

**ID: 139**

**Oral Presentation**

*Topics:* Sentinels Data Exploitation to monitor the status of the coastal zone environment, Remote Sensing of marginal Seas and coastal zone

*Keywords:* Copernicus, European Space Agency

**ESA and Copernicus Satellite Missions for Coastal Science: Today and Tomorrow**

**Craig James Donlon**

European Space Agency, Netherlands, The

The coastal zone is a complex region presenting significant challenges to society that are inherently interdisciplinary across the aquatic and terrestrial disciplines including wetlands, shoreline processes, the water surface, the water column, bathymetry and benthic cover types and societal use of the coastal zone. Regular observations of physical and biogeochemical components in inland and coastal waters are required for effective integrated coastal management in support EU directives including the Marine Strategy Framework Directive (MSFD), the Water Framework Directive (WFD), Bathing Water Directive (BWD), Natura 2000, the Maritime Spatial Planning Directive (MSPD) and Integrated Coastal Management (ICM), the Habitats Directive on habitat mapping and monitoring and the Ramsar Convention on Wetland. However, satellite measurements in the coastal environment remain a because: extreme marine bio-optical complexity exists from clear to dark waters, from turbid sediment to highly eutrophic waters; extreme atmospheric and surface (land-to-coast) gradients exist presenting challenges for atmospheric corrections, and adjacency effects; extreme coastal dynamics exist (especially in tidal regions) that are exacerbated by bathymetry (shallowing waters), complex coastline, varied winds leading to complex ageostrophic sub-mesoscale marine structures; extreme societal pressures exist with migration to the coastline and development of coastal megacities that place extreme pressure on the coastal environment (transportation, aquaculture, shipping, fisheries, pollution, marine debris/plastics, tourism...); extreme societal risk exists including sea level rise, storm surge, coastal flooding, harmful algal blooms, pollution events, water quality amongst others. This presentation reviews by example how the European Space Agency and the European Union Copernicus programme are addressing these issues using a fleet of innovative satellite missions that are sustained until ~2030.

**ID: 116**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone, Role of Coastal Zone Management in adapting to climate change

*Keywords:* atlas, marginal seas, ICM

**The European Atlas of the Seas: Combining Conventional and Satellite Data for ICM Applications**

**Vittorio Barale**

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The European Atlas of the Seas – originally foreseen by the Integrated Maritime Policy (IMP) of the European Union (EU) as a simple web-based, public-oriented information system for education and communication – today aims to mediate between the research domain and a varied group of practitioners, in need of using specialized information. The overall idea is to combine together conventional and satellite data, as well as environmental and socio-economic data, converting complex scientific information about coasts, seas and oceans into graphical form, so that non-specialists may access (and fuse) available products, without having to transfer or process large amounts of data. The Atlas latest release (Version 4) can be particularly useful in applications dealing with Integrated Coastal Management (ICM). The information content of the Atlas comprises a series of geographical layers, subdivided in background fields, pre-arranged thematic maps and a series of data layers from which do-it-yourself maps can be constructed. All maps follow consistent cartographic rules and can be extracted for external use. The Atlas database is updated regularly, but historical data remain accessible after the updates, so that time series may be constructed. Tools for map exploration and combination can be used to combine together more layers, providing professional users with analysis and interpretation capabilities, to couple data into graphical indicators. The web application for accessing Atlas contents offers links to other Marine Information Systems, and is available to a broad audience from computers, tablets and mobile devices.

**ID: 101**

**Oral Presentation**

*Topics:* Sentinels Data Exploitation to monitor the status of the coastal zone environment, Remote Sensing of marginal Seas and coastal zone

*Keywords:* Posidonia oceanica, Sentinel-2, Mediterranean Sea, Object-based image analysis (OBIA), Machine learning

**"Object-based identification and mapping of Posidonia oceanica seagrass using Sentinel-2 imagery"**

**Dimosthenis Traganos, Peter Reinartz**

DLR (German Aerospace Center), Germany

Posidonia oceanica meadows play key roles in the Mediterranean coastal zone environment, including carbon sink, protection from coastal erosion, and fishery contribution. Despite its importance, P. oceanica is declining in coverage. In this paper, we present an object-based identification and mapping of P. oceanica spatial structure based on the high-resolution Sentinel-2 imagery over the Thermaikos Gulf, northwestern Aegean Sea, Greece. Two machine learning approaches, namely Support Vector Machines and Random Forests, are applied on single-scale segmented Sentinel-2 imagery following atmospheric and water column correction to map presence and absence of P. oceanica in the Thermaikos Gulf. Moreover, object-based methods are compared to pixel-based methods. Additionally, we examine the inclusion of our newly proposed seagrass index (Normalised Difference Seagrass Index; NDSgl) in the pre-classification stage of both object- and pixel-based approaches. Our results indicate that object-based methods are more accurate than per-pixel methods, while the segmented water column corrected imagery classified by Random Forests display the marginally best user and Kappa accuracy in identifying P. oceanica. NDSgl shows its quantitative superiority when paired with Support Vector Machines and/or object-based approaches. Our paper adds practical knowledge to the scarce applications of object-based image analysis for the remote sensing of seagrasses and broadly the coastal environment. In the near future, exploitation of the wealth of

information derived from Sentinel-2 combined with machine learning algorithms will allow the cost- and time-efficient mapping and monitoring of *P. oceanica*. This will enable the effective restoration, management and conservation of these highly valuable Mediterranean coastal ecosystems.

**ID: 103**

**Oral Presentation**

*Topics:* Sentinels Data Exploitation to monitor the status of the coastal zone environment

*Keywords:* Sentinel-1, Aquaculture, Agriculture, Time Series

**Mapping of Aquaculture and Agriculture in Coastal Zones based on Satellite Data Time Series**

**Patrick Leinenkugel<sup>1</sup>, Marco Ottinger<sup>2</sup>, Kersten Clauss<sup>2</sup>, Claudia Kuenzer<sup>1</sup>**

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The global expansion of agriculture and aquaculture as a result of socioeconomic development exerts immense pressure on the natural ecosystems in the world's coastal zones. In Asia, rice is the most important food crop and can be found frequently in river deltas and coastal zones, particularly cultivated according to highly intensified cropping schemes with up to 3 harvests per year. Aquaculture is one of the fastest-growing animal food production sectors worldwide and the main protein source in many countries. While intensified rice cultivation and aquaculture offer great potential for global food security, the rapid expansion and unsustainable practices also have negative impacts on coastal ecosystem quality.

We present examples of how time series approaches based on multispectral MODIS data and Sentinel-1A/B radar data facilitate the mapping of the complex spatial and temporal patterns of rice paddy and aquaculture in coastal zones. For the mapping of terrestrial aquaculture, high spatial resolution Sentinel-1 Interferometric Wide Swath images were collected and processed to obtain temporally filtered images. The specific backscatter response of water surfaces and the distinct rectangular structure of pond components, extracted by image segmentation, allow for a reliable separation of terrestrial aquaculture areas from other water bodies (e.g. natural water bodies, rice paddy).

To analyse rice harvest patterns and long term agricultural intensification we exploited the high temporal resolution of 15 years of MODIS data. In addition, based on Sentinel-1 SAR images, we created rice paddy maps as well as seasonality maps at 10m resolution by image segmentation and multi-temporal classification of backscatter time-series at object level.

Results of our aquaculture and rice paddy classification are presented for selected study sites in Asia.

**ID: 138**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* Sea of Azov, evolution of passive admixture, remote observations, numerical modeling, assimilation of satellite data, comparative analysis of satellite and model parameters data

**The Evolution of Pollution in the Azov Sea According to Satellite Observations and Numerical Simulation**

**Tatiana Yakovlevna Shulga**

FSBSI Marine Hydrophysical Institute of RAS, Russian Federation

The paper discusses methods for sharing information obtained by remote sensing of the sea surface from space and model solutions. The results of numerical modeling and satellite observations data on the state of water in the Sea of Azov for 2013-2014 are summarized based on the new model algorithms. Three-dimensional hydrodynamic model POM (Princeton Ocean Model) was used in numerical studies to analyze the evolution of pollution on the basis of the solution of the transport and diffusion equation. Level-2 data from MODIS at satellite Aqua for 2013 - 2014 with a spatial resolution of one kilometer were used in the work. The following parameters were calculated according to satellite data: the ratio of normalized brightness of the light coming from under the water surface in two spectral channels 531 and 488 nm, and the backscattering coefficient of light by the particles of the suspension at a wavelength of 555 nm. These data determine the presence of suspended matter (e.g., mineral suspended matter from river discharges or rising from the bottom as a result of a strong wind), and suspended matter of biological origin (e.g., coccolithophorides bloom). Simulation of pollutant propagation scenarios was made using meteorological data of the SKIRON atmospheric modeling system. A series of numerical experiments was carried out for initial concentrations of the pollutant corresponding to the data of satellite observations. In order to analyze the consistency of satellite observation data and modeling results, comparison of concentration of the contaminant at the sea surface is made.

**ID: 133**

**Oral Presentation**

*Topics:* Sentinels Data Exploitation to monitor the status of the coastal zone environment, Remote Sensing of marginal Seas and coastal zone, New technologies and in situ measurements

*Keywords:* remote sensing, baltic sea, in situ, monitoring, cyanobacteria

**Current Challenges and Opportunities For Remote Sensing In The Baltic Sea**

**Stefan Simis<sup>1</sup>, Gavin Tilstone<sup>1</sup>, Silvia Pardo<sup>1</sup>, Nick Selmes<sup>1</sup>, Kari Kallio<sup>2</sup>, Jenni Attila<sup>2</sup>**

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Current Challenges and Opportunities For Remote Sensing In The Baltic Sea

The Baltic Sea has always been a special case in ocean colour remote sensing, due to its unique combination of clear but highly absorbing waters, complex coastline, strong gradients in dissolved organic matter absorption, marginally connected individual basins and seasonal phytoplankton blooms which include summer blooms of cyanobacteria. Given the environmental pressures acting on the system it is no surprise that the Baltic Sea is also intensively sampled and its optical properties are well understood in accessible areas. In some respects the Baltic Sea has become a testing ground for new environmental monitoring methods.

With marine monitoring services mushrooming in the fertile Copernicus landscape it is time to take the pulse of remote sensing in the Baltic Sea. How well do current solutions really represent the optical diversity of the Baltic Sea? Are we ready for Sentinel-3 and Sentinel-2? In this talk, successes and shortcomings in the state-of-the-art of remote sensing will be highlighted in the hope that our community of Baltic Sea remote sensing and in situ optics experts can decide on the best marriage of remote and in situ observation activities to progress beyond the state-of-the-art.

**ID: 117**

#### Oral Presentation

*Topics:* Land-Sea Interaction

*Keywords:* Remote Sensing, Suspended sediment, Particle size distribution

### **Remote sensing analysis of the Tiber River sediment plume (Tyrrhenian Sea): spectral signature of erratic vs. persistent events**

**Federico Falcini<sup>1</sup>, Jaime Pitarch<sup>1</sup>, Annalisa Di Cicco<sup>1</sup>, Salvatore Marullo<sup>2</sup>, Vittorio Brando<sup>1</sup>, William Nardin<sup>3</sup>**

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Several coastal regions have been increasingly affected by intense, often catastrophic, flash floods that deliver significant amounts of sediment along shorelines. A crucial question regards the impact of these impulsive runoffs in terms of coastal sedimentation and sediment characteristics. Here we perform a satellite-based analysis that quantify particle size distribution (PSD) of riverine suspended sediment, relating different discharge stages (i.e., erratic vs. persistent) to the grain-size distribution of the wash load. We estimate PSD by retrieving particle backscattering coefficient spectrum with a physics-based approach that does not require field calibration. A monthly analysis of twelve-year datasets reveals that erratic stages are prone to deliver coarser sediment with respect to the persistent stages. This result agrees with previous studies related to suspended sediment rating curves and shows that coastal plumes generated by flashy events would give an effective contribution to coastal geomorphology by supplying the coarse material.

**ID: 106**

#### Oral Presentation

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* phytoplankton, NAP, OC-CCI

### **On The Spatial-temporal Distribution Of Non-algal Particles From Space**

**Marco Bellacicco<sup>2</sup>, Rosalia Santoleri<sup>1</sup>, Gianluca Volpe<sup>1</sup>, Jaime Pitarch<sup>1</sup>, Vittorio Brando<sup>1</sup>, Angela Landolfi<sup>3</sup>, Simone Colella<sup>1</sup>, Nathan Briggs<sup>2</sup>**

<sup>1</sup>Institute of Atmospheric Sciences and Climate (CNR-ISAC), Italy; <sup>2</sup>Laboratoire d'Océanographie de Villefranche-sur-Mer; <sup>3</sup>GEOMAR Helmholtz Centre for Ocean Research Kiel

In the last decade phytoplankton has been commonly studied from space. However non-algal particles (NAP) analysis, including heterotrophic bacteria and virus, are relatively recent. A thorough assessment of the distribution and dynamics of NAP could help to improve the understanding of marine ecosystems. In this work, global monthly climatologies of the NAP fraction that varies independent from chlorophyll are derived from the satellite particulate backscattering coefficient (bbp) and chlorophyll (Chl). NAP is computed at pixel scale using the 18 years of ESA OC-CCI v3 monthly satellite data. We find a clear seasonal pattern of NAP from northern to southern oceans, following the patterns of Chl which is associated with seasonal biological production. High NAP values are always found in productive regions like polar seas, the North Atlantic blooms area and the equatorial Pacific, as well as shelf regions (i.e. Patagonian shelf) affected by upwelling regimes. In contrast, the poor Chl and bbp relationship prevents accurate NAP estimations in oligotrophic areas like the sub-tropical gyres. Accurate NAP calculations for different regions and seasons will improve our understanding of phytoplankton dynamics and its impact on global ocean carbon budget.

**ID: 109**

#### Oral Presentation

*Topics:* Remote Sensing of marginal Seas and coastal zone, Remote Sensing of inland waters, New technologies and in situ measurements

*Keywords:* lidar, UFL, TSS, TSM, remote

### **Application Of Remote Laser Sensing For High-Performance Measurements Of Total Suspended Solids Concentration In The Upper Layer**

**Vadim Pelevin<sup>1,2</sup>, Varvara Osokina<sup>1,2</sup>, Vyacheslav Kremenetskiy<sup>1,2</sup>**

<sup>1</sup>Shirshov Institute of Oceanology RAS, Russian Federation; <sup>2</sup>Aquamarine Ltd, Russia

Spatial distribution of total suspended solids (TSS) in the near-surface layer of seas and lakes as one of the main water quality parameter is an important factor affecting its hydro-optical and hydrophysical properties. Its investigation is an important task, but the collection of TSS concentration data with high spatial resolution is difficult in view of the lack in the arsenal of standard oceanological instruments of the appropriate methodological and hardware tools.

The report presents the results of the practical application of lidar in various waters to determine the content of TSS from the signal of the elastic backscattering of the UV laser pulse. The measurements were carried out by the lidars UFL-series from a moving vessel with pulse repetition rate up to 2 Hz. Water samples from the surface layer were collected to obtain reference data of TSS concentration in weight units.

The measurements were carried out in dozens of expeditions in various water bodies - from fresh to hypersaline waters, as well of various trophic levels. Calibration of lidar measurements was carried out in each particular basin under the current seasonal conditions, since the proportionality coefficient between the elastic scattering of laser radiation and the mass content of the TSS depends, at least, on the granulometric composition of the mineral suspended matter. Calibrated lidar makes it possible to obtain the TSS spatial distribution pattern in the near-surface layer with a high spatial resolution (from the first meters), on a large basin in a short time.

**ID: 124**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* regional divergence, coastalization, coastal region, inland region, night-time lights, VIIRS, remote sensing

### **Mapping regional divergence: night-time light satellite imagery in defining coastalisation of Europe**

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<sup>1</sup>Immanuel Kant Baltic Federal University, Russian Federation; <sup>2</sup>Southern Federal University, Russian Federation

Marine coasts have always been natural growth poles for the mankind attracting population, entrepreneurship, industrial agglomeration, financial flows to the adjacent coastal zones. Contemporary research on integrated coastal management suggests that coastalization effect remains to be the catalyst factor of regional development and will strengthen within the next quarter of a century. The increasing socio-spatial polarization and dispersion among countries against the regional convergence policies puts the 'marine factor' on the research agenda of human geographers. The aim of this article is to test the applicability of remote sensing technologies in capturing the coastalization processes across Europe by undertaking a comparison of results obtained via statistical multivariate analysis and the night-time light satellite imagery. The study is based on analysis of population density and GRP in PPP figures for 413 NUTS 2 level regions of Europe. The totality of regions is grouped into clusters depending on their performance figures. The allocated clusters reflect a clear differentiation between coastal and inland types of territories, while juxtaposition of statistical data with night-time light satellite imagery enables to clarify the coastalization effect.

**ID: 114**

**Poster**

*Topics:* Optical properties of CDOM and aquatic microorganisms

*Keywords:* bacteriochlorophyll, fluorescence, green sulfur bacteria, stratified lakes, the White Sea

### **Depth Distribution of Bacteriochlorophylls from the Lakes at Different Stages of Isolation from the White Sea**

**Anastasiia Kharcheva<sup>1</sup>, Anna Zhiltsova<sup>1</sup>, Elena Krasnova<sup>2</sup>, Dmitriy Voronov<sup>3,4</sup>, Svetlana Patsaeva<sup>1</sup>**

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The lagoons and lakes found in at different stages of isolation from the White Sea are a special group of hydrological objects. Their evolution is associated with the uplift of the Kandalaksha Bay coast. Stratified structure in such water bodies is formed under the influence of conditions affecting not only physicochemical characteristics of the water but biological ones as well. Green sulfur bacteria are anoxygenic phototrophic microorganisms that live in the chemocline zone (the water layer with transition from aerobic conditions to anaerobic) and in the anaerobic zone in the stratified lakes separating from the White Sea. Fluorescence spectra of green sulfur bacteria show two longwave bands: (1) emission with maximum at 740-770 nm that corresponds to BChl d and e fluorescence and (2) emission with maximum at 815 nm that corresponds to BChl a fluorescence. The maximum of the first emission band can be shifted depending on the type of bacteria and their pigment composition. In this work we report on spectroscopic studies performed in 2015-2016 on water samples from different depths taken from the water bodies at different stages of isolation from the White Sea. Fluorescence measurements were performed using luminescence spectrometer Solar CM2203. Absorption spectra were registered by spectrophotometers Unico and Solar PB2201. Aceton-methanol (7:2) extracts of water samples were prepared to calculate the concentration of BChls. Depth distributions of BChl fluorescence, BChl concentrations were plotted and compared with physical and hydrochemical characteristics of waters. The work was supported by the Russian Foundation for Basic Research, project no. 16-05-00548a.

**ID: 118**

**Poster**

*Topics:* Optical properties of CDOM and aquatic microorganisms

*Keywords:* Bacteriochlorophyll, fluorescence, anoxygenic phototrophic bacteria, stratified lakes, the White Sea

### **Spectroscopic Diagnostics of Anoxygenic Phototrophic Bacteria with Different Pigmentation from Stratified Water Bodies of Kandalaksha Bay, the White Sea**

**Anna Zhiltsova<sup>1</sup>, Anastasiia Kharcheva<sup>1</sup>, Elena Krasnova<sup>2</sup>, Dmitriy Voronov<sup>3,4</sup>, Svetlana Patsaeva<sup>1</sup>**

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Sciences (Kharkevich Institute), Moscow, Russia; <sup>4</sup>Lomonosov Moscow State University, A.N. Belozersky Institute of Physico-Chemical Biology, Moscow, Russia

The stratified lakes are a special group of hydrological objects. In aquatic systems with abnormal circulation of water the anoxygenic phototrophic microorganisms, green sulfur bacteria (GSB), may be of a particular interest. GSB are divided into two types according to their pigmentation: green-coloured and brown-coloured bacteria. The optical properties of the pigments make possible the study of the properties of microorganisms using spectral methods. In this work we performed spectroscopic measurements for natural water samples taken in March 2017 from several relic lakes with stratified water layers: Trekhtzvetnoe, N. Ershovskoye, Lagoon on the Cape Zeleny and Bolshie Khruslomeny. We developed spectral method to found out the ratio of different strains of bacteria in natural water sample without its extraction by organic solvents. This algorithm includes fitting of the bacteriochlorophyll fluorescence spectrum excited at 440 nm by Gaussian curves. We found parameters of approximating curves for different types of bacteria: the fluorescence peak in the 740-820 nm region for brown-colored bacteria is fitted by Gaussian curve with maximum at 760 nm and bandwidth 57 nm; for brown-colored bacteria the Gaussian is centered at 745 nm and has a width of 46,5 nm. Depth distributions of GSB differing in pigmentation were plotted for studied lakes with stratified water structure. These results are important for further in situ detection of two types of bacteria. The work was supported by the Russian Foundation for Basic Research, project no. 16-05-00548a.

#### **D: 127**

##### **Poster**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* Baltic Sea, coastal zone, upwelling, SST

#### **Observation of upwelling in the southeastern Baltic via satellite and contact data**

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The coastal upwelling, which is common phenomenon in the Baltic Sea, leads to decrease in sea surface temperature (SST) and influences on the balance of biogenic elements and phytoplankton distribution within the euphotic zone (Lehmann et al., 2002; Lehmann & Myrberg 2008; Myrberg et al. Al., 2010; Lehmann et al., 2012). On the basis of satellite and contact measurements which was recorded during the period from June 5 to June 13, 2016 characteristics and dynamics of upwelling are considered. Scales of temporal and spatial variability of sea surface water temperature in a coastal zone of southeast Baltic near the coast of the Kaliningrad region are described. This upwelling was caused by the strong north wind (up to 12 m / s). This upwelling led to the significant sea surface temperature drop-more than 10 ° C within one day. Width of a zone of upwelling manifestation in the field of distribution of the surface temperature made about 25 km. The satellite data were compared with the data of the thermistor chain and shipborne CTD data. Use of in situ and satellite data has allowed estimating the vertical distribution of temperature and its gradients.

#### **ID: 130**

##### **Poster**

*Topics:* New technologies and in situ measurements

*Keywords:* CDOM, fDOM, gelbstoff, Kondor

#### **Methods and tools of CDOM-fDOM in-situ monitoring**

**Anna Alex. Chepyzhenko, Alexey Illich Chepyzhenko**

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The operational (spectrophotometric and fluorescent) methods of DOM in-situ determining are based on CDOM (gelbstoff, fDOM, is 70-80% of total DOM) optical properties investigations and may improve the algorithms of biophysical characteristics' determining by remote sensing methods.

The new spectrophotometric CDOM-measurement channel is based on spectral attenuation coefficient ratio at two spectral regions (maximum and minimum of absorption) for selected range - 405/570 nm measuring.

The fluorescent channel of optically active substances measuring is unified, differing only in spectral excitation/emission (Ex/Em) regions - i.e. radiator type, optical illuminators and light filters marks, that form the basis for fluorimeters' for basic bio-optical substances creating with Ex/Em: chlorophyll-a (450/680), fDOM (370/450), TrDOM (255/370).

Relations between the DOM units presentations (Slope, QSU and mg/l) were received by verifications with a sample solution of quinine sulfate (QSU) and direct high-temperature catalytic carbon combustion (CDOC) (ppb QSU) method (based on data bank of experimental studies in various water areas and seasons by Russian and USA scientists: US Geological Survey, California Water Science Center, School of Marine Sciences, University of Maine, USA, POI RAS), are stable and may be described by equations:  $fDOM(QSU) = -25212 \cdot S(nm^{-1}) + 47$ ;  $CDOC(mg/l) = -1752 \cdot S(nm^{-1}) + 33.56$ , ( $R2 \approx 0,87$ ),  $CDOC(mg/l) = 0.0695 \cdot fDOM(ppb QSU) + 0.8234$ ;  $CDOC(mg/l) = 0,2980720533 + 0,08527896183 \cdot fDOM + 0,0001100136396 \cdot fDOM^2$  ( $R2 = 0.84$  for the range of 1.5-9 mg/l (typical for marine and coastal waters) and  $R2 = 0.926$  for extended range - up to 30 mg/l).

The CDOM-fDOM measuring channels were used during research expeditions into the Black Sea coastal zone and the pouring regions (the Kerch Strait) inside the multiparametric biophysical complex "Kondor".

#### **ID: 132**

##### **Poster**

*Topics:* New technologies and in situ measurements, Impact of varying physical forcing on morphodynamics and ecosystems

*Keywords:* laserscanning, Baltic sea, geomorphology, morphodynamics, storm impact

## Using Terrestrial Laserscanning For Assessing Storm Forced Morphological Changes Of The Curonian Spit Beach And Foredune System

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The sandy shores of the Curonian Spit (the Russian sector of the South-East Baltic) are regularly exposed to storm activity. The foredune serves as a barrier to protecting ecosystems and settlements from hazardous hydrometeorological phenomena. Separate series of storms as a result of their influence earlier led to intensive erosion of dune sites until its breakthrough and flooding of spit territories. With the use of terrestrial laser scanning technology, morphological changes were monitored in the beach and foredune system to quantify changes under the influence of storm events. For the assessment, pre-storm measurements of the state of the system as well as measurements after a series of storm events in 2014 - 2016 were carried out. This allowed obtaining simultaneous high-accuracy digital terrain models of the shore relief for morphodynamics analysis. The most severe changes associated with the erosion of the windward slope of the dune occur when the combined effect of several events occurs. Long-term exposure to strong winds of open directions, wind surges and waves, leads to beach erosion, loss of morphological forms and deficit of sandy sediments. As a result, the dissipation of wave energy decreases, which can lead to foredune erosion in the following storm events. This shows that the sequence and time of individual storm events impact plays an important role for the variability of the entire system. The use of high-precision remote sensing techniques allows accurate estimates of the dynamics of sand material in coastal systems. Such assessments provide information on the morphological response to repeated storm events, including with variable impact parameters for making effective decisions in the field of coastal defence.

**ID: 108**

Poster

*Topics:* Optical properties of CDOM and aquatic microorganisms

*Keywords:* Microscopic fungi, mycelium and spores, fluorescence, humic substances

### Fluorescence Detection of Mycelium and Spores of Microscopic Fungi with Different Pigmentation

**Elena Fedoseeva**<sup>1</sup>, **Daria Khundzhua**<sup>2</sup>, **Vera Terekhova**<sup>3,4</sup>, **Svetlana Patsaeva**<sup>2</sup>

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Detection and identification of microorganisms in aquatic environments is a challenging task for remote sensing. Fluorescence measurements of fungal particles (for example, mycelium and spores) could be very important for assessment of the presence of fungi in water sources, their biomass estimation and to study biodeterioration. Fungi can be detected in the laboratory and using remote sensing techniques (Raimondi et al., 2007). The aim of our study was to assess the opportunities of fluorescence spectroscopy as technique for microscopic fungi detection, classification of parts of fungal biomass (mycelium and spores), and discrimination between several fungal strains. The strains with different pigmentation *Trichoderma harzianum*, *Alternaria alternata* and *Cladosporium cladosporioides* (kindly provided by Marfenina O.E. and Ivanova A.E., Soil Science Faculty of Moscow State University) were examined at various stages of their growth as suspensions in aquatic medium, as well as in presence of dissolved humic substances. Fluorescence emission spectra were measured using a luminescence spectrometer Solar CM2203 at several wavelengths of the exciting radiation (270, 310, 325 and 355 nm) for liquid samples placed in quartz cuvettes. The correlation between spores numbers and fluorescence intensities has been revealed. The fluorescence reflection spectra of mycelium and spores on agar nutrient media were detected using photometer Solar PB2201. Results demonstrate the feasibility of fluorescence measurements to detect fungal biomass in situ and in vivo and to discriminate between the examined strains in aquatic medium in presence of humic substances as background fluorophores. The research was supported by Russian Foundation of Basic Research (grant 16-34-00690 mol\_a).

**ID: 119**

Poster

*Topics:* New technologies and in situ measurements

*Keywords:* mineral water, Raman spectroscopy, artificial neural networks

### Determination Of Ionic Composition Of Natural And Artificial Mineral Waters By Raman Spectroscopy And Neural Networks: Various Approaches And Their Results

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Diagnostics of individual components in multi-component aqueous mixtures is of great demand in various fields of industry and ecology. In particular, an important application is control of composition of mineral waters, containing ions of inorganic salts, gas molecules and colloidal particles.

One of the methods to solve this problem is use of Raman spectroscopy. Taking Raman spectra is express, it can be performed in remote mode, and it does not require special chemical substances and preparation of samples. Possibility of using Raman spectra for determination of ionic composition of water solution arises from the dependence of shape and intensities of different parts of the solution spectrum on the concentration of each specific ion, and this dependence is different for different ions.

However, non-linear interaction between various components requires special mathematical methods such as artificial neural networks (ANN) for spectra processing. ANN can be trained by example without using physically based models; so a representative spectra array is required to train an ANN.

As desired values for ANN, concentrations of the components obtained by alternative methods are used: those obtained with ionometer, or minimum or maximum values specified at the label on the bottle. On the other hand, ANN may be trained either on

spectra of real mineral waters, or on spectra of artificial solutions prepared in the ion concentration ranges corresponding to those in mineral waters.

In this study, we test various combinations of these approaches searching for a method to obtain minimal determination error for ion concentrations.

This study has been performed at the expense of Russian Science Foundation, grant no. 14-11-00579.

**ID: 129**

**Poster**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* stratification, chemocline, phytoplankton pigments, spectra, photochemistry

### **Phytoplankton in Thin Colored Layers of Five Stratified Lakes on the White Sea Coast: Its Environment and Chlorophyll Fluorescence**

**Elena D. Krasnova<sup>1</sup>, Tatiana A. Belevich<sup>1</sup>, Ludmila E. Efimova<sup>2</sup>, Anastasiia V. Kharcheva<sup>3</sup>, Natalia M. Kokryatskaya<sup>4</sup>, Galina N. Losyuk<sup>4</sup>, Dmitry N. Matorin<sup>1</sup>, Daria A. Todorenko<sup>1</sup>, Dmitry A. Voronov<sup>5,6</sup>, Svetlana Patsaeva<sup>3</sup>**

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In the coastal saline lakes on the White Sea shore different water layers overlay: surface aerobic and anoxic strata with a transition zone (chemocline) between them. In the deeper part of the salt aerobic stratum and in the chemocline, phototrophic microorganisms often form colored layers of 10-15 cm thickness. We investigated thin colored layers in five stratified lakes at the different stages of their isolation from the Sea using absorption and fluorescence spectroscopy, photobiology (measurements of primary photochemistry and photosystem II activity), and optical microscopy. The upper thin colored layer located in the aerobic strata (around 1,5 m depth) is greenish in all the lakes due to presence of unicellular algae containing chlorophyll a. Few decimeters below is located the oxic-anoxic interface colored in bright green, red or pink with dominating mixotrophic flagellates (*Rhodomonas* sp., *Cryptomonas* sp., *Euglena* sp.). A bit deeper, in the reduced zone of the chemocline dense green or brown cultures of anoxygenic phototrophs (green sulfur bacteria) appear, decreasing in concentration down to the lake bottom. The chemocline environment is characterized by lessened sunlight, high concentration of nutrients, and the presence of H<sub>2</sub>S. The photosynthetic apparatus of algae associated with the chemocline is characterized by high values of maximum quantum yield of primary photochemistry, activity of electron transport, photosynthetic performance of photosystem II, fraction of the active centers and low values of heat dissipation. The functional status of photosynthetic apparatus of cryptophytae algae, chemocline habitants, was found more efficient than that of green algae living in the aerobic layer. The work was supported by the Russian Foundation for Basic Research, project no. 16-05-00548a.

**ID: 131**

**Poster**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* Southeastern Baltic Sea, satellite data, oil pollution, sea surface

### **Peculiarities of Spatial Distribution of Oil Pollution at the Sea Surface In The Southeastern Baltic Sea by Satellite Data**

**Elena Bulycheva, Andrey Kostianoy**

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From June 2004 to present, satellite monitoring of oil pollution of the Southeastern Baltic Sea surface is carried out. From June 2004 to December 2015, in total 1946 images from satellites equipped with SAR (ASAR) tools have been received and analyzed. Research area includes EEZs of Russian Federation, Lithuanian Republic, and part of Polish EEZ limited by 18E from the West. As a result of the images analysis, 638 oil spills with a total area of 1862 km<sup>2</sup> were detected in the research area. It was noticed, that the most polluted area of the Southeastern Baltic Sea is Russian sector, where 55% from the total amount of detected oil spills and its' fragments were detected. 33% of total oil spills and fragments were detected in Polish EEZ, and 12% in Lithuanian sector. The most polluted area of the Russian sector is territorial waters, where 59.4% of oil spills and its' fragments detected in Russian EEZ were located. In territorial waters of Poland 23% from total amount of spills detected in Polish EEZ were located. The cleanest territorial waters are in Lithuania – only 12% of oil spills detected in the Lithuanian EEZ were found within 12 nm zone. It was estimated that, in average, for every 100 km<sup>2</sup> of the Russian, Polish and Lithuanian EEZ four (10 km<sup>2</sup>), two (6 km<sup>2</sup>) and one oil spill (3 km<sup>2</sup>) were detected during 12 years, respectively.

The research was supported by the Russian Science Foundation Project N 14-50-00095.

**ID: 120**

**Poster**

*Topics:* New technologies and in situ measurements

*Keywords:* multi-component solutions, Raman spectroscopy, wavelet neural networks

### **Use of Adaptive Methods to Solve the Inverse Problem of Determination of Ionic Composition of Multi-component Solutions**

**Alexander Efitov<sup>1</sup>, Sergey Dolenko<sup>1</sup>, Tatiana Dolenko<sup>1,2</sup>, Kirill Laptinskiy<sup>1,2</sup>, Sergey Burikov<sup>1,2</sup>**

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Determination of ionic composition of multi-component water solutions is a topical problem in ecology and industry. One of the methods for performing such diagnostics is using Raman spectroscopy, which is express and non-contact. However, due to a very complex non-linear dependence of the shape and intensity of the Raman spectrum on ionic composition of the solution, one needs special mathematical methods to solve this complex inverse problem.

This problem can be successfully solved using adaptive methods of data processing, including artificial neural networks (ANN), multiple regression analysis and partial least squares methods. The best results were obtained by perceptron type ANN. However, due to the high number of input features (spectral channels), formation of adequate training set requires a large number of spectra. It is difficult and very time-consuming problem.

The requirements can be reduced by extracting a moderate amount of informative features by transformation of the initial data. Methods based on standard deviation or correlation are not very efficient due to their linear nature. Use of wavelet transformation with subsequent filtering is more promising.

Another approach used in this study consists of application of wavelet ANN instead of perceptron ANN. Using combinations of various wavelets as a basis for decomposition of the approximated dependence allows one to reduce the number of used basis functions as well as approximation error.

The results of using wavelet filtration and wavelet ANN are reported in comparison with previous results obtained by perceptron type ANN.

This study has been supported by RFBR grant no. 17-07-01479.

**ID: 102**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* Upwelling, Biogenic Slicks, Chlorophyll-a distribution, Synthetic aperture radar, Southeastern Baltic Sea

### **On Radar Signatures Of Upwelling Regions**

**Werner Alpers**

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The conventional way to study upwelling regions by remote sensing is to use infrared and optical sensors by which the sea surface temperature (SST) and the chlorophyll-a (Chl-a) concentration is measured. However, also synthetic aperture radars (SARs) are useful instruments to study upwelling regions. Upwelling regions are areas of high biological activity, where the marine beings (plankton and fish) secrete surface active substances which rise to the sea surface and damp there the short surface waves, which are responsible for the radar backscattering. Thus upwelling areas manifest themselves on SAR images often as areas of reduced normalized radar cross section (NRCS). However, not only biogenic slicks associated with upwelling regions cause a reduction of the NRCS, but also the change the stability of the air-sea interface (from neutrally-stable to stable) because in upwelling regions the SST is usually lower than over the adjacent areas. On the other hand, algae blooms consisting of the macro-algae consisting of blades that can stick out of the water surface can increase the sea surface roughness and thus increase the NRCS. Biogenic slicks visible on SAR images as areas of reduced NRCS are often confounded with mineral oil films. Criteria for discriminating between both types of surface films are presented. Furthermore, the correlation between Chl-a distribution and biogenic slick coverage in upwelling areas, like in the southeastern Baltic Sea, the South China Sea east of Hainan, and the East China Sea north of Taiwan, is discussed.

**ID: 105**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* SST, Climate, Operational Oceanography

### **Long-Term Changes In The Northeastern Atlantic And Mediterranean Sst From 1982 To 2016: A Contribution Of The Operational Oceanography To The Determination Of The Present Day Climate**

**Salvatore Marullo<sup>1</sup>, Andrea Pisano<sup>2</sup>, Vincenzo Artale<sup>1</sup>, Bruno Buongiorno Nardelli<sup>2</sup>, Rosalia Santoleri<sup>2</sup>**

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Estimating long-term SST changes is crucial to evaluate global warming impact at regional scales. Here, we analyze the Mediterranean (MED) and the Northwestern Atlantic Box (NWA) SST changes over the last 35 years (1982 - 2016) by combining reprocessed (REP) and near-real-time (NRT) data. The Italian National Research Council (CNR) has recently produced daily (nighttime), 4 km resolution REP MED level 4 datasets (REP L4), also covering the adjacent Atlantic region, based on the latest Pathfinder v5.2 AVHRR dataset (1982-2012). These data represent the longest satellite MED SST L4 time series and are freely distributed through the European Copernicus Marine Environment Monitoring Service (CMEMS). However, as Pathfinder has not yet released an update of its product, the REP data end in 2012. To fill in the gap between 2013 and 2016, we investigated the possibility to extend the time series by using the Mediterranean near real time (NRT), multi-sensor L4 SST data at Ultra-High spatial Resolution (UHR) produced by CNR, which are distributed through CMEMS and now mirrored at GHRSSST. Since this product is available since 2008, the consistency with the REP has been assessed. Combining the REP L4 data (1982-2012) and a bias-corrected version of the NRT L4 data (2013-2016), we built the SST time series and provided updated estimates of the MED and NWA SST trends. The analysis shows that The Atlantic Box and The Mediterranean Sea have similar trend behavior until 2008. Afterward the Mediterranean Sea SST continued to increase while the Atlantic persisted in its warming pause.

**ID: 142**

**Oral Presentation**

*Topics:* Impact of varying physical forcing on morphodynamics and ecosystems

*Keywords:* satellite altimetry, mesoscale eddies, local fronts, dynamics of pelagic objects aggregations, sustainable fishing.

**The Influence Of Mesoscale Water Dynamics On Pelagic Objects Of Fishery By Altimetric Measurements**

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The relationships between mesoscale eddies and local fronts dynamics in the upper ocean layers have been studied using satellite altimetric measurements in connection with the distribution of pelagic objects aggregations. The study was carried out in coastal upwelling areas off the North-West coast of Africa and in the Scotia Sea.

The applicability of various algorithms for mesoscale eddies detection and tracking in satellite altimetry data in case of mesoscale dynamics study was analyzed. In addition, direct ADCP measurements of the ocean currents velocity and directions were compared with the results of calculations based on altimetric measurements.

The comparison has shown satisfactory coincidence. The displacement and density parameters of pelagic fishery objects aggregations were obtained from direct measurements of Russian trawlers crews in the study areas, as well as from the results of the international synoptic survey of the biomass of Antarctic krill in the Scotia Sea (KSS-2000), carried out in 2000 by research vessels of Russia, Great Britain and the United States.

The distribution features of small pelagic species in the Canary upwelling area (sardine, anchovy, sardinella, mackerel and horse mackerel), as well as Antarctic krill (*Euphausia superba*) in the Scotia Sea, were established in connection with the parameters of mesoscale eddies and local fronts obtained from altimetric measurements.

The obtained results may have important practical implications for determining fishing intensity in the adjacent exclusive economic zones (EEZ) of the North-West coast of Africa, and for estimating the maximum sustainable yield (MSY) of Antarctic krill in the Scotia Sea.

**ID: 137**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone, New technologies and in situ measurements

*Keywords:* lidar fluorosensor, chlorophyll a, Antarctic seas

**Lidar Monitoring of Chlorophyll A During Recent Italian Antarctic Expeditions**

**Luca Fiorani, Federico Angelini, Florinda Artuso, Dario Cataldi, Francesco Colao**

ENEA, Italy

Lidar fluorosensors are probably the more common laser-induced fluorescence (LIF) instruments and have been extensively operated by ENEA to monitor water bodies (Fiorani et al. 2011). LIF spectra contain signatures of phytoplankton pigments, chromophoric dissolved organic matter and dispersed impurities, such as crude oils. In a typical lidar fluorosensor, substances are detected measuring their emission at specific bands after excitation by a frequency-tripled Nd:YAG laser at 355 nm.

Recently, an innovative compact lidar fluorosensor was applied to real-time sensing of chlorophyll a, during the ROSS sea Mesoscale Experiment (RoME), conducted in the XXIX and XXXI Italian Antarctic expeditions.

This paper will present the technological advancement of the lidar fluorosensor and the results of the oceanographic campaigns.

Fiorani L, Colao F, Guarracino M, Marullo S, Palucci A, Poreh D (2011) Comparison between satellite radiometers and lidar fluorosensor in the Arctic Sea off the Svalbard Islands, 5th Workshop on Remote Sensing of the Coastal Zone, EARSel, Prague, Czech Republic.

**ID: 107**

**Oral Presentation**

*Topics:* Optical properties of CDOM and aquatic microorganisms

*Keywords:* CDOM, fluorescence spectroscopy, fluorescence quantum yield, absorbance spectroscopy, differentiation of absorption spectra

**Spectral Properties of Chromophoric Dissolved Organic Matter (CDOM) in Different Aquatic Environments**

**Svetlana Patsaeva, Olga Gorshkova**

M.V.Lomonosov Moscow State University, Russian Federation

Dissolved organic matter (DOM) is present in all types of natural water and constitutes a significant reservoir of organic carbon in coastal zones. Since the chromophoric DOM (CDOM) absorbs UV light and emit luminescence, its spectral-optical properties are widely used in ecological monitoring of natural aquatic environments. The presentation summarizes major CDOM spectral characteristics experimentally measured for various samples (solutions of fulvic acids and humic acids, marine and riverine water, freshwater and relic lakes, oxic-anoxic environments). The utilization of absorbance spectroscopy and differentiation of optical densities for CDOM characterization and discrimination from other chromophoric materials in water is described. Special attention is made for dependencies of emission wavelength and fluorescence quantum yield on the wavelength of exciting radiation. The dependencies of fluorescence characteristics on wavelength of excitation are discussed from the point of view of CDOM source and its structural composition.

**ID: 136**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* Turbulence, buoyancy frequency, vertical turbulent diffusion coefficient, turbulent energy dissipation rate, internal waves

**Interaction Peculiarities Of The Main Pycnocline And Active Upper Layer In The Connection Region Of The Shelf And Continental Slope**

**Luba Globina Globina**

Marine Hydrophysical Institute of the Russian Academy of Sciences, Russian Federation

Measurements data of the three vector velocity pulsation by a free-falling probe measuring complex Sigma-1, during the summer expedition in main thermocline, near western part of the Heracleian Peninsula was interpreted in terms of the vertical turbulent diffusion coefficient (K) and buoyancy frequency (N) in the presence stable stratification of fine structure. For each profile of the buoyancy frequency, two stratified layers were identified in depth: a layer above the maximum of the buoyancy frequency and a layer below the maximum of the buoyancy frequency. The estimation of dependence of the vertical turbulent diffusion coefficient on the stratification was obtained for two selected layers. The main characteristics of small-scale turbulence (the frictional stress, turbulent energy dissipation rate, turbulent viscosity coefficients) were calculated to obtain the required dependence. From the obtained equalities of the turbulent diffusion coefficient and the buoyancy frequency was established that the index for N in the ratio K(N) for the stratified layer above the maximum N is equal to two, while the index for N in the upper stratified layer of the main pycnocline changes in accordance with the model developed by us earlier for the World Ocean.

**ID: 122**

**Oral Presentation**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* Permafrost, Arctic Siberia, Ground Ice, Thaw Subsidence, Photogrammetry

**Elevation Change Detection for Quantification of Extensive Permafrost Thaw Subsidence in East Siberian Coastal Lowlands**

**Frank Günther<sup>1</sup>, Alexandra A. Veremeeva<sup>2</sup>, Georgy T. Maximov<sup>3</sup>, Andreas Fricke<sup>4</sup>, Mahmud Haghshenas Haghghi<sup>5</sup>, Alexander I. Kizyakov<sup>6</sup>, Guido Grosse<sup>1</sup>**

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Permanently frozen ground in the Arctic is being destabilized by continuing permafrost degradation, an indicator of climate change in the northern high latitudes. Accelerated coastal erosion due to sea ice reduction and an increased intensity of ground settlement through ground ice melt caused by rising summer air temperatures result in widespread geomorphological activity. The objective of our study is to analyze time series of repeat terrestrial laser scanning (rLiDAR) for quantification of extensive land surface lowering through thaw subsidence, which is the main unknown in terms of recent landscape development in the vast but neglected coastal lowlands of the East Siberian Arctic. These in-situ data provide the basis for calibration and validation of large scale surface change assessments using very high resolution space-borne elevation data with high precision. Complementing our surveys, we conducted botanical mapping. This allows us to relate elevation differences to specific surface conditions and enhances our capabilities to extrapolate our local observations to larger areas through land-cover classifications of multispectral remote sensing data such as Sentinel-2. Additionally, highly detailed digital elevation models (DEMs) with sub-metre accuracy have been photogrammetrically derived from satellite stereo data. These DEMs contain valuable terrain height information for 3D change detection, in case of DEMs representing the state of a study area at different points in time. The results show that elevation differences are almost always negative. When calculated as rates over time, land surface lowering in the ground-ice-rich Siberian coastal lowlands permafrost amounts to 3-10 cm per year.

**ID: 115**

**Oral Presentation**

*Topics:* New technologies and in situ measurements

*Keywords:* Marine pigments, Chlorophyll, HPLC, Mediterranean Sea, Phytoplankton

**Five-Year Pigment Composition Measurements in the Mediterranean Sea. A Study on the Characterization of the Phytoplankton Assemblage Structure.**

**Florinda Artuso<sup>1</sup>, Dario Cataldi<sup>1</sup>, Salvatore Marullo<sup>1</sup>, Antonia Lai<sup>1</sup>, Francesco Colao<sup>1</sup>, Federico Angelini<sup>1</sup>, Antonio Palucci<sup>1</sup>, Annalisa Di Cicco<sup>2</sup>, Michela Sammartino<sup>2</sup>, Simone Colella<sup>2</sup>, Gianluca Volpe<sup>2</sup>, Vittorio Brando<sup>2</sup>, Federico Falcini<sup>2</sup>, Rosalia Santoleri<sup>2</sup>, Luca Fiorani<sup>1</sup>**

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Simultaneous information on algal biomass abundance and its assemblage structure may be derived from phytoplankton pigment composition measurements. For that reason the analysis of chlorophyll a (Chl a) and the accessory pigments is receiving growing interest in marine studies and ocean color satellite field. The High Performance Liquid Chromatography (HPLC) is the reference technique recommended by the Joint Global Ocean Flux Study (JGOFS) program for the marine pigment analysis. In this work, we will present the results of HPLC pigment measurements carried out in the Mediterranean Sea during 5 years of oceanographic cruises and the resulting assessment of different phytoplankton taxonomic groups (PFTs), size classes (PSCs) and biomass distribution.

Investigations started in November 2010 with chlorophyll analysis. Hereafter, the marine pigments most commonly used in chemotaxonomic and photo-physiological studies were determined during the spring cruises, carried out from 2012 to 2015. The investigated area covered the Western Mediterranean, spanning the Adriatic coasts till the Strait of Gibraltar. Chl a was used as a proxy

to quantify the phytoplankton biomass, while diagnostic pigments (DPs) were employed as size-class markers and to evaluate the surface distribution of the main taxa. Results showed a high local variability of phytoplankton distribution, but a general oligotrophic regime with the dominance of nano-phytoplankton. Phytoplankton assemblage is characterized by the prevalence of diatoms in the eutrophic coastal zones, while chromophyte nanoflagellates are on average the principal taxa in the whole detected area. The study is aimed to understand the mechanisms that drive the Mediterranean Sea ecosystem processes.

**ID: 111**

**Oral Presentation**

*Topics:* Optical properties of CDOM and aquatic microorganisms

*Keywords:* Fluorescence, bacteriochlorophylls (BChls), anaerobic photoautotrophic bacteria, anoxygenic photosynthesis

### **The Use of Bacteriochlorophyll Fluorescence for Detection of Green Sulphur Bacteria**

**Svetlana Patsaeva**

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While chlorophyll a fluorescence is well documented and widely used to study phytoplankton biomass and its photosynthetic activity, the spectral properties of bacteriochlorophylls (BChls) are still poorly described. Green sulfur bacteria (Chlorobiaceae) represent obligately anaerobic photoautotrophic bacteria with anoxygenic type of photosynthesis. Two types of green sulfur bacteria differ in pigments: green-colored strains contain BChl c, d and carotenoid chlorobactin; brown colored ones contain BChl e and carotenoid isorenieratin. In addition BChl a and chlorophyll a are also present. Fluorescence of green sulfur bacteria excited with the blue light demonstrates two overlapping bands: the emission of so called chlorosome chlorophylls (BChls c, d and e) in the range 740-770 nm and the emission of BChl a with maximum at 815 nm. The intensity of BChls fluorescence reflects total concentration of pigments in the cells and can be used to estimate biomass of phototrophic bacteria in water. We summarize the results of spectral measurements performed in 2015-2017 on water samples from several lagoons and lakes at the White Sea coast. In those stratified water reservoirs massive bacterial blooming can be found near the chemocline zone at depth about 2 m. From multiple studies it was discovered that depth distribution of BChl fluorescence intensity and BChl concentration estimated from extractions were not equivalent: water layer with maximal fluorescence typically was located 10-15 cm lower the layer with highest BChl concentration. This fact can be explained by BChl fluorescence quenching in upper layer of the chemocline with insufficient value of redox potential. The value of redox-dependent fluorescence quenching may serve as an indicator of physiological status of phototrophic bacteria of the transition zone and anaerobic layer.

**ID: 113**

**Poster**

*Topics:* Optical properties of CDOM and aquatic microorganisms

*Keywords:* CDOM, Suwannee River, fluorescence quantum yield, size exclusion chromatography

### **Fluorescence Quantum Yield as a Function of Excitation Wavelength for Fractionated CDOM from the Suwannee River**

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Chromophoric dissolved organic matter (CDOM) is present in all types of natural water and plays a significant role in their biogeochemistry and optical properties. The main fluorescence characteristics like an excitation/emission maximum wavelengths and fluorescence quantum yield (QY) can provide the key information about CDOM structure and sources. The objective of this work was to study correlation between fluorescence QY and excitation wavelength for Suwannee River (SR) whole CDOM and its fractions A, B and C+D, obtained by size exclusion chromatography–polyacrylamide gel electrophoresis setup for which the nominal molecular size (NMS) varied in the order A>B>C+D>10kDa. Fraction with NMS<10kDa was lost during fraction purification and did not used for analysis. Fluorescence emission spectra were registered for different excitation wavelengths in the range 270 – 600 nm with the step 10 nm. The fluorescence QY was determined using a solution of sulphate quinine as a fluorescence QY reference. Our studies revealed that fluorescence quantum yield of SR CDOM depends on excitation wavelength: increase from QY=1,3% at wavelength excitation 270 nm to a maximum QY=2,5% at wavelength excitation 350 nm and decrease monotonically thereafter. The behavior of the fluorescence QY of SR CDOM fractions was found similar, but the fraction with the smallest molecular size (C+D fraction) had the highest value of QY. It was shown that the protein-like fluorescence was almost exclusively located in high molecular size fraction A and medium molecular size fraction B with the smaller value of QY. The work has been supported by Russian Foundation for Basic Research (project 15-04-00525-a).

**ID: 141**

**Poster**

*Topics:* Remote Sensing of marginal Seas and coastal zone, New technologies and in situ measurements

*Keywords:* chlorophyll "a" concentration, suspended matter, South-eastern Baltic, MODIS imagery

### **Variability Of Chlorophyll "A" And Suspended Matter Concentrations In The Surface Layer Of The South-Eastern Baltic**

**Tatiana Bukanova<sup>1</sup>, Ekaterina Bubnova<sup>2</sup>, Vladimir Gritsenko<sup>2</sup>**

<sup>1</sup>P.P. Shirshov Institute of Oceanology; <sup>2</sup>Immanuel Kant Baltic Federal University

Eutrophication is an urgent environmental problem of the Baltic Sea. The South–Eastern Baltic presents a particular sensitive marine area which includes coastal waters, shallow land–locked lagoons, and runoff areas of the Vistula River, Baltiysk and Klaipeda Straits. Thus it requires regular monitoring and control of core environmental indicators such as chlorophyll "a" and suspended matter concentrations.

The goal of the study is to examine distribution of chlorophyll "a" and suspended matter in the surface layer of the South-eastern Baltic. The spatial and temporal variability of chlorophyll "a" and suspended matter concentrations is analyzed using the data from MODIS satellite imagery and ship measurements. The concentration of chlorophyll "a" was calculated by a regional algorithm developed from in situ data in the given region. The seasonal and interannual variability of the chlorophyll "a" and suspended matter concentrations is considered.

**ID: 135**

Poster

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* The Baltic Sea, The Vistula Lagoon, satellite ice monitoring, radar images, polynya

### **Temporal Variations of Polynya Characteristics in the Vistula Lagoon of the Baltic Sea by Remote Sensing Data**

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P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences

Every winter there is a water opening in the ice field (polynya) near the navigable Strait of Baltiysk in the Vistula Lagoon. The Vistula Lagoon is the second largest shallow estuarine lagoon of the Baltic Sea. The Lagoon is separated from the sea by a narrow sand spit. The main characteristic features of ice processes in the Vistula Lagoon are periodical ice breakdown and the polynya occurrence. We analysed 158 synthetic aperture radar (SAR) satellite images for the period from 26 December 2010 to 6 March 2017. The polynya was observed on 73 of them. The size of the polynya ranges from 1 to 22 square km with an average length of 3 km, and width of 4 km. It can have various shapes, either round or stretched along one of the axes (often into the Vistula Lagoon) with smooth or saw-edged borders. To examine the primary factors of polynya formation and its variability over time we correlated its characteristics with oceanic and atmospheric variables such as air temperature, wind speed and direction, and intrusions of sea water. It is assumed that there may be an additional factor (possibly surface waves) that may significantly influence the dynamics of the polynya. Research was supported by the theme N 0149-2014-0017 of State Assignment of the Institute of Oceanology of the Russian Academy of Sciences (2017-2019).

**ID: 112**

Poster

*Topics:* Optical properties of CDOM and aquatic microorganisms

*Keywords:* CDOM, SUVA index, absorption slope ratio, "blue shift" of fluorescence, protein-like fluorescence

### **Optical Properties of Surface Waters in the Laptev Sea Shelf along Salinity Gradient**

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The Laptev Sea surface waters with salinities varying from 3 to 30 psu allow to study optical properties of chromophoric dissolved organic matter (CDOM) along a salinity gradient. We describe the results of on-board measurements of spectral properties for surface water sampled along 130°E, from the river Lena estuary to the near-oceanic environments. Absorption spectra were measured in the wavelength range 200-650 nm. Fluorescence emission spectra were excited with wavelengths ranging from 230 to 550 nm. The specific UV absorbance index (SUVA) calculated by normalizing the absorbance at 254 nm to the DOC concentration was found similar in different locations of the Laptev Sea shelf (2.41-2.52 m<sup>2</sup> g C<sup>-1</sup>) but increased significantly at the continental slope (5.25 m<sup>2</sup> g C<sup>-1</sup>). The absorption slope ratio SR increased from 0.93 at the Lena Delta region to 1.07 near the continental slope, indicating distribution of terrestrial CDOM throughout the Laptev Sea shelf. CDOM fluorescence spectra typically manifested a single humic-type band with a maximum at 425-455 nm depending on the excitation wavelength. Change in excitation from 270 to 310 nm lead to the so called "blue shift" of CDOM fluorescence emission to shorter wavelengths up to 30 nm. CDOM fluorescence intensity decreased with the distance from the river Lena due to the mixing of river and marine waters. For the samples collected near the continental slope the UV protein-like fluorescence within 290-320 nm became observable indicating the presence of labile autochthonous organic matter. This study was financially supported by the Russian Foundation for Basic Research, grant №16-35-60032 mol\_a\_dk.

**ID: 125**

Poster

*Topics:* Sentinels Data Exploitation to monitor the status of the coastal zone environment, Remote Sensing of marginal Seas and coastal zone, Land-Sea Interaction

*Keywords:* suspended matter, chlorophyll, Black Sea, plume of the Mzymta river, Space Station Alpha, SAR Sentinel-1, remote sensing, the dissolved terrigenous substance, spectrometer

### **Comparison Of The Suspended Matter And Chlorophyll Fields In The Mzymta River Plume (Adler Coastal Zone Of The Black Sea) In May 2015 Get By Remote Sensing (Photography Optical And Radiophysical) And "In Situ" By Spectrophotometry Laboratory Methods**

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Data of distribution of the suspended matter and chlorophyll in the Mzymta River plume (Adler, the Black Sea) is carried out in May, 2015 (photographic – from the cosmic station Alpha and radio-physical - with the Sentinel-1 SAR artificial satellite) methods. Photos from a board of the International Space Station Alpha have been received by the Russian astronauts within the Space experiment "Hurricane" 5/25/2015. In the same temporary intervals the staff of Shirshov Institute of Oceanology of Russian Academy of Sciences (SIO RAS) has taken samples of sea water onboard R/V during the complex scientific cruise of SIO RAS "The Black Sea 2015" around the Mzymta River drain which have been investigated further by spectrophotometry methods in Laboratory of interaction of the ocean with waters of land and anthropogenous processes of SIO RAS. Data from the radar from the synthesized aperture (Sentinel-1 SAR) on the same sea district have been obtained from archive (2015), processed and combined with pictures with the Alpha by the staff of the Engineering and technological center of ScanEx (Moscow, Russia). Results of researches have shown good coincidence of the areas which are taken out in the sea by the Mzymta River of the suspended matter and dissolved terrigenous substances received both in optical visible, and in radio physical ranges and also their coincidence to isolines of concentration of the suspended matter and chlorophyll in the samples taken by "in situ". Further us it is planned to conduct longer researches in common by various remote-sensing instruments and by contact methods onboard R/V for creation of the all-weather round-the-clock and all the year round operating system of monitoring of carrying out by the rivers of the Black Sea of various terrigenous substances, using a combination of both optical and radio-physical methods.

**ID: 134**

**Poster**

*Topics:* Sentinels Data Exploitation to monitor the status of the coastal zone environment, Remote Sensing of marginal Seas and coastal zone, Remote Sensing of inland waters, New technologies and in situ measurements

*Keywords:* monitoring, wfd, lakes, reservoirs, coastal, remote sensing, water quality, reporting, services

### **Earth Observation-based services for Monitoring and Reporting of Ecological Status (EOMORES)**

**Stefan Simis<sup>1</sup>, Eleni Papathanasopoulou<sup>1</sup>, Annelies Hommersom<sup>2</sup>, Kathrin Poser<sup>2</sup>, Claudia Giardino<sup>3</sup>, Mariano Bresciani<sup>3</sup>, Giacomo Decarolis<sup>3</sup>, Miguel Dionisio<sup>4</sup>, Saku Anttila<sup>5</sup>, Jenni Attila<sup>5</sup>, Diana Vaičiūtė<sup>6</sup>, Dimitri Papadakis<sup>7</sup>, Andrew Tyler<sup>8</sup>, Evangelos Spyarakos<sup>8</sup>**

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The H2020 project EOMORES develops operational monitoring and reporting services for inland and coastal water quality based on a combination of satellite data, innovative in situ instrumentation and ecological models.

Lakes, reservoirs and coastal water bodies constitute essential components of the hydrological and biogeochemical water cycles and influence ecology, economy, and human welfare, providing ecosystem services in multiple and sometimes conflicting ways. Knowledge about the state of inland and coastal water bodies in therefore of great interest to support data-driven management.

EOMORES will provide:

- operational water quality monitoring and forecasting for water management
- implementation of validated EO-based water quality indicators for WFD and other reporting frameworks
- historic compilation of data for specific ecological analysis and assessment of management impacts

The poster will introduce the project and the methodologies used.

**ID: 128**

**Poster**

*Topics:* Remote Sensing of marginal Seas and coastal zone

*Keywords:* marine ecosystem, data assimilation, remote sensing

### **Monitoring of the Black Sea ecosystem evolution on the basis of remote sensing data assimilation in the model**

**Larisa Ivanovna Sukhikh, Viktor Lvovich Dorofeyev**

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The work demonstrates some results of the Black Sea ecosystem dynamics, based on numerical simulations with assimilation of satellite data. The Black Sea ecosystem model is a coupled, eddy-resolving 3D basin-scale circulation and biogeochemical model with 5 km horizontal grid size. The circulation model includes 35 calculation levels, which thicken toward the sea surface. It assimilates satellite data on the sea-surface temperature and sea level anomalies. The circulation model provides the input to the biogeochemical model.

The biogeochemical model extends from the sea surface to 200m depth with non-uniformly spaced 18 z-levels. It includes 15 state variables. Nitrogen is considered to be the only limiting factor for phytoplankton growth. The model assimilates satellite measurements, which are the maps of chlorophyll concentration fields reconstructed based on remote sensing data from SeaWiFS (satellite OrbView) and MODIS (satellites Aqua and Terra) using the regional optical model of the Black Sea. Assimilation technique is based on optimal interpolation and nudging. The model and assimilated satellite data were used to fulfill reanalysis of the Black Sea ecosystem evolution during period from 1998 till 2012. Quality of the reanalysis was assessed using the Black Sea Oceanographic Database, which contains the direct measurements of chlorophyll, nitrates and dissolved oxygen concentrations in seawater. The assessment showed that the reanalysis fields satisfactorily reproduce seasonal variability and vertical distribution of chlorophyll, nitrate and dissolved oxygen concentrations in deep part of the Black Sea and on north-western shelf as well.

**ID: 100**

Poster

*Topics:* Remote Sensing of inland waters

*Keywords:* Vulnerability, remote sensing, GIS, Principle component analysis

### **Vulnerability Evaluation in Central Dry Zone Area of Myanmar**

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The central dry zone area of Myanmar is characterized as vulnerable area due to water stressed and one of the most food insecure regions in the country. In this region, the adverse effects of climate change are believed to be a major constraint to vulnerability. These extreme climatic events are likely increase in frequency and magnitude of serious drought periods and extreme floods. For vulnerability assessment we used remote sensing (RS) and geographical information system (GIS) technology and develop a numerical model, using spatial principle component analysis (SPCA) in ArcGIS software and evaluate two decade (1995, 2005 & 2016) vulnerability evaluation. The model contains following indicators: discharge change, climate moisture, drained area, flood risk, irrigation, evapotranspiration, precipitation, surface runoff, nitrogen load and population distribution. According to the numerical results, the vulnerability is classified into five levels: slight, light, medial, heavy and very heavy level by means of the cluster principle. The results show that vulnerability in the study area from 1995 to 2016 is at medial (25%) and heavy (25%) level and presents from south-west to north east direction. The vulnerability change trend show worst situation in 1995 (29.80) and best one in 2005 (17.45) but again vulnerability was increase in 2016 (21.58). In the study area the main driving forces for dynamic change in vulnerability is the intensive land use and high population density. This spatial approach allowed the analysis of different indicators, providing a platform for data integration as well as a visually powerful overview of the study area.

**ID: 123**

Poster

*Topics:* Remote Sensing of inland waters

*Keywords:* Yedoma region, permafrost, remote sensing, thermokarst lakes, baydzherakhs

### **Monitoring of Thermokarst Lake Changes and Coastal Dynamics in Permafrost Landscapes of the East-Siberian Sea Region Using High Resolution Imagery and DEM Data**

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The coastal region bordering the East-Siberian Sea is covered by ice-rich Yedoma deposits, which are extremely vulnerable to thaw in the course of climate warming in the high latitudes. Widespread permafrost degradation throughout the Arctic resulted in relief changes on ground-ice-cored Yedoma uplands. In order to track dynamics of these processes in the Kolyma lowland tundra at Cape Maly Chukochy (N 72.08°, E 159.9°), we used a set of very high resolution remote sensing imagery (GeoEye and historical airphotos) which were compared with DEM data (TanDEM-X and derived from WorldView-2). Analysis of meteorological data have put observed changes into the context of warming and wetting trends.

Yedoma uplands represent flat bogged areas featuring a high number of thermokarst ponds with an average size of 5-10 in diameter. Our image dataset revealed a doubling in the number and areal coverage of ponds from 1972 to 2009 and a further twofold increase until 2013, while thermokarst lakes that formed within Yedoma deposits increased by 7-10 %, being partially in agreement with studies conducted elsewhere in the Arctic. Coastal erosion rates from 1972 until 2013 were high and 1,5 m per year on average. We used the areal extend of thermokarst mounds (baydzherakhs) on Yedoma slopes as indicator for ground ice melt and our estimates show a baydzherakhs coverage increase of 20 % by 2013.

All these changes highlight the activation and acceleration of permafrost degradation on Yedoma uplands in response to increasing air temperatures and precipitation in the East-Siberian Sea coastal region.

**ID: 104**

Poster

*Topics:* Impact of varying physical forcing on morphodynamics and ecosystems

*Keywords:* shift of the Gulf Stream, oil rainbow film, drop in water shear viscosity, anthropogenic influence on the global climate

### **Anomalous Shift of the Gulf Stream in 2011**

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In 2015 in Le Bourget, France, the 21st session of the Conference of the Paris (COP21) took place as a part of UN Framework Convention on Climate Change. The aim of COP21 was to achieve an international agreement on climate with the purpose of keeping the global average temperature rise below 2°C. Ecological disasters, such as the Deepwater Horizon disaster in the Gulf of Mexico on Apr. 20, 2010, may lead to local ocean warming above 2°C and trigger uncontrollable global-scale processes.

A new physical mechanism is suggested to explain the unprecedented (~200 km) northward Gulf Stream shift during summer-fall of 2011 near Carolina coasts. It is demonstrated that inertial "sliding" off the former trajectory during eastward turn was due to anomalous water heating to a specific temperature (19-20°C), which caused a several-fold reduction in sea water shear viscosity as a result of thermally induced conversion of H<sub>2</sub>O spin para/ortho isomers. It is shown that the anomalous water heating is a consequence of the disaster in the Gulf of Mexico and associated oil spill, which has led to oil rainbow film formation over the area of a hundred thousand square kilometers, thus ensuring extra ocean warming.

**ID: 143**

**Poster**

*Topics:* Sentinels Data Exploitation to monitor the status of the coastal zone environment

*Keywords:* The Black Sea, coastal zone, hydrophysical polygon, direct measurements, mesoscale and sub-mesoscale processes, sea surface, satellite data

**Mesoscale and sub-mesoscale sea surface processes detection using satellite data and direct measurements at the hydrophysical polygon in the Black Sea coastal zone**

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Mesoscale and sub-mesoscale sea surface processes and phenomena characteristic of the north-eastern part of the Black Sea was detected using medium and high-resolution satellite data. Data obtained from regular direct measurements using an autonomous seabed and anchored buoy stations, surface drifters, towing of ADCP, ship CTD- measurements were used to research manifestations of processes in the surface water layer detected by satellite data.

Satellite data allow us to recognize dynamic structures by their manifestations on the surface of the oceans and seas. Due to the small spatial and temporal character of coastal dynamic structures, their study using direct measurement methods is rather difficult. In Russia, only a limited number of studies have been carried out investigation of the mesoscale and sub-mesoscale vortex dynamics of the Black Sea. These studies are mainly carried out at the hydrophysical polygon of the Institute of Earth Sciences of the Russian Academy of Sciences.

Direct measurements has allowed to receive the hydro, hydro-chemical and bio-optical data with high space-time resolution. Systems perform fast transfer of a data to the coastal center. These in situ data allow us to study the characteristics and mechanisms of the variability of the marine environment and biota with sub-mesoscale spatial resolution. Water-exchange processes in the system "shelf-deep basin" and ocean-atmosphere interaction are studied among others.

The obtained results help us to better understand the interrelationship of surface inhomogeneities observed with satellites with hydro physical processes in the near-surface water layer.