

EXPORTS 1, ACS data processing – Inline
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Cruise name: EXPORTS 1

Cruise id: RR1813

Ship: R/V Roger Revelle

Location: Station Papa, North East Pacific

Dates at sea: 2018/08/11 to 2018/09/12 01:00

Epoch 1:2018/08/14 4:30 to 2018/08/23 9:00

Epoch 2:2018/08/23 9:00 to 2018/08/31 9:00

Epoch 3:2018/08/31 9:00 to 2018/09/08 9:00

At Station P: 2018/08/14 0:00 to 2018/08/23 9:00

Operators: Nils Haëntjens, Guillaume Bourdin and Emmanuel Boss

Group Leaders: Emmanuel Boss and Lee Karp-Boss

ACS serial numbers:

- ACS298 (11-Aug-2018 01:58:00 to 20-Aug-2018 17:58:00)
- ACS301 (20-Aug-2018 19:15:59 to 12-Sep-2018 01:00:00)

Revision 4 - Gaussian decomposition:

We unsmoothed and decomposed a_p following Chase et al., 2013 (software: <http://misclab.umeoce.maine.edu/software.php>) to obtain additional products:

- $a_d(400)$, absorption by non-algal particles at 400nm. We assumed the following model: $ad=ad(400)\exp(-0.01(\lambda-400))$. Units=1/m
- $agauss(\lambda=[406,434,453,470,492,523,550,584,617,638,660,675]\text{nm})$ – peak Gaussian absorption to 12 Gaussian with standard deviations=[16,12,12,13,16,14,14,16,13,11,11,10]nm respectively. Units=1/m
- $agaus_mae$ – metric of goodness of fit between reconstructed spectra from decomposition and original spectra for wavelengths between 440 and 705nm computed as the average absolute deviation = $\text{sum}(\text{abs}(\text{spectra}-\text{model}))/\text{num_wavelengths}$.

Revision 3:

The relationship used to derive chlorophyll a from line height was tuned to the HPLC samples collected during the expedition. Chlorophyll a is now derived with:

$$[\text{chl}] = 138.14 \times \text{line_height}^{1.11}$$

Fields were renamed to match updated convention of SeaBASS:

Chl → chl_lineheight

POC → POC_cp

Note that POC is still using the global relationship from Gardner et al. (2006) due to large variabilities in the POC to cp ratio, a tuned relationship will likely not significantly affect the results.

Particulate files are unchanged. Only the product file is updated.

Revision 2:

Gamma in the file EXPORTS-EXPORTSNP_InLine-ACS-Products_20180811-20180912_R1 was not processed for the ACS 301 and was populated with -9999 (NaN) values. The bug was corrected, and a beautiful diel cycle can now be observed for the entire campaign. Only the file EXPORTS-EXPORTSNP_InLine-ACS-Products_20180811-20180912_R2 is concerned by this revision. The processing stays identical.

Revision 1:

We use a calibration independent technique (Slade et al., 2010) to obtain particulate absorption (a_p) and attenuation (c_p) by differencing measurements with a 0.2 μ m filter from measurements made with no filter. Dissolved absorption and attenuation are obtained by subtracting daily MilliQ run from .2 μ m 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 a_g and c_g spectrums.

Two ACS, serial number 298 and 301, are used during the campaign, ACS 298 was used from the beginning of the campaign to 2018/08/20 18:10 and ACS 301 was used from 2018/08/20 20:17 to the end of the expedition. The change in ACS is not related to any dysfunction of instrument on the InLine system but rather an issue with the ACS-301 when profiling, not affecting underway observations. 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 device files are used for wavelength registration, to convert binary counts from the instruments into scientific units (1/m) independent of instruments temperature, and to indicate the last service of the instrument.

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.

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):
 - $\text{line_height} = a_p(676) - (39/65 \times a_p(650) + 26/65 \times a_p(715))$
 - $\text{chl} = 157 \times \text{line_height}^{1.22}$ (relationship NOT applied here, from Tara Ocean)
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- The particulate organic carbon (POC) is computed using the particulate attenuation at 660 nm Using the global relationship from Gardner et al. (2006):
 - $\text{POC} = 380 \times c_p(660)$
- Gamma is computed using the method of Boss et al. 2001.

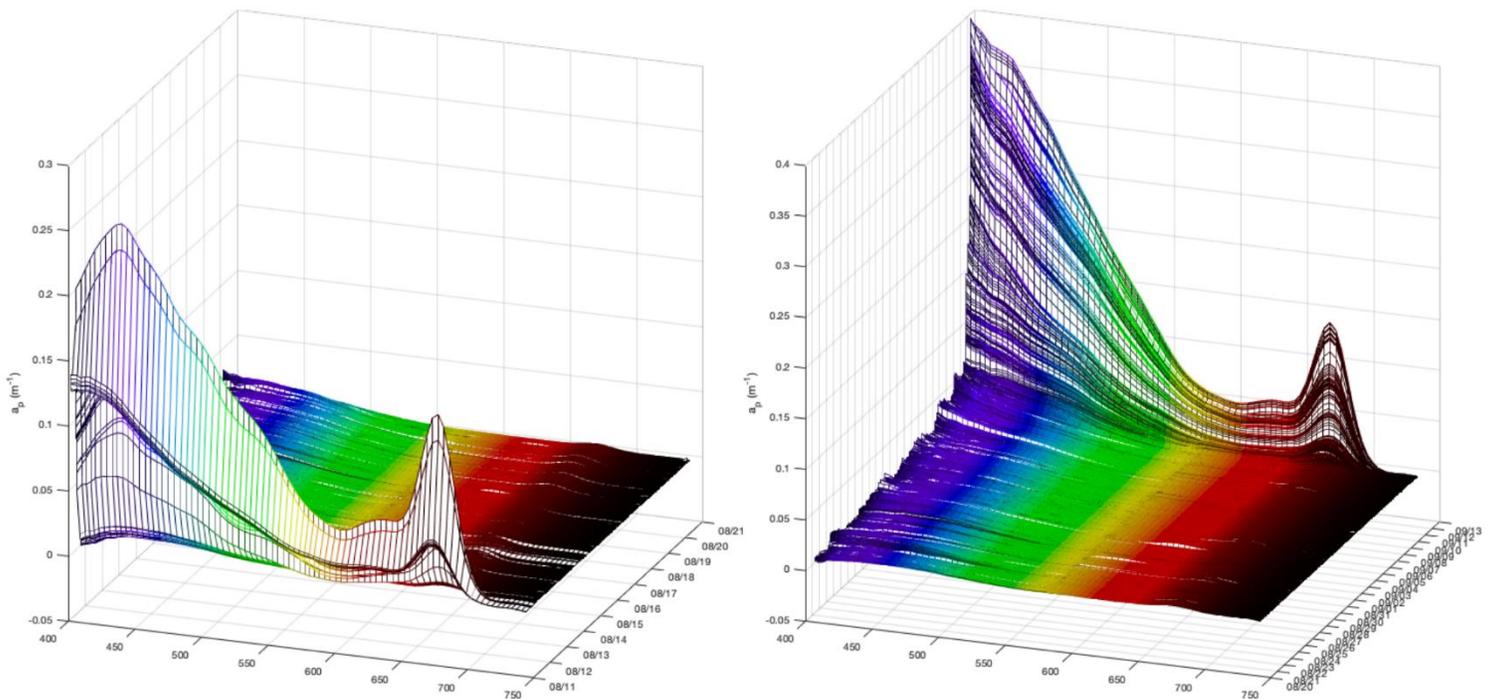


Figure 1. Particulate absorption spectrums during the entire expedition measured with ACS 298 (left) and ACS 301 (right). The higher absorptions at the beginning and the end of the expedition are in coastal waters.

For more information please contact us

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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).