Recent Advances for ROSACE: A European Design for the Copernicus Ocean Colour System Vicarious Calibration Infrastructure

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ABSTRACT

The European Copernicus programme ensures long-term delivery of high-quality, global satellite ocean colour radiometry (OCR) observations from its **Sentinel-3 (S3)** satellite series carrying the ocean and land colour instrument (OLCI). In particular, the S3/OLCI provides marine **water leaving reflectance** and derived products to the Copernicus marine environment monitoring service, CMEMS, for which data quality is of paramount importance. This is why OCR system vicarious calibration (OC-SVC), which allows **uncertainties** of these products to stay within required specifications, is crucial for this part of the operational capabilities of Copernicus. The European organisation for the exploitation of meteorological satellites (EUMETSAT) operates the S3/OLCI marine ground segment, and envisions having an SVC infrastructure deployed and operated for the long-term. A design for such an SVC infrastructure, named radiometry for ocean colour satellites calibration and community engagement (ROSACE), has been submitted to Copernicus by a consortium made of three European research institutions, a National Metrology Institute, and two small- to medium-sized enterprises (SMEs). **ROSACE proposes a 2-site infrastructure deployed in the Eastern and Western Mediterranean Seas, capable of delivering up to about 80 high quality matchups per year for OC-SVC** of the S3/OLCI missions. This paper describes recent advances in the operational calibration capabilities for ROSACE and also the results of an updated climatological characterisation of the proposed site areas. Recent advances by the National Physical Laboratory of the UK are presented that will operationally provide **unprecedented calibration accuracy** for ROSACE through their new Spectroscopically Tuneable Absolute Radiometric, calibration and characterisation, Optical Ground Support Equipment (**STAR-CC-OGSE**). Furthermore, the **new climatological characterisation** results, presented here, reconfirm the MSEA site near Crete as an optimal location for OC-SVC in European Waters and the capital gain of an extended observatory that combines the BOUSSOLE and MSEA locations in providing a fit-for-purpose OC-SVC infrastructure for Copernicus.

ROSACE

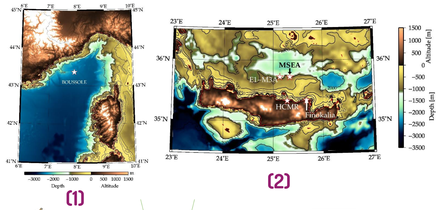
What ROSACE is and its strengths:

Field Segment

- Two complementary sites ensuring redundancy and metrological foundation: BOUSSOLE (1) and MSEA (2)
- A new deployment platform based on the BOUSSOLE buoy design (4)
- New optical system (5)
- New calibration and characterization systems (12)
- New field relative calibration monitoring system (6)
- Systematic round robin intercalibrations for validations of procedures and measurements/uncertainties
- Options for extending the network with profiling floats (16)

Ground Segment

- Semi-supervised data processing (3)
- Near real time, adjusted mode and delayed mode products
- Uncertainty per measurement for easy screening of SVC-quality data (7)
- Modularity



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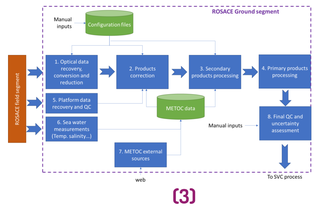

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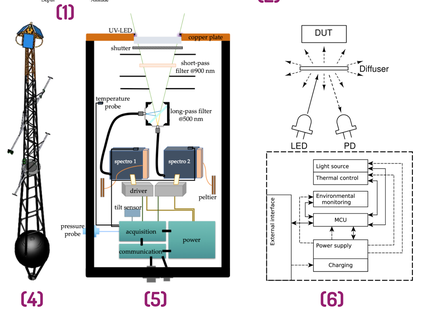

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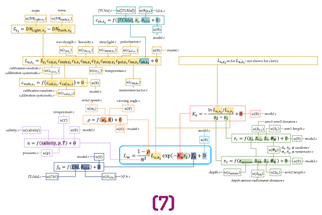


(7)

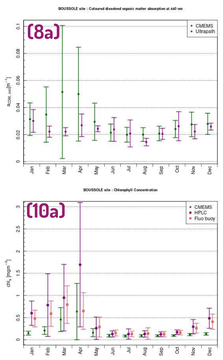
MATCH-UP POTENTIAL

		Elimination criteria								
		Collocation	Satellite measurements		Field measurements				All	
			Glint	SZA	Clear-sky	[TChla]	Buoy tilt	Wind Speed	83 % rate	100 % rate
BOUSSOLE	N matchups	175	133	120	55	88	89	96	29	36
	% reduction		24	10	58	34	34	28	78	73
MSEA	N matchups	168	115	115	52	109	98	84	42	52
	% reduction		30	0	54	6	14	28	63	55

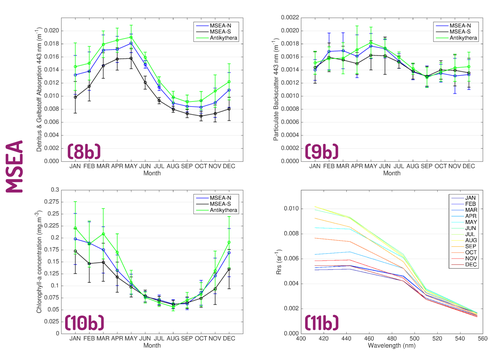
Estimates of average yearly SVC-quality match-up potential at BOUSSOLE and MSEA. Collocations are progressively reduced by applying elimination criteria to satellite and field measurements. Rates refers to successful field data acquisition rates in realistic (83 %) and optimal (100 %) scenarios.

OCEAN

BOUSSOLE

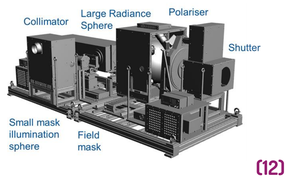


MSEA



Monthly climatologies of: coloured dissolved organic matter absorption at 440 nm (8a,b), particulate backscattering coefficient at 443 nm (9a,b), Chlorophyll-a concentration (10a,b), and remote sensing reflectance spectra (11a,b) at BOUSSOLE (left) and MSEA (right) stations. Different colours for BOUSSOLE indicate different data sources (in situ or satellite). Different colors for MSEA indicate additional sites south of Crete (MSEA-S) and NW of Crete (Antikythera).

STAR-CC-OGSE



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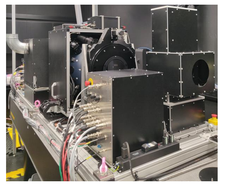
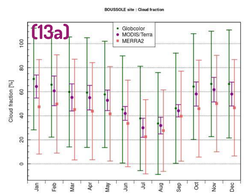


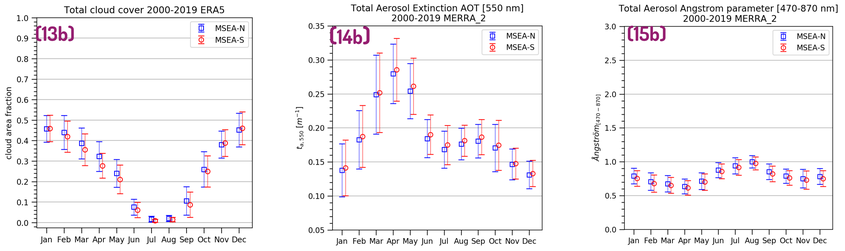
The STAR-CC-OGSE is a versatile facility for radiometric calibration and characterization (spectral response and straylight). It is provided with collimated beam source allowing monochromatic continuous fine-tuning from 260 nm to 2700 nm (narrow line-width <0.1 pm). The expected absolute calibration uncertainty is 0.5 %. It is now available at the NPL facility.

ATMOSPHERE

BOUSSOLE

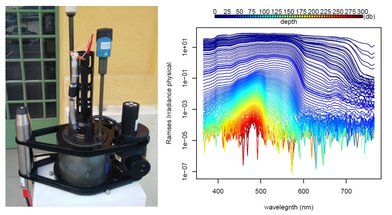


MSEA



Monthly climatologies of: cloud fraction (13a,b), aerosol optical thickness at 550 nm (14a,b) and Ångström exponent at 443-865 nm (15a,b) at BOUSSOLE (top) and MSEA (bottom) stations. Different colours for BOUSSOLE indicate different satellite data sources. Different colours for MSEA indicate two sites north and south of Crete (MSEA-S, MSEA-S).

TOWARD HYPER-PROVAL



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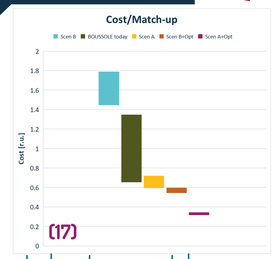
A Trios Ramses irradiance sensor has been integrated onto a Provor CTS5 (NKE) float and deployed for the first time at BOUSSOLE for testing. The next step will be integration of radiance/irradiance on the two-arms ProVal platform.

BUDGET ANALYSIS



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Estimated costs per match-up range of the ROSACE infrastructure in different scenarios relative to current BOUSSOLE costs.
B=BOUSSOLE
A=BOUSSOLE+MSEA
Opt=deployment ProVal for 4 months/year.

ACKNOWLEDGEMENTS

Disclaimer

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Antoine D, Vellucci V, Banks AC, Bardey P, Bretagnon M, Bruniquel V, Deru A, Hembise Fanton d'Andon O, Lerebourg C, Mangin A, Crozel D, Victori S, Kalampokis A, Karageorgis AP, Petihakis G, Psarra S, Golbol M, Leymarie E, Bialek A, Fox N, Hunt S, Kuusk J, Laizans K, Kanakidou M. ROSACE: A Proposed European Design for the Copernicus Ocean Colour System Vicarious Calibration Infrastructure. *Remote Sensing*. 2020; 12(10):1535. https://doi.org/10.3390/rs12101535