Comparison of Scattering Correction Methods for AC-S

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Intro

- Measurements of absorption coefficients (a(λ), in m−1) collected in situ are overestimated due to the scattering of the reflecting tube absorption meter.

“Flat” or “Baseline” method

$$a_{\mathrm{flat}}(\lambda) = a_{\mathrm{m}}(\lambda) - a_{\mathrm{m}}(\lambda_0)$$

Reference wavelength (λ_0):
AC-9 use 715 nm
AC-S use longest wavelength in NIR band

Constant fraction of b (scattering) “fixed”

$$a(\lambda) = a_m^{TS}(\lambda) - F\,[c_m^{TS}(\lambda) - a_m^{TS}(\lambda)\,].$$

Where F is a constant
Choice of F between 0.14 (clear waters) to 0.18 (turbid waters)

“Proportional” method

$$a_{corr}^{TS}(\lambda) = a_m^{TS}(\lambda) - \frac{a_m^{TS}(\lambda_r)}{c_m^{TS}(\lambda_r) - a_m^{TS}(\lambda_r)}[c_m^{TS}(\lambda) - a_m^{TS}(\lambda)]$$

⇓

$$a_{\mathrm{prop}}(\lambda) = a_{\mathrm{m}}(\lambda) - a_{\mathrm{m}}(\lambda_0) \cdot \frac{b_{\mathrm{m}}(\lambda)}{b_{\mathrm{m}}(\lambda_0)}$$

Reference wavelength (λ_0):
AC-9 use 715 nm
AC-S use longest wavelength in NIR band

Curated Datasets

- Oregon Shelf Coastal Surface-Piercing Profiler (CSPP, CE02SHSP)
  - Deployment 19, spanning 2021-04-06 to 2021-04-29 (76 profiles from 0~70 m)
  - Deployment 15, spanning 2019-08-13 to 2019-10-14 (58 profiles from 0~70 m)

- Continental Margin, Slope Base Cabled Shallow Profiler (RS01SBPS)
  - Deployment 4, spanning 2017-08-04 to 2017-10-08 (12 profiles from 5~200 m)

- Instruments: AC-S, CTD, FLORT

Comparison of Sea water Temperature

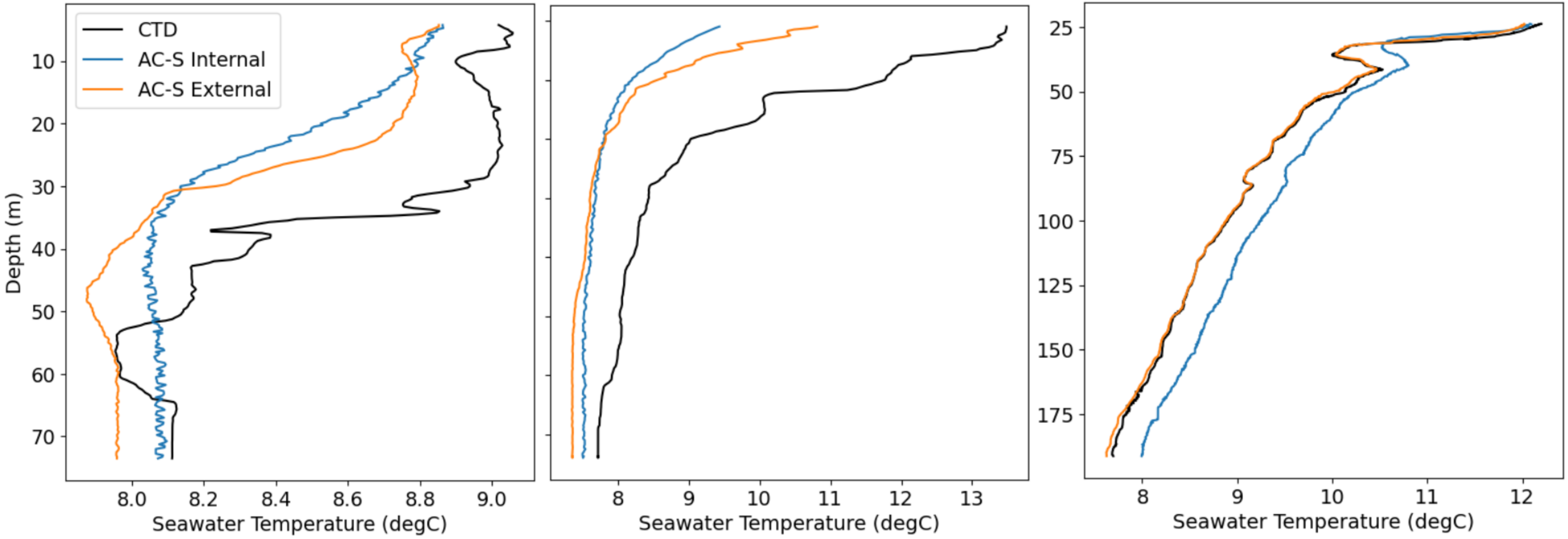
Oregon Shelf Coastal Surface-Piercing Profiler (CSPP, CE02SHSP)

Continental Margin, Slope Base Cabled Shallow Profiler (RS01SBPS)

2021-04-06 to 2021-04-29

2019-08-13 to 2019-10-14

2017-08-04 to 2017-10-08



Oregon Shelf Coastal Surface-Piercing Profiler (CSPP, CE02SHSP)

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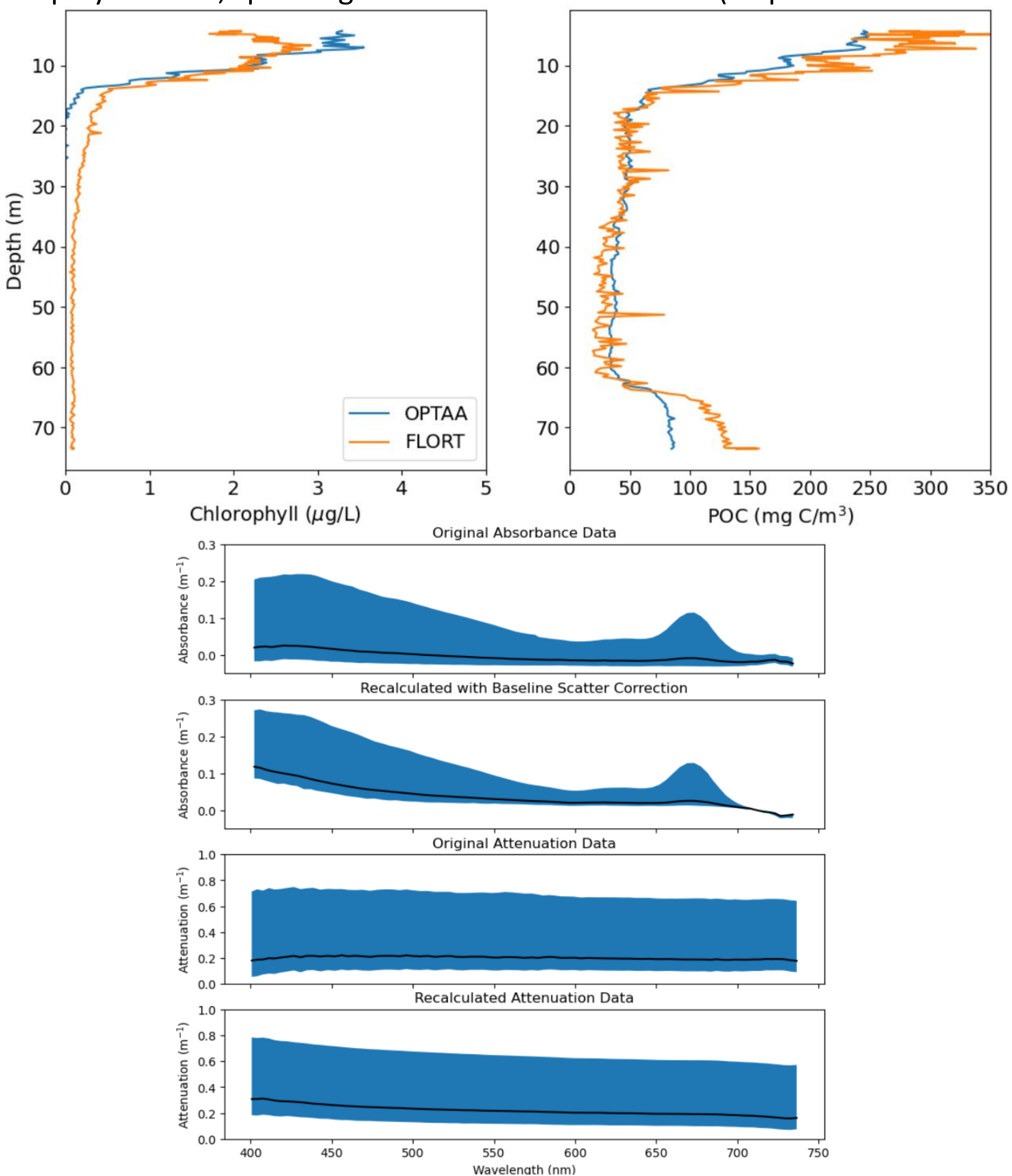
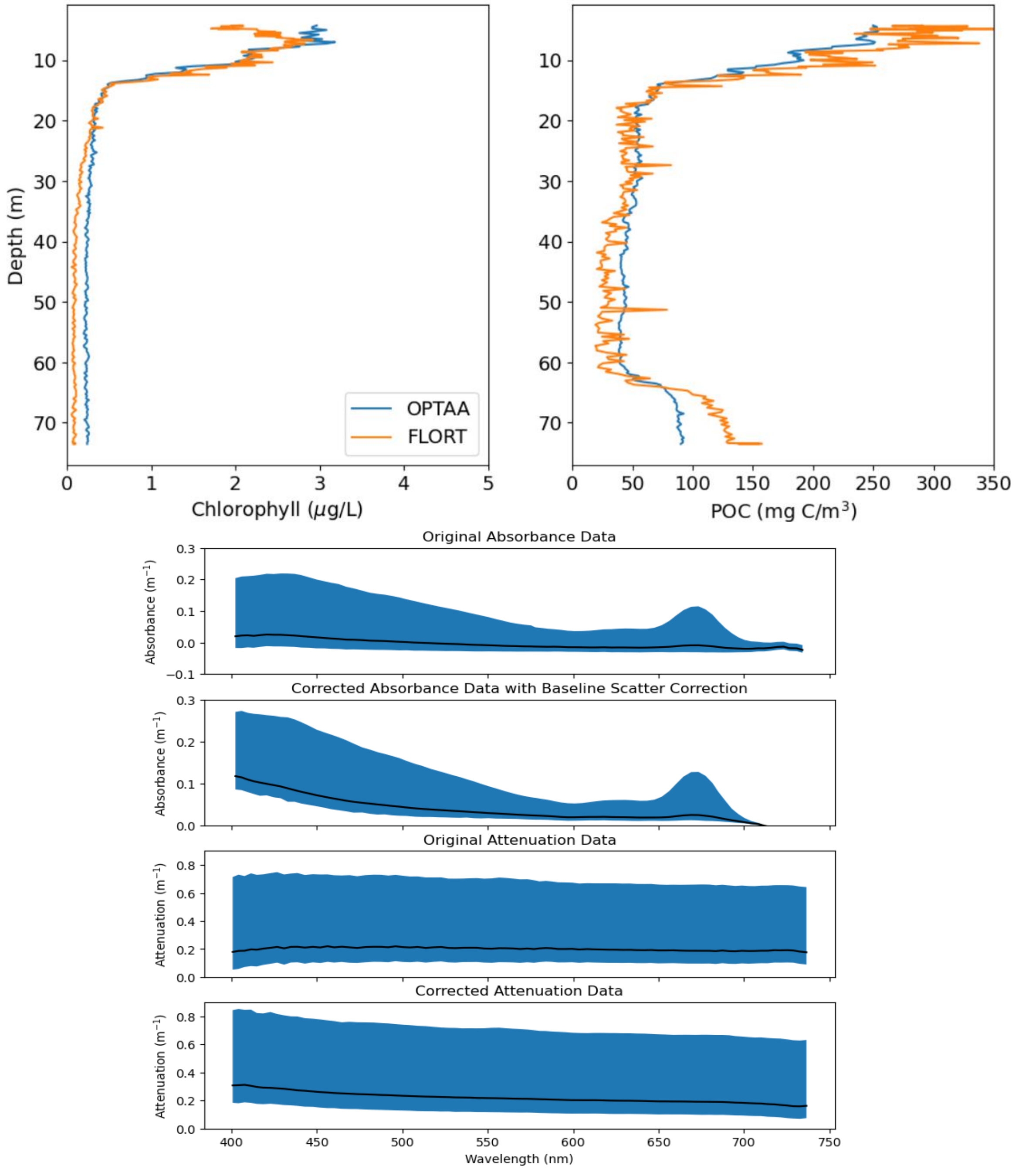


Pre-Deployment Pure Water Calibrations



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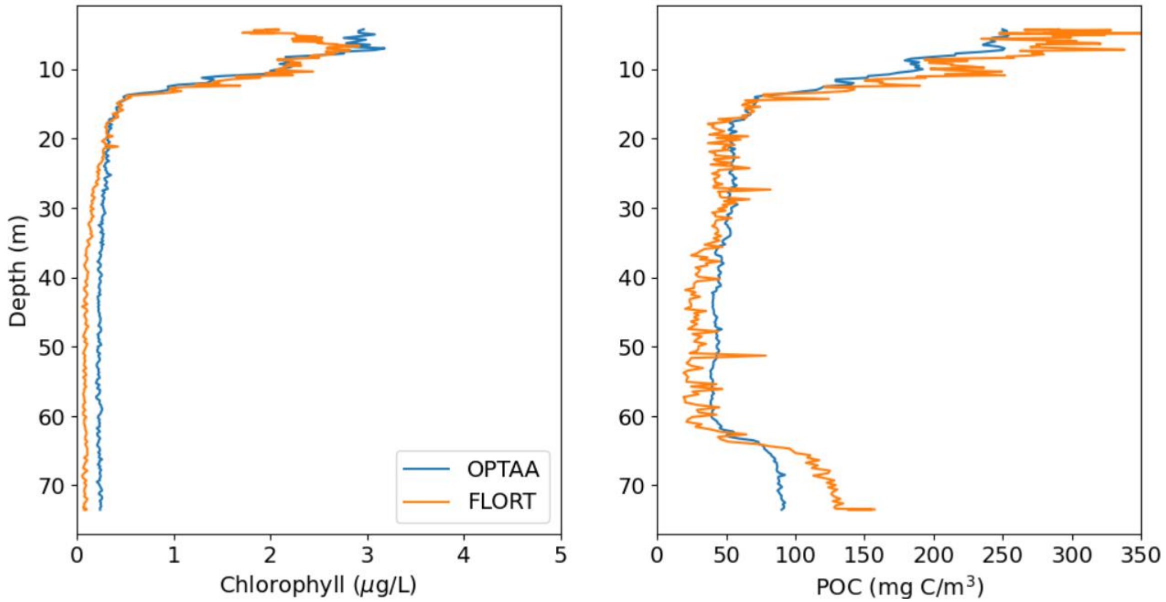
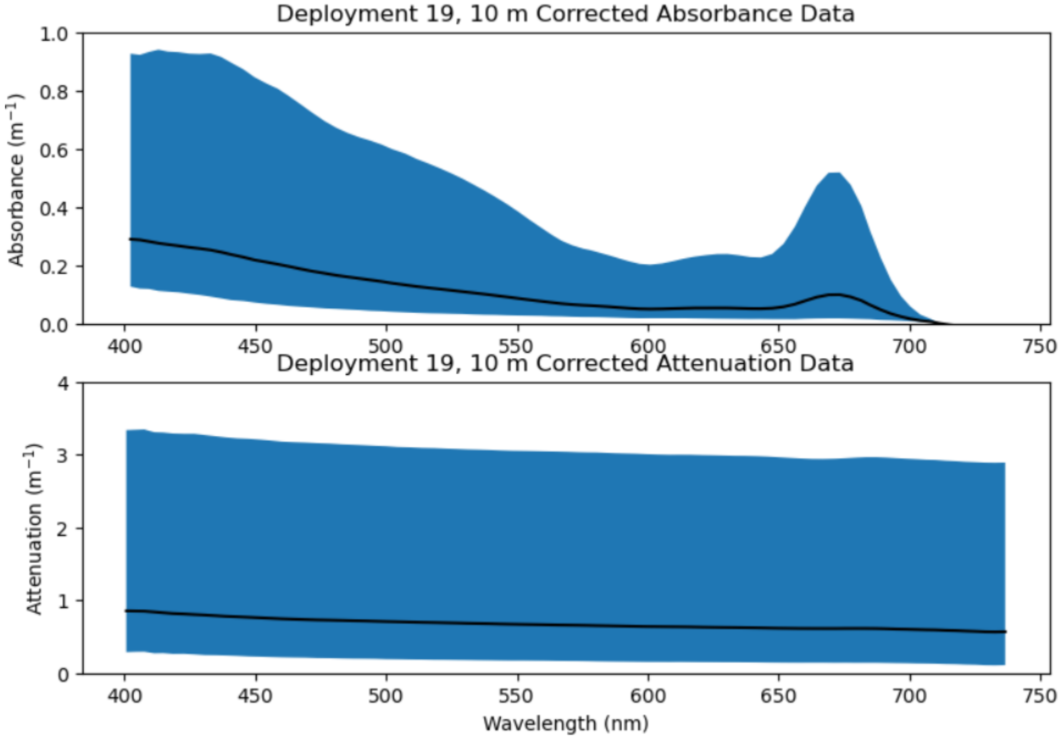
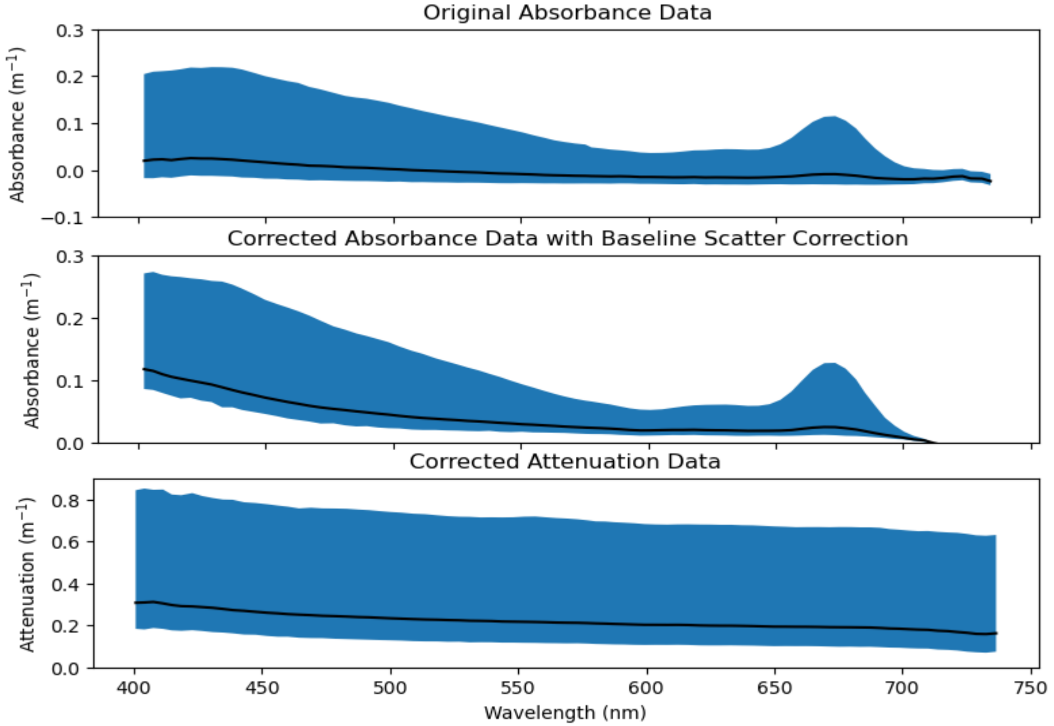


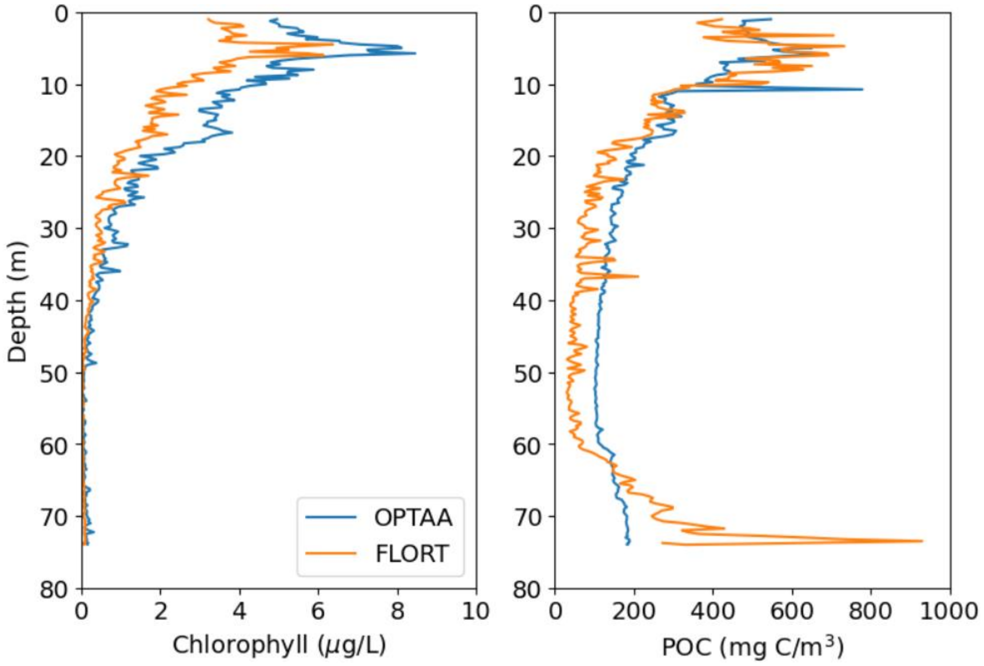
a slice at 10 m for the entire deployment

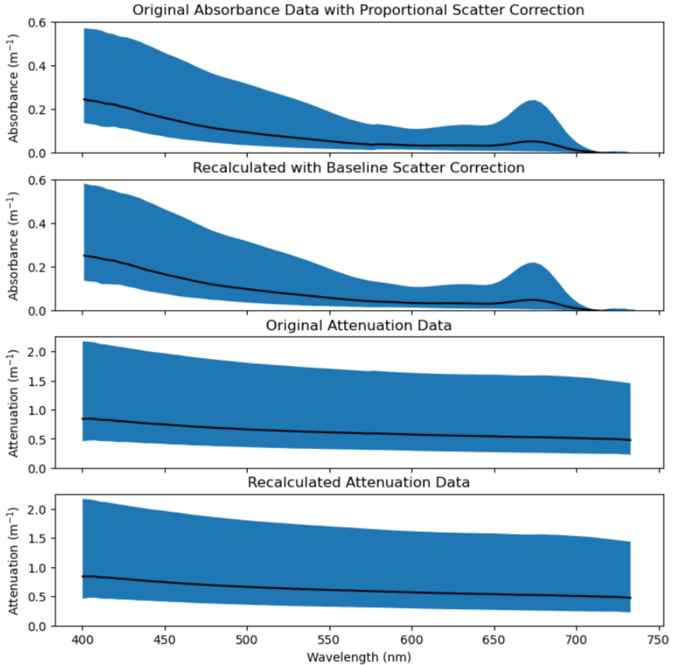




Oregon Shelf Coastal Surface-Piercing Profiler (CSPP, CE02SHSP)

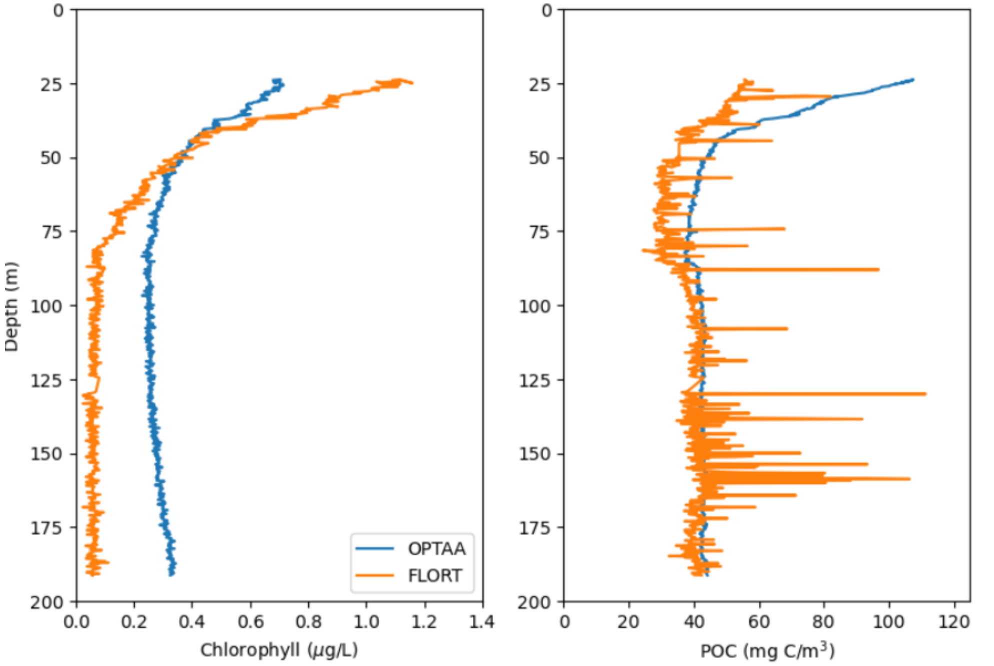
Deployment 15, spanning 2019-08-13 to 2019-10-14 (58 profiles from 0~70 m)

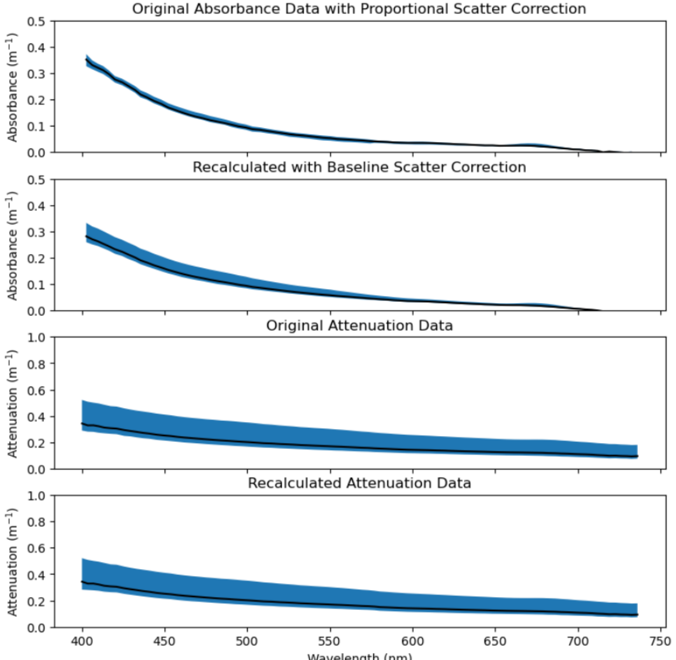




Continental Margin, Slope Base Cabled Shallow Profiler (RS01SBPS)

Deployment 4, spanning 2017-08-04 to 2017-10-08 (12 profiles from 5~200 m)





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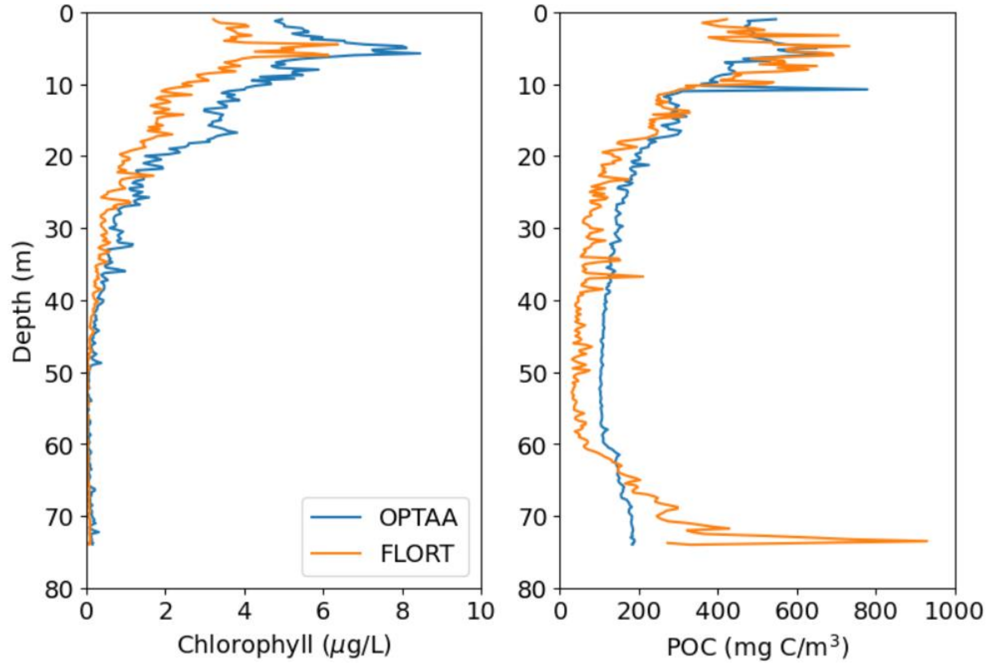

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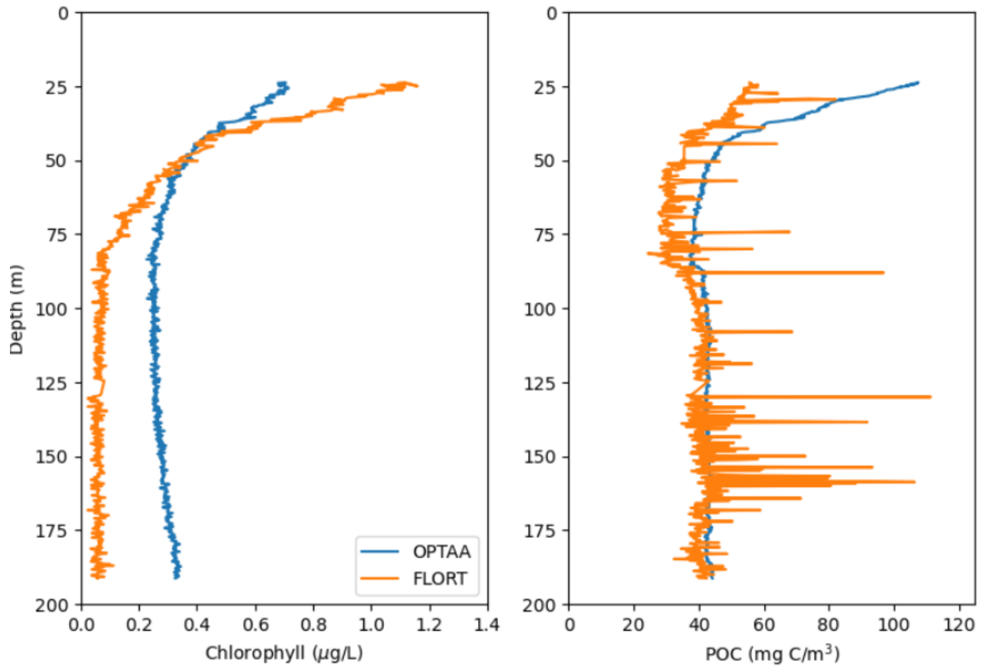

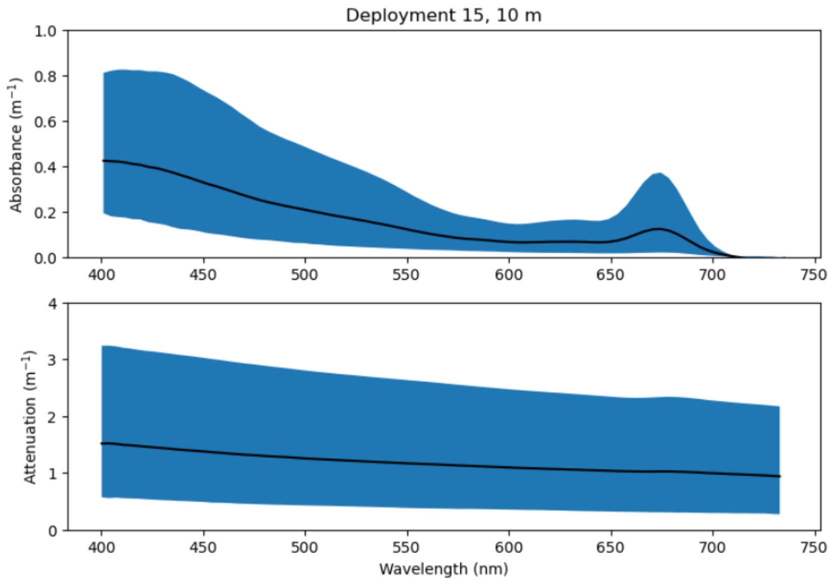

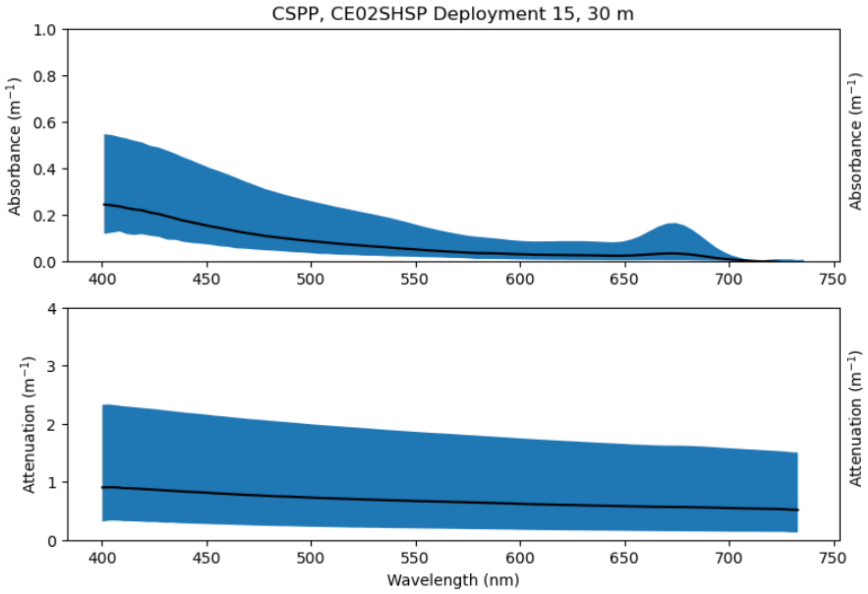

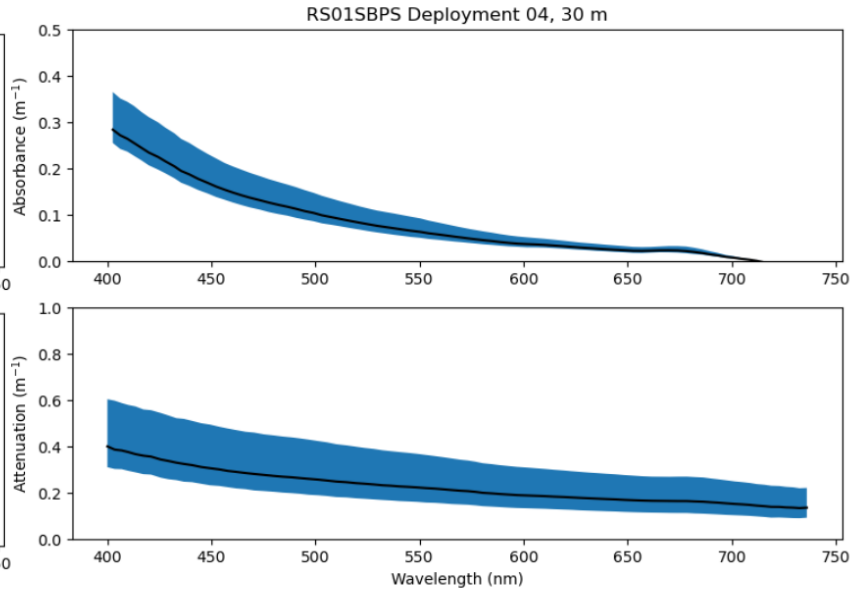

Literature Review

May Oct

Flat

Prop

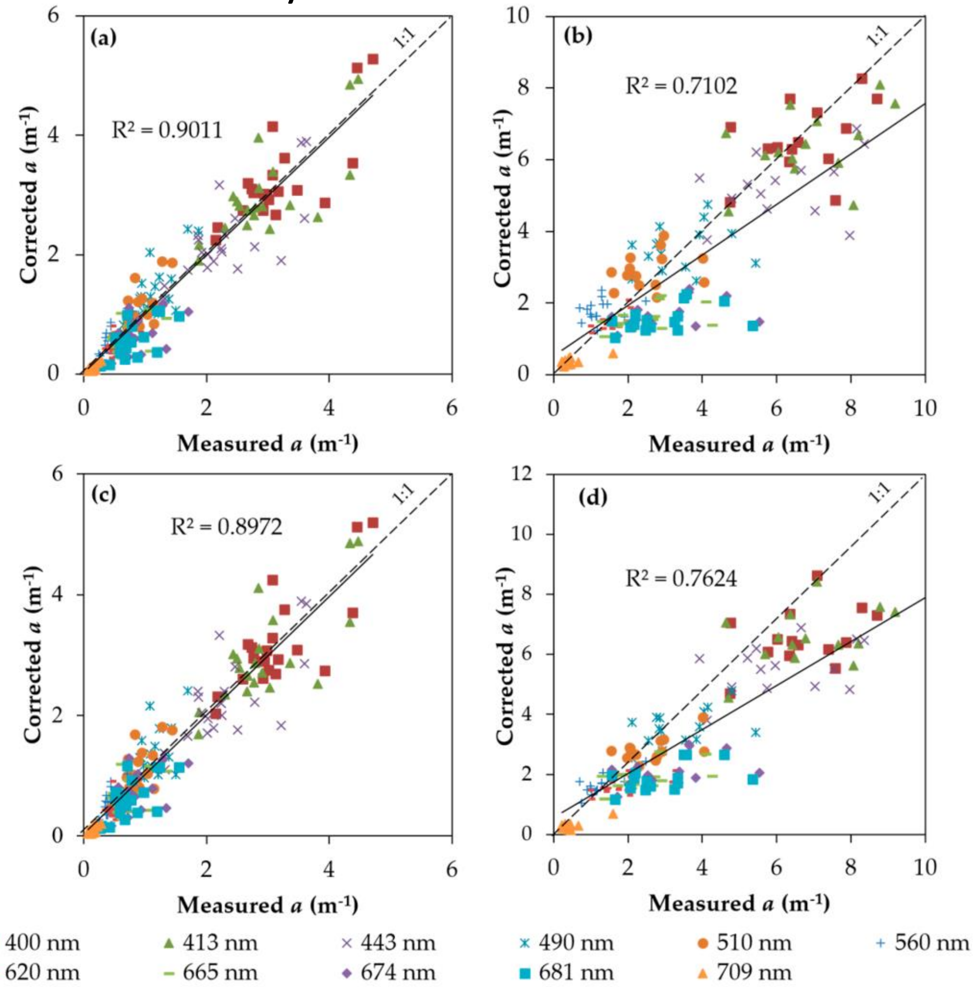

Figure 5. Measurements of *a*(λ) obtained by spectrophotometry in the laboratory and acquired by an ac-s meter, and previously corrected using the flat method the proportional method.

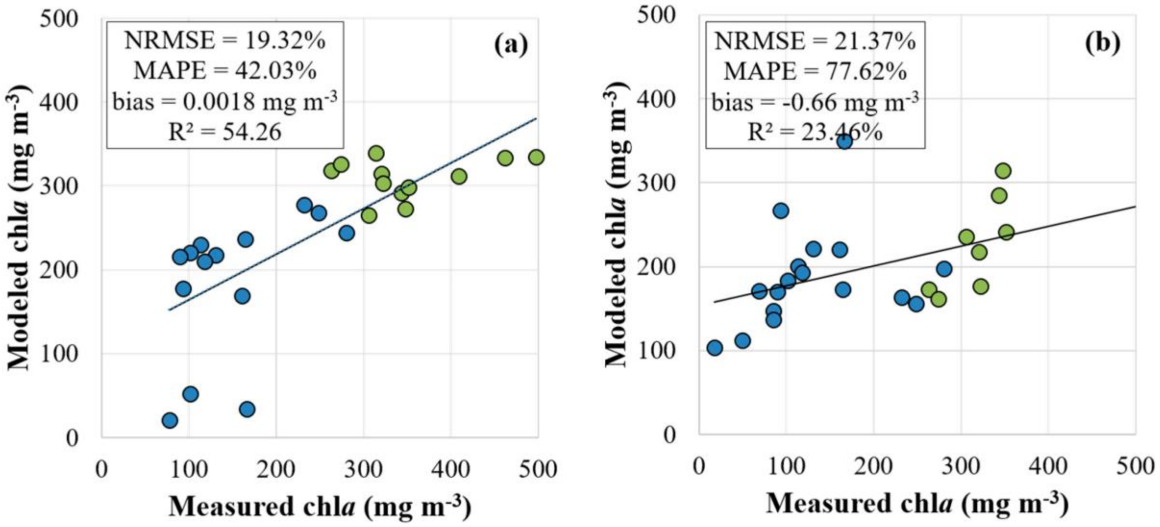

Figure 4. Chl*a* retrieval algorithm fitted using *a*(λ) values that were derived from scattering correction methods: (**a**) flat and (**b**) proportional.

Result

- These methods were applied to two datasets that were measured in May and October 2014.
- The flat technique exhibited the lowest errors for lower a(λ) values (May dataset)
- The proportional was better with the higher a(λ) values (October).
- The proportional method maintained the shape of the a(λ) values better than the other methods.
- Both methods gave a similar performance statistically.
- Flat method produced the best estimations of Chla content for both datasets.
- Flat method is recommended to correct AC-S data in phytoplankton-dominated waters with a large Chla range.

Watanabe, Fernanda, et al. (2018)

Literature Review

Spectral Angle Mapper (SAM) was used to compare the *a*(λ) value that was measured by an ac-s mater and the laboratory spectrophotometer.

SAM determines the similarity level between the spectral curves (vector), calculating the angle between them at every wavelength. *SAM* is therefore not affected by the magnitude variation of the spectrum, taking into account only the shape of the curves.

$$SAM = \cos^{-1}\left(\frac{\sum_{i=1}^{n}(x_i \times x_i')}{\left(\sum_{i=1}^{n} x_i\right)^{1/2} \times \left(\sum_{i=1}^{n} x_i'\right)^{1/2}}\right)$$

Table 2. Assessment of the scattering error correction methods for the datasets collected in May and October 2014 using root mean square error (RMSE) (m^{-1}), normalized root mean square error (NRMSE) (%), mean absolute percentage error (MAPE) (%), bias (m^{-1}), and a Spectral Angle Mapper (SAM) (rad).

Method	RMSE	NRMSE	MAPE	bias	SAM
Correction for May 2014					
Flat	**0.257**	**7.95**	**29.26**	**0.048**	0.103
Constant fraction	0.292	9.25	49.20	1.127	0.199
Proportional	0.263	8.22	30.57	0.053	**0.098**
Correction for October 2014					
Flat	0.969	13.03	34.89	−0.182	0.154
Constant fraction	3.124	48.14	859.84	3.046	0.348
Proportional	**0.833**	**11.20**	**31.03**	**−0.131**	**0.127**