Journées Scientifiques LEFE/GMMC 2019
12 au 14 juin 2019


Site du colloque


Pause déjeuner

Université de Toulon
Campus de Toulon – Bât. PI – Amphi FA001
70 Avenue Roger Devoucoux 83000 TOULON

Recueil des Résumés de Communications

Ce document rassemble les résumés des communications qui seront présentées aux journées GMMC sous forme orale ou poster. Le numéro du résumé correspond à son ordre de présentation dans le programme.

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1. Vue d'ensemble de la Conférence Oceanobs19
Sabrina Speich (ENS/LMD, Paris)

2. From observation to information and users: the Copernicus Marine Service perspective.
Yann Drillet (*Mercator Ocean International, Toulouse)*

3. FAIR Principles: Data Services.
Sylvie Pouliquen (*Centre Coriolis, Iremer, Plouzané)*

4. Toward a 4-D vision of the ocean carbon: synergy between active and passive sensors
Cédric Jamet (*Laboratoire d'Océanologie et de Géosciences, 28 avenue Foch, BP 80 62930 Wimereux)*

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5. OceanGliders, programme associé du GOOS pour les planeurs sous-marins
Laurent Mortier et Pierre Testor (*LOCEAN, Paris)*

Le programme OceanGliders a été lancé en 2016 pour soutenir la coordination et le renforcement de l'activité globale des planeurs sous-marins ou gliders pour l'observation de l'océan. OceanGliders contribue aux efforts internationaux du Global Ocean Observing system (GOOS) qui coordonne les programmes d'observation de l'océan pour le climat, la santé des océans et les services opérationnels. Il rassemble des scientifiques et des ingénieurs qui utilisent des gliders dans le monde entier : (1) pour observer à long terme les processus et phénomènes océaniques physiques, biogéochimiques et biologiques pertinents, en vue de contribuer à des applications sociétales; et (2) pour contribuer au GOOS par la diffusion de données en temps réel et en mode différé. Le programme OceanGliders est réparti entre les systèmes d'observation nationaux et régionaux et contribue de manière significative à leurs

stratégies d'échantillonnage intégrées, multi-échelles et multi-plateformes. OceanGliders partage les bonnes pratiques, les exigences et les connaissances scientifiques nécessaires aux opérations de pilotage des gliders, à la collecte et à l'analyse de données. Il surveille également l'activité globale des gliders et soutient la diffusion des données de planeurs via des bases de données régionales et mondiales, en temps réel et différé, facilitant ainsi l'accès aux données à la communauté plus large. OceanGliders soutient actuellement des initiatives nationales, régionales et mondiales visant à élargir les capacités et l'application des gliders sur quelques thèmes clefs, tels que de la mesure des courants de bord, la transformation de l'eau, y compris en zone polaire, et la prévision des tempêtes.

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6. Ship-Based Contributions to Global Ocean, Weather, and Climate Observing Systems

Gaël Alory (*LEGOS, Toulouse)*

7. Planetary Heat Balance and Global Ocean Heat Content

Benoit Messignac (*LEGOS, Toulouse)*

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8. Beyond Chl-a: is large scale plankton abundance and diversity observatory could be made possible thanks to available technologies?

Fabien Lombard (*Laboratoire d'Océanographie de Villefranche)*

While plankton abundance and its diversity have a crucial role in vertical (biogeochemical) and horizontal (trophic) flux, there is very little global observation framework of plankton beyond chlorophyll measurements. We have at hand all the techniques and the technologies to make globally quantitative observations of plankton in the world oceans, and for sizes varying from sub-microns to centimeters. Some of these technologies have been available for years while others have only recently emerged. Use of these technologies is critical to improve understanding of the processes that control abundances, distributions and composition of plankton, provide data necessary to constrain and improve ecosystem and biogeochemical models, and forecast changes in marine ecosystems in light of climate change. We propose ranked action-item recommendations for the next 10 years to move toward our vision of a holistic ocean-wide plankton observing system.

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9. PIRATA: A SUSTAINED OBSERVING SYSTEM FOR TROPICAL ATLANTIC CLIMATE RESEARCH AND FORECASTING

Jérôme Llido[1], Bernard Bourlès[2], Moacyr Araujo[3], Michael J. McPhaden[4], Peter Brandt[5,6], Gregory R. Foltz[7], Rick Lumpkin[7], Hervé Giordani[8], Fabrice Hernandez[1,3], Nathalie Lefèvre[9], Paulo Nobre[10], Edmo Campos[11,12], Ramalingam Saravanan[13], Janice Trotte-Duhà[14], Marcus Dengler[5], Johannes Hahn[5], Rebecca Hummels[5], Joke F. Lübbecke[5,6], Mathieu Rouault[15], Leticia Cotrim[16], Adrienne Sutton4, Markus Jochum[17] and Renellys C. Perez[7].

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PIRATA (Prediction and Research Moored Array in the Tropical Atlantic) is a multinational program initiated in 1997 to improve our knowledge and understanding of ocean-atmosphere variability in the tropical Atlantic, a region that strongly influences in a wide range of timescales the hydro-climates and, consequently, the economies of the regions bordering the Atlantic Ocean. PIRATA is motivated by both fundamental scientific questions and societal needs for improved prediction of weather and climate variability and their impacts. To address these challenges, PIRATA network has evolved naturally over time to reach now an array of 18 moored buoys providing meteorological and oceanographic data transmitted in real-time, disseminated via Global Telecommunication System (GTS) and Global Data Servers. Additionally, 3 subsurface ADCP moorings deployed along the equator complete this network. Through yearly mooring servicing, data and sensors are calibrated and recorded high-frequency data are collected. The dedicated cruises of yearly maintenance of the PIRATA network allow complementary measurements of a large set of physical, biogeochemical and biological data along repeated ship track lines and provide platforms for deployment of other components of the Tropical Atlantic Observing System.
With more than 20 years old, PIRATA provides invaluable data time series for scientific research, monitoring and operational forecasts and analyses. Indeed, sustained measurements over 2-decades in the tropical Atlantic are extremely important for observing ocean - atmosphere variability on interannual to multi-decadal timescales and changes in response to global warming. From 2015, PIRATA buoys are progressively replaced by new T-Flex systems, more performing, allowing high-frequency real time data transmission as well as potential enhancements and deployments of new sensors at existing sites playing a key role in the future Tropical Atlantic Observing System.

10. Dynamical processes of the west African Oxygen Minimum Zone: results from the SENOX project

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The nearshore band along subtropical northwestern Africa holds a major upwelling system hosting important industrial and artisanal fisheries. This oceanic system intersects the west-African Oxygen Minimum Zone, a subsurface water body with low oxygen concentrations. In contrast with other OMZs such as off Peru and Chile, two distinct poorly-oxygenated (hypoxic) layers (O_2<60 µmol L^{-1}) can be identified: a deep (300-600 m) and a shallow (50-200 m) layer. The shallow OMZ varies seasonally presumably as a result of the tight control by the respiration of sinking organic matter produced in the surface layer during the boreal winter-spring upwelling season.
Recent scientific activities have taken place in the framework of collaborative projects between French and Senegalese scientists in the last decade. These studies have mostly focused on the ocean dynamics and biogeochemical cycles over the continental shelf located south of Dakar. Measurements have shown for the first time that the bottom shelf waters can become anoxic(O_2< 5 µmol L^{-1}), with important impacts on the nitrogen cycle and living resources. Moreover, realistic regional modelling has allowed us to describe the seasonal variability of the circulation and 3D Lagrangian pathways of upwelled waters over the shelf and slope region. However, the dynamical and biogeochemical processes responsible for the oxygen depletion of shelf waters remain largely unknown.
In this work, we study the dynamics of dissolved oxygen in the west-African basin using Mercator global model output and a regional coupled physical-biogeochemical model (CROCO-PISCES). The regional model is forced by boundary conditions from various GCMs (including ORCA12 operated by Mercator-Ocean) and by various atmospheric forcings. Results show that the deep OMZ is not well reproduced mainly because of advection of oxygen-rich waters into the OMZ region. In contrast, the modelled shallow OMZ is more realistic and oxygen temporal variability over the shelf is well reproduced in comparison with measurements at the MELAX site. These preliminary results indicate that the regional model driven by high-frequency boundary conditions can be used as an efficient tool to decipher and hindcast oxygen variability on the Senegalese shelf.

11. Internal tides in the Solomon Sea : Characteristics and impacts

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The Solomon Sea is the last passageway for the low-latitude western boundary currents of the Southwest Pacific that connect the subtropics to the equator by supplying water of subtropical origin to the Equatorial Undercurrent (EUC), Warm Pool, and Indonesian Through flow. The complex bottom bathymetric features encountered in the area allow strong generation of internal tides leading to one of the hot spot in the world for enhanced dissipation and mixing. Based on tidal forced, hourly output of NEMO high-resolution model and new methodology for tidal energy diagnostics based one vertical modes, we better characterize the internal tides in the Salomon Sea. M2 is the most important baroclinic tide component; it is principally generated at the entrance of the Solomon Strait, the southern extremity of the Solomon Island and the Papouasy New Guinea eastern tip. Part of these waves dissipate locally and the rest is propagated away from generation sites, which is in good agreement with the observed sea surface height (SSH). In addition, the variability of the stratification and mean circulation during ENSO lead to interannual variability of the incoherent internal tide. Comparison of simulation with and without tidal forcing show that the diapycnal tidal mixing is responsible for a fresher and cooler sea surface. It produces also a fresher thermocline water, by eroding the maximum of salinity of upper thermocline water.

12. Equatorial biases in biogeochemistry with data-assimilated ocean circulation models: a Lagrangian perspective

Simon van Gennip, Marie Drevillon, Charly Régnier, Jean Michel Lellouche, Eric Grenier, Coralie Perruche, Mathieu Hamon, Elisabeth Rémy, Florent Gasparin, Yann Drillet

Mercator-Ocean International, Toulouse

Data assimilation of observations into dynamical equation of ocean models improves estimate of ocean conditions, yet when such models are used to force biogeochemical models (BGCM), large biases appear in sensitive biogeochemistry fields such as chlorophyll or nitrate. This is particularly true along the equator where BGCMs with assimilated physics are over-productive. Here we investigate such biases in productivity within the equatorial Pacific from a Lagrangian perspective. We use two 1/12 degree coarsened global physical twin model runs with identical forcing but differing in that one is free and the other uses data assimilation, together with their respective embedded BGCM. We examine ocean circulation pathways that reach the euphotic zone and how they affect BGC variables, and propose potential mechanisms that could improve circulation and potentially reduce the equatorial biogeochemical biases.

13. Response of the South Eastern Pacific Oxygen Minimum Zone to ENSO

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While observations suggest a long-term expansion of the Oxygen Minimum Zone (OMZ) in the South Eastern Pacific (SEP), it also exhibits a large interannual to decadal variability in its upper and lower limits. The uncertainty of the fate of the SEP OMZ in a warmer climate as simulated by Earth system models also questions to which extent natural variability in the OMZ can obscure the detection of externally forced trends. Here we analyze long-term simulations from a hierarchy of models of the OMZ off Peru and Chile and show that a significant share of the variability is not linearly related to climate modes (including ENSO), suggesting that it originates from internal dynamics associated to both local non-linear physical and biogeochemical processes. Still the OMZ volume tends to shrink during strong Eastern Pacific El Niño while it expands during La Niña and Central Pacific El Niño events. It is shown in particular that La Niña and strong El Niño events significantly modulate the OMZ volume through the transport of water masses of equatorial origin by the Peru/Chile undercurrent and the propagation of extra-tropical Rossby waves. Implications of our results are discussed in terms of the challenge for developing an Eastern Pacific observing system in the frame of the TPOS2020 program, considering the time of emergence for climate-trend detection above background variability.

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14. Argo technology and integration on the global ocean observing system

Guillaume Maze (*LOPS Brest)*

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15. ANDRO : An Argo-based deep displacement atlas

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Since early 2000's, thousands of Argo floats have been deployed over the World Ocean, gathering temperature and salinity data from the upper 2000 m with a 10-day or so sampling period. Between each profiles the Argo profiling floats drift at a nominal parking depth around 1000 dbar. Meanwhile their deep displacements can be used to map the ocean circulation at their drifting depth.
In collaboration with Coriolis Data Center and Service National Argo-France at LOPS Laboratory (Brest, France), a comprehensive delayed mode processing of the Argo data collected has been done to produce a world atlas, named ANDRO (Ollitrault and Rannou, 2013), of float subsurface displacements. The ANDRO deep velocities have been initially estimated from Argo data along the same lines and with almost the same format as Yomaha'07 atlas (Lebedev et al. 2007).
The processing of the whole Argo dataset collected prior to 1 January 2010 has been initially performed to produce a world-wide dataset of deep displacements. Since 2010, ANDRO has been regularly updated, in priority with data managed by the Coriolis Data Assembly Center (DAC), and gradually with data managed by the other DACS. This ANDRO numerical atlas comprises some 880 000 deep displacements, from almost 7600 Argo floats (including 51% of the total Argo fleet). These displacements, based only on Argos or GPS surface locations, have been fully checked and corrected for possible errors. Pressures measured by the floats while drifting at depth are visually checked and used to estimate a mean displacement depth, which is much more accurate than using the nominal parking pressure : 71% of the float displacements are in the layer (750, 1250) dbar with a good (more or less uniform) coverage of all the oceans, except around Antarctica (south of 60°S). Two deeper layers (1250, 1750) and (1750, 2250) dbar are also sampled (12% and 6% of the float displacements, respectively) but with lower geographical coverage. Grounded cycles (i.e., when the float hits the sea floor during its deep drift) are visually identified and not used for deep displacement estimates. ANDRO is available online on ASCII format on the doi : https://www.seanoe.org/data/00360/47077/.

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16. Etat des lieux du contrôle qualité des flotteurs BGC-Argo

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Les six «core» variables du programme BGC-Argo (flotteurs ARGO équipés de capteurs biogéochimiques) sont la concentration en chlorophylle (CHLA), le coefficient de rétrodiffusion particulaire (BBP), le pH, la concentration en nitrate (NITRATE), la concentration en oxygène dissout (DOXY) et la radiometrie (PAR+irradiance). Dans le cadre du programme national LEFE-GMMC, des flotteurs profileurs BGC-Argo sont mis à disposition de la communauté scientifique, à travers des projets évalués chaque année par le CS GMMC. Ces flotteurs sont équipés en standard pour trois de ces six «core» variables (CHLA, BBP, PAR+irradiance) et complétés opportunément par un capteur oxygène et/ou un capteur nitrate.
A l'heure actuelle, la flotte mondiale de flotteurs BGC-Argo a atteint plus de 350 unités, dont 26 déployés (y compris les flotteurs récupéres et redéployés) par des équipes françaises dans le cadre de l'AO annuel du programme national LEFE-GMMC. La définition, l'implémentation et la validation d'un système de contrôle de qualité (QC) des observations BGC-Argo sont considérées comme des objectifs majeurs de l'activité BGC-Argo internationale et française. Ici, l'état d'avancement et les prochaines échéances du contrôle qualité des flotteurs BGC-Argo seront présentés. Des efforts ont été portés sur la variable DOXY (nouveau test en temps réel pour discriminer les données biofoulées, ajustement en temps réel sur la climatologie). Ces améliorations seront illustrées ainsi que le statut du QC pour les autres variables (CHLA, BBP, PAR+irradiance, pH et NITRATE)).

17. Measuring and understanding sea level changes at global, regional and local scales; Inferences on coastal impacts

Anny Cazenave (*LEGOS, Toulouse et ISSI, Bern)*

Climate-related sea level rise is one of the best indicators of global climate change. Although being a slow process, sea level rise is also recognized as a major threat affecting low-lying, highly populated coastal regions of the world. Because of crucial importance for adaptation purposes and associated socio-economic issues, measuring and understanding present-day sea level changes from global to local scales stand among the highest priorities in ocean and climate research. The Decadal Survey Report published by the National Research Council of the US National Academies (NRC, 2018) listed sea level rise among its highest priorities for the next decade and identified two major questions to be answered: (1) How much will sea level rise, globally and regionally, over the next decade and beyond, and what will be the role of ice sheets and ocean heat storage? (2) How will local sea level change along coastlines around the world in the next decade to century? To address these issues, understand processes causing sea level changes from global to coastal scales and assess impacts on coastal populations, as well as validate climate models used for projections, a broad range of observing systems used in synergy is needed. Here we discuss three interconnected themes and address associated observational requirements:
(1) *Sea level rise at global and regional scales and causes.* Needs include: maintaining the constellation of high-precision altimetry missions on the long-term, with at least 2 satellites in orbit, and at least one covering high-latitude regions (Arctic Ocean); maintaining Core Argo and develop Deep Argo; improve the T/S coverage in poorly sampled regions (Arctic, Indonesian seas); maintaining and improve GRACE-type space gravimetry missions to measure mass changes contributing to global and regional sea level (ocean mass, glaciers and ice sheet mass balance, land water storage); improve models of glacial isostatic adjustment (GIA) and other solid Earth processes linked to present-day ice melting to interpret space gravimetry over oceans and ice sheets, and quantify fingerprints of regional sea level change.
(2)Coastal sea level measurements: Sea level rise in coastal zones, highly under-sampled by tide gauges, remains poorly known. Objectives are: exploit new altimetry technology (Delay-Doppler, Laser and interferometric altimetry on CryoSat, Sentinel-3A/B, IceSat-2 and SWOT missions) to monitor high-resolution sea level changes in coastal regions and combine with reprocessed conventional altimetry

missions to provide long-term coastal sea level time series; improve the tide gauge network; explore the use of GNSS reflectometry to measure sea level at the coast.
(3)Coastal processes and coastal responses: Implement systematic monitoring of the world coastal zones in different types of environments using space-based and in situ sensors to measure: (i) forcing factors affecting coastal zones, in addition to sea level rise, over different spatio-temporal scales: winds & waves, shelf currents, storm surges, river runoff in estuaries, sediment supply and transport, vertical land motions and land use; (ii) coastal responses: change in shoreline position, in estuaries morphology, in land topography at the land-sea interface and in coastal bathymetry; (ii) understand the roles of the different forcings, in particular sea level rise.

18. Sustained Mediterranean Observing System

Patrick Raimbault (*MIO*)

19. TRANSMED: Séries temporelles de SSS et SST à travers le Bassin Occidental de la Méditerranée depuis 2012 : quelles leçons, quel avenir ?

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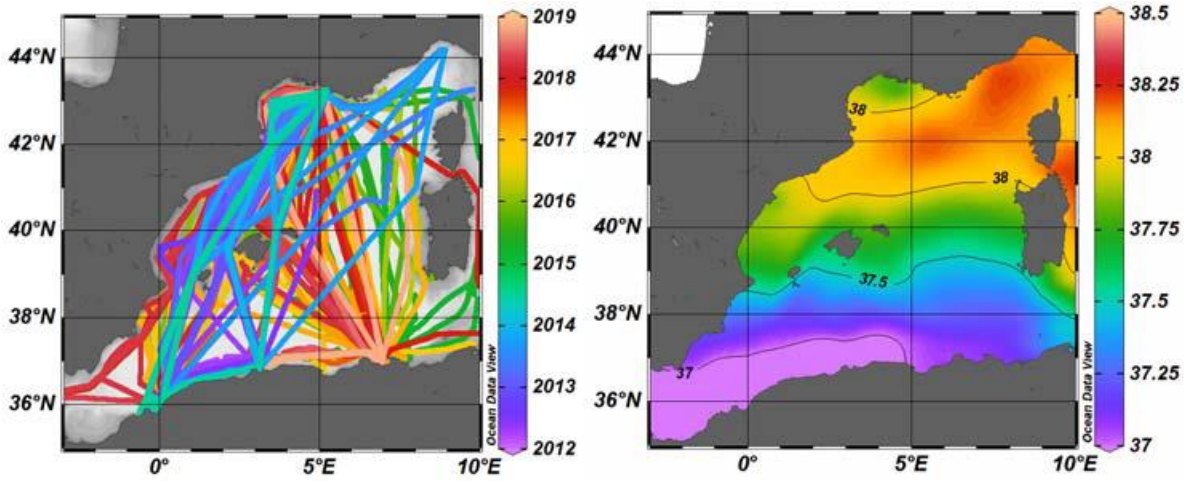
Dans le cadre du programme HyMeX (2010-2020, www.hymex.org) le système de thermosalinomètre low-cost et autonome TRANSMED (www.ifremer.fr/transmed) est devenu opérationnel. Depuis février 2012 la température (SST) et la salinité (SSS) de surface sont enregistrées toutes les 10s (~80m) par des navires d'opportunité sur des routes Marseille-Algérie (cf Figure). Les données sont transmises en temps quasi-réel, puis les fichiers bâtis avec la SSS médiane calculée sur 2min sont envoyés toutes les 24h à Coriolis. Il s'agit d'un système simple, que nous avons donc pu transposer sur un autre navire lorsque le 1er a été dédié à un service hors Méditerranée. De plus c'est un système ouvert que nous pouvons faire évoluer puisque bâti autour de logiciels ouverts avec le soutien de la Division Technique de l'INSU. La miniaturisation du système est déjà en cours, et devrait permettre, dans une deuxième étape, d'équiper également des vedettes côtières (îles du Frioul, PN Calanques et PN Port-Cros, ASPIM en géneral). Cette présentation fera le point sur les résultats acquis, les évolutions futures et les points de blocage de ce type de stratégie.



Distribution spatio-temporelle des routes TRANSMED suivies depuis 2012 (gauche). Distribution spatiale de la SSS correspondante (droite)

20. Réseau HTM-NET de mesures des niveaux d'eau et des températures sur le littoral provençal : apports à l'étude de la dynamique océanique de l'échelle littorale à l'échelle globale

Vincent Rey[1], Caroline Paugam [1], Christiane Dufresn[2], Isabelle Taupier-Letage[1], Jean-Luc Fuda[1], Didier Mallarino[1], Samuel Meulé[3], Tathy Missamou[1], Gilles Rougier[1], Damien Sous[1]

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Un réseau d'instruments de mesure a été installé dans différents ports, le long de la côte varoise, entre les îles d'Hyères à l'est et la baie de Sanary à l'ouest (réseau HTM-NET, https://htmnet.mio.osupytheas.fr/HTMNET/squel.php?content=accueil.php) entre 2013 et 2018, puis étendu début 2019 aux Bouches-du-Rhône, entre La Ciotat et le Cap Couronne, ainsi que dans l'étang de Berre. Deux capteurs piézométriques, l'un immergé et l'autre émergé, permettent de connaitre la pression atmosphérique, le niveau d'eau et la température au niveau du capteur immergé. Le réseau compte actuellement 15 stations dont 13 munies d'un transmetteur GSM qui permet une acquisition en temps quasi-réel des données (toutes les dix minutes jusqu'à fin 2018, puis toutes les deux minutes en 2019). Les données de niveau sont accessibles sur le site REFMAR du Shom.

La mise en place de ce réseau avait été motivée lors de l'étude de la dynamique des échanges de masses d'eaux entre le large et la rade de Toulon (Dufresne, 2014 ; Dufresne et al, 2014), par le rôle potentiel des variations de niveau d'eau sur la dynamique à l'échelle des baies. Elle est actuellement également motivée par l'étude et la compréhension des basculements de plan d'eau et de seiches à l'échelle de baies semi-ouvertes ou fermées. Les données de niveau permettent de retrouver les signaux de marée, semi-diurnes ou diurnes, d'amplitude environ 0.10m, et font apparaitre de plus fortes variations de niveau, de l'ordre de 0.50m, associées aux variations barométriques. Les effets de dilatation stérique sont également observés, d'une amplitude de l'ordre de 0.10m, effets dont la variabilité suit la variabilité interannuelle des températures. Les effets du vent sur les niveaux sont de l'ordre de plus ou moins 0.10m dans la petite rade de Toulon comparés aux îles d'Hyères, respectivement par conditions de vent d'est ou de Mistral. Les données de température mettent en évidence le déclenchement d'upwellings lors des épisodes de Mistral, en période stratifiée, dans certaines baies, et la variabilité de leur intensité en fonction de l'intensité et de l'orientation du coup de Mistral. Elles permettent également d'appréhender les échanges de masse d'eau, notamment entre la rade de Toulon et le large en période hivernale.

Outre la dynamique à l'échelle littorale, le réseau permet également d'apporter des informations intéressantes pour les études des niveaux d'eau à l'échelle des bassins, ici du bassin Méditerranéen occidental, pour lesquelles les données altimétriques sont souvent confrontées ou validées par les données des marégraphes (Adloff et al, 2018; Bonaduce et al, 2016). Or il apparait clairement que par conditions de vent fort (de terre ou du large), des différences de niveau significatives (de l'ordre de 0.10m) peuvent exister entre le fond de baies, où sont implantés les marégraphes, et la zone côtière (dans le cas présent l'île de Port-Cros). Il en est de même pour les données de température de l'eau en surface (SST), dont les données satellitales sont écartées dans beaucoup de produits car non « réalistes » (Buongiorno Nardelli et al, 2013). Or en été, des températures de 15°C ne sont pas anormales en présence d'upwellings, comme le montrent clairement les mesures sur les stations du réseau HTM-NET et de TRANSMED. Les données du réseau apportent donc également une validation des données satellitales à l'échelle littorale et côtière.

Mots clefs : Réseau d'observation, Niveaux d'eau, Températures sub-surface, Marée, Surcote, Seiche, basculement de plan d'eau, upwelling, mélange des masses d'eau.

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21. Observing the Ocean Surface Topography at High Resolution by the Surface Water and Ocean Topography (SWOT) Mission

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The future international Surface Water and Ocean Topography (SWOT) Mission, planned for launch in 2021, will make high-resolution 2D observations of sea-surface height using the SAR radar interferometry technique. With measurements over a swath of 120 km (20 km nadir gap), SWOT will map the entire earth up to 77.6° latitude every 21 days. Today's mapped altimeter data resolve scales of 150 km wavelength whereas the SWOT measurement will extend our 2D observations down to possibly 15 km, offering opportunities to observe the oceanic dynamic processes at these scales that act as one of the main gateways connecting the interior of the ocean to the upper layer. These processes provide both sinks and sources for the kinetic energy at larger scales, involving both low-frequency geostrophically balanced motions and high-frequency internal tides and gravity waves. The active vertical exchanges linked to these scales have impacts on the local and global budgets of heat, carbon and nutrients for biogeochemical cycles.
To mitigate the challenge of the temporal sampling, the first 90 days of the mission after the commissioning phase will be flown in a 1-day repeat fast-sampling phase for calibration and validation. This improved temporal sampling will allow enhanced understanding of the measurement at 15-150 km wavelengths in terms of signals and measurement errors. There will be two measurements a day at the crossover regions, where the 2D measurement at twice daily interval will provide the maximum amount of information on rapidly changing signals and errors. During this phase, in-situ observations of the ocean dynamic height will be deployed to evaluate the relationship of the sea surface height measurement to the ocean's internal processes. Airborne lidar will also be flown to measure the sea surface height for comparison with the satellite observations.
The SWOT mission's topics of oceanographic investigations cover mesoscale and submesoscale processes; modeling and data assimilation; tides, waves, and high-frequency processes; calibration and validation; coastal and estuarine processes. Due to the challenges posed by the coarse temporal sampling and measurement errors, the science investigations will heavily depend on modeling and assimilation for the construction of high-level gridded products.

22. Atténuation de la variabilité chaotique observée par altimétrie.

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Des simulations ensemblistes permettent de séparer la variabilité océanique en signaux déterministes (forcés par l'atmosphère) et chaotiques (générés par l'océan et de phase aléatoire). Des études récentes ont montré que ce "chaos" peut masquer le signal déterministe dans de nombreuses régions, et pourrait perturber la détection et l'attribution du changement climatique dans l'océan (tendances du contenu thermique et du niveau des mers, en particulier). Nous avons développé un filtre spatial, calibré sur la simulation globale ensembliste OCCIPUT, permettant d'atténuer le chaos et de révéler des signaux basse fréquence forcés par l'atmosphère dans les données altimétriques. Une alternative à ce filtre, basée sur l'intelligence artificielle, est en cours d'élaboration et permet d'améliorer les résultats. Les applications observationnelles de ces techniques seront discutées.

23. Fabrice Ardhuin (LOPS): Exploring ocean surface currents and waves: the ESA EE9 Sea surface KInematics Multiscale monitoring (SKIM) Mission

Fabrice Ardhuin[1], Craig Donlon2, Erik de Witte[2], Alessandro Battaglia[3], Peter Brandt[4], Fabrice Collard[5], Geir Engen[6], Daniele Hauser[7], Paco Lopez-Dekker[8], Louis Marie[1], Adrien Martin[9], Jamie Shutler[10], Detlef Stammer[11], Michel Tsamados[12], Erik van Sebille[13], Bertrand Chapron[1], Jean Marc Delouis[1], Bjorn Frommknecht[2], Frederic Nouguier[1], Lucile Gaultier[5], Martin Suess[2], Tania Casal[2], Marie Helene Rio[2], Bjorn Rommen$_2$, Gerhard Ressler[2], Clement Ubelmann[14].

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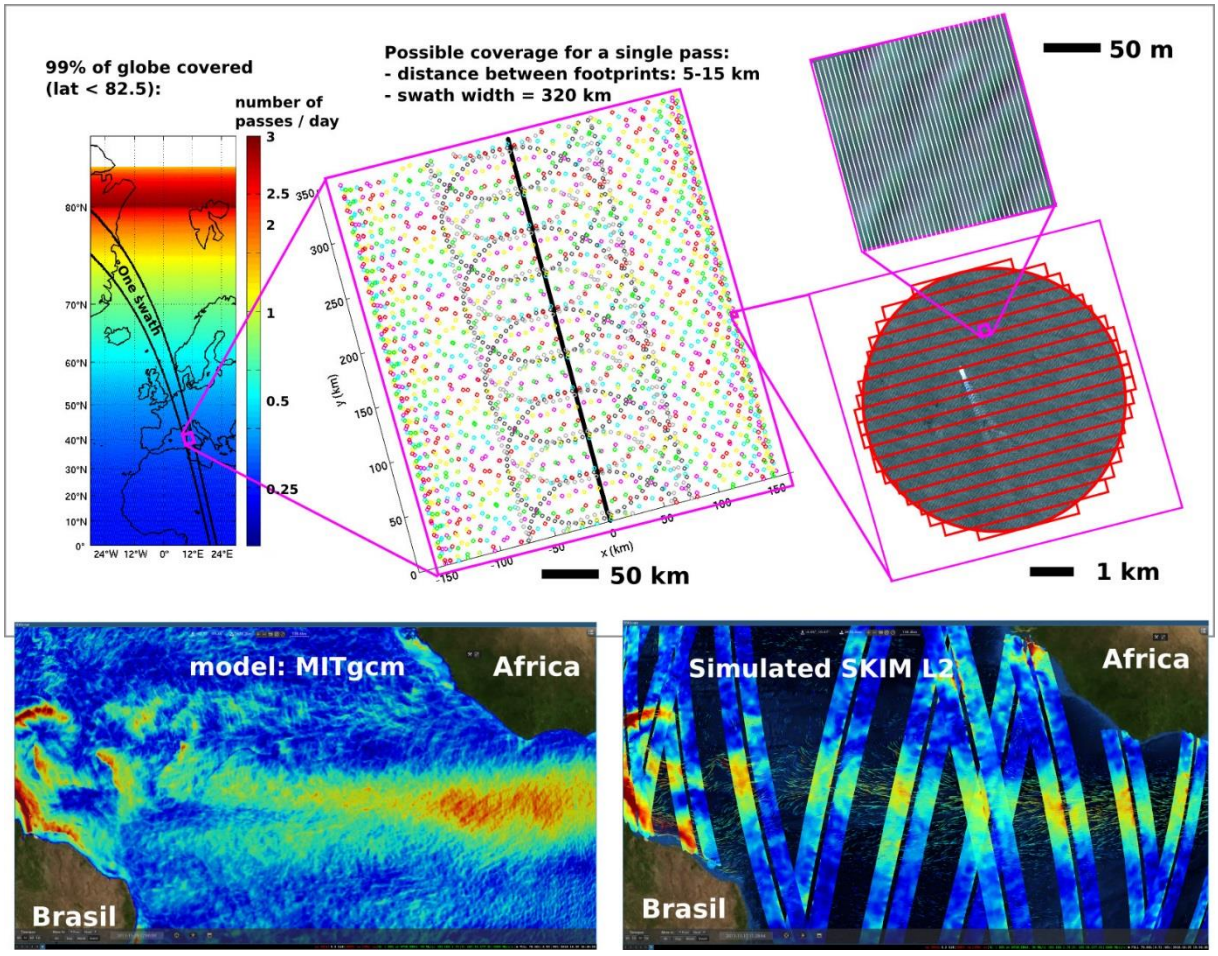
SKIM is an ESA Earth Explorer-9 candidate mission designed to measure directly, for the first time, the Total Surface Current Velocity (TSCV). SKIM will also measure the full ocean wave spectrum. The final selection of Earth Explorer 9 will be announced in September 2019, following a User Consultation Meeting in Cambridge, UK, on July 16 and 17, 2019.

SKIM's main instrument is a Ka-band Doppler Wave and Current Scatterometer, that builds on satellite altimetry, including a nadir altimeter beam, and the first ocean wave spectrometer SWIM on CFOSAT. SKIM is designed to fly in loose convoy with MetOp-SGB, which provides scatterometer vector winds and radiometer-derived ice concentration and atmospheric range corrections for the nadir beam. Using rotating beams across a 330 km swath, SKIM will explore beyond the 200 km - 15 days resolution of ocean currents that can be diagnosed today from sea level at mid latitudes.

SKIM will fill two important blind spots: in the tropics and in the marginal ice zone, and expand the effective space and time resolution of the altimeter constellation by a factor 2 or more. The novel direct measurement of surface currents in the top two meters will produce the first maps of the equatorial upwellings that are critical for understanding and forecasting the heat budget at the equator with far-reaching weather and climate consequences, for example on the African monsoon. TSCV maps will also allow the first monitoring of the highly dynamic currents at the ice edge. Adding this new and fundamental variable to Earth Observation capability together with high fidelity measurements of wave spectra will allow scientists to address a wide range of questions, including:

- How do TSCV & Waves, in particular in tropical ocean, influence the global heat, carbon and water cycles?
- How do TSCV and Waves transport surface material (plankton, plastics, oil, people..)?
- How do small mesoscales contribute to heat & freshwater transport and energy cascade, in particular in the emerging Arctic? How does the ocean engine works?
- How do TSCV and Waves modify surface ocean – lower atmosphere fluxes,including vertical?
- How do TSCV and Waves combine to form extreme sea states and freak waves?
- Are the new generation of ocean models (such as developped by DRAKKAR and Mercator) realistic?

This presentation will explain how SKIM measurements will be used to address these scientific challenges using examples from mission and instrument simulator outputs. The details of the mission concept and rationale are described in the "Report for Mission Selection" that will be submitted to ESA on May 31st. A preliminary (and incomplete) version is available for feedback: https://tinyurl.com/SKIMRfMS, and registration for the July meeting is possible here: https://tinyurl.com/EE9UCM



24. Vents forts de radiomètres (SMOS, WINDSAT,...) pendant les événements de cyclones : quel impact sur la prévision des états de mers ?

Lotfi Aouf[(1)], Nicolas Reul[(2)], Hervé Giordani[(3)], Alice Dalphinet[(1)]

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Le vent joue un rôle important dans la prévision des états de mers dans des événements extrêmes comme les ouragans ou cyclones. Récemment des traitements spécifiques ont permis de restituer à partir des radiomètres (SMOS, SMAP, WINDSAT,...) des vents forts de très bonne qualité. Cette étude évalue l'utilisation de ces vents dans le modèle de vagues MFWAM pour les cas de cyclones. Plusieurs jeux de données de vents ont été fournis dans le cadre du projet SMOSSTORMS (ESA/IFREMER). La technique consiste à interpoler les vents radiomètre SMOS (ou WINDSAT) près de l'œil du cyclone avec les vents de modèle. La validation de ces tests est effectuée avec les hauteurs de vagues issues de l'altimétrie. Différents cas de cyclones et ouragans durant les dix dernières années ont été traités. Parmi lesquelles on peut citer l'exemple des trois ouragans successifs (« three brothers case » : Kilo, Ignacio and Jimena) dans le pacifique tropicale pendant l'été 2015. La validation des simulations du modèle MFWAM a montré l'amélioration des hauteurs de vagues sur la trajectoire des cyclones. Les résultats révèlent la réduction du biais sur les hauteurs de vagues généré par les erreurs de l'estimation du vent du modèle atmosphérique ECMWF.

Dans cette présentation nous présenterons aussi l'impact de l'utilisation d'une température de surface (SST) issue du modèle d'océan en forçage d'une simulation à haute résolution du modèle atmosphérique MESO-NH dans l'atlantique tropicale. Il est clairement montré l'amélioration des vents issus de cette simulation en comparaison avec une analyse du modèle ECMWF.

25. Nearshore and Littoral Observing

Nicolas Savoye et Christophe Delacours (*EPOC, Bordeaux)*

26. Satellite Salinity Observing System: Recent Discoveries and the Way Forward

J. Boutin[4], N. Reul[9] et la communauté SMOS-Ocean française

LOCEAN, Paris

Dans cette intervention, nous résumerons le white paper soumis à Oceanobs (résumé ci-dessous), en insistant plus particulièrement sur les travaux passés et futurs de la communauté française en lien avec les mesures de salinité satellitaire.

Résumé du white paper soumis à Oceanobs

Nadya Vinogradova[1,2*], Tong Lee[3], Jacqueline Boutin[4], Kyla Drushka[5], Severine Fournier[3], Roberto Sabia[6], Detlef Stammer[7], Eric Bayler[8], Nicolas Reul[9], Arnold Gordon[10], Oleg Melnichenko[11], Laifang Li[12], Eric Hackert[13], Matthew Martin[14], Nicolas Kolodziejczyk[4], Audrey Hasson[4], Shannon Brown[3], Sidharth Misra[3] and Eric Lindstrom[1]

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Advances in L-band microwave satellite radiometry in the past decade, pioneered by ESA's SMOS and NASA's Aquarius and SMAP missions, have demonstrated an unprecedented capability to observe global sea surface salinity (SSS) from space.

Measurements from these missions are the only means to probe the very-near surface salinity (top cm), providing a unique monitoring capability for the interfacial exchanges of water between the atmosphere and the upper-ocean, and delivering a wealth of information on various salinity processes in the ocean, linkages with the climate and water cycle, including land-sea connections, and providing constraints for ocean prediction models. The satellite SSS data are complimentary to the existing in situ systems such as Argo that provide accurate depiction of large-scale salinity variability in the open ocean but under-sample mesoscale variability, coastal oceans and marginal seas, and energetic regions such as boundary currents and fronts. In particular, salinity remote sensing has proven valuable to systematically monitor the open oceans as well as coastal regions up to approximately 40 km from the coasts. This is critical to addressing societally relevant topics, such as land-sea linkages, coastal-open ocean exchanges, research in the carbon cycle, near-surface mixing, and air-sea exchange of gas and mass. In this paper, we provide a community perspective on the major achievements of satellite SSS for the aforementioned topics, the unique capability of satellite salinity observing system and its complementarity with other platforms, uncertainty characteristics of satellite SSS, and measurement versus sampling errors in relation to in situ salinity measurements.

We also discuss the need for technological innovations to improve the accuracy, resolution, and coverage of satellite SSS, and the way forward to both continue and enhance salinity remote sensing as part of the integrated Earth Observing System in order to address societal needs.

27. Interannual impact of extreme wintertime weather on the North Atlantic subtropical stratification

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Serving as the largest heat reservoir on earth, the North Atlantic subtropical gyre was shown to have experienced warming since 1970. But this trend sits on top of a large interannual variability driven by mechanisms that are yet to be clarified, especially with regard to extreme winter events. In this research, we developed an observation-based ocean heat budget of the upper 800 m in the western subtropical North Atlantic, a region where heat is mostly stored in the Eighteen Degree Mode water (EDW). On interannual time scale, the variability of geostrophic advection, mostly driven by the Gulf stream, is the most dominant factor to that of the ocean heat content (OHC) variability, 2.5 times as large as that of Ekman advection and almost four times as large as that of surface heat loss (which dominates at the seasonal cycle only). However, the annually ventilated EDW exhibits extreme values in 2008, 2013, and 2015 that correspond to opposite OHC anomalies. We will show that Ekman advection is the best indicator and driving mechanism explaining these extreme occurrences. We will further show that such extreme Ekman advection patterns can be linked to large scale atmospheric weather storms and that both storm intensity and duration have an impact on the extremity of EDW ventilation and North Atlantic heat content. This work is part of the 2017-2019 LEFE GMMC/IMAGO SOMOVAR project.

28. Forced and chaotic variability of the subtropical North Atlantic

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The Gulf of Mexico (GoM) is a basin with strong turbulent activity, dominated by the large anticyclonic eddies shed by the Loop Current. Some authors attribute the variability in the basin to the atmospheric forcing, while others affirm that the system is mainly chaotic. Determining the respective contributions of the ocean chaos and of the atmospheric forcing in this region is an important question for societal and economic reasons, and is relevant for ocean forecasting. Our objective is to understand the interplay between the intrinsic/chaotic variability in the GoM and the atmospheric forcing, using a 1/4° ocean/sea-ice 50-member ensemble simulation of the North Atlantic performed in the framework of the OCCIPUT project. The daily SSH 1997-2012 variability is analyzed probabilistically using ensemble PDFs and entropy-based metrics. We identify regions (Loop Current, central GoM, Caribbean Sea) where the oceanic variability is mainly chaotic, distinguishing between short timescales (weekly to monthly) and longer ones (annual to interannual). The temporal modulation of the ensemble dispersion and entropy allows us to identify regions where the oceanic "chaos", which spontaneously emerges from mesoscale turbulence, is counteracted by the atmospheric variability; examples include hurricanes which drive storm surges within all ensemble members, atmospherically-forced entropy minima which propagate at lower frequencies across the domain, etc. We also investigate the relationships between the chaotic and forced variability of the LC extension (and the eddy shedding) with the transport fluctuations through the Yucatan Channel (YC) and the Florida Straits (FS). We found high coherence between the LC extension and the YC deep transport, around the period of 270-365 days, with a phase around 45°, meaning that the YC transport lags the LC. This probabilistic investigation sheds light on actual constraint exerted by the atmosphere on the turbulent ocean, the predictability of the GoM circulation, and is in line with operational oceanography objectives.

29. Global Reanalysis of Ocean biogeochemistry (GREEN-GROG)

Marion Gehlen and the Green-Grog consortium (*LSCE/IPSL – Gif-sur-Yvette, France)*

Global observing capabilities have improved significantly over the past two decades. The increasing amount of data and their improved spatial/temporal coverage spurred the development and implementation of ocean data assimilation platforms in parallel to the rise of operational oceanography. However, these important advances are mostly limited to physical oceanography, which is in part explained by the still limited set of biogeochemical observations available at the spatial and temporal coverage needed for biogeochemical forecasting and analysis. This is about to change with the deployment of BGC ARGO and the addition of biogeochemical sensor to a variety of platforms. The availability of novel biogeochemical data streams in real-time needs to be anticipated by the development of integrated data-model systems for biogeochemical forecasting and (re)analysis. Within this larger context, the PPR Green-Grog contributed to the development of the capacity for assimilation of biogeochemical observations in coupled physical-biogeochemical model systems at Mercator Océan for real-time forecasting and biogeochemical (re)analysis. This presentation will present a 3-year synthesis of project results. It will highlight major numerical developments in the fields of ocean circulation modelling and data assimilation, as well as a machine learning approach to the reconstruction of multi-decadal time series of surface pCO_2 and show case applications to marine ecosystem management.

30. Assessment of the (very) next CMEMS Global biogeochemical forecasting operational system, with assimilation of Ocean Colour data

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The operational production of data-assimilated biogeochemical state of the ocean is one of the challenging core projects of the Copernicus Marine Environment Monitoring Service (hereafter CMEMS). In that framework, Mercator Ocean International is in charge of improving the realism of its global ¼° coupled physical-biogeochemical simulations, analyses and re-analyses, and to develop an effective capacity to routinely estimate the biogeochemical state of the ocean, including, amongst others, the implementation of biogeochemical data assimilation. Primary objectives are to enhance the time representation of the seasonal cycle in the real time and reanalysis systems, and to provide a better control of the production in the equatorial regions.

In that framework, Mercator Ocean International has successfully updated its global biogeochemical analysis and forecasting system with an Ocean Color data assimilation capability. In this system, the biogeochemical model (NEMO/PISCES) is offline coupled with the dynamical ocean (PSY4 1/12° coarsened to 1/4° resolution) at a daily frequency, and benefits from the assimilation of satellite (SSH-SST-SIC) and in situ physical data. However, a biogeochemical climatological damping is activated in order to mitigate the impact of some mis-constrained processes (a priori, vertical velocities) of this physical data-assimilated forcing (under investigation). The dedicated assimilation of biogeochemical data relies on a simplified version of the SEEK filter, where the forecast error covariances are built from a fixed-basis - but seasonally variable - ensemble of anomalies computed from a multi-year numerical experiment (without biogeochemical data assimilation) with respect to a running mean. Regarding Ocean Colour observations, the system relies, as a first step, on the CMEMS Global Ocean surface chlorophyll concentration products, delivered in NRT. This system shall be commissioned in 2019.

The objective of this presentation is thus to provide (1) a short description of the implementation of the aforementioned data assimilation methodology in the forecasting system; (2) a synthesis of the assessment of this global biogeochemical forecasting system, by cross-comparing the assimilated solution with various datasets, both spatial (Ocean Colour) and in situ (BGC-Argo, GLODAP), and (3) a synthetic overview of the impact/benefit of the assimilation of the Ocean Colour data.

31. The numerical grid construction problem in topographic constrained flows: The Denmark Strait Overflow case

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We investigate in this study the sensitivity of the representation of the Denmark Strait Overflow (DSO) produced by NEMO (version 3.6) in z-coordinates to the horizontal and vertical grid resolutions and to various numerical and physical parameters (momentum advection scheme, lateral friction, bottom boundary layer parameterisation, closure parameterisation, etc.). None of the physical parameters tested had a significant impact on the overflow representation, being the grid construction regarding the horizontal and vertical resolution the most sensitive parameters to the overflow representation.
Three different horizontal resolution are used 1/12°, 1/36° and 1/60° (these last two with a local horizontal refinement) combined with 4 number of vertical levels 46, 75, 150 and 300; obtaining a set of 12 simulations.
It is shown that once an adequate horizontal resolution is used to resolve the DSO, the choice on the vertical number of levels relies on two concepts. On one hand we should use enough number of vertical levels to resolve the bottom boundary layer, and on the other, the number of vertical levels has to be coherent with the horizontal resolution used. If this coherence is not present, the vertical mixing scheme makes the dense water sink preferably along the slope of the numerical grid (which flattens when vertical resolution increases) and not along the bottom slope. This produces a thickening of the plume and enhances its dilution in the ambient fluid.
From this conclusion we can also extract the fact that it does not matters how fine the vertical and the horizontal resolution can be, in z-coordinates we cannot properly resolve all the slopes. Therefore, other solutions are proposed.

32. Eddy viscosity identification in the Ekman layer in North Western Mediterranean Sea

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The marine upper layer is basically controlled by wind stress and sun heating with a high temporal variability from the wind gusts to diurnal and seasonal signals, up to climatic time scales. This so called "mixing" or "euphotic" layer constitutes a major source of uncertainty of predictive coupled Ocean - Atmosphere models for both climatic and pollutant or biogeochemical dispersion applications.
Tridimensional analyses of spatio-temporal variability of the sea surface currents, temperature, salinity and sea level have been performed in North Western Mediterranean sea from available pluri-annual data bases of surface currents when measured both in horizontal direction by HF radar mapping [1] and in the vertical from acoustic Doppler current profilers on fixed moorings and drifted buoys [2]. In complement, meteorological and sea state data [3] and high precision sea level probes [4] have been deployed in the framework of the HTM-NET network.
Basic processes occurring in the ocean surface layer in the dedicated microtidal site are considered to explain observed inertial motion, Ekman layer, vortex formation, surface and internal waves fields and sea level [5].
Three main purposes are addressed here concerning i) databases analysis in the objective of detecting rare and extreme events, ii) revisiting physical processes including instabilities and iii) identification of turbulent models parameters commonly used in ocean circulation models.

Extreme and rare events

Data processing techniques based on dynamic systems [6,7] have are applied to identify rare and extreme events in plurennial series of data in the marine surface layer. Moreover the analysis of recurrence allows to get and compute new statistical indicators, like local dimensions, whose large excursions are related to extratropical storms or blocking, and the extremal index which was renamed as local persistence indicator, suitable to estimate the average cluster size of the trajectories within the neighborhood of a given state of the system.

Physical processes

This investigation is focusing on the Ekman layer from high resolution vertical profiles of horizontal velocity (Fig. 1) and surface currents maps (Fig2). Spatio-temporal evolution of the Ekman spiral as documented in wind events is investigated by reference to the unsteady Ekman solution [8]. Moreover, theoretical analysis of the impact of varying eddy viscosity both in time and depth on dynamics of the Ekman layer by using Green's function [9] allowed to characterized the Ekman spiral inflectional instability.

Turbulence models identification

The sensitivity of the velocity profiles to eddy viscosity distribution is investigated using stochastic optimal control techniques based on Simultaneous Perturbation Stochastic Approximation method [10], with and without stratification. This method is applied to key parameters of different turbulence closure models (fig.3).

Acknowledgements. The research was supported by the CNRS - LEFE TURBORADAR project, the DGA - ASTRID TURBIDENT project, the URBARISQ project funded by Université de Toulon and Toulon Provence Mediterranée and

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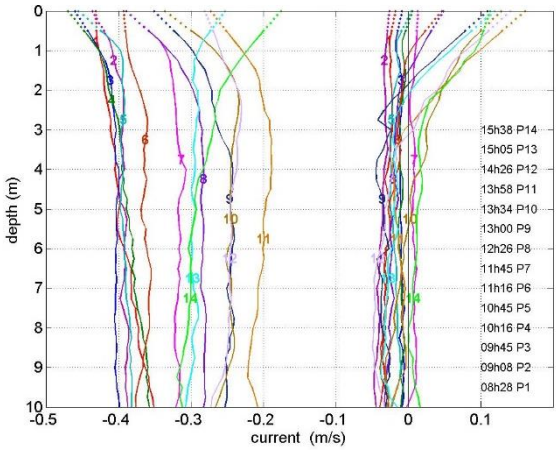

Fig. 1. Horizontal velocity profiles in the surface layer during a wind event : Rotation and deepening of the Ekman layer are sensitive to eddy viscosity.

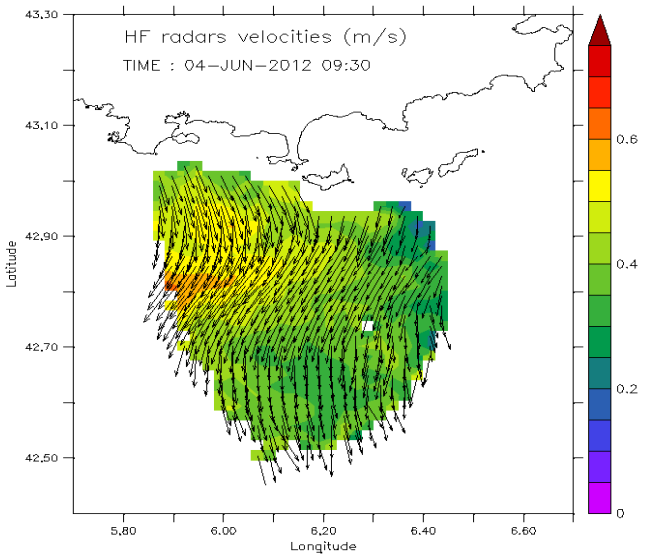

Fig. 2. HF radar surface currents map during the field experiment.

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33. Étude et caractérisation du Front Nord Baléares dans MEDRYS1V2

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Nous présentons une étude portant sur la caractérisation et la variabilité des structures thermo-halines de surface dans la zone du front Nord Baléares (NBF), siège d'une dynamique tourbillonnaire complexe encore méconnue, mais qui constitue pourtant une source d'interrogations en terme de circulation générale, de transferts méridiens de chaleur et de masse, et de biogéographie de la Méditerranée Occidentale. Ce travail exploite la réanalyse MEDRYS1V2 (1992-2013) et est basé sur l'analyse statistique d'indices frontaux définis, selon une approche de type Fedorov, à partir des gradients spatiaux locaux et journaliers de température et de salinité, normalisés par les gradients climatologiques correspondants. Les comparaisons avec des données satellites (SST et ADT) et de gliders ont d'abord permis de s'assurer de la capacité de la réanalyse à générer des structures frontales cohérentes et significatives. L'analyse climatologique (sur les vingt années de la réanalyse) de l'occurrence de ces indices frontaux permet d'identifier des zones préférentielles de présence de ces structures, mais aussi un comportement différent entre les fronts de température et de salinité. Les fronts de température sont surtout décelables en été et en automne, principalement liés au forçage du vent dans le Nord du bassin (Mistral et Tramontane) qui génère des upwellings et un noyau d'eaux plus froides du Golfe du Lion jusqu'au centre de la Mer Ligure, et entretient le contraste avec les eaux plus chaudes du Sud du bassin, de la mer des Baléares et de celles du Courant Nord. Les fronts de salinité sont plus présents tout au long de l'année et, dans la zone supposée du NBF, sont en continuité du front des Baléares vers l'Est, mais bifurquant rapidement vers le Sud de la Sardaigne au-delà de 6°E en s'alignant sur la limite Nord des tourbillons algériens d'eaux atlantiques. Ces résultats suggèrent que l'appellation NBF devrait être restreinte à la zone de récurrence conjointe des structures frontales de température et de salinité s'étendant du Nord de l'île de Minorque jusque 6°E. Les statistiques d'occurrences calculées durant les hivers de formation d'eaux profondes montrent un déplacement du front de salinité associé au NBF de l'ordre d'un degré de latitude vers le Sud.

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34. Impacts des ondes de gravité de surface sur un front de marée: interprétation depuis un modèle couplé

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Laboratoire d'Océanographie Physique et Spatiale (LOPS,UMR6523/Ifremer/IRD/UBO/CNRS), Brest

Au cours des dernières années, de nombreux efforts ont été consacrés à la compréhension et à la quantification des effets des vagues sur les courants et le mélange des couches de surface océaniques. Les conséquences physiques et biogéochimiques sont non négligeables et font l'objet d'attention particulière en régions côtières, car les écosystèmes côtiers sont extrêmement productifs et contiennent une grande diversité biologique et des ressources halieutiques abondantes.

Au large de la Bretagne, la mer d'Iroise est un excellent laboratoire naturel pour étudier les interactions vague-océan-atmosphère. Les courants de marée y sont intenses et un front thermique de surface, le front d'Ouessant, se développe chaque été. Il est caractérisé par un fort gradient de température à la surface de l'océan séparant les eaux homogènes de températures modérées (<14 ° C) près de la côte et les eaux stratifiées et chaudes en surface (> 16 ° C) au large. En Iroise, les vagues sont générées au large du fait d'un fetch important, les vents sont majoritairement d'ouest.

Nous présentons ici les résultats basés sur un ensemble réaliste de simulations haute résolution (500-1500 m) forcées et couplées. Pour évaluer les actions et rétroactions entre les compartiments océan atmosphère et vagues, une méthodologie a été développée dans le cadre du projet AMICO financé par les programmes Copernicus et GMES du Ministère du Développement Durable. Elle consiste en une arborescence de simulations, des études statistiques et une analyse des différents termes du bilan des équations d'évolution des principales variables océaniques dans cadre d'un couplage Océan-Atmosphère-Vagues. Le système numérique consiste en un modèle 3D de circulation hydrodynamique côtière (MARS3D), un modèle spectral d'état de mer (WW3), et un modèle atmosphérique à mésoéchelle non hydrostatique (MesoNH). Ces 3 compartiments sont couplés entre eux grâce à la librairie OASIS-MCT. Eprouvé, cet outil et son cadre d'analyse sont maintenant déployés et exploités par le projet COTA3COT du programme Lefe/GMMC.

Notre expérience numérique reproduit une période de vents de sud-ouest faibles à modérés, comme observés lors de la campagne à la mer FroMVar (Variable Front de Marée) au début de septembre 2011. Les vagues se développent progressivement au cours de la période considérée de 2 jours, se propageant vers le nord-est puis est. En comparant une simulation océanique libre avec une simulation couplée, nous montrons que la prise en compte des interactions vagues-courant font que le front d'Ouessant migre vers le large. Un tel déplacement frontal peut s'expliquer par une augmentation du mélange et / ou une augmentation (diminution) de l'advection vers l'ouest (est) en période de jusant (flot) dans le run couplé par rapport au run libre. Bien que contre-intuitif - la dérive de Stokes étant dirigée vers le nord-est - le diagnostic de l'équation de la température révèle qu'une variation de l'advection horizontale est le facteur dominant pour expliquer le décalage frontal. Ce changement d'advection résulte de changements induits par les vagues dans le courant quasi eulérien. Ceux-ci peuvent être attribués à l'impact du mélange induit par les vagues sur la structure verticale du courant quasi-eulérien. Le diagnostic de l'équation du moment et l'analyse des exécutions partiellement couplées permettent de mieux comprendre les processus clés en jeu.

35. Assessing the impact of the 2014 warm blob on biogeochemical cycles using a Mercator biogeochemical model and a BGC-Argo float database

Alexandre Mignot, Florent Gasparin, Coralie Perruche (*Mercator Ocean International, Toulouse).*

The warm blob was the largest marine heat wave that occurred in the last decade in the global ocean. It consisted of a large and anomalous patch of warm water in the north-east Pacific Ocean that appeared in late 2013 and persisted through 2014 and 2015. Several observations reported a significant decrease in marine phytoplankton productivity that impacted on higher levels of the food chain. Using the outputs

from a Mercator biogeochemical model and a BGC-Argo float database, we show that the decrease in primary production was due a reduction in the physical transport of nutrients. We also show that the warm blob caused a deoxygenation and dampened the uptake of CO2 from the atmosphere. Our results highlighted the importance of synergy between model and observations to better understand and monitor marine heat waves, which are expected to intensify with ongoing global warming.

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36. Using a 1D Atmospheric Boundary layer to improve air-sea interactions, first tests in the North-East Atlantic

Théo Brivoal (Mercator océan, CNRM) , Guillaume Samson (Mercator océan), Hervé Giordani (CNRM), Romain Bourdallé-Badie (Mercator océan), and Florian Lemarié (INRIA)

Air-sea interactions at mesoscales can have a significant impact on the oceanic circulation. Dynamic and thermal feedbacks are modulating the wind work input in the ocean, therefore influencing the upper ocean. High-resolution fully coupled ocean-atmosphere models are able to reproduce realistically these interactions, but the computational cost of such configurations remain very high.
To overcome such constraint, the alternative approach proposed here is based on a uni-dimensional vertical Atmospheric Boundary Layer (ABL1D) model. The model is driven by large-scale atmospheric data and reproduce turbulent vertical processes within the Atmospheric Boundary Layer. The ABL1D model is implemented within the NEMO ocean model.
Here, we compare two-weeks oceanic forecasts generated with the NEMO model forced by deterministic atmospheric forecasts with those generated by the ABL1D-NEMO coupled model over the Iberian – Biscay – Irish (IBI) regional configuration.
The impact on oceanic forecasts is evaluated by different ways: first, the model behavior regarding ocean-atmosphere feedbacks is evaluated by computing dynamic and thermal coupling coefficients and by assessing the impact on the surface EKE. Then, the model realism is validated against classic observations such as currents, sea surface temperature, salinity and temperature profiles and Mixed Layer Depth. We show that the coupled model is able to realistically simulate coupling coefficients and to improve EKE level. Our results suggest that our approach is well-suited to represent realistically air-sea interactions without the computational cost of a complete ocean-atmosphere coupled model.

Posters

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37. The French contribution to the Voluntary Observing Ships network of Sea Surface Salinity

Alory G.[1], P. Téchiné[1], T. Delcroix[1], D. Diverrès[2], C. Bachelier[3], D. Varillon[3], S. Jacquin[2], J. Grelet[2], G. Reverdin[4], E. Kestenare[1], R. Morrow[1], B. Bourlès[2]

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Sea Surface Salinity (SSS) is an essential climate variable that requires long term in situ observation. The French SSS Observation Service (SSS-OS) manages a network of Voluntary Observing Ships equipped with thermos-salinographs (TSG). The network is global though more concentrated in the tropical Pacific and North Atlantic oceans. The acquisition system is autonomous with real time transmission and is regularly serviced at harbor calls. There are distinct real time and delayed time processing chains. Real time processing includes automatic alerts in case data are outside of climatic limits, to detect potential instrument problems, and graphical monitoring tools. Delayed time processing relies on a dedicated software for attribution of data quality flags by visual inspection, and correction of TSG time series by comparison with daily water samples and collocated Argo data. The SSS-OS real time data feed the Coriolis operational oceanography database, while the research-quality delayed time data can be extracted for selected time and geographical ranges through a user-friendly web interface. Delayed time data are also combined with other SSS data sources to produce gridded files for the Pacific and Atlantic oceans. A short review of the research conducted with these data is given. It includes observation-based process-oriented

and climate studies from regional to global scale as well as studies where in situ SSS is used for calibration/validation of models, coral proxies or satellite data.

38. Intra-seasonal barotropic effects in the global ocean: the BINGO project

M. Afroosa[1], B. Rohith[1], Arya Paul[1], Fabien Durand[2], Romain Bourdallé-Badie[3], Laurent Testut[2], S.S.C. Shenoi[1]

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Changes in sea level may be attributed either to barotropic (involving the entire water column) or baroclinic processes (governed by stratification). It has been widely accepted that barotropic sea level changes in the tropics are insignificant at intraseasonal time scales (periods of 30–80 days). However, in a recent study (Rohith et al., 2019)[1] based on bottom pressure records, we presented evidence for significant basin-wide barotropic sea level variability in the tropical Indian Ocean during December–April, with standard deviations amounting to ~30–60% of the standard deviation in total intraseasonal sea level variability. The origin of this variability is linked to a small patch of wind over the Eastern Indian Ocean, associated with boreal winter Madden–Julian Oscillations (MJO). The Indian Ocean barotropic sea level is forced remotely from this relatively small region, primarily through barotropic Rossby waves (Fig. 1).
The LEFE/GMMC BINGO project (Barotropic INfluence in the Global Ocean, 2019-2021) aims at investigating this phenomenon in the global context, based on NEMO ORCA12 global model.

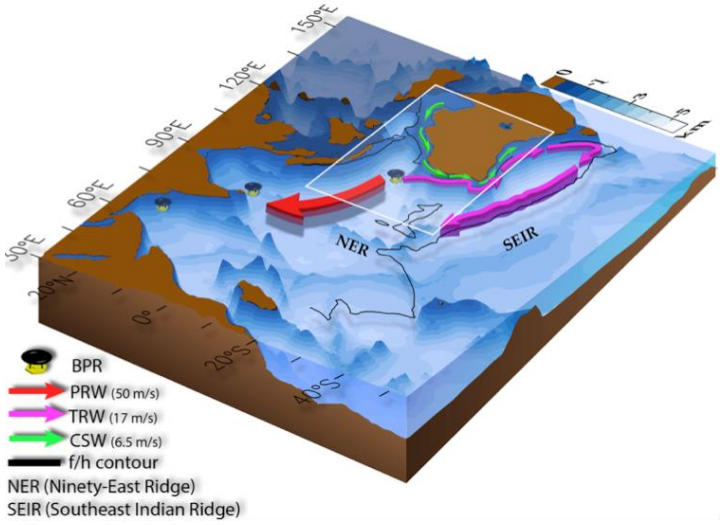

Fig. 1. Barotropic waves involved in the forcing of the Indian Ocean intra-seasonal barotropic variability by the MJO winds blowing on the white box int he eastern part of the basin. After Rohith et al., 2019.

First, it is found that the coherency of intraseasonal barotropic sea level variability extends far beyond the tropical Indian Ocean, as it is observed in virtually all ocean basins; the Pacific Ocean primarily oscillates in phase opposition with the Indian and Atlantic basins. Our modeling framework is identical to the one routinely developed and used at Mercator-Ocean. It is found that NEMO ORCA12 has good skills to reproduce the observed intra-seasonal barotropic variability, in all basins. The model is then used to investigate the underlying processes responsible for the observed variability, through sensitivity experiments. It is found that the Indonesian straits play a key role in the inter-basin water mass exchanges. Our results have significant implications on the way intra-seasonal variability of sea level has to be viewed, across the ocean basins. They also show that a specific attention is required in the key-region of the eastern tropical Indian ocean, for a proper numerical modeling of the barotropic sea level at global scale.

[1] Rohith, B., A. Paul, F. Durand, L. Testut, S. Prerna, SSVS Ramakrishna and SSC Shenoi, Basin-wide sea level coherency in tropical Indian Ocean driven by Madden-Julian Oscillation. *Nature Communications*, doi: 10.1038/s41467-019-09243-5, 2019

39. A coupled ocean-atmosphere regional simulation of the tropical Atlantic Ocean : comparison with observations and sensitivity to numerical choices

Manon Gévaudan, Julien Jouanno, Fabien Durand, Guillaume Morvan, Florian Nivert

LEGOS, Université de Toulouse, CNES, CNRS, IRD, UPS, Toulouse, France. e-mail: manon.gevaudan@legos.obs-mip.fr

A strong ocean-atmosphere coupling takes place in the western tropical Atlantic Ocean. This region contains indeed warm waters (over 28°C) which lead to the development of deep convection and to heavy precipitation below the Inter-Tropical Convergence Zone (ITCZ). In order to study this coupling, a high resolution (~ 25 km) NEMO-WRF configuration is developed, encompassing the whole tropical Atlantic basin (15°S-35°N). A detailed comparison of the simulation with satellite and PIRATA observations was achieved. Sensitivity testing of WRF parameterizations allows us to identify the radiative scheme and planetary boundary layer scheme that reproduce adequately the main features of the region in terms of SST, SSS, precipitations, heat fluxes, mixed layer and barrier layer depths.
As a next step, this numerical set-up will be used to investigate the influence of salinity stratification on the air-sea dynamics of the western tropical Atlantic Ocean. Indeed, this region receives an important freshwater supply from river runoff (Amazon, Orinoco) and from ITCZ, which largely control the upper ocean stratification and lead to the formation of a thick, widespread barrier layer, which impact on the regional climate remains controversial.

40. Surface and subsurface horizontal and vertical velocity in the equatorial tropical Pacific

Florent Gasparin[1], Eric Greiner[1], Sophie Cravatte[2], Jean Michel Lellouche[1], Romain Bourdalle-Badie[1], Simon Van Gennip[1]

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The tropical Pacific region is the place of strong air-sea interactions, where the ocean exchanges heat, moisture and carbon dioxide with the atmosphere associated with specific physical and biogeochemical mechanisms. Based on the two main ocean reanalyses developed at Mercator Ocean (the ¼° GLORYS2V4 and the 1/12° GLORYS12V1), the strength and limitations to represent key structures are investigated here. The evaluation of these ocean state estimates is mostly based on intercomparison and comparison with independent (ADCP currents) and non-independent *in situ* data sets (T/S profiles from TAO/TRITON moorings and Argo floats) by focusing on the characteristics of the thermocline, the intensity of tropical cells, and the horizontal and vertical structures of surface and subsurface currents. A particular focus on vertical physics, associated with the equatorial upwelling, will provide some elements to better understand the impact of data assimilation on equatorial physics, which is suspected to strongly influence on biogeochemical model solutions.

41. TPOS2020: Repenser le système d'observations océan-atmosphère dans le Pacifique Tropical : Avancées du second rapport et vision pour OceanObs'19

Sophie Cravatte[1], Boris Dewitte[1,2], Florent Gasparin[3], et tous les coauteurs du second rapport (coordinating lead authors: W. S. Kessler[3], S. Wijffels[4], S. Cravatte[1]1 and N. Smith[5])

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[2]Centro de Estudios Avanzado en Zonas Áridas (CEAZA), Coquimbo, Chile
[3]Mercator-Océan, Toulouse, France
[4]NOAA / Pacific Marine Environmental Laboratory. Seattle WA USA
[5]Retired

TPOS2020 (Tropical Pacific Observing System for 2020) est un projet international, dont l'objectif est de donner une feuille de route basée sur l'état de l`art des connaissances et des moyens d'observation pour faire évoluer le système d'observation dans le Pacifique Tropical d'ici 2020. TPOS2020 a en particulier l'ambition d'être intégré, pérenne et de répondre à la fois aux besoins de la recherche sur le climat et aux

besoins des centres de prévision opérationnels. Il inclut aussi une réflexion sur les besoins pérennes en observations biogéochimiques.
Le second rapport de TPOS2020 s'appuie sur les conclusions du premier rapport publié en décembre 2016, et fait évoluer ses recommandations en prenant en compte de nouvelles analyses et des retours de la communauté. Toujours centré sur l'étude de la variabilité interannuelle (ENSO), il affine les recommandations du 1ier rapport (en précisant en particulier le design du réseau de mouillages), avec une attention particulière pour détecter les variations décennales et à plus long terme, et développe des thèmes insuffisamment couverts dans le 1ier rapport :

- les besoins pour les centres de prévisions saisonnière à interannuelle, et pour la prévision sub-saisonnière à saisonnière
- les besoins et solutions pérennes en biogéochimie
- les besoins et solutions pour la région du Pacifique Ouest, à la fois pour la surveillance des courants de bord ouest et pour mieux comprendre les interactions complexes océan-atmosphère aux échelles diurnes à intra-saisonnières
- les besoins et solutions pour la région du Pacifique Est, région sévèrement impactée par les événements extrêmes El Nino et posant toujours des problèmes pour la modélisation forcée et couplée

Les recommandations formulées, et les raisonnements et justifications qui les sous-tendent seront présentés.

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42. Amazon river discharge contribution to tropical Atlantic sea level changes

Pierrick Giffard, William Llovel, Julien Jouanno, Guillaume Morvan

LEGOS, Toulouse

Global mean sea level rise is one of the most important consequences of the on-going global warming. Satellite altimetry has revealed a linear increase of 3.2 mm/yr since 1993 that is explained by both global ocean warming and freshwater incomes from continental ice melt. At regional scale, sea level trends present large variation around its global average. Other physical processes are at play such as changes in salinity, ocean circulation and dynamics, heat, freshwater and wind stress fluxes from the atmosphere and freshwater from continental runoffs. If the ocean heat content change has been largely investigated, changes in salinity has been neglected because of the lack of in situ salinity data. Since the 2000s and with the Argo program, we have now accessed to an unprecedented amount of salinity measurements revealing the importance of salinity changes to regional sea level.
The Amazon River discharges a very large volume of freshwater into the Tropical Atlantic Ocean (~17% of the total world river discharge). It may participate to the regional variability of the sea level, but its impact is largely unknown. In order to isolate its contribution, we used a set of regional simulations of the Tropical Atlantic at 1/4° horizontal resolution based on NEMO model integrated over 1993-2017. A detailed comparison of the model sea surface salinity and sea surface height with satellite observations ensures that the model properly simulates these quantities. Comparisons of simulations with and without Amazon runoff show the large contribution to regional mean sea increase in the whole Caribbean reaching 5 cm near the Greater Antilles. This mean increase is mostly due to the halo-steric contribution located in the upper 250 m of the ocean, while thermo-steric effects associated with the freshwater input tend to counterbalance this effect. The model also show significant contributions of the Amazon River on seasonal and interannual sea level variability.

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43. Intraseasonal to Interannual SSS Variations in the Tropical Pacific Ocean : Insights from SMOS

A. Hasson, J. Boutin, E. Guilyardi (LOCEAN, France), Tom Farrar (WHOI, USA) Tong Lee (JPL/CalTech, USA) Frederick Bingham (CMS/UNCW, USA), Martin Puy (UTexas, USA)

Near-surface salinity shows variability at all scales in the North Tropical Pacific Ocean, caused by both freshwater fluxes from the heavy precipitation of the Intertropical Convergence Zone (ITCZ) and ocean dynamics linked to the system of strong zonal tropical surface currents: the North Equatorial Current (NEC), Counter Current (NECC), and the South Equatorial Current (SEC). Previous studies highlight a strong

impact of rainfall on the sea surface salinity (SSS) retrieved from the Soil Moisture and Ocean Salinity (SMOS) and Soil Moisture Active Passive (SMAP). Discrepancy with In situ (top 50cm) indicates the transient rainfall imprint and the importance of ocean dynamics. Intra-seasonal variability has been studied in terms of surface temperature, sea surface height and precipitation anomalies but not in salinity. This variability is associated with barotropic Rossby waves radiating from the equator, westward propagating eddies at 10-13°N intensifying in the NEC, the Madden-Julian Oscillation and Tropical Instability Waves. Interannual variability of the Tropical Pacific Ocean is dominated by the El Niño phenomenon. The 2015 event showed one of the strongest temperature anomaly ever observed and the strongest interannual salinity anomaly observed from space.

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44. Caractérisation des incertitudes pour l'assimilation d'observations de glace de mer dans le modèle NEMO

Jean-Michel Brankart, Christophe Calone, Ann'Sophie Tissier, Pierre Brasseur

Institut des Geosciences de l'Environnement - Grenoble

L'objectif général de ce travail est de faire progresser les systèmes d'assimilation de données dans les modèles couplés océan-glace, par une meilleure description des incertitudes sur les simulations numériques et sur les observations des propriétés de la glace de mer. Plusieurs méthodes ont été développées et explorées au cours de ce projet: la paramétrisation stochastique des incertitudes sur le modèle, le traitement ensembliste des flux air-mer, la transformation anamorphique, pour tenir compte des non-gaussianités, et la vérification probabiliste des résultats (fiabilité et résolution).Ces méthodes ont été explorées à l'aide de simulation ensemblistes menées avec deux configurations du modèle NEMO: ORCA2/LIM2, puis CREG4/LIM3. Le poster se concentre uniquement sur les résultats obtenus avec CREG4/LIM3.En résumé, nous avons trouvé que ces développements étaient utiles parce que: (i) la simulation d'un système non-linéaire complexe ne peut être complète sans une description appropriée des incertitudes (qui ne peuvent être découplées de la simulation de l'état moyen),(ii) la distribution de probabilité des propriétés de la glace de mer est essentiellement non-gaussienne (en particulier parce qu'elles sont limitées par des bornes) et (iii) la distribution de probabilité des erreurs d'observation est non-gaussienne et asymétrique.

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45. CROSSROAD: Climatic Role of Subpolar Slopes: A Regional Observational Array off NewfoundlanD

Damien Desbruyères (LOPS) and collaborators

An observational experimental setup is proposed for the horizon 2022-2024 to investigate the dynamics and thermodynamics of the deep western boundary current in the “transition zone” of the North Atlantic, around Flemish Cap, Newfoundland. Located between the subtropical RAPID and subpolar OSNAP mooring arrays, this confined region represents a unique choke point for most of the North Atlantic large-scale currents and water masses involved in the Atlantic Meridional Overturning Circulation (AMOC). Horizontal export and latitudinal coherence, water mass transformation and vertical motions, as well as shelf-slope-interior exchanges will be studied with repeat hydrography, moorings, drifting and profiling floats, and gliders. This poster will review some of the scientific motivations behind the project and provide a preliminary experimental and collaborative plan.

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46. SMOC: a new global surface current product containing the effect of the ocean general circulation, waves and tides

Yann Drillet, Stéphane Law Chune, Bruno Levier et Marie Drévillon

Mercator Ocean International, Toulouse

Following the steps of what is being done for various current products derived from the observations, SMOC (Surface and Merged Ocean Currents) is a composite surface current product that combines data

from the CMEMS modeling systems to approach the net velocity felt by a body at sea surface. In SMOC, the total current is obtained from the simple addition of contributions from the oceanic general circulation, tides and waves. In the presence of strong wind sea, the wave-induced Stokes current can indeed contribute half of the surface drift. On the shelf, tide is another major mechanism controlling the exchanges between the coast and the open sea. We present here the characteristics of the product as well as the validation methods used. These are based on comparison with drifting buoys in Eulerian and Lagrangian mode, but also on comparison with in-situ current measurement and coastal radar data. SMOC is distributed on the global domain, with a horizontal resolution of 1/12° and with an hourly frequency. All horizontal components and their sum are delivered, so that the user can select and focus on each component individually. Three independent systems are used to compute SMOC products which are the CMEMS global high resolution (1/12°) real time forecasting system, the CMEMS global waves (1/10°) forecasting system and the FES tidal model . SMOC data are computed daily, with one day of hindcast for the previous day, and five days of forecast ahead from the date of production.

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47. Surface and Upper Ocean Circulation from the combined use of in situ and space borne observations

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CMEMS MULTIOBS TAC proposes Qualified Global Ocean products based on satellite & in situ observations and data fusion techniques. 4 MULTIOBS products are dedicated to ocean currents. Satellite observations (GOCE Geoide, altimetry SLA, multi-satellite SST, SMOS SSS), in situ observations (Argo floats & surface drifters), and ECMWF wind stress associated with data fusion techniques are used to generate these 3D & 2D ocean velocities. They are available in Near-Real-Time or as Multi-Year Products for the past 10 to 25 year.
Methods and products concerning the 3D geostrophic currents, and the 2D surface/15m currents are presented. The performances of the 15m currents are illustrated with SVP drifters. The recent change in the 3D currents is illustrated with an ADCP section at the equator, and with YoMaHa drifts at 1000m. The interest of MULTIOBS for marine resources is illustrated with seals tracks. The next version for the Ekman model is presented. Gains obtained with a data synergy between altimeter velocities and SST are presented.

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48. Two superimposed cold and fresh anomalies enhanced Irminger Sea deep convection in 2016 – 2018

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While Earth system models project a reduction, or even a shut-down, of deep convection in the North Atlantic Ocean in response to anthropogenic forcing, deep convection returned to the Irminger Sea in 2008 and occurred several times since then to reach exceptional depths > 1,500 m in 2015 and 2016. In this context, we used Argo data to show that deep convection persisted in the Irminger Sea during two additional years in 2017 and 2018 with maximum convection depth > 1,300 m. In this article, we investigate the respective roles of air-sea flux and preconditioning of the water column to explain this exceptional 4-year persistence of deep convection; we quantified them in terms of buoyancy and analyzed both the heat and freshwater components. The air-sea buoyancy flux was 10 % weaker than the air-sea heat flux because of the non-negligible and opposite effect of the air-sea freshwater flux. Contrary to the very negative air-sea buoyancy flux that was observed during winter 2015, the buoyancy fluxes over the

Irminger Sea during winters 2016, 2017 and 2018 were close to climatological average. We estimated the preconditioning of the water column as the buoyancy that needs to be removed (B) from the end of summer water column to homogenize the water column down to a given depth. The remarkable differences between the preconditioning for winters 2016 – 2018 compared to the mean 2008 – 2015 were i) lower B for winters 2016 – 2018 than for the mean 2008 - 2015 and ii) B remained almost constant from 600 m down to ~1,300 m for winters 2016 – 2018 while it increased for the mean 2008 - 2015. Both, low B and almost constant B down to ~1,300 m are indicative of the favorable preconditioning of the water column during 2016 – 2018. By computing the relative contributions of θ and S to B, we showed that, on average, the thermal term governed B in the layer 0 – 800 m, while the salinity term shaped B below 800 m. During 2016 - 2018, the favorable preconditioning was due to the combined effects of a cooling of the intermediate water (200 – 800 m), which reduced B, and a decrease in salinity in the 1,200 – 1,400 m layer, which deepened the deep halocline between the Labrador Sea Water and the Island Scotland Overflow Water and decreased B in this layer. This favorable preconditioning permitted the very deep convection observed in 2016 – 2018 despite the atmospheric forcing was close to the climatological average.

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49. CODEP: La cellule Opérationnelle Déploiement

Nathanaële Lebreton (SHOM) et Noé Poffa (IFREMER/COA)

Sur le site IFREMER de Brest, et celui du SHOM la cellule Opérationnelle Déploiement (COA) est le soutien instrumental au réseau ARGO France de Coriolis. Composé de deux personnes (SHOM, N. Lebreton et IFREMER, N. Poffa), la cellule assure le soutien aux équipes scientifiques utilisateurs de profileurs ARGO. Leur travail consiste après avoir recetté et qualifié chacun des instruments (60 par an), chercher des supports de déploiement dans des zones/bassins proposées par le comité de pilotage ARGO France ou en appliquant les recommandations mentionnées dans le document ARGO-France de stratégie de déploiement (publication janvier 2019) Certains flotteurs sont attribués dans le cadre de l'AO GMMC (10 à 30 par an). Une fois les flotteurs alloués dans le cadre GMMC, une prise de contact puis des tâches avec des rôles bien définis se mettent en place entre la cellule et le PI (scientifique) demandeur. Ce poster a pour but de faire connaître:

Les types d'instruments qui peuvent être demandés dans le cadre de l'AO

Le travail de la cellule et ce qui lui est propre. *En amont:* commande, échanges/discussion avec NKE, planifications des livraisons, recette, stockage, expéditions. La transmission de la documentation: protocoles de mise à l'eau et fiche de mise à l'eau. *En Aval:* déclaration en base des profileurs et suivi à la mer.

Les taches qui sont discutées avec le PI: Gestion de transformation d'instruments, les programmations des instruments, le planning de mise à disposition, le TD.

Cela dans le but de faire connaître les contraintes et la façon de travailler de la cellule afin de mettre à disposition le matériel dans les meilleures conditions, se répartir les rôles et éviter des complications. Le Poster refera un historique sur les campagnes GMMC passées (jusqu'en 2018) et ce qui aura lieu cette année (c'est à dire les projets retenus pour 2019). Ce poster est une mise à jour du poster présenté en 2016 qui avait permis des échanges et des discussions sur les besoins avec différents instituts, équipes, laboratoires.

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50. How can Surface Water Ocean Topography (SWOT) satellite better reconstruct horizontal and vertical velocities?

Babette Christelle Tchonang[1, 2], Pierre-Yves Le Traon[1], Mounir Benkiran[1], and Giovanni Ruggiero[1]

[1]Mercator Ocean , Toulouse, [2]Centre National d'Etude Spatiale (CNES), Toulouse.

The impact of Surface Water Ocean Topography (SWOT) satellite on the ocean horizontal and vertical velocities is investigated by means of OSSEs (observing system simulation experiments). These experiments are performed with a regional data assimilation system, implemented in the Iberian–Biscay–Ireland (IBI) region, at 1/12° resolution using simulated observations derived from a fully eddy-resolving

free simulation at 1/36° resolution over the same region. The objective of the experiments is to assess the ability of SWOT to constrain the ocean analyses and forecasts with respect to conventional nadir altimeters (Jason 1, Jason 2 and Envisat). Previous analysis of these experiments conducted in Benkiran et al. (2016) have shown a great improvement (when using SWOT-like data rather than conventional altimeters) of the root-mean-squared-error (rmse) of the Sea Surface Height (SSH) calculated with respect to the true ocean. This Work further explores these results including the analysis of the horizontal and vertical velocities fields and their vertical structure. Preliminary analysis shows that SWOT data allows a better positioning of eddies on frontal zone and thus a better control of the horizontal and vertical velocities. Assimilation of SWOT data does not only improve the surface velocity; it also improves velocity field at the depth. There is a clear positive impact of the assimilation of SWOT up to 1000m of depth.

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51. WINKLEX : un exercice d'intercomparaison pour les équipes impliquées dans les mesures d'oxygène dissous acquises à partir de différentes plateformes fixes et mobiles

Laurent. Coppola[1] et Thibaut. Wagener[2] (pour le groupe WINKLEX*)

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[2] Institut Méditerranéen d'Océanologie (MIO – UMR 7294)

La concentration en oxygène dissous océanique peut être mesurée par des capteurs fiables qui sont déployés sur différentes plateformes fixes et mobiles (mouillages, bateaux, gliders et flotteurs Argo). Cette concentration en oxygène est considérée comme une « *Essential Oceanic Variable* » nécessitant d'être intégrée en priorité dans les systèmes d'observations. En effet, l'étude de cette variable contribue à mieux comprendre le fonctionnement biogéochimique des océans et prévoir son évolution. Cependant, pour contribuer à cet objectif, la précision et la justesse des mesures d'oxygène acquises dans les systèmes d'observation devrait tendre vers des valeurs de l'ordre de 1 $\mu mol.kg^{-1}$. Pour atteindre ce niveau de justesse, la maîtrise des mesures par la méthode « historique » de Winkler reste indispensable comme référence ultime dans les chaînes de calibration/validation de données d'oxygène.
Le projet WINKLEX (financé par le GMMC en 2018) visait à organiser au niveau national un exercice d'intercomparaison de mesures d'oxygène par la méthode de Winkler pour les laboratoires français impliqués dans la calibration/validation des données d'oxygène contribuant au système d'observation global des océans. Cet exercice a eu lieu du 9 au 13 Avril 2018 à Villefranche sur Mer avec la participation de 8 laboratoires.
Cette communication présente cet exercice d'inter-comparaison et les résultats obtenus. Nous montrerons que, sur l'ensemble des mesures réalisées par les différentes équipes françaises impliquées, les résultats sont assez hétérogènes et n'atteignent pas l'objectif de justesse attendu. Les pistes d'amélioration que cet exercice à permis de mettre en évidence seront présentées et discutées. Enfin, l'hétérogénéité des résultats « Winkler » obtenus sera appliquée à une chaîne de calibration/validation de données de capteurs afin d'illustrer les conséquences de ces résultats pour les systèmes d'observations.

** Groupe WINKLEX:*
Présent à l'exercice d'intercomparaison à Villefranche sur mer : F. Baurand (IRD Brest), P. Branellec (IFREMER Brest), L. Chirurgien (MIO Marseille), L. Coppola (LOV Villefranche), E. Diamond (IMEV Villefranche/Mer), N. Lamande (IFREMER Brest), D. Lefevre (MIO Marseille), A. Paulmier (LEGOS Toulouse), F. Petit (IMEV Villefranche/Mer), E. Soto (IMEV Villefranche/Mer), T. Wagener (MIO Marseille)
Excusés : J. Fin (LOCEAN Paris), J. Salaun (SHOM Brest), S. Fercocq (SHOM Brest)
Autres personnes contactées dans le cadre de ce projet : N. Metzl (LOCEAN), F. Dumas (SHOM), J. Grelet (IRD), P. Rousselot (IRD), V. Thierry (IFREMER), F. Salvetat (IFREMER).

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52. Sub Inertial Internal Tides Dynamics and Dissipation (DISSIP).

Yannis Cuypers[1], Noé Lahaye[2], Pascale Bouruet Aubertot[1], Anda Vladoiu[1], Jonathan Gula[2], Guillaume Roullet[2], Clement Rousset[1], Bruno Ferron[2], Fréderic Vivier[1].

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The LEFE/CNRS DISSIP project (2018-2020) aims at characterizing the sub inertial internal tides dynamics that is for the most part M2 internal tides generated poleward of 74.5 (N/S) and K1 internal tide generated poleward of 30 °(N/ S). Sub inertial internal tide SiIT cannot propagate freely in the ocean interior it is trapped at the bottom topography where it will either dissipate or propagate as topographic waves. SiIT has been shown to represent locally an important source of mixing for instance in the Kuril archipelago (Tanaka 2010) or in the Yermak plateau (Fer et al) 2016. At the global scale GCM have shown that as much as 30% of the diurnal tides was generated above its critical latitude (Muller 2013). Using linear wave theory and vertical normal mode decomposition Falahat and Nycander (2015), FN 15 hereafter, were able to provide global maps of the sub inertial tide energy, yet their computation was restricted to a small topography assumption and required an hypothesis for atypical dissipation time scale. The DISSIP project uses available simulations and rich data set from previous projects (ANR OPTIMISM, LEFE/ STEP LEFE/GRAVILUCK ANR LUCKYSCALES) in 3 contrasted regions:

- An Arctic fjord in Svalbard, where the high frequency variability is dominated by the SiIT M2.
- The Sicily strait a turbulent hot spot in the Mediterranean Sea where a large part of the variability is associated with the SiIT.
- The Lucky Strike region of the Mid Atlantic ridge, which has constituted in the past years a natural laboratory for the observation of the internal tides dissipation (Polzin et al 1997, Pasquet et al 2016).

We show here the structure of the SiIT for these 3 sites from data and/or model and provide some comparisons with the FN15 parameterization which represents a first step toward a GCM parameterization.

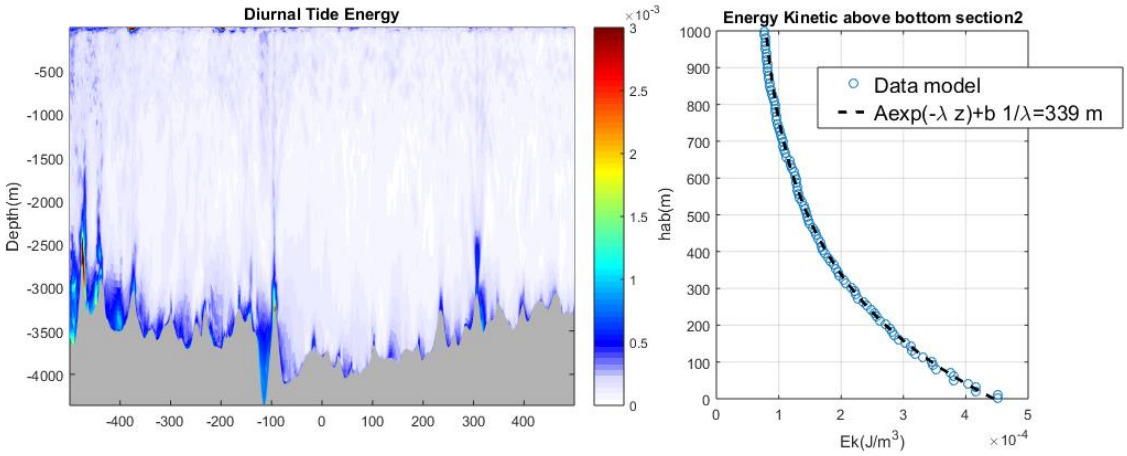

Figure 1 Trapped Diurnal Internal tides energy in a high resolution simulation of the Lucky Strike region of the Mid Atlantic ridge.

53. New 3-dimensional biogeochemical products derived from machine learning-based methods

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As part of the Copernicus Marine Environmental Monitoring Service (CMEMS), the thematic assembly center multi-observation aims to provide global qualified ocean products based on observations (satellite and *in situ*) and data fusion techniques. In this framework, two new biogeochemical products are developed. The first product, online from the CMEMS website since April 2019, is composed of more than 30,000 vertical profiles of nutrient derived from Biogeochemical-Argo (BGC-Argo) concurrent temperature, salinity and oxygen profiles qualified in delayed mode using a neural network-based method. The second product, that will be online in early 2020, will provide a 3 years' time series of weekly 3-dimensional fields of particulate organic carbon (POC) and chlorophyll-a concentration. The POC fields are estimated from merged satellite and hydrological profiling floats data using a neural network based method. The chlorophyll-a concentration fields will be first estimated from ocean color using already developed empirical relationships and will be upgraded using a neural network-based algorithm the next year (early 2021). These products represent an important source of information for the quality control of BGC-Argo float observations, data assimilation and the initialization/validation of biogeochemical models.

54. The Global Monitoring and Forecasting Center in the Copernicus Marine Environment Monitoring Service: global ocean eddy-resolving physical analysis, forecasting and reanalysis

Y. Drillet[1], J.-M. Lellouche[1], J. Lamouroux[1], R. Bourdallé-Badie[1], C. Perruche[1], O. Le Galloudec[1], E. Greiner[2], G. Garric[1], C. Regnier[1], M. Drévillon[1], C. Bricaud[1], S. Law Chune[1], M. Clavier[1], L. Aouf[3], P. Lehodey[2]

[1]Mercator Océan, Ramonville Saint Agne. [2]CLS, Ramonville Saint Agne. [3]Météo France, Toulouse.

Since the beginning of Copernicus Marine Environment Monitoring Service (CMEMS) in 2015, Mercator Ocean is coordinating the Global Monitoring and Forecasting Center (GLO MFC) and is developing new version of the systems. Over the past years, Mercator Ocean with GLO MFC partners (mainly Météo France and CLS) have been regularly upgrading its global ocean systems and products through improvements in the ocean model, assimilation scheme, assimilated data sets, for the 3D ocean physics and biogeochemistry and more recently for the waves and Low and Mid-Trophic Level (LMTL) products. Current global systems are based on the NEMO ocean model at 1/12° and the SAM2 data assimilation scheme developed at Mercator Ocean and based on a reduced-order Kalman filter. Along track altimeter data (Sea Level Anomaly – SLA), satellite Sea Surface Temperature (SST), Sea Ice Concentration and *in situ* temperature and salinity (T/S) vertical profiles are jointly assimilated. Moreover, a 3D-VAR scheme provides a correction for the slowly-evolving large-scale biases in temperature and salinity. The biogeochemistry model is based on PISCES model at ¼° forced by the physical analysis and forecast, recently data assimilation of ocean color has been implemented in the real time system. The wave system is based on MFWAM model at 1/10° resolution assimilating significant wave height and wave spectra. The LMTL products are functional groups of zooplancton and micronecton provided with seapodym-ltml model constrain by global physical and biogeochemical model outputs and observations. This presentation will provide an overview of the available global products which are disseminated through CMEMS platform and an overall assessment of these products. Specific focus will be on the interaction and retro actions between the systems, as for example impact of the surface current in the wave forecast, physical forcing of the biogeochemistry or the LMTL models and how complexity in the coupling between the components could be important to improve interannual reanalysis and short term forecast.

55. Assessment of existing services and new services provided by the Copernicus Marine In Situ Thematic Assembly Centre

Sylvie Pouliquen, Loïc Petit de la Villéon and the CMEMS INSTAC partners

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Context

The Copernicus Marine Environment Monitoring Service (CMEMS) is one of the six operational services of the European Copernicus programme. It is designed to respond to issues emerging in the environmental, business and scientific sectors. The role of the CMEMS Thematic Assembly Centres (TACs) is to collect, process and quality control upstream satellite and in-situ data required both to constrain and validate modelling and data assimilation systems and to directly serve downstream applications and services.
Within CMEMS, the In Situ Thematic Assembly Centre (INSTAC) ensures that a steady supply of in situ ocean measurements is made available to the other service components and to other external intermediate and final users
The In Situ TAC provides vertical profiles and time series data coming from different types of instrument (floats, drifters, moorings, gliders, vessels, …) and different physical parameters (temperature, salinity, currents, sea level, …). In the frame of the first phase of CMEMS (May 2015-April 2018), the In Situ TAC has consolidated the near real Time products and added to the catalogue reprocessed historical products:

Existing and planned services

In the past four years (2015-2019) CMEMS INSTAC set up the operational service and provided data related to the following areas:

- In Near real time
    - Temperature and salinity at both regional and global levels
    - Wave at both regional and global levels
    - Current from drifters and since April 2019 from HF Radars (total current in 2019 and Radial in 2020)
    - Carbon data NRT data from ICOS and non ICOS stations started in April 2019
- In delayed mode (reprocessed products): all products are updated every 6 month except Carbon ones updated annually
    - A merged product (1950-2018) between the CORA CMEMS and ENACT4 product managed by MetOFFICE. Synchronisation with ICES and WOD/USA is done on a yearly basis (April release)
    - A surface current product, designed for reanalysis that integrates the best available version of in situ data for Ocean surface currents for the period 1990-2018. HF radar will be added in 2020 (total current) and 2021 (radial current)
    - A wave product that integrates quality-controlled wave data, both near-real time and historical, collected from more than 400 platforms around the globe.
    - An enhanced version of an historical BGC (Chl-a in 04/2019, O2 in 11/2019 and nutrient in 04/2020) product generated with completely redesigned assessment procedure that will also impact the NRT processing whenever possible.

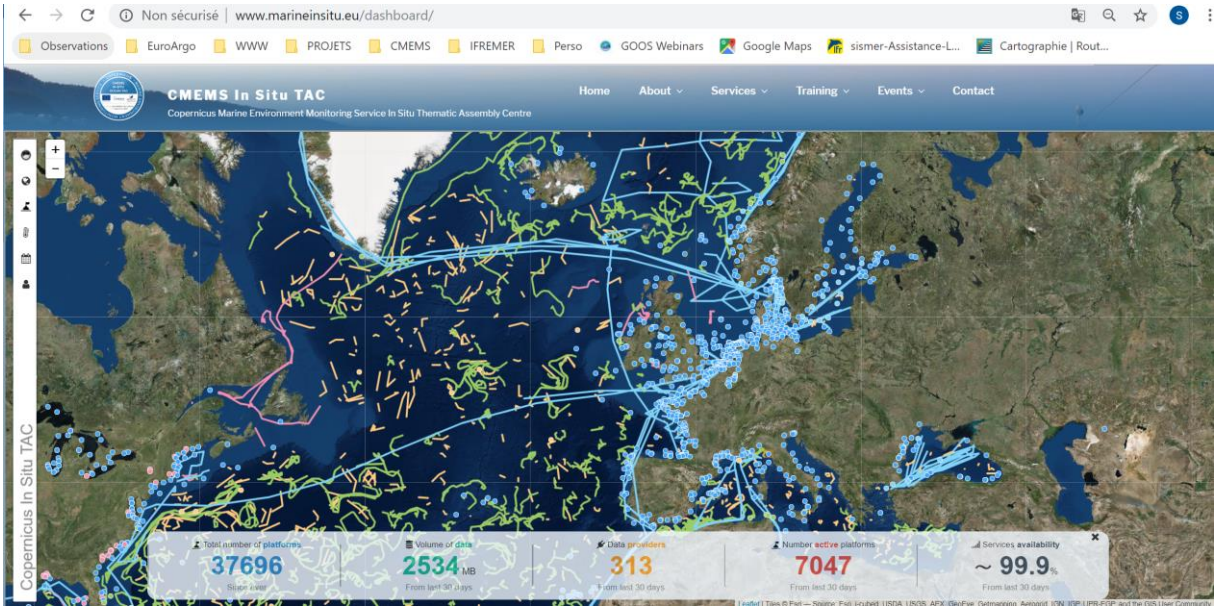

Figure 2 : : Dashboard of the INSTAC service http://www.marineinsitu.eu 30 days of data coverage

The INSTAC is a distributed centre with a global component operated by Coriolis Data Centre closely link the JCOMM networks and 6 regional components developed in partnership with the EuroGOOS ROOSes (Regional Operational Oceanographic Systems).

Moreover, the CMEMS INSTAC is one key element of the in situ data management in Europe closely linked to the major European data integration initiatives such as EMODnet Physics, EMODnet Chemistry and SeaDataNet.

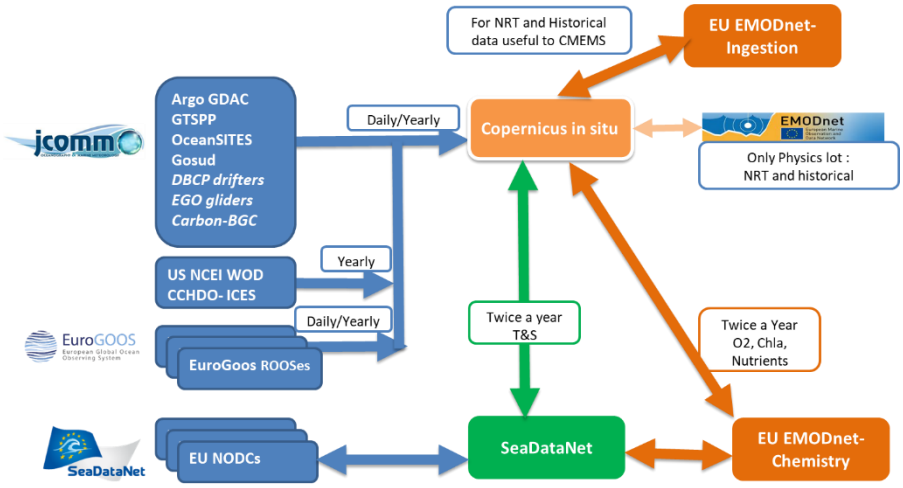

Figure 3: CMEMS INSTAC Interfaces with other data systems

New services planned for the CMEMS INSTAC phase 2 (2018-2021)

In the second phase on CMEMS INSTAC (2018-2021) is extending its activities to the distribution of HF-Radar, the integration of carbon products in link with ICOS and to the extension in time and space coverage of the existing products as well as enhancing the BGC product in close collaboration with EMODNET-Chemistry.

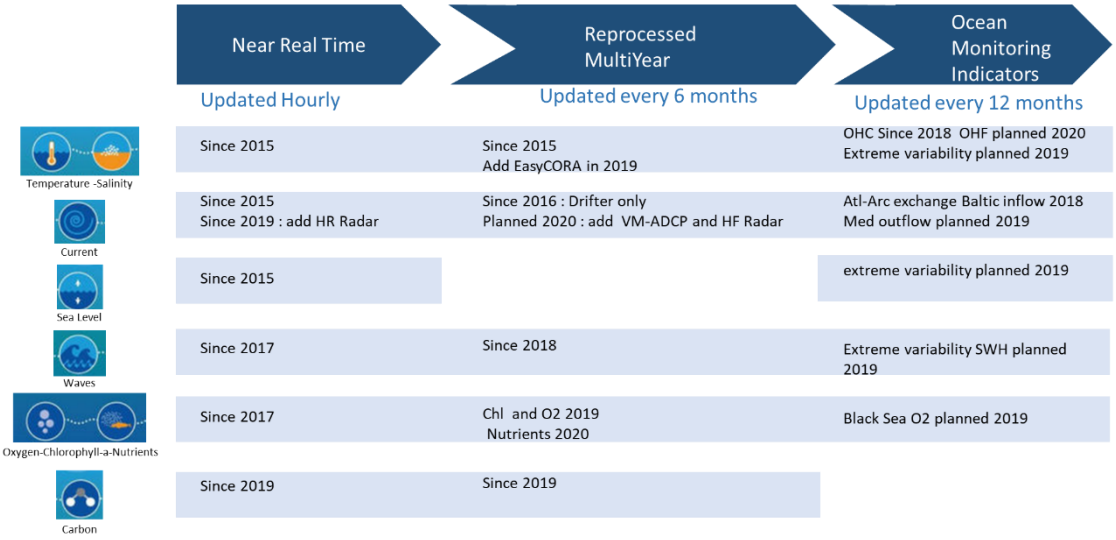

Figure 4: IN SITU TAC product catalogue

Integrated services such as CMEMS INSTAC products, facilitate and extend the use of existing in -situ observation by a wider community and also help highlighting the existing gaps in the observing systems within an integrated multiplatform design.

The poster will provide an overview of the existing and planned INSTAC services until the end of CMEMS-INSATC phase2 which ends in April 2021.

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56. North-Atlantic Ocean Subtropical Gyre: Mechanisms of Observed low-frequency VARiability

Guillaume Mazé

LOPS, Brest

This work is part of the 2017-2019 LEFE GMMC/IMAGO SOMOVAR project. Here we focus on results obtained from the first work package focusing on the observed structure and variability of the NASTG. Using Argo based recent ocean analysis and historical datasets going back to the 1960s, we diagnosed the low-frequency variability of one NASTG stratification key component: the Eighteen Degree Water (EDW). We have found a 2005-2015 decadal trend of reduced EDW heat content due to a combined reduction of its volume and temperature. These changes are explained by modified EDW formation regions and mixed layer properties and will be put into a much larger context of multi-decadal trends of the North-Atlantic Western Boundary system.

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57. Estimating the biogeochemical state of the North Atlantic through the assimilation of surface chlorophyll into a coupled ensemble simulation

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Estimating the biogeochemical state of the ocean is fundamental due to its key role mediating the global stocks of carbon. The optimal combination of observational data with the dynamical equations embedded in models through data assimilation offers perspectives to produce data potentially more accurate and with a higher spatio-temporal coverage than that provided either by observations or models alone. The generation of synthetic products that provide the best possible description of the biogeochemical ocean state and its evolution during the last decades is indeed one of the core projects of the Copernicus Marine Environment Monitoring Service (CMEMS). With the objective of contributing to this task, a 1-year experiment from a novel biogeochemical data assimilation method is presented as a contribution to the GMMC Green-Grog project. The method relies upon the daily integration of satellite chlorophyll data into a probabilistic ensemble simulation of a three-dimensional online-coupled NEMO-PISCES model for the

North Atlantic. For that end, 24 trajectories are updated daily by a square root algorithm based on the SEEK filter using a multivariate scheme in which only biogeochemical variables are updated. Anamorphosis transformations are applied both to each variable of the state vector and to the observations prior the analysis update to deal with non-Gaussian distributions. In this study, we evaluate the impact of using this assimilation methodology on analyses and forecast, in order to provide guidelines for the implementation of an operational system based on ensemble simulations. The assimilation efficiency is assessed with respect to a homologous non-assimilation ensemble experiment. The results show that the assimilation system improves the surface analysis and forecast chlorophyll concentrations displayed by the assimilated data set. However, several regions display imbalances in the correlations between the observed and non-observed variables. To deal with these inconsistencies, a methodology that permits to perform data assimilation only to the fluctuating component of the model is implemented. It consists on applying time-independent transformations prior to the analysis to both the observations and the forecast ensemble using their respective climatologies. We expect these transformations smooth out the influence of the assimilation in those region where model attractors are too strong. Preliminary results illustrate the effect of corrections made on chlorophyll in the regions of interest. In this presentation, we will introduce this original approach, and determine its impacts on relevant biogeochemical variables of the analysis and forecast ensembles.

Keywords: Biogeochemical DA, Ensemble DA, Fundamentals and methodologies of data assimilation

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58. The Iberia-Biscay-Ireland (IBI) configuration : assessment of the model's capacity to reproduce regional dynamics

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Le service européen CMEMS (Copernicus Marine Environment Monitoring Service) met à disposition de la communauté scientifique une importante base de données de simulations numériques et observations, à l'échelle de l'océan global mais aussi au niveau régional et côtier. Dans ce cadre, le Iberia-Biscay-Ireland Monitoring and Forecasting Center (IBI-MFC) fournit des simulations de physique, biogéochimie et vagues dans une région qui englobe le contour Atlantique français et la Méditerranée jusqu'au Golfe du Lion. La haute résolution (1/36°, soit 2km) du modèle de physique permet de reproduire les processus côtiers à méso-échelle tels que les upwellings, tourbillons, la marée ou encore les échanges côte-large. IBI est basée sur la version 3.6 de NEMO, et possède 50 niveaux verticaux. Elle est forcée aux frontières latérales par la solution globale de CMEMS au 1/12° et en surface par les champs tri-horaires de ECMWF. La marée (forcée par TPXO7.1, 11 harmoniques) et 33 rivières sont paramétrées. IBI assimile les données ARGO (T, S), ainsi que la SST et SLA satellite, basée sur une méthode SEEK (Singular Extended Evolutive Kalman Filter).

Les simulations IBI sont disponibles depuis 2011 en prévisions à court-terme (+5j) pour des applications de type opérationnel, mais aussi en mode réanalyse (1992-2017), avec des sorties 3D mensuelles et quotidiennes. Les prévisions sont de plus disponibles en 3D à une fréquence horaire pour la zone côtière. Les produits IBI sont disponibles gratuitement sur http://marine.copernicus.eu IBI est systématiquement validé par des observations indépendantes, afin de s'assurer du réalisme du modèle et évaluer ses capacités. Des efforts continus sont faits pour mettre en place des indicateurs qui permettent de quantifier la qualité de la solution, tant sur le long terme que sur sa capacité à reproduire des événements spécifiques. Des intercomparaisons de modèles sont également effectuées de façon régulière, comparant IBI avec le modèle global du CMEMS et d'autres configurations régionales à plus haute résolution (ex. SAMPA). Ici sont présentés des examples de l'apport de la haute-résolution dans la reproduction des processus côtiers, tel que les échanges entre Atlantique et Méditerranée au niveau du détroit de Gibraltar (comparaison appuyée par des données de radar HF). Ce travail complet de validation et évaluation permet d'identifier les qualités et les points faibles de IBI. Les principales améliorations en cours portent d'une part sur un changement de la solution de marée (passage à FES2014, et estimation de l'apport de

nouvelles harmoniques et du Self Attraction and Loading (SAL) effect) et d'autre part sur des tests de sensibilité sur l'impact de la bathymétrie sur les processus côtiers (passage de GEBCO à EMODnet). Les résultats préliminaires de ces améliorations sont discutés ici.

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59. Some regional results after deployments of Joint Research Activity Projects in the framework of the H2020 JERICO-NEXT project

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In JERICO-NEXT, six Joint Research Activity Projects (JRAPs) were implemented to put forward the added value of JERICO-NEXT. JRAPs keep on track the JERICO-NEXT course of actions via synthesis and application activities based on interactions with other WPs. They help establishing some topical approaches for the scientific strategy and gives inputs to establish the network strategy after JERICO-NEXT. These six JRAPs are implemented to address different key environmental questions and/or policy requirements such as those considered by the MSFD, and according to the 6 JERICO scientific areas:

1- JRAP-1 on pelagic biodiversity
2- JRAP-2 on benthic biodiversity
3- JRAP-3 on chemical contaminant occurrence and related biological responses
4- JRAP-4 on hydrography and transport
5- JRAP-5 on carbon fluxes and carbonate system
6- JRAP-6 on operational oceanography.

These JRAPs were not intending to implement similar actions at each JERICO-RI site but only to a selection of sites/regions according to the consortium interests and requirements from local to regional scales. These regions and sites are: Bay of Biscay (South East Bay of Biscay, Portuguese Margin and Nazaré Canyon, Gironde Mud patch and Bay of Brest), Channel and North Sea, Kattegat and Skagerrak Sea, Baltic Sea, Norwegian Sea, Med. Sea (from Liguria to the Ibiza Channel, Northern Adriatic Sea, Cretan Sea). As the project and the JRAPs were not a priori organised to fit with regional to local needs audience can see a weak point in the way JERICO-NEXT is addressing scientific integration, but actually it is a progressing job that shows a way forward. Consequently, it is paramount to synthesize the preliminary results after deployments in JRAPs, which is the purpose of this presentation.

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60. Sur la situation de l'ECV vent de surface. (Partie océanique.)

Raymond Zaharia et José Gonella

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La communauté scientifique ne peut que se réjouir des mises en orbite réussies d'ADM-Aeolus et de CFOSat. Toutefois, compte tenu de leurs durées de vie, ces 2 satellites ne pourront contribuer que de façon indirecte à une meilleure connaissance de la tendance climatique de la partie océanique de l'ECV (Essential Climate Variable) Vent de surface. Les auteurs font les 8 constats suivants relatifs aux moyens d'observation disponibles pour cette ECV:

- Parmi les diverses catégories d'instruments en service opérationnel fournissant des séries temporelles de couverture géographique et de durée suffisantes, *aucun ne possède les qualités métrologiques requises.* [Pour détecter des tendances climatiques locales, et pour établir des moyennes mensuelles Océan global.]
- Cette situation se complique du fait que certains instruments (comme les altimètres des missions Jason ou Sentinel-3, ainsi que le radiomètre micro-onde de SMOS), n'ont pas pour mission principale la mesure de vent.
- En outre, cette dichotomie (entre "*instruments Météo*" et "*instruments non Météo*"), correspond aussi à des opérateurs différents (agences spatiales, puis organismes météo.)

- Cela fait presque 10 ans qu'il existe une *controverse sur l'aptitude à l'observation des vents forts* (dont il est raisonnable de présumer une tendance à la hausse, compte tenu de la relation de Clausius Clapeyron). Voir par exemple la conclusion de [1].
- Un autre facteur susceptible de bloquer les seuls efforts envisageables à moyen terme pour améliorer la connaissance de cette ECV, réside dans le fait que les instruments qui possèdent une "*aptitude vents forts moins médiocre*"... fournissent une estimation de la vitesse du vent, mais pas sa direction.
Cette particularité est parfois utilisée pour mettre de côté *la série longue des observations de vents par les altimètres*, (ce qui n'est pas le cas des radiomètres micro-ondes, bien qu'ils ne fournissent pas non plus la direction du vent.)
- Les observations de hauteurs des vagues fournies par les altimètres sont assimilées dans les réanalyses, mais pas celles du "*Sigma zéro*". Cette méthode se fonde sur la volonté de *ne pas donner un poids excessif aux altimètres*. Cependant, *la mesure altimètre peut intervenir sur des états de mer différents, (Houle croisée ou "Mer du vent seulement")*, Compte tenu de la situation sous optimale décrite ci-dessus, il peut être pénalisant de limiter ainsi l'usage des observations disponibles. En effet, le risque que le poids des diffusiomètres imprime des tendances irréalistes (que, fort heureusement, la puissance des outils d'assimilation contribue à redresser en partie), ne peut être écarté.
- Des tests fragmentaires sur des champs de "*vent synthétique*" mixant la direction fournie par les analyses météo avec la vitesse fournie par des observations altimètres ont été réalisés "ex post" dans le cadre de travaux de thèse **[2]**, (notamment au LEGOS et au Centre d'Etudes Biologiques de Chizé.) Ces tests ont permis d'améliorer la cohérence des résultats obtenus.
- Les jeux de données disponibles ont certes beaucoup fait progresser la qualité des prévisions météo, mais sont inadaptés au progrès de la connaissance de l'ECV considérée.

En conclusion, les auteurs soutiennent qu'on ne peut exclure que les observations faites depuis 25 ans possèdent des propriétés de complémentarité largement sous exploitées. (Voir par exemple : http://www.clubdesargonautes.com/Wind-trends-TPJ1J2-&-ERA5.jpg)
Même si les réanalyses peuvent corriger en partie les biais et les hétérogénéités inévitables, les auteurs proposent de les explorer de façon plus systématique, (ce qui suppose d'écarter les arguments non démontrés souvent avancés pour s'abstenir de le faire, par exemple : "*The sampling patterns are driving the perceived differences*." [3])

En outre,
- la prise en compte de données "non météo" même sévèrement sous échantillonnées, (mais dont les séries de mesures concernent *des zones 6 à 10 fois plus réduites*), peut donner accès à de l'information de petite échelle horizontale, (10 km ou plus petit), qui ne peut être représentée dans les réanalyses. Diverses problématiques bénéficieraient d'une telle évolution, en particulier la prise en compte, dans de futurs OGCMs couplés O-A, des interactions air-mer [4].
- en Europe, des programmes comme la CCI de l'ESA ou la C3S de Copernicus sont concernés par ces améliorations éventuelles, et pourraient soutenir des tests systématiques en vue d'identifier des possibilités de retraitements [5].
- Outre-Atlantique, on observe une préoccupation complémentaire relative aux réseaux de mesure in situ. (Cf. http://tpos2020.org/wp-content/uploads/TPOS%202020%20Second%20Report%20Draft%20for%20Review_FINAL_28Feb2019.pdf p. 109 & 110.) En haute mer, comme en zones littorales, les enjeux sociétaux d'une connaissance insuffisante de l'ECV Vent de surface sont considérables, notamment pour ce qui concerne le secteur émergent des services climatiques. Les auteurs considèrent que, jusqu'en 2040 au moins, il n'existe guère d'autre possibilité que celle esquissée ci-dessus pour accéder, (notamment lors de futures réanalyses), à une meilleure connaissance de l'ECV vent de surface. Au bénéfice, entre autres, de la science du climat, et aussi des services climatiques, c. à d. des attentes de la société.
Les auteurs remercient Michael Ablain, Boris Dewitte, & Sophie Cravatte pour les échanges fructueux qu'ils ont eus avec eux.

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