Coastcolour in the Aegean Sea – Eastern Mediterranean

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Abstract

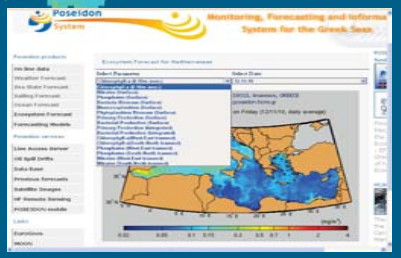
This poster presentation provides an initial assessment of the Coastcolour products for the Aegean Sea – Eastern Mediterranean. It does this in the context of the developments in ocean colour at HCMR. It highlights some details of the Aegean-Sea, Eastern Mediterranean test site and in-situ data for the project and the need for accurate coastal ocean colour products at HCMR. Previous validation efforts as well as recent and ongoing developments in ocean colour research are shown and their relevance to Coastcolour highlighted.

Location

Biological activity in the upper ocean can be directly related to climate change. In particular, phytoplankton plays a crucial role in fixing CO_2 through photosynthesis (primary productivity) and thus mediating in carbon fluxes between the ocean and the atmosphere. The Eastern Mediterranean represents an ideal marine environment for investigating changes in biological activity of the upper ocean. This is because its ultra-oligotrophic character makes it more sensitive to input changes as they tend to be explicitly expressed in ecosystem responses (Turley, 1999). Over recent decades HCMR has extensively sampled parameters important to measuring and monitoring this in the Eastern Mediterranean through research cruises. The major sampling efforts that include coastal regions, and that coincide with the Coastcolour temporal range (2005-2009), and where chlorophyll-a, CDOM or suspended particulate matter have been measured by HCMR, are summarised in the figure above.

The need for accurate ocean colour products at HCMR

- Biological oceanography, e.g. phytoplankton monitoring and climate change
- Coastal water quality monitoring
- Coupled Hydrodynamic-ecological modelling



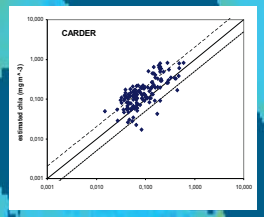
An important part of biological oceanography at HCMR looks at basin scale estimates of phytoplankton biomass and primary productivity in the upper ocean. This requires high resolution wide area coverage data not easily provided by conventional surveys. 'Ocean colour' satellite remote sensing can provide this in terms of chlorophyll-a estimates which act as a good index for phytoplankton biomass if these estimates are accurate.

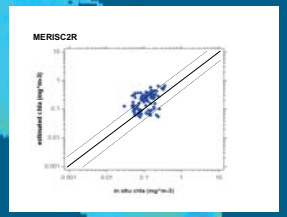
Data on coastal water quality is essential for HCMR in order to follow some important EU directives (e.g. Water Framework Directive and Marine Strategy Framework Directive) that relate to the quality of the marine environment. Being able to rely on the accuracy of satellite estimates of biophysical and hydrological optical parameters would aid in this monitoring effort.

The POSEIDON monitoring, forecasting and information system for the Greek Seas (see above) uses atmospheric, hydrodynamic, wave and ecological models. The assimilation of accurate satellite ocean colour products would improve coupled hydrodynamic-ecological models and their output, thus improving the system. The more reliable the data the better the models will be constrained.

Ocean Colour Product Validation

Chlorophyll-a





	N	r	slope	D	AD	PD	APD	R
carder	149	0,703	1,472 (0,069)	0,057	0,060	63,063	67,606	1,631
gsm01	114	0,723	1,531 (0,073)	0,066	0,070	80,527	85,341	1,805
oc3	159	0,718	1,810 (0,080)	0,160	0,160	210,468	210,468	3,105
clark	158	0,755	2,238 (0,092)	0,180	0,181	256,990	256,990	3,570

	N	r	slope	D	AD	PD	APD	R
merisc2r	96	0.5218	1.108 (0.094)	0.1075	0.1317	107.4182	121.9031	2.0742

Biological oceanographers at HCMR have for decades sampled and demanded accurate chlorophyll-a as one of the standard parameters for their phytoplankton and biological productivity studies. It was for this reason that in 2005 we first looked at the accuracy of this parameter derived from satellite data in the Aegean and Eastern Mediterranean. Unfortunately, the accuracy of satellite derived chlorophyll-a estimates, particularly for case 2 and more often than not for case 1 waters, has been found to be low in the Eastern Mediterranean. During our tests (unpublished, see summary figures and tables above) we concurred with previous research (e.g. Bricaud et al., 2002, Sancak et al., 2005) with even locally tuned algorithms failing to provide data of sufficient quality for our needs. This is in part due to the oligotrophic nature of the region (with concentration ranges extending to extremely low levels) and also we believe due to the predominantly empirical algorithm methodology previously employed, where they tend to only perform well for the regions where the *in situ* data was collected that was used for their creation. Clearly, if there are accuracy problems for case 1 waters the problem will be compounded for case 2 waters where other optically active components present in the water column, such as non algal suspended particulate matter and coloured dissolved organic matter, cause empirical relationships to break down. Following the recommendations of the IOCCG (IOCCG, 2005) we turned our attention to IOP and radiative transfer based analytical approaches.

Coastcolour and Recent Advances

HMCR has contributed to the Coastcolour validation effort with the following extensive in-situ data sets:

- Sampled chlorophyll data from 2002-2009. For Chlorophyll a determinations water samples are taken from 6 standard depths (2, 10, 20, 50, 75 and 100 m) in the euphotic layer. After filtration chlorophyll a is determined fluorometrically according to Yentsch and Menzel (1963), using a Turner Designs 112 fluorometer.
- CDOM absorption data from 2008
- Suspended particulate matter data from 2005 and 2008. This included the optical data from the Chelsea Alphatracka II and WetLabs C-Star transmissometers as well as sampled concentrations of SPM.

These data have been taken from HCMR research cruises and monitoring efforts in the Eastern Mediterranean and the hundreds of sample stations included represent the work of many HCMR scientists and technicians.

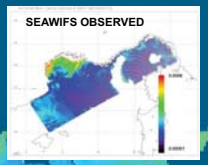
Initial comparisons between Coastcolour derived parameters and in-situ measurements show a much better agreement than those from previous satellite derived estimates. However, to date only a limited number of match-ups have been looked at between 2005 and 2008 thus precluding a full statistical analysis. Furthermore, the chlorophyll comparison, although good, is not really valid as the temporal match-up was not exact (a difference of 2-3 days).

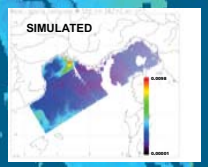
It is envisaged that if the project provides users with the ability to implement the full Coastcolour processing methodology then enough match-ups to produce valid statistical results may be possible from pre-2005 data and data collected from ongoing efforts.

Nevertheless, preliminary results look very encouraging and provide support for the Coastcolour improved coastal ocean colour methodology (see Coastcolour Product User Guide - http:\\coastcolour.org).

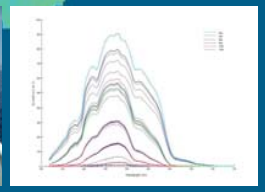
ONGOING OCEAN COLOUR WORK AT HCMR

- OBSERVATION OPERATOR SYSTEM
- HYPERSPECTRAL RADIOMETRY FIELD MEASUREMENTS
- TIME SERIES TREND ANALYSES

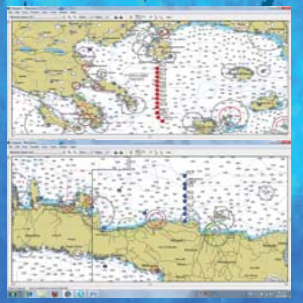




One alternative approach we are following at HCMR for more accurate and useful products from ocean colour data is the observation operator system we have developed with other European partners (Banks et al., 2011). This is based on biogeochemical, biooptical and radiative transfer modelling and sensor simulation.



Recently HCMR has initiated a remote sensing and bio-optics development program internally. This includes the purchase and operation of hyperspectral radiometers for both on board and euphotic zone casts deployment for a more comprehensive optical satellite sensor validation capability in the Eastern Mediterranean. These have been operational on major cruises since 2010. This capability is being extended early in 2012 to a full optical suite of in situ sensors that are capable of being deployed simultaneously with the biogeochemical sensors on our large CTD+ rosette or separately from smaller research vessels. The full suite is comprised of absorption, backscatter, CDOM, PAR, and auxiliary sensors as well as 3 hyperspectral radiometers.



Bio-optical survey of the Aegean and M3A Buoy Monitoring Site

Simultaneously to the remote sensing and bio-optics initiative, HCMR has designated one of the POSEIDON buoys as a biological oceanographic observatory in the Eastern Mediterranean. This is known as the M3A buoy (see photograph) and since 2010 detailed biogeochemical measurements are sampled monthly from the site to supplement the on-board sensors. From next year the full optical suite of sensors will also be deployed during these monthly visits.

For the first time these capabilities will allow a concurrent biogeochemical and optical survey of the Aegean within an upcoming European project following the Northern and Southern transects as seen in the maps above. The Southern cruise transect has been designed to include the M3A site.

When considered altogether these new data and capabilities will allow HCMR to contribute to ongoing ocean colour validation and development inspired by Coastcolour.

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