Comparison of Sentinel-3 OLCI simulated data with MERIS for Ocean Color parameter estimation

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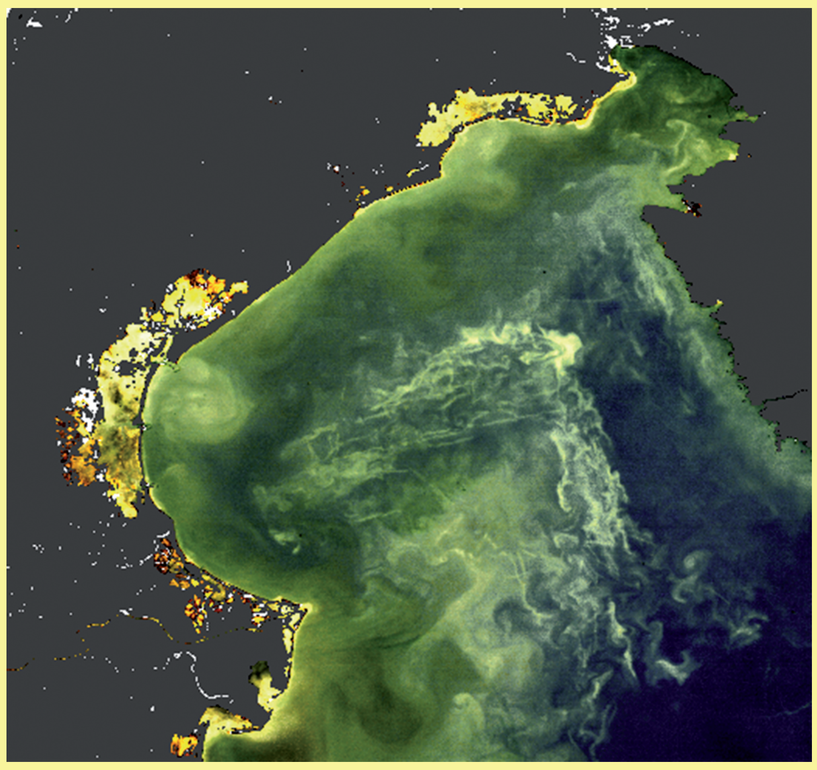
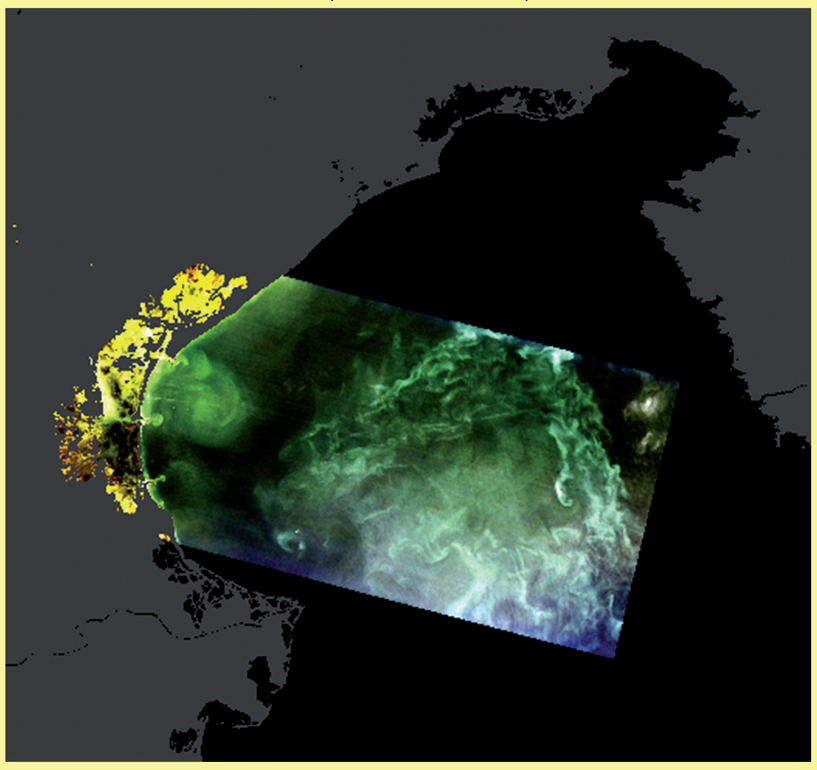
ESA's upcoming satellite Sentinel-3 will provide continuity for altimeter and optical medium spatial resolution imagery, with high temporal resolution. The aim is to ensure continuity to ENVISAT observations, as well as MODIS and SeaWiFS. Sentinel-3 will carry the OLCI sensor (Ocean and Land Color Instrument), a multispectral medium resolution instrument planned for Ocean Color observation designed to minimise sun-glint and composed with 21 spectral bands. In comparison to the latter sensors, Sentinel-3 includes two new spectral bands in the NIR spectrum for the aerosol retrieval required to perform an accurate atmospheric correction a new band in the red region, which represents a peak in of the plankton bloom centered at 673.75 nm.
The objective of this study is to evaluate the performance of the upcoming multispectral sensor by comparing OLCI reflectance, obtained from hyperspectral satellite imagery processing, with synchronous MERIS data. Selected satellite observations, acquired on 11/01/2012 over northern Adriatic Sea basin, show turbidity patterns due to wave-generated resuspension of sediments during intense wind stress conditions, which caused variation in water column turbidity.

Envisat MERIS
acquired on 11 January 2012 09:49:14 UTC
(tristimulus RGB)



Simulated OLCI multispectral
from HICO optical hyperspectral
acquired on 11 January 2012 13:21:15 UTC
(tristimulus RGB)



MATERIALS AND METHODS

HICO optical hyperspectral data, acquired on 11 January 2012 13:21:15 UTC, has been used to simulate OLCI multispectral data in both spatial and spectral scales. The atmospheric correction of HICO image was performed by the HICO@CRI algorithm described in Bassani et al. (2015). The algorithm is based on the 6SV atmospheric radiative transfer model (Kotchenova et al., 2008; Vermote et al., 1997). The 6SV code simulates the crucial contributions (i.e., specular reflection, foam contribution) for atmospheric correction over water, as reported in Kotchenova et al. (2006). Gao et al. (2000) water-leaving reflectance equation is solved, furthermore HICO@CRI algorithm removes the adjacency effect, not negligible in coastal zones, using the empirical formula (Vermote et al., 1997).
In order to evaluate the performance of the simulated OLCI data for Ocean Color products retrieval, CoastColour algorithm (Brockmann et al., 2012) has been used to estimate L2W geophysical water products from inversion of Remote sensing reflectances (Rrs) spectra.
Envisat MERIS acquired on 11 January 2012 09:49:14 UTC has been used to quantitatively compare Rrs and L2W geophysical water products. MERIS Level 1 Full Resolution Full Swath data (MER_FRS_1P) has been collected through the MERIS MERCI system and processed from L1b to L2W using CoastColour v2 processor, to perform atmospheric correction and geophysical parameters estimation.

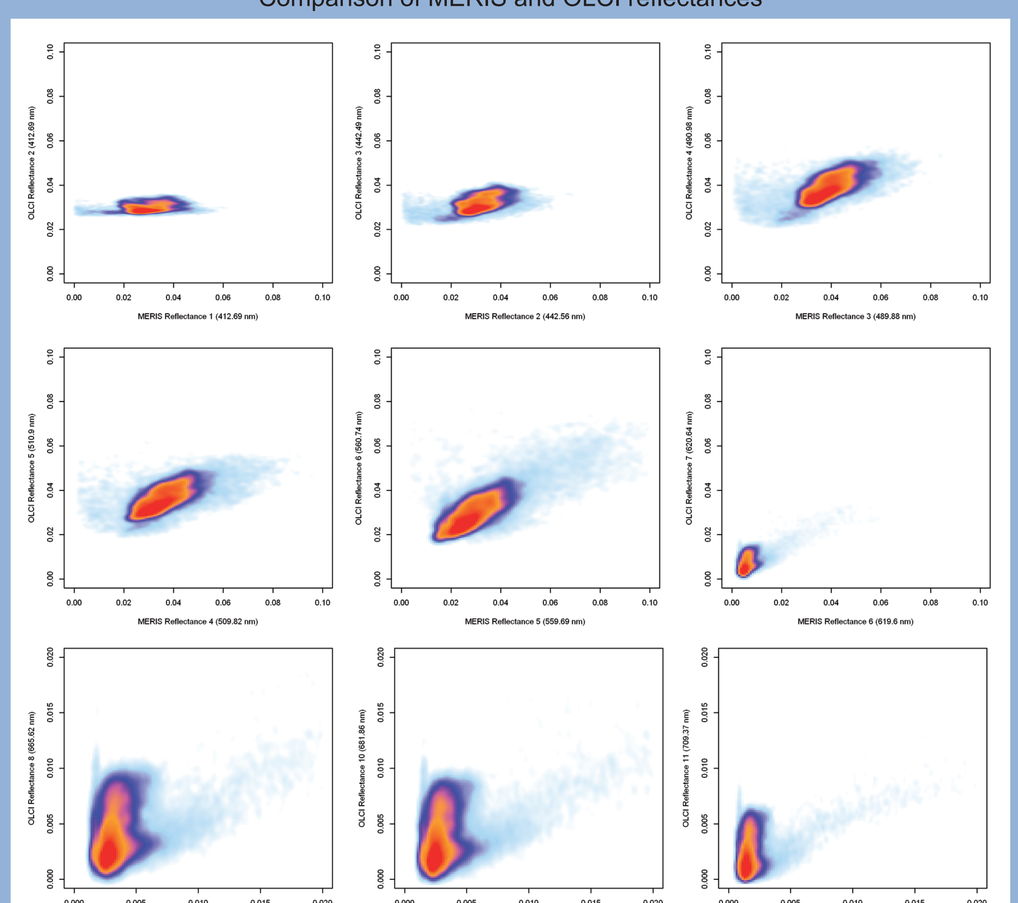
RESULTS

The comparison of MERIS Rrs and OLCI simulated Rrs reported in the scatterplot figure show high correlation of reflectances, R2 values ranges between 0.07 and 0.56. It has to be noticed that the HICO data has been acquired with about 3 hours delay, thus pixel matching may figure out differences due to hydrodynamic forcing. Low correlation of reflectance band at 412nm may be related to the use of different atmospheric correction methods, accounting for different corrections. Decreasing correlation with increasing of wavelengths may related to low reflectance values and decreasing signal to noise ratio.
Total Suspended Matter estimated from MERIS Rrs and OLCI simulated Rrs has been retrieved for the comparison of L2W products. Estimated TSM products show a good agreement (R2=0.7), as reported in TSM maps and scatterplot.
Maps of TSM show an increased turbidity in the offshore area, with spatial patterns revealing small scale hydrodynamic features. Estimated turbidity, is due to high sediment concentration in the water column, due to wave-generated sediment resuspension and transport during intense wind forcing.

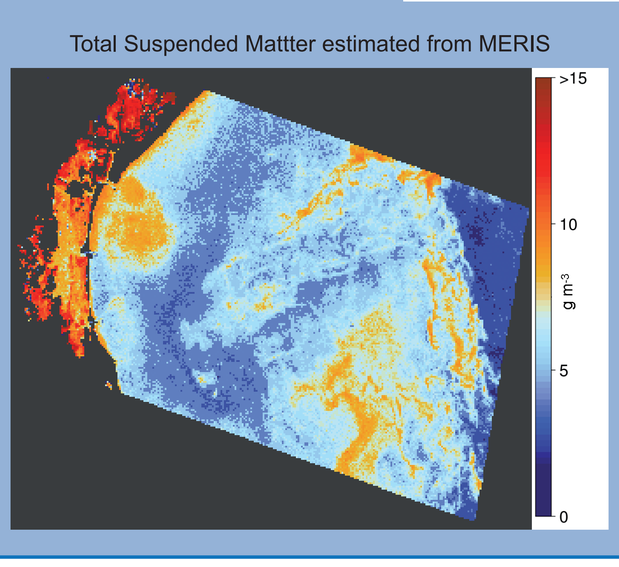
OLCI and MERIS spectral configuration
Coefficient of determination of Rrs comparison

	OLCI Wavelength	FWHM	MERIS Wavelength	FWHM	Coefficient of determination
Band 1	400.28	14.63			
Band 2	412.69	9.80	412.69	9.94	0.07
Band 3	442.49	9.91	442.56	9.95	0.23
Band 4	490.98	9.94	489.88	9.96	0.41
Band 5	510.90	9.94	509.82	9.96	0.40
Band 6	560.74	9.95	559.69	9.97	0.53
Band 7	620.64	9.98	619.60	9.98	0.56
Band 8	665.62	9.99	664.57	9.99	0.49
Band 9	674.36	7.48			
Band 10	681.86	7.51	680.82	7.49	0.47
Band 11	709.37	9.98	708.33	9.99	0.49
Band 12	754.39	7.49	753.37	7.50	0.30
Band 13	761.89	2.65	761.51	3.74	
Band 14	764.40	3.76			
Band 15	768.15	2.65			
Band 16	779.41	14.99	778.41	15.01	0.29
Band 17	865.73	19.93	864.88	20.05	0.21
Band 18	885.73	9.95	884.94	10.02	
Band 19	900.74	9.96	900.00	10.02	
Band 20	940.74	19.81			
Band 21	1024.67	23.89			

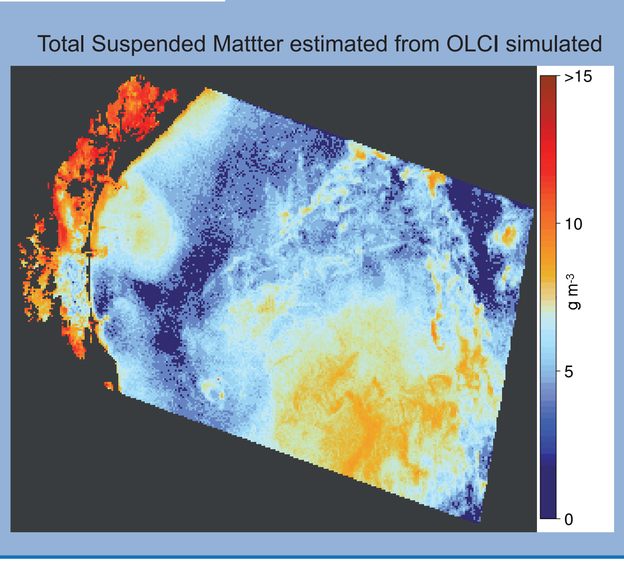
Comparison of MERIS and OLCI reflectances



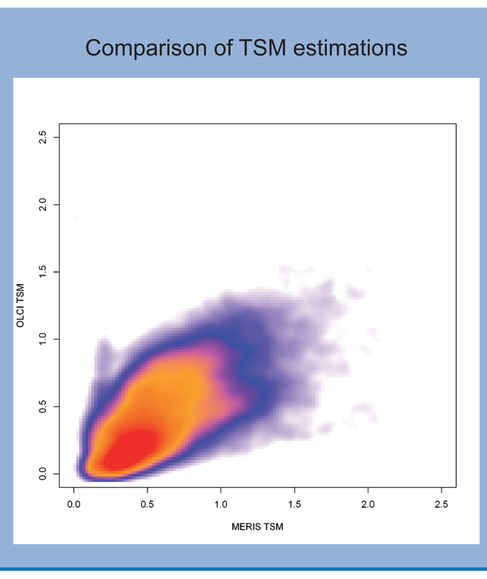
Total Suspended Mattter estimated from MERIS



Total Suspended Mattter estimated from OLCI simulated



Comparison of TSM estimations



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