THE 10th INTERNATIONAL WORKSHOP ON MODELING THE OCEAN

IWMO2018 – June 25-28 2018 – Santos (Brazil)

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Mendes Plaza Hotel

Av. Mal. Floriano Peixoto, 42 - Gonzaga, Santos, Sao Paulo, Brazil

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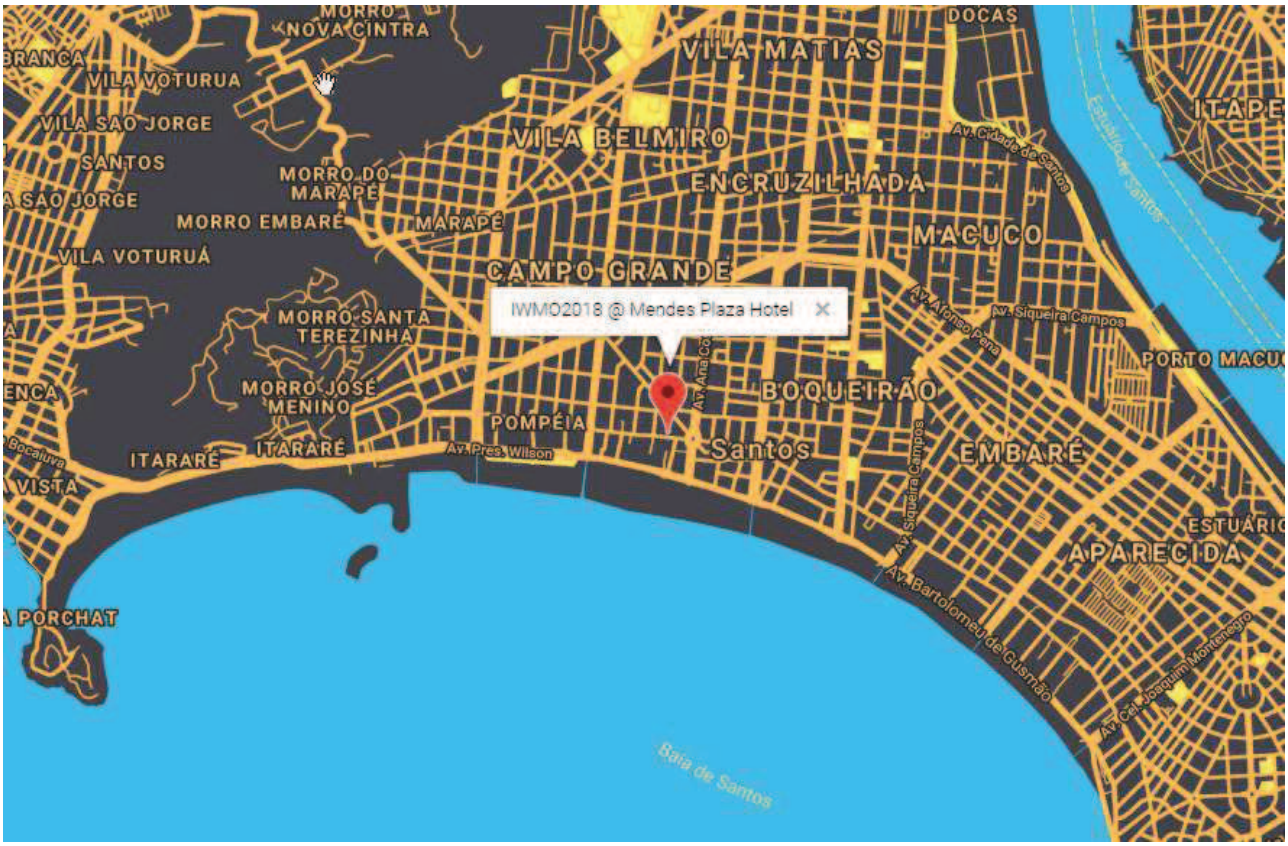

MEETING AND PLACE

The International Workshop on Modeling the Ocean evolved from a small group meeting of the Princeton Ocean Model (POM) http://www.ccpo.odu.edu/POMWEB/, but it is open to the ocean modeling community at large. The IWMO focuses on all aspects of ocean and coupled air-wave-sea, ice and current-sediment modeling: processes, analysis and prediction. As in the past workshops, young scientists were encouraged to attend the Outstanding Young Scientist Awards competition. In 2018, the IWMO received 77 papers submitted by participants of 12 countries around the globe from which fruitful discussions are expected to interconnect the knowledge of the attendants. A Special Issue of Ocean Dynamics will be opened for all attendants of IWMO2018 in the normal peer review system of the Springer Link.

The city of Santos in Brazil was chosen due tothe closeness to Sao Paulo, its history and the touristic structure. The choice of a hotel was intended to facilitate the daily access to the meeting, preventing big displacements and exposure of the attendants in a place where English is an unusual language. But at just 1-block distance to the beach, there is anatural appeal to walk at the promenade to breath the sea breezeand see local people and customs.

PROPOSED SESSIONS

Air-sea-ice Coupled Processes
Large Scale Circulation and Climate Dynamics
Ecosystem, Biogeochemical &Interdisciplinary Science
Multi-scale Interactions: Gyres, Eddies &Fronts
Waves, Currents and Turbulence
Shelf/Slope, Coastal &Marginal Sea Processes
Model Development &Application
From Observations to Model Predictions

INVITED SPEAKERS

George Mellor – Professor Emeritus of Princeton University
Alan Blumberg – JUPITER Hydroscience Risk Analysis
Alexander Babanin– The University of Melbourne
Ruoying He – North Carolina State University
Fei Chai – University of Maine& Second Institute of Oceanography

ORGANIZERS

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Program and Abstracts Book
Design and Edition: Ricardo de Camargo

CONTENTS

The 10th International Workshop on Modeling the Ocean
IWMO2018

Program

MONDAY JUNE'25

07h30-	**Registration**	
08h15-08h30	Conference Opening– Welcome **Ricardo**(logistics; POSTER; 15min+5min; OYSAs; Note slowly-varying PERIODS of BREAKS & LUNCHES etc.)	
08h30	**Air-sea-ice Coupled Processes** **Chairs Humio Mitsudera & Luciano Pezzi**	
08h30-08h50	Air-sea interactions during strong winter extratropical storms	*Ruoying He (North Carolina St.Univ.)*
08h50-09h10	Numerical modeling of the interactions between hurricanes, the Gulf Stream and coastal sea level	*Tal Ezer (OldDominium Univ.)*
09h10-09h30	Sea surface cooling mechanism during ocean SACZ episodes at Southwestern Atlantic	*Luciano P. Pezzi (INPE)*
09h30-09h50	Modeling seasonal and interannual variability of Great Lakes ice cover using FVCOM+ice model	*Jia Wang (NOAA)*
09h50-10h10	A deep-learning Algorithm of neural network for parameterizing typhoon-induced SST cooling	*Jun Wei (PekingUniversity)*
10h10-10h30	Young ocean waves favor the rapid intensification of tropical cyclones	*Leo Oey (National Central University)*
10h30-10h50	***Coffee-break* (Set up POSTERs)**	
10h50	**Large Scale Circulation and Climate Dynamics** **Chairs Yasumasa Miyazawa & Moacyr Araujo**	
10h50-11h10	Development of an Inter-basin Pacific-Indian Ocean Model: The Indonesian ThroughFlow (ITF) and the Circulation in the Banda Sea	*Huijie Xue (University of Maine)*
11h10-11h30	Dynamics of Brazil/Malvinas confluence and its bifurcation into the Subtropical Front and the Subantarctic Front	*Humio Mitsudera (Hokkaido University)*
11h30-11h50	Land-falling typhoons are controlled by the meridional oscillation of the Kuroshio Extension	*Leo Oey (National Central University)*
11h50-12h10	South and Tropical Atlantic dynamic variability	*Joseph Harari (USP)*
12h10-12h30	Arctic Hydrological Processes and Changes revealed with Concurrent Satellite Remote Sensing Data	*Shiming Xu (Tsinghua University)*
12h30-14h00	***Lunch* (1 hour 30 min)(Set up POSTERs)**	

13h15-14h00	**Round Table Discussion Session** **Chairs Yu-Lin Chang, Fanghua Xu & Tsubasa Kodaira**	
14h00	**Ecosystem, Biogeochemical & Interdisciplinary Science** **Chairs Xiao Hua Wang & Carlos Teixeira**	
14h00-14h20	BGC-Argo Observations and Physical-Biogeochemical Modeling	*Fei Chai (Univ. Maine& SIO)*
14h20-14h40	Potential impact of ocean circulation on the declining Japanese eel catches	*Yu-Lin Chang (JAMSTEC)*
14h40-15h00	Biophysical modeling of the Brazilian sardine: from reproduction to your table	*Douglas Gherardi (INPE)*
15h00-15h20	Regional variations in the subsurface biogeochemical response to mesoscale eddies in the North Pacific	*Fanghua Xu (Tsinghua University)*
15h20-15h40	Simulation of the distribution of 137 Cs in the ocean from nuclear tests	*Chang Zhao (First Inst. Oceanogr.)*
15h40-16h10	***Coffee-break*(Set up POSTERs)**	
16h10	**Multi-scale Interactions: Gyres, Eddies &Fronts** **Chairs Yign Noh & Paulo Calil**	
16h10-16h30	Wind-induced subduction at the South Atlantic subtropical front	*Paulo Calil (FURG)*
16h30-16h50	On the scale dependence of oceanic eddy potential energy dissipation	*Stuart Bishop (North Carolina St.Univ.)*
16h50-17h10	Frontolysis by surface heat flux in the Agulhas Return Current region with a focus on mixed layer processes	*Shun Ohishi (Nagoya University)(**OYSA**)*
17h10-17h30	Topographic–baroclinic Instability and Formation of Kuroshio Current Loop	*Jingsong Guo (First Inst. Oceanogr.)*
18h30	***Bus departure to welcome icebreak-cocktail***	

TUESDAY JUNE'26

08h30	**Waves, Currents and Turbulence** **Chairs Jinyu Sheng & Xiao Hua Wang**	
08h30-08h50	On the two components of wind-driven ocean surface stress	*George Mellor (Princeton University)*
08h50-09h10	Ocean Waves as a Missing Link Between Atmosphere and Ocean	*Alexander Babanin (Univ.Melbourne)*
09h10-09h30	Nonlinear Wave Ensemble Averaging using Neural Networks	*Ricardo Campos (UMD/NOAA)*
09h30-09h50	Longer waves modulation on short waves dissipation source term	*Pedro V.Guimaraes (SHOM) (**OYSA**)*
09h50-10h10	Influence of the Improved Ocean Mixed Layer Process in the Earth System Model: Langmuir Circulation and Diurnal Warming	*Yign Noh (Yonsei University)*
10h10-10h30	A Numerical Simulation of Surface Waves, Wave-Current Interaction, and Langmuir Circulations	*Yutaka Yoshikawa (Kyoto University)*
10h30-11h00	***Coffee-break* (POSTERs Prelim.)**	
11h00	**Waves, Currents and Turbulence (Cont'd)** **Chairs Yutaka Yoshikawa & Tsubasa Kodaira**	
11h00-11h20	Effects of wave-current interactions on suspended-sediment dynamics during strong wave events	*Xiao Hua Wang (UNSW)*
11h20-11h40	Effects of the Non-breaking Surface Wave-induced Vertical Mixing on Winter Mixed Layer Depth in Subtropical Regions	*Siyu Chen (First Inst. Oceanogr.)*
11h40-12h00	Tidal Modulations of Surface Gravity Waves in the Gulf of Maine	*Jinyu Sheng (DalhousieUniversity)*
Announcement		
12h10-13h40	***Lunch*** **(1 hour 30 min)**	

13h40-14h40	**POSTER SESSION** **Chair Tsubasa Kodaira**	
14h40	**Shelf/Slope, Coastal & Marginal Sea Processes** **Chairs Huijie Xue & Mauro Cirano**	
14h40-15h00	Submesoscale eddies generated by Kuroshio and tidal currents around Izu islands south of Japan	*Tsubasa Kodaira (University of Tokyo)*
15h00-15h20	Observation of nonlinear interactions between near-inertial oscillations and continental shelf waves in the Northern South China Sea in 2014	*Junyi Li (Guandong Ocean Univ.)*
15h20-15h40	An LETKF-based ocean reanalysis for the Asia-Oceania region using Himawari-8 SSTs	*Shun Ohishi (Nagoya University)*
15h40-16h10	***Coffee-break* (POSTERs Prelim)**	
16h10	**Shelf/Slope, Coastal &Marginal Sea Processes (Cont'd)** **Chairs Fanghua Xu & Yu-Lin Chang**	
16h10-16h30	Influence of continental waters in the Arvoredo Marine Biological Reserve, Brazil	*Anna Dalbosco (UFSC)(**OYSA**)*
16h30-16h50	Effect of channel curvature on the salinity intrusion in idealised and real estuaries	*Johannes Pein (**OYSA**) (Helmholtz-Zentrum)*
16h50-17h10	Modelling flow-topography interactions over shelf break canyons in the southwestern tropical Atlantic	*Marcus Silva (UFPE)*
17h10-17h30	Numerical Study on the Seasonal Circulations in the Gulf of Thailand	*Changshui Xia (First Inst. Oceanogr.)*
17h30-…	***FREE time for Relaxation &Recreation***	

WEDNESDAY JUNE'27

08h30	**Model Development and Applications** **Chairs Tal Ezer & Yu-Lin Chang**	
08h30-08h50	Development of data assimilation techniques toward resolving smaller scale oceanic phenomena	*Yasumasa Miyazawa (JAMSTEC)*
08h50-09h10	On the computation of pressure in numerical ocean models, with focus on terrain following models	*Jarle Berntsen (University of Bergen)*
09h10-09h30	Revisit of Inertial Instability and Phase Error in Time Integration Schemes in Ocean and Atmospheric General Circulation Models	*Jia Wang (NOAA)*
09h30-09h50	On open boundary condition for tidally and sub-tidally forced circulation in a limited-area model	*Jianping Gan (Hong Kong U Sci Tec)*
09h50-10h10	Numerical modeling of storm surges in the coast of Mozambique	*Alberto J. Bie (USP) (**OYSA**)*
10h10-10h30	An operational forecasting system for the physical processes in the Santos Estuarine System - Southeast Brazil	*Carine Costa (USP) (**OYSA**)*
10h30-10h50	***Coffee-break***	
10h50-12h10	**POSTER SESSION (1 hour 20 min)** **Chairs Fanghua Xu & Yu-Lin Chang**	
12h10-14h00	***Lunch* (1 hour 20 min)**	
13h15-14h00	**Round Table Discussion Session** **Chairs Huijie Xue & Jarle Berntsen**	
14h00	**Model Development and Applications (Cont'd)** **Chairs Jarle Berntsen & Joseph Harari**	
14h00-14h20	Recent developments in JCOPE coastal ocean modeling	*Sergey Varlamov (JAMSTEC)*
14h20-14h40	High resolution modeling of near-shore wave processes using the implicit unstructured WAVEWATCH-III	*Fabien Leckler (SHOM)*
14h40-15h00	Forecasting Storm Tides in the South Brazil Bight	*Belmiro Castro Filho (USP)*
15h00-15h20	Regional modelling of the north Pacific Ocean currents and waves applied to plastic-debris transport and accumulation in the Great Pacific Garbage Patch	*Ivan Soares (The Ocean Cleanup)*
15h20-15h40	The Urban Ocean – The New Frontier	*Alan Blumberg (JUPITER)*
15h40-16h00	***Coffee-break***	

16h00-17h40	**Special OYSA Session** **Chairs Yu-Lin Chang, Fanghua Xu & Tsubasa Kodaira**	
16h00-16h20	Automated eddy detection in the Brazil Current near the Abrolhos bank	*Gabriel Aarao (UFES) (**OYSA**)*
16h20-16h40	Role of Brazil Current warming in amplifying 2008 Santa Catarina extreme precipitation event	*Ueslei Sutil (INPE) (**OYSA**)*
16h40-17h00	Impact of different strategies to assimilate Argo data into the HYCOM over the South Atlantic Ocean	*Filipe Costa (UFBA) (**OYSA**)*
17h00-17h20	Application of the 4D-Variational Data Assimilation Method of the Regional Ocean Modeling System (ROMS) to Simulate Circulation on the Southeast Brazilian Ocean Region	*Thiago P. Paula (UFRJ) **(OYSA)***
18h30	**Conference Dinner @ Mendes Plaza**	

THURSDAY JUNE'28

08h50	**From Observations to Model Predictions** **Chairs Ricardo de Camargo &Clemente Tanajura**	
08h50-09h10	Assessing the extended-range predictability of HYCOM+RODAS System in the South Atlantic	*Clemente Tanajura (UFBA)*
09h10-09h30	A 4D-Variational Ocean Data Assimilation System for Santos Basin, Brazil (Project Azul)	*Livia Mariano (ProOceano)*
09h30-09h50	Introduction to a Global High Resolution Ocean Forecast System – the FIOCOM	*Guansuo Wang (First Inst. Oceanogr.)*
09h50-10h10	A High-Performance Implementation of Local Ensemble Transform Kalman Filter (LETKF)	*Zheng Fan (TsinghuaUniversity)*
10h10-10h30	The impact of assimilating SST, Argo and SLA data into a tidally driven model for the Brazil Current region	*Clemente Tanajura (UFBA)*
10h30-10h50	***Coffee-break***	
10h50-12h30	**OYSA Awards** **Open discussion for IWMO2019** **Conference Closing**	

POSTER PRESENTATIONS

Study of three domestic sewage submarine outfall plumes through the use of numerical Modeling in the Sao Sebastiao channel, Sao Paulo state, Brazil
Paula Birocchi, Belmiro Mendes de Castro Filho
University of Sao Paulo

Investigating adjustment of wind profile formulas to a reference height using observation records at the Ieodo Ocean Research Station
Do-Seong Byun, Jooyoung Lee, Hyowon Kim, Eunil Lee
Korea Hydrographic and Oceanographic Agency

Tidal impacts on hydraulic geometry in the Pearl River Delta
Xiaomei Ji
Hohai University

High resolution hydrodynamic forecast system - Implementation and preliminary validation
Ronaldo Palmeira, Bruno Martins, Marcelo Andrioni, Renato Martins, Thiago de Paula
CENPES, Petrobras

Interannual Variability of South Atlantic Subtropical Mode Water Associated with Remote Climatic Patterns
Daniel Santos, Olga Sato
University of Sao Paulo

Sediment transport and morphology evolution in a low influx system: the Pirangi Estuary (Brazil)
Francisco Rafael de Lima Xavier, Carlos E P Teixeira
Institute for Marine Sciences, Federal University of Ceara

The Fate of Man-made Radionuclides in a Semi-Enclosed Basin
Danilo Augusto Silva, Belmiro Mendes de Castro Filho
University of Sao Paulo

A study on the attenuation of ocean surface gravity waves in the marginal ice zone
Rajesh Kumar
New York University

Connectivity in the Brazilian Tropical Atlantic Islands
Suzana Ribeiro, Carlos E P Teixeira
Federal University of Ceara

Circulation in Flamengo Bay, Ubatuba (SP): winter, 2017
Vanessa Paspaltzis, Carine de Godoi Rezende Costa, Jose Roberto Bairao Leite,Belmiro Mendes de Castro Filho
University of Sao Paulo

Salinity variability in the South Atlantic from satellite and model data
Pedro De Morais Chiossi, Olga Sato
University of Sao Paulo

On the interaction between the Brazil Current System and Vitoria-Trindade Ridge
Mario Neves
Federal University of Rio Grande

Wave spectrum comparison from a coupled wave/hydrodynamic simulation: preliminary results
Jonas Takeo Carvalho[1], Leandro Calado[2], Valdir Innocentini[3]
1 National Institute for Space Research
2 Brazilian Navy
3 National Institute for Space Research

Brazil Current behavior at 22°S controlled by surface forcing: A modeling approach
Douglas Nehme, Raquel Toste, Luiz Paulo Assad
Federal University of Rio de Janeiro

Simulating the annual cycle of the La Plata River plume over the Western South Atlantic shelves
Renato Cecilio
Federal University of Rio Grande do Sul

The application of the dynamical downscaling to investigate the Southwestern Atlantic Ocean under the future climate scenarios
Leilane Passos, Luciano Pezzi
National Institute for Space Research

Biological Modeling to study marine organisms behavior in climate change scenarios
Luciana Shigihara Lima, Douglas Gherardi, Leilane Passos
National Institute for Space Research

Conceptual model proposal for the continent-ocean interface of the semi-arid region of Brazil
Bruno Pereira
Federal University of Ceara

Tides and freshwater in the Florianopolis coastal region from very high resolution numerical modelling
Martinho Marta-Almeida[1], Anna Dalbosco[2], Davide Franco[2], Manuel Ruiz Villarreal[1]
1 University of Vigo
2 Federal University of Santa Catarina

ABSTRACTS

ORAL PRESENTATIONS

MONDAY, JUNE'25

AIR-SEA-ICE COUPLED PROCESSES

Air-sea interactions during strong winter extratropical storms

Ruoying He
Department of Marine, Earth and Atmospheric Sciences
North Carolina State University, Raleigh (USA)

A high-resolution, regional coupled air–sea model is used to investigate the effect of the Gulf Stream (GS) on surface wind convergence during winter extratropical cyclone (ETC) outbreaks off the east coast United States. Validations against marine buoy-observed surface wind, sea level pressure (SLP), air temperature and sea surface temperature (SST) show decent model skill. Model analyses indicate that the surface wind convergence and the Laplacian of SLP and SST are proportionate on the synoptic time scale. Strong upward vertical motions and ocean heat loss over the GS support rapid ETC intensification

Numerical modeling of the interactions between hurricanes, the Gulf Stream and coastal sea level

]

Tal Ezer
Center for Coastal Physical Oceanography
Old Dominion University, Norfolk

The Gulf Stream (GS) plays a major role in the connections between changes in large-scale ocean circulation and variations of sea level along the coast. This connection seems to apply to a wide range of time-scales, from high-frequency oscillations of days and weeks to interannual and decadal changes, and over almost all time-scales a weakening in the GS flow is related to elevated sea level along the coast and increased flooding. An idealized model based on the generalized coordinate version of POM, as well as an operational coupled hurricane-ocean forecast system are used to study the impact of hurricanes on the GS and the impact of the GS on coastal sea level. An interesting case study is when a hurricane off the coast of Florida disrupted the flow of the GS and caused sea levels to rise downstream in the Mid-Atlantic Bight, far away from the direct storm surge. The mechanism of transmitting large-scale ocean variability to the coast involves the generation of coastal trapped waves, which are highly sensitive to the detailed coastal topography in the model.

Sea surface cooling mechanism during ocean SACZ episodes at Southwestern Atlantic

Luciano Pezzi
Remote Sensing Division, Earth Observation
National Institute for Space Research, Sao Jose dos Campos

The South Atlantic Convergence Zone (SACZ) presence causes sea surface cooling at Southwestern Atlantic. Here it is investigated the relationship between atmosphere circulation, dynamic and sea surface temperature concerning air-sea interaction processes, considering intense episodes of oceanic SACZ. The investigation of dynamic and thermodynamic coupling mechanisms and how they are balanced during these episodes is made. Using a targeted set of numerical simulations that included regional ocean and atmosphere coupled models we show that during the oceanic SACZ episodes occurs the ocean surface cooling. This is caused by both persistent cloud cover in the region, such as the confluence of the winds in the Marine Atmospheric Boundary Layer (MABL) as well as the dynamic feedback caused by Ekman pumping due to cyclonic vorticity generated by the convergence of surface winds mainly in the coastal region that includes South Brazil Bight - SBB (near the coast of southeastern Brazil). This pattern should affect the heat flow on the surface, ocean currents, and heat transport in the ocean as well as the circulation in the lower atmospheric levels. Another striking feature found in this study is the emergence of a cyclonic vortex occurring on both surface and above in 850 hPa, around 24S and 45W, that up to now is yet little discussed in the literature.

Modeling seasonal and interannual variability of Great Lakes ice cover using FVCOM+ice model

Jia Wang
Great Lakes Environmental Research Lab
National Oceanic and Atmospheric Administration, Miami

A 3-d, unstructured Finite Volume Coastal Ocean Model with ice model was applied to all five Great Lakes simultaneously to simulate circulation and thermal structure from 1993 to 2016. Model results are compared to available observations of currents and temperature and ice cover. Seasonal cycle and interannual variability for all the five Great lakes were presented. Lake circulation was reasonably reproduced in comparison to the existing observation. The temperature structure was also reproduced reasonably well. The lake dynamics and thermodynamics exhibit significant annual and interannual variations. Simulated lake ice cover was validated with satellite-measured ice cover for both seasonal cycle and interannual variability. Sensitivity study was conducted on 1) surface wind-wave mixing parameterization, 2) different forcing fields, and 3) different numerical time integration schemes.

A deep-learning Algorithm of neural network for parameterizing typhoon-induced SST cooling

Jun Wei
Dept. of Atmospheric and Oceanic Sciences
School of Physics, Peking University

Algorithms based on machine-learning neural networks are proposed—the shallow learning (S-L) and deep learning (D-L) algorithms—that can potentially be used in atmosphere-only typhoon forecast models to provide flow-dependent typhoon-induced sea surface temperature cooling (SSTC) for improving typhoon predictions. The major challenge of existing SSTC algorithms in forecast models is how to accurately predict SSTC induced by an upcoming typhoon, which requires information not only from historical data, but more importantly also from the target typhoon itself. The S-L algorithm composes of a single layer of neurons with mixed atmospheric and oceanic factors. Such a structure is found to be unable to represent correctly the physical typhoon-ocean interaction. It tends to produce an unstable SSTC distribution, for which any perturbations may lead to changes in both SSTC pattern and strength. The D-L algorithm extends the neural network to a 4 x 5 neuron matrix with atmospheric and oceanic factors being separated in different layers of neurons, so that the machine learning can determine the roles of atmospheric and oceanic factors in shaping the SSTC. Therefore, it produces a stable crescent-shaped SSTC distribution, with its large-scale pattern determined mainly by atmospheric factors (e.g. winds) and small-scale features by oceanic factors (e.g. eddies). Sensitivity experiments reveal that the D-L algorithms improve maximum wind intensity errors by 60% ~ 70% for 4 case study simulations, compared to their atmosphere-only model

Young ocean waves favor the rapid intensification of tropical cyclones

Leo Oey, Lin Zhang
National Central University, Taiwan

The basic energy source for tropical cyclone is the heat that moistened air converging into the eye of the storm draws from the warm sea. Meantime, ocean surface waves developed by the strong cyclone's wind modify the air turbulence adjacent to the sea surface, which in turn modulates the distribution of air-sea exchanges of moisture and heat fluxes. In this study, we use multi-decadal global observations to show that in tropical cyclones that intensify rapidly (an increase of near-surface maximum wind speed of more than 15 m s -1 in 24 hour), there exists a significantly high areal coincidence of the distributions of high air-sea exchange coefficient produced by surface waves and moisture convergence in the core of the storm.

LARGE SCALE CIRCULATION AND CLIMATE DYNAMICS

Development of an Inter-basin Pacific-Indian Ocean Model: The Indonesian ThroughFlow (ITF)and the Circulation in the Banda Sea

Huijie Xue[1,2]and Linlin Liang[1]
1 State Key Laboratory of Tropical Oceanography, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China
2 School of Marine Sciences, University of Maine, Orono, ME, USA

The tropical Pacific Ocean and the Indian Ocean are connected via a labyrinth of passages through the Indonesian Archipelago. The Indonesian ThroughFlow (ITF) is a key component of the global conveyer belt, and it has profound influences on the ocean general circulation and climate change. However, exceedingly complicated topography of the Indonesian Archipelago exerts great difficulties in both observations and numerical modeling. In this work, the Regional Ocean Modeling System (ROMS) is implemented for the western Pacific and northern Indian oceans to depict the 3-D circulation inside the Indonesian Archipelago and its relationship to the throughflow. The model results show that the Pacific's low latitude western boundary currents are the sources of the ITF. The inflow through the Celebes Strait then the Makassar Strait originates from the Mindanao Current, while the flow entering the Halmahera Sea originates from the New Guinea Coastal Current. The ITF exits the Indonesian Archipelago mainly through the Lombok Strait, Ombai Strait and Timor Passage. While topography smoothing changes the partition among these three exiting passages, the sea level difference between the western Pacific and the eastern Indian Ocean appears to determine the total ITF transport, which can be significantly modified by including tide in the model. Moreover, the principal in- and outflows all show three-layer structures in the vertical. Similarly, there is a three- layer circulation in the Banda Sea: clockwise-counterclockwise- clockwise in the top (500m)-middle (500-2250m)- bottom (2250m) layers. The three layers in the Banda Sea are linked vertically by the upward (downward) flux from the middle layer to the top (bottom) layer, which are balanced by the net inflow of 2.12 Sv to the middle layer and the net outflow of 1.08 and 1.04 Sv from the top and bottom layer, respectively.

Dynamics of Brazil/Malvinas confluence and its bifurcation into the Subtropical Front and the Subantarctic Front

Humio Mitsudera, Yuduru Azuma and Shigeru Aoki
Institute of Low Temperature Science
Hokkaido University, Sapporo

The Brazil Current and the Malvinas Current are the western boundary currents along the east coast of the South American Continent. They are confluent approximately at 40S, overshooting up to 50S, and then bifurcating eastward into two fronts, i.e., the Subtropical Front and the Subantarctic Front. This confluence zone is known as a hot spot for primary production because the Malvinas Current supplies nutrients while the Brazil Current supplies warm waters. In this study, we discuss a dynamics of the confluence zone from a point of view of baroclinicRossby wave (BRW) characteristics where ambient barotropic flows are important. The OFES output was analyzed. We particularly paid attention to the effects of barotropic flows over gentle topographic features such as the Zapiola Drift and the Argentine Basin. Eddy thickness flux across the BRW characteristic curves is essential for causing the overshoot of the confluence and its bifurcation into the Subtropical Front and the Subantarctic Front. The eddy flux is weak eastward of the bifurcation, where these fronts follow the BRW characteristic curves that are dominated by ambient barotropic flows.

Land-falling typhoons are controlled by the meridional oscillation of the Kuroshio Extension

Lie-YauwOey, Shihming Huang
National Central University, Taiwan

Low-frequency variations of typhoon paths are often attributed to changes in the North Pacific subtropical high and monsoon through influences on the steering wind. Evidence indicates however a strong imprint of the Kuroshio on the atmosphere. Here we show that the meridional oscillation of the Kuroshio extension significantly correlates with the frequency of land-falling typhoons along East Asia, accounting for 70% of the frequency variance. We used observations and an idealized model to show that when Kuroshio shifts poleward (equatorward), sea surface temperature (SST) gradient south of the current and westerly tropospheric wind weaken (strengthen), steering more typhoons to veer toward (away from) the East Asian continent. Our analysis also shows that long-term weakening of SST gradient and westerly wind is concomitant with poleward shifting of the Kuroshio, attributed to global warming in some studies, and suggests the potential for more land-falling typhoons in East Asia in the coming decades.

South and Tropical Atlantic dynamic variability

Joseph Harari[1], Ricardo de Camargo[2]
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Data produced by hydrodynamic numerical model of the South and Tropical Atlantic, and satellite altimetry data on global scale, are submitted to analyzes in order to detect the variability of the ocean's dynamics, with emphasis on its most important features: Brazil - Malvinas confluence; South - equatorial bifurcation; Atlantic equatorial circulation; residual circulation on the Brazilian platform; coastal upwelling in Southeast Brazil; and mean sea level oscillations on the coast of the State of Sao Paulo. The hydrodynamic model used in this research is a customized version of the Princeton Ocean Model - POM, for a large-scale grid covering the South and Tropical Atlantic, with meso and small scale nestings, for both platform and coastal regions; in the simulations, the circulation generated by tides, winds and density variations is represented, for the period from 1948 to 2010. Radar altimeters on board of satellites permanently transmit high- frequency signals to the Earth and receive echoes from the surface of the sea; the reflected signals are analyzed, producing very precise information about the ocean, available since 1993, namely: sea surface height, significant wave height and surface wind intensity. Both model results and satellite altimetric data were submitted to spectral analysis, in order to determine the dynamic variability in the study area. The most important objective of this research was to determine the relative amplitude of the main periodicities in the South and Tropical Atlantic, such as that of El Nino – Southern Oscillation, for different variables (sea surface level, currents, temperature, salinity, wave heights, etc) for different regions and features (Brazil - Malvinas confluence, South – equatorial bifurcation, etc).

Arctic Hydrological Processes and Changes revealed with Concurrent Satellite Remote Sensing Data

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By using concurrent satellite data, sea ice parameters including sea ice thickness and snow depth are attained with novel retrieval methods. Basin-scale retrieval during winter from 2010 is carried out using CryoSat-2 and SMOS data. The new dataset reveals drastic thinning of snow cover over the Arctic sea ice, as well as large inter annual and spatial variability for both sea ice thickness and snow depth. Since both ice thickness and snow depth are important indicators of polar air-sea interaction and hydrological cycles, these parameters demonstrate the on-going fundamental changes in the Arctic climate system. The new dataset can also be utilized in coupled forecast systems for sea ice model initialization.

ECOSYSTEM, BIOGEOCHEMICAL & INTERDISCIPLINARY SCIENCE

BGC-Argo Observations and Physical-Biogeochemical Modeling

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The Biogeochemical-Argo (BGC-Argo) Program aims at operating a network of profiling floats equipped with sensors of key biogeochemical variables for supporting research activities that address impacts of changing climate on ocean biogeochemical cycles and ecosystems. In the North Pacific, there are only a few BGC-Argo floats deployed during the last several years. In this talk, we will show examples of using BGC-Argo floats and coupled physical-biogeochemical models to investigate how mesoscale eddies affect on biogeochemical distributions in the water column. The North Pacific Subtropical Gyre (NPSG) is an oligotrophic environment where satellite observed chlorophyll does not appear to be correlated with mesoscale eddies. We use continuous measurements from two Bio-Argo floats and show that surface chlorophyll is mostly controlled by a wind-induced mixing process, while subsurface chlorophyll maximum (SCM) is modulated by mesoscale eddies. Anomalies of dissolved oxygen (DO) are evident in eddies caused by the upwelling/downwelling process. With these Bio-Argo floats, different responses of the SCM to cyclonic and anticyclonic eddies, and those between the eddy core and edge region, are revealed by combining results from 10 tracked eddies, demonstrating diverse mechanisms associated with mesoscale and submesoscale dynamics. We also use a coupled physical-biogeochemical model based on ROMS-CoSiNE to address how mesoscale and submesoscale physical processes impact on biogeochemical distributions in the upper ocean.

Potential impact of ocean circulation on the declining Japanese eel catches

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Recruitment of Japanese eels, *Anguilla japonica*, has declined in recent decades possibly due to both anthropogenic and ocean-atmosphere factors. The potential impact of ocean circulation on the decreasing Japanese eel catches in the western North Pacific was examined based on a three-dimensional particle-tracking method, in which virtual larvae (v-larvae) were programmed to swim horizontally and vertically, in addition to being transported by ocean currents after being released in their North Equatorial Current (NEC) spawning area. Transport patterns varied among years between 1993 and 2013, and dispersion of v-larvae towards East Asia decreased in the last two decades, especially for the western Taiwan and Japan regions. In recent years, instead of entering the Kuroshio and moving towards East Asia as in the 1990s', more v-larvae tended to enter the southern areas due to the weakening of the NEC and strengthening of subsurface southward flow near the spawning area. Changes in ocean circulation in the western Pacific appear to be caused by the weakening of subtropical and tropical wind stress curl in the past two decades. This suggests that decadal changes in ocean circulation have occurred that affect the larval migration success of the Japanese eel to their recruitment areas.

Biophysical modeling of the Brazilian sardine: from reproduction to your table

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The influence of biological and physical factors on complex natural systems can be determined through mathematical formalizations in biophysical models. One example is the response of economically important fisheries resources to ocean variability, which involves different temporal and spatial scales. There is also an increasing demand from society to improve model-based prediction skills to help devise mitigatory actions. The integration of remote sensing data, in situ observations and numerical models allowed the simulation of the Brazilian sardine/environment interactions and testing of hypotheses using high resolution eddy resolving numerical grids. In western boundary current systems, such as the Brazil Current (BC) in the South Brazil Bight (SBB), the reproductive strategy of the Brazilian sardine has been linked to a stable and enriched environment with a high likelihood of larvae retention. Indeed, releasing eggs in specific spawning habitats increases larval survival, suggesting that the central-southern part of the SBB is more suitable for larvae development because of its thermodynamic characteristics. However, recent results indicate that mortality caused by prevailing oceanic conditions at early life stages alone cannot be invoked to explain the observed extreme commercial landings of the Brazilian sardine.

Regional variations in the subsurface biogeochemical response to mesoscale eddies in the North Pacific

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Ocean eddies were widely reported to strongly impact near-surface chlorophyll (CHL) but most of previous studies are confined to ocean surface. Based on large-scale historical cruise observations with ocean mesoscale eddies detected by altimeters in the North Pacific, we show that the depth-integrated nitrate and chlorophyll anomalies in the euphotic layer of eddies are on average relatively small, less than ~90% for nitrate and ~10% for chlorophyll. These eddy-driven variations decline from ocean boundaries to open ocean, due to a combination effect of eddy activity and subsurface nitrate concentration. In the oligotrophic Pacific, CHL anomalies in both CEs and AEs negatively correlate with temperature anomalies near sea surface. In contrast, an opposite correlation occurs beneath the subsurface chlorophyll maximum layer (SCML). The integrated CHL results and CHL variability at each sampling depth suggest the vertical stirring of SCML plays an important role in the near-surface CHL response to eddies.

Simulation of the distribution of 137 Cs in the ocean from nuclear tests

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Since the 1940's, a lot of nuclear tests have been carried on in many countries. Those tests, either in atmosphere or under seawater, have contributed significantly to the radionuclide contamination to the world oceans. We present spatial distributions and temporal variation of the concentration of 137 Cs in the word oceans by the radionuclides model. The 137 Cs is introduced into seawaters not only from the tests directly under seawater, but also from the global fallout due to atmospheric nuclear tests. The 137 Cs has been transported by advection, diffusion and scavenging, and its concentration reduces by radioactive decay in the ocean. The vertical and horizontal distributions of the 137 Cs in our model result agree well with the observation. The decaying process of 137 Cs is also presented in the simulation. Our result shows that the concentration of 137 Cs is higher in the Pacific than in the other oceans. And it is higher in the upper layer (<400 m) than in deep layer at a same water profile. In the offshore seas of China, the influence of 137 Cs from nuclear tests is analyzed. The 137 Cs from nuclear tests enters the offshore seas of China since 1940's. In the early 1960's, the concentrations of 137 Cs in the offshore seas of China reaches its maximum and then reduced gradually due to the decay of the 137 Cs and the dilution of sea water. By 2010, the concentrations of 137 Cs in the offshore seas of China are less than 2 Bq/m^3.

MULTI-SCALE INTERACTIONS: GYRES, EDDIES & FRONTS

Wind-induced subduction at the South Atlantic subtropical front

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The South Atlantic Subtropical Front, associated with the eastward-flowing South Atlantic Current, separates the colder, nutrient-rich waters of the subpolar gyre from the warmer, nutrient-poor waters of the subtropical gyre. Perturbations to the quasi-geostrophic, eastward flow generate meanders and filaments which induce cross-frontal exchange of water properties. Down-front winds transport denser waters from the South over warm waters from the North, inducing convective instability and subduction. Such processes occur over spatial scales of the order of 1 km and thus require high horizontal spatial resolution. In this modeling study, a high-resolution (4 km) regional grid is embedded in a basin-wide configuration (12 km) of the South Atlantic Ocean in order to test the importance of submesoscale processes in water mass subduction along the subtropical front. Stronger and more numerous eddies obtained in the high-resolution run yield more intense zonal jets along the frontal zone. Such stronger jets are more susceptible to instabilities, frontogenesis, and the generation of submesoscale meanders and filaments with O(1) Rossby number. As a consequence, vertical velocities larger than 100 md 1 are obtained in the high-resolution run, one order of magnitude larger than in the low-resolution run. Wind-driven subduction occurs along the frontal region, associated with negative Ertel potential vorticity in the surface layer. Such processes are not observed in the low-resolution run. A passive tracer experiment shows that waters with density characteristics similar to subtropical mode waters are preferentially subducted along the frontal region. The wind-driven buoyancy flux is shown to be much larger than thermal or haline fluxes during the wintertime, which highlights the importance of the frictional component in extracting PV from the surface ocean and inducing subduction, a process that has been overlooked in subtropical mode water formation in the region.

On the scale dependence of oceanic eddy potential energy dissipation

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The generation of oceanic eddy potential energy (EPE) through air-sea interaction is proportional to the positive covariance between sea surface temperature (SST) and air-sea net surface heat flux (NHF). The NHF arises from contributions due to short wave and long wave radiation, and turbulent sensible and latent heat fluxes. Recent coupled simulations of the Kuroshio Extension, where mesoscale eddies are explicitly resolved, show that the air-sea feedbacks dominate EPE destruction, effectively reducing the available energy to be converted to eddy kinetic energy (EKE). High-resolution global simulations tend to have too much EKE compared to observations in the Western Boundary Currents and Southern Ocean Antarctic Circumpolar Current. It is unclear how much of a global impact air-sea destruction of EPE has on the overall global potential and kinetic energy budgets. Recent work on mixed layer variability also shows that submesoscale mixed layer instabilities act to reduce available potential energy in the mixed layer through restratification and are most energetic during the winter months. As global simulations move towards resolving submesoscale eddies it is key that the proper sequence of events are simulated in the cascade of energy from large basin scale forcing to mesoscale, submesoscale, and smaller scales. In this study we make estimates of the global dissipation of EPE through air-sea interaction in a high-resolution global simulation and compare them to observational estimates using SST and NHF from the new Japanese Ocean Flux data sets with Use of Remote sensing Observations version-3 (J-OFURO3) product of SST and NHF, spanning 1996-2013 at 0.25^{o} and monthly temporal resolution.

Frontolysis by surface heat flux in the Agulhas Return Current region with a focus on mixed layer processes

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Detailed mechanisms for frontogenesis/frontolysis of the Agulhas Return Current (ARC) Front, defined as a maximum of the meridional sea surface temperature (SST) gradient at each longitude within the ARC region (40–50E, 55–35S), are investigated using observational datasets. The meridional gradient of surface net heat flux (NHF) is formed by larger (smaller) latent heat release to the atmosphere on the northern (southern) side of the front throughout the year. In austral summer, surface warming is weaker (stronger) on the northern (southern) side, and thus the NHF tends to relax the SST front. The weaker (stronger) surface warming, at the same time, leads to the deeper (shallower) mixed layer on the northern (southern) side. This enhances the frontolysis, because a deeper (shallower) mixed layer is less (more) sensitive to surface warming. In austral winter, stronger (weaker) surface cooling on the northern (southern) side contributes to the frontolysis. However, deeper (shallower) mixed layer is induced by stronger (weaker) surface cooling on the northern (southern) side and suppresses the frontolysis, because the deeper (shallower) mixed layer is less (more) sensitive to surface cooling. Therefore, the frontolysis by the NHF becomes stronger (weaker) through the mixed layer processes in austral summer (winter). The cause of the meridional gradient of mixed layer depth is estimated using diagnostic entrainment velocity and the Monin-Obukhov depth. Furthermore, the above mechanisms obtained from the observation are confirmed using outputs from a high-resolution coupled general circulation model. Causes of model biases are also discussed.

Topographic–baroclinic Instability and Formation of Kuroshio Current Loop

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Using time-series figures of sea-level anomaly and geostrophic currents from merged absolute dynamic topography, we analyzed the formation and evolution of the Kuroshio current loop (KCL). The main results are as follows. Perturbation origins of the KCLs are in three areas (eastern, western, and southern) surrounding the Hengchun Submarine Ridge. There are two basic types of KCL formation, i.e., “Kuroshio bend pushing” and “Kuroshio Branch rewinding”, plus their combination. The KCLs propagate westward at 1.6–4.5 cm/s. There are two forms of KCL evolution into a shed eddy. The first is such that the northern KCL section initially divides to become an eddy joining the Kuroshio Branch current, which then separates from that current to become a shed eddy. The second form is such that the northern and southern sections of the KCL are separated almost simultaneously in westward elongated process. To understand the KCL formation mechanism, we derive linear equations in phase space from the governing equations in ?-coordinates, ultimately obtaining two groups of analytical solutions for interactions between waves, topography, and the basic current field. The solutions lead to the following results. The KCL propagates westward with the group velocity of the Kuroshio center region. The Kuroshio generally sweeps over the Hengchun Submarine Ridge, especially in winter, such that there is topographic–baroclinic instability. The analytical solutions effectively reveal the dynamic mechanism of the two basic types of KCL formation.

TUESDAY, JUNE'26

WAVES, CURRENTS AND TURBULENCE

On the two components of wind-driven ocean surface stress

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When coping with numerical models of ocean surface waves and circulation, one should differentiate between wind driven drag due to turbulent skin friction and form drag, but how to do so is uncertain. The two surface forcing processes, a result of turbulent atmospheric flow over waves, are boundary conditions for momentum transfer into the water column. As in other fluid dynamic flows where viscous and/or pressure stresses are involved, one supposes there exists a governing Reynolds number. In this paper, we begin with the rather definitive near-wall data of Nikuradse and progress to equations useful for air flow over ocean surface waves for which reference is made to a consensus of formulas for drag coefficient versus wind speed. The contrast between momentum transfer and the transfer of heat and water vapor across the air-sea interface is evident; the governing equations of these scalar quantities do not contain pressure and therefore form drag is excluded.

Ocean Waves as a missing link between Atmosphere and Ocean

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Role of the waves as a link between the ocean and atmosphere will be discussed. It is rapidly becoming clear that many large-scale geophysical processes are essentially coupled with the surface waves, and those include weather, tropical cyclones, ice cover in both Hemispheres, climate and other phenomena in the atmosphere, at air/sea, sea/ice and sea/land interface, and many issues of the upper-ocean mixing below the surface. Besides, the wind-wave climate itself experiences large-scale trends and fluctuations, and can serve as an indicator for changes in the weather climate. In the presentation, we will discuss wave influences at scales from oceanic turbulence to climate, on the atmospheric and oceanic sides.

Nonlinear wave ensemble averaging using neural networks

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The present study discusses the use of Artificial Intelligence in operational wave forecasts. Initially, assessment results of NCEP/NOAA Global Wave Ensemble Forecast System (GWES) using NDBC buoys are analyzed, studying the errors of 10-m wind speed (U10m), significant wave height (Hs), and peak period (Tp) in function of forecast time and severity (percentiles). The main goal is focused on a large experiment using neural networks (NN) applied to nonlinear ensemble averages. First, using a single location approach, considering two buoys in the Pacific and the Atlantic Ocean, then moving to a spatial approach at the Gulf of Mexico. The NN simulates the residue of the ensemble mean, i.e., the difference from the arithmetic mean of the ensemble members to the buoy observations. The sensitivity NN test considered a total of 12 different numbers of neurons, 8 different filtering windows, and 100 seeds for the random initialization. Independent NN models have been constructed for specific forecast days, from Day 0 to Day 10. Results show that a small number of neurons are sufficient to reduce the bias, while 35 to 50 neurons are optimum to reduce both the scatter and average errors. More complex NN models with a higher number of neurons presented worse results. Finally, a comparison showed significant improvements of the best neural network models (NNs) compared to the traditional arithmetic ensemble mean (EM). The correlation coefficient for forecast Day 10, for example, was increased from 0.39 to 0.61 for U10m, from 0.50 to 0.76 for Hs, and from 0.38 to 0.63 for Tp. This work is part of the project “Improving Global Wind-Wave Probabilistic Forecasts and Products Beyond Week” funded by NOAA (Award Number: NA16NWS4680011).

Longer waves modulation on short waves dissipation source term

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Usually wave breaking investigations have been focused on the deterministic prediction of the onset of breaking or the stochastic prediction of the probability of breaking based on the average energy in a fixed range of frequencies. This second aspect is associated with the problem of parameterizing the dissipation in wave forecasting models. Whereas early parameterizations in wave models were based on a single steepness parameter for all the wave scales present in the sea state, the analysis of wave propagation across current gradients led Phillips (1985) to propose a parameterization base on the saturation spectrum, in which the dissipation rate of a given wave scale is associated with the energy of the same wave scale. That approach is now widely use, but it ignores the effects of longer waves on short waves. The modulating effect of longer waves on shorter waves is a nonlinear phenomenon, predicted by the third to fifth nonlinear wave interaction, and can influence wave breaking. The typical solution of the modulation effect is based on Zakharov equation for a fully-nonlinear free surface conditions. However, in the reality, the nature of these wave interactions are also highly dependent on the local wind and sea conditions, usually not considered on Zakharov formulation. Based on recent stereo video measurements and breaking detection, proposed by Leckler (2013), Guimaraes (2018) quantified the change in amplitude and breaking probabilities of wind-waves in the presence of longer swell. In this context, here we attempt to quantify the longer waves modulation on short waves amplitude and phase speed to propose a modification on the saturation-based parameterizations of wave breaking probability by taking into account a modulation transfer function in the maximum saturation level. This parameterization is aimed at connecting different scales in breaking probability, a fact that has been neglected in wave models. Our preliminary results, modifying Ardhuin et al. (2010) dissipation source function implemented in WAVEWATCH III model, show that this new source function can reproduce strong bimodality in the short wave spectrum and also the observed k^-3 spectral shapes.

Influence of the Improved Ocean Mixed Layer Process in the Earth System Model

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The ocean mixed layer plays a critical role in the climate system by controlling SST and air-sea interaction. Recent advances in the ocean mixed layer modeling showed that the simulation of the upper ocean structure, such as SST and MLD, can be significantly improved by including the effects of Langmuir circulation and diurnal warming (Noh et al. 2011, 2016). The present analyses investigates how the inclusion of these processes influence the simulation mean climate and its variation by using the GAIA earth system model, in which the Noh mixed layer model (Noh and Kim 1999) is applied. The horizontal resolutions of AGCM and OGCM are respectively 1.875^{o} and 1^{o}, and the coupling is made every hour. The results from the KPP mixed layer model are also compared to evaluate the performance of the improved mixed layer model. It is investigated in particular how the global climate is affected by the more realistic MLD in the Southern Ocean under the effect of Langmuir circulation and the more realistic SST and sea surface heat flux in the western Equatorial Pacific under the effect of diurnal warming.

A Numerical Simulation of Surface Waves, Wave-Current Interaction, and Langmuir Circulations

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Using the latest non-hydrostatic free-surface numerical model, we perform a simulation of wind-driven currents under small-amplitude monochromatic surface gravity waves. Roll structures very similar to observed Langmuir circulations (LCs) appear in the simulation only when both down-wave surface currents and waves are present. A vorticity analysis of simulated mean flow reveals that the rolls are driven by the torque of the Reynolds stress associated with wave orbital motion, which arises from a correlation between wave-induced vorticity fluctuation and the wave orbital motion itself. This wave-induced Reynolds stress torque can be interpreted as wave rectification of vorticity. We further confirm that the wave-induced torque in the present simulation is very well represented by the curl of the vortex force (VF), i.e., the vector product of mean vorticity and Stokes drift velocity. Based on these results, we conclude that the simulated rolls are LCs, and that LCs are driven by wave-current interactions described above.

Effects of wave-current interactions on suspended-sediment dynamics during strong wave events: Model development and application

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Wave-current interactions are crucial to suspended-sediment dynamics but the roles of the associated physical mechanisms, the depth-dependent wave radiation stress, Stokes drift velocity, vertical transfer of wave-generated pressure transfer to the mean momentum equation (form drag), wave dissipation as a source term in the turbulence kinetic energy equation, and mean current advection and refraction of wave energy, have not yet been fully understood. Therefore, in this study, a computationally-fast wave model developed by Mellor et al. (2008), an FVCOM hydrodynamics model and the sediment model developed by the University of New South Wales are two-way coupled to study the effect of each wave-current interaction mechanism on suspended-sediment dynamics nearshore during strong wave events in a tidally dominated and semi-closed bay, Jiaozhou Bay, China, as a case study. Comparison of Geostationary Ocean Colour Imager data and model results demonstrates that the inclusion of just the combined wave-current bottom stress in the model, as done in most previous studies, is clearly far from adequate to model accurately the suspended-sediment dynamics. The effect of each mechanism in the wave-current coupled processes is also investigated separately through numerical simulations. It is found that, even though the combined wave-current bottom stress has the largest effect, the combined effect of the other wave-current interactions, mean current advection and refraction of wave energy, wave radiation stress and form drag (from largest to smallest effect), are comparable. These mechanisms can cause significant variation in the current velocities, vertical mixing and even the bottom stress, and should obviously be paid more attention when modelling suspended-sediment dynamics during strong wave events.

Effects of the Non-breaking Surface Wave-induced Vertical Mixing on Winter Mixed Layer Depth in Subtropical Regions

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Compared to observations, the simulated multi-model mean surface oceanic mixed layer depth (MLD) during winter in the subtropical regions of both hemispheres shows deep bias from 45 CMIP5 climate models Our results from two numerical experiments using one of CMIP5 models show that the non-breaking surface wave-induced vertical mixing can serve as a remedy. The enhanced vertical mixing increases the upper ocean temperature and reduce the potential density in winter which then stabilize the upper ocean and shallow the simulated MLD depth in winterin subtropical regions. The increase of temperature in winter is not due to the air-sea interface fluxes; instead, it is the legacy of the summer temperature increase attributable to the additional vertical mixing from surface wave. The simulation biases of the annually averaged water temperatures in the upper 400 m reduced by 43% and28% in south and north latitude bands between 20°and 40°, respectively. The non-breaking surface wave induced vertical mixing shallows both boreal and austral winter MLDs by 2-11 m (a change of 5-20%) in both northern and southern subtropical regions. These results indicate that the incorporation of vertical mixing induced by the non-breaking surface waves in our experiments can improve the simulation of boreal and austral winter MLDs in northern and southern subtropical regions.

Tidal modulations of surface gravity waves in the Gulf of Maine

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Analysis of observational data demonstrates significant semidiurnal tidal modulations in the mean wave variables in the Gulf of Maine (GoM). The observed tidal modulation features significant spatial-temporal variabilities, with large magnitudes near the mouth of the GoM particularly in fall. In this study a coupled wave-circulation model is used to examine the tidal modulation of surface gravity waves in the GoM. The coupled wave-circulation model successfully reproduces the observed tidal modulation and associated spatial-temporal variabilities. Model results demonstrate that the favorable conditions for the tidal modulation in the region are swell-dominated waves associated with relatively stable wave propagating directions. The large tidal modulation in the wave height occurs at several different tidal phases, indicating the effect of nonlocal tidal currents. Process-oriented numerical experiments demonstrate that the observed tidal modulation is associated with the current-induced advection, refraction, and wavenumber shift. Model results also demonstrate that the accumulated effects of nonlocal tidal currents across Georges Bank (GB) determine the observed unusual timing of the maximum tidal modulation in the wave height behind GB in the following tidal currents. As a result, both amplitude and phase of the tidal modulation behind GB are indirectly controlled by the strong tidal currents on GB. The amplitude could reach ~0.4 m over areas just behind GB, and the phase propagates towards the inner GoM with a wavelength of ~40 km.

SHELF/SLOPE, COASTAL & MARGINAL SEA PROCESSES

Submesoscale eddies generated by Kuroshio and tidal currents around Izu islands south of Japan

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Izu islands south of Japan are known to form topographic wakes when Kuroshio approaches. Based on an ADCP observation near one of the Izu islands, Kozuisland, it is found that tidal currents are as strong as 1m/s in spring tide periods. With the strong tidal currents, it is possible that submesoscale eddies are generated not only by Kuroshio but also tidal currents. In this study, the generation of submesoscale eddies near Izu islands are studied using a numerical ocean model based on MIT General Circulation Model (MITgcm). The test period is chosen to be January and February in 2017 when the ADCP observation was conducted near Kozu island. The grid size is small enough to capture the island scale eddies near the island, but increase towards the lateral boundary. The initial and boundary conditions are set based on JCOPE2 reanalysis data. The momentum and thermal flux are calculated by using hourly atmospheric fields produced by Japan Meteorological Agency's Meso Scale Model (MSM). The predicted tidal sea surface variation is in good agreement with tide gauge records. The predicted tidal currents are also in a reasonable agreement with the ADCP observation. The numerical model results indicate island scale eddies are periodically generated by tidal currents and sometimes detached from islands. The predicted flow field indicates a similarity to the flow associated with Island Trapped Wave (ITW) as the pattern propagates clockwise direction. It is possible that the strong tidal currents near the islands are related to near resonantly generated ITW. The importance of ITW is to be examined based on an idealized experiment with horizontally uniform but vertically stratified ocean with realistic topography for Izu island region.

Observation of nonlinear interactions between near-inertial oscillations and continental shelf waves in the Northern South China Sea in 2014

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Typhoon Neoguri passed through the East China Sea in July 2014, and the upper ocean dynamical response was examined using tidal gauge and mooring data deployed in the northern South China Sea. The results show that coastally trapped waves (CTWs) remotely generated by Neoguri propagated along the coast from Liuao to Shenzhen with a phase speed of 7 m s -1 at 0.31 cycle per day (cpd). Power spectra of alongshore current indicated two energy peaks, except that of CTWs and near-inertial oscillation (NIO). The first one appeared at exactly the sum frequency fC1 (1.05 cpd) of NIO (f) and CTWs (C) with a maximum amplitude up to 0.15 m s^{-1}. The second one was peaked at the subtraction frequency fC2 (0.43 cpd) of the NIO and CTWs with a maximum amplitude up to 0.1 m s^{-1}. The forcing mechanism was analyzed by momentum equations, which suggests nonlinear wave-wave interaction between NIO and CTWs generated during typhoon.

An LETKF-based ocean reanalysis for the Asia-Oceania region using Himawari-8 SSTs

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Himawari-8 is a geostationary satellite measuring sea surface temperatures (SSTs) at a horizontal resolution of 2 km with a time interval of 10 minutes since mid-July 2015 (Bessho et al. 2016; Kurihara et al. 2016). We have calibrated Himawari-8 infrared-sensor SSTs to GCOM-W microwave-sensor SSTs (both provided by JAXA) using a 10' x 10' sliding window, and then assimilated the improved daily SST dataset (hereafter H8-SSTs) to a three-dimensional ocean reanalysis system based on sbPOM (Mellor 2004; Jordi and Wang 2012) and LETKF (Hunt et al. 2007; Miyoshi et al. 2010) with 20 members. The H8-SST assimilation system has been configured for both the southeast Asian coastal regions at a spatial resolution of 1/36 x 1/36 x 47 layers with application to fishery and marine environmental monitoring, and the large-scale Asia-Oceania region at a spatial resolution of 1/12 x 1/12 x 47 layers with application to tropical cyclone studies. Oceanic data assimilation for the southeast Asian coastal region (off Thailand and Vietnam) is a new challenge of several reasons. One reason is that the availability of the Argo float observations is limited. We have established capability to use both AQC Argo data version 1.2 (provided by JAMSTEC) and GTSPP (Sun et al. 2010) in the western South China Sea. Another reason is that high-resolution atmospheric forcing associated with the southwesterly summer and northeasterly winter monsoon is necessary to reproduce the coastal upwelling and cold tongue along the Vietnam coast, respectively. Consequently, we have investigated by performing two assimilation runs to compare a reanalysis wind forcing (JRA55; Kobayashi et al. 2015) and a satellite wind forcing (J-OFURO3; Tomita et al. in prep.). The last reason is the assessment of salinity distribution in the reanalysis data that may be attributed to the treatment of fresh-water discharges from rivers. Building a link between the additional in-site/remote-sensing measurements of shelf waters and H8-SST assimilation system is our next step.

Influence of continental waters in the Arvoredo Marine Biological Reserve, Brazil

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The present work evaluates the influence of river discharge in the waters of the Arvoredo Marine Biological Reserve (Rebiomar Arvoredo) using a realistic and very high-resolution configuration of the three-dimensional numerical model ROMS. Located in Santa Catarina inner continental shelf, Rebiomar Arvoredo is approximately 10 km away from the coast. The region is influenced by continental waters due to the proximity of the mouth of several rivers, especially River Itajai;, located 37 km north of Rebiomar, with an average flow of 480 m3 s-1, and Rio Tijucas, distant about 18 km and with an average flow of 58 m3 s-1. Low salinity waters have been identified in the region at different times of the year and under different hydrodynamic conditions. This work uses numerical results and data measured by the MAARE project (2014 to 2016) to evaluate the relationship between the various rivers in the region and the salinity conditions in Rebiomar Arvoredo. Preliminary results show a high correlation between the salinity in the area and the discharge of the nearest rivers, contradicting the recurrent attribution of low salinity in the region to Plata Plume Water (PPW).

Effect of channel curvature on the salinity intrusion in idealised and real estuaries

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Numerical model experiments are used to study the effects of coastline and bathymetric curvature on estuarine dynamics using idealised as well as realistic model topographies. These effects are demonstrated by comparing experiments with two different idealized trumpet-shaped estuaries. Meanders complicate the flow field by introducing secondary processes. For instance, meanders increase turbulence and associated mixing locally within the water column, as well as outside the meandering portion. Furthermore, meanders transform up to 30% of the along-channel momentum into secondary circulation. Flood-ebb asymmetries in the production terms of secondary circulation and mixing lead to a changed by the channel curvature balance between the flood and ebb currents. Generally speaking, the curvature increases ebb dominance. The enhanced ebb dominance shifts a density front toward the mouth of the estuary, thus reducing salt intrusion. In the second part of the study we demonstrate using an unstructured state-of-the-art model of Ems estuary that the effects arising in the idealised configuration also play an important role in real estuaries.

Modelling flow-topography interactions over shelf break canyons in the southwestern tropical Atlantic

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Alterations on the patterns of shelf break geometry and slope may give rise to a rich set of inertial and subinertial flows when alongshore currents interact with topography. This is particularly the situation found in the oceans western boundaries, where strong currents develop. In this work we use in situ observations and numerical high resolution regional modelling to investigate the interaction between the North Brazil Undercurrent (NBUC) and two deep shelf break canyons off Northeast of Brazil, south of Pernambuco Plateau. Two years (2016-2017) mooring thermistors time series are used to access temperature variability spectra. Observations are compared to numerical outputs obtained from a high-resolution process oriented Regional Ocean Modelling System (ROMS) simulation. Results indicate that the strong submesoscale eddy activity induced by NBUC-topography interaction is the prime mechanism to explain observed space-time thermohaline variability. The pumping/upwelling of cold waters near shelf break promotes vertical mixing at base of isothermal layer, supporting anomalous nutrient-rich hotspot areas and seasonal increase of mass and energy transfer across the trophic chain

Numerical Study on the Seasonal Circulations in the Gulf of Thailand

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The Gulf of Thailand is located in Southeast Asia immediately to the west of the South China Sea. The Gulf is a semi-enclosed sea that measures approximately 400-km by 800-km, covering an area of about 320000 km^2. Its location is between 6–14N and 99–105E surrounded by the Kingdom of Cambodia, Malaysia, the Kingdom of Thailand and the Socialist Republic of Vietnam. It is a part of the Sunda Shelf, which is a submerged connection between Southeast Asia Malaysia, Sumatra, Java, and Borneo, and is relatively shallow. The mean and maximum depths in the central part in the Gulf of Thailand are about 45 m and 80 m, respectively. Based on the MASNUM high-resolution wave-tide- circulation coupled ocean model, the seasonal Circulations in the Gulf of Thailand are investigated. The simulated sea surface height agrees the AVSIO data well. The simulated temperature agrees with the cruise data well. The model result shows the seasonal circulations in the Gulf of Thailand are strongly influenced by the seasonal north-east Monsoon and the south-west Monsoon. Model result also shows that the interaction between the Gulf of Thailand and the South China Sea also play an important roles in the seasonal variation of the circulations in the Gulf of Thailand. The tide and the fresh water input from the rivers also have effect on the circulations in the Gulf of Thailand.

WEDNESDAY, JUNE'27

MODEL DEVELOPMENT AND APPLICATIONS

Development of data assimilation techniques toward resolving smaller scale oceanic phenomena

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The operational ocean forecasting is based on combined use of high-resolution numerical ocean models and operational ocean observing systems. Recent development of computational resources allows including spatiotemporally high resolution for representation of detailed front variability of ocean currents. At the present time, typical sampling frequencies of most important satellite altimetry observation are approximately 10day and 100km intervals, which are not enough for capturing fine scale (1day, 1km) oceanic front variability. To resolve this issue, we are making efforts in enhancing available observation data including buoys/ships/sea birds drift at sea surface and subsurface temperature obtained by sea turtles. Also, we are developing data assimilation techniques for utilizing high-resolution satellite sea surface temperature data. Representation of horizontal scales in data assimilation algorithms plays a key role in capturing the front phenomena effectively. Another important factor is time-evolution information represented by each observation sampled at different times, and it requires development of four dimensional (4D) data assimilation techniques including 4D-variational method and 4D-Kalman filter (smoother). We discuss possible implementation of ensemble-based 4D data assimilation techniques in operational ocean forecasting systems.

On the computation of pressure in numerical ocean models, with focus on terrain following models

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Pressure in mode-split numerical ocean models is split into pressure due to the free surface elevation, internal pressure, and the pressure due to fluid motion. The last pressure component is often referred to as non-hydrostatic or dynamic pressure and it is neglected in studies with hydrostatic ocean models. In this study, several issues related to this splitting will be addressed. Will we get the same answer if we use models that solve directly for the full pressure? Are the boundary conditions for each pressure component well understood? When do we need to use non-hydrostatic ocean models? When using sigma-models or terrain following models, the internal pressure gradient errors have been of concern to many ocean model users. A discussion of these errors and what we can do to reduce them will be given. The sigma-transformation and other terrain following transformations, give additional terms also in the non-hydrostatic pressure equation. This makes it computationally more tedious to solve for non-hydrostatic pressure in sigma-models than in z-coordinate models. Techniques for solving for non-hydrostatic pressure in sigma-models will be discussed.

Revisit of Inertial Instability and Phase Error in Time Integration Schemes in Ocean and Atmospheric General Circulation Models

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This study investigates the inertial stability properties and phase error of numerical time integration schemes in several widely-used ocean and atmospheric models. These schemes include the most widely used centered differencing (i.e., leapfrog scheme or the 3-time step scheme at n-1, n, n+1), 2-time step (n, n+1) Euler scheme, 2nd, 3rd, and 4th-order Euler predictor-corrector schemes. The leapfrog scheme is proven to be neutrally stable with respect to Coriolis force since it preserves a perfect inertial motion with the amplification factor (AF) always being equal to unity, and overestimates phase speed. The Euler forward scheme is proven to be unconditionally inertially unstable since its AF is always greater than unity. To make the 2-time step Euler predictor-corrector schemes inertially stable, a split Coriolis terms must be discretized with an equal weight on both the old value (n) and the new predicted value (n+1*). It is found that 3rd- and 4th-order predictor-corrector schemes also introduce an artificial numerical solution. The inevitable phase error in a numerical scheme associated with the Coriolis parameter is analyzed in depth for some widely-used schemes. Some schemes overestimate the phase speed, while the others underestimate it. To preserve as best a phase frequency possible in a numerical model, alternating a scheme that has an overestimated phase with a scheme that has an underestimated phase is recommended. Considering all properties investigated, the leapfrog scheme is still highly recommended for a time integration scheme. As an example, the comparison between the leapfrog scheme and Euler scheme is presented in the context of Great Lakes coupled ice-lake modeling.

On open boundary condition for tidally and sub-tidally forced circulation in a limited-area model

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Dynamic inconsistence of open boundary condition (OBC) for the circulation concurrently driven by both tidal and sub-tidal forces in the open boundary has been frequently witnessed in the limited-area ocean modeling studies. In addition, local and global disturbances may not be physically sensible to be accommodated by the existing radiation condition. In this study, we develop a novel OBC that is capable to accommodate the concurrent tidal and sub-tidal forcing as well as their respective forcing in the open boundary of the limited-area model. This new Tidal and Sub-tidal or TST-OBC separates the fast-moving tidal and slower-moving sub-tidal current at OB. TST-OBC also separates total solution into local and global components such that unforced Orlanski-type radiation can be used. We apply TST-OBC to all model variables to maintain dynamic consistence. These approaches are physically and numerically sensible for the treatment of OBC. TST-OBC performs better as compared with existing OBCs in resolving TST forcing along the OB of model. Analyses and experiments suggested that the newly developed OBC considerably suppressed the reflective spurious disturbances near the open boundary and performed better than either Orlanski-type or Flather-type OBC in reproducing realistic tidally and sub-tidally forced shelf circulation in the ECS.

Numerical modeling of storm surges in the coast of Mozambique: the cases of tropical cyclones Bonita (1996) and Lisette (1997)

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The coast of Mozambique is often affected by storms, particularly tropical cyclones during summer or sometimes midlatitude systems in the southern part. Storm surges combined with high freshwater discharge can drive huge coastal floods, affecting both urban and rural areas. To improve the knowledge about the impact of storm surges in the coast of Mozambique, this study presents the first attempt to model this phenomenon through the implementation of the Princeton Ocean Model (POM) in the Southwestern Indian Ocean domain (SWIO; 2–32°S, 28–85°E) using a regular grid with 1/6° of spatial resolution and 36 sigma levels. The simulation was performed for the period 1979–2010, and the most interesting events of surges were related to tropical cyclones Bonita (1996) and Lisette (1997) that occurred in the Mozambique Channel. The results showed that the model represented well the amplitude and phase of principal lunar and solar tidal constituents, as well as it captured the spatial pattern and magnitudes of SST with slight positive bias in summer and negative bias in winter months. In terms of SSH, the model underestimated the presence of mesoscale eddies, mainly in the Mozambique Channel. Our results also showed that the atmospheric sea level pressure had a significant contribution to storm heights during the landfall of the tropical cyclones Bonita (1996) and Lisette (1997) in the coast of Mozambique contributing with about 20 and 16% of the total surge height for each case, respectively, surpassing the contribution of the tide-surge nonlinear interactions by a factor of 2.

An operational forecasting system for the physical processes in the Santos Estuarine System –Southeast Brazil

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The Santos Estuarine System (SES), located at 24.0 S, 46.3 W, is subject to storm tide events that bring coastal flooding and force the interruption of ship traffic through the Santos Harbour, the largest oceanic port in South America. The goals of this study are (i) to describe the design of the fully automated Santos Operational Forecasting System (SOFS) built to monitor and predict short term (3 days) sea surface elevation and currents in the SES and (ii) to evaluate model performance in simulating observed sea level. The SOFS hydrodynamic module is based on the urban ocean version of the Princeton Ocean Model (POM). The SES grid model is forced by tides, winds and river runoff. Tidal constants were obtained from harmonic analysis of observed sea level in SES. SES grid is nested into a South Brazil Bight (SBB) grid, with lower spatial resolution and that extends approximately 1500 km in the along-shelf direction and a few hundred kilometres in the cross-shelf direction. The SBB grid is forced by winds, density gradients and the offshore flowing Brazil Current. This last forcing is taking from Mercator Ocean, released by Copernicus Marine Service. Winds from the Brazilian developments on the Regional Atmospheric Modelling System (BRAMS) established by the Centre for Weather Forecasts and Climate Studies (with Portuguese acronym CPTEC) provide the wind stress forcing. Daily updated outputs are available at http://oceanos.nap.usp.br/temp/sofs/. Within SES, SOFS works in parallel to a net of 3 real-time observation stations. The coupled system was able to hindcast a severe storm tide event in August, 2016. Comparisons between observed and modelled sea surface oscillations provided skills of 0.92 and maximum root mean square errors of 25 cm. The good agreement with observed data shows the potential of the designed system to support both human and assets protection.

Recent developments in JCOPE coastal ocean modeling

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One of main tasks of Japan Coastal Ocean Predictability Experiment (JCOPE) group of JAMSTEC is development and improvements of real time coastal ocean prediction models and related user-oriented applications. For these purposes we are operating a spectra of ocean nested models with spatial coverage from global to local (100 km) ones, with spatial resolution from 10 km to hundred meters. As example of regional real-time operated tide resolving models, the JCOPE-T-EAS model for East Asian Seas surrounding Japan is described. It uses generalized sigma vertical coordinates, the code is MPI parallel code that supports almost arbitrary rectangular decomposition and can be run both on supercomputers and on local multiprocessor workstations. Spatial resolution of model is 1/36 degree, it uses the real-time meteorological analyzes and forecasts for short term coastal ocean prediction of up to 10 days. Recent improvements of modeling system included updated river discharges module and data base for more than 100 Japanese rivers. Experiments with coupling to the real-time river discharge prediction model were done and demonstrated importance of such information for coastal environment, especially for cases of typhoons passing over Japan. Other important update was an implementation of direct multi-scale 3D variational data assimilation subsystem. It replaced earlier used spectral nudging method and allowed utilize modern satellite high resolution SST data provided from Himawari-8 geostationary satellite. These and other improvements of JCOPE downscaled ocean simulation system allow as to serve better quality information for research and applications.

High resolution modeling of near-shore wave processes using the implicit unstructured WAVEWATCHIII

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Boussinesq-type models are good tools to model the near-shore wave processes at high resolution. Nevertheless, they are limited to short events and small grids (~1 km2) due to high computational cost. Also, they can hardly model the wave growth due to wind forcing. Spectral models like WaveWatchIII (WW3) allow wave modeling at different ocean-basin scales, from large rectilinear grids in offshore areas to high resolution unstructured grids in coastal zones using the multi-grids approach of Tolman (2007). Over the last decade, various numerical schemes have been added to WW3 to allow for the integration of the model over these unstructured meshes. Nevertheless, solving the equations with explicit schemes in WW3 requires a trade-off between spatial resolution and computational time. For operational applications, this limits the resolution to about 200m in coastal waters. Therefore, an implicit scheme has been developed to integrate the Wave Action Equation efficiently in time. This new scheme integrates all propagation dimensions as well as the source term directly using block Gauss-Seidel solver. The source terms are linearized based on Patankar rules or simple Picard iteration, thus avoiding splitting errors in fractional step method. In this work, we present the last elements of the validation study of this new numerical scheme in WW3. In this study, we first compared the 1/12 regular grid implemented over the Gulf of Mexico currently used as operational setup at NCEP with three unstructured meshes with coarse resolution (~2 km), mid resolution (~200 m) and high resolution (~10m). The new implicit scheme has been tested in hurricane conditions and has been compared with the explicit schemes already available in WW3. Results obtained with the implicit scheme show a very good match with those obtained with the explicit methods at deep-sea buoys. The implicit scheme on the mid/high-resolutions unstructured meshes matched the significant wave height and peak arrival time at near-shore observatories (~10 m depth) whereas the peak was delayed in the explicit scheme simulation on the same unstructured grids and was missing in the structured grid due to its poor resolution. The use of the high-resolution mesh with the implicit scheme also showed a clear improvement of model results with both satellite altimeter data and buoy observatories, keeping the computational cost as low as the explicit scheme on the mid-resolution grid. Then, we implemented WW3 on the Iroise Sea (Brittany, France) with a high resolution mesh. We investigated the new scheme's ability to account for small scale near-shore phenomena affecting waves. An extensive field campaign during 2013-2014 winter, combining deep water, middle depth up to inter-tidal zone wave observations, was used for comparison with model results. The 7 consecutive storms recorded during this winter allowed to validate the model capabilities in extreme conditions. Despite the well-known limitations of the spectral modeling in shallow water, the better solving of near-shore wave processes with higher resolution bathymetry clearly improves the modeled wave field. The validation of the new implicit scheme provided in this study clearly shows that WW3 is now also a valued model for shallow water wave modeling applications. This constitutes a major breakthrough in the context of the increasing needs of high resolution near-shore wave modeling. Moreover, added to the others schemes already available in the WW3 framework, this new implicit scheme makes WW3 an appropriate stand-alone tool to model waves at many scales, from the global scale to near-shore areas.

Forecasting Storm Tides in the South Brazil Bight

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Storm tides in the South Brazil Bight are formed by a constructive combination of high storm surges and spring tides. The storm surges are a response of the inner continental shelf waters to the synoptic winds that blow from the south of South America, with along shelf component that leaves the coastline to the left side. The positive elevation of the coastal sea level in response to those winds is composed of two parts. First, the response to the local wind, or to the wind that is blowing on a transect with origin at the coastal measurement station, and that points offshore, in the form of Arrested Topographic Waves. Second, the response to the remote wind or to the wind that blew in positions located southward from the coastal measurement station and earlier in time, in the form of Continental Shelf Waves. In order to forecast and to simulate storm tide events we implemented the numerical model ECOM, an evolution of the POM model, developed by A. Blumberg. A seasonal climatology of temperature and salinity in the South Brazil Bight was developed and is used as initial condition for ECOM integration. The model is forced by winds made available by the Brazilian National Space Research Institute, by tides (sea level oscillations) obtained from TPXO and by estuarine discharges collected along the South Brazil Bight coastline. ECOM is run operationally at the University of Sao Paulo Oceanographic Institute Coastal Hydrodynamic Laboratory and 24 h forecasts are made available each day at the laboratory site. We examine one of the storm tide events forecasted comparing model results with observations.

Regional modelling of the north Pacific Ocean currents and waves applied to plastic-debris transport and accumulation in the Great Pacific Garbage Patch

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The Great Pacific Garbage Patch (GPGP) is the largest known oceanic plastic-debris accumulation area in the planet. Recent field expeditions made by the The Ocean Cleanup (TOC) group allowed for new estimates of the total surface plastic waste in the GPGP which accounts for up to more than 80 million kg of floating plastic debris of various size and shape, principally made of Polyethylene and Polypropylene (Lebreton et al., 2018). Understanding the transport and accumulation of plastic in the GPGP is crucial for the planning and deployment of the barriers that TOC is developing to clean the ocean of plastic debris. For this sake, the TOC modelling group has implemented the Regional Ocean Modeling System (ROMS) and Wave Watch III (WWIII) models in the area located between Hawaii and the California Coast with focus on the GPGP. The models are now running separately but are planned to run in coupled mode, in a data-assimilative operational model that is being developed by the group. A period of 8 years, between 2010 and 2017 has been already simulated, having as surface forcings the CFSR 6-hourly atmospheric data and as open-boundary values the HYCOM-NCODA daily T,S,U,V, EL GLBu0.08 data. Preliminary results show that the models are performing well in locations where NOAA buoy data are available. One major finding is that the plastic debris transportation is a consequence of the combined effect of the surface winds, the ocean currents and wave-induced Stokes drift, as well as the non-linear interaction between waves and currents. Our plans for the near future are the implementation of both models in operational mode, which will deliver forecasts that can be used by TOC in planning and executing fields operations.

The Urban Ocean – The New Frontier

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Today people forecast the weather. What is needed in the face of a changing climate, are forecasts of the impact of that weather. As climate change makes weather increasingly erratic, the ability to quickly and accurately predict and prepare becomes ever more crucial. To answer specific questions about how property owners and communities can thrive in the face of extreme weather events of the future and rising sea levels a better understanding of the dynamics of the urban ocean is necessary. The urban ocean is the place where the ocean, the land, and the people all come together. Each of these component "systems" has a profound effect on the others. The tide creates complex dynamics, often in the context of an estuary environment, that influence the physical, chemical, and biological characteristics of the region and thereby define its capability and capacity to support human life. The coastal ocean and weather patterns drive processes and events that range from highly supportive of human populations to highly threatening. This balancing act between ocean-as-sustainer and ocean-as-threat has produced a very wide range of coastal ocean "management" strategies that have themselves often resulted in significant short and long-term changes to the balance. This presentation will discuss the characteristics of the urban ocean from the standpoint of how human populations seek advantage from being located at the ocean and in so doing how they have altered the natural system, with attendant consequences for the risks of disruption. It will draw on the operational shallow water New York Harbor Observing and Prediction System (NYHOPS), and illustrate, by example, the breadth of dynamical processes that influence near coastal ocean circulation.

SPECIAL OYSA SESSION

Automated eddy detection in the Brazil Current near the Abrolhos Bank

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The Brazil Current (BC) in the ocean is characterized by a predominant pattern of meanders and eddies, such as the eddies of the Cabo Frio region, the meanders of Cape Sao Tome and the eddies of Vitoria, Abrolhos, Royal Charlotte and Ilheus. The oceanic eddies play an important role in the transport of momentum and heat and in the occurrence of upwelling events. The identification of eddies from a large dataset, obtained by satellite imagery or from numerical simulations, requires the definition of an automatic eddy detection method, which can be classified in three different criterias: physical, geometric or in the association of both (hybrids). A literature review of the comparison of each method indicated that the geometric method presents better results in the detection of eddies. Therefore, an automated eddy detection method based on the geometry of the flow was applied in order to identify the eddies near the Abrolhos region (18-20S) and to subsequently evaluate its main characteristics, such as diameter and temporal and spatial variability. For this purpose, the reanalysis dataset of the velocity field from the global ocean circulation model HYCOM was used, with resolution of 1/12 degrees.

Role of Brazil Current warming in amplifying 2008 Santa Catarina Extreme precipitation event

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In November 2008 one event is described as the most intense disaster at Santa Catarina State. A extreme precipitation event affected most part of the region located in the east side of the Serra do Mar, killing 135 people. Using the NCEP CFSR data to measure the winds near the surface, we observed easterly winds coming from the ocean to the continent when the disaster occurred. It's possible that this effect advected the moisture from the ocean to the atmosphere. The objective of this work is to investigate the effect of the Brazil Current in the 2008 Santa Catarina extreme event. Our main interest is to verify if the moisture from the ocean was carried over to the continent and if it amplified the precipitation. To fulfill our objective, we've produced two simulations using the COAWST modeling system, with the ocean (ROMS), waves (SWAN) and atmosphere (WRF) fully coupled, from 21st to 28thNovember 2008. The WRF model was nested using the NCEP FNL data with the parent domain grid spacing 12 km. The second grid had 2.5 km and the third domain 0.5 km. We've used the SODA reanalysis to run the ROMS, with ~9 km of spatial resolution and with the same grid limits as used in the WRF parent domain. The SWAN model used the same ROMS grid. The first simulation was named COA normal and the second was named COA cold. The second simulation was started with the SST 0.8^{o}C colder than the one in the COA normal experiment. This value was extracted from 1979 to 2008 SST trend over the Atlantic Southwest from CFSR data, where it was been verified that the 2008 SST was 0.8 C warmer than the verified in 1979. Comparing both simulated precipitations with a meteorological station in Blumenau, from Agencia Nacional de Aguas, was observed that the COA normal precipitation at 23 rd November was 228 mm, the COA cold presented 142 mm and the in situ data 251 mm. In both simulations was observed a strong pressure gradient over the ocean, with the easterly wind from the ocean to the continent, but COA cold precipitated water over the continent was, in general, 33% weaker than the precipitation from the COA normal experiment. Producing a atmosphere vertical plot, from 50W to 40W at 26.555S, we've visualized that the winds near the surface were coming from the ocean and were uplifted to atmosphere's higher levels at the Serra do Mar. From those results, we've concluded that the Brazil Current was warmer than the expected for the month. This fact, allied with the strong pressure gradient from the ocean to the continent, supplied the atmosphere with the moisture from the ocean. When the moisture was uplifted at the Serra do Mar, it condensed and precipitated along the east side of the Santa Catarina. It was also showed that if the ocean wasn't 0.8^{o}C warmer, the precipitated water could be 33% less than the measured in this event.

Impacts of different strategies to assimilate ARGO data into the HYCOM over the South Atlantic

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Several operational ocean forecasting systems, including those participating in the GODAE OceanView project, assimilate Argo temperature (T) and salinity (S) profiles, sea surface temperature (SST), sea level anomalies (SLA) and other data to produce their initial condition. When assimilating Argo data, a substantial impact in the model sea surface height may occur due the relationship between subsurface thermohaline structure and the absolute dynamic topography (ADT) as well as the multivariate nature of assimilation techniques. Although this has already been documented by few works, the latter did not conclude if the changes in ADT produced positive or negative corrections in the model circulation. Here we propose to investigate these impacts by assimilating Argo data into the HYbrid Coordinate Ocean Model (HYCOM) employing the basic structure of the Oceanographic Modeling and Observation Network (REMO) Ocean Data Assimilation System (RODAS). Considering the isopycnal model coordinate, there are basically two ways of assimilating Argo data into HYCOM. One is interpolating the model variables from the model layer to z-coordinate to calculate the innovation. The other is interpolating the observed data into the model vertical layers. These strategies are here denominated as ARGOz and ARGOdp, respectively. This work explores both techniques through a multivariate Ensemble Optimal Interpolation (EnOI) scheme. The model was configured with 21 layers and horizontal resolution of 1/12 degrees over the Western South Atlantic. Four experiments were performed from 1 January 2008 to 31 December 2013 taking the initial condition from a free run: (1) control run without assimilation; (2) ARGOdp which assimilates T, S and pseudo model layer thickness derived from the Argo T/S considering the innovation in the model space; (3) ARGOz which assimilates T and S considering the innovation in the observation space, (4) ARGOzT which assimilates only T considering the innovation in the observation space. ARGOdp, ARGOz and ARGOzT reduced the root mean square deviation (RMSD) with respect to the control run temperature by 13%, 16% and 19% and to the control run salinity by 15%, 20% and 4%, respectively. Significant reduction of ADT was observed only in the ARGOdp, which led to a smoothing of the ADT gradient associated with the Brazil Current (BC). This smoother gradient was not observed in the AVISO ADT nor in the other three experiments. Consequently, the ARGOdp simulated the least intense BC among the experiments and in some regions it was detected the presence of the Intermediate Counter Current instead of the BC. Therefore, the ARGOdp had a negative impact on the model ADT and the BC while ARGOz and ARGOzT showed some positive impacts. Also, ARGOzT presented a significant influence on the temperature RMSD and small correction on salinity. It shows that RODAS can be employed now to assimilate vertical profiles of T without the companion S profile, such those from XBTs and the PIRATA array. Key words: ocean data assimilation, Argo, HYCOM, Brazil Current, ADT.

Application of the 4D-Variational Data Assimilation Method of the Regional Ocean Modeling System (ROMS) to Simulate Circulation on the Southeast Brazilian Ocean Region

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This work presents a simulation of ocean circulation in the southwestern South Atlantic, with a focus on Santos and Campos Basins, using the framework of the Regional Ocean Modeling System (ROMS). This region presents a heterogeneous circulation intimately related to the presence of mesoscale features, such as eddies and meanders, associated with instabilities of the Brazil Current system. The reproduction of these features in the correct time and spatial dimensions are quite challenging in the context of a non-assimilative model, considering the limitations imposed by the model's numerical schemes, physical parameterizations, boundary conditions and surface forcing errors. In this sense, the Four Dimensional Variational Data Assimilation System (4D-VAR) distributed in ROMS was used aiming at increasing model skills and minimizing its distance to observations. Weekly observations of Sea Level Anomaly (SLA) from AVISO, daily Sea Surface Temperature (SST) fields from OSTIA and in situ vertical profiles of temperature and salinity (T/S profiles) from multiple sources were used in consecutive 7-day assimilation cycles to produce a one-year hindcast. Both assimilative and free runs were compared against global models outputs and in situ data, including current data collected in a mooring located in Santos Basin. The results showed that the ability of the assimilation run to reproduce particular events of surface dynamics was substantially increased with respect to the free run and that a significant reduction in velocity error was obtained, especially in the upper 400 m of the water column, where the error was reduced up to 56%. A diagnostic calculation of the Brazil Current (BC) and Intermediate Western Boundary Current (IWBC) transports at 22oS was also done to evaluate skills of the assimilative model to adequately simulate mass transports on the continental slope.

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FROM OBSERVATIONS TO MODEL PREDICTIONS

Assessing the extended-range predictability of HYCOM+RODAS System in the South Atlantic

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Ocean forecasting systems (OFS) have a fundamental role to deliver ocean services to society and their operational evolution has been extremely significant over the last years. The Brazilian Oceanographic Modelling and Observation Network (REMO) has developed the REMO Ocean Data Assimilation System (RODAS), which is based on an Ensemble Optimal Interpolation (EnOI) scheme applied into HYCOM over the western South Atlantic Ocean. This study aims to investigate the extended-range predictability of the HYCOM+RODAS system. The analyses produced by RODAS were used as initial condition for 48 HYCOM 30-day simulations, which were then compared to persistence (no change from the initial condition) and to a model free run. The model hindcasts had the lowest root mean square difference (RMSD) and highest correlation of sea surface temperature (SST) and sea level anomaly (SLA) with respect to RODAS analysis at all lead times. Persistence RMSD increased from 0C to 1.09C by the 30 th day and from 0 m to 0.08 m in the same period for SST and SLA, respectively, while the hindcast RMSD increased to 0.46C and 0.05 m. The free run RMSD (correlation) was always higher (lower) than that of the hindcast with an average of 0.88C and 0.13 m. In the subsurface, hindcast RMSD increase was even lower. The results suggest that HYCOM+RODAS predictive skill extends for more than a month and the thermohaline state of the ocean was consistently improved. A case study on a coastal upwelling event in the southeast coast of Brazil demonstrated that the HYCOM+RODAS system was efficiently able to reproduce this ocean feature.

A 4D-Variational Ocean Data Assimilation System for Santos Basin, Brazil (Project Azul)

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The Santos Basin Ocean Observing System (or Project Azul) is a pilot project designed to collect oceanographic data with enough time and spatial coverage to improve regional hindcasts and forecasts through data assimilation in the Santos Basin (Southeast Brazil) region. The Project was held between August, 2012 and August, 2015 and provided a significant set of in-situ data including TS profiles from gliders and profiling floats, and drifters trajectories. TS profiles together with UK Met-Office EN3 project dataset and remote data from POES AVHRR and AVISO were used to feed the data assimilation process. The data assimilation was based in the Regional Ocean Modeling System (ROMS) 4D-variational data assimilation system - a pioneer effort in Brazil. In 2018 a new phase of the project starts, Project Azul 2, with acquisition of new ocean data including deep moorings and the setup of a higher resolution DA model focused on pre salt oil exploration site. From comparisons with independent observations, the 4D-Var data assimilation system showed a great potential to improve the forecast skill of the local ocean dynamics (Fragoso et al., 2016). Besides the significant insights gained from the project, there are some tests in development to better understand and improve the data assimilation system. Highlights of the most recent developments in progress will be presented with focus on experiments to determine the best assimilation window length for the region and to improve the background-error covariance matrix modeling.

Introduction to a Global High Resolution Ocean Forecast System - the FIOCOM

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The newly-developed global high-resolution wave-tide- circulation (WTC) coupled ocean model consists of three parts, they are ocean general circulation model (MOM5), sea-ice model (SIS) and wave model (MASNUM). This global coupled ocean model has two highlight features: 1, high resolution, the horizontal resolution reach 1/10° which is eddy-resolving (~12 km), simulation of the western boundary currents is improved, the vertical resolution is also promoted to 54 vertical levels with the finest vertical resolution of 2 m; 2, comprehensive physics processes, wave-circulation coupled theory is applied, tide is also coupled into this model by introducing 8 tidal potential, inclusion of ice model is essential to achieve global simulation, thus its unique feature is that the global circulation system, mesoscale eddy field, improved upper layer ocean condition, internal tide and global barotropic tide are concurrently resolved in this single system. The ensemble adjustment Kalman filter assimilation is applied in this global high-resolution WTC coupled model, which provide solid supports to global high-resolution oceanic numerical forecasts and to serve the society.

A High-Performance Implementation of Local Ensemble Transform Kalman Filter (LETKF)

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With development of satellite measurements and in-situ data collection, more and more data becomes available for data assimilation. Subsequently, the computational time for data assimilation continuously increases. In the original parallel LETKF, some CPUs spent more than 5-fold computational time than others. The whole program has to wait for the slowest CPU, which limits the computational efficiency. In order to speed up the program, we develop a high-performance LETKF program to evenly distribute calculations among CPUs. By automatically allocating the grid points according to the surrounding observation points, we can increase data assimilation by about 100% without loss of accuracy. The new program is tested in a coupled ocean-atmosphere model. It is promising for improving efficiency of massive data assimilation in online coupled systems.

The impact of assimilating SST, Argo and SLA data into a tidally driven model for the Brazil Current region

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Ocean eddies play an important role by providing energy for lateral and vertical mixing and exchange water and properties between different oceanic regions. The Brazil Current (BC) has a well-marked mesoscale downstream Vitoria-Trindade seamount chain (20S). The BC intensely meanders and generates the well-documented Vitoria, Cape Sao Tome and Cape Frio eddies. The realistic simulation of observed mesoscale features needs high-resolution modeling and data assimilation. The inclusion of tidal forcing in the model simulation may be important because it provides a significant fraction of available energy for mixing, which affects the ocean circulation and mesoscale features. This study investigates the impact of data assimilation and tidal forcing on the Cape Sao Tome Eddies (CSTE) simulation. The HYCOM tidal configuration has 1/24 degree of horizontal resolution and 21 vertical layers that covers the waters off the Brazilian coast up to 32W with northern and southern limits at 11S and 34S. The model was forced on the surface by atmospheric fields from the Climate Forecast System Reanalysis. On the lateral boundaries, the outputs of an assimilative non-tidal 1/12 HYCOM run were imposed. Both simulations employed the REMO Ocean Data Assimilation System (RODAS) that assimilates Sea Surface Temperature, Temperature (T) and Salinity (S) profiles from Argo and Sea Level Anomaly (SLA) data. RODAS is based on the Ensemble Optimal Interpolation (EnOI) scheme. Considering that the SLA observations are tidally filtered, the model tidal signal was also removed using harmonic constituents extracted from the Control non-assimilative run (4 years). A set of 5 Observing System Experiments (OSEs) were performed to evaluate the system's behavior. The OSEs assimilated: (i) only SST (A_SST); (ii) only T/S profiles from Argo (A_TS); (iii) only SLA (A_SLA); (iv) all aforementioned observations (A_ALL); and (v) and all observations but without tides (A_ALL_NOTIDES). The model 24 h predictions were used for validation against observations that would be assimilated only in the next cycle, therefore those observations are considered as independent. An eddy tracking algorithm - presented in Faghmous, J. H. et al., 2014 – was used to validate the simulated mesoscale activity in comparison to AVISO. The eddies from AVISO data were taken as reference and a minimum distance of 50 km between the observed and simulated eddies was used to consider the model eddy as valid. All assimilated observations contributed positively by reducing the T errors in the upper 500 m. However, the S deviations increased in the A_SST and A_SLA runs in the same layer. The A_ALL run demeaned the T and S errors by 34% and 17% respectively, as well as raised in 77% (or reduced in 60%) the correlation (or deviation) between remote sensed observations of SSH (or SST) in comparison to the Control run. Six CSTE were observed between 2010 and 2011 with an average duration 53 days. The experiment A_ALL, A_SLA and A_ALL_NOTIDES represented the eddies 58.1%, 54.0% and 50.7% of the time with an average distance to the observed eddies center of 27.1 km, 28.8 km and 30.8 km, respectively. A well-describe CSTE as well as ratified with in situ data was formed on March 6th 2011 (Mill et al., 2015). The A_ALL was the only experiment capable of simulating the eddy increasing in amplitude on April 22 of 2011 and its northward migration during May 12 of 2011. Those phenomena can be explained by the higher energetic level provided by the tides and the T/S data assimilation which is the most responsible for correcting thermohaline structure. The CSTE lasted 117 days and was captured in 79%, 55 % and 68% of the observation period by the A_ALL, A_SLA and A_ALL_NOTIDES, respectively. The average distances were 27.7 km, 27.0 km and 26.3 km, accordingly. The six eddies observed were well simulated by the assimilative runs, however the A_ALL presented better results probably due to the most complete data set assimilated and the inclusion of tides.

ABSTRACTS

POSTER PRESENTATIONS

Study of three domestic sewage submarine outfall plumes through the use of numerical modeling in the Sao Sebastiao channel, Sao Paulo state, Brazil

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Dispersion of thermotolerant coliform plumes resulted from Araca, Itaquanduba and Cigarras domestic sewage submarine outfalls, located in the Sao Sebastiao channel, were modeled. They were simulated as the only pollution sources, using bacteria decay for summer and winter of 2016. The main goal was to determine if and what areas were impacted by the disposal systems. Simulated concentrations were qualitatively compared with Enterococos and thermotolerant coliforms data available by sanitary agencies in Sao Paulo state (CETESB and SABESP). Modeled concentrations did not exceed the limit stated by CONAMA Resolution 274 (2000), with an exception in June of 2013 and 2016. We concluded that channel hydrodynamic patterns are sufficient to disperse material coming from the sewage disposals. Araca adjacent areas presented the highest persistence of coliform concentrations. However, modeled concentrations did not exceed 1000 NMP/100mL in more than 0.1% of the time. Simulations reproduced satisfactorily coliforms variability and dispersion in the region.

Investigating adjustment of wind profile formulas to a reference height using observation records at the Ieodo Ocean Research Station

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Conventionally, winds measured at various heights at sea are adjusted to a 10-m reference height. These converted data are used to calculate wind stress and heat flux at the sea surface and to conduct validation and verification of winds simulated from meteorological models and measured from space borne scatterometer. In this study, we have tested three well-known empirical wind profile formulas to examine their applicability into 10-m reference level wind speed: Power Law equation (U_10^PW) and two Logarithmic Profile formulas (U_10^LP83 and U_10^S88). In these experiments, we used 2015 oceanic and meteorological records measured at the Ieodo Ocean Research Station (IORS) running by the Korea Hydrographic and Oceanographic Agency (KHOA). The IORS, which is located on submarine rock called Ieodo in the East China Sea, has measured offshore meteorological and oceanographic data since June 2003. The adjusted wind speed data were compared with those by Liu-Katsaros-Businger model (LKB) which is an extensively tested, well-known and more-accurate wind profile model. The U_10^S88 result gives more closer to the LKB. In addition, we have estimated the aerodynamic surface roughness height (z_0) around the IORS from the LKB using full-year 2015 observation records. Results show that the annual mean of z_0 is 1.020 x 10^{-4} m, which is smaller than that in open sea with typically value of 10^{-4} m. Further, its standard deviation is 1.50 x 10^{-4} m, showing relatively large monthly and seasonal variability with the highest value of 3.074 x 10^{-4} m in July. In conclusion, use of the estimated value of z_0 in U_10^S88 can lead to better adjustment of the wind speeds around Ieodo area for real-time wind services.

Tidal impacts on hydraulic geometry in the Pearl River Delta

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Tidal rivers are intrinsically complex, as tidal propagation is influenced by river discharge and vice versa. An unstructured mesh, finite element model driven by the tides and river discharge is applied to simulate the hydrodynamics processes in the Pearl River Estuary, China. The validated model results are used to study the tidal impacts on the variation of hydraulic geometry. A method to quantify the tidal signature on delta morphology has been developed, by including the maximum tidal discharge amplitude in the hydraulic geometry concept. The relationship between the maximum tidal discharge amplitude and the cross-sectional area throughout the network indicates that the tides play an important role in the cross section morphology, sometimes decisive, surrogate the river discharge. In general, the net effect of the tides in the Pearl River Delta is to reduce the inequality in discharge division. The maximum tidal discharge is quantified by the sum of the mean fortnightly, diurnal, semi-diurnal and quarter-diurnal tidal discharge amplitudes. The semi-diurnal tide make the greatest contribution followed by the diurnal, and quarter-diurnal tides. The contribution of diurnal, semi-diurnal and quarter-diurnal tides to the long-term averaged water level in the river channel decrease from the river outlets to the delta apex. Whereas the fortnightly tides show smaller contribution, but travel further upstream and increase from the river outlets to the delta apex.

High resolution hydrodynamic forecast system - Implementation and preliminary validation

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The design, implementation and preliminary validation of a Brazilian southeast coast hydrodynamic forecast system based on Delft-FLOW model is presented. Delft-FLOW model is able to simulate hydrodynamic circulation as a response to baroclinic and barotropic forcing, as well as the transfer of momentum to the hydrodynamic system due to the wind system, and the flow transfer from meso and large-scale models. This system has been developed in order to reproduce hydrodynamic of coastal and estuarine systems from Guanabara bay to Sao Sebastiao channel including the complex circulation around the islands. The main goal is to provide current and tide forecast for operations on Oil Terminal regions: TEBAR (Almirante Barroso), TEBIG (Ilha Grande) and TABG (Guanabara Bay). These terminals are located along southeast Brazilian coast, from Ilha Bela (Sao Paulo) to Cabo Frio (Rio de Janeiro).The Delft3D-FLOW source code, version 6906, was compiled in parallel on Linux server, using gnu compilers and MPICH library. The horizontal resolution grid has 671x260 elements ranging from 80 meters inside bays to 2000 meters offshore, near the shelf break. The vertical column is divided in 10 sigma layers. Atmospheric forcings on free surface, wind and sea level pressure, was setup through operational runs with COSMO from INMET, available with 7 Km of horizontal resolution. Currents and level boundary conditions were assembled with HYCOM/REMO and TPX8 harmonic tides by Riemann techniques. Bathymetry has been built from a mixed of ETOPO1 and Nautical Charts digitalized. This setup runs for 72 hours using parallel processing with MPI through shell, python and Matlabscripts. For the validation, a hindcast for the period between August and November 2016 was run and the harmonic constants and tide reconstruction at different points along the coast were used to compare tide amplitudes and phases. The model current circulation was analyzed based on a horizontal current profiler, obtained from PETROBRAS near TEBAR, and four buoy current series on Rio de Janeiro area, one from PNBOIA project (buoy BG), and three from SimCosta project (buoy RJ1, RJ2 and RJ3).Tidal amplitude an phases has very well accuracy levels at many different points along coast and currents velocities time series showed satisfactory skills in comparison with data buoy measures.
The results presented for the hindcast validation period demonstrated that the physical processes were represented effectively in different scales. Eventually, this system is enabled for operational planning and coastal emergency contingencies.

Interannual Variability of South Atlantic Subtropical Mode Water Associated with Remote Climatic Patterns

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Mode waters are characterized as distinct volume in the ocean with a picnostad, a low-density gradient layer, trapped between the seasonal and the main thermoclines most of the year. They are not considered water masses because they only include a very restricted range of temperature (T) and salinity (S), precisely because of the picnostat condition. Therefore, their major characteristic is the homogeneity of properties (T, S, density, O2, potential vorticity, among others).Subtropical mode waters (STMW) are a specific kind of mode water generated in the poleward edge of subtropical gyres, near the boundary currents. Their formation occurs from winter to spring when harsh atmospheric conditions induce a buoyancy decrease of the surface waters by means of latent heat loss from the ocean to the atmosphere. This convective mixing process is a mechanism that increases vertical mixing, by subducting the surface water to just above the permanent thermocline. Notably during the summer, when seasonal thermocline is formed, this homogeneous layer is isolated from the surface. Thereby original characteristics acquired during the formation time such as temperature, salinity, and density of this water volume are conserved for a period of time that can last over several annual cycles. The interaction between the ocean and the atmosphere is crucial for the formation and variability of the volume of mode water. For this reason, the atmospheric teleconnections with remote processes, e.g. El Nino, may modify local patterns and influence the amount of mode water formed during one winter and subsequent ones. Thus, the purpose of this work is to investigate the hypothesis that the interannual variability associated with remote processes such as El Nino, Atlantic Meridional Mode, Antarctic Oscillation, among others, influence the mode water volume present in the South Atlantic. The main objective of the project is to determine a STMW volume time series in the South Atlantic using the Global Ocean Assimilation System (GODAS) model and determine its correlation and lag relative to climateindices. The mean T and S from GODAS from 1980 to 2017 are compared with the World Ocean Atlas 2013 (WOA13) for validation. Seasonal and annual mean fields are examined at the surface, 100m, 300m, and 500m on both data sets. After the validation, the model data are processed for detection of mode water using the following parameters: T between 13^{o}C and and 18^{o}C, S between 35.0 and 36.5, and potential vorticity smaller than 1.5 x 10 m s , and/or a vertical temperature gradient less than 0.02oC m-1. The final stage consists of estimating the correlation coefficient between the mode water volume and the climate indices anomalies. The anomaly is calculated by removing the annual mean cycle from both time series. GODAS validation procedures showed that the model represents well the long-term climatological TS field from WOA13. The largest discrepancies are generally associated with highly dynamic areas, such as regions of large river discharges. Nevertheless, these results were expected because the climatological data usually undergo a heavy smoothing process due to the averaging of temperature and salinity, thus small variations in time hardly appear at these kinds of data. After the detection of the mode water it became possible to determine the volume formed as a function of month. This result allowed us to describe some important characteristics of the STMW in our area of study. The long-term average of volume observed is 2.15 x 10 m^{3}. In general, the annual maximum occurs in the winter, followed by a steep decline of the volume and the minimum in the summer/fall months. During the 1980-1982 and 2000-2003 periods there was a significant decrease in the mode water volume detected compared to the mean of the whole 37-years long time series. The next step of our study is to investigate if the interannual changes observed in the STMW volume are significantly correlated to remote processes mentioned above.

Sediment transport and morphology evolution in a low influx system: the Pirangi Estuary (Brazil)

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The Pirangi River estuary, is a shallow (>5m deep), bar build and low influx system, dominated by a mesotidal regime (~3.2 tidal range), located in the semi-arid state of Ceara, in the Brazilian's Northeast Region. The estuary presents a classical circulation in the four first months of the year during the local wet season. During the dry season, from July to December, the estuary became hypersaliny. The consequent water deficit in the region led to the construction of weirs and dams, which intensified the problems of hypersalination and changed the sediment dynamics within the estuary. The main goal of this paper is to characterize the overall sediment distribution and morphology changes along the Pirangi River estuary, considering climatological conditions. The Delft3D model was used to simulate the circulation during one climatological year and the morphology changes extended to 10 years using a morphological acceleration factor (MORFAC). The model was forced in the open boundaries with the four main tidal components (M2, S2, O1 and K1) for the region. Local winds were also used to force the model and climatological discharge values were add 15 km from the estuary entrance. The salinity at the boundaries were set to 35. The simulation were initialized with a uniform idealized 5 m layer thickness of cohesive and no-cohesive (D50=200) sediments. The tidal sea level results from the model were validated with local tidal harmonics and the no-tidal velocities compared with the literature. Our preliminary results shows that the sediment transport is driven mainly by tidal currents. There is no overall tendency of erosion nor accretion within the estuary. A seasonal variation is present: the estuary bar presents a larger accretion during the wet season while the upper regions of the estuary during the dry season. The morphodynamics of an estuarine system is very complex, and since we utilized some simplifications (ex: uniform distribution of sediments) in the numerical simulations more research is need to better represent the morphological changes of the Pirangi estuary.

The Fate of Man-made Radionuclides in a Semi-Enclosed Basin

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Seawater from the Itaorna Cove is used for cooling the nuclear reactors in the Almirante Alvaro Alberto Nuclear Power Plant, being subsequently discharged back into the sea, at Saco de Piraquara de Fora, in the Southeast coast of Brazil. Consequently, in a hypothetical scenario of nuclear leakage, these polluted waters will be discharged into the system with a great amount o radioactive material originated from the nuclear power plant. This study aims to investigate how wind and tides force the dispersion of the radioactive material in the estuary system of Ilha Grande. We used the hydrodynamic module, from Stevens Estuarine and Coastal Ocean Model (sECOM), followed by its tracer module to analyze the development of the dispersion, observing which cities will be impacted by the nuclear leakage and how long this radioactive material would persist in the bay. We obtained currents higher than 0.6 m s-1 , varying with the wind direction, with the tidal- driven circulation stronger than the wind-driven in the East side of the domain. We observed the dispersion of radioactive material evolving mainly to eastward and northeastward, depending on the wind direction. Numerical experiments have shown that the radioactive plume could reach the following cities: Angra dos Reis, Paraty, Mangaratiba, Marambaia and Mambucada, with maximum values varying from $1.8x10^{6}$Bq m^{-3} to $8x10^{7}$Bq m^{-3}, persisting in the seawater for at least 50 days. We also observed that the dilution of radioactive material is more effective when the plume reaches zones with intensified currents, such as the East of the modeled area.

A study on the attenuation of ocean surface gravity waves in the marginal ice zone

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Wave-ice interaction studies are very important for any model predicting wave characteristics in ice covered seas. When waves enter an ice field there is always some scattering and dissipation of wave energy. Large swells from the open ocean may penetrate into the ice near the ice edge, creating floes a few tens of meters across, creating a zone called marginal ice zone (MIZ). Ocean surface gravity waves can modify and redistribute the sea ice cover in the MIZ. In this study, the state-of-the-art third generation wave model WAM has been used to investigate the attenuation of ocean surface gravity waves in the marginal ice zone. The attenuation is examined with respect to two wave buoys deployed 2 km apart in the Marginal Ice Zone close to 62.8 S, 29.8 E on 4th July, 2017. Our modeling simulation shows that the waves are higher near the location of the buoys in the absence of sea ice. Thus the waves get attenuated by the sea ice and with the help of our model simulation and satellite observations we quantify the rate of attenuation.

Connectivity in the Brazilian Tropical Atlantic Islands

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The understanding of the recruitment and connectivity of marine species that has planktonic stages is a complex task and it needs a multidisciplinary approach. For example, the lobsters are an important fishery resource for the Northeast region of Brazil that has been over exploited for many years. These organisms have a very complex life cycle, with the duration of a pelagic larval stage of one year with up to 11 larval stages and a puerulus stage, in which it acquire the ability to swim and migrate from the ocean to coastal habitats. For showing such a long pelagic larval duration, this larvae can be transported to places far from where the spawn has occurred. Since the adult individuals are benthic and cannot survive to depths higher than 200 m, one of the questions to be answered is the origin of the lobster stocks found in Brazilian archipelagos: Sao Pedro e Sao Paulo Archipelago (ASPSP), Fernando de Noronha Archipelago (FN) and Rocas Atoll (AR). Surface circulation data, between 2002 and 2012, from the reanalysis of the HYCOM/NCODA global model, with resolution of 0.08 degrees, were incorporated to the Individuals Based Model Ichthyop, in order to study the lobster larvae dispersion. The model domain covers the intertropical Atlantic region between the latitudes of 30N and 25S, where the three target islands are located. The simulations were realized in backward mode with the initial release of larvae at the position where the islands are situated. The larvae were released in April and September and the trajectories monitored for 7 months. ASPSP, FN, AR and the Brazilian continental shelf (PCB) present high connectivity, where one region can be used as an ecological trampolines and guarantee the indirect genetic flux within the regions. Spawns in the PCB in February ensure a larger connectivity among the islands. The Ascension Island (IA) and Cape Verde (CV) can also be a source of larvae to the Brazilian islands, although in a much lower grade. In this case, the larger connectivity happens with the larvae released in September for IA and April for CV. Even though the African coast shows highest percentages of connectivity, it cannot be expected as a source of lobster larvae to the Brazilian islands, since there are no equivalent populations in Africa. Nevertheless, we show for the first time that connectivity is present between Brazilian Islands and the African Coast in less than seven months. A large interannual variability in the connectivity between all regions is also present. Our results can be useful to understand the surface advection of materials in the Tropical Atlantic and to connectivity studies of other species with a planktonic life cycle.

Circulation in Flamengo Bay, Ubatuba (SP): winter, 2017

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Coastal regions have a unique importance, not only in economic issues but also in ecological and environmental aspects. To properly accomplish the management of coastal zones, with the necessary scientific and technical bases, studies are necessary to understand and predict the natural processes occurring in those environments. In this context, the main objective of this study is to characterize the circulation and the sea surface oscillations at Flamengo Bay (FB), located in Ubatuba, in the northern coast of Sao Paulo state, using numerical modeling as a tool to simulate the currents and the sea surface oscillations, with special attention to the FB hydrodynamic responses to local and remote forcing. To verify the influence of each forcing, the numerical model ECOM (Estuarine and Coastal Ocean Model) was implemented in the region and two different simulations, including and omitting the influence of remote wind, were created: a first one considering the influence of local wind, sea surface elevation generated by the wind in the Southeast Brazilian Bight (SBB), tides and density gradients (S1); and another considering only local wind, tidal and density gradients forcing (S2). Remote wind influence was included in the open boundary of FB model grid, from the nesting of the FB grid to a coarser-resolution SBB grid. First, theoretical salinity and temperature data were used as initial conditions for the simulations, along with theoretical and homogeneous local wind. These initial experiments have shown that the circulation in FB is mainly forced by local wind, with less influence of the wind acting in the adjacent continental shelf. On the other hand, sea surface elevation appears to be influenced by the processes associated with the remote wind acting in the SBB. The circulation pattern was mostly anticyclonic under the influence of the “good weather local wind” (northeastern). During a cold front passage the surface currents were shifted northward, following the wind direction. In the absence of the local wind forcing, a different pattern of circulation was observed: currents entering at the edges and exiting at the center of the FB entrance. In order to continue this study, new simulations are being created initialized with local salinity and temperature data measured in situ at FB, during 2017’s winter season. Moreover, local wind data provided by the Centre for Weather Forecasts and Climate Studies (CPTEC), for this winter season, is being used as the local wind forcing. These results will be compared with hydrographic and current data measured in situ at FB during the winter of 2017. In such manner, it will be possible to obtain a description and characterization of the circulation, sea surface oscillations and physical properties in FB during the study period.

Salinity variability in the South Atlantic from satellite and model data

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Observations of the temporal and spatial variability of the South Atlantic Ocean are of great scientific interest due to its influence on the regional weather and global climate through the Meridional Overturning Circulation (MOC). These changes directly affect society through variations in the pattern of rain, humidity, heat flux, and wind patterns. Despite this, there are still many gaps in understanding the full implications and impacts of ocean variability. The salinity is one of the least understood, mainly due to the absence of broad and long-term sustainable in situ data in the South Atlantic. Although, this has been changing lately with the surge of satellite missions designed to measure surface salinity, along with the increase of active Argo profilers. Salinity influences the formation of water masses and the sea surface topography, affecting circulation patterns. It also has an important role on the oceanic component of the planet's hydrological cycle because it is affected by some of the atmospheric forcing such as precipitation, evaporation, and consequently, the latent heat flux, as well as continental runoff, ice formation and melting. In this study, sea surface salinity data obtained from two satellite sources (SMOS, Aquarius) are processed and evaluated to quantify spatial and temporal variability in the South Atlantic Ocean. Regions of persistent surface salinity gradients are found in the form of oceanic fronts.The detection of these fronts are done using satellite data, climatological data of the World Ocean Atlas (WOA13) and outputs from the latest release of the "Estimating the Circulation and Climate of the Ocean"(ECCO) consortium, which combines many modern remotely-sensed and in-situ observations with the general circulation model from the Massachusetts Institute of Technology (MITgcm). The objective of this analysis is to investigate the connection between the surface salinity fronts and the physical processes that occur in the interior of the ocean. As a preliminary result, surface salinity fronts were found to be similar between satellite and model data at regions of intense river discharge and along the edges of the subtropical gyre. Gradients were more intense (= 2 g/kg.km ×10-3) and persistent (60% of occurrences in the whole period of study) at the Brazil-Malvinas confluence region, where strong turbulent mixing occurs; along the southern boundary of the gyre, between the South Atlantic current (SAC) and the Malvinas current (MC); and at the Agulhas retroflection system, influenced by the intrusion of salty and warm waters from the Pacific Ocean. Less intense (= 1 g/kg.km ×10-3) and less persistent (20-50%) fronts were located at the upper boundary of the gyre, where geostrophic currents are weaker. These fronts tend to follow the boundary limits between the tropical evaporative region (E-P > 0), and the subtropical precipitative region (E-P < 0). The salinity anomaly time series (total-annual cycle) are estimated from each satellite data source to quantify the interannual variability and trends. These anomalies are then compared with the model anomalies and correlated with the forcing terms of the salinity budget equation, which are calculated separately using ECCO outputs. This will provide an estimate of the dominant processes controlling then intensity and distribution of salinity fronts and salinity variability in the South Atlantic.

On the interaction between the Brazil Current System and Vitoria-Trindade Ridge.

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The Brazil Current System is a vertically heterogeneous composite of layered set of western boundary currents of the South Atlantic Subtropical Gyre. In the Vitoria-Trindade Ridge (VTR), a quasi-zonal seamount chain at 21S, the surface layer, generally called the Brazil Current (BC), follows the continental shelf along eastern and southern Brazil. On the other hand, the intermediate layer, the Intermediate Western Boundary Current (IWBC) opposing the BC direction is set up. To study how the VTR affects Brazil Current System we use the Regional Ocean Modeling System (ROMS) with a bottom topography resolution of 2 km e 6 km. According to the model results, the effects of VTR on the Brazil Current System include a change on the circulation pattern of the BC from a resulting flow from sucessive eddies to a well-definied flow between channels formed by the VTR seamounts. This condition increases the poleward transport and decrease the turbulent process north of the VTR. Another result suggests that VTR presence decrease the equatorial-ward transport of the IWBC as well as turbulent process north of VTR. This work is part of the REMARSUL/CAPES project.

Wave spectrum comparison from a coupled wave/hydrodynamic simulation: preliminary results

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The modeling of waves generated by winds, especially the spectral representation, has presented considerable advances in the last decades, both in parameterizations and it physics as well as in computational technologies. This advance has allowed, nowadays, the improvement and implementation of new parametrizations for linear and non-linear phenomena. Many large-scale processes are essentially coupled to surface waves, including tropical cyclones, storms and other events in the atmosphere, and in the ocean's surface layers (Babanin et al., 2017). One of these phenomena is the wave-current interaction, whose mathematical formulation is quite complex and its effects on the spectral energy of the waves and at the surface layers are not known well when compared with other ocean processes. The waves are strained and refracted by currents, exchanges of mass and momentum occur between the waves and mean flow (Smith, 2006). From this interaction we highlight the Stokes Drift (difference between Lagrangean and Eulerian velocity), Radiation Stress and Langmouir currents, the last one important in the evolution of the mixed layer. In order to investigate the influence of these processes on the wave spectral energy, it was considered using a coupled system where the hydrodynamic and surface wave simulations could interact. In this way, the most recent version of COAWST (Warner et. al., 2010) was chosen, in which the wave spectral model WW3 is coupled with the hydrodynamic model ROMS. The study area chosen was the southeast oceanic region of Brazil, focusing on the Santos and Campos Basins. This choice is due to available buoy data from Brazilian National Buoy Program (PNBOIA), and also because in this region there is an intensification of the Brazil Current meandering and eddies generation, providing conditions, for example, of adverse currents along the waves propagation mainly from south, east and northeast, both swell and/or windsea, which provide a multimodal wave spectrum Three simulations were carried out: the first two standalone (WW3 and ROMS) and the last coupled for the year of 2012. On this preliminary evaluation the models were forced with atmosphere conditions from ERA-interim, boundary conditions from HYCOM and tides from TPXO8. WW3 model has been configured with the default options of ST4. The results showed that coupled simulations reproduced significant wave height (Hs) series around 18% less RMSE and around 15% more SD compared with uncoupled simulations and correlation around 90% for both simulations. In general, the Taylor Diagram analysis showed a better performance of coupled simulations. During periods of higher Hs values, especially for swell cases, coupled simulations represented better the buoy oscillations, but for some specific periods the performance was better for uncoupled simulations. During these specific periods, wave peak direction presented fast and large changes, and the differences between the wave energy spectrum for coupled and uncoupled simulations showed greater variations. It was also noticed during these specific periods that the coupled source terms like nonlinear interaction (Snl) and wave break (Sds) showed a slight increase whereas the wind input term (Sin) a reduction. It is necessary to perform longer periods of simulations, and analyze other source of data to cover a greater range of wave propagating and currents situations. Also, it is suggested to analyze the wave energy spectrum partitioned in individual wave systems. Visually it is possible to identify more than one wave system, both in the model and in the buoy data, and it could make difference to better understand the distribution and lost of wave energy due to the presence of currents. From these preliminary results the conclusion is the tendency to carry out coupled simulations in future studies and purposes.

Brazil Current behavior at 22°S controlled by surface forcing: A modeling approach

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In the last years, the influence of atmospheric fluxes over ocean upper levels state have been a very relevant oceanographic field, particularly modeling and forecasting the interactions between these two components. In this way, the present study focus on hydrodynamic modeling of Brazilian east/southeast continental shelf (15S-30S; 30W-51W) by using the Regional Ocean Modeling System (ROMS) and aimed to verify the effects of momentum exchange from different atmospheric forcings over the Brazil Current (BC) volume transport. First, the surface wind kinetic energy from Climate Forecast System Reanalysis (CFSR) and ERA-Interim reanalysis were analyzed from 1979 to 2010. From December 1981 to May 1983, was observed the maximum energy difference and it was defined as the modeling time interval. Two experiments were conducted using a climatology computed from Mercator Global Ocean Analysis (1/12 degree) as boundary and initial conditions and ETOPO1 as the source of bathymetry, only changing the atmospheric reanalysis as surface forcing. Thereby, it was noticed that CFSR was spatially and temporally more energetic than ERA-Interim what reflected on BC volume transport at 22S. In this study, BC was defined as the southward flow, limited by the isobaths of 50 m (40.46W) and 2000 m (39.54W) and vertically from surface to the bottom of the South Atlantic Central Water. In the experiment forced by CFSR, daily average volume transport of BC was 15% more intense than when forced by ERA-Interim (-6.0 Sv and -5.2 Sv). Despite this, both flows satisfactorily represented BC transport at this latitude according literature. However, when analyzing the influence of offshore limit over BC volume transport, it was verified that the observed difference, at first associated with the atmospheric forcing kinetic energy, was indeed linked to the change on the BC position between experiments. Shifting the offshore limit of analyzed section to 39.29°W, the BC volume transport in the CFSR experiment was only 8% more intense than in ERA-Interim experiment and moving to 39W no differences were found in the average values. Thus, it was evident that different sources of atmospheric forcing, even with similar characteristics, can affect the oceanographic features not only considering their energetic content but also their distribution pattern.

Simulating the annual cycle of the La Plata River plume over the Western South Atlantic shelves

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Every year, a massive amount of brackish water makes its way to the Brazilian southern and southeastern shelves hence enriching the coastal waters with nutrients and biomass, which are essential to improve the fisheries production of the region. Originated from the run-off of the La Plata River, this brackish water known as the La Plata River plume is a result of the turbulent mixture with adjacent saltier shelf waters. Forced then by the prevailing winds, which present strong annual variation, this water reaches its northernmost position (23S) during the winter, returning to the region in front of La Plata estuary (36S) during the summer, in a remarkable excursion of over a thousand kilometers. The aim of the present work is to simulate such excursion, reproducing the horizontal and vertical density stratifications that allow this process to occur and also the extreme positioning of the plume during winter and summertime. The numerical modeling framework produced is expected to be useful during the future development of a coastal monitoring system. In order to accomplish this task, a modified version of the Princeton Ocean Model (POM) was utilized using heat flux, wind and mass fields as obtained from the NCEP Reanalysis (R1). Among the major drawbacks of this model are the truncation error on the baroclinic pressure gradient (BPG) calculations and the magnified along-sigma diffusion due to the vertical discretization. To overcome these two problems, the model subtracts the area averaged climatological density field from the variable density field and also makes use of a relaxation to the temperature and salinity climatology. However, due to the under-representation of the river plume on the climatology and the strong density gradients that naturally occur in this particular case, these solutions are not enough to avoid large errors. Therefore, this work proposes the use of a sixth-order BPG calculations and a variable horizontal mixing coefficient as a possible alternative solution. The numerical experiments were set using neither relaxation to climatology nor density reduction, which then allowed the simulated plume to freely evolve. It was possible to demonstrate the applicability of both proposed changes by noticing the better representation of the plume dynamics when compared to the climatology used. While the climatology barely shows the plume, the simulated plume promptly enlarges, then advances over Brazilian waters and finally retracts as actually observed in the field. Vertical profiles also show the strong annual variation observed on the density stratifications. Animations made from these results are available at the project's website (www.renatocecilio.org).

The application of the dynamical downscaling to investigate the Southwestern Atlantic Ocean under the future climate scenarios

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Atmosphere-Ocean Coupled General Circulation Models (AOGCMs) are currently important tools for studying the impact of greenhouse gas emissions on the climate system. However, such models are characterized by low horizontal resolution (e.g., 1 degree, 1/4 degree), and the subgrid-scale physical processes are represented by parameterization. The technique so-called "dynamical downscaling" is used to improve the representation of these physical processes by reducing the associated uncertainties with the model low resolution. In this work, dynamical downscaling experiments were performed using the oceanic components from three AOGCMs: CCSM4, HadGEM2-ES and BESM. We used the Regional Ocean Modeling System (ROMS), with a horizontal resolution of 1/12 degrees in a numeric domain that encompasses the Southwestern Atlantic (SWA) Ocean (5–55S; 30–73W). Different experiments considered the historical period (1988-2005) and the future scenarios RCP4.5 and RCP8.5 (2083-2099) of CMIP5. Preliminary results indicated that the downscaling provides a better representation of the mesoscale oceanic processes in the study area, mainly in the regions of high dynamics. The mean RMSD of the sea surface temperature (SST) from the historical CCSM4 results and their dynamical downscaling with respect to the Optimum Interpolated SST are respectively 3.83 C and 2.44 C in the Brazil-Malvinas Confluence region. In subsurface waters, comparisons in relation to the World Ocean Atlas (WOA13) climatology exhibit smaller temperature and salinity errors whenever the downscaling is applied. The dynamical downscaling has provided a better ocean representation such that new steps aim to investigate more accurately how the Brazil Current responds to climate change scenarios.

Biological Modeling to study marine organisms behavior in climate change scenarios

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Marine Protected Areas (MPA) have the purpose ensure the conservation of biodiversity patterns, biological connectivity and mitigate regime shifts due to climate change. Projections of future climate change scenarios point to alterations in ocean circulation and sea surface temperature, affecting the life cycle of marine organisms. These changes directly affect the reproduction and dispersal capacity of marine organisms, including changes in egg and larvae survival conditions, as well as in the trajectory imposed by the surface circulation. Thus, future projections from global coupled numerical modeling solutions will be used to model the biological connectivity and acclimation patterns of the reef fishes into Brazilian oceanic islands and the continental shelf. For this study it will be used the global model HadGEM2-ES ensemble r2i1p1, historical, RCP 4.5 and RCP 8.5. The oceanic downscaling of these scenarios was made using the Regional Oceanic Model System (ROMS) with grid horizontal resolution of 1/12 degree, and the Ichthyop for the individual-based (IBM) biological modeling. Preliminary results of historical downscaling indicated that it provided a better representation of the mesoscale ocean processes in the study area. This result will be used to evaluate egg release and larvae recruitment sites reef fishes of genus *Sparisoma* (*Scaridae*) like a target scenario in the IBM simulation, and subsequently will be made the analysis of the differences between historical simulations and future projections.

Conceptual model proposal for the continent-ocean interface of the semi-arid region of Brazil: Effects of territorial development and modernization

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The continent ocean interface concentrates a range of modern industrial productive activities (agriculture, livestock, energy production). Scientific studies show that these activities alter the transfer of materials between the continent and ocean (concentrations) of materials between these compartments. In semi-arid regions such as the state of Ceara, located in northeastern Brazil, this problem is aggravated by the environmental characteristics of the semi-arid regions (intermittent rivers, high evaporation, several months without rainfall), where marine primary productivity is limited by the continental water supply that in turn is altered in concentrations of elements such as Nitrogen and Phosphorus due to the development of agriculture and other productive activities in the coastal zone or along the hydrographic basin of the main rivers. Another intervention on the continent's ocean interface is the construction of dams, responsible for regulating the water flow and retaining part of the materials that would once reach the oceans. From this it is possible that there is a change in the growth of the biological communities from the alteration in the abundance of individuals of each trophic level. With the use and development of numerical models of the marine ecosystem, it is possible to know the capacity of support of the environment. Thus, we aim to develop a conceptual model for the analysis of ecosystems and the growth / transformation of the coastal / marine biological community of the northern coast of the Brazilian Northeast, especially the coast of the State of Ceara. As main focus we have the objective of elaborating a conceptual model that encompasses elements of the modern social processes in their parameterization and thus verify which parameters are necessary to model the current biogeochemical cycles. For this we start from the bibliographical review of researches that sought to verify which are the main alterations between the transport of materials between ocean continent. For parameterization of the model, we search for data available from observations in situ. The software SEADAS was used to analyze the primary productivity in the study region. Models (ROMS) used during the course marine ecossystem modeling, will be the basis for building the growth of trophic chains and relationships between predator and prey. With the Matlab software, the graphics and figures were elaborated. Efforts to create models that can verify the situation and predict future scenarios is fundamental within the analysis of the effects of the current periods of formation and modernization of the territory. It is expected to observe changes in the trophic webs from the transport changes in the continent ocean interface and their effects on the primary productivity and development of the biological community and to elaborate indices capable of verifying the support capacity of coastal / marine ecosystems and the continent ocean interface tropical semi-arid zone of Brazil.

Tides and freshwater in the Florianopolis coastal region from very high resolution numerical modelling

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A very high resolution numerical configuration of model ROMS was created to study the oceanographic conditions of the shelf region around Florianopolis (South Brazil). The model run 3 years (2013-2015) forces with tides and with realistic river discharge, atmospheric and lateral boundary conditions. The configuration included three nested domains with increasing resolution, from about 4km to less than 150m, in order to resolve the details of circulation around the Florianopolis island. In order to evaluate the riverine influence in the region, the largest domain extends from the the Brazilian southern border to Ilhabela, thus including all the main fresh water sources from Patos Lagoon to the Sao Paulo coastal region. This study is divided in three parts: the first part provides a detailed description of the model configuration; the second one describes the tides in terms of amplitudes, phases and current ellipses of the main tidal constituents; the third part analyses the seasonal variability of the freshwater associated with all the rivers included in the configuration. For this last purposes, Lagrangian and Eulerian techniques were used to access the presence and extent of freshwater and to evaluate the northward extension of the plume of Rio de la Plata. The results show the localized influence of the smaller rivers, due to the coastline geometry, a wider spatial influence of the large river Itajai;, and the generally negligible presence of river plumes from the southermost rivers, namely the difficulty of the River de la Plata to reach Florianopolis.

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