Deriving diel changes of the backscattering coefficient from in situ apparent optical properties: a case study in the Mediterranean Sea (Boussole site).

Malika Kheireddine[1,2], David Antoine[1,3], Vincenzo Vellucci[1] and Bernard Gentili[1]

[1]*Sorbonne Universités, Université Pierre et Marie Curie (UPMC), Centre National de la Recherche Scientifique (CNRS), UMR 7093, Laboratoire d'Océanographie de Villefranche (LOV), Observatoire océanologique, F-06230, Villefranche-sur-Mer, France*
[2]*Now at : King Abdullah University of Science and Technology, Red Sea Research Center, Thuwal, Kingdom of Saudi Arabia*
[3]*Now at : Department of Imaging and Applied Physics, Remote Sensing and Satellite Research Group, Curtin University, Perth, WA 6845, Australia*

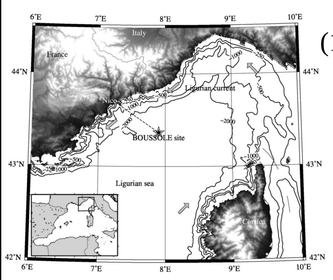
malika.kheireddine@kaust.edu.sa

The focus on the diurnal scale is a preparatory phase in the development of the future generation of ocean colour sensors embarked on geostationary platforms. To take full advantage of the hourly observations that these missions will provide, it is imperative to better understand the diurnal variability of the marine reflectance.

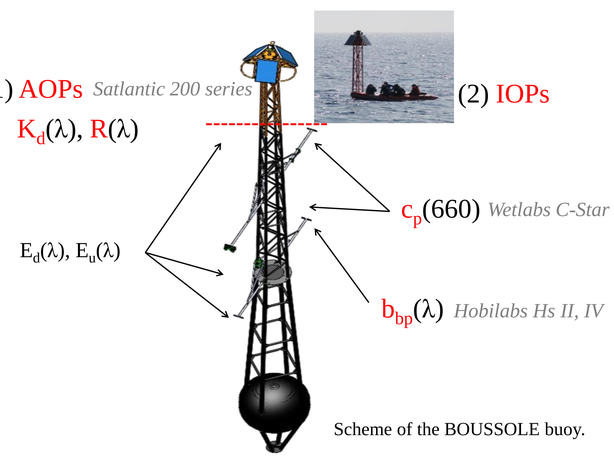
It is still unclear whether or not the diel variability of IOPs (Inherent Optical Properties), in particular of b_{bp} (particulate backscattering coefficient) that is observed *in situ* transfers as a sizeable diel variability of AOPs (Apparent Optical Properties) (both from *in situ* and remote sensing measurements). The objective is to analyze the IOPs variability and to study the transfer of this variability to the AOPs.

1. The BOUSSOLE project

In the NW Mediterranean Sea, at an oceanic site (case 1 waters), the BOUSSOLE mooring allows continuous recording of optical properties since September 2003 (Antoine *et al.*, 2006; 2008).

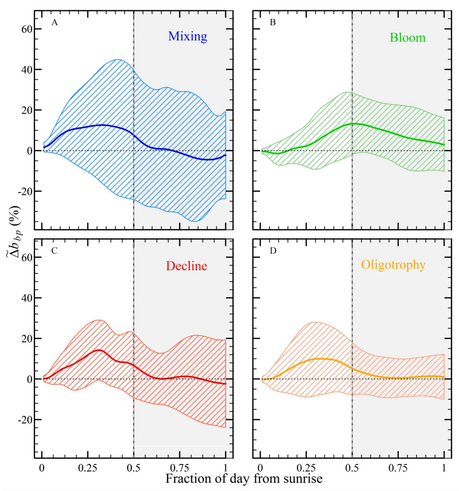


Map of the Northwestern Mediterranean sea showing the location of the site BOUSSOLE in the Ligurian sea (white star).



Scheme of the BOUSSOLE buoy.

2. Diel variability of b_{bp}



Average $\tilde{\Delta}\, b_{bp}$ (± standard deviation dashed area) during situations of mixing, bloom, decline and oligotrophy. The light grey area at right of each panel indicates the night-time.

You can read more about diel variability of b_{bp} in Kheireddine and Antoine, 2014.

The relative amplitude of b_{bp}, $\tilde{\Delta}b_{bp}$, vary between 10-15% ± 20-30% according to the season.

The timing of the daily peak in b_{bp}, during periods of mixing, decline and oligotrophy was considerably earlier than that of b_{bp} during the bloom period.

This work uses data collected in the frame of the BOUSSOLE project, which is supported by CNES, ESA and NASA.

Antoine, D. M. Chami, H. Claustre, F. D'Ortenzio, A. Morel, G. Bécu, B. Gentili, F. Louis, J. Ras, E. Roussier, A.J. Scott, D. Tailliez, S. B. Hooker, P. Guevel, J.-F. Desté, C. Dempsey and D. Adams. 2006, BOUSSOLE : a joint CNRS-INSU, ESA, CNES and NASA Ocean Color Calibration And Validation Activity. NASA Technical memorandum N° 2006 - 214147, 61 pp.
Antoine, D., F. D'Ortenzio, S. B. Hooker, G Bécu, B. Gentili, D. Tailliez, and A. J. Scott (2008), Assessment of uncertainty in the ocean reflectance determined by three satellite ocean color sensors (MERIS, SeaWiFS and MODIS-A) at an offshore site in the Mediterranean Sea (BOUSSOLE project), Journal of Geophysical Research, 113, C07013, doi:10.1029/2007JC004472.
Kheireddine, M and D. Antoine. (2014). Diel variability of the particulate beam attenuation and backscattering coefficients in the northwestern Mediterranean Sea (BOUSSOLE site). Journal of Geophysical Research, 119, doi: 10.1002/2014JC010007.
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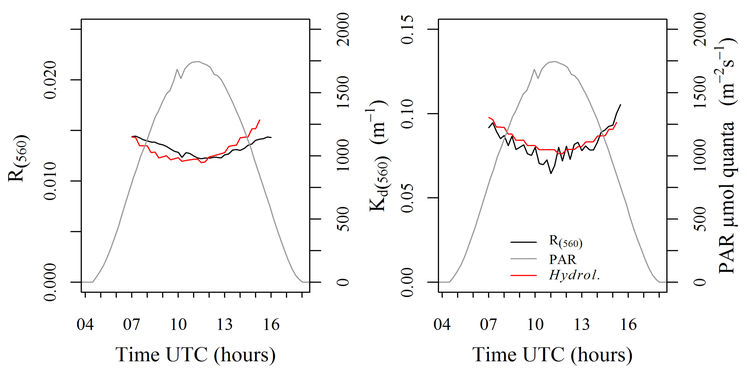
Morel, A., and S. Maritorena.(2001). Bio-optical properties of oceanic waters: A reappraisal. Journal of Geophysical Research. **106:** 7163-7180.doi: 10.1029/2000jc000319.

See poster 2019: Diel to seasonal scale of the spectral slope of b_{bp} in the NW Mediterranean presented by M. Barnes.
See poster 2085: Spatial-temporal dynamics of CDOM and CDM light absorption coefficients in the Mediterranean Sea: from in situ data to a SEAWIFS climatology presented by E. Organelli.
See poster 2122: The BOUSSOLE bio-optics time series – New developments in the frame of the BIOCAREX project presented by M. Golbol.
See poster 2084: Shadowing corrections of BOUSSOLE radiometric measurements presented by V. Vellucci.

3. Optical closure

In situ IOPs → Radiative transfer (*Hydrolight*) → Modeled AOPs

Are the modeled R and K_d are consistent with *in situ* measurements of AOPs?



Example of daily changes of R (A), K_d (B), PAR (gray line) and modeled R and K_d (red line, *Hydrolight*) at 560 nm.

Modeled R and K_d are in agreement with daily variations of *in situ* R and K_d.

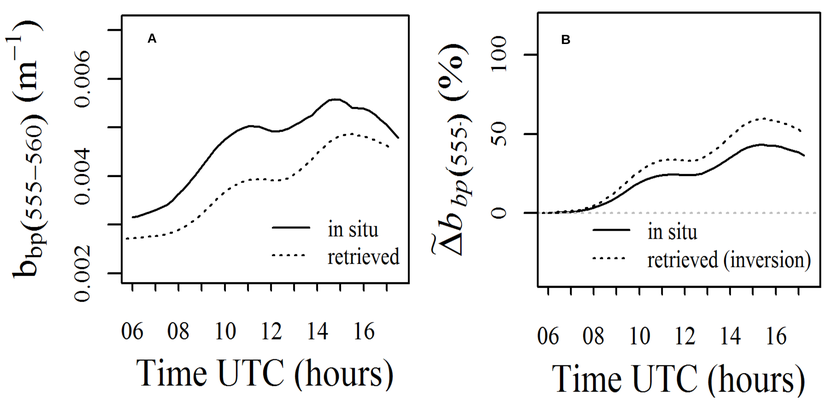
Results demonstrate the consistency of the AOPs and IOPs measurements performed at BOUSSOLE site.

4. Inversion performance

IOPs, particularly b_b are derived from AOPs (R and K_d) (Morel and Gentili, 2004; Morel and Gentili, 1991).

In situ AOPs → Inversion algorithm → Modeled b_{bp}

Is it possible to retrieve the diurnal changes of b_{bp} from inversion of *in situ* measurements of AOPs?



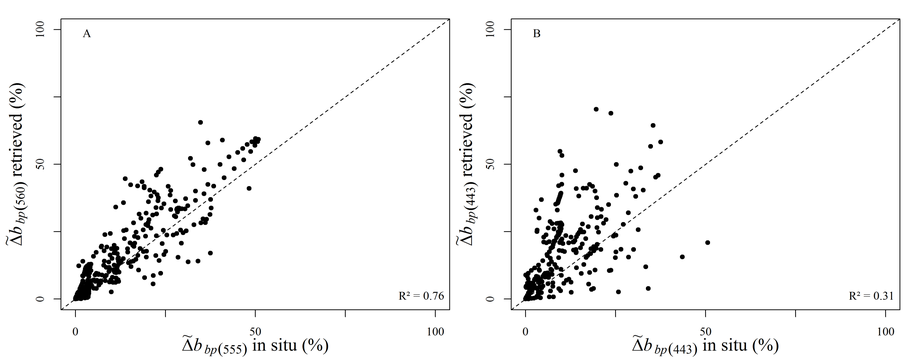
Example of daily changes in b_{bp} *in situ* (solid line) and retrieved (dashed line) (A) and in $\tilde{\Delta}b_{bp}$ in situ (solid line) and retrieved (dashed line) (B) in green (555-560 nm).

We can reproduce the relative daily increase generally observed for b_{bp}.

Use $\tilde{\Delta}b_{bp}$ to infer biogeochemical quantities with AOPs- derived values, is more conceivable in the green.

The situation is less favorable at 443 nm, where the dispersion of measured versus inverted estimations is larger than the dispersion observed in green.

The performance of current AOP inversions is clearly insufficient for those methods being used to derive diel signals of relatively low amplitude.



$\tilde{\Delta}\, b_{bp}$ retrieved from R and K_d as a function of $\tilde{\Delta}\, b_{bp}$ in situ, for λ= 555-560 nm (A) and λ= 443 nm (B). The dashed line indicates the line 1:1.