Copernicus FRM4SOC FICE 2025

Training on
In Situ Ocean Colour Radiometry

A view on Near-Surface Methods

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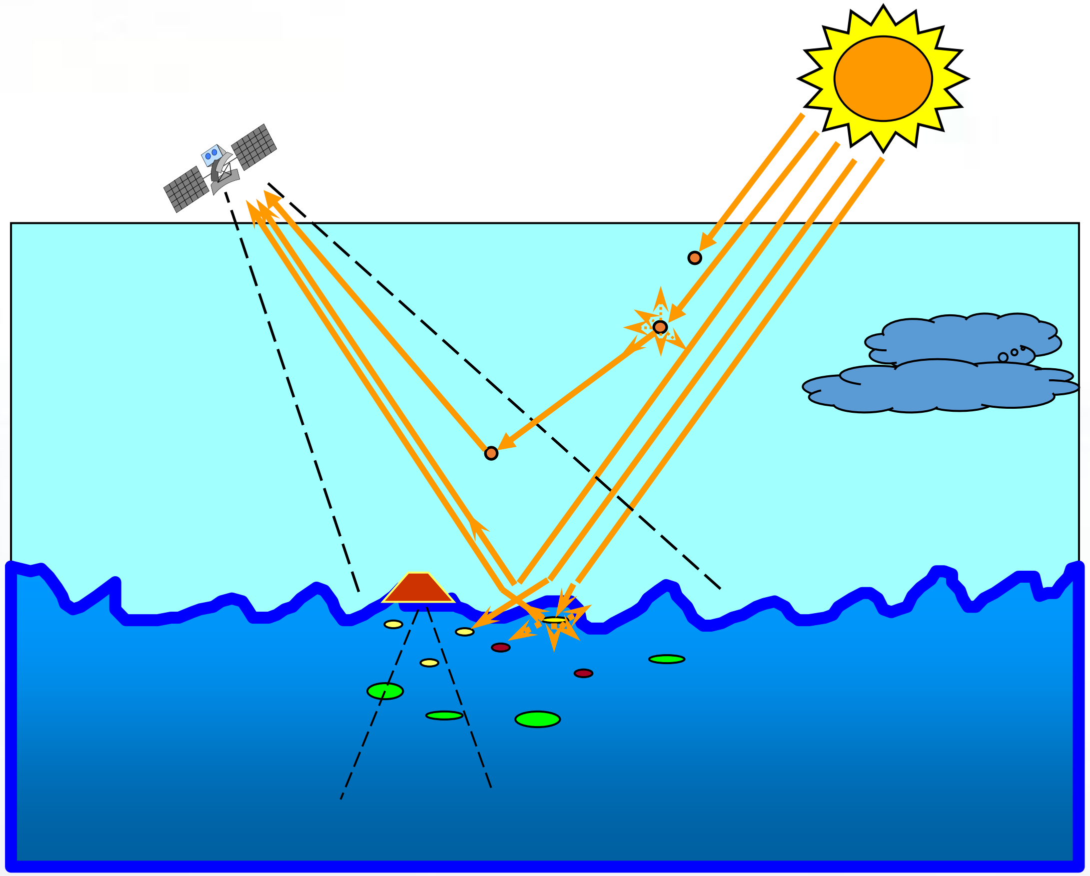
Near-surface radiometry

Historical dates

1990s: Early successful measurements
2010s: Methods assessment
2020s: Comprehensive uncertainty analysis



Advantages

1. Simple deployment procedure
2. Insensitive to coastal water optical stratifications

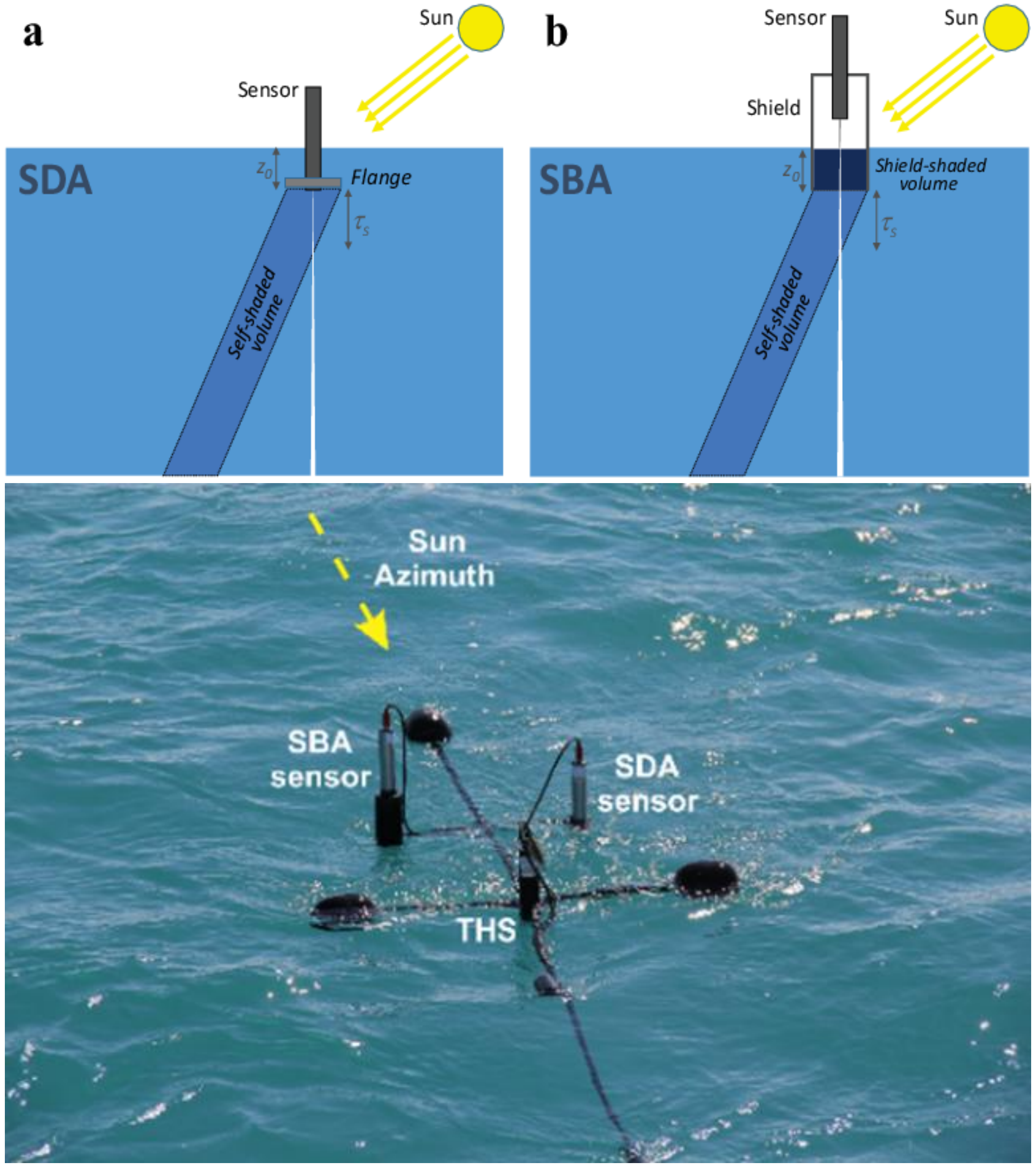
Drawback

1. Cannot produce profiles of radiometric quantities
2. Restricted to a few radiometric quantities (*i.e.*, L_w)
3. Highly sensitive to wave perturbations
4. Requires corrections for shading perturbations and for near-surface in-water transmittance/attenuation

On near-surface radiometry

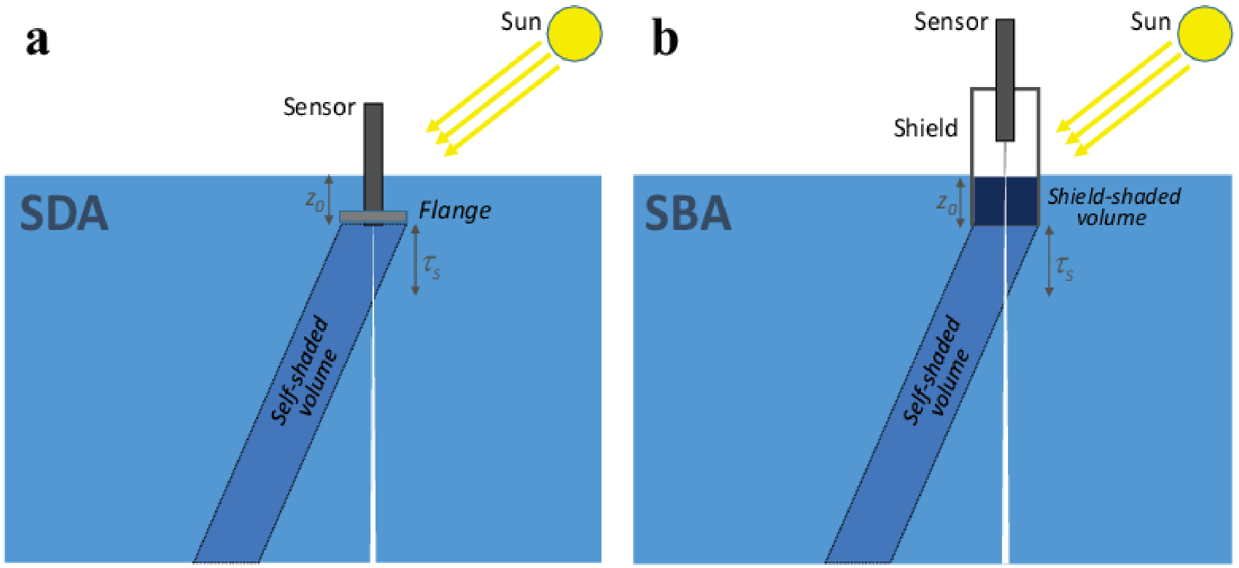
SBA (the Sky Blocked Approach) was suggested to be superior to other in-water or above-water methods because of its immediacy and the capability of 'directly' measure the water-leaving radiance. For instance, SDA (the Single Depth Approach) requires correction for the transmittance of L_u from below to above water in view of determining L_w.

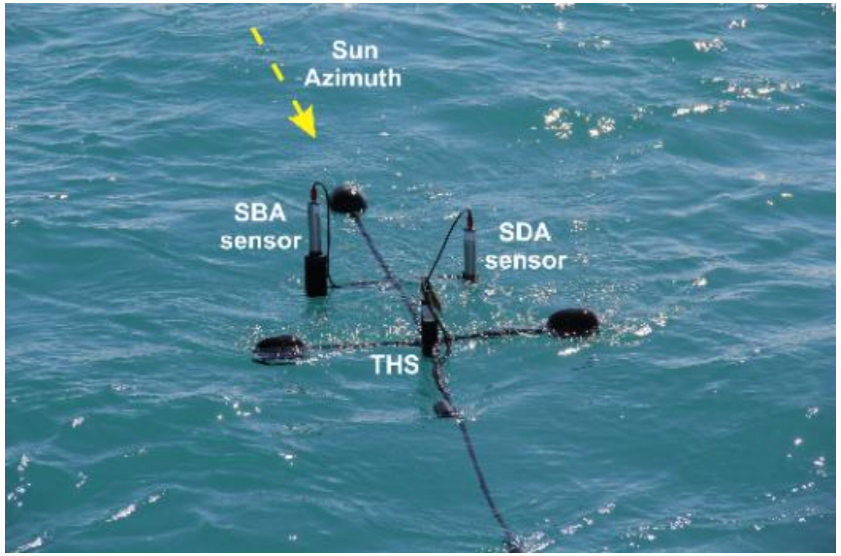
SBA and SDA methods were comprehensively compared through a specific experiment requiring the design of a dedicated measuring system and the collection of data across diverse water types.



G. Zibordi and M. Talone, M. , "On the equivalence of near-surface methods to determine the water-leaving radiance." Opt. Express, 28(3), 3200-3214 (2020).

Single-depth and sky-blocked approaches





In water !

$$L_W^{SDA}(\lambda) = L_u(z_0,\lambda) \cdot C_{ss}^{SDA}(\lambda, a, I_r, \theta_0, R_d, f^{SDA}) \cdot C_{K_L}(\lambda, K_L, z_0) \cdot \frac{t_{wa}(\lambda)}{n_w^2(\lambda)}$$

Above water !

$$L_W^{SBA}(\lambda) = L_W(z_0,\lambda) \cdot C_{ss}^{SBA}(\lambda, a, I_r, R_d, f^{SBA}) \cdot C_{K_L}(\lambda, K_L, z_0) \cdot C_{is}(\lambda, a, b_b, z_0)$$

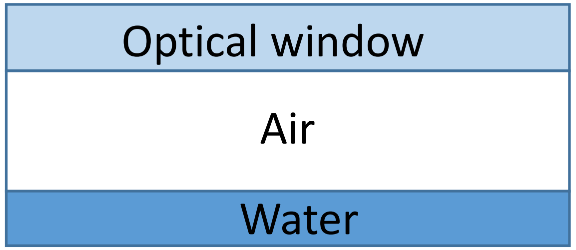
Korea Ocean Research & Development Institute (KORDI), "Development of red-tide and water turbidity algorithms using ocean color satellite," BSPE 98721-00-1224-01, (1999).

A. Tanaka, H. Sasaki and J. Ishizaka, "Alternative measuring method for water-leaving radiance using a radiance sensor with a domed cover," Opt. Express 14(8), 3099–3105 (2006).

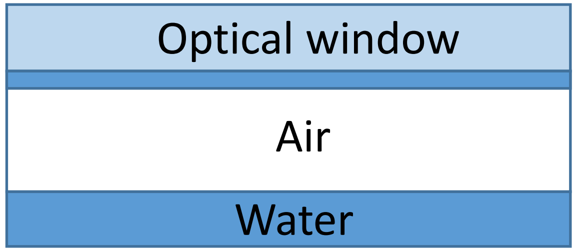
Z. Lee, Y. H. Ahn, C. Mobley and R. Arnone, "Removal of surface-reflected light for the measurement of remote-sensing reflectance from …," Opt. Express, 18 (25), 26313–26324 (2010).

G. Zibordi and M. Talone, M. , "On the equivalence of near-surface methods to determine the water-leaving radiance." Opt. Express, 28(3), 3200-3214 (2020).

… and what about the water likely splashing on the optical window?



$t_{ag}(\lambda)$



$t_{wa}(\lambda) \cdot t_{wg}(\lambda)$

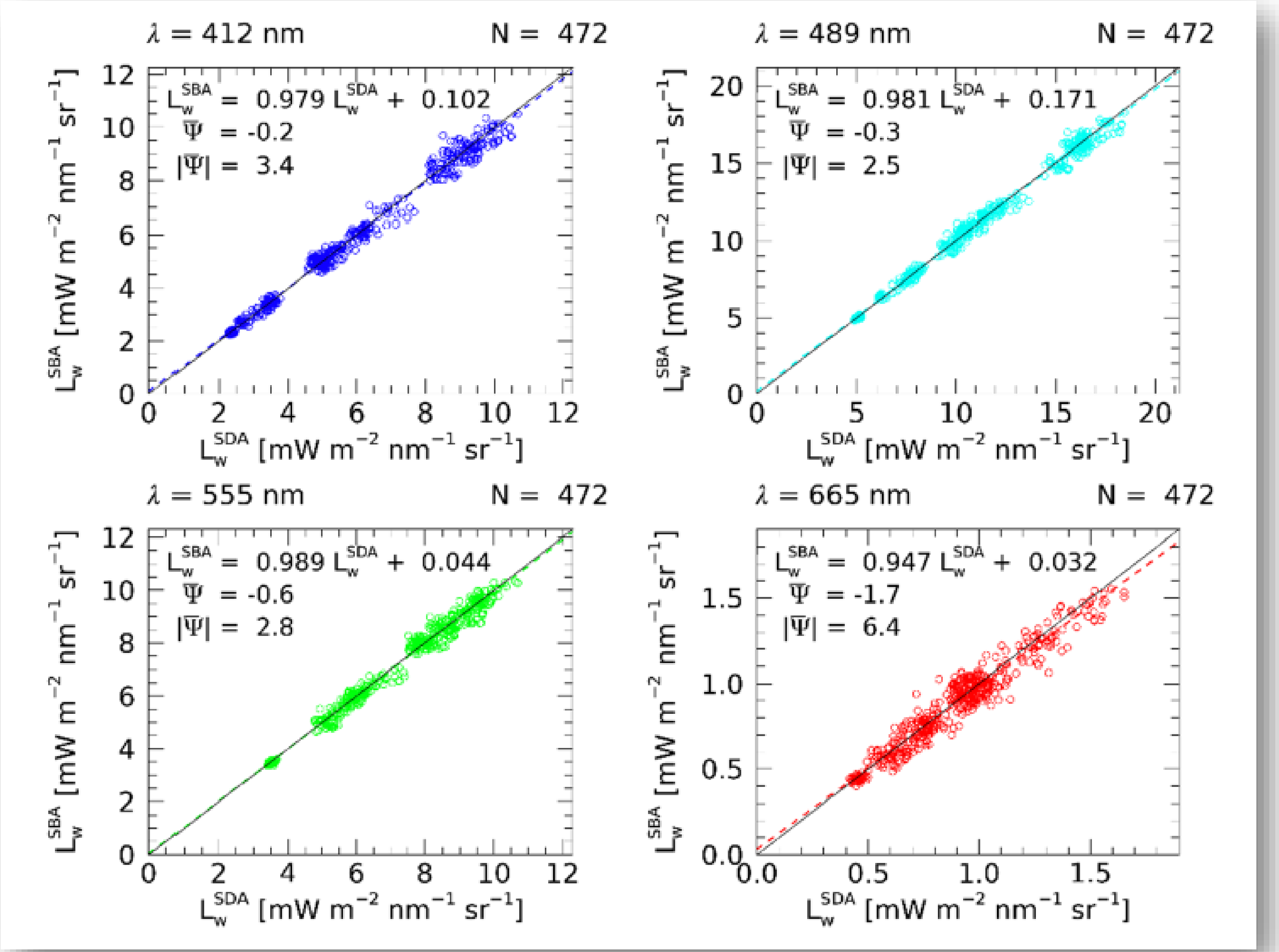
$$C_{ww}(\lambda) = t_{wa}(\lambda) \cdot t_{wg}(\lambda)/t_{ag}(\lambda)$$

accounts for the wet optical window (idealized as a homogenous water film on the optical window) determined by the ratio of the combined transmittances of air-water and water-window interfaces $t_{wa}(\lambda) \cdot t_{wg}(\lambda)$ to that of an air-window interface $t_{ag}(\lambda)$, all computed applying the small angle approximation.

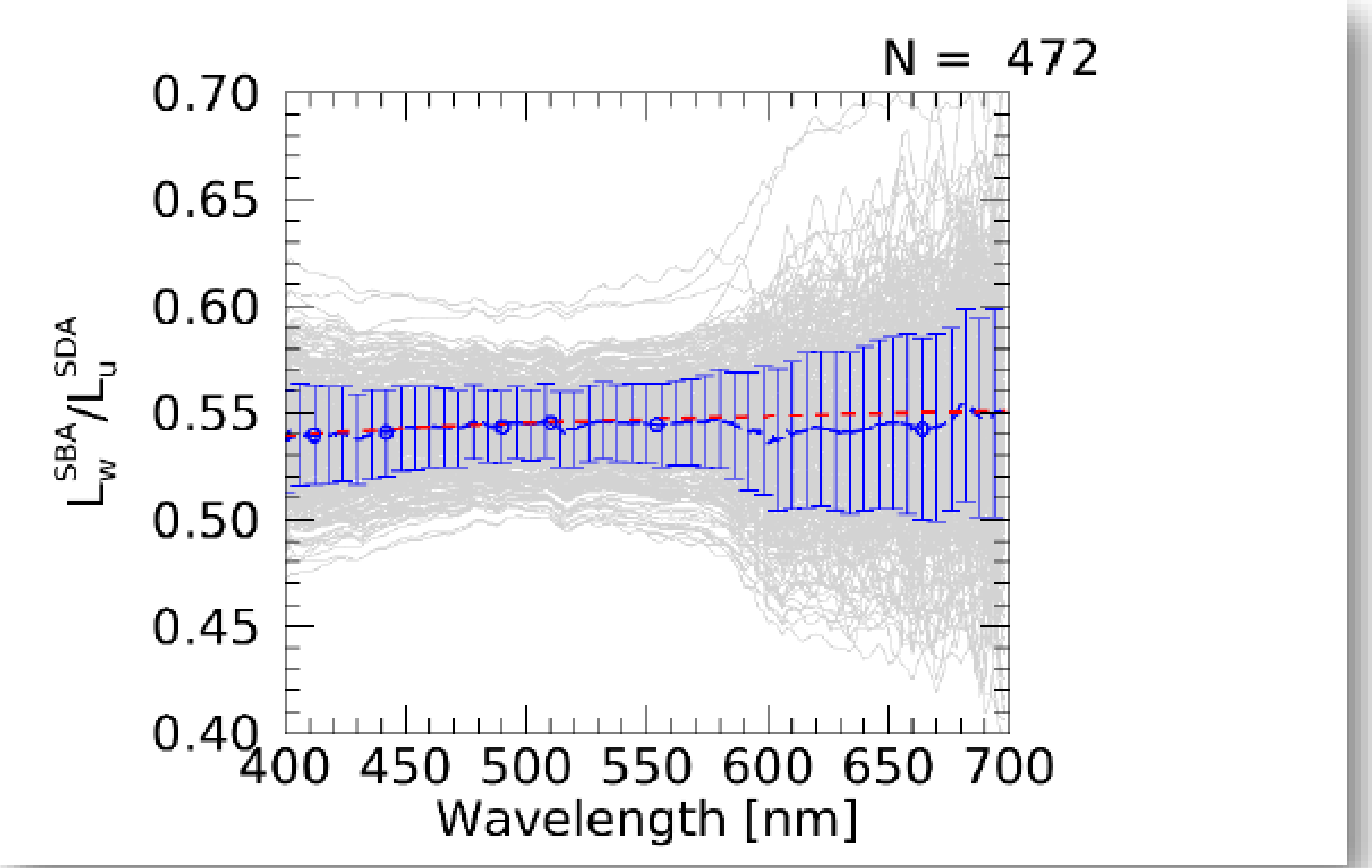
The correction $C_{ww}(\lambda)$ exhibits value of approximately 1.3% slightly varying with λ.

Laboratory verifications of such a correction showed values varying from a fraction of a percent to several percent depending on the size and spatial distribution of water drops on the optical window. Because of this, $C_{ww}(\lambda)$ must be considered an idealized correction, still representative of the impact of water on the optical window of the SBA sensor.

Supporting the equivalence of the two methods

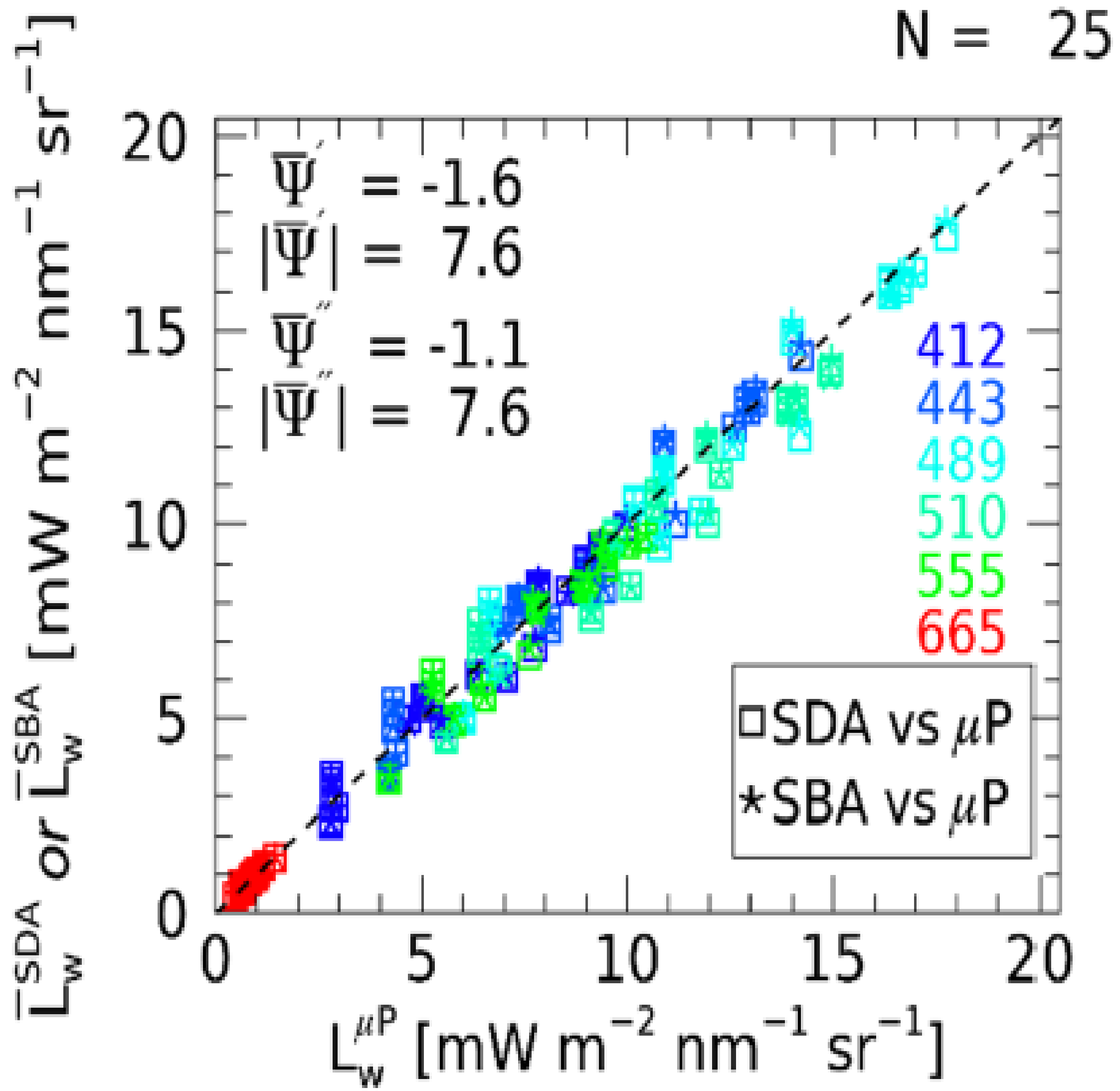


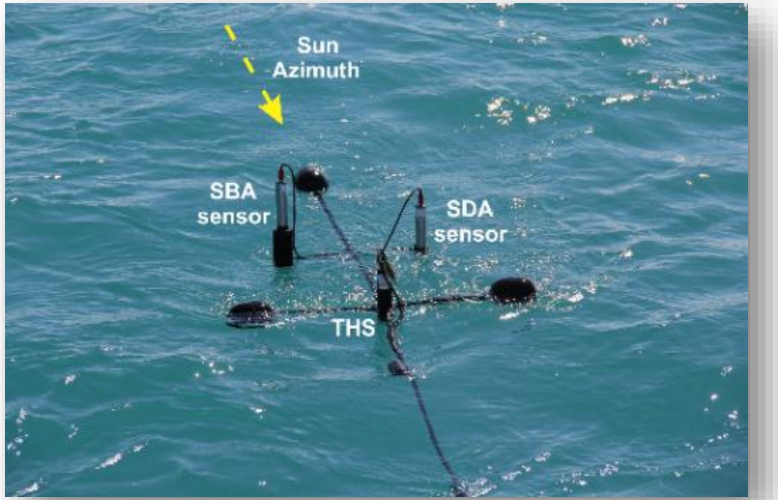
Further … on the equivalence of the two methods

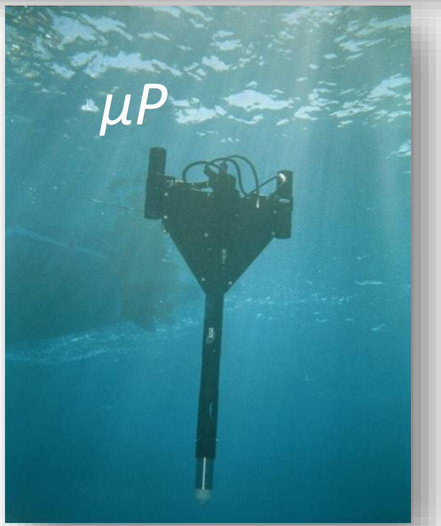


$$1/\frac{t_{wa}(\lambda)}{n_w^{\ 2}(\lambda)}=0.54$$

Further … on the equivalence of the two methods







End

Conclusions

Near surface radiometric methods exhibit equivalence, which is fully supported by their inter-comparison and also their comparison with in-water radiometry methods.

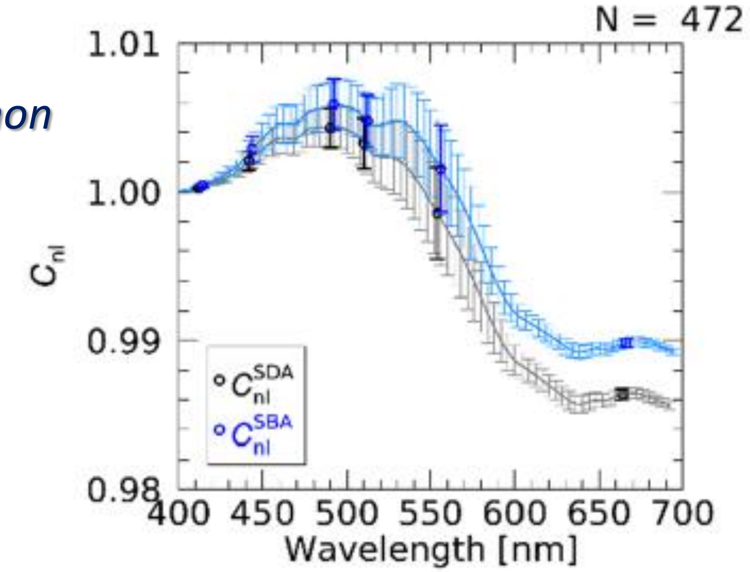
Definitively, all radiometric measurement methods exhibit advantages and disadvantages.

Near-surface methods, comprehensively implemented, can easily support manned radiometric measurements.

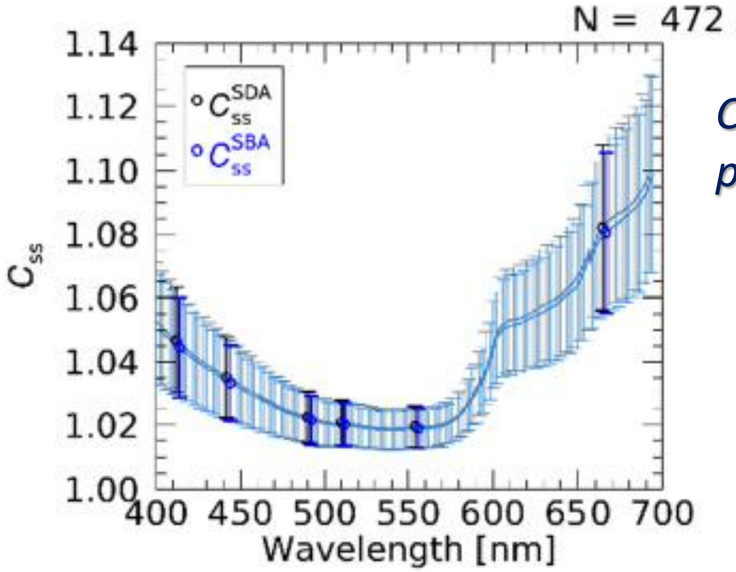
Still, above-water radiometry, benefitting of consolidated technology, accurate calibration and characterizations, comprehensive measurement protocols (implying the application of community-shared quality assurance, processing and quality control procedures) exhibit relevance for both manned and automated operations and has already amply shown the capability to support satellite ocean color applications.

Errors quantification

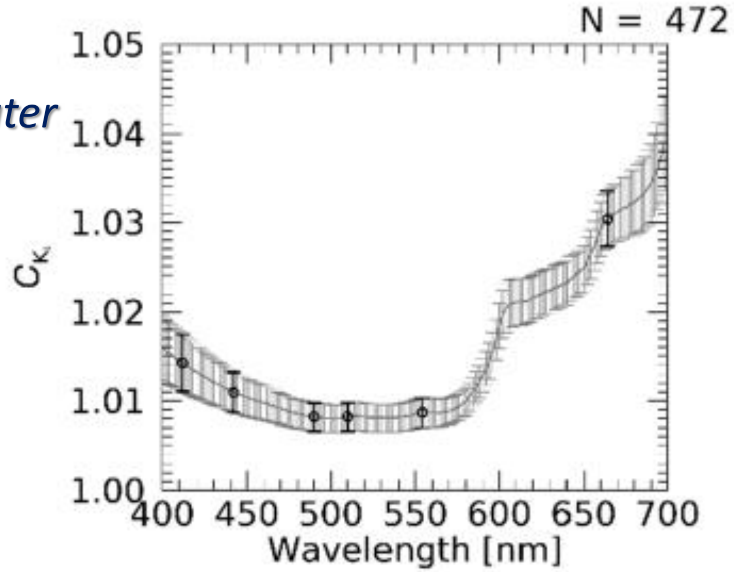
Corrections for the non linear response



Corrections for self-shading perturbations



Correction for the water attenuation between the depths z_0 and 0^-



Corrections for the immersed portion of the shield