European Commission

Marine Regions Relevant for Ocean Color System Vicarious Calibration

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Background literature

G.Zibordi and F. Mélin. ***Marine and atmospheric optical properties in regions of relevance for ocean color system vicarious calibration***. *Remote Sensing of Environment*, 190, 122–136, 2017.

G.Zibordi, F. Mélin and M. Talone. ***System Vicarious Calibration for Copernicus Ocean Colour Missions: Requirements and Recommendations for a European Site***, EUR 28433 EN, doi:10.2760/155759, 2017.

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Introduction

Zibordi and Mélin (2016) compared a number of established SVC sites but also evaluated potential sites under consideration:

The North Pacific Ocean (**NPO**) with the Marine Optical Buoy (MOBy) site managed NOAA (Clark et al. 1997);

The Arabian Sea (**ASea**) with the Kavaratti site managed by ISRO (Shukla et al. 2011);

The Ligurian Sea (**LSea**) with the BOUée pour l'acquiSition d'une Série Optique à Long termE (BOUSSOLE) site managed by LOV (Antoine et al. 2008).

The Mediterranean Sea (**MSea**) near the Island of Crete;

The Caribbean Sea (**CSea**) near Puerto Rico Islands;

The North Atlantic Ocean (**NAO**) near Azores Islands;

The Eastern Indian Ocean (**EIO**) near Rottnest Island off Perth;

The Strait of Sicily (**SoS**) near the Pantelleria Island;

The Balearic Sea (**BSea**) in the proximity of the Balearic Islands.

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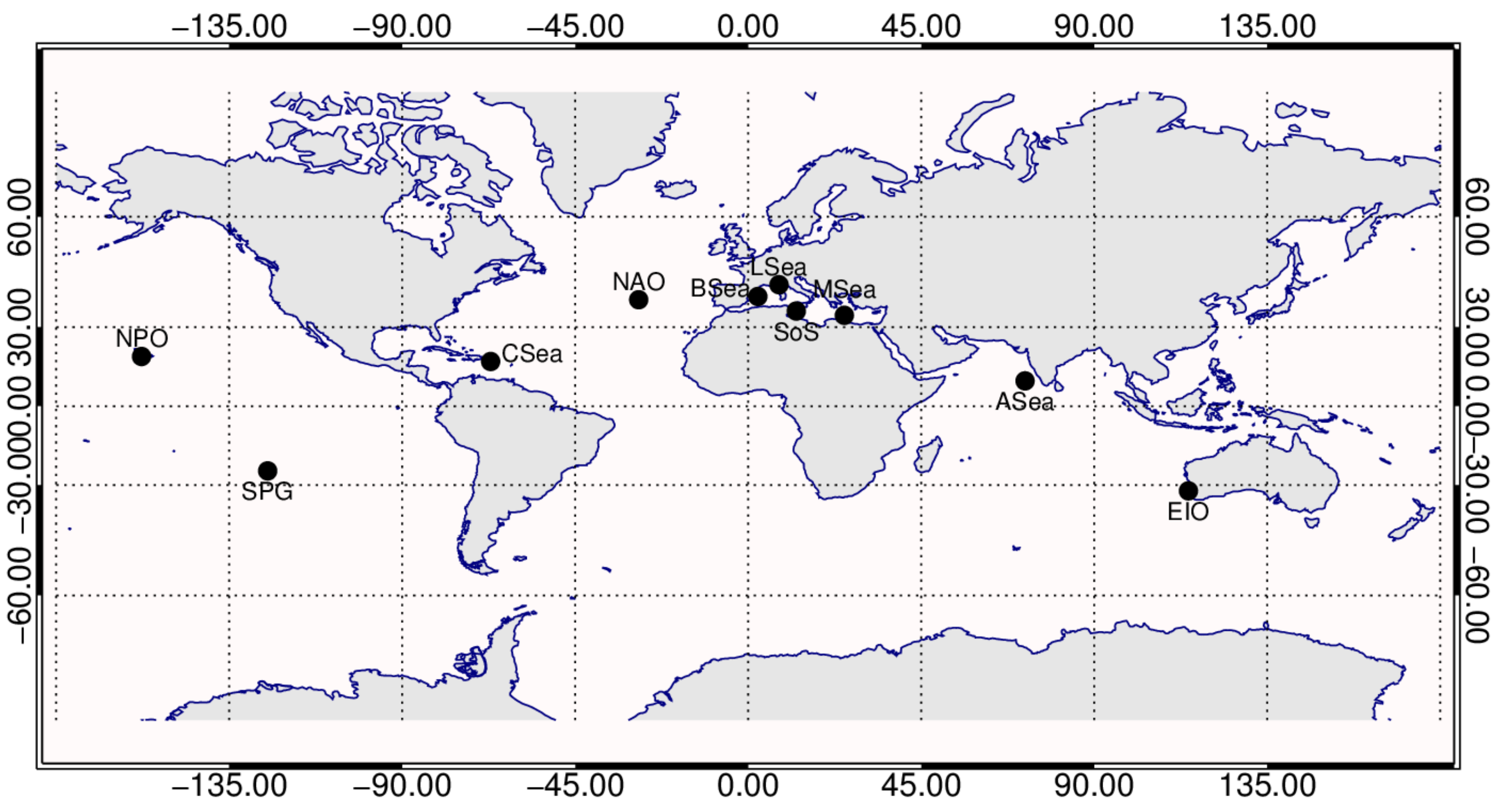
The sites

Without excluding other candidate areas, the regions considered satisfy the needs for:

i. nearby islands or coastal locations essential to ensure maintenance services of the offshore SVC infrastructure;

ii. distance from the coast to minimize adjacency effects in satellite data; and finally

iii. waters representative of the most common oceanic conditions.



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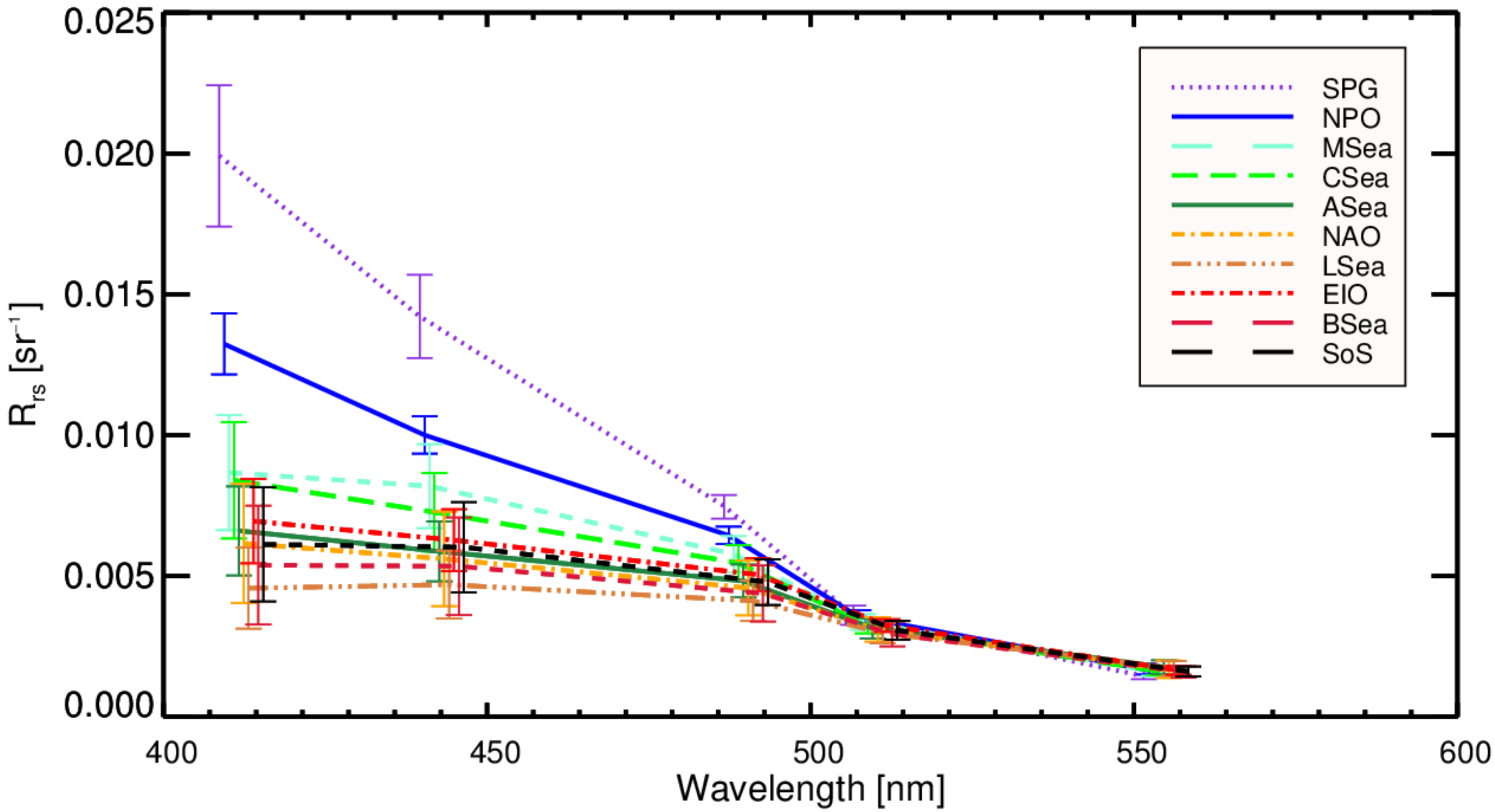
R_{RS} Spectra



Mean values of R_{rs} determined with SeaWiFS Level-3 data from the entire mission at the 412-555 nm bands for the considered marine regions. Error bars indicate $\pm 1\sigma$.

The South Pacific Gyre (SPG) spectrum is included as a virtual reference due to its highly oligotrophic waters likely ideal for SVC.

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Observations and potential matchups

	N	M	M vs N [%]	M_{CV}	M_{CV} vs M[%]
NPO	1768	212	12.0	187	88.2
MSea	2472	821	33.2	798	97.2
CSea	2071	242	11.7	218	90.1
ASea	1842	114	6.2	103	90.4
NAO	2796	274	9.8	256	93.4
LSea	3024	873	28.9	827	94.7
EIO	2101	382	18.2	367	96.1

SeaWiFS Level-2 full-resolution data over a 5-year period (1999-2003):

N indicates the number of available observations;

M is the number of cases remaining after applying the SeaDAS default exclusion flags;

M_{CV} indicates the number of cases that also passed the homogeneity test defined by a variation coefficient $C_V<0.2$ determined from the 5x5 values of R_{rs} at the 443, 490 and 555 nm bands.

Sites equivalence

Mean *m* and standard deviation σ of SeaWiFS Level-2 data products (*M*) non-flagged by the default SeaDAS exclusion flags:
R_{rs}(555) in units of sr^{-1} × 10^{-3}, k_d(490) in units of m^{-1}, *Chla* in units of µg l^{-1}, τ_a(865) and the α dimensionless.

		R_{rs}(555)		k_d(490)		Chla		τ_a(865)		α	
	M	m	σ	m	σ	m	σ	m	σ	m	σ
NPO	212	**1.54**	**0.29**	**0.027**	**0.004**	**0.07**	**0.01**	**0.07**	**0.04**	**0.88**	**0.40**
MSea	821	1.51	0.33	0.029	0.006	0.09	0.03	0.08	0.05	1.22	0.41
CSea	242	1.54	0.23	0.033	0.009	0.13	0.07	0.08	0.05	0.69	0.42
ASea	114	1.62	0.30	0.043	0.011	0.19	0.11	0.11	0.05	1.14	0.29
NAO	274	1.68	0.41	0.047	0.020	0.25	0.22	0.06	0.04	1.09	0.45
LSea	873	1.65	0.41	0.051	0.020	0.28	0.23	0.07	0.04	1.45	0.37
EIO	382	1.53	0.25	0.036	0.008	0.15	0.05	0.05	0.03	0.76	0.55
SoS	722	1.49	0.35	0.037	0.010	0.17	0.09	0.09	0.05	1.10	0.42
BSea	794	1.57	0.37	0.043	0.012	0.20	0.11	0.08	0.04	1.29	0.42

Basis for the identification of a new SVC site

Equivalence of measurement conditions across marine regions is expected to minimize differences in *g*-factors regardless of the geographic location of the SVC site.

However, the identification of multiple SVC sites may imply trading-off criteria related to the marine/atmospheric properties.

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Potential for match-ups

SeaWiFS Level-2 observations M_{CV} over the 5-year period not affected by SeaDAS Level-2 default exclusion flags and passing the spatial homogeneity with: *Chla*≤0.1 μg l^{-1}, *Chla*≤0.2 μg l^{-1}, τ_a(865) ≤0.10, τ_a(865) ≤0.15 and α≤1.0.

M_{Q1} indicates the number of potential high quality matchups identified through the application of combined tests on *Chla*≤0.1 μg l^{-1}, τ_a(865) ≤0.1 and α≤1.0 (M_{Q1}/year is the related number of potential high quality matchups per year).

M_{Q2} indicates results from the application of combined tests with *Chla*≤0.2 μg l^{-1}, τ_a(865) ≤0.15 and α≤1.0.

	M_{CV}	Chla≤0.1	Chla≤0.2	τ_a(865)≤.1	τ_a(865)≤0.15	α≤1.0	M_{Q1}(M_{Q1}/yr)	M_{Q2}(M_{Q2}/yr)
NPO	187	182	187	153	177	107	75 (15.0)	98 (19.6)
MSea	798	572	794	570	714	212	59 (11.8)	147 (29.4)
CSea	218	79	197	164	195	172	48 (9.6)	141 (28.2)
ASea	103	0	80	37	83	21	0 (0.0)	13 (2.6)
NAO	256	3	156	219	246	102	1 (0.2)	56 (11.2)
LSea	827	0	400	668	790	87	0 (0.0)	36 (7.2)
EIO	367	53	328	337	363	235	42 (8.4)	220 (44.0)
SoS	693	140	523	462	598	275	10 (2.0)	135 (27.0)
BSea	735	30	500	556	692	121	4 (0.8)	61 (12.2)

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General conclusion

Zibordi and Mélin (2017) came to the conclusion that *the analysis on potential high quality matchups confirms the superior location of the MOBy site in the northern Pacific Ocean for SVC.*

While recognizing that no site is superior for all criteria reviewed in the analysis, it nonetheless suggests that the Eastern Mediterranean Sea near the Island of Crete exhibits best equivalence with NPO and could be considered a suitable choice for a European SVC complying with requirements for the creation of CDRs.

Extended conclusion

When considering criteria less strict than those leading to best equivalence between NPO and MSea, the Eastern Indian Ocean region near Rottnest Island appears an excellent candidate for SVC.

EIO also offers the unique advantage of being located in the southern hemisphere, which implies solar zenith cycles opposite to those characterizing SVC sites located in the northern hemisphere.

Definitively, the existence of two sites operated in the two hemispheres would provide seasonal alternatives to SVC of satellite sensors heavily affected by glint perturbations.

Final Statement

It is further restated that the full analysis summarized above and the related conclusions, are strictly based on the assumption of MOBY (both region and radiometry) as the “ideal model” for SVC as a result of its demonstrated capability to deliver high precision *g*-factors with current atmospheric correction codes (see Zibordi et al. 2015).

The suggestion of alternative SVC sites based on selection criteria less strict than those applied in Zibordi and Mélin (2017) is definitively workable, but it would imply the need to demonstrate their suitability to meet the uncertainties required for *g*-factors devoted to support climate applications.