# Tuesday, April 9

14:00 - 16:30 **Breakout WS 1**: Open Source Scientific Computing Tool and Resources

**Co-chairs:** Joaquín E. Chaves (NASA GSFC/SSAI), Erdem M. Karaköylü (NASA GSFC/SAIC), Joel P. Scott (NASA GSFC/SAIC)

*Ocean color practitioners have principally relied on commercial off-the-shelf software (COTS) for data analysis (e.g., IDL, Matlab). Use, support, and maintenance of COTS requires paid licenses, and often come with proprietary, black-box features. This framework hinders task-oriented modification and is an obstacle to transparency, code sharing, and reproducibility. While COTS were instrumental in propelling a revolution in our understanding of the oceans, the restrictions associated with their use have now become an obstacle to innovation and the establishment of ocean color as a truly global discipline in terms of the diversity of data users and producers (i.e., mission-sponsoring nations).*

*However, during the past few years there has been an explosive growth in computational power, data availability, and the open source software movement. In combination, these factors have resulted in the democratization of advanced computational tools and platforms for diverse commercial and scientific applications. There is now a rich ecosystem of easily-accessible, open source (i.e. freely available and modifiable) software. This ecosystem includes programming languages, such as R, Python, and Octave, and their derivative software packages and libraries developed for domain-specific applications. These tools are now easily accessible via the internet and their use is reinforced with online resources such as GitHub and Bitbucket, as well as project management platforms such as the Open Science Framework. This shift in paradigm, has lowered the threshold for entry, expanded the user pool, and increased opportunity for collaboration, while promoting scientific innovation, transparency, and reproducibility. The rise of open source software, new data analysis methods, and greater computational power enables new approaches for answering ocean color research questions, conducting instrument calibration and algorithm validation, and streamlining data access, use, and availability.*

***Key questions***

- *What recent shifts among Ocean Color community have there been towards open source tools?*
- *How and why is the community using these tools?*
- *How are teaching, mentoring, and research deliverables being changed by open source?*
- *Are these tools promoting reproducibility, code preservation, accessibility, diversity & inclusion?*

**AGENDA**

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|---|---|
| 14:00 -14:05 | Intro, motivation and goals (co-chair: **J. Chaves (**NASA GSFC/SSAI): Open Source software revolution: Resources and opportunities for ocean color science research, data distribution, education and mentoring |
| 14:05 - 14:25 | Python for multi-year GOCI ocean color product analysis: sharing advantages and issues. **Myung-Sook Park** (KIOST) |
| 14:25 -14:30 | QA and interactive discussion. |
| 14:30 -14:50 | Leveraging Python & Jupyter Notebook to validate satellite ocean color retrievals via SeaBASS data. **Joel Scott** (NASA GSFC/SAIC) |
| 14:50 -14:55 | QA and interactive discussion. |
| 14:55 -15:00 | ***Coffee break*** |
| 15:00 -15:20 | Use of Python and SeaDAS for Ocean Color Processing, Analysis and Visualization. **Bruce Monger (**Cornell U.) |
| 15:20 -15:25 | QA and interactive discussion. |
| 15:25 -15:45 | The importance of open science principles for expanding and diversifying the user base of marine satellite data. **Hayley Evers-King** (Plymouth Marine Lab) |
| 15:45 -15:50 | QA and interactive discussion. |
| 15:50 -16:10 | Probabilistic Programming Workflow in Python. **Erdem Karaköylü** (NASA GSFC/SAIC) |
| 16:10 -16:15 | QA and interactive discussion. |
| 16:15 -16:30 | Summary and group discussion (Co-chairs, others) |

14:00 - 16:30 **Breakout WS 2**: Going beyond HPLC: Coming to rapid consensus on science requirements for assessing phytoplankton composition from satellite imagery

**Co-chairs:** Astrid Bracher (AWI), Ryan Vandermeulen (NASA), Stewart Bernard (CSIR)

*New orbital imaging spectrometers are being developed that cover the ultraviolet, visible, and near infrared spectrum with a stated objective of assessing phytoplankton composition and diversity across the world ocean. The capability to quantitatively retrieve major phytoplankton taxonomic groups or size classes based on their optical signature has been demonstrated in the open ocean using in the open ocean using satellite data from multispectral (MERIS, MODIS, SeaWiFS) as well as very highly spectrally resolved (< 1nm, SCIAMACHY) sensors. However, the enhanced utility of hyperspectral imaging (with spectral resolution between 4 to 7 nm) still needs to be demonstrated across diverse aquatic regimes and the science requirements need to be specifically designed for phytoplankton group detection from satellites.*

*We believe it is imperative that community members focusing on ocean colour phytoplankton composition come together in a short timeframe to assess the minimum set of recommendations required to establish field programs for validation datasets, and thus maximize the utility of future hyperspectral, as well as multispectral, imaging missions. Specific questions need to be addressed which we will introduce by speed talks and then discuss within the breakout group.*

***OBJECTIVE:*** *What kinds of laboratory, field, airborne, and satellite data and modelling efforts are required for algorithm development and validation of aquatic biodiversity across the globe?*

*More detailed questions that need to be addressed at the IOCS breakout group include:*

*1. Can we develop minimum recommendations for a useful set of measurements and for whether there are suites of measurements that meet most of the objectives.*
*2. What blooms can be feasibly detected and how are they relevant to global biogeochemistry?*
*3. How do we best utilise existing programs or recommend new programs to validate satellite approaches for detecting ephemeral blooms in the sea?*

**AGENDA**

14:00 -14:05 Introduction **Astrid Bracher** (AWI)

14:05 -14:15 Minimum requirements for lab and field work, measurements for sufficient PFT algorithm evaluation
Overview on Requirements. **Colleen Mouw** (University of Rhode Island)
Discussion (Chair: **Ryan Vandermeulen**, NASA)

14:25 -15:15 Detection of phytoplankton blooms of specific groups and species. Australian Waters: Arnold Dekker CSIRO); SE Asian Waters: Shaoling Shang (Xiamen University), **Wonkook Kim (**KIOST);South American Waters **Ana Dogliotti** (IAFE); European Waters: **Tiit Kutser** (University of Tartu); North-American and global waters: **Tihomir Kostadinov** (California State University); Discussion (Chair: **Stewart Bernard,** CSIR)

15:15 - 15:30 Role of synthetic data sets and IOP/radiative transfer modelling: ocean radiative transfer model SCIATRAN **Hongyan Xi** (AWI); Synthetic data sets: hyper-vs multispectral **Jianwei Wei** (U. Mass); Discussion **A. Bracher**

15:30 - 16:15 How to validate satellite approaches for detecting ephemeral blooms. International and Australian efforts **Lesley Clementson** (CSIRO); Efforts of NASA **Ryan Vandermeulen** (NASA); European and Korean efforts **Astrid Bracher** (AWI); Chinese efforts **Shaoling Shang** ( Xiamen University)

15:50 - 16:15 Discussion - how to move forward to achieve global *in-situ* validation data sets (Chair: **Stewart Bernard**,)

16:15 - 16:30 Final discussion, summary and recommendations (Chair: **Ryan Vandermeulen**, NASA)

# Tuesday, April 9

14:00 - 16:30 **Breakout WS 3**: HighTemporal/Spatial Resolution Applications

**Co-chairs:** Joe Salisbury (UNH) Kevin Turpie (NASA GSFC), Maria Tzortziou Columbia Univ.), Arnold Dekker (CSIRO), Wonlook Kim (KIOST), Antonio Mannino (NASA GSFC)

*High spatial resolution ( < 50 m) and high frequency (<2 hr) ocean observations from space provide a unique capability for assessing and quantifying change in highly dynamic environments on scales commensurate to key observable processes and features.. Existing geostationary missions, e.g.,GOCI, have demonstrated the feasibility and utility of high-frequency ocean color observations, while high-spatial resolution sensors, such as Sentinel-2, have provided an exciting opportunity to capture fine scale aquatic features not previously observed. Although there is new remote sensing asset development in the coming decade, observational gaps and technological challenges remain for high quality, high temporal and high spatial resolution remote sensing of highly dynamic and spatially complex processes . This breakout workshop will provide a forum to address these observational gaps and technological challenges.*

*One of the objectives is to identify how existing, or planned, high resolution remote sensing technologies can support applications/science end-users and stakeholders and determine what still must be developed. The breakout session will also facilitate an open discussion on the status and future directions of high spatial resolution remote sensing for coastal, estuarine, ice edge and inland aquatic ecosystems, including an update on NASA's planned mission Surface Biology and Geology (SBG).*

*The workshop will also delve into the new science enabled by the high temporal resolution data available from GOCI, GOCI -2, Himawari 8 and ABI, and will explore emerging opportunities to study tidal and diurnal processes including photo-physiology, net phytoplankton production and distributions of optically active substances in time and space of the open ocean and its margins.*

**AGENDA**

**High-Temporal Resolution Capabilities Discussion**

14:00 - 14:10 Overview **Antonio Mannino, Wonkook Kim**

14:00-14:50 Questions **Joe Salisbury, Maria Tzortziou, Chuanmin Hu, ZhongPing Lee**

1. How can existing or planned, high-temporal resolution observational capabilities be utilized in the study of the open ocean and its margin systems? (successful utilization of current or planned high-temporal resolution observations, new science enabled by high-frequency ocean color observations).
2. What challenges, limitations or uncertainties are associated with the usage of high-temporal remote sensing observations and what gaps exist in current or planned remote sensing infrastructure?

**High-Spatial Resolution Capabilities Discussion**

14:50 - 15:00 Overview **Arnold Dekker**

15:00 - 15:40 Questions **Maria Tzortziou, Nima Pahlevan, Joe Ortiz, Chuanmin Hu, ZhongPing Lee, Eric Hochberg**

1. How can existing or planned, high-spatial resolution observational capabilities be utilized in the study of aquatic margin systems? (successful utilization of current or planned high-spatial res. Observatioons, new science enabled by high-spatial resolution coastal, estuarine, ice edge and inland aquatic data).
2. What challenges, limitations or uncertainties are associated with the usage of high-spatial resolution remote sensing observations and what gaps exist in the current or planned remote sensing infrastructure?

**Combined High-Spatial/High-Temporal Resolution Capabilities**

15:40 - 15:50 Overview. **Maria Tzortziou**

15:50 - 16:30 Questions **Arnold Dekker, Nima Pahlevan, Joe Ortiz, Chuanmin Hu, ZhongPing Lee, Eric Hochberg, Joe Salisbury, Antonio Mannino, Wonkook Kim**

1. What applications can be better achieved by combining high-temporal and high-frequency data?
2. Can high-temporal and high-spatial resolution observations be fused into a single product?
3. Attention to what common attributes help promote interoperability of high-temporal or high-spatial resolution remote sensing products and what are common end-user objectives and requirements?

# Wednesday, April 10

14:00 - 16:30 **Breakout WS 4**: Remote Sensing of Optically Complex and Shallow Waters

**Co-chairs:** ZhongPing Lee (Univ. Mass Boston), Dirk Aurin (NASA GSFC)

*Optically complex waters and shallow water environments continue to present unique challenges to our evolving understanding of ocean color remote sensing, and to the operational and mission capabilities we are bringing to bear on the problem today. By definition, complex waters contain optically active constituents which fail to co-vary in concentration or optical characteristics with one another, thus belying the assumptions we tend to use in the open ocean to invert reflected sunlight for the estimation of those constituent properties such as chlorophyll concentration. Also, variations in the vertical dimension further complicate the matter. Shallow water reflectances are often anomalously high (i.e. routinely masked and problematic for atmospheric correction), and characterized by extreme spatial heterogeneity compared to most other aquatic environments, while also contributing an additional unknown parameter to the inversion of the light field beyond the capability of standard semi-analytical approaches. Most current and legacy ocean color sensors are not optimized for observing optically complex or shallow waters – for example having too few spectral channels for accurate separation of inherent optical properties or characterization of phytoplankton pigments, saturating over shallow or turbid pixels, or underestimating constituent concentrations due to spatial/vertical sampling limitations, among other problems. These technological limitations exist despite the fact that many of these waters are situated near-shore or inshore and host fragile and important ecosystems such as coral reefs and fisheries that are important to human life, while being significantly impacted by human activity. As more sophisticated sensors are developed with higher spatial, temporal, and spectral resolutions, as well as polarization sensitivity and active sensing through LIDAR, their capabilities have the potential to vastly change and improve how we study optically complex and shallow waters remotely. This workshop is designed to explore these recent developments and consider whether our theoretical understanding is keeping pace with technological capabilities scheduled to come online in the near future.*

***Key Questions***

*• What are the main challenges to accurate remote sensing in optically complex and/or shallow waters today? (Common issues and regional-specific challenges)*

*• How will developments in mission and operational capabilities over the next 3-5 years impact current limitations in ocean color remote sensing within these environments? (Plume evolution, PFTs/species differentiation/phytoplankton absorption coefficient distinction, CDOM source and properties (spectral slope, CDOM/DOC), masking/saturation of high turbidity pixels/regions, adjacency issues, marine aerosol discrimination, etc.)*

*• What new developments are there in global or regional algorithms in complex and shallow waters that will be able to take advantage of these technological improvements?*

*• How can we improve our ability to classify water types/bottom types in order to facilitate operational analysis of ocean color in optically complex and shallow environments?*

*• Aside from optical data, what information -- such as tides, currents, temperature, bathymetry, salinity, etc. – can be made available through other means, can/should be employed when inverting a remote sensing spectrum?*

**AGENDA**

14:00-14:05 Welcome remarks. **ZhongPing Lee**

14:05-14:25 Challenges and recommendations for remote sensing of optically complex waters. **Colleen Mouw**

14:25-14:45 Evolving biogeochemical and optical dynamics of DOM and particles in the coastal Arctic. **Antonio Mannino**

14:45-14:55 Challenges in detecting and differentiating floating algae and other materials in OC imagery. **Chuanmin Hu**

14:55-15:05 Optical RS of marine oil spills: detection, spectral discrimination, and optical processes. **Yingcheng Lu**

15:05-15:15 CALIPSO: lessons learned and future perspective. **Yongxiang Hu**

15:15-15:25 Multi-wavelength ocean lidar: implications from numerical simulations/ field measurements. **Deric Gray**

15:25-15:35 Hyperspectral remote sensing of shallow waters. **Rodrigo Garcia**

15:35-15:45 Remote Sensing of Coral Reef Morphology and Ecology. **Eric Hochberg**

15:45-16:20 Group discussion on key questions.

16:20-16:30 Wrap-up and adjourn. **Dirk Aurin**

# Wednesday, April 10

14:00 - 16:30 **Breakout WS 5**: Vicarious Calibration and Validation Protocols

**Co-chairs:** Giuseppe Zibordi (JRC, EU), Kenneth Voss (University of Miami) , B. Carol Johnson (NIST)

*The Breakout Workshop will attempt to reach consensus on standardized protocols for the operational identification and application of in situ measurements to system vicarious calibration (SVC) and validation processes. Consensus should consider the need to apply state-of-the-art methods (e.g., the need for detailed uncertainty budgets for in situ measurements), recognizing practical limitations intrinsic of the SVC and validation processes (e.g., the difficulty/impossibility of addressing sub-pixel variability).*
*Separate sub-sessions on SVC and validation processes should answer the following key points:*

*i. What are the fundamental requirements for in situ measurements supporting single missions for regional/global applications or multiple-missions addressing climate studies (e.g., geophysical quantities, spectral characteristics, uncertainty budgets and traceability, geographical relevance)?*

*ii. What are the fundamental physical methods to enforce equivalence of satellite and in situ data (e.g., application of identical corrections for brdf effects, corrections for minimizing the impact of different spectral bands)?*

*iii. What are the fundamental criteria to be met for the construction of matchups (e.g., local spatial/ temporal variability, observation conditions, ranges of applicability, time-lags between in situ and satellite data, geographical origin of the in situ data, …) and additionally, what are the fundamental methods and criteria that should be commonly applied for the statistical analysis of matchup data and the following presentation of summary results (e.g., the statistical methods for the determination of systematic differences and dispersions affecting satellite data with respect to in situ measurements, the information complementing matchup analysis when presenting results)?*

*The goal of the breakout session will be to lead to the definition/consolidation of basic protocols (i.e., standard guides) supporting SVC and validation processes. Care should be placed in ranking requirements by stressing the fact that different spatial/temporal/geophysical applications may impose very different levels of requirements.*

***Key Questions***
*To lead to the definition/consolidation of basic protocols supporting validation and SVC processes, key questions are:*
*i. What are the fundamental requirements for in situ measurements supporting single missions for regional/global applications or multiple-missions for climate studies ?*
*ii. What are the fundamental physical methods to enforce equivalence of satellite and in situ data ?*
*iii. What are the fundamental criteria to be met for the construction of matchups and additionally what are the fundamental methods and criteria that should be applied for the statistical analysis of matchup data and the following presentation of summary results ?*

**AGENDA**

14:00 -14:15 Introduction to practices for the construction of *in situ* – satellite matchups, their application to the validation of data products and the presentation of matchup statistics. **Giuseppe Zibordi** (JRC, EU)

14:15 -15:00 Group discussion

***Coffee available (without break)***

15:00-15:15 Introduction to practices for the construction of *in situ* - satellite matchups, their application to SVC and the statistical assessment of derived calibration factors. **Kenneth Voss** (University of Miami)

15:15-16:00 Group discussion

16:00-16:30 Wrap-up and consensus consolidation

**Anyone involved in the validation of satellite ocean colour data products or SVC is kindly invited to participate and contribute the breakout workshop.**

14:00 - 16:30 **Breakout WS 6**: Research to Operations (R2O) Applications

**Co-chairs:** Veronica Lance (NOAA), Ewa Kwiatkowska (EUMETSAT)

*The value to society of satellite-based ocean colour (OC) remote sensing observations is realized when they are used to improve decision outcomes. For OC to be incorporated routinely into downstream user operations, data products must be consistent, routine and sustained, mature, relatively stable, fit-for-purpose, discoverable, and accessible in forms conducive to their use. The new paradigm of "operational" satellite data extends beyond near-real time to also include consistent, longer term time series. Given the multiple satellite missions now routinely providing robust OC data along with additional missions anticipated in the near future and out into the coming decades, OC has reached the maturity to be incorporated into downstream operational applications, yet barriers remain.*

*The 2013 IOCS splinter session, Operational Ocean Colour Data in Support of Research, Applications and Services, produced 15 recommendations. In the past ~6 years, many of these recommendations have been implemented. This workshop will assess the status and impacts of the 2013 recommendations and consider the next level of progress from the perspectives of users (clients), remote sensing scientists, and those working to bridge gaps between them. Our goal is to identify executable steps toward getting OC data into more applications where they can make a positive impact on decision outcomes. The scope includes both 1) broad, efforts in making OC data more accessible (intellectually and functionally) to a wider audience and 2) narrow, vertically integrated services that drive the value chain from earth observations to actionable information for targeted applications.*

*This workshop will aim to answer the question "Where are the biggest gaps or obstacles in achieving fit-for-purpose OC data that meet the needs of operational users and how can we close these gaps and reduce obstacles" To help to answer this question, requirements and experiences will be discussed based on operational application cases, such as harmful algal bloom forecasting, coral reef and fisheries management, ocean prediction, and various commercial applications.*

***Key Questions***

*1) What are the user requirements for operational OC products and where should the main research and technical efforts be concentrated?*

*2) What developments in approaches, techniques and/or tools are needed to address users at multiple levels of sophistication, how best to supply necessary details while not overwhelming as needed for free and open access to data through multiple outlets and serving distinct and diverse audiences?*

*3) What mechanisms are useful to bring developers and users together at early stages and how best to engage parties to achieve successful implementation?*

**AGENDA**

14:00 - 14:10 Overview "operational" OC satellite remote sensing. **Veronica Lance** (NOAA), **Ewa Kwiatkowska** (EUMETSAT)

14:10 – 14:20 Discussion: identification of recommendations from 2013 which are incomplete but still relevant, input on session objectives

**Obstacles and successes with operational OC data services**

14:20 – 14:30 Remote sensing for applied fisheries research. **Dabin Lee** (Pusan National University)

14:30 – 14:40 NOAA Fisheries Management. **Cara Wilson**

14:40 – 14:50 National Oceans and Coastal Information Management System (OCIMS). **Stewart Bernard** (CSIR)

14:50 – 15:00 **Mario Castro de Lera** (Deep Blue Globe UG) , **Pablo Ruiz Sánchez** (ESA incubator)

15:00 – 15:20 Discussion: where is the biggest gap in achieving fit-for-purpose OC data? Where should the main research, technical, training and outreach efforts be focused?

**Approaches, techniques, tools to address users at multiple levels of sophistication**

15:20 – 15:30 Experience from user training. **Hayley Evers-King** (EUMETSAT / PML)

15:30 – 15:50 Discussion: what details best to supply what to do not to overwhelm

**Bringing agencies, information services and users together**

15:50 – 16:00 Assuring the broad uptake of OC data services. **Gianluca Volpe** (CMEMS)

16:00 – 16:20 Discussion: how to know if data are "fit-for-purpose"?

16:20 – 16:30 Key points, synthesis and actions. **Veronica Lance** (NOAA), **Ewa Kwiatkowska** (EUMETSAT)

# Thursday, April 11

09:30 - 12:15 **Breakout WS 7**: Emerging Technologies for Ocean Colour

**Co-chairs:** Mike Twardowski (HBOI-FAU) and Griet Neukermans (LOV/CNRS)

*This session will focus on breakthrough technologies for ocean color remote sensing research. Interactive talks will be given for key areas of ocean color observing, each followed by a group discussion.*

*Presentations and discussions will be organized into a peer reviewed publication to raise awareness of these breakthroughs in the ocean color community.*

**AGENDA**

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|---|---|
| 09:30 - 09:35 | Introduction to session. **Mike Twardowski** (HBOI-FAU) |
| 09:35 – 09:50 | Radiometric validation: HYPERNETS/WATERHYPERNETS next generation hyperspectral, multi-view validation system. **Kevin Ruddick** (RBINS) |
| 09:50 – 10:00 | Radiometric cal/val: HYPERNAV float. **Andrew Barnard** (SeaBird) |
| 10:00 - 10:10 | Radiometric cal/val: ProVal float. **Griet Neukermans** (LOV) |
| | ***Coffee available (without break)*** |
| 10:10 – 10:40 | Group Discussion: Radiometric cal/val advances in support of OC missions. |
| 10:40 – 10:50 | Inherent optical property validation: Hyperspectral backscattering sensor. **Wayne Slade** (Sequoia Scientific) |
| 10:50 – 11:20 | Group Discussion: IOP advances for validation for OC missions. |
| 11:20 - 11:35 | The remote sensor and platform: A novel spatial light modulator imaging system for high altitude platforms. **Mike Twardowski** (HBOI-FAU) |
| 11:35 – 12:05 | Group discussion: Remote sensor and platform advances for OC missions - this will focus on new potential applications for breakthrough technologies in ocean color such as these and their potential to directly support or compliment ongoing and future international ocean color missions. |
| 12:05 - 12:15 | Summary and preparation of key messages |

# Thursday, April 11

09:30 - 12:15 **Breakout WS 8**: Ocean Colour Satellite Sensor Calibration

**Chair:** Gerhard Meister (NASA)

*This workshop is the main forum for the IOCCG Task Force on 'Ocean Color Satellite Sensor Calibration'. The task force was established to answer to the needs of all ocean colour missions because accurately calibrated and characterized satellite sensors are a prerequisite for most of the OCR applications, from climate, Earth system science and marine ecosystem monitoring, to operational services including water quality, fisheries and algal blooms. The specific goal of this workshop is to support the calibration teams of all current and planned ocean color sensors, providing an opportunity to learn about the latest calibration developments from the agency calibration representatives and experts.*

*The list of speakers indicates that calibration experts from almost all current and future ocean color missions will be present to share their experience and discuss possible improvements to their current approach regarding both prelaunch and on-orbit calibration/ characterization.*

***Key questions***

*- What are the main concerns regarding on-orbit calibration of currently active sensors?*

*- Are there new approaches to the prelaunch characterization of ocean color sensors?*

**AGENDA**

09:30 - 09:35 Introduction. **Gerhard Meister (**NASA)

09:35 - 09:50 Calibration program for the Ocean Color Instrument (OCI) on the PACE mission. **Gerhard Meister** (NASA)

09:50 - 10:05 JPSS-2 VIIRS pre-launch calibration and characterization. **Jack Xiong** (NASA GSFC)

10:05 - 10:20 OLCI-B straylight correction performance assessment using Moon observation. **Ludovic Bourg** (ACRI-ST, ESA)

10:20 - 10:35 Estimating straylight impact on ocean color products based on point-spread functions. **Shihyan Lee** (NASA)

10:35 - 10:50 On-orbit calibration results of GOCI and pre-launch test results of GOCI-II. **Seongick Cho/Kibeom Ahn** (KIOST)

10:50 - 11:05 NOAA VIIRS calibration results. **Menghua Wang** (NOAA)

11:05 - 11:15 ***Coffee break***

11:15 - 11:30 Radiometric calibration of SGLI on-orbit. **Hiroshi Murakami** (JAXA)

11:30 - 11:45 On-orbit performance of the HY-1C/COCTS. **Xianqiang He** (SIO, SOA)

11:45 - 12:00 Sentinel-3B OLCI solar diffuser characterization on orbit. **Ewa Kwiatkowska** (EUMETSAT)

12:00 - 12:15 OLCI-A and OLCI-B cross-calibration using the tandem-flight period. **Ludovic Bourg** (ACRI-ST, ESA)

# Thursday, April 11

09:30 - 12:15 **Breakout WS 9**: Atmospheric Correction Under Complex/Extreme Environments

**Co-chairs:** Constant Mazeran (SOLVO), Amir Ibrahim (NASA), Robert Frouin (UCSD)

*Space agencies have been successful in producing high quality ocean color (OC) data from satellite remote sensing over the open ocean where the atmospheric conditions are near ideal. However, there is still a strong necessity to improve OC remote sensing under more complex conditions frequently observed by satellites. The OC signal is only a small fraction of the total signal measured by a sensor at the top of atmosphere, rendering the atmospheric correction (AC) a challenging task. A non-robust AC algorithm can induce failures in OC retrievals under complex conditions, resulting in loss of a significant volume of OC data. These complex conditions include for instance strongly scattering waters in the near-infrared, highly absorbing waters in the visible, strongly absorbing aerosols, presence of thin clouds, sub-pixel variability, adjacency effects near bright targets, shallow waters, residual sun glint, and high viewing or solar zenith angles. Another technical challenge to foster OC data in complex environments is to provide users with an evolved level of confidence, such as per-pixel uncertainties (e.g. mission requirements of Sentinel-3), instead of binary flags (success/failure).*

*Building on the earlier IOCS 2013 session about atmospheric correction (Advances in atmospheric correction of satellite Ocean-Color imagery), the goal of the present workshop is to review the recent progress achieved by the OC community and help identifying the remaining gaps in current algorithms. The outcome is to provide space agencies with the priority focus that would extend the benefit of operational OC missions. To maintain a focused and fruitful discussion, the workshop will be structured around three main topics and a final discussion: atmospheric correction over optically-complex waters (Part 1); atmospheric correction in the presence of absorbing aerosols (Part 2); uncertainty estimates (Part 3); and a final discussion to exchange about other important topics that should receive more attention in the future (e.g. AC over shallow waters, synergy between sensors, use of global numerical model outputs). The workshop will provide the audience with a quick feedback about the on-going international OC activities (notably two IOCCG working groups: Inter-comparison of Atmospheric Correction Algorithms Over Optically-Complex Waters and Uncertainties in Ocean Color Remote Sensing) and will keep two-thirds of the time for live discussion guided by seed questions. The workshop will reflect on the active context in OC embracing both operational and emerging technologies: long-term Sentinel-3 program (OLCI), high resolution missions (Sentinel-2, Landsat), hyperspectral sensor (PACE) and geostationary orbit (GOCI-II).*

**AGENDA**

09:30 - 09:35 Introduction, goal and organization of the workshop. **Constant Mazeran, Amir Ibrahim, Robert Frouin**

**Part I: Atmospheric correction over optically-complex waters**

09:35 - 09:45 Key findings of the IOCGG WG Intercomparison of Atmospheric Correction Algorithms Over Optically-Complex Waters. **Cédric Jamet** (ULCO)

09:45 - 09:55 Review of EUMETSAT Bright Pixel Correction for Sentinel-3/OLCI. **Constant Mazeran** (SOLVO)

09:55 –10:05 Review of CEOS/ESA/NASA ACIX I and ACIX II activity for Landsat/Sentinel-2 atmospheric correction over inland and nearshore coastal waters. **Nima Pahlevan** (NASA/GSFC)

10:05 –10:30 Group discussion: What is the most robust strategy for AC over optically-complex waters?

***Coffee will be available from 10:00 outside the room in case people want to slip out (without break)***

**Part II: Atmospheric correction in the presence of absorbing aerosol** (chair: Amir Ibrahim)

10:30 - 10:40 Physics and remote-sensing of absorbing aerosol. **Robert Frouin** (UCSD)

10:40 - 10:50 $NO_2$ correction over coastal waters. **Maria Tzortziou** (CCNY)

10:50 –11:20 Group discussion: how to detect and correct for absorbing aerosols?

**Part III: Uncertainties of atmospheric correction** (chair: Frédéric Mélin)

11:20 –11:30 Key findings of IOCCG WG Uncertainties in Ocean Colour Remote Sensing. **Frédéric Mélin** (JRC)

11:30 –11:55 Group discussion: How to derive uncertainties in the atmospheric correction?

**Final group discussion** (co-chairs Constant Mazeran, Amir Ibrahim, Robert Frouin)

11:55 –12:15 Other techniques/ideas for AC in complex environments. Preparation of key message for the agencies.