Supplementary Materials

See the bibliography of the article for the complete references cited in the supplementary materials.

A Characteristics of the sensors

Abbreviation	Full name	Satellite	Spatial resolution (m)	Spectral resolution	Temporal resolution	Swath (km)	Comments
ABI	Advanced Baseline Imager	Geostationary Operational Environmental Satellite (GOES)	500 - 2000	16 bands 0.47 - 13.3μm	10min		Geostationnary satellite
Dove	-	Planetscope	3	4 bands 0.4 - 0.8μm	1d	30	Polar-orbiting satellite
GOCI-II	Global Ocean Color Imager-II	Geostationary Korea Multi-Purpose Satellite-2 (GK2B)	500	8 bands 0.4 - 0.9μm	1h	2500	Geostationnary satellite
MERIS	Medium Resolution Imaging Spectrometer	Envisat	300	15 bands 0.4 - 1.04μm	3d	1150	Polar-orbiting satellite
MODIS	Moderate-Resolution Imaging Spectroradiometer	Aqua/Terra	250 - 1000	36 bands 0.4 - 14.4μm	1 - 2d	2330	Polar-orbiting satellite
MSI	MultiSpectral Instrument	Sentinel-2 (S2)	10 - 60	13 bands 0.4 - 2.2μm	5d	290	Polar-orbiting satellite Coast only (20km)
OLI	Operational Land Imager	Landsat 8	15 - 100	11 bands 0.4 - 12.5μm	16d	185	Polar-orbiting satellite Coast only
OLCI	Ocean and Land Colour Instrument	Sentinel-3 (S3)	300	21 bands 0.4 - 1.02μm	2d	1270	Polar-orbiting satellite
TM, ETM+	(Enhanced) Thematic Mapper (Plus)	Landsat 4, 5, 7	30 - 60	8 bands 0.45 - 12.5μm	16d	185	Polar-orbiting satellite Coast only (100-200km)
VIIRS	Visible Infrared Imaging Radiometer Suite	Suomi National Polar-orbiting Partnership (SNPP)	375 - 750	22 bands 0.4 - 12μm	1d	3040	Polar-orbiting satellite
WV-2	WorldView-2	WorldView-2	2	8 bands 0.4 - 1μm	Irregular	16	Polar-orbiting satellite

B Types of atmospheric correction

Atmospheric correction	Algorithm/Software	Sensor	Studies
TOA radiance/reflectance	-	MERIS	Gower and King 2011; Gower et al. 2013, 2006
		MSI	Ody et al. 2019; Qi et al. 2022
		OLCI	
		ABI	Minghelli et al. 2021
Rayleigh scattering correction	SeaDAS	MODIS	Descloitres et al. 2021; Hu et al. 2023; Minghelli et al. 2021; Ody et al. 2019; Podlejski et al. 2022; Sun et al. 2024; Wang and Hu 2016, 2018, 2020
		OLCI	Hu et al. 2023; Sun et al. 2024
		VIIRS	Hu et al. 2023; Sun et al. 2024; Wang and Hu 2018
	ACOLITE	MSI	Wang and Hu 2020
		OLI	
	POLYMER	MSI	Descloitres et al. 2021
	G2AC	GOCI-II	Shin et al. 2021
Aerosol, sunglint and Rayleigh scattering correction	POLYMERext	OLCI	Schamberger et al. 2022a,b

C Cloud, Land and Sunglint masks

L: Radiance, R: Rayleigh-corrected reflectance, R_{TOA}: TOA reflectance, R_{bkg}: Background reflectance

Mask	Threshold criteria	Sensor	Studies
Cloud, Land, Sunglint	$L(665) > 15mW.m^{-2}.nm^{-1}.sr^{-1}$	MERIS	Gower and King 2008, 2011
Cloud, Land	$R(NIR) > 0.13$	ABI	Minghelli et al. 2021
	$R(1610) > 0.1$	MSI	Wang and Hu 2020
Cloud	Provided cloud flag	OLCI	Ody et al. 2019
	$R(2250) > 0.03$	VIIRS	
	$R_{TOA}(665) > 0.15$	MSI	
	$R_{TOA}(665) > 0.1$		Qi et al. 2022
	$R(2130) > 0.03$	MODIS	Descloitres et al. 2021; Minghelli et al. 2021; Ody et al. 2019; Podlejski et al. 2022
Cloud, Sunglint	$R(667)$ or $R(748)$ or $R(869) > 0.2$	MODIS	Descloitres et al. 2021; Podlejski et al. 2022; Wang and Hu 2016
	$R(671)$ or $R(745)$ or $R(862) > 0.05$	VIIRS	Wang and Hu 2018
	$R(869) > 0.027$	MODIS, OlCI, VIIRS	Hu et al. 2023
	$R(SWIR) - 1.4 * R(SWIR)_{bkg} > 0$		Sun et al. 2024
	$R(1610) - R_{bkg}(1610) > 0.01$ and $R(2202) - R_{bkg}(2202) > 0.008$	MSI	Wang and Hu 2020

D Indices abbreviations

Abbreviation	Full name
MCI	Maximum Chlorophyll Index
FAI	Floating Algae Index
MSI-MFAI	Modified FAI for MSI
AFAI	Alternative FAI
LD	Line Depth
FLH	Fluorescence Line Height
MRE	MODIS Red Edge
NDVI	Normalized Difference Vegetation Index
RGR	Red/Green band Ratio
DVI	Difference Vegetation Index
SRG	Slope of the Red/Green
SAVI	Soil Adjusted Vegetation Index
EVI	Enhanced Vegetation Index
ARVI	Atmospherically Resistant Vegetation Index
GRD	Green/Red Difference

E Spectral indices used in *Sargassum* detection

R: Reflectance; NIR: Near-InfraRed; λ: Wavelength; C, C_1, C_2, C_3: Constants; See Suppl. Mat. A and D for indexes and sensors abbreviations

Reference not in the bibliography: Gower, J. F. R., King, S. A. (2019). "The distribution of pelagic Sargassum observed with OLCI". In: International Journal of Remote Sensing 41.15, pp. 5669–5679. issn: 0143-1161, 1366-5901. doi: 10.1080/01431161.2019.1658240. url: https://www.tandfonline.com/doi/full/10.1080/01431161.2019.1658240

Index	Formula	Wavelength (nm)	Sensor	Studies
MCI	$R_{\lambda_2} - R'_{\lambda_2}$ with $R'_{\lambda_2} = R_{\lambda_1} + (R_{\lambda_3} - R_{\lambda_1}) * \frac{\lambda_2-\lambda_1}{\lambda_3-\lambda_1}$	λ_1: 681, λ_2: 709, λ_3: 753	MERIS, OLCI	Gower and King 2011, 2019; Gower et al. 2013, 2006; Laval et al. 2023; Ody et al. 2019; Schamberger et al. 2022a,b
FAI		λ_1: 645, λ_2: 859, λ_3: 1240	MODIS	Hu 2009; Hu et al. 2015; Laval et al. 2023; Wang and Hu 2021
		λ_1: 655, λ_2: 865, λ_3: 1610	OLI	Cuevas et al. 2018; Uribe-Martínez et al. 2022; Wang and Hu 2021
		λ_1: 660, λ_2: 825, λ_3: 1650	TM, ETM+	Hu et al. 2015, 2016
		λ_1: 659, λ_2: 833, λ_3: 949	WV-2	Wang and Hu 2021
		λ_1: 665, λ_2: 865, λ_3: 1610	MSI	Laval et al. 2023; Wang and Hu 2020
MSI-MFAI		λ_1: 665, λ_2: 833, λ_3: 940	MSI	Ody et al. 2019
AFAI		λ_1: 667, λ_2: 748, λ_3: 869	MODIS	Descloitres et al. 2021; Hu et al. 2023; Laval et al. 2023; Maréchal et al. 2017; Minghelli et al. 2021; Ody et al. 2019; Podlejski et al. 2022; Rodríguez-Martínez et al. 2022; Sun et al. 2024; Wang and Hu 2016, 2017; Wang et al. 2018
		λ_1: 665, λ_2: 740, λ_3: 865	MSI	Descloitres et al. 2021; Laval et al. 2023; Qi and Hu 2021; Qi et al. 2022
		λ_1: 665, λ_2: 754, λ_3: 865	OLCI	Hu et al. 2023; Qi and Hu 2021; Sun et al. 2024
		λ_1: 671, λ_2: 745, λ_3: 862	VIIRS	Hu et al. 2023; Ody et al. 2019; Sun et al. 2024
LD		λ_1: 602, λ_2: 623, λ_3: 647	-	Hu et al. 2015
FLH		λ_1: 665, λ_2: 676, λ_3: 746	MODIS	Gower et al. 2006
MRE		λ_1: 678, λ_2: 748, λ_3: 870	MODIS	Gower et al. 2013
NDVI	$\frac{R_{NIR}-R_{Red}}{R_{NIR}+R_{Red}}$	λ_{Red}: 640, λ_{NIR}: 860	ABI, PRISM	Dierssen et al. 2015; Hu et al. 2015; Minghelli et al. 2021
		λ_{Red}: 665, λ_{NIR}: 865	OLCI	Laval et al. 2023
		λ_{Red}: 655, λ_{NIR}: 865	OLI	Cuevas et al. 2018; Uribe-Martínez et al. 2022
		λ_{Red}: 665, λ_{NIR}: 833	MSI	Fidai et al. 2023; Laval et al. 2023
		λ_{Red}: 645, λ_{NIR}: 859	MODIS	Hu 2009
SI	$\frac{R_{\lambda_2}}{R_{\lambda_1}}$	λ_1: 633, λ_2: 646	-	Hu et al. 2015
		λ_1: 630, λ_2: 650	GOCI-II, PRISM	Dierssen et al. 2015; Shin et al. 2021
RGR	$\frac{R_{Red}}{R_{Green}}$	λ_{Green}: 555, λ_{Red}: 647	-	Hu et al. 2015
DVI	$R_{NIR} - R_{Red}$	λ_{NIR}: 865, λ_{Red}: 660	GOCI-II	Shin et al. 2021
EVI	$C * \frac{R_{NIR}-R_{Red}}{R_{NIR}+C_1*R_{Red}-C_2*R_{Blue}+C_3}$	λ_{Blue}: 469, λ_{Red}: 645, λ_{NIR}: 859	MODIS	Hu 2009
		λ_{Blue}: 482, λ_{Red}: 655, λ_{NIR}: 865	OLI	Cuevas et al. 2018; Uribe-Martínez et al. 2022
SRG	$\frac{R_{Red}-R_{Green}}{\lambda_{Red}-\lambda_{Green}} * 1000$	λ_{Green}: 555, λ_{Red}: 660	GOCI-II	Shin et al. 2021
GRD	$(R_{Red} - R_{Green})$	λ_{Green}: 560, λ_{Red}: 665	OLCI, MSI	Qi and Hu 2021
SAVI	$\frac{R_{NIR}-R_{Red}}{R_{NIR}+R_{Red}+C} * (1 + C)$	λ_{Red}: 655, λ_{NIR}: 865	OLI	Cuevas et al. 2018; Uribe-Martínez et al. 2022
ARVI	$\frac{R_{NIR}-(R_{Red}-C*(R_{Blue}-R_{Red}))}{R_{NIR}+(R_{Red}-C*(R_{Blue}-R_{Red}))}$	λ_{Blue}: 482, λ_{Red}: 655, λ_{NIR}: 865	OLI	Cuevas et al. 2018; Uribe-Martínez et al. 2022

F Estimation of *Sargassum* biomass

d_{Sarg}: *Sargassum* density biomass; FC: Fractional Cover; SRI: Spectral Reflectance Index

Index	Formula	Comments	Studies
FAI	$FC = \frac{\text{Number of pixels with } Sargassum}{\text{Total number of pixels}} * 100$	-	Hu et al. 2016
MCI	$FC = \alpha * \sum_{m=b+t}^{m=\infty} (m-b) * n(m)$ with α is a constant, b is the background value, t is the threshold value, $n(m)$ is the number of pixels with an index value of m	-	Gower and King 2008, 2011
AFAI	$FC = \frac{SRI - SRI_l}{SRI_u - SRI_l} * 100$ with SRI_l and SRI_u are the lower and upper bounds for a given pixel, corresponding to a 0% and 100% coverage respectively	The coefficients are either determined by radiative transfer modeling or by extracting the SRI value of pixels without any *Sargassum.*	Wang and Hu 2016
AFAI	$\delta SRI = \alpha * FC$ with α is a constant function of reflectance of pure *Sargassum* and of pure water at different wavelengths	α can be analytically calculated or empirically determined by extracting the δSRI value of pixels with dense, thick and shallow mats as a proxy of pure *Sargassum* pixel ($FC = 1$) Relationship only valid for indices defined as a linear function of reflectances (e.g. AFAI, FAI or MCI)	Descloitres et al. 2021
AFAI	$d_{Sarg} = \alpha_0 * AFAI \quad \text{if } 0 < AFAI < \beta$ $d_{Sarg} = \alpha_1 * (AFAI - \beta)^2 + \alpha_2 * (AFAI - \beta) + \alpha_3 \quad \text{if } AFAI > \beta$ with $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ and β values depending on the sensor	-	Wang et al. 2018
FAI			Wang and Hu 2020

G Machine learning algorithms used in *Sargassum* detection

CNN: Convolutional Neural Network; RGB: Red Green Blue; Rc: Rayleigh-corrected

Objective	Algorithm	Sensor	Classes	Input data	Studies
Detection at sea	RandomForest	OLI	*Sargassum*, open sea, cloud, cloud shadow, sunglint	Surface reflectance of B and NIR or SWIR bands, NDVI, ARVI, SAVI, EVI, FAI	Cuevas et al. 2018
					Uribe-Martínez et al. 2022
	ErisNet, Multilayer perceptron, Fully Convolutional Network	MODIS	*Sargassum*, no *Sargassum*	Surface and TOA reflectance in 7 bands (VIS, NIR SWIR)	Arellano-Verdejo et al. 2019
	ErisNet, UNet, SegNet, New developed CNN approach	MSI, OLCI		Surface reflectance in all bands	Laval et al. 2023
	VGGUnet	Dove		TOA radiance of RGB bands	Wang and Hu 2021
		MSI, OLI, WV-2		FAI	
	UNet	MSI		AFAI	Qi et al. 2022
		MODIS, OLCI, VIIRS		Rc reflectance in 7 bands (VIS and NIR) + AFAI	Hu et al. 2023
	FANet			Rc reflectance in 4 bands (VIS and NIR) + AFAI	Sun et al. 2024
On shore detection	MobileNetV2	Ground photographs	*Sargassum*, Vegetation, Sky, Water, Sea foam and swash, Sand, Anthropomorphic features	RGB images	Valentini and Balouin 2020
	LeNet-5, AlexNet, VGG16		*Sargassum*, no *Sargassum*		Arellano-Verdejo and Lazcano-Hernández 2021
	Support Vector Machine				Rutten et al. 2021
	AlexNet, GoogleNet, VGG, ResNet		*Sargassum* amount: No, Low, Mild, Plenty, Excessive		Vasquez et al. 2022
	Pix2Pix		*Sargassum*, Sand, Other		Arellano-Verdejo et al. 2022
		Drone photographs			Arellano-Verdejo and Lazcano-Hernandez 2024
	UNet	Dove	*Sargassum* on beach, *Sargassum* on water	TOA reflectance in 4 bands (RBG + NIR)	Zhang et al. 2022
Decay stages	RandomForest	MSI	Fresh *Sargassum*, Decomposing *Sargassum*, Brown tide , Water, Mangrove, Clouds	TOA reflectance of 12 bands of MSI + 16 indexes	León-Pérez et al. 2023
False detection correction	Naive Bayes classifier, Decision tree, Support Vector Machine, Linear Discriminant Analysis, Adaboost, Gradient Tree Boosting, XGBoost, RandomForest	MODIS	*Sargassum*, no *Sargassum*	Indexes of geographical proximity to other patches, to coasts, of time persistence and FC standard deviation per aggregation	Podlejski et al. 2022

H Detection and discrimination threshold

The range in Hu et al. 2015 refers to water turbidity; in Qi and Hu 2021 it refers to water turbidity and atmospheric conditions.
FC: Fractional coverage

Sensor	Index	Detection condition (% of pixel size)	Discrimination condition (% of pixel size)	Studies
MODIS	FAI	$Slickwidth > 25\%$	-	Hu 2009
MODIS	AFAI	$FC > 0.2\%$	-	Wang and Hu 2016
ABI	NDVI	$FC > 2\%$	-	Minghelli et al. 2021
Simulated sensor (60m spatial resolution)	NDVI	$FC > 1 - 2\%$	$FC > 20 - 30\%$	Hu et al. 2015
OLCI	AFAI/GRD	$FC > 0.27 - 0.55\%$	$FC > 0.65 - 2.03\%$	Qi and Hu 2021
MSI	AFAI/GRD	$FC > 0.84 - 2.19\%$	$FC > 2.13 - 6.21\%$	Qi and Hu 2021

I Ocean surface velocity data sources

Source	Nature	Resolution	Studies
Global HYbrid Coordinate Ocean Model (HYCOM)	Model	1/12°	Brooks et al. 2019, 2018; Franks et al. 2016; Johns et al. 2020; Johnson et al. 2020; Lara-Hernández et al. 2024; Putman et al. 2018, 2020
Ocean reanalysis from Mercator Ocean (GLORYS12 and GLORYS2V4)		1/12° 1/4°	Berline et al. 2020; Jouanno et al. 2021, 2023, 2025; Machado et al. 2024; Marsh et al. 2021; Podlejski et al. 2024
Surface and Merged Ocean Currents (SMOC)	Observation	1/12°	Sebille et al. 2021
Ocean Surface Current Analysis Real-time (OSCAR)		1/3°	Johnson et al. 2020
Drifter-based currents climatology		1/12°	Alleyne et al. 2023; Johns et al. 2020; Podlejski et al. 2023
Altimetry-derived geostrophic velocity		1/4°	Bonner et al. 2024; Podlejski et al. 2023

J Wind velocity data sources

Source	Nature	Resolution	Studies
National Centers for Environmental Prediction (NCEP) Reanalysis	Model	2.5°	Johns et al. 2020; Johnson et al. 2020; Lara-Hernández et al. 2024; Putman et al. 2018; Zhong et al. 2012
European Centre for Medium-Range Weather Forecasts (ECMWF) and forecast products		HRES: 9km ERA5: 0.25° SEAS5: 36km DFS5.2: 0.7°	Berline et al. 2020; Bonner et al. 2024; Jouanno et al. 2021, 2023, 2025; Lara-Hernández et al. 2024; Marsh et al. 2021; Podlejski et al. 2023, 2024
National Oceanic and Atmospheric Administration (NOAA) Blended Sea Winds dataset	Observation	0.25°	Putman et al. 2020

K Windage factor

Reference not in the bibliography: Olascoaga, M. J., Beron-Vera, F. J., Beyea, R. T., Bonner, G., Castelluci, M., Goni, G. J., Guigand, C., Putman, N. F. (2023). "Physics-informed laboratory estimation of Sargassum windage". In: Physics of Fluids 35.11, p. 111702. issn: 1070-6631, 1089-7666. doi: 10.1063/5.0175179. url: `https://pubs.aip.org/pof/article/35/11/111702/2920880/Physics-informed-laboratory-estimation-of`

Current data sources	Windage	Studies
Model-based currents	1%	Berline et al. 2020; Johns et al. 2020; Johnson et al. 2020; Jouanno et al. 2023; Marsh et al. 2021; Podlejski et al. 2024; Putman et al. 2018
	0.1%	Jouanno et al. 2021
Drifter-based currents	0.5%	Alleyne et al. 2023; Johnson et al. 2020
Dedicated drifters tracking Sargassum aggregations	0-3%	Tussenbroek et al. 2024
Sargassum velocity from satellite tracking	3%	Podlejski et al. 2023
Laboratory experiments	0.02-0.96%	Olascoaga et al. 2023

L Field measurements of *Sargassum* aggregations

Topic	Objective	Data	Type	Studies
Offshore measures	*Sargassum* detection	Spectral measurements	Boat	Dierssen et al. 2015; Hu et al. 2015
	Presence / Absence of *Sargassum*	List of pixels labeled if Sargassum observed	Undefined	Arellano-Verdejo et al. 2019
		Geolocated photos	Aircraft	Hu et al. 2015, 2016
		Hyperspectral acquisitions		
	Sargassum distribution and abundance	Rafts latitude and longitude recordings	Aircraft	Hu et al. 2015; Powers et al. 2013
			Boat	Changeux 2017; Goodwin et al. 2022; Ody et al. 2019; Thibaut 2017
		Hyperspectral acquisitions	Aircraft	Dierssen et al. 2015; Szekielda et al. 2010
		Raft size measurements	Aircraft	Hu et al. 2016
			Boat	Hu et al. 2016; Ody et al. 2019
		Extrapolation of *Sargassum* occurrence from an ichthyoplankton database	Boat	Sanchez-Rubio et al. 2018
	Modelisation of biomass density from spectral measures	Spectral, wet weight and areal coverage measurements	Boat	Wang et al. 2018
	Disintegration of aggregations due to wind	Hyperspectral acquisitions	Aircraft	Marmorino et al. 2011
	Sargassum aggregation trajectory	Trackers deployed on *Sargassum* mats	Drifters	Fidai et al. 2023; Putman et al. 2020; Tussenbroek et al. 2024

Topic	Objective	Data	Type	Studies
Onshore measures	Presence / Absence of beached *Sargassum*	Opportunistic photos of the shoreline	Drone	Hernández et al. 2022
		Beach surveys reports	Land-based	Maréchal et al. 2017
		Beach photos gathered through crowdsourcing		Arellano-Verdejo and Lazcano-Hernández 2021; Trinanes et al. 2021
		Videos, Webcams		Trinanes et al. 2021
	Composition and abundance in morphotypes	Beach photos gathered through crowdsourcing		Iporac et al. 2022
		Weight measurement		García-Sánchez et al. 2020; Torres-Conde et al. 2023; Vázquez-Delfín et al. 2021
		Volume measurement		Alleyne et al. 2023
		Sampling for identification		Mendez-Tejeda and Rosado Jiménez 2019
	Sargassum distribution and abundance	Beach photos gathered through crowdsourcing		Arellano-Verdejo et al. 2022; Iporac et al. 2022; Putman et al. 2023
		Videos, Webcams		Bouvier 2024; Moisan et al. 2021; Putman et al. 2023; Rutten et al. 2021; Uribe-Martínez et al. 2022; Valentini and Balouin 2020
		Volume of algae removed by hotels/municipalities		Rodríguez-Martínez et al. 2022; Sissini et al. 2017; Uribe-Martínez et al. 2022
		Cross-sectional area estimation		Bartlett and Elmer 2021
		Photos of the shoreline	Drone	Arellano-Verdejo and Lazcano-Hernandez 2024; Arellano-Verdejo et al. 2022
	Sargassum decaying stages	Opportunistic photos of the shoreline	Boat, Drone	León-Pérez et al. 2023
		Spectral measurements, Photos of the shoreline	Land-based, Drone	Fidai et al. 2024