OceanPredict
Advancing the science of ocean prediction

International Coordination Meeting (ICM9)

Coastal and Shelf Seas Task Team (COSS-TT)

ABSTRACTS

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Workshop sessions

Workshop themes	ICM9 themes
1	**Theme 1 – Science in support of Coastal Ocean forecasting:** scientific advances in Coastal and Regional Ocean Forecasting Systems (R/COFS), including process understanding and interactions (land-sea, atmosphere-ocean and currents-waves), model evaluation, probabilistic approaches and observing system evaluation (such as Observing System Simulation Experiments).
2	**Theme 2 – Coastal and Regional (pre-)operational ocean forecasting systems and applications:** system descriptions and updates; requirements for real-time operations and forecasts (incl. model details, open boundary conditions, river outflow, atmospheric forcings); assimilation and verification in those systems; coastal forecasting system applications, user- and citizen-oriented products and uptake in coastal regions.
3	**Theme 3 – Seamless integration between Coastal and Regional systems (R/COFS under COSS-TT) and Large scale systems (LOFS under OceanPredict):** nesting and downscaling, comparison of solutions of nested (R/COFS) and outer (LOFS) models over the same domain, advances in seamless integration of systems and demonstration of value added through one-way and two-way nesting.
4	**Theme 4 – Synergy between altimetry and modelling in coastal regions**: up-to-date and future altimeter products presentation; connectivity with in-situ; data assimilation and modelling use cases for regional/coastal oceans; coastal/off-shore signal continuity.
5	**Special theme 5 – Machine Learning:** ML contributions to regional and coastal data analysis and forecasting

Oral **abstracts (by session category) – Full abstracts can be found below**

Theme 1 – Science in support of Coastal Ocean forecasting

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1.2	Vertical mixing and inertial motions by high frequency wind variability in the stratified Yellow Sea during the summer 2010	Byoung-Ju	Choi	Chonnam National University, Korea
1.3	Dynamics paradigm of geostrophic cross-isobath transport over a highly variable shelf topographic regime	Jianping	Gan	The Hong Kong University of Science and Technology
1.4	Variability of Marine Heat Waves over different coastal environments: applications in South Florida and NE Mediterranean Sea	Yannis	Androulidakis	Aristotle University of Thessaloniki
1.5	River–coastal–ocean continuum modeling in Western Mediterranean Italian coasts: Assessment of near-river dynamics and salt wedge intrusion	Ivan	Federico	CMCC
1.6	New findings on Dynamics of Rivre plumes in Coastal Ocean	Peter	Zavialov	P.P.Shirshov Institute of Oceanology, Russia
1.7	Predicting future coastal sea level rise: statistical models based on local observations versus climate model predictions	Tal	Ezer	Old Dominion University
1.8	The importance of the land-sea breeze in driving coastal dynamics of the southern Benguela upwelling system	Giles	Fearon	University of Cape Town, South Africa & South African Environmental Observation Network (SAEON)
1.9	Evaluation of the NEMO coastal model of the St. Lawrence estuary	Simon	St-Onge Drouin	Fisheries and Oceans Canada
1.10	A New High-Resolution Ocean Forecasting system for the Baltic Sea	Vasily	Korabel	Danish Meteorological Institute
1.11	Doing science with the operational model outputs: analyses of El Nino related anomalies over the continental slope off Oregon	Alexander	Kurapov	NOAA/NOS/OCS/CSDL/CMMB

1.12	Adding Baroclinicity and Sea Ice Effects to a Global Total Water Level Forecast Model	Pengcheng	Wang	Environment and Climate Change Canada
1.13	Forcing mechanisms of the circulation on the Brazilian Equatorial Shelf	Alessandro	Aguiar	State University of Rio de Janeiro
Poster.1	Pathways of oceanic water intrusion into the Amazon Continental Shelf	Pedro Paulo	Freitas (1)	Federal University of Pará, Brazil
Poster.2	Coastal-trapped waves along the East-Southeastern Brazilian continental margin: Propagation and modal structures	Pedro Paulo	Freitas (2)	Federal University of Pará, Brazil
Poster.3	The Newport (OR) Model Testbed in Support of Fundamental Research for Forecasting US Pacific Northwest Coastal Processes	Merrick C	Haller	Oregon State University

Theme 2 – Coastal and Regional (pre-)operational ocean forecasting systems and applications

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2.2	Port-scale forecast models and relocatable modelling on the Pacific coast of Canada	Michael	Dunphy	Fisheries and Oceans Canada
2.3	Developing additional products based on the West Coast Operational Forecast System (WCOFS)	Christopher	Edwards	University of California, Santa Cruz
2.4	Oceanographic and Meteorological Models in Search and Rescue	Cristina	Forbes	United States Coast Guard, USA
2.5	Coastal prediction at ECCC - Overview of modelling systems and applications	Jean-Philippe	Paquin	Environnement et changement climatique Canada
2.6	Intercomparison and ensemble project of all regional prediction models in Japan	Naoki	Hirose	RIAM, Kyushu University
2.7	A comprehensive monitoring and forecasting system applied for cross-sea immersed tube tunnel constructions	Lunyu	Wu	National Marine Environmental Forecasting Center, Ministry of Natural Resources China
2.8	Operational forecasting systems for maritime emergency in China: an integrated decision support for maritime emergency response and management	Miaoyin	Zhang	National Marine Environmental Forecasting Center, Ministry of Natural Resources of China

2.9	CoastFLOOD: a reduced complexity, high-resolution, flood model for coastal inundation due to storm surges.	Christos	Makris	Research Associate, School of Civil Engineering, Aristotle University of Thessaloniki
2.10	An update on the research, research-to-operation and operational services at the NOAA National Ocean Services Storm Surge Modeling Team	Saeed	Moghimi	NOAA/UCAR
2.11	Port-scale forecast models on the Atlantic coast of Canada	Stephanne	Taylor	Fisheries and Oceans Canada
2.12	Continued Development of a Daily Operational Model for the Mississippi Sound and Bight	Kemal	Cambazoglu	The University of Southern Mississippi
Poster.4	Progress on the Operationalization of Canada's OPP Port Ocean Prediction Systems and Dynamic Hydrographic Products by CHS	Ji	Lei	DFO-ECCC
Poster.5	A new daily SST analysis system at ECCC	Sergey	Skachko	ECCC
Poster.6	The Construction and Application of the MaCOM Model: A Chinese-Approach to an Independent, Globalized, Digitized Modernization of Ocean Forecasting	Miaoyin	Zhang	NMEFC

Theme 3 – Seamless integration between Coastal and Regional systems (R/COFS under COSS-TT) and Large scale systems (LOFS under OceanPredict)

No	Abstract title	First name	Surname	Affiliation
3.1	Nologin Oceanic Weather System: delivering operational services for the Copernicus Marine and developing coastal downstream applications in the European North East Atlantic.	Marcos	Garcia Sotillo	Nologin / NOW (Nologin Ocean Weather systems)
3.2	Multigrid nested ocean ensembles using stochastic modelling	Vassilios	Vervatis	National and Kapodistrian University of Athens
3.3	A kilometric scale nested configuration over the Iberian - Biscay - Ireland area: assessment and impact on ocean dynamics	Theo	Brivoal	Mercator Ocean / CNRM
3.4	South Africa's Operational Ocean Forecasting Developments	Jennifer	Veitch	South African Environmental Observation Network

Theme 4 – Synergy between altimetry and modelling in coastal regions

No	Abstract title	First name	Surname	Affiliation
4.1	Influence of the assimilation of sea surface height data on the ocean state in the North- and Baltic Seas	Sophie	Vliegen	AWI
4.2	Toward Higher resolution along-track Level-3 sea level altimetry products	Marie-Isabelle	Pujol	CLS
4.3	SWOT OSSE for the Canadian East coast using the Regional Ice Ocean Prediction System	Gregory	Smith	Environment and Climate Change Canada

Special theme 5 – Machine Learning

No	Abstract title	First name	Surname	Affiliation
5.1	A deep learning-based technique for long-term prediction of sea surface temperature: over the Aegean, Ionian and Cretan Seas (NE Mediterranean Sea)	Marios	Krestenitis	Center for Research and Technology Hellas, Information Technologies Institute, Greece
5.2	The Synergy of Data from Profiling Floats, Machine Learning and Numerical Modeling: Case of the Black Sea Euphotic Zone	Emil	Stanev	Hereon
5.3	Shelf-open sea exchange processes across the narrow shelf of the southeastern Mediterranean Sea	Steve	Brenner	Bar Ilan University

Submitted oral abstract (in order of themes)

Theme 1: Science in support to coastal ocean forecasting

1.1	Colette	Kerry	UNSW Australia	Oral

Observation impact in Australia's Western Boundary Current System: from the coherent jet to the eddy field.

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Along the coast of south-eastern Australia, the East Australian Current (EAC) transitions from a coherent jet to an energetic eddy field and its interactions with coastal waters drive complex ocean currents and temperature gradients. Using a regional ocean model (2.5-6km resolution) and 4-dimensional variational data assimilation, we assess the impact of various observations on the prediction of EAC transport and eddies. In addition to the traditional data streams (satellite derived SSH and SST, Argo profiling floats and XBT lines) we exploit novel observations collected as part of Australia's Integrated Marine Observing System, including observations from a deep-water mooring array and shelf moorings, a high-frequency (HF) radar array and a suite of ocean glider missions. Here we present three different methods to assess observation impact in the EAC, with consistent results. Firstly, a comparison of experiments with and without the novel observations allows us to assess their value in prediction of current transport and eddy structure. Secondly, variational methods allow us to quantify directly how each observation contributes to the state-estimate solution. Thirdly, a series of Observing System Simulation Experiments are designed to assess the impact of subsurface temperature observations and the impact of sampling the (upstream) coherent jet versus the (downstream) eddy field. We show that observation impact is far-reaching; both up and downstream. We find that observations taken in regions with greater natural variability contribute most to constraining the model estimates, and subsurface observations have a high impact relative to the number of observations. We then assess the capacity of a downscaling approach (to 750-1000m resolution) to predict the circulation along the landward edge of the EAC where the cyclonic band of vorticity allows small scale instabilities to grow. This work provides information on the value of specific observation platforms for prediction of the EAC and analogous WBC systems, and identifies some challenges associated with the representation of fine-scale flows in regional forecasts for downscaling purposes.

1.2	Byoung-Ju	Choi	Chonnam National University, Korea	Oral

Vertical mixing and inertial motions by high frequency wind variability in the stratified Yellow Sea during the summer 2010

Byoung-Ju Choi[1] and Jung-Woon Choi[2]

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The thermal and dynamical structure in the upper layer of coastal ocean is affected by the wind variability. To identify physical processes, which affect the temperature and thickness of surface mixed layer (ML) in the Yellow Sea, and to find required time interval of wind forcing that generates the responsible physical process in a coastal ocean model. Numerical simulations were performed with time intervals of 1, 3, 6, and 24-hourly wind forcing while that of other atmospheric forcing was kept 1-hour interval. When high frequency variability of winds was included, mixed layer temperature (MLT) decreased, and the surface mixed layer depth (MLD) and salinity (MLS) increased in the Yellow Sea in the summer. Variability of temperature in the upper layer of the coastal ocean had periods of near-inertial and internal tides. As the temporal resolution of wind forcing increased, vertical mixing across the thermocline and entrainment process at the bottom of ML reduced heat content in the surface layer due to the enhanced inertial oscillations while the net surface heat flux into the ocean increased. The net effect of high-frequency winds reduced the MLT by enhancing the near-inertial oscillations in temperature variability in the thermocline layer at depths of 10–30 m in the central YS. At least 6-hourly wind forcing is required to provide inertial motions and vertical mixing in the thermocline layer in the stratified sea. It is expected that fluxes of nutrients and CO_2 between the subsurface and upper layers increase due to near-inertial waves induced by high frequency variability of winds.

1.3	Jianping	Gan	The Hong Kong University of Science and Technology	Oral

Dynamics paradigm of geostrophic cross-isobath transport over a highly variable shelf topographic regime

Jianping GAN and Chiwing HUI

Center for Ocean Research in Hong Kong and Macau, Department of Ocean Science and Department of Mathematics, The Hong Kong University of Science and Technology

We investigated the spatial variability and alongshore dynamics linkage of 3D upwelling circulation over a highly variable shelf topography and driven by wind, tides, waves, terrestrial discharge, local and remote forcing in the Northern South China shelf. The upwelling circulation is characterized by the northeastward and shoreward flows with distinct jet bounded between nearshore isobath (30 m) and offshore isobath (70 m). The jet is interrupted by buoyancy in the river plume-affected region off an estuary. The intensified upwelling or cross-isobath transport *u* occurs in the steep, concave, and widened shelves due to the topography-induced dynamics. Unlike locally dominated *u*, the along-isobath transport *v* shows strong alongshore correlation and remote linkage. Both *v* and *u* are geostrophic dominant, governed by meandering isobaths and the associated along-isobath pressure gradient (*Py**), respectively and they exhibited strong spatial variability. Meanwhile, *u* is visibly modulated by the bottom Ekman transport and the nonlinearity transport, both of which varied substantially in different topographic regimes over the shelf. We presented novel analyses of vorticity

dynamics under different dynamics regimes over the shelf and showed that the shoreward geostrophic cross-isobath (GCT) or *Py** is contributed by bottom stress curl arising from shear vorticity/curvature vorticity over the relatively flat shelf/meandering shelf nearshore. Flow with high Rossby number occurred in the plume frontal region and over the steep shelf, where nonlinear vorticity advection and Joint Effect Baroclinity and Relief (JEBAR) further modulated the GCT. These dynamics processes are modulated by tidal forcing and wave-current interaction.The study demonstrated the variability of the spatial variability of wind-driven upwelling circulation based on the GCT that is novelly illustrated by the topographically controlled vorticity dynamics.

1.4	Yannis	Androulidakis	Aristotle University of Thessaloniki	Oral

Variability of Marine Heat Waves over different coastal environments: applications in South Florida and NE Mediterranean Sea

Yannis Androulidakis, Vassiliki Kourafalou, Yannis Krestenitis

Sea Surface Temperature (SST) is an important parameter of the earth's climate and increasing SST trends have been associated with adverse effects on coastal ecosystems, with important environmental and socioeconomic implications. Marine Heat Wave (MHW) events are increasingly recognized as an important factor in the sustainability of coastal environments (both natural and urban), in the context of climate change. MHW events are extreme climatic episodes affiliated with warm SST values that persist for days to months, over a specific oceanic area. They are related to increasing trends of SST at the adjacent ocean waters. We investigate the formation of MHW events during prolonged periods (past decades) and focus on the relationship between MHW events and the spatial and temporal SST variability. We have adopted a methodology that uses continuous high-resolution satellite observations, field observations, meteorological data, and numerical hydrodynamic simulations. We discuss the interannual variability and the spatial differences between coastal regions with different socieconomic and environmental characteristics: South Florida and northeastern (NE) Mediterranean. The main motivation of the study was to contribute to the understanding of climate change impacts around the coastal areas, by examining the increasing temperature trends (SST) in the surrounding ocean waters and the resulting MHWs that can impact the marine and urban environments. The goal was to identify the SST differences between the sub-regions and the respective coastal waters during the last decades. This can be potentially useful to the research on the implications between physical and biochemical properties. We also evaluate the environmental met-ocean factors that are responsible for the interannual SST variability and trends of each coastal area, focusing on the formation of MHWs and their interannual variability. For South Florida, the interannual positive trend of the MHWs was 0.75 events/decade with 7.4 days/decade duration increase and was associated to the general increasing SST trend over the entire region (0.19^{o}C/decade), following the respective atmospheric temperature (0.21^{o}C/decade) and the heat flux (~5000 J/m^{2}/decade) increases. In NE Mediterranean Sea, the interannual trends of MHWs were stronger (1.7 events/decade) with 21.3 days/decade increase in the total annual duration.

1.5	Ivan	Federico	CMCC	Oral

River–coastal–ocean continuum modeling in Western Mediterranean Italian coasts: Assessment of near-river dynamics and salt wedge intrusion

I. Federico[1], S. Bonamanoa[2], S. Causio[1], Viviana Piermattei[1], Daniele Piazzolla[1], Sergio Scanu[1], Alice Madonia[1], Giovanni De Cillis[1], Eric Jansen[1], Giorgio Fersini[3], Giovanni Coppini[1], Marco Marcelli[2]

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[3]Port System Authority of the Central Northern Tyrrhenian Sea, Molo Vespucci, Port of Civitavecchia, 00053, Civitavecchia, RM, Italy

The complex processes that occur in river delta areas cannot be fully resolved using traditional structured-mesh models. A seamless unstructured-grid approach could support advances in the estimation and modeling of such dynamics across scales. In this paper, a river–coastal–ocean continuum modeling representation was developed for the Tiber River delta, including surrounding coastal areas and open-ocean zones along the Lazio coast (Western Mediterranean Sea, Tyrrhenian Sea, Italy). Using temperature and salinity profiles acquired from historical data of near-river CTD, we demonstrate that this representation reproduces the coastal dynamic processes in the Tiber delta zone better than the classic coastal–ocean representation, minimizing the need for calibration and sensitivity experiments. The model results are compared to a large amount of new observational data (temperature, salinity, and surface currents) obtained specifically to investigate multiple spatial and temporal processes (open-ocean, coastal and near- and along-river). In general, the model shows good overall accuracy, also in reproducing salt wedge intrusion along the southern Tiber branch. Moreover, the results suggest the presence of an anticyclonic gyre in the vicinity of the river mouth of the northern branch that is induced mainly by river discharge and coastal morphology. Owing to its capacity to simulate multi-scale processes in a seamless fashion from the open ocean to the river delta zone, this model can be implemented in the near future within an operational framework to support coastal forecasting activities and deliver useful and reliable ocean information.

1.6	Peter	Zavialov	P.P.Shirshov Institute of Oceanology, Russia	Oral

NEW FINDINGS ON DYNAMICS OF RIVER PLUMES IN COASTAL OCEAN

Peter O. Zavialov

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As principal mediators of land-sea exchanges, river plumes in coastal ocean have been subject to extensive studies. However, as pointed out in one relatively recent review [Horner-Devine et al. (2015)], "*although these studies have clarified many individual processes, a holistic description of the interaction and relative importance of different mixing and transport processes in river plumes has not yet been realized*". This is so partly because observational data at spatial and temporal resolution sufficient to elucidate the internal structure and variability of plumes, especially those of modest sized rivers, are rare.

In this presentation, some insightful result from recent field studies of river plumes will be reported. Firstly, we present and analyze high temporal resolution sea surface height data records from pressure sensors deployed on the inner shelf within the plumes of small-to-medium size rivers of the Black Sea basin. While the low-frequency changes of the SSH at periods of 6 h or longer accounted for about 90%

of the total variability and were strongly correlated with the wind, superimposed on them there always existed high frequency oscillations, not correlated with either the wind stress or atmospheric pressure. Furthermore, the amplitudes and the periods of these high-frequency oscillations appeared to be proportional to the horizontal scale of the river plume, as well as to each other. A simple semi-analytical model focused on the interplay between the plume's mass and the momentum budgets demonstrated that periodic oscillations of the sea surface height should be inherent to river plumes, and also helped to explain the abovementioned dependencies.

We then discuss fine spatial structure of suspended and dissolved matter in river plume based on results of a high resolution field survey conducted in the plume generated by the discharge from the Patos Lagoon at the coast of Brazil in Southwestern Atlantic. The concentration of total suspended matter (TSM) and organic matter (as represented by total organic carbon, TOC) were mapped using an ultraviolet fluorescent LiDAR, which allowed for extensive data coverage (total of 79,387 simultaneous determinations of TSM and TOC). Four distinct regions of the plume were identified with respect to variability of TOC and TSM concentrations: the fully mixed "near-source" region where concentrations were maximum and TSM settling prevailed; the stratified "core" region where TSM and TOC concentrations were subject to abrupt decrease mainly due to turbulent mixing with surrounding waters; the "inner" plume characterized by elevated spatial variability and patchiness of both TSM and TOC fields, significant increase of salinity and shallowing of the plume oceanward; and more uniform "outer" plume. The "core" part of the plume within the jetties and outside them at distances less than 1 km from the lagoon mouth was responsible for about 30% of both TSM and TOC contents and over 50% of TSM removal from the plume, mainly due to turbulent mixing. Another 25% of TSM withdrawal from occurred in the "inner" part of the plume, and only 10% of the TSM loss from the plume took place beyond this region - even though this "outer" part of the plume occupied almost half of the plume area.

REFERENCE

Horner-Devine, A.R., Hetland, R.D., MacDonald, D.G., 2015. Mixing and transport in coastal river plumes. Annu. Rev. Fluid Mech. 47, 569e594. https://doi.org/ 10.1146/annurev-fluid-010313-141408.

1.7	Tal	Ezer	Old Dominion University	Oral

Predicting future coastal sea level rise: statistical models based on local observations versus climate model predictions.

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Sea level rise (SLR) puts many coasts around the world at high risk of increased flooding. However, global climate models that predict SLR for different scenarios may not account for many local factors that are very different from place to place- these include tides, waves, vertical land movement, seasonal to decadal sea level variations, impact of ocean currents, and frequency of major storm surges at different coasts. Therefore, as a testbed in the Chesapeake Bay (CB) region, a simple statistical prediction method based on random sampling of past data was tested as a tool to account for the combined impact of various factors affecting sea level variability; the prediction also estimates the probability of future flooding. The results show for example that under intermediate SLR projection, a storm surge that occurred only once in the past ~100 year may become a frequent

event by 2100. Significant differences in sea level variability and SLR within the Chesapeake Bay were also investigated, where for example, annual and semiannual tides, as well as land subsidence differ at different locations. Even the impact of the North Atlantic Oscillation (NAO) on sea level vary in space within the CB. Monthly sea level projections until 2100 based on statistics and past trends results in much larger spatial differences than SLR scenarios based on climate models.

References:

Ezer, T. (2022), A demonstration of a simple methodology of flood prediction for a coastal city under threat of sea level rise: the case of Norfolk, VA, USA, Earth's Future, 10(9), doi:10.1029/2022EF002786

Ezer, T. (2023), Sea level acceleration and variability in the Chesapeake Bay: past trends, future projections, and spatial variations within the Bay, Ocean Dynamics, 73(1), 23-34, doi:10.1007/s10236-022-01536-6

1.8	Giles	Fearon	University of Cape Town, South Africa & South African Environmental Observation Network (SAEON)	Oral

The importance of the land-sea breeze in driving coastal dynamics of the southern Benguela upwelling system

Giles Fearon[1,2,3], Steven Herbette[4], Gildas Cambon[4], Jennifer Veitch[3,5], Jan-Olaf Meynecke[6,7], Alakendra N. Roychoudhury[8] and Marcello Vichi[1,2]

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[7] Coastal and Marine Research Centre, Griffith University, Southport, Qld, Australia.
[8] Earth Sciences, Stellenbosch University, Cape Town, South Africa

The physical and biogeochemical functioning of eastern boundary upwelling systems is generally understood within the context of the upwelling – relaxation cycle, driven by sub-diurnal wind variability (i.e. with a time-scale of greater than a day). Here, we employ a realistically configured and validated 3D model of the southern Benguela upwelling system to quantify the impact of super-diurnal winds associated with the land-sea breeze (LSB). The ocean response to the LSB is found to be particularly enhanced within St Helena Bay (SHB), a hotspot for productivity which is also prone to Harmful Algal Bloom (HAB) development. We attribute the enhanced response to a combination of near-critical latitude for diurnal-inertial resonance (~32.5°S), the local amplification of the LSB, and the local development of a shallow stratified surface layer through bay retention. Event-scale diapycnal mixing is particularly enhanced within SHB, as highlighted by a numerical experiment initialised with a subsurface passive tracer. These super-diurnal processes are shown to influence sub-diurnal dynamics within SHB through their modulation of the vertical water column structure.

The results suggest that the LSB is likely to play an important role in the productivity and therefore HAB development within SHB, primarily through diapycnal nutrient flux associated with enhanced vertical mixing. This points to the importance of properly resolving both the spatial and temporal variability of the LSB in atmospheric forcing products used in ocean forecast systems for the region, which are currently under development.

1.9	Simon	St-Onge Drouin	Fisheries and Oceans Canada	Oral

Evaluation of the NEMO coastal model of the St. Lawrence estuary

Under the Drift Prediction and Nearshore Modelling (DPNM) sub-initiative of Canada's Oceans Protection Plan (OPP), six high resolution NEMO coastal models have been developed to enhance safety for navigation and Canada's Government response capacity in the case of environmental emergency (e.g. oil spill). The results of the 200m and 500m resolution St. Lawrence estuary models (STLE200 and STLE500) are compared with observations of water level, current meter, temperature and salinity and drift experiment. Results are also compared with outputs from CIOPS-E, the actual operational model, where domains overlap.

1.10	Vasily	Korabel	Danish Meteorological Institute	Oral

A New High-Resolution Ocean Forecasting system for the Baltic Sea

Vasily Korabel, Ida Ringgaard, Vibeke Huess, Jens Murawski, Jun She, Lena Spruch, Anja Lindenthal, and Balmfc Team

The Baltic Sea is an important region for both physical and biogeochemical research, as it provides a link between the global ocean and coastal scales. BAL MFC consortium within Copernicus Marine Service is dedicated to providing users with high-quality data from a state-of-the-art forecasting system. This system offers both operational near-real-time forecasts and reanalysis products dating back to 1993, and is updated twice daily with a 1-nautical-mile horizontal resolution. In December 2020, a new coupled model system based on Nemo4.0 was introduced and became operational for near-real-time forecasts, and is now part of the CMEMS product portfolio. We introduce a new CMEMS high-resolution ocean reanalysis for the Baltic Sea for the period from 1993 to 2021 produced using the BAL MFC system. The reanalysis is an upgrade of the existing CMEMS products and introduces numerous changes including higher horizontal resolution, approximately 1.9 km, a new versions of ocean, ice and biogeochemical models, and a new data assimilation scheme. We assess the performance of the new reanalyses focusing on the ocean dynamics and several key biogeochemichal parameters. We demonstrate the utility of the new highresolution ocean reanalysis for understanding the dynamics of the Baltic Sea and improving our ability produce a physically consistent combination of model and observations. For example we have used the reanalysis to study the occurrence and evolution of salt water inflows from the North Sea. Our results suggest that the high resolution of the reanalysis enables more accurate predictions of these events.

1.11	Alexander	Kurapov	NOAA/NOS/OCS/CSDL/CMMB	No preference	No theme info

Doing science with the operational model outputs: analyses of El Niño related anomalies over the continental slope off Oregon

Alexander Kurapov, NOAA/NOS/OCS/CSDL/CMMB

The US West Coast Operational Forecast System (WCOFS) is a regional prediction system run operationally at the National Oceanic and Atmospheric Administration (NOAA). 3-day forecasts of the flows within the US Exclusive Economic Zone are constrained by assimilation of HF radar surface currents and satellite SSH and SST. Efforts are ongoing to improve the system resolution and the impact of the data on the forecasts. In addition, as part of the model skill assessment, the dynamical core of WCOFS, based on ROMS, was run at the 2-km resolution without data assimilation for a period of 2008-2018. This period included the 2014-2016 heat wave, which was supported by the atmospheric anomaly in the Gulf of Alaska, known as “the warm blob”, and the major El Niño. Model-data comparisons confirm that the regional model reproduces the impacts of these basin scale phenomena on the shelf and slope flows. In particular, episodes of weaker stratification are discovered over the continental slope off Oregon (41-46N) in summer 2014 and 2015. These are explained as the effect of the advection of the strong seasonal alongshore gradient of the potential vorticity (PV) by the anomalously strong poleward alongslope current. The strong seasonal PV gradient over the slope is maintained by the coastal upwelling and shelf-slope volume exchange. The velocity anomaly propagates to Oregon from the southern boundary at 24N (in Mexico) with coastally trapped waves and is associated with the deepening of the isopycnal surfaces over the slope as part of El Niño.

Going just one step beyond model-data comparisons for models developed for the operational use improves our understanding of and intuition about how the coastal ocean works.

1.12	Pengcheng	Wang	Environment and Climate Change Canada	Oral

Adding Baroclinicity and Sea Ice Effects to a Global Total Water Level Forecast Model

Pengcheng Wang and Natacha B. Bernier

In operational water level forecast systems, the effects of baroclinicity and the effects of sea ice are typically neglected. In this study, we developed effective and efficient ways of adding the two processes to a global operational total water level system, the 1/12° GDSPS at ECCC. (1) Baroclinic effects are added by upgrading the GDSPS from barotropic to a light baroclinic model with an optimized vertical grid of nine ocean levels. Temperature and salinity for each layer is weakly nudged to fields provided by a coarser resolution (1/4°), data-assimilative model. This adds realistic baroclinic variability with periods exceeding about 15 days to the GDSPS while allowing the higher frequency variability to evolve freely. Accounting for baroclinic processes in this manner results in only a 10% additional computational cost. The value of adding baroclinicity is demonstrated across the sea level frequency spectrum, and the importance of modeling baroclinically-modified coastal trapped waves is illustrated. (2) Ice effects are added in the GDSPS via the parameterized ice-ocean stress. The approach features a novel, consistent representation of the tidal relative ice-ocean velocities based on a transfer function derived from ice and ocean tidal ellipses given by an external ice-ocean model. The impact of adding ice effects is demonstrated via improved tides and surges. Physical processes relevant for the modulations of tides are examined, and in particular, the impact of the under-ice friction and its accompanied large shifts of tidal amphidromes are discussed.

1.13	Alessandro	Aguiar	State University of Rio de Janeiro	No presentation preference

Forcing mechanisms of the circulation on the Brazilian Equatorial Shelf

The Brazilian Equatorial Shelf (BES) is a very dynamic region due to the influence of various forcings: trade winds, macrotides, the Amazon River, and the North Brazil Current (NBC). To investigate each forcing's role in BES circulation, a control simulation and three sensitivity simulations (without rivers, without tides,
and without winds) were performed using the Regional Ocean Modeling System (ROMS) with a horizontal resolution of 1/24◦ and realistic forcings. The results showed that the NBC advected low-salinity waters from the Amazon River northwestward to Caribbean Sea and occasionally eastward through the NBC retroflection. The NBC exhibited the strongest flow when all forcings were included in the simulation. On the other hand, southeasterly winds inhibited the NBC retroflection system and, thus reducing its contribution to North Equatorial Counter Current (NECC) and Equatorial Undercurrent (EUC). The simulation without tides showed a plume more advected by the NBC and constricted to the first 10 m of the water column, while in the simulation without wind the plume was less advected northwestward by the weakened NBC and spread more toward the
shelf break. The correlation analysis highlighted the complexity of the system, the complementarity of the forcings and their time-variable interdependence. The three sensitivity simulations and correlation analysis demonstrated the wind to be the main mechanism of the circulation in the BES. The sensitivity simulations also gave insight of how circulation would respond in a future scenario if climate changes persist. Previous studies suggest that the reduced Amazon runoff may indirectly weaken Atlantic ITCZ and thus trade winds causing a weakened circulation in tropical Atlantic. Our results show that this weakened circulation would advect even less fresh water northward, worsening the disturbances in North Atlantic due to the reduced freshwater supply.

Poster.1	Pedro Paulo	Freitas (1)	Federal University of Pará, Brazil	Poster (Mauro Cirano)

Pathways of oceanic water intrusion into the Amazon Continental Shelf

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The Amazon Continental Shelf (ACS) is a shallow region (>100 m), with a maximum width of 330 km, which encloses the northern portion of the Brazilian continental shelf and is delimited between 2°S and 4°N. The ACS is located on a continental margin of great potential for the development of strategic economic activities and has great ecological and climatic importance on a global scale. Although important scientific efforts have been made to understand the hydrodynamics of the ACS and the dispersion of the Amazon River plume, there are still few studies that address oceanic water intrusion into the ACS, especially in terms of identifying preferential pathways and temporal

variability of these intrusions. The aim of the present study is to characterize the existence of preferential ocean water intrusion pathways into the ACS along 3 sectors: Maranhão (MA shelf), Pará (PA shelf) and Amapá (AP shelf). This study is based on: i) 306 surface drifter trajectories along 1344 km of the ACS provided by the Global Drifter Program (GDP), ii) 20 years of high resolution numerical reanalysis results (GLORYS12V1) provided by the Copernicus Marine Environment Monitoring Service (CMEMS) and iii) simulations with the Lagrangian model Parcels v2.2.0. The drifters from GDP were selected for the period between 2001 and 2020 and in the area between 40°W and 55°W, and 6°S and 6°N. We have used the GLORYS12V1 daily surface velocity fields (u and v) for the area between 55°W and 30°W, and 6°S and 6°N to force the simulations with the Lagrangian model. In the Lagrangean experiment, over a period of 20 years, we daily released 2 particles at 39°W, 2°S and 39°W, 1°S, accounting for a total of 14608 released particles. Based on the scientific literature about the morphology of the ACS and the average position of the North Brazil Current (NBC), this study adopted as a criterion for intrusion into the ACS the detection of drifters and/or particles crossing the 50 m isobath and standing in equal or shallow depths for at least 1 day. The preferential sector for intrusion of drifters and simulated particles into the ACS is the MA shelf with 67%, followed by the PA shelf with 32%. The AP shelf sector shows low intrusion, corresponding to less than 1%. The intrusion rate into the ACS is highest during the austral summer/autumn in all sectors, being around 55% in the MA shelf and PA shelf and 100% in the AP shelf. The seasonality of the trade winds and NBC are the forcing mechanisms of the variability in the oceanic water intrusion into the ACS. Rotatory spectral analysis of the velocity series collected by the drifters shows that the principal semidiurnal lunar constituent M2 modulates the drifter trajectories on the ACS. This study is part of a project that aims to characterize the spatio-temporal variability of the hydrodynamics of the ACS. A high-resolution hydrodynamical model (ROMS) is being implemented in the region in order to investigate other forcing mechanisms relevant to the hydrodynamics of the continental shelf and cross-shelf exchanges. This project has financial support from National Council for Scientific and Technological Development (CNPq, process 406506/2022-1). Keywords: cross-shelf exchanges, Global Drifter Program, lagrangian modeling, Ocean Forecasting and Analysis System.

Poster.2	Pedro Paulo	Freitas (2)	Federal University of Pará, Brazil	Poster (Mauro Cirano)

COASTAL-TRAPPED WAVES ALONG THE EAST-SOUTHEASTERN BRAZILIAN CONTINENTAL MARGIN: PROPAGATION AND MODAL STRUCTURES

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The propagation of Coastal Trapped Waves (CTW) can be an important mechanism for the variability of currents along the continental shelf and slope regions. The present work aims to characterize the propagation of CTWs along the East/Southeastern Brazilian continental margin, and its effect on sea level and currents. The data set used consists of coastal sea level time series measured at 11 coastal stations between 48°S to 12°S and continental shelf-break velocity time series measured at 5 stations between 31.5°S and 16°S, where all stations are parts of the Global Ocean Observing System (GOOS). In addition, a high-resolution ocean model (HYCOM 1/24°) configuration from the UFRJ/COPPE Physical Oceanography Laboratory was used. The data were filtered by a 4th order bandpass with

cutoff frequencies of 0.025 and 0.43 cycles per day (cpd), which cover typical periods (3 - 30 days) of propagation of synoptic atmospheric systems in the region. The in situ data indicates that the CTW coastal sea level propagates equatorward between 28°S and 22°S at a speed of 11 m/s and then decreases to speeds of 3 m/s, which is followed by a decrease in amplitude and correlation when compared to the signal further south, at the generation region. Overall, the coastal sea level is highly correlated with variations in the intensity and direction of the alongshore currents at the continental shelf-break between 31.5°S and 16°S, indicating that the CTW propagation can be perceived near the shelf-slope region and therefore can also interact with the adjacent Brazil Current. Spectral analyses of the coastal sea level time series between 44°S and 11°S extracted from the HYCOM model show that the energy in the 3 and 30-day band is higher in the Argentine shelf region (41°S) and significantly decreases between 22°S and 18°S. These analyses indicate that waves with periods between 3 and 10 days propagate phase with velocity from 9- 10 m/s up to 22°S, while longer period waves (>10 days) present phase propagation further north (18°S), with speeds between 3-5 m/s. The latitudinal variations of the phase velocity of the CTWs indicate a close relation with the width of the Brazilian East/Southeast continental shelf. EOF analyses of 3 and 30-day band filtered velocity along selected cross-shore sections show that the first statistical mode is dominant (>75%) along the coast. However, between 23.7°S and 20.7°S, a region that encompasses the Cabo Frio coastal upwelling, the second statistical mode shows an increase in percentage importance (~19%). Using the linear model of Brink and Chapman (1987), it was possible to identify that the structure of the second statistical mode in this region is similar to that of the first CTW baroclinic mode. Keywords: Continental Shelf Waves, HYCOM, GOOS, Baroclinic modes.

Poster.3	Merrick C	Haller	Oregon State University	Poster

The Newport (OR) Model Testbed in Support of Fundamental Research for Forecasting US Pacific Northwest Coastal Processes

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Through a collaborative project funded through the US Army Corps of Engineers, we are spinning up a sub-regional scale model testbed centered around Newport (OR) on the US Pacific Northwest coast. The ultimate goal of the project is to develop a West Coast-scale wave and water level forecasting system that can be used to prepare for extratropical storm impacts. On the US West Coast, total water levels generated during extratropical storms are dominated by waves that interact with complex bathymetry, tides, currents, and atmospheric pressure fluctuations. In the ongoing pursuit of an efficient and accurate total water level modeling framework, here we present a model test bed that is centered on Yaquina Bay and the city of Newport, Oregon. and pursue the evaluation of both coupled and uncoupled wave and circulation models.

At this stage, we are testing the recently implemented shallow water physics, implicit numerics, and domain decomposition parallelization advancements of WaveWatch III alongside SWAN and coupled SWAN-ADCIRC implementations. Complex domain geometry, including a headland, a rocky submerged reef, and two tidal inlets (one engineered), is resolved to 10 m using an unstructured mesh. Evaluation of the wave models is carried out using an extensive cross-shore array of wave sensors in water depths that range from 160 m to 8 m, including NDBC buoys, OOI installations, as

well as recent nearshore deployments of pressure gages and Spotter buoys. This domain also serves as the initial buildout of a West Coast Coastal Storm Modeling System (WC-STORM), which will predict the coastal response to parameterized extratropical storms in the Pacific Ocean.

Theme 2: Coastal and Regional (pre-)operational ocean forecasting systems and applications

2.1	Tomasz	Dabrowski	Marine Institute	Oral

Operational forecasting models for Irish regional and coastal waters and their applications

Tomasz Dabrowski, Kieran Lyons, Diego Pereiro, Hazem Nagy, Joseph McGovern, Glenn Nolan

Marine Institute, Rinville, Oranmore, Co. Galway, Ireland.

The Marine Institute, Ireland, developed and maintains an operational ocean and wave forecasting system based on ROMS and SWAN, respectively. The models are implemented at a regional scale (NE Atlantic) and at a local scale for selected coastal regions in the west of Ireland. The NE Atlantic model runs at c. 1.1 km horizontal resolution around Ireland and 3.5 km resolution in the south of the domain and has 40 sigma terrain-following levels. Open ocean boundary conditions in the form of daily averaged temperature, salinity, sea surface height and 3D momentum are obtained from the Copernicus global model (GLOBAL_ANALYSISFORECAST_PHY_001_024). Tide forcing is prescribed by applying elevations and barotropic velocities for 10 major tide constituents, which are taken from the TPXO8 1/30° global inverse barotropic tide model. The ECMWF 0.1° atmospheric forcing is applied at the free surface and bulk formulae for computing heat fluxes has been applied. Major freshwater sources are implemented in the model. The coastal scale models comprise of two c.200 m resolution and 20 vertical levels for the mid-west and south-west coasts of Ireland and one 70 m resolution, 8 vertical levels, model of Galway Bay. The models are nested one-way and offline in the NE Atlantic model, whereby 1 hourly boundary conditions are provided, and the Galway Bay model constitutes a 2-level nesting.

Recent developments include prescription of near-real time freshwater inputs from gauged rivers, application of a wetting-drying scheme, tests of nesting directly in the Copernicus regional models and development of a high resolution models of Galway Bay and Clew Bay. The former has been implemented operationally and the latter is in the pre-operational phase. Improvements gained through these recent developments will be reported on.

The wave modelling system comprises of a regional scale and a coastal scale model for the mid-west coast of Ireland and its set-up will be briefly introduced. Recent upgrades include transition from GFS to ECMWF wind forcing and from WaveWatch III to the Copernicus wave model forcing at open boundaries as well as the development of the aforementioned coastal scale model. Improvements to the model skill will be briefly presented.

Model outputs are freely disseminated via Thredds and Erddap servers. An overview of selected operational applications will be presented to include a weather window tool and web applications in support of search and rescue and in support of native oyster restoration and oyster aquaculture in Galway Bay.

2.2	Michael	Dunphy	Fisheries and Oceans Canada	Oral

Port-scale forecast models and relocatable modelling on the Pacific coast of Canada

Michael Dunphy, Maxim Krassovski, Andy Lin, Hauke Blanken

Under the Canadian government's Oceans Protection Plan (OPP) we have developed near-shore short-range forecast models to support electronic navigation and emergency response for three Pacific coast ports: Kitimat, the Lower Fraser River, and Vancouver Harbour at 100, 30 and 20 m resolution, respectively. The models are based on NEMO 3.6 and downscale results from the Coastal Ice-Ocean Prediction System operated by Environment and Climate Change Canada. Each system has completed a multi-year hindcast period and a two-month forecast period of daily 48-hour forecasts. Evaluation against available observations finds that the models outperform existing operational systems. Meanwhile, a relocatable modelling system is also in preparation to develop the capacity for rapid model deployment at any area in Canadian coastal waters. Here we have developed a prototype system for the Pacific coast and are working toward expanding it to the Atlantic coast and to the arctic.

2.3	Christopher	Edwards	University of California, Santa Cruz	Oral

Developing additional products based on the West Coast Operational Forecast System (WCOFS)

Christopher A. Edwards, Patrick T. Drake, Clarissa Anderson, Stephanie Brodie, Elliott L. Hazen, Michael G. Jacox, and Alexander L. Kurapov

The West Coast Operational Forecast System (WCOFS) represents NOAA's first operational, data assimilative coastal ocean model. Running operationally since March 2021, WCOFS spans a large fraction of waters off the west coast of North America at 4 km resolution, providing 3-day hindcast state estimates constrained by sea surface temperature, in situ temperature and salinity from gliders, and HF Radar. Importantly, this system provides a foundation for additional, value-added regional products. We present here results from several models that use WCOFS to provide further information of interest to west coast stakeholders. In particular, we report on multiple products in development: (a) a biogeochemical model product based on the NEMURO ecosystem model, (b) nested physical models for high resolution analysis of marine protected area connectivity, (c) a statistical model for harmful algal blooms, and (d) a species distribution model for managed fisheries.

2.4	Cristina	Forbes	United States Coast Guard	Oral

Oceanographic and Meteorological Models in Search and Rescue

CRISTINA FORBES

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Search and rescue planning tools and programs involve the use of surface currents and wind data to perform drift simulations to determine the approximate location of the distressed persons lost at sea. A fundamental complex aspect of the SAR mission is that the 3-dimensional search entity (person or craft) is located in the interface between two dynamical fluids of contrasting densities and varying vertical, horizontal and temporal properties. Therefore, it is necessary for SAR marine operations to 1) possess a deep understanding of the regional oceanographic and atmospheric dynamics, 2) knowledge on how a drifting object is influenced by the relative exposure (due to its

buoyancy) to environmental forces such as wind and currents and 3) advanced tools that integrate these dominant factors. The United States Coast Guard (USCG) employs the Search And Rescue Optimal Planning System (SAROPS) for search and rescue (SAR) and planning (USCG Addendum, 2022). SAROPS access to accurate ocean and atmospheric modeling forecast data is critical for drift modeling simulations and planning during the search for survivors and survivor crafts lost at sea. SAROPS obtains surface currents and winds through the Environmental Data Server (EDS) and draws upon characteristics of 107 different search objects. Using the environmental data and search object characteristics, SAROPS employs a Monte Carlo method to account for uncertainties, performing thousands of simulations to establish search areas. It generates probability maps of the most likely location of the endangered individuals and vessels. It then combines them with the availability of search units to produce operationally feasible search plans that maximize the probability of detection. Consequently, it is evident that the availability and access to high-quality and reliable global and regional winds and surface currents data, derived from the latest state-of-the-art forecast modeling systems available, and, from observational networks is essential for accurate prediction of the drift of persons at sea, targeted SAR operations and planning and narrowing of search areas in the marine environment. As of 2022, SAROPS accesses 105 different ocean (63) and meteorological models (42) via the EDS. Specific data from these ocean/met numerical prediction models, developed and run by academia and various international/national government agencies, is directly applied to SAR operations. [1] Additionally, the USCG's Probability of Survival Decision Aid (PSDA), which predicts the likelihood of survival of an individual due to exposure to a wide range and extreme conditions, also requires environmental data to calculate survival time estimates of persons immersed in water. The PSDA takes into account the environmental components (e.g.. relative humidity, air and water temperatures, wind speeds), human anthropogenic parameters (height, weight, fat%) and clothing to produce survivability time estimates.

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2.5	Jean-Philippe	Paquin	Environnement et changement climatique Canada	Oral

Coastal prediction at ECCC – Overview of modelling systems and applications

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Environment and Climate Change Canada (ECCC) developed two high-resolution Coastal Ice-Ocean Prediction Systems (CIOPS) to enhance numerical guidance in case of emergency response in the aquatic environment. The CIOPS systems provide operational short-term 48h forecasts four times daily.

This presentation will describe the CIOPS configuration and model components for both east and west coasts systems, model evaluation, the current limitations and challenges. We will present the ongoing efforts to characterize CIOPS-East long-term statistics, interannual variability, and representation of extreme events through the analysis of a multi-decadal hindcast simulation. The applications of the CIOPS outputs by partners in ECCC and other government departments will briefly be discussed.

Lastly, we will present future projects considered such as evaluating the added value of coupling with atmospheric prediction system, interactive hydrological and river routing forecasting systems on different timescale over the Great Lakes and the CIOPS-East model domains.

2.6	Naoki	Hirose	RIAM, Kyushu University	No preference

Intercomparison and ensemble project of all regional prediction models in Japan

Naoki HIROSE[1], Nariaki HIROSE, Yasumasa MIYAZAWA, Shun OHISHI, Yusuke TANAKA, Shuichi WATANABE

[1]*RIAM, Kyushu University*

We just proposed a research project to compare and also to combine different coastal ocean predictions in Japan. The six prediction models are DREAMS, MOVE, JCOPE, FRA-ROMS, LORA, and SEAoME. First, we select a few small zones to closely compare the differences among the six ocean DA models. The intercomparison is more important than the comparison to observation data at the initial phase. One purpose of this intercomparison is to define metrics to effectively measure the coastal ocean dynamics. Second, in-situ and remotely-sensed measurement data are used to find the problems of each ocean model. We probably need to repeat the forward and inverse estimation processes to improve the forecast performance of individual models. Third, the ensemble combinations are finally conducted and the multi-model ensemble prediction is open with the support of Japan Marine Science Foundation.
The small experimental zones will be extended to all coastal waters along the Japanese archipelago after 2028.

2.7	Lunyu	Wu	NMEFC, Ministry of Natural Resources of China	Oral

A comprehensive monitoring and forecasting system applied for cross-sea immersed tube tunnel constructions

Lunyu Wu, Zhaohui Yin, Huanqing Huang, Li Chen, Fang Hou, Yi Wang

The precise prediction of wind, wave, current and sediment in coastal region is of great importance for the construction of immersed tube tunnel to select the appropriate hydrometeorological window. In this talk we will present a comprehensive forecasting system that serves for tunnel constructions in the Pearl River Estuary. The forecast system is based on real-time observational network and

numerical models. To better resolve irregular coastlines and small-scale topography, both atmospheric and ocean models have sufficiently high resolutions in concerned area by using nesting approach or unstructured grids. The observed data are firstly applied to calibrate model parameters then assimilated in the forecast models and finally used to correct the forecasting or nowcasting products by various short-term forecasting techniques such as regression analyses. System verification are also performed using a year-round data. After the introduction of the system, the talk will focus on the current prediction of the foundation trench, especially the mechanism of the formation of large bottom current, which is virtual to the installation of the tube. Other disastrous processes to marine tunnel constructions such as freak waves are also observed and discussed.

2.8	Miaoyin	Zhang	NMEFC, Ministry of Natural Resources of China	Oral

Operational forecasting systems for maritime emergency in China: an integrated decision support for maritime emergency response and management

Miaoyin Zhang, Yiqiu Yang, Yan Li, Yun Li, Kaixuan Guo, Han Yu

Decision making in maritime emergency response and management are complex due to lack of efficient decision support during maritime emergencies, especially under multi-event scenario. With the development of coastal construction and maritime transport, emergencies including accidental oil spills, search and rescue (SAR) activities, and leakage of hazardous chemical substance pose threat to the environment and human activities. With increasing demand for shortening responding time to reduce human and economic losses, decision support for maritime emergency response based on operational forecasting systems is becoming increasingly important.

The National Marine Environmental Forecasting Center (NMEFC), affiliated to Ministry of Natural Resources of China, has been making great efforts in constructing operational emergency forecasting systems, which integrating satellite observations, meteo-oceanographic model, oil spill model, SAR model to perform forecast of drift trajectory for short-term and long-term covering waters from regional to global. The systems were applied to the supporting service for emergency response operations in Malaysia Airlines Flight MH370, collision of the oil tanker Sanchi, hazardous chemical leakage in Tianjin Port, near-shore volcanic eruptions which formed floating pumice rafts, and etc.

The operational emergency forecasting systems in NMEFC consist of oil spill forecasting system and SAR forecasting system. A two-dimensional module and a three-dimensional module for oil spill forecasting system have been established with a simulation scope from the China seas to the North Pacific. The SAR forecasting model experienced two phases of development: we independently developed the NMEFCSAR with a non-linear module for ship trajectory calculation and a linear model for person drifting trajectory calculation, then the multi-model ensemble forecast method was applied in the system since 2012. The forcing filed of the operational emergency forecasting system is acquire from Chinese Global operational Oceanography Forecasting System (CGOFS-v2). Applications of the operational emergency forecasting systems are introduced, and validations studies are carried out for oil distribution and drifting trajectory.

2.9	Christos	Makris	Research Associate, School of Civil Engineering, Aristotle University of Thessaloniki	Oral

CoastFLOOD: a reduced complexity, high-resolution, flood model for coastal inundation due to storm surges.

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Storm surges due to severe weather events threaten low-land littoral areas by increasing the risk of seawater inundation of coastal floodplains. The latter is mainly responsible for land loss, coastal erosion, damages on onshore infrastructure and properties, environmental degradation of coastal aquatic ecosystems, saltwater intrusion in coastal aquifers, and occasionally human casualties, etc. We hereby present recent developments of a numerical modelling system for coastal inundation induced by sea level elevation due to storm surges, potentially enhanced by astronomical tides and/or Mean Sea Level (MSL) rise. CoastFLOOD is a reduced complexity numerical model for high-resolution simulations of coastal inundation in local-scale littoral floodplains. It is a 2-D horizontal, GIS raster-based storage-cell, mass balance flood model for low-land coastal areas, following a simplified formulation for the Shallow Water Equations (SWEs). The storm surge on the shoreline drives the seawater flow on the coastal floodplain via Manning-type equations in decoupled 2-D formulation. Therefore, CoastFLOOD can be fed either by outputs of regional-scale simulations for storm surges with operational forecast model HiReSS, or by field data for Sea Level Anomaly (SLA) from satellite altimetry and *in situ* observations at the coastal zone.
CoastFLOOD performs highly detailed modelling seawater uprush and flood routing due to episodic, mid- or long-term, sea level elevation on the coastline over a 1-5m resolution ortho-regular Cartesian raster grid. New updated features of the model are discussed herein concerning the detailed surveying of terrain roughness and bottom friction, expansion of Dirichlet boundary conditions for coastal currents (besides sea level), enhancement of wet/dry cell techniques for flood front propagation over steep water slopes, etc. Furthermore, several issues are discussed about the proper inclusion of coastal structures, port infrastructure, beach formations, and rocky shores in the model grid. Land elevation grids are derived by post-processing of available geospatial datasets from freely available high-resolution Digital Elevation Models (DEMs). The operational flood forecast model validation is performed with the use of satellite observations (Sentinel-2 images) producing the Normalized Difference Water Index (NDWI). CoastFLOOD results are also compared to a simplified, static level, "bathtub" inundation approach with hydraulic connectivity. The model output refers to flood hazard maps on areas of classified land elevation for different SLA scenarios. Applications over low-land areas along the Greek coastline are provided. These refer to both short-term operational forecasts and long-term climatic studies.

2.10	Saeed	Moghimi	NOAA	Oral

An update on the research, research-to-operation and operational services at the NOAA National Ocean Services Storm Surge Modeling Team

Saeed Moghimi[1], Yuji Funakoshi[1], Soroosh Mani[2], Gregory Seroka[5], Panagiotis Velissariou[1], Bahram Khazaei[1], Yunfang Sun[3], William Pringle[4], Zizang Yang[5], Edward Myers[5]

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[5] *NOAA*

National Ocean Service's (NOS) Office of Coast Survey (OCS) develops NOS' storm surge modeling infrastructure to continually advance the current Operational coastal flooding inundation Forecasting Systems (OFS). The goal is to provide high quality guidance to the end users and stakeholders in public and private sectors. NOS/OCS' storm surge modeling team engages in research, development and operational support of the NOS' storm surge modeling portfolio. In this talk, we will inform the community regarding recent advances and plans on following areas:

- Advances in the coastal coupling application (CoastalApp and ufs-coastal)
- Recent upgrades in Surge and Tide Operational Forecast System (STOFS)
    - Global ADCIRC based components recent upgrade (STOFS-2D-Global)
    - Implementation of a new 3D core for the STOFS system for Atlantic and plans for its upgrades in 2023 (STOFS-3D-Atlantic)
    - Moving towards pre-operational testing and operational implementation of the 3D core for the Pacific region (STOFS-3D-Pacific)
- Recent advancements in the cloud-based on-demand hurricane surge prediction prototype and plans to contribute in development of the next generation Psurge system in partnership and support of the NOAA National Hurricane Center.
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2.11	Stephanne	Taylor	Fisheries and Oceans Canada	Oral

Port-scale forecast models on the Atlantic coast of Canada

Stephanne Taylor, Rachel Horwitz, Simon St. Onge-Drouin, Adam Drozdowski, William (Chengzhu) Xu, Xianmin Hu

Under the Canadian government's Oceans Protection Plan (OPP), NEMO3.6 has been used to develop near-shore forecasting models for the port of Saint John, the St. Lawrence estuary, and the port of Canso. The project aims to operationalize these systems to produce short-term forecasts for e-navigation solutions and spill / trajectory modelling to support emergency response teams. These models each have two levels: the first level has ~500 m resolution that is downscaled from the Coastal Ice-Ocean Prediction System from Environment and Climate Change Canada, and the second has 100 or 200 m resolution downscaled from the 500 m domain. Each system has been run for a six year hindcast period as well as a two month forecast period, where forecasts are launched daily. Evaluation of the system is done with a range of observations, including water level, water properties, and water velocities, and the high resolution systems are found to outperform existing operational systems, particularly in harbours and near the shore. Operational considerations include the use of real-time river gauge data and forecasting the St. Lawrence freshwater input. Ongoing development work using NEMO 4.0 over the Bay of Fundy domain includes the use of wetting and drying routines to better capture the circulation around the region's extensive tidal flats.

2.12	Kemal	Cambazoglu	The University of Southern Mississippi	Oral

Continued Development of a Daily Operational Model for the Mississippi Sound and Bight

Brandy Armstrong, Kemal Cambazoglu*, Jerry D. Wiggert

School of Ocean Science and Engineering, The University of Southern Mississippi

The msb-COAWST model is a daily instance of the 400 m resolution, 24-layer circulation model of the Mississippi Sound and Bight (msb) region based on a regional application established during the GoMRI-funded CONCORDE consortium by The University of Southern Mississippi (USM) modeling group. Running from June 20, 2022 to present, the modeling system provides guidance to the coastal management community on the impact that local rivers and freshwater diversions, e.g. Bonnet Carré

Spillway (BCS), have on conditions in the Mississippi Sound. The msb-COAWST model enables us to provide the tools and resources needed to better evaluate complex scientific issues and inform natural resource management decisions in the study area.
Input for the Regional Ocean Modeling System (ROMS), at the core of msbCOAWST, includes NOAA National Water Model (NWM) as river forcing, and NOAA High Resolution Rapid Refresh (HRRR) as atmospheric forcing. A regional application of Navy Coastal Ocean Model (NCOM) for American Seas (AMSEAS) is used as open boundary conditions (Figure 1). Assimilated observations include observed stream gage values (NWM), radar data (HRRR), and all quality-controlled observations of satellite sea surface temperature, altimetry, surface and profile temperature and salinity in the region (NCOM-AMSEAS).
Daily msbCOAWST output is available to the public through Coastal CUBEnet (http://oceancube.usm.edu/) where it can be compared with in situ observations and assist with the design of more robust observation networks. Collaborators can also access data from the USM THREDDS server. Currently a pre-operational daily hindcast is being run, and future efforts plan to include a now-cast and a one-day forecast. Future model versions could assimilate and synthesize in situ observations including H/F RADAR currents to improve model forecasts.

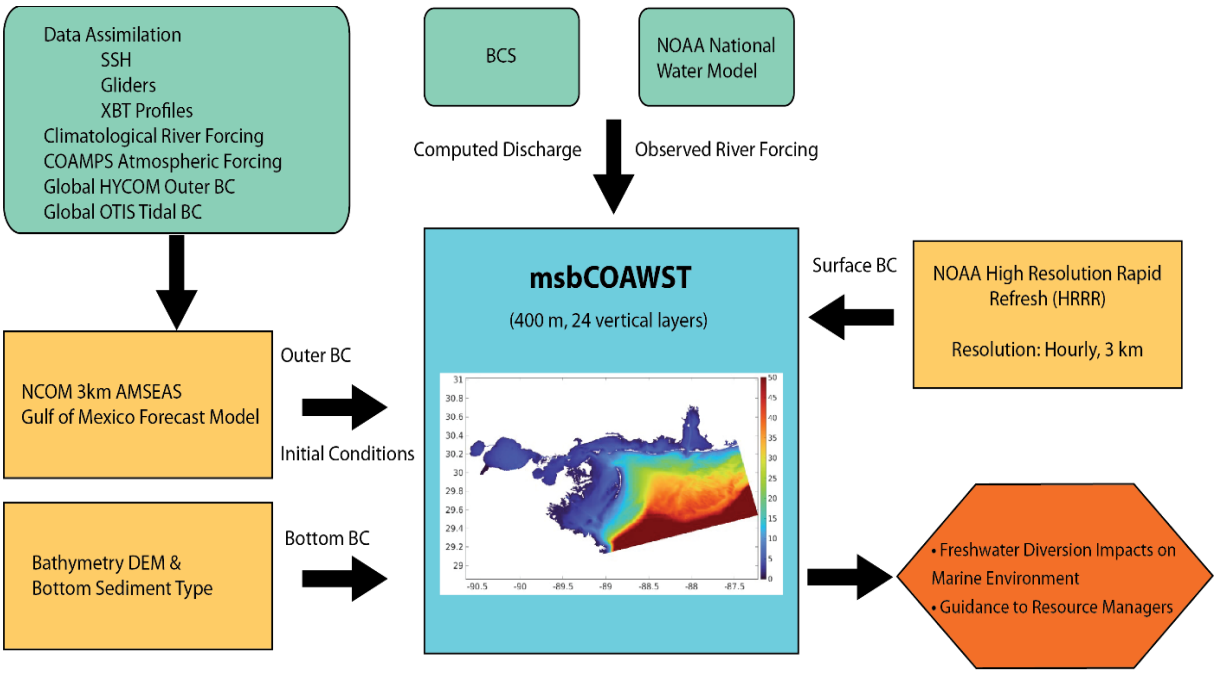

Figure 1. The modeling framework of the daily operational modeling system for Mississippi Sound and Bight

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Poster.4	Ji	Lei	DFO-ECCC	Oral

Progress on the Operationalization of Canada's OPP Port Ocean Prediction Systems and Dynamic Hydrographic Products by CHS

As the DFO science group continues to improve Canada's OPP Port Ocean Prediction Systems (POPS), the Dynamic Hydrographic Products (DHP) team of the Canadian Hydrographic Service is working to enable the operational service of these systems. A series of efforts have been applied to have the POPS running daily in a pseudo operational set up on the Canadian General Purpose Science Cluster (GPSC). Based on the model outputs, the DHP team also produces daily S-100 products (i.e. water

level and surface current predictions) that fit the standards for multi-usage as defined by the International Hydrographic Organization. At present, all model data and DHP products are available on the GPSC server for users within the government of Canada science network; and efforts will be made to have them available for a wider range of users in the future. In this presentation, we will give an overview of the data produced by the DHP team and its usage.

Poster.5	Sergey	Skachko	ECCC	Oral

A new daily SST analysis system at ECCC

Sergey Skachko, Mark Buehner, Dorina Surcel-Colan, Pierre Koclas, Alain Caya, Yves Franklin Ngueto, Ervig Lapalme, Kamel Chikar

A new global daily Sea Surface Temperature (SST) analysis system has been developed at Environment and Climate Change Canada (ECCC) to replace the existing operational system. All components of the new SST analysis system are implemented within the Modular and Integrated Data Assimilation System (MIDAS) software. MIDAS is already used for the data assimilation component of the main operational Numerical Weather Prediction (NWP) systems. The new SST analysis system, integrated together with the global sea-ice analysis, will be part of the combined surface analysis used for all operational prediction systems at ECCC. The data assimilation method used to compute the new SST analyses is 3D-Var with a diffusion operator for representing the horizontal correlations. New algorithms for the data quality control and satellite data bias estimation have also been developed for the new system. The performance of the new system is examined relative to the current operational system by using independent data and the impact of using the new SST analyses within other prediction system is evaluated.

Poster.6	Miaoyin	Zhang	NMEFC, Ministry of Natural Resources of China	Oral

The Construction and Application of the MaCOM Model: A Chinese-Approach to an Independent, Globalized, Digitized Modernization of Ocean Forecasting

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Abstract

The Mass Conservation Ocean Model (MaCOM 1.0) is constructed by National Marine Environmental Forecasting Center (NMEFC), affiliated to Ministry of Natural Resources of China, in the demands of an accurate, autonomous, and high-efficient numerical model for marine environmental forecasting from regional to global scale. The MaCOM model was released to the public in 2021, which fills the gap in the operational oceanography numerical forecasting in China, and shows great application values in areas such as climate change assessment, marine scientific research, and marine environmental security.

The MaCOM model is innovative in conservation of mass, horizontal grid dimension reduction, parallel graph topology communication and GPU acceleration, which is in general featured as

multigrid support, and high-efficiency and energy-saving heterogeneous computing. In MaCOM, the assumption of volume conservation in current mainstream global ocean circulation models is replaced by the true mass conservation of sea water. The seawater temperature and salinity dynamics are adjusted to conform to the physical reality, and the speed is faster (less than 1 day) after the adjustment, which can meet the demand of short and medium term ocean forecast. The precision of core elements forecasts, such as sea surface temperature and sea surface height, has been significantly improved. The operational efficiency of the model is an important technical index to evaluate a marine operational forecasting model. At present, the mainstream global ocean circulation models all adopt MPI parallel computing technology to improve the operation efficiency. The MaCOM mode also uses MPI parallel scheme to realize efficient operation, which is mainly embodied in three aspects: mode parallel meshing, communication design, and optimization, and asynchronous parallel I/O design.

The MaCOM model establishes a series of key technologies and methods that can be controlled independently, and effectively fills the gap in the construction and implement of autonomous ocean circulation numerical systems in China. The prediction skills of MaCOM model in aspects of vertical structure of thermohaline, sea surface temperature, sea surface height anomaly, and current field are comparable to that of international mainstream ocean circulation models. This talk will introduce the model configurations and evaluation results, and its applications in operational oceanography forecasting.

Theme 3: Seamless integration between Coastal and Regional systems (R/COFS under COSS-TT) and Large scale systems (LOFS under OceanPredict)

3.1	Marcos	Garcia Sotillo	Nologin / NOW (Nologin Ocean Weather systems)	Oral

Nologin Oceanic Weather System: delivering operational services for the Copernicus Marine and developing coastal downstream applications in the European North-East Atlantic

M. G. Sotillo[1], M. Drevillon[2], A Amo[1], C. Toledano[1], S. Ciliberti[1], L Aouf[3], J. Lin[1], A. Pascual[1], M. Garcia-Leon[1], P. Rey[4] , O. Ballesteros[1], J. Asensio[1], L. Castrillo[1], R. Alonso[1], B. Pérez[5], M. Espino[6], M. De Juan[7], J. García-Valdecasas[8], V Serrano[9], A. Gallardo[1], J. M. García-Valdecasas[1], R. Aznar[1].

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2) MOI Mercator Ocean international. Toulouse, France.
3) Centro de Supercomputación de Galicia (CESGA), Santiago de Compostela, Spain;
4) MeteoFrance, Toulouse, France
5) Puertos del Estado, Madrid Spain
6) Laboratorio Ingeniería Marítima / Universidad Politécnica de Cataluña, Barcelona, Spain
7) Fundación ValenciaPort, Valencia, Spain
8) Oritia & Boreas SL, Granada, Spain
9) IMIDA -Instituto Murciano de Investigación y Desarrollo Agrario y Medioambiental-, Murcia, Spain.

Monitoring and forecasting ocean services using observations and numerical models advances oceanography and provides the baseline for practical applications of societal relevance. **Nologin Ocean Weather Systems** (**NOW**, operating from Santiago de Compostela and Madrid, Spain) is an active player in this framework, cooperating at international level to advance and build operational ocean systems and services for blue economy, climate monitoring and ocean health.

In the context of the Copernicus Marine Service, NOW co-leads with Mercator Ocean International (MOI) the **Iberian-Biscay-Ireland Monitoring and Forecasting Centre (IBI-MFC)**: it delivers regular and complete ocean information for the IBI area, covering the European Atlantic façade and the westernmost part of the Mediterranean Sea. The IBI-MFC products catalogue includes reanalysis, analysis and up to 10 days forecast data for the Blue (ocean physics and waves) and Green (biogeochemical) ocean components. Product quality assessment is operationally performed to provide users science-based consistent information. The IBI-MFC operational suites (hosted and run in CESGA HPC resources) embed best state of the art modelling solutions and data assimilation schemes, developed for this specific regional area (based on NEMO-PISCES model engine for physics and biogeochemistry, and on WAM for the waves built by MeteoFrance and NOW). Present contribution highlights main upgrades achieved during the previous Copernicus1 phase (Sotillo et al, 2021) and the currently on-going and planned evolutions for this new Copernicus-2 phase (2022-2024 period). Among others, a significant model resolution increase is expected, especially in multi-year IBI reanalysis products that will multiply by 3 their resolution, allowing the delivery of all (Near-Real-Time forecasts and Multi-Year reanalysis) products for ocean physics, waves and biogeochemistry in a single common grid at 1/36º resolution, which is one major IBI-MFC goal. Furthermore, a new interim stream will be implemented to allow updates of IBI MY reanalyses closer to present time and NRT ocean

forecasts will be extended up to a 10-day horizon. In addition, Artificial Intelligence (AI) techniques are being tested to improve the forcing data (i.e. winds and ocean currents) used in the regional IBI wave forecasting service.

In the coastal downstream side, NOW is involved in several service initiatives. Among others, and in the context of an IMIDA (the Agriculture and Environmental Research Centre for the Murcia Region) service, NOW is dealing with the coordination of a new multi-model water balance **forecasting system for the Mar Menor**, a coastal saltwater lagoon located in the South-East of Spain. The area is heavily affected by the joint action of intensive agriculture and flash floods that drive high concentrations of nutrients (nitrates and phosphorous) to the lagoon, unleashing episodic eutrophication and related later anoxia events that severely impacts on existing biota. This new multi-model service aims contributing to the forecasting and monitoring of the lagoon ecosystem health. It includes (i) an atmospheric module (HARMONIE-AEMET at 2.5 km resolution), (ii) two surface hydrological models (SWAT and TETIS), together with (iii) a groundwater module (SUTRA) to simulate freshwater contributions from the quaternary aquifer and finally (iv) two coastal circulation models of the Mar Menor lagoon (based on ROMS and SHYFEM) that includes the three channels connecting Mar Menor with the Mediterranean Sea. Also in the Mediterranean Spanish coast but focused on planning climate change adaptation and mitigation strategies, NOW is making assessment of climatic changes in the wave state at Valencia, Gandia and Sagunto Ports. To this aim, different **high resolution climate scenarios at harbour scales** (up to year 2100) were generated in the ECCLIPSE Project, downscaling climate model projections through a hybrid methodology using dynamic models and AI based solutions. Finally, and more in the user service side, OSPAC (Operational Services for Ports and Cities) is an **advanced service aggregator User Interface** (co-developed by Puertos del Estado and Nologin in the framework of EuroSea project) for visualizing in targeted regions: (i) real time met-ocean parameters from in-situ stations and (ii) met-ocean forecast products from high resolution models. OSPAC users can easily set-up highly customizable warnings for any parameter available in the catalogue; and simulate oil-spill and floating debris forecasts on-demand basis. The tool is being initially deployed in 3 pilot sites (Barcelona (Spain), Taranto (Italy) and Buenaventura (Colombia)). The OSPAC UI tool has recently been selected as a demonstrator by the European Commission's Innovative Radar (2022).

3.2	Vassilios	Vervatis	National and Kapodistrian University of Athens	Oral

Multigrid nested ocean ensembles using stochastic modelling

Vassilios Vervatis (1), Pierre De Mey-Frémaux (2), Nadia Ayoub (2), Malek Ghantous (3), Sarantis Sofianos (1)

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(2) LEGOS/CNRS, France,
(3) Collecte Localisation Satellites, France

A Bay of Biscay dual-grid configuration is used as a test case to explore regional and coastal ocean model uncertainties based on lateral and surface boundary conditions. Medium-range ensemble simulations of high-resolution parent (1/36^{o}) and child (1/108^{o}) domains are carried out perturbing the wind forcing. Ocean model boundary errors are assessed via Target Operational Protocols i.e., TOP-0: perturbing the wind of the parent, 1-way downscale in the child; TOP-1: perturbing the wind of the parent and the child, 1-way downscale in the child; TOP-2: perturbing the wind of the parent and the

child, 2-way downscale/upscale in the child/parent. The study is based on a Copernicus Marine research project named MULTICAST, meant to contribute to the evolution of ensemble ocean forecasting capabilities, using stochastic modelling and multigrid covariances for advanced data assimilation methods.

3.3	Theo	Brivoal	Mercator Ocean / CNRM	Oral

A kilometric scale nested configuration over the Iberian - Biscay - Ireland area: assessment and impact on ocean dynamics

Theo Brivoal
Mercator Ocean / CNRM

In the framework of the IMMERSE project, the NEMO ocean model has recently undergone a deep rewriting. This includes a reformulation of the vertical coordinate, optimized cache memory access, a new time stepping with an extended stability range and an improvement of the vertical physics and air-sea interactions. As a testbed of the freshly released v4.2 version, we present here a new kilometric scale configuration, two-way nested in the existing Copernicus IBI operational system, spanning the Bay of Biscay and the western Mediterranean Sea. With explicit tidal forcing, and the associated ubiquitous presence of large internal waves, this also makes a challenging test for the online block structured refinement procedure.

Based on an 18-month long experiment (January 2017 – June 2018), we perform a standard validation of our nested configuration against satellite and in-situ data. The tidal harmonics, the sea level anomalies and the internal tides simulated by the model are consistent with satellite observations. We show that balanced motions and internal waves are well transmitted across the nest boundaries.
Then, we investigate the impact of the high-resolution nest on the ocean currents by comparing the simulation with a twin experiment over the same period but without nest. Based on an analysis of the frequency-wavenumber kinetic energy spectrum, we show that the high-resolution nest increases the kinetic energy of submesoscale motions and internal waves in the Bay of Biscay, and of the meso and submesoscale structures in the Mediterranean Sea.

3.4	Jennifer	Veitch	South African Environmental Observation Network	Oral

South Africa's Operational Ocean Forecasting Developments

Jennifer Veitch[1,2], Giles Fearon[1], Zach Smith[1] Matthew Carr[1,2] and Cristina Russo[4]

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Algoa Bay is situated at the edge of the Agulhas Current, where it transitions from being relatively stable, to unstable as the continental shelf broadens in the downstream direction. As one of South

Africa's largest bays it provides a degree of shelter from the southern hemisphere's most powerful western boundary current and is being utilized for offshore ship refueling operations. The environmental risks involved, the highly dynamic offshore boundary and the good network of measurements in the bay have led to it being identified as a pilot site for the development of an operational forecast system that would support stakeholders and decision makers in the case of coastal hazards. To this end, a step by step approach was followed in order to produce a downscaled forecast system optimized for this region and that can be readily configured for other key locations around the coastline. The first step was to evaluate and intercompare various global models as potential boundary conditions. The next step was to develop high-resolution, limited duration hindcast CROCO/ROMS simulations, using different ocean boundary forcings and resolution atmospheric products. Comparisons with temperature recorders and ADCPs at various locations within the bay reveal the differences in the skill of the different models and that their ensemble mean performs best. The tools for the modelling approach have been 'dockerized' for the ease of implementation in key locations of the South African coastline. Using this dockerized workflow solution a second bay-scale operational forecast system has been implemented for the South West Cape Coast region, which is home to a lucrative aquaculture industry that are periodically impacted by severe harmful algal blooms. These limited area-forecast systems developed for high-use and sensitive regions of the South African coastline will be integrated into the National Oceans and Coastal Information Management Systems (OCIMS) as a decision support tool to support good governance of the coastal environment.

Theme 4: Synergy between altimetry and modelling in coastal regions

4.1	Sophie	Vliegen	Alfred-Wegener-Institut (AWI), Helmholtz Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany	Oral

Influence of the assimilation of sea surface height data on the ocean state in the North- and Baltic Seas

Sophie Vliegen

AWI

In this study, the effect of assimilating CMEMS altimetry along-track sea level anomaly data into the HIROMB-BOOS-Model for the North- and Baltic Seas is analysed. High temporal variation in sea surface height (SSH) due to the tides in the North Sea requires assimilation of the altimetry data at observation time. Therefore, the concept of asynchronous data assimilation is exploit. Different experiments, including additional assimilation of sea surface temperature (SST), are assessed over a three-month period. The results show increases in SSH up to 20cm in the North Sea, predominantly in the open waters, and up to 6cm over the entire Baltic Sea. However, a systematic positive offset between the observations and the model simulations in SSH is found. After correction, the magnitude of the influence reduces to 5cm and even results in a decrease in SSH along the Norwegian Trench and the Bothnian bay. Validating with independent tide gauge data along the coasts yields small effects, which result in changes in correlation up to 0.02 and in RMSE up to 3cm. Additionally, SST average RMSE is decreased by 0.09°. In conclusion, assimilating along-track satellite data in a coastal area can lead to more accurate state estimations despite the limitations of this type of data in coastal areas like the North- and Baltic Seas.

4.2	Marie-Isabelle	Pujol	CLS	Oral

Toward Higher resolution along-track Level-3 sea level altimetry products

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In 1998, first Level3 along-track, user friendly altimeter products have been developed with support from CNES and delivered to the users on AVISO+. The Level3 processing includes a homogenization of the SLA for the different altimeters (i.e. reduction of the global and regional biases), allowing the users to directly use the products without any pre-processing. They are widely used for different applications, including assimilation in numerical models. Since 2008, such products are generated and disseminated by the Copernicus Marine Service (CMEMS; previously MyOcean during its demonstration phase).

Since few years, efforts are done in order to improve the altimeter measurement in open ocean and coastal area. While the observation of the small mesoscale signal remains a challenge for the conventional altimeter measurement, new techniques and processing allow to significantly reduce the measurement errors and noises. Additionally, with the future altimeter missions as the large swath SWOT mission, the altimeter processing will face a new challenge be able to accurately process the signal at finer spatial scales.
A new generation of along-track products is under development with support from CNES (DUACS-RD project) and ESA (EO4SIBS project). They are derived from high resolution (20Hz) altimeter measurement and are specifically processed in order to solve finer scales up than the conventional 1Hz product and better sample the coastal areas. They merge recent developments that enable to optimize the Sentinel3 SAR altimeter processing (Boy 2017, Moreau,2018) and the Jason/Altika noise level (Zaron 2016, Tran 2019) and allow us to better exploit the fine-scale content of the altimetric missions. They also take into account improvements that are also done in geophysical corrections estimation (e.g. internal tide model [Zaron 2018]) and local Mean Sea Surface Estimation (e.g. Dibarboure et Pujol, 2019). Different experimental/samples datasets, with a nearly 1km (5Hz) sampling, are already available on AVISO+ (https://www.aviso.altimetry.fr/duacs), CMEMS (https://marine.copernicus.eu/). and EO4SIBS (http://www.eo4sibs.uliege.be/). They can be tested by users. New samples are also under preparation. Additionally, an operational L3 5Hz production in CMEMS started from late November 2022. We will present these experimental & operational 5Hz products.

4.3	Gregory	Smith	Environment and Climate Change Canada	Oral

SWOT OSSE for the Canadian East coast using the Regional Ice Ocean Prediction System

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The SWOT satellite mission was launched in December 2022. This innovative wide-swath altimeter has the potential to provide a significant improvement in the constraint on fine-scale features in operational coastal ocean analysis systems. Here we use an Observing System Simulation Experiment (OSSE) framework to assess the potential impact of SWOT on the quality of analyses from the Regional Ice Ocean Prediction System (RIOPS). RIOPS is running operationally at the Canadian Centre for Environmental Prediction and providing numerical guidance for the Canadian Coast Guard for search and rescue and environmental emergency response efforts (among other applications). RIOPS combines three analysis systems: a multivariate reduced-order Kalman filter for the ocean, a 3DVar scheme for bias correction of temperature and salinity profiles, and a 3DVar approach for sea ice concentration. We aim to assess the extent to which SWOT data may improve RIOPS surface currents along the Canadian east coast. A particular focus is on the representation of near-surface currents during intense weather events.

Theme 5 – Machine Learning

5.2	Marios	Krestenitis	Center for Research and Technology Hellas, Information Technologies Institute, Greece	Oral

A deep learning-based technique for long-term prediction of sea surface temperature: over the Aegean, Ionian and Cretan Seas (NE Mediterranean Sea)

Marios Krestenitis[1], Yannis Androulidakis[2,3], Yannis Krestenitis[2]

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3. Laboratory of Physical and Chemical Oceanography, Department of Marine Sciences, University of the Aegean, Greece

Sea Surface Temperature (SST) is a fundamental measure of the global climate system, closely related with marine and coastal ecosystems, as well as, weather and atmospheric events. Excess high SST values over a prolonged time period are considered as Marine Heat Waves (MHW) and have a critical impact on oceanic water quality affecting the local ecosystem along with the related commercial activities, e.g., fisheries operation. Since the MHW phenomena are expected to be increased in the feature, due to overall climate change, forecasting these events can lead to developing tailored strategies to deteriorate their impact. Towards this direction, predicting SST is a crucial, yet challenging, task that can enable to foresee the upcoming MHWs. In the literature, a wide variety of different approaches has been proposed for SST values prediction. Yet, the majority of the existing methods either are designed to provide near-future SST forecasts (hours to a few days), or long-term predictions in climatic scales (decades to century) that are based on hypothetical scenarios that need to be proven. In this work, we present a robust deep learning-based method, designed for more efficient long-term SST forecasting based on available high-resolution observations (satellite-derived SST). Specifically, the deployed model processes the annual SST measurements combined with 5 other relevant measures, such as air temperature, wind speed, radiations, sea level pressure and predicts the SST sequence of the following year. The proposed method utilizes the effectiveness of well-known DL architectures in order to accurately predict the SST values for several subregions of the NW Mediterranean Sea (Aegean, Ionian, Cretan Seas: AIC) simultaneously, while its modular design allows fine-tuning the framework for different spatial and/or temporal resolutions, according to the use case. The model was trained and evaluated on collected satellite data (0.01 degree) from the AIC region over a 15-year period (2008-2022). Results imply that the proposed method can efficiently predict SST values, even in case of processing previously unseen data, comprising a robust methodology that can contribute to the predictability of MHWs.

5.3	Emil	Stanev	Hereon	Oral

The Synergy of Data From Profiling Floats, Machine Learning and Numerical Modeling: Case of the Black Sea Euphotic Zone

E. V. Stanev

Data from profiling floats in the Black Sea revealed complex temporal and spatial relationships between physical variables and oxygen, chlorophyll and the backscattering coefficient at 700 nm, as well as some limits in understanding the details of biogeochemistry dynamics. To account for different interdependences between physical and biogeochemical properties, a feedforward backpropagation neural network (NN) was used. This NN learns from data recorded by profiling floats and predicts biogeochemical states using physical measurements only. The performance was very high, particularly for oxygen, but it decreased when the NN was applied to older data because the interrelationships between the physical and biogeochemical properties have changed recently. The biogeochemical states reconstructed by the NN using physical data produced by a coupled physical–biogeochemical operational model were better than the biogeochemical outputs of the same coupled model. Therefore, the use of data from profiling floats, physical properties from numerical models and NNs appears to be a powerful approach for reconstructing the 4D dynamics of the euphotic zone. Basin-wide patterns and temporal variabilities in oxygen, backscattering coefficient and chlorophyll were also analyzed. Of particular interest is the reconstruction of short-lived biogeochemical features, particularly in coastal anticyclone areas, which are difficult to observe with available floats at the basin scale.

5.1	Steve	Brenner	Bar Ilan University	Oral

Shelf-open sea exchange processes across the narrow shelf of the southeastern Mediterranean Sea

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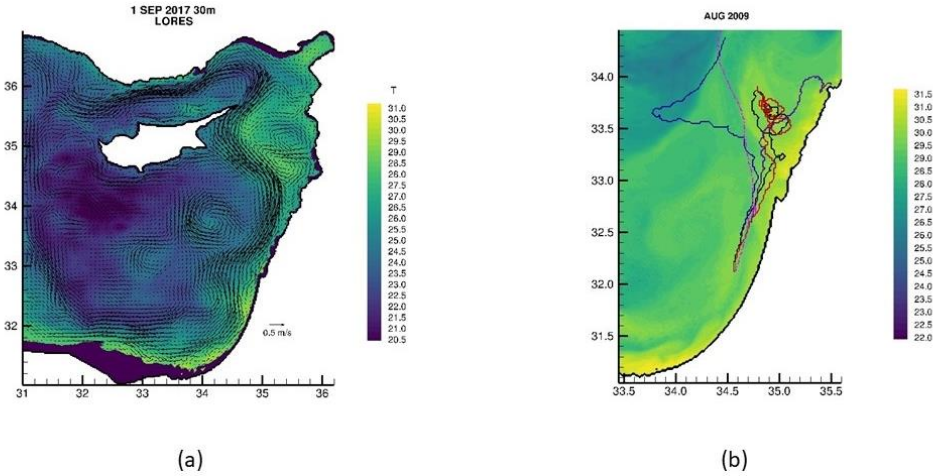
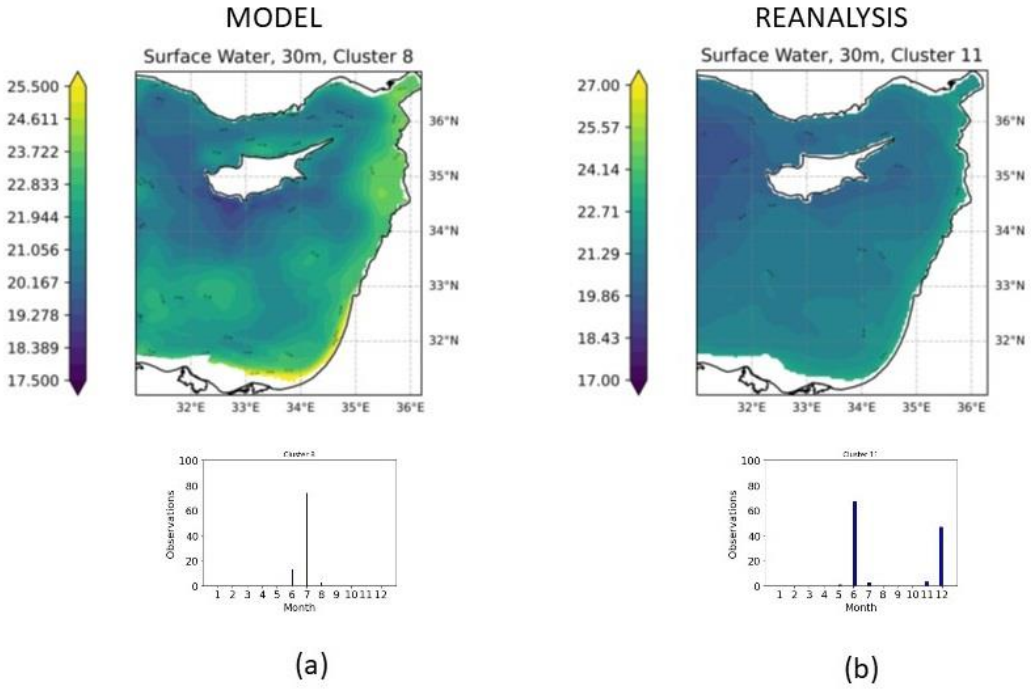
Onshore-offshore exchange and transport processes play a major role in determining the horizontal and vertical fluxes of dissolved and suspended material such as nutrients or pollutant, as well as microbial and planktonic communities. Horizontal transport can be accomplished through the circulation on various temporal and spatial scales including the mean flow, meandering shelf break jets, frontal zones, filaments, and mesoscale to submesocale eddies. One of the unique features of southeastern Mediterranean is its relatively narrow continental shelf and slope along the coast, varying from ~15 km in the north to ~40 km in the south. The proximity of the deep sea to the coastal region lends special importance to shelf-open sea exchange processes in this region. This is especially important these days considering the environmental risks posed by accelerated exploitation and use of the sea, including extensive offshore natural gas exploration and drilling as well as the operation of large capacity desalination facilities. We are investigating these processes through the combined analyses of remotely sensed sea surface data (SST), a long-term ocean reanalysis of the Mediterranean Sea, and a series of high resolution downscaling simulations with a three dimensional ocean model. The SST and reanalysis data were analyzed with a K-means cluster analysis to identify the dominant circulation patterns. Both the cluster analysis and the model downscaling simulations suggest that the large, anticyclonic Shikmona usually located to the southeast of Cyprus, in an important mechanism contributing to the transport of shelf water to the open sea. It forms as a growing meander of the northward shelf-slope current flowing along the coasts of Israel and Lebanon. Examples of results from the downscaling simulations from Aug 2017 and Aug 2009 are shown in Fig.1. Examples of the results from the K-means cluster analysis of the downscaling simulation and the ocean reanalysis for the period 1 Jan 2016 – 31 Dec 2018 are shown in Fig. 2.



(a) (b)

***Fig. 1**. (a) Downscaled temperature and current vectors at 30 m on 1 Sep 2017, and (b) model simulated near surface temperature on 16 Aug 2009 and month-long trajectories of five virtual drifters released at various locations near the shelf break on 1 Aug 2009 (black, red, blue, and purple drifters located at 10 m depth; pink (dashed) drifter located at 100 m depth).*



(a) (b)

***Fig. 2**. Sample of results of k-means cluster analysis of the 30 m temperature field for the three-year period of the downscaling simulations: (a) model results and (b) reanalysis.*