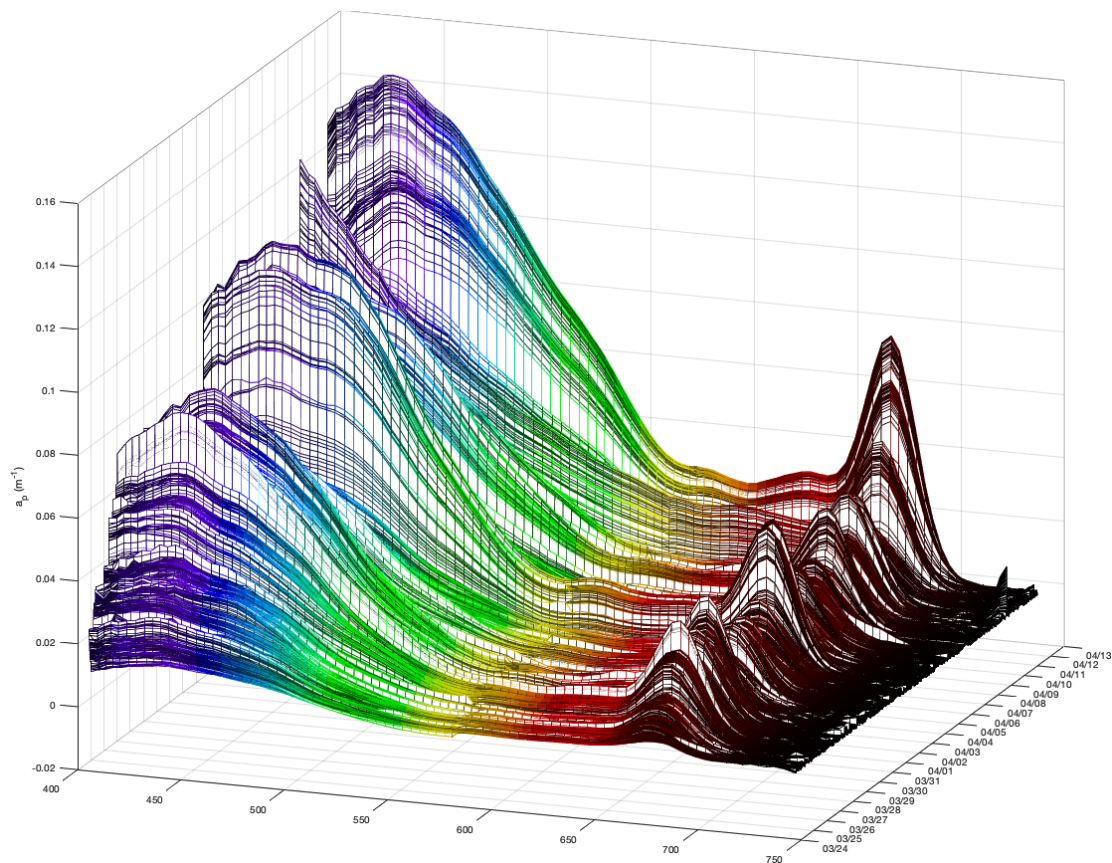- Gamma is computed using the method of Boss et al. 2001.

Figure 1. Particulate absorption spectrums measured from March 24 to April 13, 2018 during the 4th NAAMES campaign.
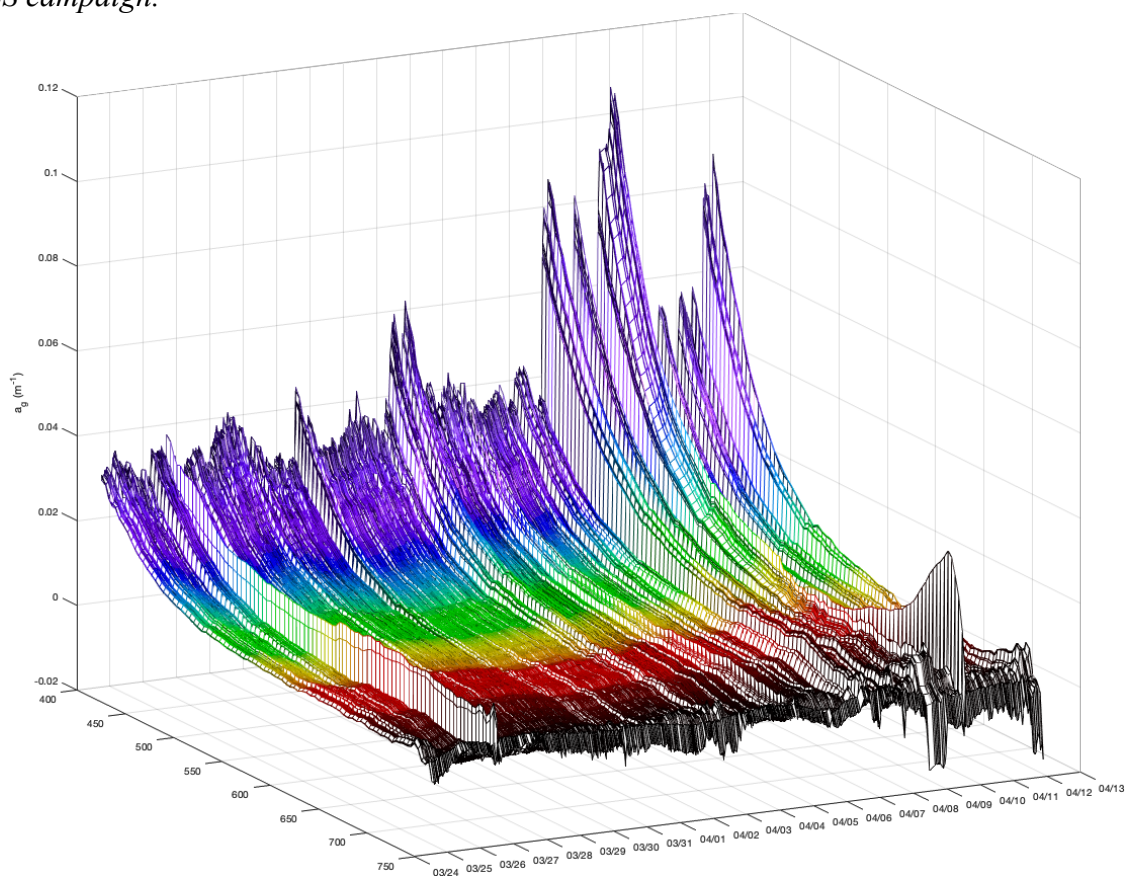

Figure 2. Dissolved absorption spectrums measured from March 24 to April 13, 2018 during the 4th NAAMES campaign.

References:

Boss, E., W.S. Pegau, W.D. Gardner, J.R.V. Zaneveld, A.H. Barnard., M.S. Twardowski, G.C. Chang, and T.D. Dickey, 2001. Spectral particulate attenuation and particle size distribution in the bottom boundary layer of a continental shelf. Journal of Geophysical Research, 106, 9509-9516.

Emmanuel Boss, Marc Picheral, Thomas Leeuw, Alison Chase, Eric Karsenti, Gabriel Gorsky, Lisa Taylor, Wayne Slade, Josephine Ras, Herve Claustre, 2013.The characteristics of particulate absorption, scattering and attenuation coefficients in the surface ocean; Contribution of the Tara Oceans expedition, Methods in Oceanography.

Chase, A., et al., 2013. Decomposition of in situ particulate absorption spectra. Methods in Oceanography 7, 110-124.

Gardner, W.D., Mishonov, A., Richardson, M.J., 2006. Global POC concentrations from in-situ and satellite data. Deep Sea Res. II 53, 718–740.

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).