Sea Surface Salinity off Panama in the Eastern Pacific: seasonal dynamics from in situ and SMOS data

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The freshest surface waters in the tropical Pacific are located near the south-east border of the Eastern Pacific Warm Pool. In this region, the seasonal migration of the Intertropical Convergence Zone (ITCZ) over the American Cordillera gives rise to monsoon-like wind and rain patterns that deeply imprint the seasonal cycle of Sea Surface Salinity (SSS) and Sea Surface Temperature (SST). Using in situ data from voluntary observing ships, we depict the quasi-permanent presence of the Far Eastern Pacific Fresh Pool (FEPFP, with typical SSS lower than 33) mostly confined between 85°W and the Panama coast in December, but which extend westward until 95°W in March. Another major feature of the FEPFP is the strong and permanent signature in SSS fronts near its edge. We investigate the seasonal dynamics of this FEPFP using complementary satellite wind, rain, sea level and in situ oceanic current data at the air-sea interface, along with hydrographic profiles. The FEPFP appears in June in the Panama Bight due to the strong summer rains associated with the northward migration of the ITCZ over Central America. During the second half of the year, the eastward North Equatorial Counter Current keeps it trapped to the coast and strengthens the SSS front on its western edge. During boreal winter, as the ITCZ moves southward, the north-easterly Panama gap wind creates a south-westward jet-like current in its path with a dipole of Ekman pumping/eddies on its flanks. As a result, upwelling in the Panama Bight brings to the surface cold and salty waters which erode the FEPFP on its eastern side while both the jet current and the enhanced South Equatorial Current stretch the FEPFP westward until it nearly disappears in May. Newly available Soil Moisture Ocean Salinity (SMOS) satellite SSS data proves able to capture the main seasonal features of the FEPFP and monitor its spatial extent.

An EOF-based technique to compute merged high resolution sea surface temperature fields

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High quality sea surface temperature (SST) data sets are needed for various applications, including numerical weather prediction, ocean forecasting and climate research. The coverage, resolution and precision of individual SST satellite observations is not sufficient for these applications, therefore the merging of these complementary data sets is needed to reduce the final data set error. This is usually performed by optimal interpolation (OI).

We present an extension of the capabilities of DINEOF (Data INterpolating Empirical Orthogonal Functions) to merge data from different platforms. The analysis is based on the formalism of OI, but the crucial difference is that the error covariance is not parametrized a priori using an analytical expression, but expressed using a spatial EOF basis calculated by DINEOF. This EOF basis represents more realistically the complex variability of SST data sets than the parametric covariance used in most OI applications.

An example will be presented using data from a polar-orbiting satellite (AVHRR on MetOp) and a geostationary satellite (SEVIRI on MSG). The high spatial resolution of the polar-orbiting satellite and the high temporal resolution of the geostationary satellite are retained to create a very high spatial and temporal resolution field of the western Mediterranean SST. The results are validated with independent data.

Reconstruction of Total Suspended Matter data over the North Sea using DINEOF: use of the Gaussian anamorphosis transformation

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Total Suspended Matter (TSM) from the SEVIRI sensor in the North Sea will be analysed using DINEOF (Data INterpolating Empirical Orthogonal Functions), an EOF-based technique to reconstruct missing data. The information needed to reconstruct the missing data is computed internally based on a truncated EOF basis, so no assumptions about the statistics of the data have to be made.

DINEOF uses the mean and covariance of the original data to calculate the EOF basis. If the data are normally distributed, then the probability density distribution can be completely described by their mean and the eigenvectors of the covariance matrix (the EOFs). Variables such as TSM, however, do not have a Gaussian distribution, since TSM is never smaller than zero. DINEOF typically does not take this into account. To overcome this, a logarithmic transformation is usually performed to non-Gaussian variables, although the exponential transformation needed to retrieve the original variable units after using DINEOF leads sometimes to unrealistic high values in the reconstruction. An empirical transformation, which allows to obtain a normally distributed variable based solely on the data themselves, will be applied. This procedure, called Gaussian anamorphosis, is sometimes used in data assimilation.

A Gaussian anamorphosis transformation will be applied to the TSM data of the North Sea prior to their reconstruction. The high spatial and temporal dynamics of the gap-free geostationary TSM data set will be analysed, focusing on tidal dynamics and sub-daily variability.

Influence of suspended particle concentration, composition and size on the variability of inherent optical properties of the Southern North Sea

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Suspended particles and the relationships between their concentration, composition and size with optical properties (light absorption, and attenuation in the visible and near-infrared spectral regions) were investigated in transects performed from the Belgian to the English coasts of the Southern North Sea. Results individualize three geographical zones in the domain, each one with specific biogeochemical and optical properties: Scheldt coastal zone (SCZ), Middle of the Southern North Sea (MSNS) and Thames coastal zone (TCZ). Concentrations of organic (inorganic) particles were always higher in the SCZ (TCZ). The load of particles in the MSNS was low and dominated by organic forms. The spectral shape of particle attenuation showed a wide range from negative to positive slopes. Particle size distributions were power-law shaped along the coasts (especially in the TCZ) but bimodal in the MSNS notably during the spring phytoplankton bloom. This bimodal size distribution and more precisely a size peak around 7μm resulted in an unexpected negative spectral slope of the particle attenuation coefficient. The variations in the particulate mass-specific IOPs between the three regions were maintained over seasonal variations. The implications in terms of remote sensing inversion of IOPs into biogeochemical parameters, such as chlorophyll a and total suspended matter, in coastal waters are discussed.

Ocean Colour Signal Characterisation and New Algorithms for Eutrophic and Hypertrophic Coastal and Inland Waters.

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There is an increasing demand for routine ocean colour products in eutrophic and hypertrophic coastal and inland waters, both for multi-annual ecosystem characterization and operational water resource management. Such waters are complex and challenging: with high and variable concentrations of different phytoplankton groups, sediment and gelbstoff; small or semi-enclosed water bodies with considerable land adjacency effects; and often difficult atmospheric correction due to the presence of both turbid waters and attenuating aerosols. An analysis is undertaken of the typical in-water optical properties of such waters, focusing on the development of Harmful Algal Bloom and eutrophication detection algorithms in high biomass waters as one of the more easily achievable goals for coastal and inland waters. Hyperspectral radiometry and supporting measurements, from the highly productive Benguela upwelling system and a variety of South African inland water bodies, are used to identify the most important spectral components of the water-leaving reflectance signal for both prokaryotic and eukaryotic dominated waters. Hydrolight radiative transfer modeling, focusing on the need for representative phytoplankton-specific spectral phase functions and other inherent optical properties, is used to further identify principal spectral reflectance features, and their underlying causal phenomena. The importance of bands in the 550 nm to 750 nm range, as the primary signal carriers for such water types, is highlighted and accompanied by relevant recommendations for future sensors. Finally, a top-of-atmosphere algorithm for MERIS full resolution data is presented, capable of quantifying chlorophyll a concentrations $>$ 5 mg m-3, identifying surface vegetation or floating algal mats, and identifying cyanobacterial-dominated assemblages. The Maximum Peak Height empirical switching algorithm primarily makes use of the biomass- and assemblage-related variability in the chlorophyll fluorescence and backscattering/absorption related peaks between 620 and 753 nm. Sample application is shown in both coastal upwelling systems and a variety of different inland water bodies in Africa.

Estimating pCO2 from remote sensing in the Belgian Coastal Zone

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In coastal waters, a purely field observation based approach will probably be insufficient to better constrain estimates of air-sea CO2 fluxes, to study their inter-annual variability and their long-term changes. One approach to achieve these goals is to use remotely sensed fields of relevant biogeochemical variables to extrapolate available data, and produce maps of the partial pressure of CO2 (pCO2) and air-sea CO2 fluxes. In the open ocean this approach has to some extent been successfully used based on fields of chlorophyll-a (Chl-a) and sea surface temperature (SST). This approach remains challenging in coastal waters that have complex optical properties (Case-II waters) and that exhibit highly dynamic pCO2 temporal and spatial variations. In the frame of the Belgian funded BELCOLOUR-II project (Optical remote sensing of marine, coastal and inland waters; http://www.mumm.ac.be/BELCOLOUR/), three field cruises per year (April, July and September) for optical measurements were carried in 2007, 2008, 2009 in the Southern Bight of the North Sea (SBNS). Based on these data-sets, we derived algorithms to compute pCO2 from Chl-a and sea surface salinity (SSS) using multi-polynomial regressions (MPR). Here we report the first application of the MPR algorithms to derive pCO2 fields in the Belgian coastal zone based on data gathered in 2007, using remote sensed Chl-a (MERIS) and SSS computed with a 3-D hydrodynamical model of SBNS (COHERENS).

Quantification and reduction of striping on MODIS/VIIRS top-of-atmosphere clear-sky ocean radiances and derived products.

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Monitoring the quality of clear-sky ocean radiances is critical for the generation of consistent Sea Surface Temperature (SST) products. The combined use of multiple detectors and a double-sided mirror in whiskbroom scanners like MODIS and VIIRS may introduce striping in the imagery, due to detector-to-detector and mirror side radiometric differences. Given the persistence of this artifact on level 2 ocean products, further analysis of level 1 radiances is required to quantify and reduce the amount of stripe noise.

This paper investigates the degree of striping on IR clear-sky ocean radiances used for the generation of Terra/Aqua MODIS and VIIRS SST products. Our methodology relies on a recent technique introduced in [*Bouali and Ladjal*, 2011], which is able to remove detector-to-detector, mirror side and random stripes while preserving the integrity of the original signal. Results presented in this paper aim towards quantification of stripe noise for inter-band and inter-sensor comparisons, improved understanding of its spatio-temporal characteristics and ultimately its reduction on SST data.

REFERENCES

Bouali, M., Ladjal, S., 2011. Toward Optimal Destriping of MODIS Data using a Unidirectional Variational Model. *IEEE Transactions on Geoscience and Remote Sensing*, vol. 49, issue 8, pp.2924-2935.

SEA SURFACE SALINITY AS MEASURED BY SMOS AND BY SURFACE AUTONOMOUS DRIFTERS: IMPACT OF RAIN

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The ESA/SMOS (European Space Agency/Soil Moisture and Ocean Salinity) satellite mission provides new measurements of Sea Surface Salinity (SSS) using L-band radiometry. After correcting SMOS brightness temperatures from systematic biases, SMOS sea surface salinity (SSS) reproduce quite well large scale expected SSS variations [*Font et al*., 2011].

At L-band frequency, the skin depth is 1 centimetre while most in situ SSS measurements are taken at a few meters depth. A preliminary study based on ARGO vertical profiles (*Hénocq* et al., 2009) indicated that vertical salinity differences between 1m and 10m depth higher than 0.1 pss-78 are observed in the 3 oceans, mainly between 0° and 15°N, coinciding with the average position of the Inter Tropical Convergence Zones characterized by high precipitation rates.

In order to better document the variability of the SSS in the top 50cm of the sea surface, the Metocean and the Pacific Gyre companies have instrumented SVP drifters with sensors measuring conductivity at 30-50cm depth. In addition, new light floats named SURPLAS have been built at LOCEAN laboratory to measure conductivity at 15cm depth. SURPLAS floats have been tied to SVP drifters allowing the study of the SSS and SST stratification between 15cm and 50cm depth. In 2010, simultaneous to the first year of SMOS measurements, 33 SVP drifters and 9 SURPLAS floats have been deployed by the French teams involved in the SMOS GLOSCAL Cal/Val project in the North Atlantic, in the Bay of Biscay, in the tropical Atlantic and in the western tropical Pacific Ocean. Altogether, they recorded measurements during 4800 days.

In this paper, we will present new results about SSS freshening linked to rain events as recorded at various depths by autonomous drifters and as deduced from the SMOS radiometer measurements.

Reverdin et al. [2011] have analyzed the drifter measurements in the tropical oceans in 2007-2010 and have identified individual freshening events larger than 0.1 pss-78 (averaging 0.56 pss-78 at 50 cm) often related with local rainfall. When two measurement levels are available, the initial salinity signal is larger by more than 20% at the shallow depth (15 cm) compared with the deeper measurement level (near 50 cm).

Comparisons between reprocessed SMOS SSS and ARGO SSS at 5m depth have been performed in the subtropical Atlantic Ocean, in the region where the 2012-2013 “Salinity Processes in the Upper Ocean Regional Study” (SPURS) experiments dedicated to the calibration and validation of SMOS and Aquarius satellite measurements will take place. They indicate a standard deviation of the difference of 0.2pss-78 once SMOS SSS are averaged over typical GODAE scales (10days-one month, 100kmx100km). On another hand, the same kind of comparison in the Intertropical Convergence zone of the Pacific Ocean indicates a standard deviation of the difference of 0.4pss-78 and a mean difference 0.1pss-78 lower in the ITCZ than in the SPURS region. Correlation with SSM/I rain rates shows that the larger standard deviation and the negative difference in the ITCZ is mainly attributable to rain events. The effect of rain freshening on the 1cm SSS will be discussed together with possible effect of rain induced roughness on L-band brightness temperature.

REFERENCES

Boutin et al., 2011. Sea Surface Salinity from SMOS satellite and in situ observations: surface autonomous drifters in the tropical Atlantic Ocean, SMOS Science Workshop, Arles, Sept. 2011 (extended abstract).

Font, J., J. Boutin, N. Reul, P. Spurgeon, J. Ballabrera-Poy, A. Chuprin, C. Gabarro, J. Gourrion, S. Guimbard, C. Hénocq et al., 2011. SMOS first data analysis for sea surface salinity determination, *International Journal of Remote Sensing*, in press.

Hénocq, C., J. Boutin, G. Reverdin, F. Petitcolin, S. Arnault, P. Lattes, 2010. Vertical Variability of Near-Surface Salinity in the Tropics: Consequences for L-Band Radiometer Calibration and Validation. *Journal of Atmospheric and Oceanic Technology*, 27, 192-209.

Reverdin, G., S. Morrisset, J. Boutin, and N. Martin, 2011. Rain-induced variability of near sea-surface T and S from drifter data" [Paper #2011JC007549] *Journal of Geophysical Research* – Oceans, accepted.

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Observation of cyanobacteria bloom in the Curonian Lagoon with multi-source satellite data

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Cyanobacteria blooms have recently been one of the major impact factors compromising the equilibrium of water bodies because they can start a series of chain reactions greatly impacting the quality and the trophic chain inside the ecosystem. Cyanobacteria blooms present really complex dynamics both in spatial and in temporal dimensions, being characterized by very fast migration ability inside the water column as well as by high splitting capacity of their cells. Extremely developed blooms may appear as a thick surface cyanobacteria layer (scum) completely covering the water surface.

The presence of scum intensely modifies the water spectral signal, hampering the estimation of chlorophyll-a (chl-a) and other photosynthetic pigments concentrations by both semi-empirical and analytical approaches applied to ocean colour sensors. In fact, the retrieval and collection of inherent and apparent optical properties, commonly used by these approaches, comes out very complicated because these aggregations are easily altered by the sampling activities and they prevent the use of water optics instrumentations with immersion devices. Moreover, elevated chl-a concentrations are mixed together with associated biological products, spatially intersecting in consecutive patches. Lastly, measure protocols regulating the sampling procedure are not yet standardized rendering the data intercomparison very difficult.

Extended aquatic ecosystems affected by intense cyanobacterial bloom could be successfully mapped and monitored by means of satellite sensors. In fact their synoptic view and revisiting time turn out as very suitable properties to detect these phenomena both spatially and temporally. This approach can be fruitfully applied to the Curonian Lagoon, the largest European lagoon (1584 km2) between Lithuania and Russia, which every summer, since more than 20 years, presents intense cyanobacteria blooms with associated scum phenomena.

The aim of this work is to analyze the scum development by using both passive and active remote sensing technology: MERIS and ASAR onboard of Envisat-a, MODIS onboard of Terra and Aqua and the synthetic aperture radar onboard of COSMO-SkyMed platforms. Ocean colour data can be integrated with the occurrence of backscatter patterns in time-coincident SAR imagery to detect scums consequently improving the knowledge about their detection. In particular, the integrated information allows the definition of new algorithms and thresholds range in fuzzy logic approach for the characterization and mapping of scum events.

A specific images dataset covering the 2011 summer season on the Curonian Lagoon, together with radiometric and limnological data, enabled the detection of a hyperscum crust event on 4 August, 2011, in conjunction with dystrophic conditions of the Lagoon. This bloom event has been characterized and mapped thanks to the application of different semi-empirical algorithms specifically designed for chl-a and phycocyanin concentration retrieval, as well as thanks to the analysis of the radar signal. Furthermore, the differentiation of endmembers reflecting different bloom conditions by *Aphanizomenon flos-aquae*, helped the mapping procedure inside the Lagoon. The results would allow the detection of other cyanobacteria bloom events characterized by surface scum layer in the summer season.

This study emphasizes the advantages given by the synergy of passive and active remote sensing technology in the evaluation of intense cyanobacteria blooms. The joined action of different sensors could allow the monitoring of the variability and dynamism characterizing these so intense phenomena, hardly detectable with traditional in situ techniques.

The Ocean Colour Climate Change Initiative: a round-robin comparison of in-water bio-optical inversion algorithms

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The ESA funded Ocean-Colour Climate-Change Initiative (OC-CCI) aims to create a long-term, consistent, error-characterised time series of ocean-colour products, for use in climate change studies. A key part of OC-CCI is the selection of suitable algorithms that meet user requirements and project goals. We partitioned the algorithms into two components: sensor calibration and atmospheric correction, necessary to convert the satellite-retrieved signal into spectral remote-sensing reflectance; and in-water bio-optical inversion algorithms, for converting the spectral remote-sensing reflectance into biogeochemical variables such as chlorophyll-a concentrations, or key Apparent Optical Properties (AOPs) or Inherent Optical Properties (IOPs) required by the user community. Here we present results from the comparison of in-water bio-optical inversion algorithms. Eight IOP models (12 versions in total) and 16 chlorophyll-a models were evaluated using qualitative and quantitative selection criteria. The qualitative selection criteria were designed to check whether the algorithms were appropriate in view of the requirements of OC-CCI, whereas the quantitative selection criteria involved evaluating and ranking candidate algorithms using a number of statistical tests and a database of coincident measurements of spectral remote-sensing reflectance, AOPs, IOPs and chlorophyll-a (NASA NOMAD database, *Werdell and Bailey*, 2005). Results from the comparison indicate that both empirical (band-ratio type algorithms) and semi-analytical algorithms should be taken forward into the next stage of the project. The inter-comparison demonstrated that all evaluated algorithms had certain desirable features and that the possibility of further improvements should be explored by combining the best features of various algorithms. It is also recommended that a high-quality dataset independent of NOMAD be used to evaluate algorithms further. The OC-CCI strategy is open to the possibility that better algorithms will emerge in the future. This should involve periodic re-evaluations of algorithms and adoptions of new algorithms whenever appropriate.

References: Werdell, P.J. and Bailey, S.W., 2005. An improved in situ bio-optical data set from ocean colour algorithm development and satellite data production validation. *Remote Sensing of Environment*, 98, 122-140.

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CoastColour Approach for Consensus Case 2 Regional Algorithm Protocols

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In 2010 ESA has launched the CoastColour project to fully exploit the potential of the MERIS instrument for remote sensing of the coastal zone. CoastColour is developing, demonstrating, validating and intercomparing different Case 2 algorithms over a global range of coastal water types, identifying best practices, and promoting discussion of the results in an open, public form. In May 2012 CoastColour will complete a large dataset of water quality products from 27 coastal areas distributed globally. As part of the project, alternative Case2 processing algorithms were tested, and Round Robin algorithm intercomparison was carried out. The lessons learnt from this analysis is synthesised in Consensus Case 2 Regional Algorithm Protocols which shall serve as guidelines for future algorithm development in optically complex waters.

A novel approach to the high resolution interpolation of in situ Sea Surface Salinity using satellite SST data

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A novel technique for the high resolution interpolation of in situ sea surface salinity (SSS) observations has been developed and tested. The method is based on an Optimal Interpolation (OI) algorithm that includes satellite sea surface temperature (SST) differences in the covariance estimation. The covariance function parameters (i.e. spatial, temporal and thermal decorrelation scales) and the noise-to-signal ratio have been determined empirically, by minimizing the root mean square error and mean bias errors with respect to fully independent validation datasets. Both in situ observations and simulated data extracted from a numerical model output were used to run these tests. Different filters have been applied to sea surface temperature data in order to remove the large-scale variability associated with air-sea interactions, as a high correlation between SST and SSS is expected only at smaller scales. In the tests performed on in situ observations, the lowest errors were obtained selecting covariance decorrelation scales of 400 km, 6 days and 2.75 °C, respectively, a noise-to-signal ratio of 0.01 and filtering the scales longer than 1000 km in the SST time series. This resulted in a root mean square error of 0.11 psu and a mean bias error 0.01 psu, improving by 25% and 60%, respectively, with respect to standard univariate products.

Towards high resolution mapping of 3D mesoscale dynamics from observations: results of the MESCLA project

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Within the MyOcean R&D project MESCLA (MEsoSCale dynamical Analysis through combined model, satellite and in situ data), different estimates of the vertical velocities derived from observations have been compared. Two main approaches have been considered, one based on the retrieval of 3D fields from the observations alone and one based on the analyses provided by MyOcean MERCATOR models. The motivation for this double approach is that, while data assimilation in numerical models is crucial to obtain more accurate analyses and forecasts, its results might be significantly influenced by specific model configurations (e.g. forcing, parameterization of smaller scale processes and spatial resolution). On the other hand, the purely observational approach is limited by the underlying assumptions of simplified dynamical models and by the relatively low resolution of present products. MESCLA developed innovative methods for the high resolution mapping of 3D mesoscale dynamics from observations, proposing new products that might be used to gradually build the next generations of operational observational products.

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Studies of the bio-optical characteristics of the Russian northern seas

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Studies of the bio-optical characteristics of the Russian northern seas by using satellite and ship data (the White Sea as an example)

The use of satellite ocean color data for study of the bio-optical characteristics of the Russian northern seas is considered. Such seas, as the White, Barents, and Kara, have their specific features, regarded in the algorithm development and using satellite ocean color data, in particular, most of them are strongly influenced by river runoff and referred to Case 2 waters. The standard algorithm can result in great errors there, and the regional algorithms are needed for retrieval of the bio-optical characteristics from satellite data. Such algorithms are derived on the basis of in situ measured data. Taking the White Sea as an example, the regional algorithms for estimation of chlorophyll, suspended matter and yellow substance content are described and some results of the joint use of satellite and ship data are presented.

The use of new DEIMOS-1 high-resolution satellite imagery to study the spatial variability of Guadalquivir River plume (SW Iberian Peninsula).

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Estuarine environments are characterized by complex morphodynamics and are critically important in determining the supply of sediment and nutrients to coastal regions. These local nutrient and sediment inputs may have large impacts on several socio-economic strategic activities; such as fisheries, aquaculture, tourism and navigation. Hence, low-cost, regular, synoptic monitoring of estuaries and their adjacent coastal regions is essential for the effective management of coastal zones. This is especially the case in the Gulf of Cadiz (SW Iberian Peninsula) where fertilization by the Guadalquivir River, is the major factor determining the primary productivity of the region, which in turn controls the abundance of commercially important fisheries resources, such as anchovy. Tourism and aquaculture are also regionally important, as is the maintenance of navigation to the port of Sevilla. Discernment of the mechanisms (tides, waves, wind stress, currents and river discharge) that affect the transport and distribution of river-borne material, so as to assess the estuaries impact on socio-economic strategic activities, can only be realistically attained via remote sensing. Hence, this study used high spatial (22 m), medium spectral (visible and near infrared, 3 bands, Band 3 (510-618 nm), Band 2 (614-698 nm), and Band 1 (755-906 nm)) resolution images from the new DEIMOS-1 satellite to map the concentration of total suspended solids (TSS) within the Guadalquivir River turbidity plume under different conditions of physical forcing. Eight images between 2010 and 2011 were georeferenced, radiometrically calibrated (using image-based techniques) and the relationship between in-situ [TSS] and remote sensing reflectance band ratios was examined. The results suggested a strong agreement between predicted and measured [TSS], confirming the potential of remote sensing for monitoring the Guadalquivir River plume. Examining the spatial distribution of the plume in relation to meteorological and oceanographic forcing revealed the importance of tide, wind direction and the magnitude of river run-off in determining the shape of the plume. In conclusion, DEIMOS-1 images enable new opportunities for a better understanding of coastal zones, and may provide valuable information for scientists, and decision makers involved in the management of large estuaries.

Influence of strong wind event on phytoplankton bloom during northeast monsoon in northern South China Sea

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We examined the influence of strong wind event on the variability of chlorophyll a (Chl) based on multi-sensor satellite measurements and Argo buoy observation in the northern South China Sea (NSCS) during northeast monsoon since 2002. The satellite data included sea surface temperature (SST) derived from TRMM TMI, Chl data from MODIS/Aqua and ocean wind vector from QuikSCAT. The results showed that the strong wind event (with wind speed >10m/s) occurred frequently and intermittently in the NSCS from early October to late February. After a strong wind event, the SST decreased and chl concentration increased. During the periods which northeast monsoon prevails, the short-term variability of chl has high positive and negative relationship with wind speed and SST, respectively. The mixed layer could deepen by 30m, SST decrease by 2.5°C and salinity increase by 0.3 after a strong northeastern wind event occurred in the mid December 2006. And the Chl concentration increased by 0.25mg/m^3. It was suggested that strong wind event could enhance the upper ocean mixing and weaken vertical stratification, then bring the rich-nutrient into the surface, and thus result in the increase of Chl concentration in the NSCS.

Optical properties of Black Sea case 2 waters

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Ocean color observations by satellite provide the data needed to quantify optically active constituents of sea water (living algae, particulate organic/mineral material, colored dissolved matter) but the general empiric algorithms used to derive these quantities are usually poorly adapted to specific coastal water in which the different components does not covariate, as it is the case in the Black Sea, and particularly on the North Western shelf (NWS).

In order to provide additional material to understand the imperfections of the satellite algorithms and to study the dynamics of optically active material in the BS-NWS, we address the penetration of light in the Black Sea by setting up a specific optical model included in the 3D biogeochemical GHER model.

While relying on state-of-the art literature [*Neukermans,2012; Stramsky,2007; Vaillancourt, 2004*] for the parameterization of absorption and backscattering by the modeled phytoplankton and particulate matter components, the set-up also makes use of in-situ photosynthetically active radiation (PAR) profiles to assess the effect of unrepresented and optically relevant water constituent, such as the colored dissolved matter.

By computing absorption and backscattering coefficients to derive diffuse attenuation, the model allows derivation of diffuse attenuation coefficients, more easily comparable with satellite measured quantities. In this way, the effectiveness of case II specific algorithms used to derive concentrations from satellite products can be directly assessed for this region.

In-situ chlorophyll measurements then comes as a third-party additional point of view, completing by triangulation the comparison of model results and satellite observations (Seawifs) and the study of the Black Sea NWS photosynthesis dynamics.

The importance of light penetration scheme in the biogeochemical model is finally illustrated by evidencing its impact on the resolution of bottom oxygen concentration, which constitutes a major issue of the Black Sea NWS environmental status [*Mamaev, 1997*].

REFERENCES

Mamaev, V., and Zaitsev, Y.: Marine biological diversity in the Black Sea : A study of change and decline, volume 3 of Black Sea environmental series, United Nation Publications,, 208 pp., 1997

Neukermans, G., Loisel, H., Mériaux, X., Astoreca, R., and McKee, D.: In situ variability of mass-specific beam attenuation and backscattering of marine particles with respect to particle size, density, and composition, Limnol. Oceanogr. 57(1), 124–144, 2012

Stramski, D., M., Babin, and S., Wozniak: Variations in the optical properties of terrigenous mineral-rich particulate matter suspended in seawater, Limnol. Oceanogr. 52(6), 2418–2433, 2007

Vaillancourt, Robert D., Brown, Christopher W., Guillard, Robert R. L., and Balch, William M.: Light backscattering properties of marine phytoplankton: relationships to cell size, chemical composition and taxonomy, Journal of Plankton Research 26(2), 191–212, 2004

Monitoring the Ushant Front with MSG/SEVIRI derived Sea Surface Temperature data .

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Hourly Sea Surface Temperature (SST) fields derived from the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) onboard Meteosat Second Generation (MSG) are frequently used in studies of the diurnal cycle of the ocean. In this presentation, we focus on an other aspect of SST variability: the tidal current induced short time variability in the Ushant region (Western Brittany). In a first part we use hourly thermal front fields deduced from MSG/SEVIRI derived SST data on the 30th of May 2009. We show that the longitudinal displacements of the front in a point North of Ushant correspond to the tidal advection in this point, even in a moderate tide case such as the one studied. In a second part, we use the Ireland-Biscay-Iberia Regional MERCATOR model hourly outputs to test the ability of a Maximum Cross Correlation (MCC) method [*Emery et al*, 1986] to derive surface velocities from thermal structures displacements in this context. We compare velocity fields derived from SST and from SST gradients to model velocities used as "ground truth" and conclude that using SST fields seems more efficient to retrieve surface velocities. The method is then applied to hourly SEVIRI data on the 30th of May and to a spring tide sequence in September 2011.

REFERENCES

W. J. Emery, A. C. Thomas, M. J. Collins, W. R. Crawford, and D. L. Mackas, 1986: An objective method for computing advective surface velocities from sequential infrared satellite images. *J. Geophysical Res*., 91, 12 865-12 878.

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Ocean Color for Detection of Red Tides in the Southwestern Florida Coastal Region

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Near real-time ocean color data from the Seaviewing Wide Field-of-view Sensor (SeaWiFS) was used to detect and trace harmful algal bloom (HAB) (also termed as red tides) in the Southwest Florida coastal water, which was treated as Case-2 water, i.e., its optical characteristics are influenced not only by phytoplankton and related particles, but also by other substances, that vary independently of phytoplankton, notably inorganic particles in suspension and yellow substances. Similar to Ahn et al. (2006), a red tide index was constructed from in-situ radiometric measurements of the three SeaWiFS bands centered at 411 nm, 510 nm, and 555 nm to achieve derivation of indices that are then related to absorbing characteristics of harmful algae (i.e., Lw at 443 nm) from which a best fit with a cubic polynomial function is obtained providing indices of higher ranges for HABs and lower and slightly reduced ranges for turbid and non-bloom water. In order to quantify the HABs in terms of chlorophyll (Chl), an empirical relationship is established between the RI and in-situ Chl in surface water which yields a Red tide index Chlorophyll Algorithm (RCA). In contrast, the band-ratio chlorophyll product of SeaWiFS in this complex coastal environment provided false information. The red tide that formed from November to December 2004 off SW Florida was revealed by RCA imagery, and was confirmed by field sampling to contain medium (10**4 to 10**5 cells/L) to high (>10**5 cells/L) concentrations of the toxic Karenia brevis. The RCA imagery also showed that the bloom started in mid October south of Charlotte Harbor, and that it developed and moved to the south and southwest in the subsequent weeks. Our results show that the SeaWiFS data provides an unprecedented tool for research and managers to study and monitor algal blooms in coastal environments.

Thirty Years of Global SST Front Probability

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This presentation will examine the global probability of detecting a sea surface temperature (SST) front as a function of time between 1981 and 2010 using the University of Rhode Island Single Image Edge Detection (SIED) algorithm. The algorithm is applied to the global daily daytime and nighttime 4 km Pathfinder (v5.2) fields developed by the University of Miami and National Oceanographic Data Center of NOAA. The number of clear pixels in these fields are summed globally by month as are the number of front pixels and the latter are divided by the former to obtain the probability of finding a front globally for the given month. This analysis is performed separately for nighttime and daytime fields. Preliminary results suggest a slight decrease in the global front probability over the 30 year period for both daytime and nighttime fronts. More surprisingly, it shows a long term fluctuation, with a period O(16 yrs), in front probability of 5% of the mean value (approximately 10% for daytime fronts and 8% for nighttime fronts). Also of interest are the differences in the long term fluctuations between daytime and nighttime front probabilities. At the writing of this abstract the source of these fluctuations is not known.

Harmonic and DINEOF analysis for North Sea SPM patterns

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In this paper we compare two methods to extract spatial and temporal patterns from North Sea SPM imagery. These methods, as well as the extracted patterns, will be incorporated in a future quality control system. This system should be able to deal with the purchase of SPM remote sensing (RS) products for the Southern North Sea from different providers, from different satellites and for multiple years. In this quality control system two aspects should be dealt with: consistency and veracity. For both the relation with situ data (IS) is very important. SPM IS data for the Dutch part of the North Sea have been collected for several decades, at several tens of locations, within the national monitoring program of Rijkswaterstaat called MWTL. Incorporation of RS data into the Dutch national monitoring requires a smooth connection with the MWTL IS data. However, despite the long-term abundance of MWTL, appropriate match-ups for validation with RS are very scarce. There are several tens of IS locations, but they were historically sampled on weekly basis at most, and this frequency is gradually going down to monthly or even bi-monthly. Nevertheless, we face the challenge of designing a quality control system for RS data that can guarantee a monitoring program consisting of a smooth blend of RS data and MWTL IS data.

Following the quality control system of [*Franz*, 2005], we distinguish two steps. First, a small number of IS locations with high-frequency data can be used to assess match-up performance. Additional match-ups can be created by filling remote sensing datasets [*Nechad et al*, 2011], allowing for more quasi-simultaneous matchups with high frequency IS measurements (e.g. OBS on the Cefas buoys). Unfortunately only few of such devices are operational. In addition, these devices tend to be deployed for relatively short time periods only, so they cannot perform the role that the MOBY has in [*Franz*, 2005]. In addition, the numerous low-frequency MWTL IS data also have to used to assess the performance of RS in a qualitative way. For a full year, the MWTL data and the RS data are plotted into one graph, e.g. [*Eleveld et al*., 2008]. This allows inspecting agreement of ranges visually, but the absence of match-ups does not allow to perform any quantitative statistics. Therefore an additional quality control step is need: the comparison of bulk statistics from [*Franz*, 2005].

In this paper we focus on two methods to extract spatial and temporal patterns that can be used for the comparison of bulk statistics: harmonic analysis following [*Pietrzak et al*, 2011] and EOF analysis using DINEOF, e.g. [*Beckers & Rixen*, 2003; *Alvera-Azcárate*, 2005]. The most simple pattern for bulk statistics is the annual geometric mean map, as already used by [*Eleveld et al*., 2008]. The harmonic method also yields a similar mean map that is less sensitive to outliers. In addition we used it to generate amplitude + phase maps of seasonal semi-seasonal and quarter-seasonal variations. DINEOF for North Sea SPM patterns return up to 9 optimal modes, with the first two modes containing nearly all variance. Higher modes are needed to reconstruct the original images, but tend to be less useful for direct use as pattern themselves. Finally, we compare the harmonic and EOF modes for normal vs. log-transformed SPM values in terms of their usability validation with bulk statistics. We do the same for the sensitivity of the patterns to RS data rejection criteria.

REFERENCES

Alvera-Azcárate, A., A. Barth, M. Rixen, and J.-M. Beckers, 2005. Reconstruction of incomplete oceanographic data sets using Empirical Orthogonal Functions. Application to the Adriatic Sea. *Ocean Modelling*, 2003, 9:325--346, 2005.

Beckers, J.-M., and M. Rixen. EOF calculations and data filling from incomplete oceanographic data sets. *Journal of Atmospheric and Oceanic Technology*, 20(12):1839--1856, 2003.

Franz, B.A., 2005. Methods of assessing the quality and consistency of ocean color products. NASA ocean color forum, http://oceancolor.gsfc.nasa.gov/DOCS/methods/sensor_analysis_methods.html

Nechad, B., A. Alvera-Azcárate, K. Ruddick, and N. Greenwood, 2011. Reconstruction of MODIS total suspended matter time series maps by DINEOF and validation with autonomous platform data. Ocean Dynamics, 61:1205-1214, 2011.

Pietrzak, J.D., de Boer, G.J., Eleveld, M.A., 2011. Mechanisms controlling the intra-annual mesoscale variability of SST and SPM in the southern North Sea, *Continental Shelf Research*, 31(6), 594-610.

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Cool Water Brought by Upwelling Benefits Coral Reef in the background of Global Warming along South Coast of Hainan Island, China

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Global warming resulted in great negative effect on coral ecosystem in recent 50 years. In order to make clear coral reef status in the background of global warming along south coast of Hainan Island, China, satellite data of Landsat, Quickbird, CBERS, HJ-1A, MODIS, NOAA coral watch data and in situ observation data were used to retrieve the information of coral reef status and surrounding environmental factors. Based on the retrieved information, the relationship between coral reef species, coverage, and climate change factors were studied in the paper. Results showed that summer sea surface temperature in most of South China Sea in most strong ENSO years (2002 and 2010) was greater than 31 degree celcius from May to July, about 3 degree celcius greater than the upper limits of coral appropriate growth temperature, however, cool water brought by upwelling along south coast of Hainan Island were found distributed in the area in every summer month, especially in strong ENSO event year (2002 and 2010). Compared with coral reef species and coverage along southeast coast of Hainan Island from 1990 to 2010, variation of coral reef species and coverage were not evidently affected by global warming. Degree weekly heat (DWH) indexes were also not greater than 2 along the south coast of Hainan Province in strong ENSO years. By analyzing environmental factors and found that cool water brought by upwelling may be the main reason for protecting coral reef from global warming damage.

RETRIEVAL OF OCEANIC PHYTOPLANKTON WITH A COMBINED PHYTODOAS-RTM METHOD UTILIZING HYPER SPECTRAL SATELLITE MEASUREMENTS

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Global information on the quantitative distribution of major phytoplankton functional types (PFTs) of the world ocean is important for understanding the marine phytoplankton's role in the global marine ecosystem and its impact on global climate.

In this study an improved Phytoplankton Differential Optical Absorption Spectroscopy (PhytoDOAS) method for the retrieval of major PFTs from satellite measurements utilizing the hyper spectral instrument SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography) is introduced [*Bracher et al.,* 2009; *Sadeghi et al.,* 2011].

This specialized PhytoDOAS method combines the fit algorithm with radiative transfer calculations based on a look-up table approach. For this purpose the full coupled atmospheric-ocean radiative transfer model SCIATRAN is used. The method is applied to the complete SCIAMACHY data set (2002-2011) and examples of retrieval results are shown here. Four different types of PFTs are detected simultaneously by fitting the differential specific absorption spectra of each species to the satellite measurement. These are diatoms, cyanobacteria, dinoflagellates and coccolithophores, which is dominated by the Emiliania huxleyi species. The global phytoplankton distributions were validated with collocated HPLC (High-Performance Liquid Chromatography) in-situ measurements and shows quite good agreement.

REFERENCES

Bracher, A., Vountas, M., Dinter, T., Burrows, J.P., Rttgers, R., Peeken, I.: Quantitative observation of cyanobacteria and diatoms from space using PhytoDOAS on SCIAMACHY data. *Biogeosciences*, 6, 751-764, 2009.

Sadeghi, A., Dinter, T., Vountas, M., Taylor, B., Altenburg-Soppa, M., and Bracher, A.: Remote sensing of coccolithophore blooms in selected oceanic regions using the PhytoDOAS method applied to hyper-spectral satellite data, *Biogeosciences Discuss.*, 8, 11725-11765, 2011.

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Including temperature and salinity variations of pure water optical properties in a Case 2 water retrieval algorithm.

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The light absorption, scattering and the real part of the refractive index of pure water vary with the ambient temperature and salinity. We examined the influence of these variations on modelled remote sensing reflectance of open ocean and coastal waters for the natural range of temperature (-2 – 30 °C) and salinity (0 – 45 PSU). The strongest influence was found for the change in total light scattering induced by changes in seawater salinity. The variations due to temperature and salinity were included in a bio-optical model and a NeuralNetwork-based Case 2 water retrieval algorithm was used for sensitivity studies to examine its performance for areas with a strong salinity gradient, e.g. the Baltic Sea where salinity varies from 0 PSU in the east to about 25 PSU close to the North Sea. The performance of this new algorithm will be compared to the standard MERIS Algal-2 algorithm.

Variability of La Plata River extremely turbid waters using MODIS-Aqua images and its relation to fish habitat selection

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La Plata River drains the second largest basin in South America after the Amazon River and is considered one of the most turbid rivers in the world. It carries high amounts of nutrients, suspended particulate and dissolved organic matter to the adjacent shelf waters which impact the ocean's physical, chemical and biological properties. The estuary is an area of high ecological importance. The outer region, where the freshwater (rich in nutrients) interacts with the coastal water, is the spawning and nursery area of many coastal species. The objective of the present study is to analyze the variability and offshore export of La Plata turbid waters into the adjacent continental shelf and its relation to the habitat selection of the whitemouth croaker Micropogonias furnieri. This fish is one of the most important species in terms of biomass that supports the traditional fisheries of the Argentinean, Brasilian and Uruguayan coastal region and its spatial distribution is highly influenced by salinity and turbidity differentially according to the life stage. Satellite ocean color data were used to present the synoptic quantification of turbidity variability on seasonal and interannual timescales for La Plata river plume area. Eight years (2002-2010) of MODIS-Aqua local area coverage were analyzed. Standard ocean colour products are not valid in these extremely turbid waters. Therefore, turbidity maps were generated using near infrared (NIR) and short wave infrared (SWIR) bands with a modified atmospheric correction algorithm which takes into account non-zero reflectance in the SWIR bands. Results show that the spatial distribution pattern of age-classes of Micropogonias furnieri is highly related to specific turbidity ranges. The role of forcing such as river discharge and wind-driven circulation in the redistribution of the sediment plume is also analyzed both at seasonal and interannual time scales using in situ and scatterometer wind data.

The GMES Sentinel-3 Mission: Overview and Status.

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Global Monitoring for Environment and Security (GMES) is the European programme to establish a European capacity for Earth Observation. GMES is designed to provide European policy makers and public authorities with accurate and timely information to better manage the environment, understand and mitigate the effects of climate change and ensure civil security. Sentinel-3 is an Earth observation satellite mission designed for GMES to ensure the long-term collection and operational delivery of high-quality measurements to GMES ocean, land, atmospheric, emergency and security services. Key Sentinel-3 measurement requirements, corresponding to identified user needs, have been derived from GMES as follows:

- Sea surface topography (SSH), significant wave height (Hs) and surface wind speed derived over the global ocean to an equivalent accuracy and precision as that presently achieved by ENVISAT Radar Altimeter-2 (RA-2) but with enhanced surface topography measurements in the coastal zone, sea ice regions and over inland rivers, their tributaries and lakes.
- Sea surface temperature (SST) determined for oceanic and coastal waters globally to an equivalent accuracy and precision as that presently achieved by the ENVISAT Advanced Along Track Scanning Radiometer (AATSR) over the ocean (i.e. <0.3 K), at a spatial resolution of 1 km.
- Visible, and Short-Wave Infrared radiances for oceanic, inland and coastal waters at a spatial resolution of ≤0.3 km (simultaneously and co-registered with SST measurements), determined to an equivalent level of accuracy and precision as ENVISAT Medium Resolution Imaging Spectrometer with complete ocean coverage in 2-3 days.
- Visible and infrared radiances over global land-surfaces in 1-2 days, sea-ice and ice-sheets equivalent to those currently provided from ENVISAT MERIS, AATSR and Système Probatoire d'Observation de la Terre (SPOT) Vegetation.

The Sentinel-3 mission addresses these requirements by implementing and operating:

- A dual frequency, delay-Doppler Synthetic Aperture Radar Altimeter (SRAL) instrument supported by a dual frequency passive microwave radiometer (MWR) for wet-tropospheric correction, a GPS receiver and a laser retro-reflector for precise orbit determination.
- A highly sensitive Ocean and Land Colour Imager (OLCI) delivering multi-channel wide-swath optical measurements for ocean and land surfaces.
- A dual-view Sea and Land Surface Temperature Radiometer (SLSTR) delivering accurate surface ocean, land, and ice temperature.
- A collaborative ground segment providing management of the mission, management, development, production and access to core data products in an operational near real time delivery context.

The mission foresees a series of satellites, each having 7-year lifetime, over a 20-year period starting with the launch of Sentinel-3A in 2013. During full operations two identical satellites will be maintained in the same orbit with a phase delay of 180°.

This paper provides an overview of the GMES Sentinel-3 mission including the mission background and user requirements, a technical description of the space segment, a brief overview of the ground segment concept, and a summary description of Sentinel-3 data products and their anticipated performance.

Contribution to the validation of GOCI products over turbid waters with MERIS, MODIS and field measurements data

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This work takes part to the validation of Geostationary Ocean Color Imager (GOCI) data acquired from April to November 2011. Intercomparisons between GOCI, MERIS and MODIS satellite geophysical products, namely the top-of-atmosphere, Rayleigh-corrected and seawater reflectances, are presented, analyzed and discussed. The study area encompasses the Yellow and East China Seas, and includes clear, moderately turbid, turbid and highly turbid coastal waters. The analysis is based on direct comparisons with MERIS and MODIS satellite products as well as on match-ups with field measurements. Several atmospheric correction schemes of satellite data are considered and tested.

MERIS data comes from the ESA 3rd reprocessing (Lerebourg & Bruniquel, ESA report ref. A879.NT.008.ACRI-ST, 2011), including an updated Bright Pixel Atmospheric Correction for coastal waters (Moore & Lavender, MERIS ATBD 2.6, 2011) and neural network inversion for the total suspended matters (Doerffer, MERIS ATBD 2.25, 2011). Performance of other MERIS alternative algorithms developed recently for the CNES French agency are also presented and discussed. MODIS Aqua data comes from the NASA R2009.1/R2010.0 reprocessing including the updated near-infrared water-leaving reflectance model (Bailey et al. 2010). The field measurements were carried out during two consecutive oceanographic campaigns organized by the KORDI research institute in September and October 2011.

Reference: Bailey S.W, Franz B.A and P.J. Werdell (2010). Estimation of near-infrared water-leaving reflectance for satellite ocean color data processing. Optics Express, 18, 7521-7527.

Sense and Sensibility: Remote Sensing of Ocean Colour, its Accuracies, and Implications for Models

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Coastal Biomass Observatory Services (EU FP7-project CoBiOS, 2011-2013) combine remote sensing data and models to observe state, and predict both path and wax-and-wane of algal blooms. In situ data are used for validation and skill assessment. Intercomparison enables evaluation of remote sensing algorithms, measures of attenuation (KD), and retrieved concentrations of chlorophyll-a (CHL), total suspended matter (TSM), coloured dissolved organic matter (CDOM) and measures of their accuracy. We present parameters derived from remote sensing and model results side-by-side, compare them and assess their skill. We give examples of use of remotely sensed radiation (light), and optically-modelled in-water absorption, scattering, and attenuation, and retrieved concentrations of CHL (as a first estimate for standing stock phytoplankton), TSM (transporting resuspended nutrients), and CDOM (as a DOC component) into biogeochemical models. We also show how such a comprehensive approach can progress the understanding of mechanisms that regulate near-surface surface optics and concentrations. However, establishing relationships between abiotic drivers and shelf sea biology relies heavily on accuracy of parameterisation or generalisation in implementation of detailed processes and feedback loops. Many biogeochemical models contain optics in the form of empirical optical approximations. We use optical relations between KD and concentrations to argue that redesign of these biogeochemical models around semi-analytical optical modeling with remotely sensed observations could be desirable in light limited systems.

Weather and climate related spatial variability of high turbidity areas in the North Sea and the English Channel

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The present research focuses on large scale geographical variability of high turbidity zones in the North Sea and the English Channel using meteorological and remote sensing data. The remote sensing data consist of surface suspended particulate matter (SPM) concentration maps retrieved from the marine reflectance in the visible band centred at 667nm of the MODIS sensor onboard the satellite AQUA, using the SPM algorithm calibrated for turbid waters [Nechad et al., 2010]. Meteorological data are from the UK Met Office and consist of 6 hourly wind and pressure fields. In order to investigate the weather related influence on SPM concentration in a larger area weather classification has been used to summarize the atmospheric circulation. We have used 11 weather types (WT), which are described using the locations of high and low-pressure centres, geostrophic winds and vorticity indices [Demuzere et al., 2009]. This classification is based on a simplification of the original 27 WT of Lamb's classification [Jenkinson and Collison, 1977]. The SPM concentration derived from MODIS satellite is assembled according to these weather types and statistically treated to investigate the influence of large scale meteorological patterns on the spatial variability of SPM concentration in the southern North Sea and the English Channel. Further the influence of climatology, as expressed by the North Atlantic Oscillation (NAO) index, has been investigated.

The results show a correlation of geographical distribution of SPM concentration and weather types in the North Sea. Typically an alternation of higher SPM concentration areas between the Southern and the German Bight during different weather types was observed. Climatological influences are clearly identified when comparing the SPM distribution during a winter with a positive and a negative NAO index. During a winter with negative NAO, the SPM concentration is on average higher in the southern Bight, whereas during a winter with positive NAO index an on average higher SPM concentration occurs in the German Bight. The results also show that satellite images should be used with care, as they are biased to certain weather types and not all types are proportionally represented in satellite images. The method proposed is different from previous work on SPM concentration distribution, which was mainly based on oceanographic data (wave, currents, tides, wind, temperature) and seasonal and neap/spring variations [e.g. Dobrynin et al., 2010, Pietrzak et al., 2011). It offers new research perspectives, such as the possibility of investigating how climate change scenarios will affect the SPM concentration distribution. The latter is important in order to predict changes in habitat types.

REFERENCES

Demuzere, M., Werner, M., van Lipzig, N.P.M., Roeckner, E., 2009. An analysis of present and future ECHAM5 pressure fields using a classification of circulation patterns. Int. J. Climatol., 29, 1796-1810.

Dobrynin, M., Gayer, G., Pleskachevsky, A., Günther, H., 2010. Effect of waves and currents on the dynamics and seasonal variations of suspended particulate matter in the North Sea. J. Marine Syst., 82, 1-20. Jenkinson, A.F., Collison, F.P., 1977. An initial climatology of gales over the North Sea; Synoptic Climatology Branch Memorandum? 62, Meteorological Office, London.

Nechad, B., Ruddick, K.G., Park, Y., 2010. Calibration and validation of a generic multisensor algorithm for mapping of total suspended matter in turbid waters. Remote Sens. Environ., 114, 854–866.

Pietrzak, J.D., de Boer, G.J., Eleveld, M.A., 2011. Mechanisms controlling the intra-annual mesoscale variability of SST and SPM in the southern NorthSea. Cont. Shelf Res., 31, 594-610.

SMOS CP34 Soil Moisture and Ocean Salinity maps

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The ESA's Soil Moisture and Ocean Salinity (SMOS) mission was launched on November 2009. SMOS provides global maps of the Earth's surface Ocean Salinity (OS) and Soil Moisture (SM) every 3 days with a spatial resolution of 40-50 km and an adequate accuracy for climatologic studies. SMOS carries the Microwave Imaging Radiometer using Aperture Synthesis (MIRAS), a novel 2D interferometer with 69 antennas distributed over a Y-shaped array.

For ocean applications, SMOS sea surface salinity (SSS) maps are operationally generated at the Spanish SMOS Level 3 and 4 Data Processing Centre (CP34). Experimental SSS and Soil Moisture (SM) maps are being developed and distributed at the SMOS Barcelona Expert Center (SMOS-BEC) to take the most out of SMOS observations. Present efforts on L3 are focused on the application of Objective Analysis on L2 data to produce L3 maps with greater accuracy and interpolated into data gaps. Ongoing work on L4 production aims at the development of data fusion techniques which combine the SMOS data with other satellite observation types (e.g., AMSR-E sea surface temperature, surface chlorophyll concentration or Aquarius SSS data). The technique is based on the use of singularity analysis, to exploit data synergy [Turiel et al. 2009]. The information provided by singularity exponents is then used to reconstruct SSS fields satisfying the multi-scale characteristics of geophysical flows.

L3 and L4 maps are validated with near-surface measurements provided by Argo profilers, which allow us to define several quality metrics. We have found that the implementation of these techniques significantly improve data accuracy with respect to L2 maps.

For land applications, SMOS spatial resolution is adequate for improving our understanding of water and energy fluxes between the atmosphere, the soil surface, and subsurface. However, it is insufficient for regional applications, such as land and water resources management, agricultural productivity, weather and climate forecasting, and flood and drought mitigation, which require a spatial resolution of 1 to 10 km. At the SMOS-BEC, a downscaling algorithm that combines SMOS radiometric estimates with MODIS VIS/IR satellite data has been implemented to distribute 1 km SM maps. The downscaling algorithm was first applied to a set of SMOS images acquired during the commissioning phase over South-Eastern Australia. Results from comparison with ground-based soil moisture measurements showed that soil moisture variability is effectively captured at 10 and 1 km spatial scales, without a significant degradation of the root mean square error [Piles et al., 2011]. This downscaling approach is now being applied to different regions so as to evaluate the performance of the algorithm over a wide variety of land covers and climate conditions. Likewise, its validation at an intermediate resolution using L-band airborne estimates is underway.

REFERENCES

A. Turiel et al., "The multifractal structure of satellite sea surface temperature maps can be used to obtain global maps of streamlines", Ocean Science 5, 447-460 (2009)

M. Piles et al.,"Downscaling SMOS-derived Soil Moisture Using MODIS Visible/Infrared Data", IEEE Trans. Geosc. and Remote Sens., vol 49, pag.352-374 (2011)

Variability of the spring bloom in the Labrador Sea from SeaWiFS and Seaglider

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Seagliders and SeaWiFS ocean colour are used to investigate the spring phytoplankton bloom in the Labrador Sea, and physical drivers of bloom intensity and timing. The Labrador Sea is a highly productive region in the North Atlantic which is both an important region for deep water formation, and a site where climate change effects (melting of Greenland and Arctic ice) may impact oceanic processes. We find that the start of the intense spring bloom in the northern Labrador Sea is controlled by the mixed layer depth, and primarily by a fresh surface layer overlying the saltier deep water. SeaWiFS data are used to generate spatial and interannual knowledge of the bloom characteristics. A Seaglider–equipped with CTD and WETlabs ecopuck (fluorescence and optical backscatter)–provide an *in situ* context for the satellite data (in 2006) while conversely, SeaWiFS data provide the spatial and temporal context for the Seaglider sections.

AMSR-E and WindSAT version 7 microwave SSTs

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NASA's AQUA satellite carries the JAXA's Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E). The AQUA satellite was launched in May 2002 and returned data until October 2011. WindSat, a fully polarimetric passive microwave radiometer, was launched in January, 2003 and continues to return data. It represents an important extension to the AQUA AMSR-E and TRMM TMI retrievals. Environmental variables, such as SST, wind speed, atmospheric water vapor, cloud water, and rain rate, are calculated using a multi-stage linear regression algorithm derived through comprehensive radiative transfer model simulations. SST retrieval is prevented only in regions with sun-glitter, rain, and close to land. In Polar Regions where cloud cover regularly prevents infrared observations of SSTs, the MW observations of SST provide a significant improvement. Although calibration problems complicated and delayed SST retrievals, WindSat SSTs are now routinely processed using an updated retrieval algorithm, RSS version 7. The AMSR-E SSTs have also been re-processed to version 7. This new algorithm will be discussed and validation results for both datasets will be presented.

Mesoscale in the coastal zone of the Southern Baja California Peninsula.

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From an oceanographic point of view the southern half of the Baja California peninsula is a region of great interest due to the convergence of water masses from different origins. The California Current brings to this area water of subarctic origin than merge with those that originate inside the Gulf of California and also, from further south, in the tropical Mexican Pacific. This creates an intense mesoscale field, clearly seen in the satellite imagery populated with many features such as ocean fronts and eddies. South of Cabo San Lucas fronts are formed in the upper 100 m due to the presence of waters from the California Current and the Gulf of California [Griffiths, 1953]. Fronts here are reported mostly during spring and summer. In order to identify the presence and permanence of ocean fronts and eddies, and to identify the seasonality of such structures in the coastal zone of Southern Baja California, we processed daily high-resolution (color and sea surface temperature) images for the last ten years (2002 to 2011). The source of the data is the MODIS-AQUA project and we used level 2 data, which corresponds to 1 km spatial resolution. We chose these because they are the more appropriated for studies of the 50-km coastal band due to its high resolution. The level 2 data however, are not projected onto a Cartesian coordinate system, i.e. the pixel information, although correctly geo-referenced, is not mapped onto a regular grid and it does not always cover the same area. We applied an optimal interpolation algorithm to project the information onto a regular 1-km grid of the 50-km coastal zone around the southern half of the Baja California Peninsula. We processed thus some 6000 images of chlorophyll and sea surface temperature. From this we present a discussion of the main frontal structures and semi-permanent mesoscale eddies, its seasonality and possible origin.

REFERENCES

Griffiths, R.C. 1963. Studies of oceanic fronts in the mouth of the Gulf of California, an area of tuna migrations. F.A.O. Fish. Rep. 6(3):1583-1609

[1]CICESE unidad La Paz. Miraflores 334 Col. Bella Vista, La Paz, B.C.S., CP. 23050. Tel 52 (612) 121-3031.

Inter-comparison and improvement of atmospheric correction algorithms based on worldwide in-situ data taken in highly turbid waters

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The accuracy of ocean color data highly depends on the precision of atmospheric correction algorithms. In open ocean waters, these are based on the assumption that water leaving radiance in the Near-Infrared (NIR) is negligible (referred as the NIR Black Ocean Assumption). This assumption allows to estimate the reflectance contribution from atmospheric molecules and aerosols and hence to select the appropriate aerosol model. In contrast to open ocean water, the NIR Black Ocean Assumption is invalid for turbid waters as these present significant backscattering in the NIR due to higher concentrations of suspended matter (TSM). Accordingly, several algorithms have been developed bypassing the NIR black ocean assumption. Among these (1) the iterative method developed by Stumpf including the Gordon and Wang atmospheric correction approach, (2) the algorithm developed by Ruddick which takes into account the spatial homogeneity of the aerosol and water-leaving reflectance in the NIR, (3) the recently developed short wave infrared atmospheric correction and (4) the algorithm developed by Schroeder which uses artificial neural network techniques. In the present study, we compare these 4 algorithms using MODIS-AQUA data and in-situ data from the AERONET-OC network and from sea-campaigns in highly productive coastal waters. For less turbid waters a good agreement is observed between MODIS and in-situ remote sensing reflectance (Rrs). However, for waters with higher concentrations of TSM or very low signal in the blue the retrieved Rrs shows relative errors exceeding 100% in the blue and 50% in the green and red region of the spectrum. An unsupervised classification of about 4250 AERONET-OC and in-situ reflectance spectra divides the data in 4 distinctive groups: (1) highly turbid waters with an average TSM concentration of about 15 gm^{-3} and an average Rrs at 412 nm (Rrs_{412}) around 0.01 sr^{-1}, (2) moderate turbid waters with an average TSM concentration of 3.5 gm^{-3}, (3) dark waters with an average Rrs_{412} around 0.0005 sr^{-1} and TSM concentrations around 2.5 gm^{-3} and (4) nearly clear waters with lower Rrs values in the NIR and larger Rrs values in the blue region. The present research shows the precision of the 4 atmospheric correction methods as a function of the water class. Empirical relationships between marine reflectance at different wavelengths are also observed and seem to be function of the water type. These relationships are used to force the atmospheric correction algorithms aiding movement towards improving water leaving reflectance estimations in highly productive coastal waters.

SSS retrieval from space: an comparison study using SMOS and Aquarius data

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Since November 2nd, 2009 and June 10, 2011, two spatial missions give us the ability to measure sea surface salinity (SSS) from space. The Microwave Imaging Radiometer using Aperture Synthesis (MIRAS) instrument onboard the Soil Moisture and Ocean Salinity (SMOS) mission [Font et al. 2004] and a 3 feed horn radiometer onboard the Aquarius mission [Le Vine et al. 2007]. These two missions provide global coverage SSS products with different repetition rates, spatial resolutions and accuracies. The complexity of SMOS measurements, the amount of external contaminations at L-Band (sun, galaxy, ionosphere, radio frequency interferences...), the different SSS retrieval algorithms and auxiliary data sources used by SMOS and Aquarius, will certainly give non negligible differences in term of final SSS product.

In order to be able to interpret these observed differences, different strategies can be investigated including spatio-temporal averaging technics. This kind of approach is investigated here on the sea surface brightness temperature rather than on the SSS in order to be able to have a consistent SSS retrieval algorithm and sea surface related auxiliary parameters between SMOS and Aquarius.

A subset of SMOS sea surface brightness temperature in the same incidence angle configuration as Aquarius is first considered. An Aquarius and SMOS level 2 sea surface brightness temperature dataset for three incidence angles ($\theta_{i=1,2,3}$ =28.7°, 37.8°, 45.6°) , spatially averaged in a regular grid of $1^\circ \times 1^\circ$ and temporally averaged over a month, is built for the last 4 months of 2011. A new retrieval algorithm is developed and apply to this new product to get the SSS.

This comparison study gives the opportunity to highlight possible instrumental biases and focus on possible issues regarding galactic and ionospheric signal corrections. Results with new auxiliary data sources like sea surface temperature (SST) or wind speed retrieved by other microwave satellites, which should be more accurate than NCEP or ECMWF model predictions, will be presented. The scatterometer on board Aquarius that give viable additional informations of the sea surface roughness contribution at L-band and the link between active/passive measurements will be investigated. As an example, a comparison of the sea surface roughness induced brightness temperature as seen by SMOS and Aquarius for different polarization states will be presented.

REFERENCES

J. Font, G. S. E. Lagerloef, D. M. Le Vine, A. Camps, and O. Z. Zanife. The determination of surface salinity with the European SMOS space mission. *IEEE Transactions on Geoscience and Remote Sensing*, 42(10): 2196–2205, Oct. 2004.

D. M. Le Vine, G. S. E. Lagerloef, F. R. Colomb, S. H. Yueh, and F. A. Pellerano. Aquarius: An instrument to monitor sea surface salinity from space. *IEEE Transactions on Geoscience and Remote Sensing*, 45(7): 2040–2050, July 2007.

STUDY OF RED TIDE DEVELOPING IN THE PERSIAN GULF AND OMAN SEA USING REMOTE SENSING DATA FROM MODIS SENSOR

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Problems associated with red tide or blooms of unicellular marine algae, known as Harmful AlgalBloom (HAB), are global and appear to be increasing in severity and extent. A red tide of kind of Cochlodinium polykrikoides engenders duration early of autumn 2008 until early of spring 2009 in the Persian Gulf and Oman Sea and Strait of Hormuz. In this HAB occurrence arise many of unknown phenomena that there was not many information. In this research we utilized data and images MODIS sensor of Aqua and Terra satellites. With analyzing this information we make temperature, chlorophyll-a and organic carbon pictures with autochthonous algorithm for Persian Gulf and Oman Sea in red tide. These images with field measurement and real images study for analogy measurement red tide development and that have attractive results. Results of this research show decreasing water temperature to 25ĉ trace propagation HAB. Images of satellite showed grow chl-a and organic carbon in waters in HAB's regional. In regional population industrial city of Hormuz strait coastal, density of HAB is more than other places and major current of Persian Gulf move HAB to the west regional. Most density and developing of HAB are seen in northern Strait of Hormuz by satellite.

Data assimilation and data fusion in a regional simulation

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An Ensemble Kalman filter [*Ballabrera-Poy et al.*, 2009] has been used to assimilate Sea Surface Temperature (SST) and Argo data into a regional configuration of the NEMO-OPA ocean model. Our validation of the data assimilation experiments include the comparison against a random ensemble of Argo profilers previously set aside (cross-validation), where the usual metrics are estimated from the differences of our data assimilation fields against Argo data (root mean square, mean value, standard deviation). We have also developed another metric based on the multifractal structure of the flow, comparing the histograms of singularity exponents of observations, as well as those of the background and analysis fields. While the first approach does directly measure the point by point difference between the model data and the in-situ independent observation, the second method focuses on the geophysical coherence of dynamical structures as it gives information about multi-point spatial correlations.

In a second part of this work we have analysed the relative advantages and drawbacks between data assimilation (here based on the Ensemble Kalman filter) and data fusion (here based on the Multifractal Microcanonical Formalism, see *Pottier et al.*, 2008) when applied to the production of quality remote sensing products of ocean observation. We have thus used both methods for the generation of SMOS Level 4 products of Sea Surface Salinity; the resulting maps have been validated with our metrics and analyzed at global and regional basis.

REFERENCES

Ballabrera-Poy, J., Kalnay, E., and Yang, S. 2009. Data assimilation in a system with two scales – Combining two initialization schemes. *Tellus*, 61A, 539-549.

Pottier, C., Turiel, A., Garcon, V. 2008. Inferring missing data in satellite chlorophyll maps using turbulent cascading. *Remote Sens. Environ.*, 112(12), 4242-4260.

Optimal interpolation of Chlorophyll_a satellite observations in the North Sea and Baltic Sea

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Within the Aquamar project, a method has been developed to produce daily interpolated Chlorophyll_a fields for the North Sea and Baltic Sea based upon observations from the MERIS sensor. This region is a very challenging region for satellite ocean colour and for statistical interpolation methods, due to e.g. presence of sharp fronts and occasional high temporal variability.

The data that are used in the method are Chlorophyll_a observations from the Case 2R processor for the years 2006 and 2007. In addition, in situ observations have been obtained from the danish national monitoring program, to validate the performance of the OI algorithm.

In the development of the OI algorithm, spatially varying error covariance functions have been derived from the empirical results as well as the guess error variance. The method works on the data in log-normal distribution and the validity of this assumptions for this will also be discussed.

The presentation will focus on the empirically derived spatial error covariances and the performance of the OI algorithm. Monthly and seasonal validation statistics will be presented and recommendations given for future work within the ocean colour merging and interpolation techniques.

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A Multi-sensor satellite sea surface temperature bias adjustment method for the Arctic Ocean

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The extreme atmospheric and oceanographic conditions in the Arctic Ocean result in elevated errors on satellite sea surface temperature (SST) observations in this region, compared to other regions of the global ocean.

The use of one satellite sensor, such as the AATSR, as a reference against which the other products can be referenced, does not work well in the Arctic Ocean. The presentation will therefore focus upon a new technique to perform a multi-sensor bias adjustment of satellite sea surface temperature. The technique is tested using 6 of the most widely used global satellite products from Infrared (AATSR, AVHRR and Modis) and Microwave (AMSR-E) sensors and has been derived taking into account the detailed error characteristics of each of the satellite products.

A test data set has been constructed for one year and the impact of the multi-sensor adjustment method has been assessed against independent in situ observations. In addition, examples will be shown on the bias correction fields obtained for Metop-A and simulated bias correction fields obtained using Numerical Weather Prediction output and radiative transfer modelling.

The improvement of using the new bias corrected fields in an Arctic Level 4 analysis will also be demonstrated through the use of the operational DMI Optimal Interpolation data processing system, which is similar to the operational Arctic level 4 SST product delivered in the MyOcean SST TAC.

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Model assessment for coastal water absorption coefficients in East China Sea

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The performances of three models for water absorption coefficients were validated in the coastal of East China Sea, which including Quasi-analytical algorithm (QAA), Garver-Siegel-Maritorena model (GSM) and constrained Linear Matrix (LM). The model retrieved parameters, namely absorption coefficients of phytoplankton (aph), colored dissolved and detrital organic matters (acdm) and total absorption coefficients (a) were compared at five wavelengths (412, 443, 490, 510, and 555 nm). The bio-optical datasets used in this study were two distinctive types of waters, with total suspended matters (TSM) $<$10mg/L (clear) and TSM$>$10mg/L (turbid) respectively, and different results were obtained. In clear waters, the QAA model performed the best in retrieving aph and a, while the most accurate acdm was achieved by LM. In contrast, in turbid waters all three models tend to yield large errors with varying magnitudes at different wavelengths, only QAA model showed a slightly better performance. The modified QAA based on longer reference wavelength and field measured data improved the results of acdm and a. Our analysis reflects that additional refinements are needed to produce accurate estimates of water absorption coefficients in East China Sea.

Estimation of the total absorption $a(\lambda)$ and the backscattering $b_b(\lambda)$ parameters using a neural network inversion in coastal waters

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It is a challenging task to estimate the inherent optical properties (IOPs) of seawater in coastal waters. Empirical and semi-analytical methods have been developed for the past several years and they estimate differents parameters and present different accuracies. This study presents a new way to estimate two fundamentals IOPs: a, the total absorption and b_b, the back-scattering coefficients. To do so, a neural network inversion was developed to estimate those parameters at any wavelengths, which is a novelty, from the remote-sensing reflectance spectrum in the visible. In-situ and theoretical datasets were used to calibrate the neural network. The new empirical inversion is compared to the standard NASA algorithm and the algorithm of Lee. Maps of a and b_b in the English Channel will be presented using MODIS-AQUA and MERIS images.

Reconstruction of incomplete satellite SST data sets combining optical and microwave remote sensing products over the China Sea by the DINEOF methodology

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With the continuous development of satellite remote sensing technology and data accumulation in the past few decades, remote sensing data of different time resolution (daily, 3-day composite, 8-day composite, Monthly, Annual composite and so on) and higher spatial resolution have been free to be shared. Satellite remote sensing is characterized by periodicity, macroscopy, real-time and low cost, which is the reason why it is widely used in ocean monitoring. Remote sensing data has become a major means by which we learn more about ocean processes. Because of the clouds coverage over the ocean and changes in scanning orbit of sensors, the satellite remote sensing data obtained by the visible and infrared bands often show missing data in a large proportion. As the statistics show, due to the clouds coverage, the missing data take up quite an amount in all the data. Even in the 5 day's average and fusion processed data, the missing ratio reaches as high as 40% (Ding et al., 2009). The missing data greatly limit the use of remote sensing data. Several methods have been used in dealing with the reconstruction of missing data (Zhu et al., 1995; Tan et al.,2000; Mao et al.,2003; He et al., 2003; Beckers and Rixen, 2003; Ma, 2004; A.Alvera -Azcárate et al., 2005, 2007, 2009; Knodrashov et al., 2006). And in the field of image processing, reconstruction of missing data is equal to image restoration or image reconstruction, and mainly the used data sets are related in time or space. In the related research on this subject, DINEOF methodology has been widely used. The DINEOF methodology allows calculation of missing data in geophysical datasets without requiring a priori knowledge about statistics of the full dataset and has previously been applied to SST reconstructions. In the relevant literature, this methodology was mainly applied by using the single source of data (A.Alvera-Azcárate et al., 2005, 2007, 2009; Beckers et al, 2003, 2006; E.Mauri et al., 2007, 2008; Ganzedo et al., 2011). As the dynamics of ocean water characteristics and the strong temporal variability, there are many uncertainties in applying the DINEOF methodology to SST reconstructions using a single sensor data. Compared with visible and infrared remote sensing, microwave remote sensing is specially characterized by all weather, all time, strong permeability, plenty of multi-band and polarization information. Based on physically nonlinear iteration and linear regression algorithm, the inversion precision of the AMSR-E SST can be up to 0.5K. We propose an improved method of reconstructing missing data sets based on DINEOF(A.Alvera et al., 2005, 2007, 2009). This study features is combining optical and microwave remote sensing products over the China Sea using the DINEOF methodology to achieve the reconstruction of high spatial resolution remote sensing SST products data sets. The optical MODIS/Aqua SST (11μ daytime) products with the spatial resolution of 4km were selected, while microwave AMSR-E/Aqua SST products with the spatial resolution of 0.25 degree (Unfortunately, the AMSR-E antenna stopped spinning at 0726GMT Oct 4 and AMSR-E is currently not producing any data). The study area focuses on China Sea, and the remote sensing data sets of optical MODIS/Aqua SST and AMSR-E/Aqua SST products generated in 2009 all the year were used. In the model interpolation process, we will take into account the problems of the microwave and infrared optical data product scale mismatching, sensor system error elimination, DINEOF model parameters optimization, model precision evaluation and the effect of sea-land interaction process (such as the seasonal effect of the Yangtze river diluted water) on the interpolation accuracy. We hope our work can provide some experience for DINEOF methodology in multi-source data comprehensive application, including the scale transformation rule between different data, the relationship between the error distribution and ocean physical process. Keyword: Optical remote sensing; Microwave remote sensing;Data Interpolating Empirical Orthogonal Functions methodology(DINEOF);Missing data;Scale issues ;China Sea

Application of SST as provided by the Group for High Resolution Sea Surface Temperature (GHRSST)

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The Group for High Resolution Sea Surface Temperature (GHRSST) provides a wide variety of users in the fields of oceanography and atmospheric sciences with Sea Surface Temperature (SST) products. In addition to the operational service, GHRSST supports best practice in development of the Climate Data Record (CDR) of SST which is an Essential Climate Variable (ECV) for global change studies. GHRSST links research, operations and users with dedicated sub-groups on SST research issues: e.g., improved cloud and sea-ice discrimination, particularly at high latitudes and at night; improved resolution fields (1 km) together with information on feature resolution; algorithm improvement for both infra-red and microwave; improved error characterisation; provision of inland water surface temperature and ice cover; and optimal combination of data sets. The importance of these for the different user applications are outlined in this talk.

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Variability of the large-scale oceanic frontal zones as revealed from analysis of the global satellite SST data

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Comparative analysis of the long-term variability of the major large-scale climatic oceanic frontal zones (OFZ) based on the global satellite measurements of sea surface temperature (SST) is presented. High spatial resolution global SST data obtained from AVHRR measurements (monthly mean at approximately 4 km spatial resolution; PATHFINDER product) for the period 1982-2009 have been used. To suppress the mesoscale variability and reveal the gross features of the long-term variability we used zonally averaged SST within the selected areas of OFZ manifestations (initially, SST was averaged for the seasons of maximum OFZ intensity which are different for subpolar and subtropical areas and for northern and southern hemispheres). Then, we calculated the magnitude of meridional gradient of zonally averaged SST (G) and found out its maximum (Gmax) and meridional position of Gmax (OFZ core) for each OFZ. As a result, we obtained time series of Gmax and its position for subpolar and subtropical OFZ in Atlantic and Pacific (both hemispheres) and in Indian Ocean and also for equatorial fronts in eastern Pacific. Preliminary analysis indicates that all subpolar OFZ (except southern Pacific) exhibit pronounced quasi-decadal (8-10 years) variability of Gmax. In the southern Pacific the period of variability is shorter (6-8 years). In the northern hemisphere and in southern Pacific and Indian Ocean intensification of SST gradient is accompanied by the northward shift of OFZ core (meridional position of Gmax). In the southern Atlantic the tendency is contrary (i.e., subpolar OFZ intensification is accompanied by southward shift of the core). Statistically significant positive linear trend of subpolar OFZ intensity is evident only in southern Pacific and Indian Ocean. In those areas an intensification of subpolar OFZ is associated with the southward shift of frontal cores. Amplitude of the long-term variability of SST gradient in the northern hemisphere (0.4-0.5 deg.C/100km) is twice as higher compare to southern hemisphere (0.2-0.3 deg.C/100km). Subtropical OFZ also demonstrate long-term variability (7-10 years) though less regular compare to subpolar fronts. Intensification of subtropical OFZ is accompanied by the pole ward shift of the frontal cores. The period of variability of equatorial OFZ in Pacific is about 4-6 years, which is consistent with ENSO index variations. The possible connection of OFZ variability with the large-scale atmospheric forcing is discussed.

Detection and Analysis of Fronts in the North Sea

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Fronts in the ocean are important oceanographic structures because of their role as boundaries between water masses with different properties and their strong influence on the local dynamic, the dispersion and concentration of substances. Fronts are defined as regions where the properties of water change significantly over a relatively short distance. The main parameters to detect fronts from satellite data are differences in the SST, but also large changes in total suspended matter (river plume fronts) or in chlorophyll concentration are indicators for different water masses or indicating different biological regimes. The characteristics of fronts have been used to develop an algorithms for front detection comprising pre-processing steps and the identification of fronts itself. A nine year time series of AATSR and MERIS data have been processed applying the algorithms for the North Sea for the years 2002-2011. The identification and location of persistent fronts is of particular interest as well as the movement and location of different front types. The work is conducted in the framework of the KLIWAS project funded by the Federal Ministry of Transport, Building and Urban Development.

The problem of satellite monitoring of coccolithophore blooms in the Black Sea

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Satellite observation is an eminently suitable tool for monitoring and study of coccolithophore blooms but the quantitative estimation needs perfected algorithms. The current satellite algorithm using data of ocean color scanners, such as SeaWiFS and MODIS, (http://oceancolor.gsfc.nasa.gov/seadas/) is based on retrieval of the backscattering coefficient b_b and then estimation of the calcite concentration via an empirical relationship. The regional algorithm for the Black Sea developed by specialists from SIO RAS (http://optics.ocean.ru/) is also an empirical relationship between the coccolithophoride concentration and the particle backscattering coefficient based on *in situ* measured data. The drawback of the both algorithms is that "non-coccolithophore" related backscattering is not accounted for. This shortcoming is particularly significant for the Black Sea which is strongly influenced by river run-off.

We analyze the problem of taking into account the "non-coccolithophore" backscattering by using the integrated approach with the comprehensive data set including satellite data and optical, hydrological and biogeochemical parameters measured *in situ* in the eastern part of the Black Sea. Features of the satellite study of the coccolithophore blooms in the Black and Barents seas are compared. The advanced algorithms are proposed.

Satellite monitoring of THE Nord Stream gas pipeline Construction in Russian waters of the Gulf of Finland in 2010-2011

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To assess the impact of construction of the Russian section of the Nord Stream gas pipeline on the formation of fields of suspended matter in the eastern Gulf of Finland a daily satellite monitoring was organized in the period from 12 May to 31 December 2010 and from 1 April to 30 November 2011. The objectives of the monitoring included: (1) identification of the spots of turbid waters in the vicinity of the pipeline and in the surrounding waters of the eastern Gulf of Finland, (2) determination of natural areas of suspended matter distribution, (3) separation of the effects of anthropogenic impact on the marine environment and natural processes responsible for an increase in the water turbidity, and (4) monitoring of the transboundary transport of turbid waters. For this purpose, we used all informative (cloudy free over the pipeline route) satellite images, obtained with MODIS-Terra and –Aqua (spatial resolution 250-1000 m) and MERIS Envisat (260 m). In addition, ASAR Envisat imagery was used to determine ice cover and the position of the ice edge in the Gulf of Finland.

Only a few cases of local patches of water with high concentration of suspended matter can be attributed to the construction of the pipeline (only in the vicinity of Portovaya Bay), however, its concentration was less than that agreed by the State Environmental Expertise of the Russian Federation. All other detections of turbid waters, crossing the pipeline, were of natural origin (wind-wave mixing, river plumes, transboundary transport). Our conclusions were confirmed by the turbidity maps of the Gulf of Finland presented at the web site of the Finnish Environment Institute (SYKE, www.environment.fi/turbidity). Natural processes of sediment resuspension in waters of the Gulf of Finland have a much larger scale and intensity than the observed effects of pipeline construction. Increased turbidity of water through natural processes can to a thousand times be greater than the anthropogenic impact as a result of pipeline construction. Transboundary transport of suspended matter is an important factor in increasing the turbidity of water in the vicinity of the pipeline in the Gulf of Finland. Note also that the meso-scale and small-scale vortex structures (eddies, jets and dipoles with a characteristic horizontal scale of 5-30 km) significantly influence the redistribution of suspended matter in sea water and can advect turbid waters at distances of 50-100 km from the shore.

Ocean Colour time series of MERIS data for comparing atmospheric correction algorithms

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We show MERIS data of a full year over two fairly homogenous areas of the North Atlantic and the South Pacific Gyre. The level 1b-data are processed with different atmospheric correction algorithms: the version 8 of the standard processor MERIS MEGS, the SeaDAS processsor, the POLYMER processor and a development from the Case2Regional processor using a forward neural net combined with a Levenberg-Marquardt optimisation. The spatial and temporal assymetries in time series over one year are examined for the different algorithms, and they show across-track angle dependencies. The errors specific to particular algorithms are discussed, with particular reference to the implications when the products with errors that are seasonally-dependent are used to study trends using multi-year time series data.

Acknowledgments. Acknowledge Mermaid team and all Mermaid PIs. For a publication we have to offer a co-authorship to all Mermaid Pis (ca.40).

Comparing in-situ measurements of water leaving reflectance with corresponding MERIS products derived using different atmospheric correction algorithms

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The in-situ measurements from the MEris MAtchup In-situ Database (Mermaid) is compared to MERIS level 1b-data processed with different atmospheric correction algorithms: the standard processor for MERIS (MEGS-8), the SeaDAS processsor, the POLYMER processor and a development from the Case2 Regional processor using a forward neural net combined with a Levenberg-Marquardt optimisation. The comparison is made with different subsets using individual and common quality flags to all algorithms, for different subsets of in-situ sites used. Comparisons are made for individual common wavelengths and for spectral fits.

Acknowledgments. Acknowledge Mermaid team and all Mermaid PIs. For a publication we have to offer a co-authorship to all Mermaid Pis (ca.40).

Remote sensing of phytoplankton variability off South-Western Iberia: a sentinel for climate change?

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The region off southwestern Iberia (NE Atlantic) encompasses a wide variety of oceanographic regimes, including coastal areas impacted by upwelling, riverine inputs and submarine groundwater discharge, submarine canyons and seamounts, , and open ocean waters. Overall, this heterogeneous region is classified as being very sensitive to climate change (IPCC, 2007), and climate-driven alterations (e.g., sea surface warming, changes in upwelling patterns and intensity) have been recently reported for the area (e.g., Relvas et al. 2009). This study, integrated in the framework of the ongoing PhytoClima project (Remote sensing of phytoplankton variability off South-Western Iberia: a sentinel for climate change? - PTDC/AAC-CLI/114512/2009), aims to: (a) identify relevant drivers underlying phytoplankton variability off SW Iberia, over a 15-year period, and (b) explore linkages between meteorological forcing and phytoplankton dynamics. Daily surface chlorophyll a concentration, a proxy for phytoplankton biomass, was derived from SeaWiFS (Sea-viewing Wide Field-of-view Sensor) and MODIS-A (Moderate-resolution Imaging Spectroradiometer), at 1 km resolution, for 1998-2012 period. Environmental determinants of phytoplankton distribution, such as regional meterological data and physical-chemical oceanographic variables (e.g., sea surface temperature, upwelling intensity) were extracted or estimated using information derived from satellite imagery, land-based meteorological stations, and national and international databases. Chlorophyll a concentration at off-shelf locations was significantly lower than coastal areas, and exhibited a fairly stable unimodal annual cycle, with maximum during March. Coastal locations displayed more variable annual cycles, probably impacted by upwelling dynamics and riverine influences. Future project approaches include the acquisition of in situ data to validate remote sensing products, and the integrated analysis of phytoplankton and environmental data in the context of dynamic biogeochemical or ecological provinces. REFERENCES IPCC, 2007. Climate change 2007: Synthesis report. Contribution of working groups I, II and III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Geneve, IPCC. Relvas, P., J. Luis, and A. M. P. Santos,2009. Importance of the mesoscale in the decadal changes observed in the northern Canary upwelling system, Geophys. Res.Lett., 36 L22601, doi:10.1029/2009GL040504.

Manifestation of the mesoscale phenomena in surface roughness, altimetry, optical and thermal properties of the upper layer.

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Medium and high resolution optical data (MODIS, MERIS, TM, ETM+), altimetry and radar data together with meteorological re-analysis are used for investigation of eddies, upwellings and internal wave manifestation in the Black Sea and Strait of Gibraltar. The next topics are discussed: 1. Sea surface roughness by optical scanners data – upwelling, eddies, pollutions and internal waves manifestation in sun glitter pattern. 2. Coastal upwelling - thermal and optical properties and impact on sea level and surface roughness. 3. Eddies manifestation in variation of the upper layer properties - different remote sensing sensors. 4. Statistic for 1994-2010 years and properties of eddies in the Black Sea, impact of the wind forcing – altimetry and meteorological data analysis.

Error Characteristics of MODIS sea surface temperature (SST) Algorithm.

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In this study we have used an extensive dataset of co-located satellite derived SST (from MODIS sensors) and in situ observations from various platforms to statistically analyze SST residuals (Satellite SST – In situ SST). The objective of this analysis is to illustrate under what circumstances an algorithm performs well, and when it performs badly (i.e. not enough to know that the retrievals represent the mean conditions well) and to give guidance to improve algorithm performance for new sensors like VIIRS.

There are no perfect reference fields. As reference fields we use bulk SST measured from buoys (drifting and moored) and skin SST measured from Marine-Atmospheric Emitted Radiance Interferometer (M-AERI). M-AERI is the reference standard for satellite SST retrievals (AVHRR, AATSR, as well as MODIS), and for other ship-board radiometers. The uncertainties in the reference field must be well known so they are not attributed to the satellite retrieval. Buoy SSTs have a residual bias error of about 0.15K with RMS errors closer to 0.5K.

The statistical approach to coefficient estimation used in MODIS algorithm produces a skin temperature biased by the mean skin-bulk temperature difference. The comprehensive error characterization yielded a SST(11-12 micron) rms of the order of 0.5K and SST4(3-4 microns) about 0.4K. SST4 is less effected by aerosol and dust. The algorithm is robust and there is no seasonal variations. The outliers are mainly negative implying over-estimation by the SST algorithm. Underestimation of SST appear correlated with lower wind speeds, water vapour and aerosol regions. Whereas overestimation of SST appears correlated along coastal regions and known upwelling regions and maybe related to anomalous atmospheric conditions. The mean of SST residual is < -0.2K. At wind speeds greater than 3 m/s, applying a cool skin bias of about 0.2K to the buoy data, reduces the mean MODIS SST residual to near zero. Although global rms is about 0.5K, regions like the North Atlantic and Eastern Pacific have larger rms. Night time SSTs are cooler than daytime possibly due to the combined effect of skin and thermal stratification of the upper ocean layers.

Our analysis also showed systematic patterns in residual uncertainties indicating shortcomings in the atmospheric correction algorithms. We will further discuss these shortcomings and indicate how they can be improved for future SST algorithm development. These results are important for climate studies and merging of different SST data streams.

CONCENTRATION OF THE SUSPENSION AND CHLOROPHYLL-A DERIVED FROM OPTICAL SCANNERS FOR THE COASTAL WATERS

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The big importance of the coastal marine zones for economy (industry, transport, agriculture, tourism, recreation) on the one hand and vulnerability of their ecology with another are the reasons of that these zones are the object of the enhanced attention from the many international and national scientific organizations, and also from many experts. The major problems of such zones are the coastal erosion, eutrophication, hypoxia, sedimentation, pollution. These phenomena are connected by various ways with the optical characteristics of the water environment which can be determined from the multispectral optical satellites such as SeaWiFS, MODIS, Landsat etc. [*Khanbilvardi et al., 2005; Kushnir & Stanichny, 2006; Kushnir, 2009]*.

One of the feature of the marine coastal zones is rather high turbidity of water environment because of significant concentration of mineral and organic suspension, phyto- and zooplankton which essentially change the form of spectra and intensify of the brightness of the water leaving radiation (WLR). It means inefficient of the widely used methods of the optical satellites data processing for rather transparent sea water and dictates necessity of new methods for the coastal marine areas. One of such methods is considered in this work.

This method is based on the international AERONET project which data have processed in MHI. The analysis has shown that spatial variability of the aerosol over the Azov-Black Sea basin is defined, mainly, by large-scale advection of air mass, and the characteristic spatial scale of aerosol formations exceeds of 100 km. At the same time the characteristic distance from turbidity coastal waters to waters with a high transparency equal, as a rule, of tens km. It allows to assume that characteristics of the atmospheric aerosol on scales of 10 km are identical to turbidity coastal waters and adjoining waters with rather high transparency. Signals of brightness of WLR from transparent water on waves of $\lambda = 0.645\mu$ and $\lambda = 0.8585\mu$ negligibly are small and consequently signals measured by the satellite photometer are equal to aerosol and molecular scattering of the atmosphere brightness. At that time, the signals of brightness of WLR from the neighborhood zone of the turbidity coastal waters is the sum of signals of the same atmospheric scattering and WLR from the coastal waters. Calculation of the normalized brightness of the WLR from sea surface on the noted waves is based on the simplified relationship of atmospheric correction as:

$$L_T(\lambda) = L_A(\lambda) + L_R(\lambda) + L_W(\lambda)t(\lambda), \qquad (1)$$

where $L_T(\lambda)$ is the-brightness of the radiation measured by onboard photometer; $L_W(\lambda)$ is the brightness WLR of the sea surface, $L_A(\lambda), L_R(\lambda)$ are the brightness of aerosol and molecular atmosphere scattering, $t(\lambda)$ is the light-transmission factor, equal to $\exp\{-[0{,}5\tau_R(\lambda) + \tau_{Oz}(\lambda)](\cos\theta_v)^{-1}\}$, $\tau_R(\lambda)$ is the optical thickness of the layer of molecular scattering, τ_{Oz} is the optical thickness of the ozone layer, θ_V is the zenith angle of the satellite.

As the informative parameter for calculations of the suspension and chlorophyll-a concentration (C_S, C_{Chl}) was used the index of color which are defined as a combination of the optical channels data with various λ. One of such combinations represents the relation of the normalized brightness $L_{WN}(\lambda)$ in two spectral zones, i.e.

$$I_{WN}(0.645/0.8585) = L_{WN}(0.645)/L_{WN}(0.8585). \qquad (2)$$

As we noted, the minimum signals of brightness for transparent waters correspond to brightness of atmospheric signals. So it is possible to write down the following relationship for the color index:

$$I_{WN}(0.645/0.8585) = \frac{L_t(0.645) - \min[L_t(0.645)]}{L_t(0.8585) - \min[L_t(0.8585)]} \cdot P(0.645/0.8585), \qquad (3)$$

where $\min[L_t(0.645)]$ and $\min([_t(0.8585)]$ are the minimum values of the measured signals concerning transparent waters adjoining to coastal zones,

$$P(0.645/0.8585) = \exp\{[\frac{\tau_R(0.645) - \tau_R(0.8585)}{2} + \tau_{Oz}(0.645) - \tau_{Oz}(0.8585)](\frac{1}{\cos\theta_V} + \frac{1}{\cos\theta_S})\}$$

is the correction multiplier considering atmosphere light-transmission and recalculation of brightness of the ascending radiation in brightness of the normalized ascending radiation. At the change of the zenith corners of the satellite θ_V and of the Sun θ_S from zero to 60 degrees, relative changes of the correction multiplier do not exceed of ± 6 %.

Direct measurements of the suspension and chlorophyll concentration have shown the significant correlation with the index of color. The spatial distributions of concentration of the suspension and chlorophyll-a for various areas of the coastal zone of the Azov - Black Sea basin have been calculated using the calibrating dependences in form of $C_S = f_1[I(0.645/0.8585)]$ and, $C_{Chl} = f_2[I(0.645/0.8585)]$.

REFERENCES

Khanbilvardi R., Shteinman B., Kushnir V, Stanichny S., Ahmed S., Gilerson A., Gross B. Moshary F. 2005. Optical inhomogeneities of water in the New York coastal zone determined using multispectral satellite data//Coastal Engineering. Vol. 78. P. 57-67.

Kushnir V.M., Stanichny S.V. 2007. Color Index in the Northwestern Black Sea from Space Color Scanner Data//Earth Research from Space. No 4. P. 62-73 (in Russian, abstract in English).

Kushnir V.M. 2009. Characteristics of the Azov Sea Near-Surface Layer Derived from the Optical Scanners of the MODIS System//Earth Research from Space. No 3. P. 35-46 (in Russian, abstract in English).

Aquarius Satellite Salinity Measurements; Performance, Calibration and Early Science Results During the First Eight Months

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The US-Argentine Aquarius/SAC-D satellite was launched June 10, 2011 with a suite of sensors for Earth observation and a primary mission to monitor global variations in ocean surface salinity to study the links between ocean circulation, water cycle and climate. Measurements include salinity, wind, rain, surface temperature, sea ice, soil moisture, night images, atmospheric soundings and space environment, coupled with an active educational program. At the time of this writing, the Aquarius sensor has collected ocean salinity data since late August 2011, and initial unvalidated data have been released for evaluation. Aquarius samples the global ocean surface salinity field every seven days and is designed to achieve 0.2 psu accuracy over monthly averages on 150 km spatial scale. The data show very robust signatures of the basin scale salinity patterns and many details on sub-basin scales. This presentation will provide a review of the first eight months of salinity data, including the status of calibration and validation, ancillary wind and other corrections, a description of the resolvable salinity variations and other notable findings in the initial measurements.

Development and validation of an algorithm estimating primary production in the Southern North Sea

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An algorithm to estimate daily primary production (PP algorithm) in the Southern North Sea from satellite and climatology data is described and tested. This algorithm - a wavelength-integrated but time- and depth-resolved photosynthesis model - includes three parameters: the maximal photosynthetic capacity P^B_{max}, the photosynthetic efficiency α^B and the vertical light attenuation coefficient K_d(PAR). These parameters are estimated from statistical models developed and validated on basis of experimentally determined photosynthetic parameters, PAR vertical profiles and relevant environmental data in the area. P^B_{max} is derived from temperature and phosphate concentrations using a multiple linear regression model while α^B is calculated from P^B_{max} using a simple linear regression model. A natural logarithmic regression model taking into account the optically active components of these Case 2 waters, i.e. chlorophyll *a (*Chl *a*), suspended matter (SM) and dissolved coloured organic matter (CDOM approached by salinity) provides the best description of K_d(PAR). The three models have very good predictive capacity.

The constructed PP algorithm is tested by using successively field, and MODIS-derived and climatology data (temperature, phosphate, Chl a, SM, salinity-derived CDOM) as inputs and the estimated daily PP is compared with *in situ* PP measured by traditional method. Results obtained for 17 stations constituting the validation data set are shown and the errors are estimated and discussed. Clearly the deviations between PP algorithm predictions and *in situ* PP are higher when using remote-sensing and climatology data due to errors on both parameterizations and the retrieved data. It is suggested that an approach combining remote sensing and hydrodynamical-ecological modeling would allow the PP algorithm developed in this study to be fully functional in the Southern north Sea.

Please send your abstract by e-mail to oceanphys@ulg.ac.be

Please presentation(s)

Chlorophyll_a algorithms for MODIS and MERIS full resolution imagery: a comparison between Case 1 and Case 2 Ligurian and North Tyrrhenian waters

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We present the results of a work based on MODIS (moderate resolution imaging spectroradiometer) and MERIS (medium resolution imaging spectrometer) full resolution satellite data, to estimate concentrations of chlorophyll_a ([CHL]) in the Ligurian and North Tyrrhenian sea. We tested the performance of ocean color chlorophyll algorithms, OC3M [O'Reilly et al. 2000] and MedOC3 [Santoleri et al. 2008], which are standard algorithms known to overestimate [CHL] in Mediterranean oligotrophic waters, together with two new algorithms, OC5 [Gohin et al. 2002] and SAM_LT [Maselli et al. 2009], which exploits more of the satellite spectral information. This evaluation exercise has been carried out using *in situ* data taken in the North Tyrrhenian and Ligurian Seas during recent oceanographic campaigns. The four algorithms perform differently in Case 1 and Case 2 waters defined following global and local classification criteria. In particular, the mentioned [CHL] overestimation of the two standard algorithms is more evident in intermediate and Case 2 waters. The two new algorithms are less sensitive to this problem, and are generally more accurate in Case 2 waters. An analysis of the different reliability of the algorithms depending on varying water properties is then provided.

REFERENCES

Gohin, F., Druon, J. N., Lampert, L. 2002. A five channel chlorophyll concentration algorithm applied to SeaWiFS data processed by SeaDAS in coastal waters. *Int. J. Remote Sensing*, 23, 8, 1639 – 166.

Maselli F., Massi, L., Pieri, M., Santini, C., 2009. Spectral angle minimization for the retrieval of optically active seawater constituents from MODIS data. *Photogrammetric Engineering & Remote Sensing*, 75 (5): 595-605.

O'Reilly, J. E., and 24 Coauthors, 2000. SeaWiFS Postlaunch Calibration and Validation Analyses, Part 3. *NASA Tech. Memo. 2000-206892,* Vol. 11, S.B. Hooker and E.R. Firestone, Eds., NASA Goddard Space Flight Center, 49 pp.

Santoleri, R., Volpe, G., Marullo, S., Buongiorno Nardelli, B., 2008. *Open waters optical remote sensing of the Mediterranean Seas. Remote sensing of the European Seas*, 103-116, Springer Netherlands.

The Importance of Quality Control for Science: Spaceborne Medium Resolution Optical Sensors

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Spaceborne optical sensors provide parameters over the ocean and terrestrial environments often on a global basis. On behalf of the European Space Agency (ESA), Quality Control (QC) support for MERIS, MODIS, SeaWiFS and Landsat (5 and 7) is provided through Sensor Performance Product and Algorithms (SPPA) Teams based at ARGANS - with expert support from ACRI-ST and Gael Consultant - under the VEGA Space lead IDEAS consortium. Systematic and manual activities are performed by the SPPA Teams in order to provide consistent QC and support to the global remote sensing community.

Daily MERIS production is monitored through automatically generated reports that ensure near-real time (NRT) monitoring of the operational state of the instrument. Any anomalous product generation is investigated by the SPPA Team and advice issued to ESA. This same activity is also carried out for MODIS received in Europe as an ESA Third Party Mission (TPM). In addition to NRT QC of products from the MERCI MODIS online catalogue, the MODIS SPPA Team also provides NRT QC support under the GMES framework to the MyOcean MODIS Rolling Archive. All products are automatically downloaded and interrogated using the NASA SeaDAS package including processing to Level 2 (derived surface parameters). The Team also QC's European coverage of Landsat 5 and 7 products is as an ESA TPM. Systematic analysis is at the point of processing in the Station. In addition, a large number of Landsat 5 TM sys-corrected products are retrieved for Long Loop Sensor Analysis each day, which involves the comparison of radiometric values between multiple products, located over specific areas such as the Libyan Desert and Lacrau (France) and provides a historical timeline of the radiometric accuracy of the instrument throughout the lifetime of the mission.

Validation of the regional algorithms for the sea surface temperature observation using the AVHRR NOAA sensors in the Black and Caspian Seas

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Satellite AVHRR radiometer data processing algorithms for calculation the sea surface temperature (SST) recommended by NOAA do not work well in the inland seas, such as the Black and Caspian Seas. The average salinity of the World Ocean is about 35‰, with a range from 34 to 36‰. The Black Sea surface layer has a salinity of about 18‰. The Caspian Sea salinity is relatively low, on average of about 12,6‰. In the Northern Caspian a mean salinity ranges from 6 to 11‰ and decreases to 0,3‰ in of the Volga Delta. From November to March the Northern Caspian is covered by ice. All these thermohaline features in both seas affect the formation of water surface brightness temperature. In turn, this requires a tuning of recommended algorithms for SST calculation from remote sensing data, and probably elaboration of new regional algorithms.

In this presentation we propose new regional algorithms for SST calculation in the Black and Caspian Seas. Verification is carried out basing on the Quasi-Lagrangian SVP-BT drifter data acquired during the Black Sea drifter experiments, the first Caspian Sea drifter experiment performed in the framework of the MACE (Multidisciplinary Analysis of the Caspian Sea Ecosystem) project and SST maps produced by Marine Hydrophysical Institute for 2006–2007. The first results showed that the developed SST regional algorithm is accurate as 0,5°C for the Black Sea and 0,7°C for the Caspian Sea.

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Comparison of SEVIRI and buoy derived diurnal warming estimates.

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Hourly SST fields derived from the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) onboard Meteosat Second Generation (MSG) are increasingly used in studies of the diurnal cycle of the oceans. Hourly diurnal warming (DW) estimates can be indeed derived as the difference between SEVIRI derived hourly daytime and predawn SST values. In this presentation we compare these estimates with equivalent quantities derived from drifting or moored buoy measurements, using the operational CMS SEVIRI matchup data base in summer 2011. An overall good agreement between SEVIRI and drifter DW estimates has been found. An unexpected underestimation of diurnal warming amplitude by SEVIRI has been identified for large DW events due to afternoon convection generating subpixel cloudiness [*Bellenger et al*, 2010]. Unsurprisingly, the SEVIRI derived DW amplitude is larger than that recorded by moored buoys, which have a deeper temperature sensor than drifters. Comparison results are then discussed by zones in the SEVIRI disk: the largest amplitudes are found in the Mediterranean Sea, but amplitude values recorded in the inter-tropical area are smaller than those recorded in the Northern Atlantic. The daily amplitude is affected by subpixel cloudiness mainly in sub-tropical or inter-tropical Atlantic

REFERENCES

H. Bellenger, Y.N. Takayabu, T. Ushiyama and K. Yoneyama, 2010, Role of diurnal warm layers in the diurnal cycle of convection over the Tropical Indian Ocean during MISMO, *Monthly Weather Review*, 138, 2426-2433.

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Towards high-temporal resolution observation of euphotic zone depth in the North Sea

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Euphotic zone depth (Zeu), practically measured as the depth where photosynthetic available radiation becomes 1% of its surface value, is not only a measure of water clarity, but also an important parameter for modeling of photosynthesis of aquatic environments. Based on radiative transfer and bio-optical models, algorithms have been developed to estimate Zeu from ocean color satellite measurements, such as MODIS/MERIS. These satellites, however, have a repeating cycle greater than a day to take measurements, thus inadequate to address the diurnal variability of water clarity or photosynthesis even if there are no clouds to block the observations. It requires high temporal resolution measurements to resolve such dynamics. For areas in the North Sea, the available high frequency (every 15 min) measurements are from the Spinning Enhanced Visible and InfraRed Imager (SEVIRI), which has measurements around 600 nm that can be related to suspended particulate matter (SPM). This SPM further provides a measure of the scattering coefficient of the water. To estimate Zeu of an aquatic environment, it requires information of both scattering and absorption. To remedy the shortage of absorption measurement from SEVIRI, a scheme to use the low-frequency measurements provided by MODIS/MERIS is developed. The effectiveness and the uncertainties resulted from the mismatch of the temporal frequencies for various regions in the North Sea are also addressed.

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Harmful Algal Bloom Detection with MODIS Inherent Optical Properties Products: A Decision Tree Application

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The Inherent Optical Properties (IOPs) including absorption and scattering characteristics are the primary indicators of water and its constituents' variations [Lee, 2006]. Along with significant progresses and achievements on the research of radiative transfer and semi-analytical remote sensing algorithms, several IOPs have already been generated and published as remote sensing products, and consequently those improvements will bring about various researches on application of IOPs in the near future. As widely known, conventional derived chlorophyll concentration has large uncertainty in coastal seawaters, especially high dissolved and particulate loading regions, and could not reflect the Harmful Algal Bloom (HAB) status in advance. When bloom causative algae brings a series of changes to water quality, it will certainly alter IOPs. In this paper the decision tree method was applied to the MODIS IOPs products along with other standard products in the East China Sea in recent years to detect large HAB events. Results proved that single IOPs parameter or the combination of IOPs and other parameters from MODIS products, such as pigment absorption coefficient, backscattering to total absorption ratio, spectral band ratio, were able to classify HAB from normal seawaters, and even discriminate dinoflagellate and diatom types roughly. Theoretical and statistical analyses on measured data are made to interpret IOPs differences from algae cell diameter, refractive index, pigment composition and other aspects [Boss, et al, 2004; Fujiki and Taguchi, 2002]. In conclusion, the remote sensing IOPs products could be applied to detect HAB in coastal optical complex waters and decision tree was a practical tool for use.

Modeling and observation of freshwater and sediment plumes at the Catalan Coast.

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Coastal ocean regions are dynamic and complex environments that are driven by an intricate interaction between atmospheric, oceanographic, estuarine/riverine and land–sea processes [Smith et al., 2010]. Specifically, freshwater discharge from rivers and urban outflows to the ocean water has profound effects on the physical, chemical, and biological processes in coastal waters. It induces circulation patterns and modifies mixing processes [Milliman and Farnsworth, 2011]. In addition, the coastal plume formed by the buoyant inflow is a highly dynamic region with significant salinity gradients and constitutes an important dynamical component of the coastal circulation [Morris et al., 1981]. Due to their ecological and dynamical importance, a good understanding of the mixing and transport processes in river plumes is required for the maintenance of coastal ecosystems and their resources. The combination of satellite ocean data, in situ coastal ocean measurements and use of numerical models offer exciting opportunities to improve our knowledge of the ocean dynamics,in coastal areas.

In this paper results from a coastal circulation model for the Catalan coast (will be compared with data from dedicated campaigns and satellite observations. The simulation incorporate river and urban discharges into the sea. The combination of local topography with torrential rain fall can produce considerable local run-off on a short time with a large impact on the receiving coastal waters. This can be captured by satellite data (Figure 1) and campaign data.

Methodology and aim

For the coastal circulation model, version 3.0 of the Regional Ocean Modeling System (ROMS, Details on [Haidvogel et al., 2000]) has been implemented for a small portion of the Catalan coast. ROMS uses sigma coordinates and solves the 3-D Reynolds-Averaged Navier-Stokes equations. The code design is modular, so that different choices for advection and mixing, for example, may be applied by simply modifying preprocessor flags. Nested increasing-resolution domains have been used in order to reproduce with enough resolution the coastal circulation. The boundary conditions are obtained from the MyOcean project [http://www.myocean.eu.org./].

River and urban run-off are estimated based on rainfall (predictions) form the contributing catchments areas. Conceptual models based on a reservoir-type schematization of the river and sewer network have been set up to allow the fast prediction of the different point source boundary conditions [Keupers et al., 2011].

Model output for selected events will be compared to satellite data from MyOcean project [http://www.myocean.eu.org./], to data from dedicated campaigns during the Field_AC project [http://lim050.upc.es/field_ac/index.html] and to data from operational buoys in the Catalan coastal area.

References

Field_AC project . (http://lim050.upc.es/field_ac/index.html). Haidvogel D.B., Blanton J., Kindle J.C., Lynch D.R. (2000). Coastal Ocean Modeling: Processes and Real-Time Systems. Oceanography. Speccial Issue , 13. Keupers, I., Willems, P., Fernandez Sainz, J., Bricheno, L., Wolf, J., Polton, J., Howarth, J., Carniel, S., Staneva, J. (2011). Methodology (including best practice guidelines) on how to identify and incorporate 'concentrated' and 'distributed' run-off in pre-operational forecasts, based on the input and requirements from our users. FIELD_AC project , D3.1, 90 pp. Milliman J.D. and Farnsworth K.L. (2011). River Discharge to the Coastal Ocean: A Global Synthesis. Cambridge: University Press. Morris A.W., Bale A.J., Howland R.J.M. (1981). Nutrient distributions in an estuary: Evidence of chemical precipitation of dissolved silicate and phosphate. Estuarine, Coastal and Shelf Science , 12, 2, 205-216. MyOcean project. (http://www.myocean.eu/). Smith R.N., Chao Y., Li P.P, Caron D.A, Jones B.H, Sukhatme G.S. (2010). Planning and Implementing Trajectories for Autonomous Underwater Vehicles to Track Evolving Ocean. Processes Based on Predictions from a Regional Ocean Model. The International Journal of Robotics Research , 29, 1475.

ISECA:Information System on the Eutrophication of our Coastal Areas

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The scope of ISECA is to advance and disseminate scientific knowledge related to eutrophication in 2Seas selected area. Eutrophication (algal development) is a major cause of the decreasing quality of coastal waters. The main objective of ISECA is to develop a technologically advanced and flexible information system for the eutrophication of coastal waters. Such a system will significantly enhance the current capability to monitor and manage coastal water quality. This system will be web-based and combine satellite Earth Observation (EO) data with simulation models to link eutrophication to the underlying causes and the potential mitigation strategies. The interaction with different coastal use functions (beach recreation, fisheries, aquaculture) and scientific knowledge from different domains will be incorporated. Selected demonstration applications will be developed for a few test locations. The expectation is that well chosen examples will convince potential users of the usefulness of the information system which will benefit from continuous contributions to the data and models used for the tool. The eutrophication models will be based on reusable model building components stored in open libraries allowing for quality improvement and scientific feedback. On the one hand the calibration of the simulation models will benefit from the EO data and on the other hand the models can be used to analyze causes and consequences of the observed eutrophication for selected sites.

Combining model and geostationary satellite data to reconstruct the hourly SST field over the Mediterranean Sea

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This work focuses on the problem of reconstructing the Sea Surface Temperature diurnal cycle over the Mediterranean Sea combining numerical model analyses and geostationary satellite measurements. Our approach is to take advantage of geostationary satellite observations as the diurnal signal source to produce gap□free optimally interpolated (OI) SST fields using model analyses as first guess. This new schema is an evolution of a previous OI schema adopted for the tropical Atlantic Ocean (Marullo et al., 2010). The main difference between the previous and the actual OI schema is the choice of the first guess that changed from daily Reynolds SSTs to hourly model analyzed SST. This implies that the new input to OI, the observed SST anomaly with respect to the model analysis, should, in principle, be free (or nearly free) of diurnal components in its power spectra allowing us to avoid the Marullo et al (2010) approach based on separate interpolations for every time of the day (e.g. interpolate the 01:00 UTC field using only data at 01:00 UTC of previous and following several days) in favor of a selection of SST anomalies within a 24 hours time window. A new mean spatial/temporal covariance function for the Mediterranean SST anomalies has been directly obtained from the data. This analysis was focused on summer 2001 including all the data and model outputs from June 1st to August 31st 2011. The OI interpolation estimate, the model first guess (provided by MyOcean Mediterranean MFC) and the SEVIRI data (provided by O&SI SAF) were evaluated using drifters data as reference. Special attention was devoted to the analysis of Diurnal Warming (DW) events that were particularly frequent during this period. Preliminary results suggest that: 1) The model reproduces quite well the Mediterranean SST diurnal cycle with exclusion of intense DW events. 2) As expected, the amplitude of the model cycle is less intense than the corresponding SEVIRI and drifter amplitudes due to the different thickness of the surface ocean layer they represent. Time shifts between model and data warming/cooling phases of the day are also discussed. 3) The Diurnal OI SST filed (DOISST), resulting from the blending of model and SEVIRI data via optimal interpolation, well reproduces the diurnal cycle (including DW events) leaving essentially unchanged the statistics of the difference between SEVIRI and drifters measurements also in data void positions where the interpolation operates.

REFERENCES

Marullo, S., R. Santoleri, V. Banzon, R. H. Evans, and M. Guarracino (2010), A diurnal-cycle resolving sea surface temperature product for the tropical Atlantic, J. Geophys. Res., 115, C05011, doi:10.1029/2009JC005466.

Geostationary Satellite Observations on Ocean Vectors Associated with Surface Currents - Challenges and Opportunity

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Frequent geostationary monitoring of surface temperature or other ocean properties is one of the latest developments in the research fields providing new opportunities to estimate surface currents at sub-diurnal scale on the basis of tracking the motion of characteristic features of the properties distribution.

The presentation describes physical basis and mathematical development of the approach chosen to derive vectors of surface motion using analysis of consecutive geostationary observations. Our approach to study ocean vectors associated with surface currents utilizes brightness temperatures giving the information on surface currents 24 hour a day.

The essence of the approach consists of two main steps complemented by extensive quality control. The first stage selects targets on ocean surface characterized by prominent gradients or other characteristics of surface properties. The second stage considers those targets as tracers and monitors their movement between consecutive images estimating the speed and direction of identified targets.

The approach to calculate ocean motion is similar to retrieval wind vectors, but at the same time significantly differ in several aspects. Clouds are tracked to derive wind, but they should be completely excluded from consideration to derive currents. There is almost a factor of 102 difference between magnitudes of wind and current speed. The spatial changes in temperatures tracked by the derived atmosphere motion are also incomparably larger than irregularities in thermal ocean features.

Described differences explain significant challenges associated with the opportunity to estimate ocean dynamics features at sub-diurnal scale. There are more open scientific questions than issue already resolved. There are problems of optimal size of tracking targets to choose and preferable time scale to monitor the motion of those targets.

The techniques to track tracer motion is based on the estimate of the best correspondence between features describing a target and the same characteristics for a full range of possible horizontal target shifts. But the method to estimate the correspondence is not predetermined. The Maximum Cross Correlation (MCC) and the Sum of Squared Distances (SSD) are selected for initial consideration.

Detailed estimating quality of surface vector retrieval for different temporal and spatial scales are used to establish an optimum strategy of data processing. The approach under development is intended to be applied to information provided by Advanced Baseline Imager (ABI) on GOES-R satellite. Full disk data from the Spinning Enhanced Visible and Infra-red Imager (SEVIRI) instrument onboard of the European Meteosat Second Generation (MSG) satellite are currently used for testing and evaluating results.

Generating a Climate Data Record for Sea Surface Temperature

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Sea surface temperature (SST) observations from space are improving in accuracy through the development of more sophisticated methods of estimation. A global SST time-series for 1991 to 2011 has been developed using Along Track Scanning Radiometers (ATSRs). This climate data record (CDR) has the following properties: full independence from in situ observations (retrieval based on the physics of radiative transfer); accuracy (absence of bias) over spatial scales of 1000 km of order 0.1 K (demonstrable for the final years of the record); with both skin SST (directly retrieved) and drifting-buoy depth estimates (inferred); and using satellite overlap periods to homogenise the record for instrument calibration. This new SST record will be described. However, the sampling the ATSRs deliver is somewhat limited compared to that of the "workhorse" for satellite SST, the Advanced Very High Resolution Radiometers (AVHRRs). Conversely, AVHRR SSTs to date are less accurate and stable. The SST element of the European Space Agency's Climate Change Initiative ("SST CCI") aims to integrate AVHRR and ATSR records to improve the sampling accuracy of the CDR. By using the ATSR as a calibration reference, consistency will be achieved while preserving independence from in situ observations. Issues related to potential aliasing of the SST diurnal cycle are more critical when using AVHRR data, and a solution to preserve the stability of the time series will be described. Provision of climate-quality SST is critical for many applications in climate science and modeling, and so key issues will be raised regarding the current and future provision of satellite SSTs and their integration with the historical record.

IN-SITU DATA AND REMOTE SENSING OF TEMPERATURE, SALINITY AND CHLOROPHYLL ON THE NORTH WESTERN BLACK SEA

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ABSTRACT. The paper presents a comparison of MODIS – AQUA satellite images for SST and Chl-a with in-situ seasonal variations of oceanographic parameters (temperature, salinity and chlorophyll). The results refer to sea water monitoring (sea surface temperature, salinity and chlorophyll) at Casino Constanta shore station ($44^0$14' N and $28^0$38' E) and on the Romanian Black Sea shelf during 2011. The forecast system for the Black Sea assimilates satellite altimeter data (AVISO/Altimetry project data) and sea surface temperature measurements (NOAA AVHRR data). The highly productive zones is usually associated with the upwelling phenomena which contribute in the heterogeneous distribution of the phytoplankton biomass (through the distribution of chlorophyll-a) and suspended and dissolved organic matter. Results of regional forecast model for NW Black Sea are presented for significant events occurred in 2011 (upwelling, algae bloom and hypoxia).

Ocean front maps for integrating dynamic thermal, colour and salinity features

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[2]

We have developed novel Earth observation (EO) methods for visualising and inferring the spatio-temporal distribution of dynamic oceanic fronts, in order to reveal new information on the surface physical oceanography. This talk will describe how front contours derived from EO thermal and colour data can be combined to best exploit these complementary data sources and to explore biophysical interactions caused by mesoscale processes. Ocean colour may reveal additional physical processes even if there is no thermal signal. Furthermore, combined visualisations of ocean fronts and preliminary salinity data from SMOS and Aquarius sensors will assist in interpretation and fusion of these datasets.

This research is based on the composite front map approach, which is to combine the location, strength and persistence of all fronts observed over several days into a single map, improving interpretation of dynamic mesoscale structures (Miller, 2009). These techniques are robust and generic, and have been applied to many studies of physical oceanography and marine animal distribution, and as an indicator of pelagic diversity for assisting the designation of marine protected areas.

Miller, P.I. (2009) Composite front maps for improved visibility of dynamic sea-surface features on cloudy SeaWiFS and AVHRR data. Journal of Marine Systems, 78(3), 327-336. doi:10.1016/j.jmarsys.2008.11.019

Shallow Water Diurnal Heating–Applications of Satellite-Derived Sea-Surface Temperature to Coastal Ecosystems

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Satellite-derived fields of sea-surface temperature (SST) in coastal areas are based on measurements made by infrared radiometers, but in the infrared clouds obscure the sea surface. Compositing spatial data taken at different times of day from several satellites can reduce the problems caused by clouds, but at the risk of introducing spurious signals resulting from diurnal heating and cooling. It is imperative to understand better the diurnal heating over shallow water, not only to improve our interpretation of satellite-derived oceanic signals, but also to know how to better use such information from satellites to monitor and understand the health of coastal ecosystems. Coral reefs present a particularly important and challenging problem, but there is a great need for better understanding of the physical processes that permit the prediction of the temperature at the corals themselves given the satellite retrievals of SST at the surface.

Here we assess the magnitude of the signals using measurements from coral reef monitoring stations in the Caribbean Sea and the Great Barrier Reef, Australia, and discuss the consequences on the application of satellite-derived SSTs to monitoring the health of coral reefs. The Integrated Coral Observing Network (ICON) program operates in situ monitoring stations on reefs in the Caribbean and Bahamas. ICON stations measure standard meteorological parameters, as well as sea temperature, salinity, pressure, and insolation. We selected the instrument pylon at the Central Caribbean Marine Institute station off Little Cayman, where there is a very small tidal influence, to augment with an additional four subsurface self-recording pressure and temperature recorders. These log measurements every six minutes, and have been in place for nearly a year providing measurements of temperature time-series under a wide range of conditions. In the Australian Great Barrier Reef (GBR) area, time series measurements of temperature are taken at $>$200 reefs with multiple loggers on each reef at different depths, each recording at 10-min intervals. Automatic Weather Station data from several sites are also available to characterize the environmental conditions.

The presentation will give a description of the magnitude of diurnal signals over the coral reefs and relate the temperature measured at the surface to those at the depths of the reefs.

A New Generation of Ship-Deployed Hyperspectral Infrared Interferometers to Extend the Climate Data Record of Sea-Surface Temperature into the VIIRS, SLSTR and AMSR-2 Era

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Uncertainties in the accuracies of all geophysical variables have important impacts on their applications, and failure to understand the characteristics of the errors inherent in fields derived from instruments on earth observation satellites can lead to contaminated results and mistaken conclusions. The sea-surface temperature (SST) is an important parameter in the global climate system and the difficulty in making adequate global measurements of SST can best be resolved by using satellite radiometers which provide self-consistent, global measurements on repeat cycles of hours to days. The radiance measured in space by infrared radiometers has its origin in the thermal skin layer of the ocean and not in the body of the water below, often referred to as the "bulk temperature" which is measured by in situ thermometers below the surface. The near-surface temperature gradients result from three distinct processes: the absorption of insolation, the heat exchange with the atmosphere, and levels of subsurface turbulent mixing. In conditions of low wind speed, the heat generated in the upper few meters of the water column by the absorption of solar radiation is not mixed through the surface layer, but causes thermal stratification and temperature differences between the uppermost layer of the ocean and the water below. There is a strong diurnal component to the magnitude of these temperature gradients, as well as a dependence on cloud cover, which modulates the insolation, and wind speed, which influences the turbulent mixing. The surface, thermal skin layer of the ocean, much less than one millimeter thick, is nearly always cooler than the underlying water because the heat flux is nearly always from the ocean to the atmosphere. Thus, validation of satellite-derived SSTs using measurements of skin SST removes many uncertainties in the comparison between the satellite and validating measurements. Over the past decade and more, three Marine-Atmospheric Emitted Radiance Interferometers (M-AERIs) have been deployed on over 40 ships in a wide range of environmental conditions to provide validation data for a number of satellite instruments used to derive global SST fields. Here we report on the development and initial deployment of a new generation of infrared interferometers that will be used to provide validation data for SSTs from VIIRS, SLSTR and AMSR-2 as well as their functioning heritage sensors. The contribution of the new satellite-derived SST fields to the Climate Data Record can be established by ensuring calibration traceability of the validation data to national SI standards.The new ship-board interferometers will be described along with the initial results from the first deployment in December 2011, and the process of establishing Climate Data Records will be discussed.

Suspended sediment monitoring and assessment for Yellow River stuary from Landsat TM/ETM+ imagery

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Abstract An atmospheric correction algorithm is developed for remotely sensed data Landsat TM/ETM+ when applied in coastal waters as Yellow river estuary, using the air molecule and aerosol scattering information provided by Moderate Resolution Imaging Spectroradiometer(MODIS aboard on Terra satellites), which has highly improved radiometric calibration, sensitivity, and spectral bands specially designed for estimating aerosol radiance. The air molecule scattering reflectance (ρ_r) of TM/ETM+ bands is derived from the Hyperspectral ρ_r by means of response-averaged calculation. The Hyperspectral ρ_r is interpolated from the ρ_r of MODIS bands calculated using the Rayleigh scattering look-up tables (LUTs) in the SeaWiFS Data Analysis System (SeaDAS) source package. The aerosol scattering reflectance (ρ_a) at shortwave infrared (SWIR) band (band 5 for TM/ETM+, about 1700nm), derived with the assumption of black water at the band, is used for the extrapolation to calculate the ρ_a at visible to near-infrared (NIR) bands based on the spectral relationship in the aerosol scattering LUTs in SeaDAS. The accuracy of the atmospheric correction algorithm is assessed by comparing the TM/ETM+ measured remote sensing reflectance (R_{rs}) with in-situ data, acquired during three cruises over Yellow river estuary and Bohai sea. The comparison shows that the algorithm can provide reasonably accurate water-leaving radiance spectra in the range of visible- NIR wavelength. The accuracy for blue, green and NIR bands are relatively lower than that for red bands, which is used for retrieving the suspended sediment concentration by means of the model developed from the in-situ data. Interannual and seasonal variability, as well as spatial distribution, of SSC in Yellow river estuary are studied and assessed using the TM/ETM+ measurements from 2000 to 2010.

Keywords Suspended sediment concentration; Remote Sensing; Yellow River estuary; Landsat

An algorithm for the attenuation of the photosynthetically available radiation (KPAR): application to MODIS and MERIS imagery and validation with Smart Buoys plateforms

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KPAR, the attenuation of the photosynthetically light radiation (PAR) with depth and the euphotic depth, ZEU, i.e. the depth at which PAR reduces to 1% of its surface value, are amongst the key parameters in ecosystem modeling for estimation of primary production in the water column. A bio-optical model of KPAR has been developed for open and coastal waters that estimates KPAR at ZEU, KPAR1%, and near the surface, KPAR95%, from the inherent optical properties (IOPs): the total absorption, a, and backscattering, bb, coefficients at 490 nm measured at water surface. KPAR is also parameterised as a function of the sun position. The model was built based on 500 synthetic data set of inherent optical properties and the associated light attenuation data generated with Hydrolight software (IOCCG, 2006). In the present study, this KPAR model is applied to MODIS and MERIS imagery and validated using in situ PAR collected by Cefas Smart Buoys and also by comparing with estimations of KPAR1% at ZEU from the in situ profiles of PAR.

The absorption and backscattering coefficients are obtained from MODIS and MERIS products via 2 different schemes: the NIR atmospheric correction algorithm (Bailey et al., 2010; Stumpf et al., 2002) is applied to the top of atmosphere (TOA) reflectance of MODIS data yielding the water-leaving reflectance. In MERIS the standard Neural Network algorithm is used to remove the atmospheric contributions from the TOA reflectance. The Quasi-Analytical Algorithm (QAA) of (Lee et al., 2005) inverts the marine signal to obtain a and bb, as is currently implemented in SeaDAS. Further, the QAA is applied to MERIS water-leaving reflectances adapted to the 4 MERIS channels 443, 490, 560 and 650 nm. Time series of KPAR1% and KPAR95% maps are derived from MERIS and MODIS a(490nm) and bb(490nm) products over the Southern North Sea, covering the period 2003-2009. Concurrent Cefas measurements of PAR at 0, 1 and 2 m depth at 2 stations located in the North Sea, namely Warp Anchorage (very turbid) and Oyster Grounds (clearer waters), are used to estimate KPAR0.5 and KPAR1.5 respectively at 0.5 and 1.5 m. The satellite KPAR95% are compared to KPAR0.5 (respectively KPAR1.5) when KPAR95% equals 0.103 m-1 (respectively 0.034 m-1). Next, a Look Up Table generated from Hydrolight simulations assuming a mixed water column with constant IOPs along the depth, is used to retrieve the ranges of absorption and backscattering coefficients that correspond to the two in situ KPAR values at 0.5 and 1.5 m, and the given sun zenith angle. This LUT is also used to retrieve the associated KPAR1%. The LUT-retrieved KPAR1% deviations from the satellite derived KPAR1% are explained in terms of a) the propagation of uncertainties from the input absorption and backscattering as expressed by the LUT-retrieved a and bb deviations from the satellite retrieved a and bb, b) the errors in in situ KPAR measurements and c) the

impact of errors in the KPAR model.

Despite the fact that different algorithms and data sources were injected in the KPAR model, a generally good agreement is found between the satellite derived KPAR1% and the corresponding in situ measurements and estimations of KPAR1%.

REFERENCES

Bailey, S. W., Franz, B. A., and Werdell, P. J. (2010): Estimation of near-infrared water-leaving reflectance for satellite ocean color data processing. Optics Express 18, 7251-7527.

IOCCG (2006): Remote Senting of Inherent Optical Properties: Fundamentals, Tests of Algorithms: Reports of the International Ocean-Colour Coordinating Group (IOCCG), Vol. 5. and Applications, Dartmouth, Canada.

Lee, Z., Darecki, M., Carder, K. L., Davis, C. O., Stramski, D., and Rhea, W. J. (2005): Diffuse attenuation coefficient of downwelling irradiance: an evaluation of remote sensing methods. Journal of Geophysical Research 110.

Stumpf, R. P., Arnone, R. A., Gould, R. W., Martinolich, P. M., and Ransibrahmanakhul, V. (2002): A partially-coupled ocean-atmosphere model for retrieval of water-leaving radiance from SeaWiFS in coastal waters., pp. 51-59: Algorithm Updates for the Fourth SeaWiFS Data reprocessing, NASA Technical Memorandum.

Spatial variability of observational biases and errors determined from collocations of IASI, AVHRR and buoy SSTs

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IASI SST observations are routinely collocated with the OSI-SAF Metop-AVHRR in situ matchup database on a monthly basis. The IASI IFOV is approximately 0.015 radians, equivalent to around 12km at nadir. Therefore within each IASI IFOV it is possible to investigate the SST variability from the higher resolution AVHRR observations and collocated buoy SSTs. Data over the period October 2010 to September 2011 have been used to investigate the global spatial variability of the observational biases and errors. In addition, investigations into how the SST variability within each IFOV is related to biases and standard deviations of the IASI observations compared to AVHRR and in situ have been performed, and how these relate to the cloud cover and standard deviation of AVHRR SSTs.

Oceanography at EUMETSAT

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The primary objective of EUMETSAT is to establish, maintain and exploit European systems of operational meteorological satellites. A further objective is to contribute to the operational monitoring of the climate as well as the detection of global climatic changes. The provision of satellite data and products satisfying meteorological and climate data requirements cover 24 hours a day, 365 days a year, through decades. Oceanography is an expanding commitment at EUMETSAT. The strategy up to 2030 includes: continuation of the Mandatory Programmes (MSG, EPS) and future (MTG, Post EPS) including observations of SST or sea surface winds; continuation of EUMETSAT Ocean Surface Topography Mapping Optional Programme (Jason-3 and preparation of a post Jason-3 programme) giving an uninterrupted sea level rise monitoring data set; participation of EUMETSAT in key ocean observation Programmes such as GMES Sentinel 3; and access to relevant data from third-parties (preparation of Agreements with ISRO and SOA): EUMETSAT is seeking access to an enhanced ocean products catalogue.

Beyond the two cases of water - water constituent retrieval algorithms and validity ranges

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In the past 5 years, about 50 matchup validation experiments were published that comprise of in situ measured and satellite retrieved case 2 water constituent concentrations. We assessed individual validity ranges for the algorithms used in those experiments.

Several generalizations and conclusions can be drawn from the analysis. Medium resolution spectrometers are clearly prevalent. With regard to Chlorophyll, MERIS is predominantly used for red-NIR ratios of eutrophic waters, while MODIS is predominantly used for OC ratios of oligotrophic waters. In the case of suspended matter, retrieval band wavelengths consistently increase with the water body's turbidity, as expected from theoretical considerations. The outcome of gelbstoff retrieval experiments is however less coherent, indicating that their accuracy is affected by effects other than just the range of gelbstoff concentration.

Individually varying concentrations in the other constituents in case 2 water are expected to be a main cause for such incoherence. We therefore propose a graphical scheme for the assessment of algorithm validity ranges based on water types that account for such complex mixture and provide an extension to the commonly known distinction of case I and case II water.

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A Study of Ocean Responses to Typhoon over the South China Sea by Using Satellite Sea Surface Temperature Data

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The ocean responses to Typhoon Cimaron, which influenced the South China Sea (SCS) from 1 to 8 November 2006, are analyzed. Based on satellite observed sea surface temperature (SST) and the climatological temperature profiles in the SCS, the mixed-layer deepening, an important parameter characterizing turbulent mixing and upwelling driven by strong typhoon winds, is derived. Corresponding to the SST drop of 4.5 C on 3 November 03, 2006, the mixed-layer deepened by 99.6 m relative to the undisturbed depth of 52.0 m. The mixed-layer deepening increases the ocean potential energy and leads to a horizontal baroclinic pressure gradient. Based on the derived mixed-layer deepening data, the potential energy increase, geostrophic velocity and vorticity are calculated. The geostrophic velocity reached 0.20 m s-1 and the negative vorticty suggests that there exists an anti-cyclonic baroclinic circulation that was strongest at the base of the mixed-layer.

Harmonization of ocean color products

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The Coastal Biomass Observatory Services (FP7 project CoBiOS) aims to integrate satellite products and ecological models into a really operational and user-relevant information service on high biomass blooms in Europe's coastal waters. The focus of the project is on the North Sea and Baltic Sea and Danish Waters. CoBiOS will produce a harmonized and validated water transparency product based on satellite images for a large variety of coastal water types which will be used to force ecological models. The process of harmonization requires several steps, including consolidation and documentation of algorithms, comparison and validation of results and a method to use the information from several sources/algorithms together in order to get to an understanding of the variability (uncertainty) of the prediction of biomass. By adopting an ensemble approach we will be able to study the spatial variability of the per pixel statistics derived from ensembles of CHL or Kd maps. E.g. the spatial distribution of the standard deviation will be analyzed to determine areas where algorithms deviate because of a different handling of SIOPs, spectral band sets etc. Spatial similarities may point to areas where the atmospheric correction is forcing the solutions. Comparison of the per pixel ensemble mean to in situ observations will provide insight in the quality of satellite based maps, and further along the line, also in the quality of in-situ observations. We will present the method and early results

Evaluation of SMOS Sea Surface Salinity over Bay of Bengal

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In many areas of the world ocean, the upper ocean salinity balance has not been well understood. It can be influenced by horizontal advection, air-sea exchange of freshwater and vertical mixing and entrainment among other processes. Bay of Bengal (BoB) in north Indian Ocean is one such basin where salinity variability is largest and least understood due to unavailability of quality observations. It is also the freshest region in the Indian Ocean by virtue of both direct seasonal monsoon rain and river runoff from Indian main land. The soil moisture and Ocean Salinity (SMOS) mission has opened an exciting opportunity to understand the sea surface salinity (SSS) over global ocean. This study focuses the evaluation of SSS over BoB for 2010. The comparison of SMOS SSS are made from Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) moored buoy data situated in central BoB (90 °E,15 °N; 90 °E,12 °N). The time series analysis shows SMOS, SSS could capture the buoy observation quite realistically. The annual mean and standard deviation (SD) from buoy and SMOS at 90 °E and 12 °N are 32.99 ppm, 32.64 ppm and 0.42 , 0.50 ppm. Further north at 90 °E and 15 °N these values from buoy and SMOS are 32.61 ppm, 32.25 ppm and 0.48 ppm, 0.72 ppm respectively. The correlation coefficient (CC) values between buoy and SMOS SSS are 0.31 and 0.48 at 90 °E, 15 °N and 90 °E, 12 °N respectively. The frequency distribution plot show higher SSS values are underestimates in SMOS as compared to buoy observation.

Marine dynamic and structur of the West Madagascar

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The complex circulation of the west Madagascar was never been subject of the discussion, or he possesses any importance of biotope potentiality and the participation of the world circulation. In this fact, 172 hydrographic stations, four years of long term observation and the past research of many authors are tools who achieved to build this research with the best quality of the result. This research can help us to give more the understanding of the physical structure at the west Madagascar water. This study makes point to identify the water masse with his propriety and characteristic, using the oceanographic parameter. The registers of data give more information of the variability annual and seasonal of the volume transport water who crossing Mozambic Channel and link Madagascar. The water masse that travels along the Mozambic channel form the complex eddies. Four or five eddies cross the Mozambic channel at the southward and make many influence biologic at the coastal zone of Madagascar. This chapter make relation between ocean circulation by the eddies and the phytoplankton productivity using the sensor remote sensing by seawiffs. In consequence, It find that he exist a correlation between water masse, eddies and chlorophyll. In this fact, the eddies result at the coastal of Madagascar by collide, production hypertrophic effect at the extreme cape of the land: Cape d'Ambre, Cape Saint André, Cape Saint Marie.

Short term upwelling/downwelling events in Fortune Bay, Newfoundland

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Fortune Bay, Newfoundland, Canada is a bay with growing aquaculture interest due to its oceanographic conditions. The bay runs from southwest to northeast with a length to width ratio of 5 and northwest arm toward the head. The arm is a bay, Belle Bay, with a dimension of 20 by 11 km.

During Summer period, numerous 1-2 day events of sub-surface temperature lowering as much as 10 degrees Celcius have been observed suggesting upwelling events along the northwestern head of Belle Bay. Short term events of temperature at 40 meter depth increasing as much as 10 degrees Celcius were also recorded in the same area suggesting downwelling processes. On the other hand, hypoxia events within the aquaculture cages located in the same area were observed suggesting a reduced circulation in the surface and sub-surface water.

The present work analyzes time series of temperature, salinity, oxygen, ocean currents as well as wind speed and direction to describe the upwelling and downwelling processes in relation to available atmospheric conditions in the region and investigates the different physical processes which drive the water movement. Remote sensed temperature from pathfinder version 5 are also analyzed to assess the geographical extent of the upwelling processes which can possibly happen on both sides of the bay. Such analysis is necessary in order to better understand the water circulation which can have an impact on the aquaculture activities in the region.

Observations of Ocean surface response to Hurricane Igor: A Salty Tropical Cyclone Wake observed from Space

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The upper ocean response to a moving hurricane is studied using satellite and in situ observations. Sea surface salinity response is emphasized using Soil Moisture and Ocean Salinity Sensor data acquired before and after the passing of Igor, a category 5 hurricane that attained wind speeds of 136 knots in September 2010. Post minus pre-hurricane satellite estimates of sea surface salinity reveal a strong surface salinity enhancement of ~1 practical salinity unit over a ~89000 km^2 ocean surface area located on the right-hand side quadrant of the storm as it passed over the Amazon and Orinoco freshwater plume. The presence of this salty wake is associated with the erosion of the freshwater plume by the hurricane-induced mixing. The strong surface layer erosion as detected from space is confirmed by in situ observation from Argo float profilers. The thermal, density and ocean color wakes are also evaluated and exhibit very consistent patterns with the sea surface salinity wake. As Igor over passed the plume on its left-hand side quadrants, the presence of a thick barrier layer below the plume inhibited mixing and significantly reduced the surface cooling in the wake of the storm, which limited the surface cooling negative feedback on Igor intensification. With this demonstrative example, we show that the new sea surface salinity measurements from space can be very useful as a complementary dataset to help predicting Tropical cyclone intensification in thick barrier layer area, such as the western tropical Atlantic.

Recent updates to the background uncertainty estimates in OSTIA system

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The UK Met Office Operational SST and sea Ice Analysis (OSTIA) system generates a daily combined foundation SST and sea ice concentration product on a 1/20° (6 km) grid. The system assimilates infra-red and microwave satellite SST observations in addition to in-situ observations. All input data is passed through an automatic quality control system and a bias correction on selected satellites using the in-situ and AATSR data as a reference is carried out. OSTIA then uses a multi-scale optimal interpolation scheme to assimilate observations onto a first guess field provided by the previous analysis with a relaxation to climatology. The sea ice concentration is obtained from the EUMETSAT OSI-SAF daily ice concentration product.

The weight given to an observation in the SST assimilation scheme is dependent on both the observation and background error covariances. These background error covariances have been re-estimated within the ESA CCI project using output from the 23 year OSTIA reanalysis. A brief overview of the OSTIA system will be presented together with the method used to estimate the background error covariances, the resulting estimates and the impact of the update to the accuracy of the OSTIA SST product.

Estimation and Validation of the Peruvian Sea Surface Temperature using NOAA - AVHRR and In-Situ Data with PACHA-RICAJ Software

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The purpose of this work is to estimate and validate the sea surface temperature (SST) from AVHRR/3 images. The study area is located between 0 and 20 °S latitude, and 100 to 70 °W longitude. The raw images have been obtained from the CLASS corresponding to Level-1b format (LAC and GAC). The in-situ SST data were measured by IMARPE during the periods: (1) October 1 to November 13, 2002, (2) March 1 to April 5, 2007 and (3) March 1 to April 5, 2008. The image processing software "Pacha-Ricaj" was used for the calibration, cloud filtering (thresholds and Great Rapid Algorithm to Surround Areas technique), Split-Windows SST, geometrical correction, monthly averages, digital filters, histograms and the validation of the results.

Challenges and opportunities for geostationary remote sensing – the next ocean colour revolution

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What new information can we get from geostationary ocean colour? Is geostationary ocean colour "just" more frequent data? What new algorithms are required to exploit this data?

Optical remote sensing of marine processes from polar-orbiting sensors such as MODIS-AQUA and Envisat/MERIS has become quite well-established over the last decade. Products such as chlorophyll a and Total Suspended Matter concentration are widely used as support for marine science and water quality monitoring. However, the sampling frequency, typically once per day, is too slow for resolving tidal and diurnal processes and the presence of clouds is a big limitation to data availability. The geostationary orbit offers a vastly improved sampling frequency, typically one image per hour or more, and hence the possibility to resolve new processes with tidal and diurnal variability. The probability of obtaining data during periods of scattered clouds is also greatly enhanced. However, the advantages go beyond simply obtaining more data. The exploitation of temporal coherency of natural processes over the timescales resolved by geostationary sensors may offer entirely new ways of processing data – instead of pure pixel-by-pixel processing, information from adjacent pixels in time may allow better constraint of the ocean colour inversion problem or provide new opportunities for data quality control via temporal outlier detection of retrieved marine or atmospheric parameters. Multiple geostationary sensors at different longitudes give extra information on the bidirectional reflectance of the ocean-atmosphere system.

This presentation will identify new opportunities inherent to high frequency data from geostationary ocean colour sensors and possibilities for new algorithms. On the other hand, the atmospheric correction for high viewing zenith and high sun zenith angles will be a more critical issue for geostationary sensors and the related challenges will also be addressed. Examples will be presented from the SEVIRI sensor over the North Sea and from the GOCI sensor over the Bohai Sea.

The presentation will conclude with a provocative question for the conference participants: If we have in the future geostationary ocean colour sensors, what rôles/niches are still available for polar-orbiting ocean colour sensors?

Spatial and temporal coherence between Amazon River discharge, salinity, and light absorption by colored organic carbon in western tropical Atlantic surface waters

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The temporal evolution and spatial distribution of surface salinity and colored detrital matter (cdm) were evaluated within and adjacent to the Amazon River Plume. Study objectives were as follows: first, to document the spatial coherence between Amazon discharge, salinity, cdm, and the nature of the salinity-cdm relationship; second, to document the temporal and spatial variability of cdm along the trajectory of the low salinity Amazon Plume, and third, to explore the departure of cdm from conservative mixing behavior along the plume trajectory into the open ocean. Time series (2003–2007) of surface salinity estimated using the Advanced Microwave Scanning Radiometer–Earth Observing System and corresponding satellite cdm absorption (acdm) data documented a plume of freshened, colored water emanating from the Amazon. Salinity and acdm were generally coherent, but there were regions in which spatial patterns of salinity and acdm did not coincide. Salinity was oppositely phased with discharge, whereas acdm was in phase but lagged discharge and typically remained high after maximum discharge. Along the river plume trajectory, acdm was inversely correlated with salinity, yet there was considerable deviation from conservative mixing behavior during all seasons. Positive anomalies in a linear relationship between salinity and acdm corresponded to areas of enhanced satellite-retrieved net primary productivity, suggesting the importance of phytoplankton biomass or its subsequent remineralization as a source of cdm. Negative anomalies tended to predominate at the distal sections of the plume trajectories, an observation consistent with the process of photo-oxidation of cdm over observed time scales of days to weeks.

Remote sensing of assimilation number for marine phytoplankton

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Estimating primary production at large spatial scales is key to our understanding of the global carbon cycle. Algorithms to estimate primary production are well established and have been used in many studies with success. One of the key parameters in these algorithms is the chlorophyll-normalised production rate under light saturation (referred to as the light saturation parameter or the assimilation number). This parameter is known to depend on temperature, light history and nutrient conditions. In this presentation we explore different algorithms to estimate the assimilation number from remotely-sensed data. Combining methods to estimate the carbon-to-chlorophyll ratio and the maximum growth rate of phytoplankton, we explore algorithms to estimate the assimilation number at the global scale. The inputs to the algorithms are the surface concentration of chlorophyll-a, sea-surface temperature, photosynthetically active radiation at the surface of the sea and climatological sea surface nutrient concentration and mixed-layer depth. A large database of in situ estimates of the assimilation number is used to provide elements of validation. The comparisons with in situ observations are promising and global maps of assimilation number are produced. They display patterns that are consistent with what is known about the distribution of this parameter.

Coastal waters monitoring: spatial or spectral resolution?

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The adaptation of algorithms to the optical complexity of coastal waters and closed domains is one of the main challenges being addressed by the ocean colour scientific community. But the high spatial variability of these domains is equally important. When using satellite monitoring as an alternative technology to traditional water monitoring, the spatial resolution is especially relevant. Having into account the Water Framework Directive (WFD) definition of coastal waters, the use of low spatial resolution satellites is insufficient to accurately resolve the strong coastal gradient of chlorophyll-a [Gohin et al, 2008]. Decisions to invest large sums to improve the ecological quality rely on the precision of the classification [Carstersen, 2007]. In this study, the use of moderate and high spatial resolution sensors to overcome this disadvantage is discussed. Special emphasis is placed on whether sensors with low spatial resolution would give different ecological status classification of a water body according to the WFD. Adequate spatial resolution should be used to apply remote sensing as an efficient technology for coastal water monitoring.

REFERENCES

Carstensen, J., 2007. Statistical principles for ecological status classification of Water Framework Directive monitoring data. Marine Pollution Bulletin 55, 3-15

Gohin, F., saulquin, B., Oger-Jeanneret, H., Lozac'h, L., Lampert, L., Lefebvre, A., Riou, P. and Bruchon, F., 2008. Towards a better assessment of the ecological status of coastal waters using satellite-derived chlorophyll-a concentrations. Remote Sensing of Environment 112, 3329-3340.

Remotely-sensed sediment dynamics on multi-temporal scales in the Yangtze Estuary and adjacent coast

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The Yangtze Estuary is one of the largest, tidally energetic and sediment-dominated turbid estuaries in the world. The distribution of suspended sediment concentration (SSC) governed by river discharge and hydrodynamic environment exhibits dynamic variations in the estuary. It is of great interests for scientists to understand dynamic sedimentology and geomorphology of estuarine systems and for engineers to deal with dredging, maintenance of safe navigation routes and harbour access. In addition, it is recognized that the suspended sediment as a tracer can play a role in observing the dispersal routes of chemical matters and pollutants into ocean. In recent years, Due to impacts of anthropogenic activities and anomalous climate change in the Yangtze River Basin in the last decade, the fluvial sediment discharged into the Yangtze Estuary was decreased rapidly, from 340 million ton per year in 2000 to 110 million ton per year in 2009. The reduction may generate large and long-term effects on the estuarine and coastal system.

Present polar-orbiting and geostationary ocean colour satellites have provided an opportunity of daily and hourly measurements of ocean colour components. They allow us to be able to observe suspended sediment distribution on multi-temporal scales. This may facilitate thorough understandings of sediment dynamic process in highly dynamic estuary system, combined with numerical dynamic models. We employed a semi-empirical radiative transfer (SERT) model coupled with a multispectral shift scheme proposed for turbid waters with a wide-range SSC, instead of current algorithms that would lead to large underestimates of the SSC in the highly turbid waters, to retrieve the SSC in the Yangtze Estuary and adjacent coast using MERIS data from 2003 to 2010 and GOCI data from April to November 2011. The MERIS-derived SSC variations on spring-neap tide and wet-dry season scales and GOCI-derived SSC variations on flood-ebb tidal phase scale were discussed. A high-resolution Changjiang (Yangtze) Coastal Model based on Finite-Volume Coastal Ocean Model (FVCOM) was applied to tidal currents simulation. Therefore, it is possible to further analyze the mechanism of the SSC distribution and variations.

Ocean dynamics on a global scale using satellite measurements

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Civilization aspiring for steady development and preservation of the biosphere, must have the knowledge of spatial distribution, seasonal dynamics and anomalies of the primary production process on the planet. Continuous monitoring of phytopigment concentrations in the ocean by space-borne methods makes possible to estimate ecological condition of biocenoses in critical areas. Unlike land vegetation, hydrological processes largely determine phytoplankton dynamics, which may be either recurrent or random.

The types of chlorophyll concentration dynamics can manifest as zones quasistationary by seasonal chlorophyll dynamics, perennial variations of phytopigment concentrations, anomalous variations, etc. While large-scale and frequently occurring phenomena have been much studied, the seldom-occurring changes of small size may be of interest for analysis of long-term processes and rare natural variations. Along with this, the ability to reflect consequences of anthropogenous impact or natural ecological disasters on the ocean biota makes the anomalous variations ecologically essential.

Close correlation of chlorophyll concentration distribution with hydrological processes makes concurrent analysis of the variability of temperature fields especially important.

The work presents SeaWiFS, MODIS and AVHRR satellite data processed to reveal spatial inhomogeneity of the seasonal course of chlorophyll concentration and sea surface temperature in the ocean in the global scale.

Areas with quasistationary and non-stationary changes of chlorophyll concentration are revealed by SeaWiFS and MODIS data.

As it is known a priori that extremely high and extremely low chlorophyll concentrations or sea surface temperature are associated with different physical processes, when mean or total values in the ocean are calculated, the processes induced by different physical reasons superpose. Thus, no correlation can be reached between the calculated total dynamics and some physical process. In this work we applied the method of statistical distribution analysis of data to every pixel. With this approach, extreme values are investigated in greater detail. We divided the range of values for every pixel into 5 parts; seasonal variations were taken into account.

The spatiotemporal distribution of the dynamics of extreme and average values was investigated. This approach made possible discovering the commonality of processes in the different oceans and defining a problem of revealing global processes responsible for this commonality.

Also it was found that the instability of the oceanic processes that was increased after the El Niño event began to decrease during the last two years.

Comparison of remotely sensed phytoplankton functional types retrievals in the Southern Ocean

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In the last years, many approaches have been developed for deriving Phytoplankton Functional Types (PFTs) or phytoplankton size classes from remote sensing observations. However most, if not all approaches are made at global scale. In this study, we focus on the Southern Ocean. We determine and compare the spatial distribution of PFTs using the methods developed by Bracher et al. (2009) and Hirata et al. (2011). The method of Hirata et al. (2011) consists of two steps. First, significant relationships are established between chlorophyll-a and biomarker pigments, as they presented using a global data set of High-Performance Liquid Chromatography (HPLC). These relationships are then applied to the chlorophyll-a (chl-a) observations by remote sensing, as they presented using the Sea-viewing-Wide-Field-of-View-Sensor (SeaWiFS). The result is the spatial distribution of microplankton (diatoms and dinoflagellates), nanoplankton, picoplankton (prokaryotes, PicoEukaryotes, Prochlorococcus sp.) and green algae. Alternatively, Bracher et al. (2009) applied the Differential Optical Absorption Spectroscopy (DOAS) technique on data derived from the sensor Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY) (PhytoDOAS method) for retrieving diatoms, dinoflagellates, cyanobacterias, prymnesiophytes and coccolithophores. The difference of PhytoDOAS to the method of Hirata et al. (2011) is the direct retrieval of the PFTs from spectrally resolved satellite data, without the use of empirical relationships. Within this study, we apply the Hirata et al. (2011) method to the GlobColour 9km Level-3 monthly chl-a data set. The empirical relationships were determined from a large HPLC pigment data set restricted to the Southern Ocean. Climatological aspects are considered for comparison of the PFTs spatial distributions for the period of 2003-2010. Limitations of both methods are discussed and improvements are suggested. References Bracher, A.; Vountas, M.; Dinter, T.; Burrows, J. P.; Röttgers, R. & Peeken, I. Quantitative observation of cyanobacteria and diatoms from space using PhytoDOAS on SCIAMACHY data. Biogeosciences, 2009, 6, 751-764. Hirata, T., Hardman-Mountford, N-J., Brewin, R-J-W., Aiken, J., Barlow, R., Suzuki, K., Isada, T., Howell, E., Hashioka, T., Noguchi-Aita, M. and Yamanaka, Y. (2011). Synoptic relationships between surface Chlorophyll-a and diagnostic pigments specific to phytoplankton functional types. Biogeosciences, 8: 311-327.

Harmful algae bloom and oil pollutions – spectral manifestations and impact on the upper layer properties

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Recent satellite systems give the unique possibility for regular monitoring of the marine environment. Proposed study is focused on application of the MULTICHANNEL, MULTISPECTRAL, MULTIPLATFORM approach for investigation of the oil films and Harmful Algae Bloom (HAB). "Deepwater Horizon" catastrophe and oil leakage in Mexican Gulf during more than three months gave a set of the quasi synchronous images from AVHRR, MODIS, MERIS, TM and ETM+ together with ASAR data. Optical and thermal properties of the oil films are studied. Oil spill appearance in optics is defined by influence of the oil film on surface reflectivity. Radiation registered by optical sensors near surface consists from water leaving radiation and reflected radiation of the upper hemisphere. Oil film manifestation is caused by two factors: - variations of the reflection coefficient of "water – film" system; - variations of the surface roughness. Note, that oil film manifestation in radar data is defined only by surface roughness. Combination of the ASAR and multispectral optical data allows to estimate the oil film thickness. Existence of the surface films impacts on the thermal properties of the water. Atypical Blue-green algae blooms (HAB) in the Caspian, Black and Azov Seas occurred last years and strongly affected on thermal properties of the sea upper layer. Manifestation of the bloom area in optical, thermal and radar data and possibility of HAB prediction are discussed.

Extraction of the Douro river plume size from MERIS Total Suspended Matter data using classification and segmentation methods

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River discharge into the coastal ocean represents a major link between terrestrial and marine systems. River plumes are an important phenomenon in coastal regions. In areas with high rates of river discharge, plumes clearly influence coastal dynamics. River plumes are a mixture of fresh water and river sediment load, with some dilution caused by currents. The river plumes are turbid and carry a high load of suspended sediments. Since these suspended sediments can be associated with nutrients, pollutants and other materials, it is of crucial importance to remotely survey their dispersal in order to assess the environmental quality of the regions surrounding river mouths. The river plumes are distinguished from surround marine waters by their high concentration of total suspended matter (TSM), which changes the color of the ocean surface (Nezlin and DiGiacomo, 2005). Satellite ocean color observations of the optical properties of coastal surface waters can be used to distinguish plume water from ambient water masses, particularly based on increased concentrations of TSM in the plumes (Teodoro et al., 2009).

In mid-2002 the European Space Agency (ESA) launched the MERIS (MEdium Resolution Imaging Spectrometer) hosting satellite ENVISAT. The primary mission of MERIS is the measurement of water colour in the oceans and in coastal areas. The aim is to convert such measurements of the water colour into a measurement of concentrations of phytoplankton chlorophyll, total suspended matter and gelbstoff. The algorithm used by ESA to retrieve the concentration of TSM from spectra of radiances and reflectance of coastal waters (Case 2 Waters) is carried out by an Artificial Neural Network (ANN) (Doerffer et al., 1999; Schiller and Doerffer, 2005). The TSM concentration is expressed as a concentration in g/m3 or Log10 (g/m3) with a valid range between 0.01-50.00 g/m3.

The main objective of this study was to explore different classification and segmentation methods, in order to accurately extract the Douro river plume (DRP) dimension, for one year time series. In this work, 88 MERIS scenes (level 2 data) from January 2009 to December 2009 were considered (data provided by ESA).

The adopted methodology consisted in the application of several segmentation algorithms. The first one was based on region growing approach, to automatically select the region seed (S) and the threshold (T) values for each image. In this algorithm two options may be used to select the S and the T values. The first option consisted in assuming S as the centroid value and T as S/2, whereas the second option is based on assuming S as the mean value of the plume region and T as half the maximum. The second option led to better results, since its nature allows for a more realistic and accurate delineation of the plume (Teodoro and Almeida, 2011). The second considered segmentation method is based on the segmentation module of the automatic image registration method HAIRIS, where an automatic detection of modes present on the histogram is performed (Gonçalves et al., 2011).

These segmentation algorithms were compared with pixel- and object-based classification approaches and also compared with manual digitalization of two independent operators. The large differences in the manual digitalization between operators support the subjectivity inherent to this process, which reinforces the interest on the application of automatic methods for the extraction of the Douro river plume size. According to Teodoro et al., (2009) and Teodoro and Almeida (2011) the parameter that most directly influences DRP dimension are the river discharges (at Crestuma dam). Therefore, in order to validate

the different segmentation methods and applied algorithms, the DRP dimension was related with Douro river discharges. In general, the considered segmentation algorithms presented a better performance when compared with the traditional classification (pixel and object based) approaches.

The plume derived from MERIS data represents DRP only when the river flow exceeds a certain threshold. During low discharge, the remotely sensed plume results from other factors. Another factor that should be considered are the breakwaters constructed in the sand spit of Douro river. Two breakwaters were constructed in order to stabilize the river mouth, between 2004 and 2008. These breakwaters have two main functions: to avoid river Douro right bank to be reached by waves, recovering the sand spit function protection; and to improve the navigation channel. However, the breakwaters changed local dynamics and consequently the amount of sediments that reach to the plume. Another important issue is related with the dredging of the Douro River navigation channel. The dredging at the mouth of the estuary interferes with the amount of sediments that are available in the Douro estuary and consequently affects the models proposed in this paper. These two points should be addressed more carefully in the future. Nevertheless, the segmentation approaches applied in this work seems to be a valid method to automatically estimate the river plume size.

Doerffer, R., Sorensen, K. and Aiken, H. J., (1999), MERIS potential for coastal applications. International Journal of Remote Sensing 9, 1809-1818.

Gonçalves, H., Gonçalves, J. A., Corte-Real, L., (2011), HAIRIS: A method for automatic image registration through histogram-based image segmentation. IEEE Transactions on Image Processing 20 (3), 776-789.

Nezlin, N. P., and DiGiacomo, P. M., (2005), Satellite ocean color observations of storm water runoff plumes along the San Pedro Shelf (southern California) during 1997 to 2003. Continental Shelf Research 25, 1692-1711.

Schiller, H. and. Doerffer, R., (2005), Improved determination of coastal water constituent concentration from MERIS data. IEEE Transactions on Geoscience and Remote Sensing 7, 1585-1591.

Teodoro, A C., Gonçalves, H., Veloso-Gomes, F. and Gonçalves, J.A., (2009), Modelling of the Douro river plume size, obtained through image segmentation of MERIS data. IEEE Geoscience and Remote Sensing Letters, Vol. 6 (1), 87-91.

Teodoro, A.C., and Almeida, H., (2011), Spatio-temporal variability analysis of the Douro River plume through MERIS data for one hydrological year. Proceedings Vol. 8174. Remote Sensing for Agriculture, Ecosystems, and Hydrology XIII, Christopher M. U. Neale; Antonino Maltese, Editors, 81741N. DOI: 10.1117/12.897519.

Variability in phytoplankton size, primary and export production in the North Atlantic from satellite data.

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Ridge and front systems have long been recognised as areas of high primary production due to associated nutrient enrichment in the photic zone. In the North Atlantic basin the mid-Atlantic ridge (MAR) is a conspicuous feature with a mean crest height of 1708m below sea level. It is dissected east to west at 52 degrees North by the Charlie-Gibb Fracture Zone (CGFZ), the location at which the Gulf Stream crosses the Atlantic and separates East North Atlantic sub-tropical Water in the south from Arctic overflow water in the North, producing a persistent thermal sub-polar front (SPF). We use 30 yrs of AVHRR Sea Surface Temperature (SST) and merged micro-wave and infra-red SST to assess thermal signatures associated with the MAR and SPF. We then implement Ocean Colour algorithms of primary (PP) and export production (EP) using 13 yrs of SeaWiFS data to assess the spatial and temporal frequency of regions of enhanced productivity in the North Atlantic. Phytoplankton size class algorithms applied to the SeaWiFS time series are then used to explain the inter-annual variability in productivity. The data suggest that outside of the spring bloom, the Reykjanes Ridge and SPF sustain higher PP and EP due to a higher micro-phytoplankton biomass. These areas are less susceptible to inter-annual climate oscillations and therefore supply a higher and more consistent export of carbon to the deep ocean.

Assessing the impact of space and time resolution of brightness temperature simulation conditions in correcting SEVIRI SST over the Adriatic Sea

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Majority of operational sea surface temperature (SST) infra-red (IR) products have small overall bias but exhibit higher absolute biases in specific regions. Previous studies [for example *Tomazic et al.*, 2011] showed that over Adriatic Sea there is a positive summer bias sometimes exceeding 0.5 K. Methodology to decrease regional biases [*Le Borgne et al.*, 2011], based on using atmospheric profiles, surface SST fields and radiative transfer model to simulate the non-linear split window SST (NLSST) algorithm error, was used to assess the impact of atmospheric profiles with different spatial resolution (ECMWF: 0.125 deg and ALADIN 2 km), different input surface SST fields (OSTIA 6 km and CNR UHR L4 1 km) and different time and space averaging criteria's in deriving the algorithm correction. SST corrections derived for the NLSST Spinning Enhanced Visible and Infrared Imager (SEVIRI) algorithm for five months (July, October and December 2010 and March and July 2011) are validated with AATSR L2 SST fields and compared to already implemented regional correction procedure at Center de Meteorologie Spatiale (CMS) to assess the optimal combination of space and time averaging criteria's and input fields.

Results show that the best improvement for all available months and for both day and night is obtained when using spatial averaging over the whole domain in combination with time averaging between the last 15 and last 31 days both for day and night time analysis. Using higher resolution ALADIN atmospheric profiles with OSTIA input SST fields didn't improve the SST correction compared to using combination of coarser ECMWF atmospheric profiles and OSTIA input SST. Small improvement, based only on analysis for two months in 2011, is obtained when using both higher spatial resolution atmospheric profiles (ALADIN) and higher resolution input SST fields (CNR UHR L4 1 km). The best improvement obtained for spatial averaging over the whole domain (Adriatic Sea) suggests that the domain should be more extended (to Mediterranean Sea) to derive optimal spatial averaging, while conclusion of improvement obtained when using both the higher spatial resolution atmospheric profiles and input SST field need extension of analysis on other months in 2010.

REFERENCES

Le Borgne, P., H. Roquet, and C. J. Merchant (2011), Estimation of sea surface temperature from the Spinning Enhanced Visible and Infra Red Imager, *Remote Sensing of Environment*, *115*, 55-65, doi:10.1016/j.rse.2010.08.004.

Tomažić, I., M. Kuzmić, G. Notarstefano, E. Mauri, and P. M. Poulain (2011), A comparative assessment of satellite-derived Adriatic Sea surface temperature, *International Journal of Remote Sensing*, *32*(17), 4871-4892, doi: 10.1080/01431161.2010.492249.

Cabo Pulmo: a comparison between in situ and satellite oceanographic measurements

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The Cabo Pulmo coral reef is a no-take marine reserve located at about 23° 27'N on the west coast of the Gulf of California, very close to the tip of the Baja California Peninsula (Mexico). Since its declaration as a National Park in 1995 no fishing has been allowed within the boundaries of the Park. It is one of the few places in the Gulf where a healthy marine community survives and, therefore, it is an area of great interest for studies that aim to understand how to preserve the marine biodiversity of the region. Cabo Pulmo is also unique because the shallow reef is separated from the deep ocean only by a steep continental slope. The oceanic currents and mesoscale eddies of the entrance to the Gulf of California can therefore interact with the shallow environment. In this work we characterize the dynamics of the currents on the reef by means of direct observations of sea level, ocean currents, hydrographic and meteorological variables. The oceanographic observations are compared with the coastal variability observed by using sea surface temperature from satellites, altimetry-derived currents and productivity derived from remotely-sensed ocean color. The emphasis of this work is on the interaction of little-known narrow current jets with the dynamics of the shallow reef. We include a discussion on the advantages and limitations of satellite oceanography for coastal applications.

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Estimation of biases in sea surface temperature obtained by MODIS and AATSR for composite map in case of highly variable temperature fields

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Current study is based on examination of satellite SST data from the years 2002-2009 in Baltic Sea. Sea surface temperature (SST) data from MODIS (MSl12 algorithm by NASA/OBPG) and AATSR (2 channels dual and nadir view) was examined to determine the differences of measurements in case of highly variable temperature fields (upwellings) in the Gulf of Finland (Baltic Sea). As the two instruments use different measuring methods the results are expected to be biased. In addition to daily remote sensing SST imagery provided by MODIS and AATSR sensors that provide information over the Gulf of Finland there is another source of operational upper layer temperature (bulk SST) data - the temperature measurements conducted regularly (daily) by ship of opportunity at a fixed depth. The combined use of the two different operational data sources – remote sensing and temperature measurements conducted by ship of opportunity – can provide good overview of the regional SST field. The remote sensing data were compared with flow trough in situ measurements that were conducted on the transect between Tallinn and Helsinki in Gulf of Finland. Only data that was measured during summer upwelling events (and therefore had high spatial variability) were considered in the analysis. The objectives of current study are (1) to quantify regionally the differences between flow through in situ temperature and SST products (MODIS and AATSR), (2) to quntify the regional biases between MODIS and AATSR SST products and (3) to develope a method to derive bias corrected daily regional SST maps in cases of highly variable SST fields using MODIS and AATSR data. For comparison of the MODIS and AATSR SST products with the corresponding measured data the root mean square temperature differences (r.m.s.), the correlation coefficient (R) and bias were calculated. The SST data obtained with MODIS and AATSR were also compared with each other. Also bias corrected r.m.s differences along the transect between the two products were calculated. The comparison showed that AATSR nadir view data had strong warm bias while dual-view AATSR and MODIS data had lower positive biases compared to in situ measurements (bulk SST). Both AATSR and MODIS SST products had similar correlation with flow through measurements 0.89, 0.93 and 0.93 for nadir-view AATSR, dual-view AATSR and MODIS respectively. Three types of composite maps were calculated in cases when data from both satellite sensors was available. (1) Uncorrected composite maps. (2) Using the estimated bias between MODIS and AATSR products the bias correction was applied to AATSR data and composite map was calculated. (3) The bias correction was applied for both images (MODIS and AATSR) in order to get composite SST map that best represents in situ measurements (bulk SST). Taking into account the detected biases between different instruments a composite SST maps were created. The analysis showed that the use of bias corrected SST images results in better SST composite maps with enough details preserved and with reduced artificial features like striping.

Turbulence-inspired fusion methods for ocean remote sensing data

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New techniques for analyzing the structure of remote sensing maps of ocean variables have been developed during recent years [*Turiel et al.*, 2008, and references therein]. These techniques have been designed in the framework of the Multifractal Microcanonical Formalism (MMF), and are appropriate for dealing with scalars submitted to the action of a turbulent flow (in this case, we are considering horizontal, quasi-geostrophic turbulence). Scalars submitted to the action of a turbulent flow develop a complex, intermittent structure: a multifractal hierarchy. The multifractal hierarchy can be evidenced by different means. The classical approach is to study global scaling properties by means of the scaling exponents of the structure functions. A different approach consists of calculating the scaling exponents at each point of the scalar. In the later case, the exponents are called singularity exponents and they are dimensionless measures of the regularity or irregularity of the function at each point.

Singularity exponents arise due to differential shear in the flow, and thus they are characteristic to the velocity field, but not to the advected scalar. Experiments with data from numerical simulations and from remote sensing sensors show that singularity exponents are almost independent of the scalar and related to the flow structure: singularity lines align with streamlines. This implies that a part of any scalar signal is common to all other scalars: the common part defines its multifractal structure.

Exploiting the redundancy (among different scalars) of the multifractal structure, we have derived a theoretical relation that can be used in data fusion without using any other information. We have applied this relation to fuse microwave SST data with SMOS SSS maps to produce enhanced SSS maps.

This technique can also be used to different goals as data assimilation in numerical models, filter noise in low-level remote sensing data, and in completing data series of Essential Climate Variables.

REFERENCES

Turiel, A., Solé, J., Nieves, V., Ballabrera-Poy, J., and García-Ladona, E., 2008. Tracking oceanic currents by singularity, analysis of Microwave Sea Surface Temperature images. *Remote Sens. Environ.*, 112(5), 2246-2260.

Monitoring of multi-year algal bloom dynamics in the North Sea using MERIS and MODIS.

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Algal blooms (AB) are generally defined as a rapid increase in the biomass of algae in an aquatic system. Satellite chlorophyll a concentrations (CHL) data are a suitable proxy for phytoplankton biomass and provide a unique means to monitor AB dynamics over a large area such as the North Sea and over many years. MUMM provides an operational daily AB detection service in European waters using MERIS and MODIS data within the framework of the MarCoast project. The basic product of this service is a daily map of AB detected using an algorithm which compares the instantaneous CHL map with a threshold CHL map. The threshold map used is a 90 percentile map of CHL for the growing season (March-November incl.) of the studied year. Such a threshold map is able to capture the high spatial variability in typical CHL concentrations throughout the European seas and hence relativise the concept of AB .

In this study, AB detection maps were created using a historical dataset of MERIS and MODIS CHL data for the years 2003 to 2010. The daily AB detection maps were subsequently used to generate yearly AB timing maps providing pixel by pixel information of the date at which a first AB was detected. With these AB timing maps representing AB dynamics both in space and time, the impact of factors such as euphotic depth (KdPAR, TSM), total water depth, water column stratification, and nutrient availability could be investigated. In European waters at the large scale a general link between the AB timing and latitude can be observed where the AB occur later in the growing season from South to North due to light availability. The situation in the North Sea is more complex since other factors such as bathymetry, turbidity and human induced eutrophication play a more significant role. Results will be presented for the spatial and interannual variability of AB timing in the North Sea as detected by satellite data, and will be explained in terms of the relevant factors.

Obtaining high quality ocean colour products at high temporal frequency by exploiting the synergy between polar-orbiting and geostationary sensors

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Polar-orbiting ocean colour sensors such as SeaWiFS, MODIS, and MERIS have been covering the world's oceans for over a decade with a revisit time of 1 to 2 days. This temporal resolution is insufficient to capture the diurnal cycles of biogeochemical processes occurring in open ocean and coastal waters, especially not in regions where cloud cover reduces data availability. Imagery from geostationary platforms can be obtained with a much higher frequency (typically every 15 or 60 minutes), and thus, in theory, can be useful to study those processes. The first ocean colour sensor on a geostationary platform, the Geostationary Ocean Colour Imager (GOCI), was launched in 2009 and in mid 2010, it started collecting hourly data for Northeast Asia. There are no geostationary ocean colour sensors over Europe yet, but, for the turbid waters of the southern North Sea, suspended particulate matter, turbidity, and vertical light attenuation products have recently become available every 15 minutes, by using the SEVIRI meteorological sensor (Neukermans et al., 2009). However, the spatial and spectral resolution of SEVIRI is limited and the calibration and atmospheric correction are less established than those of polar-orbiting sensors. This study investigates the potential of combining the higher spatial and spectral resolution and better atmospheric correction of polar-orbiters, with the higher frequency of SEVIRI in two ways. First, to obtain high frequency and high quality suspended matter, turbidity, and vertical light attenuation products, the data from polar-orbiters are modulated by the variability detected by SEVIRI. Second, SEVIRI vertical light attenuation products are refined using coloured dissolved organic matter and Chl a concentration data from polar-orbiters. Effects of the synergy are investigated using in situ data obtained from moored buoys. Additionally, moving beyond Europe, imagery from GOCI, with much better spectral, spatial and radiometric resolution than SEVIRI, is cross-correlated with MODIS imagery for selected turbid water regions.

Long-term dynamics of chlorophyll concentration and sea surface temperature in the ocean surface layer (by satellite data)

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To preserve the biosphere and to use it efficiently, it is necessary to gain a deep insight into the dynamics of the primary production process on our planet. These investigations are, however, very labor-consuming, because of the difficulties related to the accessibility of the water surface and its large size. Variability of chlorophyll concentration in the ocean is one of the most important components of this process. In this work long-term changes in chlorophyll concentration and sea surface temperature in the surface layer of the ocean have been analyzed on the basis of the MODIS and SeaWiFS from 1997 to 2010 and AVHRR data from 1985 to 2010. Trends in these data sets were calculated and compared for different periods. It has been shown that decreasing of chlorophyll concentration revealed by SeaWiFS data replaced by increasing. Minimum values were achieved in 2005-2006. Also it is very interesting to compare dynamics of sea surface temperature and chlorophyll concentration. Mostly trends of sea surface temperature and chlorophyll concentration have opposite directions but areas were revealed with a positive correlation.

Initial progress in producing an analysis system of the diurnal cycle of SST

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Diurnal variations in skin Sea Surface Temperature (SST), which can be as large as several degrees, play an important role in determining the heat flux between the ocean and atmosphere. At the UK Met Office we are engaged in a program to produce an analysis of the diurnal cycle of SST. This analysis will combine information from both satellite measurements and a diurnal model of the instantaneous skin temperature.

We present results from an analysis of the quality and coverage of the diurnal cycle by satellite SST data, both from low orbiting and geostationary satellites. Using data from the SEVIRI instrument we show the particular importance of using data from geostationary satellites in any diurnal study.

While still in the development stage, we present results from the current version of our diurnal SST analysis system. In this system we use a diurnal model based on the ECMWF's model of diurnal warming and constrain this system using a 4DVar like method to assimilate available satellite data. Unlike normal 4DVar, our system constrains the model by adjusting not only the initial temperature, but also the heat and wind forcing. The analysis that results from this process should provide the best possible match between the model and observations given their relative errors.

Remote Sensing of Sea Surface Conductivity Distribution by HF Surface Wave Radar

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This paper proposes that the HF Surface Wave Radar (HFSWR) can be exploited to remote sensing of sea surface conductivity distribution. HFSWR transmits radio waves of tens of meters in wavelength, propagating along sea surface, resonating with the surface gravity waves typically with wavelength of half of the radio wave's, thus intensified backscatters (sea echoes) can be observed at the radar site. Doppler spectra analyzing of sea echoes gives information on surface currents, waves and winds. A coastal HFSWR site is capable of yielding sea states parameters distribution covering thousands of square kilometers in nearly ten minutes observation. Typical HFSWR detecting range is 100 200km with 1 5km range resolution and 1 5 degree azimuth resolution.

Unlike microwave propagation, which is vulnerable by rain, fog and other asymmetric refractive index distribution in air mass, HF radio waves' propagation on sea surface is primarily subject to sea surface conductivity distribution (SSCD). Low conductivity will cause HF radio waves attenuating more heavily than in case of high conductivity. Therefore SSCD information can be extracted by investigating the HF radio wave attenuation speed along its propagation path. The HF radio wave attenuation is mainly composed of free-space attenuation, additional attenuation caused by ocean waves, and the Norton attenuation, which is relevant to SSCD. The first attenuation can be calculated by using standard radio propagation model. The second one can be figured out from experiential relationship as real time wave height can be inversed from sea echo Doppler spectra. Then the Norton attenuation is obtained and SSCD information can be inversed from it. Range-differential processing of the echoes' attenuation data will help to exclude affects from radar system variables and large-scale spatial structures, reduce inversion complexity and enhance inversion precision and robusticity. Salinity distribution can also be obtained as it is considered as a function of conductivity. Data quality control and data calibration are critical in the inversion process.

Estimation of suspended sediments concentrations in coastal ocean using in-situ and Hyperion data

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Suspended sediments are one of the key color-producing agents for coastal ocean. For developing workable remote sensing algorithms of sediments concentration, intensive field surveys were conducted in the Pearl River Estuary (PRE) during 2004 - 2006 to collect in situ remote sensing reflectance (Rrs) and the surface total suspended matter (TSM), total inorganic particles (TIP) and turbidity, etc. Hyperion/EO-1 hyperspectral image data (Rp) was also collected with one of surveys on Dec. 6, 2006. The in situ data show that the content of TIP and turbidity is proportional to the concentration of TSM which ranges from 6 mg/L to 140 mg/L. First-order derivatives of Rrs and Rp at 605 nm, i.e., [Rrs(610)-Rrs(600)], the band-subtraction of Rrs at 610 nm and 600 nm, and [Rp(B26)-B(25)], subtraction of Rp of the 26th and 25th bands (609.97nm, and 599.80nm) with Hyperion, are used in an exponential regression model to estimate the TSM concentrations, the mean relative errors (RE) between the estimated and measured values are 27.2% and 23.3%, respectively for Rrs data and Hyperion data, and the root mean square errors (RMSE) are 27.2 mg/L and 5.9 mg/L. Other retrieval algorithms of TSM were also compared, and, the band-subtraction algorithm [Rrs(610)-Rrs(600)] showed a better performance.

MONITORING CHANGES OF NAM CO LAKE USING REMOTE SENSING DATA (2000-2009)

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The environmental factors including snow cover and hydrologic regime of lake are all sensitive factors and can reflect ecosystem responses to changing climate. A series of satellite imagery-based environmental data archives including variation of snow cover, lake water storage and lake level in Nam Co Lake Basin, were mapped for the period 2000-2009.

Impact of wind speed error on SMOS SSS retrieval

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The Soil Moisture and Ocean Salinity (SMOS) satellite, launched in November 2009, carries the first interferometric radiometer at L-band (1.4GHz) in orbit. The global distribution of SMOS Sea Surface Salinity (SSS) is very encouraging [*Font et al*., 2011]. In particular, the latitudinal variation of SSS is well captured by SMOS [*Yin et al*., 2012] and SSS anomalies in tropical regions seen by ARGO floats also appear on SMOS SSS [*Boutin et al*., 2011].

The SMOS level 2 SSS nominal processing uses a multiparameter iterative scheme: SSS is retrieved together with wind speed and other geophysical parameters owing to the SMOS ocean surface brightness temperature measured in full polarization and for multi-incidence angles. Because SMOS brightness temperatures do not give a strong constraint on the wind speed, a priori wind speed value has a strong impact on the retrieved SSS.

The aim of this paper is to study the precision on SMOS SSS when SSM/I wind speed is used as prior instead of ECMWF.

Large discrepancies between SMOS and Argo SSS are noticed when there are large differences between SSM/I (Special Scanning Microwave Imager) and ECMWF (European Center Weather Forecast) wind speed. Actually, in this paper, we show that SMOS retrieved wind speed in the center of the swath (where the incidence angle varies from ~ 0° to 60°) is partly (but not entirely) corrected for inconsistencies between ECMWF wind speed and SSM/I radiometer wind speed, whereas the ECMWF wind speed is not adjusted on the border of the swath. The difference between ECMWF and SSM/I wind speeds may originate from wind speed inaccuracies (e.g. misplacement of atmospheric fronts) or from surface effects other than wind speeds affecting the sea surface roughness (e.g. surface currents…).

When the discrepancies between ECMWF and SSM/I wind speed is out of SMOS's capability of wind correction, the retrieved SSS is biased. We show some examples of large discrepancies between SMOS and Argo SSS when there are large differences between SSM/I and ECMWF wind speed:
1) In the Eastern equatorial Pacific in Summer of 2010, where there is a strong westward current and where the SMOS SSS is systematically to high.
2) In the southern Pacific ocean where a strong wind front occurred.

REFERENCES

Font, J., Boutin, J., , et al., 2011. SMOS first data analysis for sea surface salinity determination, *International Journal of Remote Sensing*, in press.

Yin, X., Boutin, J., , et al., 2012. Optimization of L-band sea surface emissivity models deduced from SMOS data, *IEEE Trans. Geosci. Remote Sens.*, in press

Boutin, J., Martion, N., et al., 2011. First assessment of SMOS measurements over Open Ocean: part II Sea Surface Salinity, submitted to *IEEE Trans. Geosci. Remote Sens.*

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SMOS Sea Surface Salinity Validation in South China Sea

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INTRODUCTION

Ocean salinity is one of important marine environmental dynamics parameters. Its change is closely related to marine environment and global climate change. Satellite SMOS launched by the ESA in November 2009 has the mission of Sea Surface Salinity (SSS) measurement with L band microwave radiometer. Applied Research in Geomatics, Atmosphere, Nature and Space (ARGANS) Company develops the SMOS Level 2 Ocean Salinity (L2OS) processor in collaboration with Expert Support Laboratories [*Zine et al.*, 2008]. In L2OS processor a series of physical models are applied to auxiliary data (SST, wind, etc.) and a first guess SSS, to compute the brightness temperature that should be measured at a specific polarization and geometric configuration. These values are transported to SMOS antenna level and then compared to actually measured sensitivity of L-band brightness temperature (Tb). An iterative process allows minimization of the difference between modeled and measured values, until identifying a retrieved SSS for this grid point. Three different models are proposed for the effect of ocean surface roughness in L-band emissivity and then three retrieval processes will be run in parallel, and three SSS values provided in the L2 output product.

In this paper, SSS retrieved with three different models are validated with *in situ* measurements from CTD in the South China Sea. The direct comparison of SMOS SSS to *in situ* data shows that the RMS is in the magnitude of 1.4 practical salinity unit (psu) at 0.05° by 0.05° spatial resolution. An improved surface roughness model for South China Sea is being considered and expected to be presented in the full paper submission.

DESCRIPTION OF THREE SURFACE ROUGHNESS MODELS

The brightness temperature can be expressed as the sum of two terms; the brightness temperature in the case of completely flat sea and the additional brightness temperature (ΔT_b) due to the surface roughness, as follows:

$$T_{b,p}(\theta, SST, SSS, P_{rough}) = T_{b\,Flat,p}(\theta, SST, SSS) + \Delta T_{b\,rough,p}(\theta, SST, SSS, \vec{P}_{rough}) \quad (1)$$

The first term is T_b due to the emission of a flat sea surface, which is well described by the Fresnel equations and is polarization (p) dependent. The second term is the increment of brightness temperature due to the sea surface roughness, which can be described through several parameters (P_{rough}) related to processes that modify this roughness. θ is the angle under which T_b is measured, and SST is the sea surface temperature.

A comparative analysis of the use of different rough surface emissivity models in salinity retrievals has shown that the forward model has a strong impact on the quality of the retrieved salinity and that the emissivity model errors can introduce biases in the results [*Dinnat et al.*, 2003, *Reul et al.*, 2006]. Three different roughness model options have been selected for implementation in the salinity retrieval algorithm. Two of them are theoretical models that require a statistical description of the sea surface and an asymptotic solution for rough surface electromagnetic scattering.

Model 1 uses a two-scale approach to electromagnetic scattering and the Durden and Vesecky wave spectrum multiplied by two for the rough surface description [*Durden* and *Vesecky*, 1985, *Wentz*, 1975, *Yueh*, 1997, *Dinnat et al.*, 2002].

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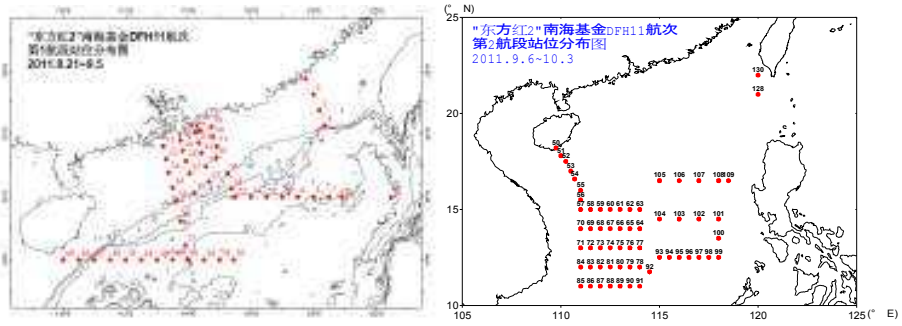
Model 2 uses the small slope approximation emission theory [*Irisov*, 1997, *Johnson* and *Zhang*, 1999] and the sea surface wave spectrum model proposed by Kudryavtsev [*Kudryavtsev et al.*, 1999]. This model partitions the ocean surface into foam free and foam-covered areas, and it includes a specific foam emissivity model to account for the effect of the presence of foam on the sea surface emission [*Reul* and *Chapron*, 2003]. Foam contribution can have a significant impact for the sea surface wind speed in excess of 10–12 ms^{-1} [*Camps et al.*, 2005].

Model 3 is a semi empirical formulation derived from the few existing data sets provided by campaigns in the Mediterranean Sea that have measured the L-band-polarized emission of the sea surface together with oceanographic and meteorological parameters recorded in coincidence with the radiometric data [*Camps et al.*, 2004, *Gabarró et al.*, 2004]. Model 3 has been used to retrieve the salinity from airborne radiometric measurements acquired in a region characterized by a large range of oceanographic conditions.

STUDY DATASET

The SSS dataset of SMOS L2 outputs and *in situ* dataset for validation are used in this study. SSS retrieved with three different models are accessed from the European Space Agency (ESA) and are bilinearly interpolated to the spatial resolution of 0.05° by 0.05°. In the South China Sea open cruise (from Aug. 24, 2011 to Oct. 3, 2011) funded by NSFC, *in situ* SSS measurements with CTD911 sensor are systematically collected. The location of Observation stations are shown in figure 1.

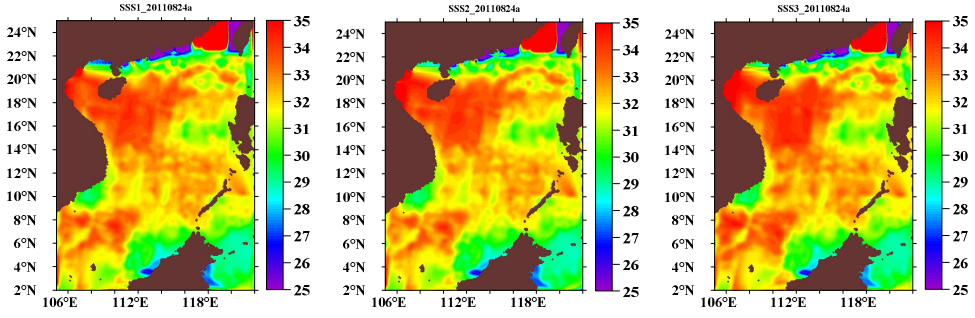


(1) (2)

Figure 1. The location of Observation stations of South China Sea open cruise, (1) route of the first phase from August 21, 2011 to September 5, 2011 and (2) route of the second phase from September 6, 2011 to October 3, 2011

COMPARISON OF THE RETRIEVED SMOS SSS TO *IN SITU* MEASUREMENTS

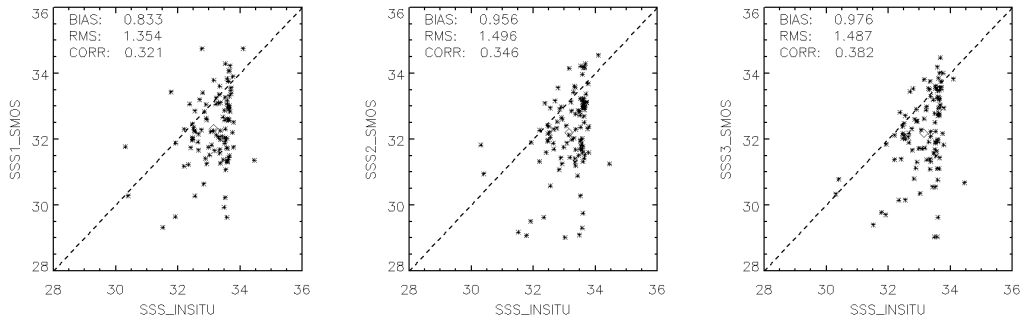
Together 264 SMOS SSS data retrieved with three surface roughness models from Aug. 24, 2011 to Oct. 3, 2011 are used for validation. Prior to validation SMOS SSS data are smoothed with 3×3 mean filter and bilinearly interpolated with the spatial resolution of 0.05° by 0.05° to reduce speckle noise. Three examples of weekly average SSS estimated from SMOS Level 2 product over the South China Sea are shown in figure 2. One can observe that SSS values in Taiwan Strait are beyond the scope of color bar because of missing data. These missing data are dominantly due to contaminated brightness temperature measurements by radio frequency interferences and therefore flagged as bad quality data.



(1) (2) (3)

Figure 2. Weekly average SMOS SSS estimated with surface roughness (1) model 1, (2) model 2 and (3) model 3 from SMOS Level 2 SSS products over South China Sea, Aug. 24 to 30, 2011

A total of 107 *in situ* SSS measurements were used to compare to SMOS SSS retrieved with three surface roughness models and the results are shown in figure 3. The statistical parameters of comparison are list in Table 1. It can be seen that the result of model 1 is better than the other two with the bias 0.833 psu, RMS 1.354 psu and correlation 0.321. This indicates that more precise SMOS SSS estimates in South China Sea need to be retrieved with new surface roughness model which is being developed by us.



(1) (2) (3)

Figure 3. The direct comparison of Weekly average SSS to *in situ* measurements, (1) model 1, (2) model 2 and (3) model 3.

Table 1. The statistical parameters of comparison of SSS from three models to *in situ* measurements

	Bias (psu)	RMS (psu)	Correlation
Model 1	0.833	1.354	0.321
Model 2	0.956	1.496	0.346
Model 3	0.976	1.487	0.382

SUMMARY

In this paper, we descript three surface roughness models chosen in L2OS processor and present three examples of the weekly average results of SMOS Sea SSS products. To assess this quality, *in situ* SSS data originate from CTD911 sensor were collected in South China Sea between August 21 and October 3, 2011. The direct comparison of SMOS SSS to *in situ* data shows that the first roughness model is best one to retrieve SSS over South China Sea with bias 0.833 psu, RMS 1.354 psu and correlation 0.321. We are developing a new surface roughness model for South China Sea which is expected to present in full paper submission.

REFERENCES

Camps, A., Font, J., Vall-llosera, M., Gabarró, C., Corbella, I., Duffo, N., Torres, F., Blanch, S., Aguasca, A., Villarino, R., Enrique, L., Miranda, J. J., Arenas, J., Juliá, A., Etcheto, J., Caselles, V., Weill, A., Boutin, J., Contardo, S., Niclós, R., Rivas, R., Reising, S. C., Wursteisen, P., Berger, M. and Martín-Neira, M., 2004. The WISE 2000 and 2001 field experiments in support of the SMOS mission: Sea surface L-band brightness temperature observations and their application to sea surface salinity retrieval, *IEEE Trans. Geosci. Remote Sens.*, vol. 42, no. 4, pp. 804–823.

Camps, A., Vall-llosera, M., Villarino, R., Reul, N., Chapron, B., Corbella, I., Duffo, N., Torres, F., Miranda, J. J., Sabia, R., Monerris, A., and Rodríguez, R., 2005. The emissivity of foam-covered water surface at L-band: Theoretical modeling and experimental results from the FROG 2003 field experiment, *IEEE Trans. Geosci. Remote Sens.*, vol. 43, no. 5, pp. 925–937.

Dinnat, E. P., Boutin, J., Caudal, G., and Etcheto, J., 2003. Issues concerning the sea emissivity modeling at L band for retrieving surface salinity, *Radio Sci.*, vol. 38, no. 4, 8060, DOI:10.1029/2002RS002637.

Durden, S. L., and Vesecky, J. F., 1985. A physical radar cross-section model for a wind-driven sea with swell, *IEEE J. Ocean. Eng*., vol. OE-10, no. 4, pp. 445–451..

E. P. Dinnat, J. Boutin, G. Caudal, J. Etcheto, and P. Waldteufel, "Influence of sea surface emissivity model parameters in L-band for the estimation of salinity," *Int. J. Remote Sens*., vol. 23, no. 23, pp. 5117–5122, Dec. 2002.

Gabarró, C., Font, J., Camps, A., Vall-llosera, M. and Juliá, A., 2004. A new empirical model of sea surface microwave emissivity for salinity remote sensing, *Geophys. Res. Lett.*, vol. 31, no. 1, pp. L01309-1–L01309-5, DOI: 10.1029/2003GL018964.

Irisov, V. G., 1997. Small-slope expansion for thermal and reflected radiation from a rough surface, *Waves Random Media*, vol. 7, no. 1, pp. 1–10.

Johnson, J. T. and Zhang, M., 1999. Theoretical study of the small slope approximation for ocean polarimetric thermal emission, *IEEE Trans. Geosci. Remote Sens*., vol. 37, no. 5, pp. 2305–2316.

Kudryavtsev, V. N., Makin, V. K., and Chapron, B., 1999. Coupled sea surfaceatmosphere model—Part 2: Spectrum of short wind waves, *J. Geophys. Res.*, vol. 104, no. C4, pp. 7625–7639.

Reul, N. and Chapron, B., 2003, A model of sea foam thickness distribution for passive microwave remote sensing applications, *J. Geophys. Res.,* vol. 108, no. C10, 3321, DOI: 10.1029/2003JC001887.

Reul, N., Chapron, B., Mevel, S., Le Traon, P.-Y., Obligis, E., Boone, C., Bahurel, P., Brasseur, P., Testut, C.-E., Tranchant, B., Font, J., Gabarró, C., Srokosz, M., Snaith, H., Gommenginger, C., Camps, A., Vall-llosera, M., Miranda, J., Sabia, R., Germain, O., Soulat, F., Bertino, L., Le Vine, D. M., and Lagerloef, G. S. E., 2006. Synergetic Aspects and Auxiliary Data Concepts for Sea Surface Salinity Measurements From Space, European Space Agency ESTEC Contract 18176/04/NL/CB, Final report.

Wentz, F. 1975. A two-scale model for foam-free sea microwave brightness temperature, *J. Geophys. Res.*, vol. 80, pp. 3441–3446.

Yueh, S. H., 1997. Modeling of wind direction signals in polarimetric sea surface brightness temperatures, *IEEE Trans. Geosci. Remote Sens.*, vol. 35, no. 6, pp. 1400–1418.

Zine, S., Boutin, J., Font, J., Reul, N., Waldteufel, P., Gabarró, C., Tenerelli, J., Petitcolin, F., Vergely, J. L., Talone, M. and Delwart ,S., 2008. Overview of the SMOS sea surface salinity prototype processor, *IEEE T. Geosci. Remote*, vol. 46, pp. 621-645, 2008.

Toward detection of sub-diurnal variation of ocean color from space

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Geostationary Ocean Color Imager (GOCI) on board the COMS satellite is an ocean color sensor with six visible spectral channels and two near infrared channels and the first of its kind operating on a geostationary orbit. It delivers images of a 2500km x2500km area around Korean peninsula eight times a day from 9 to 14 hours since July, 2010. It has demonstrated the capability to monitor fast-varying phenomena including Asian dust event, volcano eruption, sea-ice formation, floating algae event, etc. Its hourly images during daytime would also be suitable to resolve sub-diurnal variation occurring within near-surface layer. To detect weak signals of diurnal variation such as chlorophyll concentration requires high performance of radiometric measurements. Noise levels in GOCI images are compared to those in MODIS or MERIS images. High stability of atmospheric correction is also desired under varying atmosphere-surface conditions and solar direction. Efforts are made to ensure the stability of the remote sensing reflectance data after atmospheric correction. GOCI derived remote-sensing reflectance data are compared field measurements. Finally, sub-diurnal variations in selected locations are investigated using hourly images from GOCI.

Remote estimation of chlorophyll-a concentration in the Pearl River estuary and coastal waters in northern South China Sea

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In this study, we will apply satellite data to estimate chlorophyll-a (chl-a) concentration in the Pearl River estuary (PRE) and coastal waters in northern South China Sea. Three-band model and the maximum band ratio (MBR) method will be used to examine the ability of these algorithms for the estimation of the chl-a concentration in the highly mixed fresh-salt waters in the estuary and coastal waters with the in situ data of 2003, 2004, 2008 and 2009. We will specifically focus on the comparison of the performance of these models to estimate chl-a in the typical estuarine turbid waters and the evaluation for the potential of Chinese HJ-1B (Chinese Environmental Satellite Series 1B), MERIS (Medium Resolution Imaging Spectrometer) and MODIS (Moderate Resolution Imaging Spectrometer) to estimate chl-a in the estuarine turbid waters such as the PRE and coastal waters.

Assessment of the variation of total suspended sediment concentrations in Hangzhou Bay using GOCI, MODIS and HJ-1A/1B CCD images

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Hangzhou Bay, located in the northeast part of Zhejiang Province in China, is a strong tide bay with the shape like trumpet. Affected by the turbid runoff with high sediment concentrations from the Yangtze River for long time and the tide dynamics, the total suspended sediment concentrations (TSSC) in Hanghzou Bay are pretty high and have complex spatio-temporal variations. We have conducted the field investigation in Hanghzou Bay during December 2-13, 2011, and various in-situ data were measured, such as the TSSC, the chlorophyll a concentrations, the CDOM absorption coefficient at 400nm, the remote sensing reflectance, the sediment grain size, the water absorption coefficient, the water back scattering coefficient, the flow velocity, the flow direction, and so on. The in-situ data were measured at one fixed station every other hour from 7:00 a.m. to 5:00 p.m. in one day. There are three fixed stations in total, with the observation time covering the spring tide and the neap tide period. TSS is the main factor affecting the water color in Hangzhou Bay, and it is of great significance to monitor the variance of TSS at different time of tide in one day. The Geostationary Ocean Color Imager (GOCI) is the ?rst multi-channel VIS/NIR ocean color sensor operating in geostationary orbit and can provide hourly spectral images that can be used for continuous monitoring of TSS. We can get three GOCI images presently at three different time in one day. The "environment and disaster monitoring and forecasting small satellite constellations" (HJ-1A/1B satellites), launched by China on September 6, 2008, bring a new TSS monitoring opportunity. Both the HJ-1A and HJ-1B satellites are equipped with two charge-coupled device (CCD) cameras that are the same in nadir symmetry, design parameters, and characteristics. The constellation of the two satellites generates multi-spectrum CCD images with both high spatial resolution (30 m) and short revisit time (2 days). The Moderate Resolution Imaging Spectroradiometer (MODIS) image is also a good data for TSSC assessment. During our investigation, we can get three GOCI image, one HJ-1A/B CCD image, two MODIS images at different time of tide in one day. The six images can be used to monitor the variance of TSS at six different time of tide after applying the appropriate atmospheric correction methods and retrieval algorithms to correct the biases among different sensors. The in-situ data can provide enough validation for the method. This study is very important to explore the potential of using new sensors and merging different sensors data to assessment of the variation of TSSC in Hangzhou Bay using GOCI, MODIS and HJ-1A/1B CCD images. Keyword: total suspended sediment; GOCI; MODIS; HJ-1A/1B CCD; Hangzhou Bay