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Processing and exploitation of Sentinel-2 data for coastal water applications
The HIGHROC Project

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Abstract
The HIGHROC ("HIGH spatial and temporal Resolution Ocean Colour") Project will carry out the research and development necessary for the next generation coastal water products and services from ocean colour spaceborne data. Mature water quality services using spaceborne data already exist, but are limited in their spatial and temporal resolution, typically ~300m and once per day. HIGHROC will exploit new sensors such as Sentinel-2 and Landsat-8 to improve spatial resolution to ~10-30m and will use data from the geostationary METEOSAT/SEVIRI to improve temporal resolution to every 15 minutes during daylight. Services based on these new products will be supplied to end-users in User Service Trial regions to further refine the products with the objective of providing long-term sustainable services.

Existing Water Quality Services

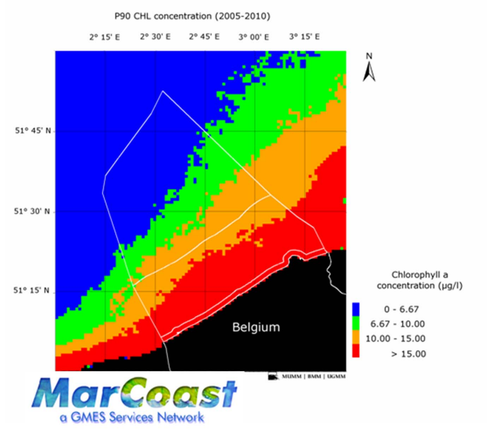

Fig 1. Belgian WFD/MSFD product showing CHLa concentration as 90% for the period Mar-Oct 2005-2010 based on MERIS data. [L3 Processing: RBINS, L2data: ACRI-ST and ESA].

The potential areas and markets of application of coastal water quality products and services have been well-established and prepared in previous projects. The monitoring requirements arising from the EU Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) have been clear drivers for end-user requirements and hence service definition. As examples these directives contain mandatory requirements for monitoring of eutrophication, including Chlorophyll a, and turbidity, both parameters which will be improved and provided by HIGHROC.

HIGHROC builds on existing ocean colour-based products and services (e.g. Fig 1 and 2), supplying end-users, typically governmental organisations, responsible for reporting to the EC under obligations from the WFD and MSFD. These existing services have successfully provided data to end-users used in these contexts. However, there are significant limitations on spatial and temporal resolution for MERIS/MODIS/VIIRS/OLCI, which limit end-user uptake.

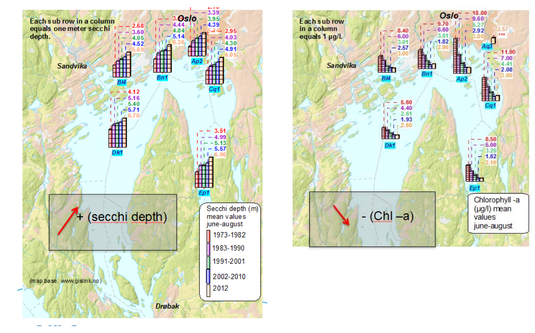

Fig 2. Extract from pollution monitoring report showing Secchi disc depth and chlorophyll–a mean values from June to August in The Oslo Fjord area. According to the newly revised Norwegian classification guidance, the classification of chlorophyll-a should be based on 90-percentile over minimum three years and recommended six years. [Berge et al., 2012].

Medium resolution
Ocean Colour
(~300m, 1day)
MERIS, MODIS, VIIRS … Sentinel-3/OCLI

High temporal resolution (15 mins)

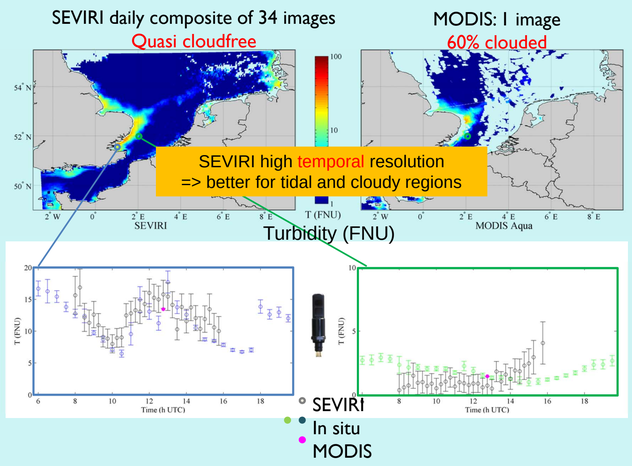

Fig 3. Turbidity measurements from satellite observations by SEVIRI (top left) and MODIS-AQUA (top right) for 15.4.2008 and time series over the day from both sensors at locations of CEFAS Smartbuoys Warp (bottom left) and West Gabbard (bottom right). In the time series *in situ* data is shown as blue/green dots, SEVIRI data as black dots and the MODIS data as a single pink dot for each location. SEVIRI data collected over day provides information in regions when MODIS was cloudy and SEVIRI captures the tidal signal missed by MODIS. [Neukermans et al, 2012] © Elsevier.

High temporal resolution (15mins!)
MSG/SEVIRI

HIGHROC Objective

The HIGHROC ("HIGH spatial and temporal Resolution Ocean Colour") Project will carry out the research and development necessary for the next generation coastal water products and services from ocean colour space-borne data, giving an order of magnitude improvement in both temporal and spatial resolution (Fig 3 and 4) and thereby opening up new application areas and strengthening existing ones.

High spatial resolution (10m!)
Sentinel-2,
Landsat-8

Improved products and services for existing End-Users:
EU Water + Marine Strategy Framework Directives
... SUSTAINABILITY

New applications:
Windfarms,
dredging, etc.

High spatial resolution (10m)

S-2 here

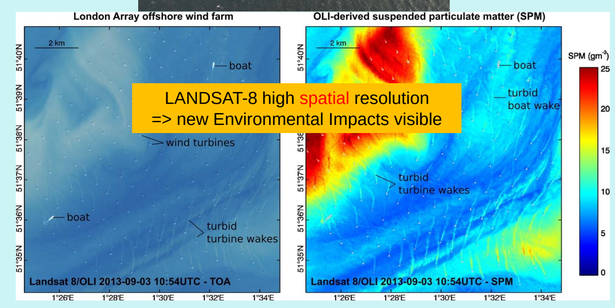

Fig 4. (top) Airborne photo of wind turbines in Belgian waters [photo: JP. Vogt, © RBINS], and Landsat-8 imagery of London Array wind farm (bottom-left: RGB top of atmosphere; bottom-right: Suspended Particulate Matter concentration) showing sediment wakes behind wind turbine monopiles [Vanhellemont Q. & Ruddick K., 2014, © Elsevier].

HIGHROC Activities

Algorithms and Image Processing

HIGHROC will develop/improve algorithms and will implement image processing chains for Sentinel-2, Sentinel-3 and MSG/SEVIRI to generate products (Table 1) for the users.

Table 1. Parameters to be generated by the HIGHROC project

Core Parameters (units)
Remote sensing reflectance spectrum (sr^{-1}) at water level
Aerosol reflectance spectrum
Aerosol reflectance Angstrom exponent
Aerosol optical thickness
Suspended Particulate Matter (g m^{-3})
Turbidity (FNU)
Particulate backscatter at 555nm (m^{-1})
Chlorophyll a (mg m^{-3})
Algal pigment absorption coefficient at 443nm (m^{-1})
Diffuse attenuation coefficient spectrum (m^{-1})
Diffuse attenuation coefficient of PAR (m^{-1})
Extra parameters (units) – under consideration
Euphotic depth (m)
CDOM absorption coefficient at 443nm (m^{-1})
Secchi disk depth (m)
RGB Image (Rayleigh corrected)
River fluxes to the sea
Primary production
Phytoplankton functional types
Phenology indicators (bloom timing)
Harmful Algae Bloom

User Service Trials

One full year of HIGHROC products will be supplied to key users in User Service Trials for each of 6 regions (Fig 5). User feedback will be continuously assessed and HIGHROC products will be improved accordingly.

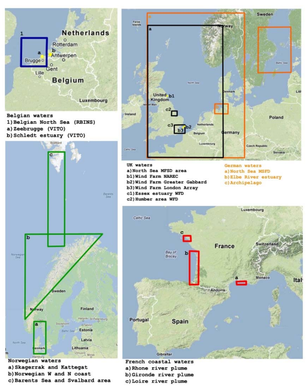

Fig 5. HIGHROC regions for User Service Trials

In situ Measurements

In situ measurements (Fig 6) will be made and used to calibrate and validate the HIGHROC algorithms and products in the User Service Trial regions and elsewhere.

Fig 6. Typical platforms used for HIGHROC in situ measurements

References
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