THE 3RD INTERNATIONAL WORKSHOP ON MODELING THE OCEAN (IWMO-2011)

June 6-9, 2011, Qingdao, P. R. China

Programme & Abstracts Book

Sponsored by:

International Cooperation Department,
State Oceanic Administration (SOA), China
http://www.soa.gov.cn

The First Institute of Oceanography (FIO), SOA, China
http://www.fio.org.cn

Hosted by:

The Key Laboratory of Marine Sciences and Numerical Modeling (MASNUM), FIO, SOA

IWMO2011 page: http://www.fio.org.cn/iwmo2011/iwmo2011.htm

Scientific Committee

Prof. Lie-Yauw Oey (Coordinator, Princeton University, USA)

Prof. Bo Qiu (University of Hawaii, USA)

Prof. Chau-Ron Wu (National Taiwan Normal University)

Prof. Fangli Qiao (First Institute of Oceanography, China)

Prof. Huijie Xue (University of Maine, USA)

Prof. Jianping Gan (Hong Kong Uni. of Science & Technology, HK)

Prof. Lian Xie (North Carolina State University, USA)

Prof. Tal Ezer (Old Dominion University, USA)

Prof. Xiaohua Wang (University of New South Wales, Australia)

Prof. Y. Miyazawa (JAMSTEC, Japan)

Local Committee

Chair: Prof. Fangli Qiao

Members:

Dr. Changshui Xia
Dr. Liangang Lv
Mr. Zhixiao Jiang
Ms. Xiaoyan Lei
Dr. Xunqiang Yin
Dr. Guansuo Wang

Organizer

Key Lab of Marine Science and Numerical Modeling (MASNUM)

First Institute of Oceanography

State Oceanic Administration

P. R. China

3rd International Workshop on Modeling the Ocean (IWMO-2011)

June 6-9, 2011, Qingdao, China

Program and Abstracts

Programme..... p.1-13

Schedule Overlook.....p.1

Session List.....p.2

Day 1 Monday June 6th…….. …… ……..p.3-5

Day 2 Tuesday June 7th……p.5-7

Day 3 Wednesday June 8th……...p.7-9

Day 4 Thursday June 9th…….p.9-10

Poster Session…….p.10-11

Abstracts…….. .p.12-106

Session 1 Vertical mixing and model applications……..p.12-19

Session 2: Ocean circulation variability & their influences on climate…….p.20-31

Session 3: **Bottom boundary layer and sediment dynamics of muddy coasts and estuaries**…….p.32-36

Session 4: Estuary, Coastal Ocean and Shelf Sea Modeling……p.37-50

Session 5: Regional Ocean model downscaling, fronts and eddies……p.51-58

Session 6: Air, sea, wave, and biogeochemical Interactions between Tropical Cyclones and Ocean.p.59-63

Session 7: Ocean predictions and model developments……...p.64-70

Session 8: Coupled physical-biogeochemical models…….. p.71-75

OYSA (Outstanding Young Scientists Award) session 1……...p.76-87

OYSA (Outstanding Young Scientists Award) session 2……..p.88-96

Poster Session……...p.97-110

Maps and other Information.....p.111

Schedule Overlook

Time		Events
June 5th (Sunday)	15:00-18:00	Registration
June 6th (Monday)	07:30-08:30	Registration
	08:30-09:30	Opening and Invited Talk – Prof. Huang
	09:30-09:50	Coffee Break and Group photo
	09:50-12:10	Session 1
	12:10-13:30	Lunch time
	13:30-17:10	OYSA 1
	18:00-20:00	Reception banquet hosted by the local organizer
June 7th (Tuesday)	08:20-09:40	Session 2
	09:40-10:00	Coffee Break
	10:00-12:00	Session 2
	12:00-13:30	Lunch time
	13:30-15:50	OYSA 2
	15:50-16:10	Coffee Break
	16:10-17:30	Session 3
June 8th (Wednesday)	08:20-10:10	Session 4 & Invited Talk – Prof. Isobe
	10:10-10:30	Coffee Break
	10:30-12:10	Session 4
	12:10-13:30	Lunch time
	13:30-15:30	Session 5
	15:30-15:50	Coffee Break
	15:50-17:30	Session 6
June 9th (Thursday)	08:20-11:00	Session 7, Session 8
	11:10-11:20	Coffee Break
	11:20-12:20	Open discussion
Mon-Thur	Poster Session	

Session List

Session 1: Vertical mixing and model applications Chair: Prof. Fangli Qiao

Session 2: Ocean circulation variability & their influences on climate: Observations and modeling Chair: Prof. Bo Qiu

Session 3: Bottom boundary layer and sediment dynamics of muddy coasts and estuaries Chair: Prof. Xiao-Hua Wang

Session 4: Estuary, Coastal Ocean and Shelf Sea Modeling Chair: Prof. L.-Y. Oey

Session 5: Regional Ocean model downscaling for multi-scale interactions and data-assimilative studies, fronts and eddies Chair: Prof. Yasumasa Miyazawa

Session 6: Air, sea, wave, and biogeochemical Interactions between Tropical Cyclones and Ocean Chair: Prof. Chau-Ron Wu

Session 7: Ocean predictions and model developments Chair: Prof. Tal Ezer

Session 8: Coupled physical-biogeochemical models Chair: Prof. Huijie Xue

OYSA (Outstanding Young Scientists Award) Session 1 Chair: Prof. L.-Y. Oey

OYSA Session 2 Chair: Prof. Tal Ezer

Poster Session

Note: There was originally a total 10 suggested sessions on the IWMO website; some sessions were later combined

Agenda of the 3rd International Workshop on Modeling the Ocean (IWMO-2011)

Jun 6-9, 2011, Qingdao, CHINA

Venue: 7th floor, Sophia Hotel
Registration: 15:00-18:00 of June 5 in the lobby of Sophia Hotel
07:30-08:30 of June 6 in the meeting room of 7th floor, Sophia Hotel

Monday June 6th

Opening ceremony and Invited Talk
Session Chair: Prof. Fangli Qiao

08:20-08:30 Welcome and Congratulation Remarks by **Prof. Zhanhai Zhang**, Director General, International Cooperation Department, SOA, China

08:30-08:40 Introduction of IWMO and OYSA **by Prof. L. Oey**

08:40-08:50 Welcome and practical information by **Prof. Fangli Qiao**

08:50-09:20 ***Norden Huang***, A Plea to the Ocean Modeling Community (Invited Lecture)

09:20-9:50 Coffee Break and Group Photo outside the entrance of the Sophia hotel

Session 1: Vertical mixing and model applications
Session Chair: Prof. Fangli Qiao

09:50-10:10 *Shuwen Zhang,* ***Lingling Xie****, Ruixue Cao, Fengqin Zhu*, Upper ocean mixing by the Kuroshio flow in the region west of the Luzon Strait in spring

10:10-10:30 ***Hidenori Aiki****, John P. Matthews, and Kevin G. Lamb*, Modeling and energetics of tidally generated wave trains in the Lombok Strait: Impact of the Indonesian Throughflow

10:30-10:50 ***Hitoshi Tamura****, Yasumasa Miyazawa, Lie-Yauw Oey*, A numerical study of the stokes drift and its penetration depth

10:50-11:10 ***Dejun Dai***, *Fangli Qiao, Hongyu Ma*, The vertical distribution of turbulent dissipation in the Yellow Sea

11:10-11:30 ***I-I Lin,*** Ocean's impact on the intensity of three recent Typhoons (Fanapi, Malakas, and Megi) – Results from the ITOP field experiment

11:30-11:50 ***Chuanjiang Huang****, Dejun Dai, Fangli Qiao, Hongyu Ma*, The observed and simulated vertical distribution of turbulent dissipation in the South China Sea

11:50-12:10 ***Fangli Qiao***, *Changshui Xia and Dejun Dai*, The applications of the non-breaking surface wave-induced vertical mixing in different ocean circulation models

12:10-13:30 Lunch time

OYSA session 1
Session Chair: Prof. L.-Y. Oey

13:30-13:50 ***Zhiyu Liu*** *and S.A. Thorpe,* Instability and Mixing in Shelf Seas

13:50-14:10 ***Zhenhua Lin*** *and Jinbao Song*, Numerical studies of internal waves degeneration initiated by a tilted thermocline

14:10-14:30 ***Hongyu Ma****, Chuanjiang Huang, Dejun Dai, Fangli Qiao,* The simulation of the observed temperature profiles in the Bashan Reservoir with different mixing schemes

14:30-14:50 ***Yajuan Song****, Fangli Qiao and Zhenya Song,* Improvement of the South Asian summer monsoon in climate model by using non-breaking wave-induced mixing

14:50-15:10 ***Wei Wei,*** *Gerrit Lohmann and Mihai Dima*, Distinct modes of internal variability in the Global Meridional Overturning Circulation associated to the Southern Hemisphere westerly winds

15:10-15:30 Coffee break

15:30-15:50 ***Xuezhu Wang****, Peiliang Li and Bo Yang,* The South China Sea Intermediate Water (SCSIW) and its exchange with Northwest Pacific

15:50-16:10 ***Dehai Song****, Xiao Hua Wang,* The study of estuarine turbidity maximum in Yangtze River Estuary

16:10-16:30 ***Olivier Gourgue****, Anouk de Brauwere, Benjamin de Brye, Eric Deleersnijder, Vincent Legat,* A depth-averaged fine sediment transport model for environmental studies in the Scheldt Estuary (Northwestern Europe)

16:30-16:50 ***Qi Shu***, *Fangli Qiao and Zhenya Song*, Inertial oscillations in floe motion near the North Pole - observations and simulation

16:50-17:10 ***Tsubasa Kodaira***, *Takuji Waseda*, Numerical analysis on the wake instability and vortex street in the geostrophic flow

17:10-17:30 ***Likui Zhang***, *Jianzheng Wu, Yonggen Sun*, Numerical Simulation of Sediment Transport in Construction of Offshore Artificial Islands in the East of Laizhou Bay

18:00-20:00 Reception hosted by the local organizer

Tuesday June 7th

Session 2: Ocean Circulation Variability & their Influences on Climate: Observations and Modeling
Session Chair: Prof. Bo Qiu

08:20-08:40 ***Bo Qiu*** *and Shuiming Chen*, Multi-Decadal Sea Level and Gyre Circulation Variability in the Western Tropical Pacific Ocean Circulation

08:40-09:00 ***Y.-L. Chang*** *and L.-Y. Oey***,** Interannual and Seasonal Variations of Kuroshio Transport East of Taiwan inferred from 29 Years of Tide-Gauge Data.

09:00-09:20 ***Yinghui He***, *Shuqun Cai, Jianling He*, A model study of the correlation of the circulation between the Western Pacific and the northern South China Sea

09:20-09:40 ***Yu-hong Zhang***, *Yan Du, Hai-ming Xu*, Seasonal variability of the west-east water mass exchange on the section of central equatorial Indian Ocean and its regional difference

09:40-10:00 ***Qingye Wang*** *and Dunxin Hu*, Seasonal variation of the Luzon undercurrent

10:00-10:20 Coffee Break

10:20-10:40 ***Li-Chiao Wang***, *Chau-Ron Wu, Lie-Yauw Oey*, Modulation on the equatorial currents by the two types of El Niño events

10:40-11:00 Bo Qiu, ***Shuiming Chen***, and Peter Hacker**,** The Kuroshio Extension

Northern Recirculation Gyre:Profiling Float Observation and Numerical Modelling

11:00-11:20 *Yi-Chia Hsin and* ***Chau-Ron Wu****,* What causes the seasonal variation of the upper-ocean Luzon Strait transport?

11:20-11:40 ***Y.-L. Chang*** *and L.-Y. Oey,* The Philippines-Taiwan Oscillation

11:40-12:00 ***Rita Tisiana Dwi Kuswardani*** *and Fangli Qiao,* The relationship between the Upwelling and the Pelagic Fish Resource in Indonesia

12:00-13:30 *Lunch time*

OYSA session 2
Session Chair: Prof. Tal Ezer

13:30-13:50 ***Rui Li*** *and Changlong Guan*, Numerical study of wave and current dynamics over barred beaches with rip channels

13:50-14:10 ***Juanjuan Wang*** and *Jinbao Song*, Intercomparison of wind stress parameterization schemes in different state of sea surface wave

14:10-14:30 ***Li Li****, Xiao Hua Wang, David Williams, Harvinder Sidhu,* Three dimensional hydrodynamics in Darwin Harbour, Northern Territory

14:30-14:50 ***Ryota Wada***, *Takuji Waseda and Hirotada Nanjo*, The coastal model for the Tsugaru Strait coupling tide and Tsugaru Warm Current

14:50-15:10 ***Bruno Seny****, Jonathan Lambrechts, Vincent Legat and Jean-François Remacle,* An efficient parallel multirate model of the Great Barrier Reef

15:10-15:30 ***Ying Bao*** *and Fangli Qiao*, Oceanic CO_2 sink and pH changes over historical time and twenty-first century

15:30-15:50 ***Yuntao Wang,*** *Shitao Wang, Shibin Ge and Zhongwei Huang* Sea Surface temperature feature and front divided water mass feature of Enteromorpha Prolifera blooms in the Yellow Sea

15:50-16:10 Coffee break

Session 3: Bottom boundary layer and sediment dynamics of muddy coasts and estuaries
Session Chair: Prof. Xiao-Hua Wang

16:10-16:30 ***Xiao Hua Wang***, Dynamics of Chinese Muddy Coasts and Estuaries

16:30-16:50 ***Jun Ono*** *and Xinyu Guo*, Modeling on the dynamics of suspended particulate matter in the East China Sea

16:50-17:10 ***Antonio Guarnieri*** *A. Souz and N. Pinardi,* Numerical modelling of sediment transport in the Adriatic sea

17:10-17:30 ***Wang Zhili*** and *Geng Yanfen*, Three-dimensional sediment transport model for the Pearl River Estuary

Wednesday June 8th

Session 4: Estuary, Coastal Ocean and Shelf Sea Modeling
Session Chair: Prof. L.-Y. Oey

08:20-08:50 ***Atsuhiko Isobe***, Ensemble numerical forecast of Kuroshio water intrusion into the shelf and coastal waters south of Japan (Invited Lecture)

08:50-09:10 *Li-Feng Lu and* ***John Z. Shi****,* Tidal effects on seasonal, spring/neap tidal and intratidal variability of the dispersion, mixing, stratification, and circulation within the plume of the partially-mixed Changjiang River estuary, China

09:10-09:30 ***Tal Ezer,*** *Will Heyman and Chris Houser,* High-resolution simulations of flow-topography interactions near coral reefs and potential implications for Caribbean fish spawning aggregations

09:30-09:50 ***Jiuxing Xing*** *and Alan M. Davies,* Modelling the tidal front and associated cold-water dome in the Irish Sea using an unstructured-grid, finite-volume model

09:50-10:10 ***Min Bao*** *and Huijie Xue*, Evaluating tidal power and impacts of power extraction in Cobscook and Passamaquoddy Bays

10:10-10:30 coffee break

Session 4: Estuary, Coastal Ocean and Shelf Sea Modeling (Continued)
Session Chair: Prof. L.-Y. Oey

10:30-10:50 ***Antoni Jordi***, *Gotzon Basterretxea and Dong-Ping Wang*, Local versus remote wind effects on the coastal circulation of a microtidal bay in the Mediterranean Sea

10:50-11:10 ***Li-Feng Lu***, *Shinichiro Kida, Keiko Takahashi,* Simulation of the sea

surface temperature in Tokyo Bay using a non-hydrostatic model

11:10-11:30 *Yanfen Geng*, ***Zhili Wang***, 1D and 2D full coupling model for tidal flow in river networks and estuaries

11:30-11:50 ***Dong-Young Lee***, *Jong-Joo Yoon, Sangik Kim, Sang-Kwon Hyun*,Coastal transformation of tides at the Yellow Sea and East China Sea

12:00-13:30 *Lunch time*

Session 5: Regional Ocean model downscaling for multi-scale interactions and data-assimilative studies, fronts and eddies
Session Chair: Prof. Yasumasa Miyazawa and Prof. Chau-Ron Wu

13:30-13:50 ***Ruoying He*** *and Ke Chen*, Data Assimilative Modeling Study on Shelf-slope Exchange Processes Induced by a Large Warm Core Eddy

13:50-14:10 ***Yasumasa Miyazawa***, *Toru Miyama, Sergey M. Varlamov, Xinyu Guo and Takuji Waseda*,The Kuroshio variation south of Japan detected by the Ensemble Kalma Filter

14:10-14:30 ***Yanyou Guo*** , *Jie Yang and Yijun Hou*, A Background error model derived from Wavewatch III considering wave direction in ocean wave data assimilation

14:30-14:50 ***Sergey Varlamov*** *and Yasumasa Miyazaw*a, Some aspects of tide simulation in regional ocean models

14:50-15:10 ***Donghui Jiang*** *and Xiao Hua Wang*, A shelf ocean circulation model for East Australian Currents (EAC): Nesting to Bluelink and downscaling techniques

15:10-15:30 ***Taerim Kim*** *and Jong-Jib Park*, Validation of bottom features on SAR images using a numerical circulation model

15:30-15:50 ***Xunqiang Yin***, Fangli Qiao, Yongzeng Yang, Yeli Yuan Sensitive experiments on horizontal mixing and statistical analysis of eddy fluxes

15:50-16:10 *Coffee Break*

Session 6: Air, sea, wave, and biogeochemical Interactions between Tropical Cyclones and Ocean
Session Chair: Prof. Chau-Ron Wu

16:10-16:30 ***Ki-Cheon Jun***, *Dong-Young Lee, Jeong-Woon Choi*,Analysis of

turbulent flux measurement at coastal waters of eastern Yellow Sea and discussion on the surface boundary condition of regional ocean prediction model

16:30-16:50 ***Zhizhong Yang***, *Youping Xu*, Atmosphere, ocean and wave simulation during Typhoon using a mesoscale coupled ocean-atmosphere system

16:50-17:10 ***Shuwen Zhang***, Hong Cui, Upper ocean's responses to tropical cyclone

Thursday June 9th

Session 7: Ocean predictions and model developments
Session Chair: Prof. Tal Ezer

08:20-08:40 ***Jarle Berntsen***, A perfectly balanced method for estimating the internal pressure gradients in sigma-coordinate ocean models

08:40-09:00 ***Bert Viikmäe***, *Tarmo Soomere and Nicole Delpeche-Ellmann,* Optimizing fairways for environmental management in the Baltic Sea

09:00-09:20 ***Wenjing Zhang***，*Shouxian Zhud*，*Lixian Dong*，*Changkuan Zhang,* A new hybrid vertical coordinate ocean model and its application in the simulation of the Changjiang diluted water

09:20-09:40 ***Guansuo Wang***, *Fangli Qiao, Changshui Xia and Yongzeng Yang,* The wave-induced mixing scheme and its application in Operational Marine Environment Forecast System in the Seas off China

Session 8: Coupled Physical-Biogeochemical Models
Session Chair: Prof. Huijie Xue

09:40-10:00 ***Huijie Xue***, A 3-Dimensional physical-biogeochemical model study of seasonal and interannual variability of phytoplankton biomass in the Gulf of Maine

10:00-10:20 ***Fei Chai***, *Peng Xiu, Huijie Xue, Lei Shi,* Modeling impacts of mesoscale eddies on biogeochemical processes in the South China Sea and Gulf of Alaska

10:20-10:40 ***Yoshikazu Sasai,*** *and Hideharu Sasaki,* Seasonal and interannual ecosystem variability in the South East Asian region: Results of an eddy-resolving physical-biological ocean model

10:40-11:00 ***Yashvant Das***, *UC Mohanty,* Simulation of the impact of tropical cyclone

on some aspects of the ocean thermal structure of Bay of Bengal (Indian Ocean) using POM

11:00-11:20 Coffee Break

11:20-12:20 Open Discussion:

1. Location of IWMO-2012
2. Publication of special issue
3. OYSA Award Ceremony
4. Other topics

Poster session
Monday-Thursday, author should appear during the coffee break times
The maximum size of the poster is 120cm (width)*80cm (height)

Endro Soeyanto, *Xinyu Guo, Jun Ono and Yasumasa Miyazawa*, Decadal variability in the sea level and Kuroshio transport in the East China Sea detected by a data assimilation ocean model

Jiechen Zhao, *Zhengya song and Fangli Qiao,* Simulation on the three-dimensional diffusion and climate effect of Pinatubo volcanic aerosols

Chai Heng Lim, *Karsten Lettmann and Jörg-Olaf Wolff*, Modelling Tidal Dynamics and Flow Patterns over Complex Bottom Topography in Potter Cove, Antarctica, using Unstructured Grid Finite Volume Coastal Ocean Model

Jicai Zhang, *Xianqing Lu, Yaping Wang, Ping Wang, Jianhua Gao,* The influence of various bottom friction parameterizations on the vertical structure of tidal currents by using POM and adjoint assimilation method

Chen Haoliang, *Song Guiting, Koh Tieh Yong, Paola Malanotte-Rizzoli,* Impact of atmospheric mesoscale convection on waters of Malacca Strait

Jingsong Gao, *Huijie Xue, and Maochong Shi, Modeling the circulation in the Gulf of Tokin and northwestern South China Sea*

Shuang Gao, *Christoph Voelker, Dieter Wolf-Gladrow,* Modeling of stable silicon isotopic distributions in the ocean and in marine sediments

Bingchen Liang, *Dong-Young Lee, Jong-Joo* Yoon Analysis of vertical flow profiles observed from different conditions and discussion on the effects of wind waves on vertical mixing

Feng Shan, *Fangli Qiao*, Simulation of the winter circulation in the Southern South China Sea

Changshui Xia, *Xingang Lv and Fangli Qiao,* Simulation of the tide and tidal current in the Qinzhou Bay

Yihang Wang, *Zenxun Wei, Yonggang Wang and Guohong Fang,* Simulation of the tide in the Southern Ocean and the Arctic Ocean

Chang Zhao, *Fangli Qiao, Guansuo Wang and Changshui Xia* ,The role of different time-scaled Bv in an ocean circulation model

H.-F. Lu, *L.-Y. Oey & C.-R. Wu*, Instability of the Subtropical Counter Current and the Generation of Eddies

Abstracts

Session 1: Vertical mixing and model applications

Chair: Prof. Fangli Qiao

Upper ocean mixing by the Kuroshio flow in the region west of the Luzon Strait in spring

Shuwen Zhang, Lingling Xie*, Ruixue Cao, Fengqin Zhu

Key Laboratory of Climate, Resources, and Environment in Continental Shelf Sea and Deep Sea, College of Ocean and Meteorology, Guangdong Ocean University, Zhanjiang, 524088, China

Email: llingxie@gmail.com

West of the Luzon Strait is a hot spot where water and energy exchange are strongly influenced by the westward intrusion of Kuroshio flow. Shipboard observations carried out during spring 2010 quantify the upper ocean mixing in the region west of the Luzon Strait. The observations indicate strong turbulent mixing occurs in the upper 300 m near the Luzon Strait. Turbulent kinetic energy dissipation rates vary by four orders of magnitude, from the noise level to about O(10-6 W kg-1), and turbulent eddy diffusivity reaches O(10-2 m2 s-1). This enhanced mixing is primarily associated with the shear unstable mechanism of the Kuroshio westward intrusion. It is revealed by in-situ observation that unstable current such as the Kuroshio west wing could induce strong mixing as large magnitude as that induced by internal tides and wind forcing. The dependency further shows the dissipation rates increase with increasing shear but decrease with increasing stratification in the observation region.

Modeling and energetics of tidally generated wave trains in the Lombok Strait: Impact of the Indonesian Throughflow

Hidenori Aiki*, John P. Matthews, and Kevin G. Lamb
Japan Agency for Marine-Earth Science and Technology, Yokohama, 236-0001 Japan
email: aiki@jamstec.go.jp

This study investigates the possible impact of the Indonesian Throughflow (ITF) on tidally generated internal waves in Lombok Strait and examines the energetics of these disturbances. Using a two‐dimensional nonhydrostatic numerical model which takes into account the variable width of the strait region, two main experiments have been performed, one without and one with an idealized ITF component in the upper layer flowing southward toward the Indian Ocean. These correspond to conditions in boreal winter and summer, respectively. Both experiments show trains of internal solitary‐like gravity waves (ISWs). Overall, ISWs are more numerous on the north side of the sill where the narrower channel in effect amplifies the disturbances. In both experiments about 3.9 GW of energy is injected into barotropic and baroclinic tidal currents, of which about 2.6 GW is radiated away by internal gravity waves. The ITF regulates the way that the radiated energy is partitioned between the two sides of the sill. Without the ITF (boreal winter), the northward radiated energy flux is greater in magnitude than that radiated to the south. However, when the ITF is present (boreal summer), the northward radiated energy flux is smaller in magnitude than that radiated to the south. This result is obtained by diagnosing the flux of the Montgomery potential which can take into account the effect of finite amplitude waves and also offers a simple and robust energy diagnosis in the presence of time mean flows.

A numerical study of the stokes drift and its penetration depth

Hitoshi Tamura1, Yasumasa Miyazawa1, Lie-Yauw Oey2

1. Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokohama, Kanagawa, Japan

2. The Program in Atmospheric and Oceanic Sciences, Princeton University, Princeton, NJ, USA

Ocean surface waves play important roles for the exchange of momentum and kinetic energy across the air-sea interface and associated upper ocean processes. The stokes drift is one of the manifestation of ocean surface waves, which can have impacts on mass and momentum transport near the surface, and the vertical mixing due to the stokes production of turbulence kinetic energy. A key point is how to estimate the stokes drift in the realistic wave conditions for practical applications. With recent advances of the third generation wave models, it can accurately reproduce wave spectra and directly estimate the stokes drift for random directional waves. The purpose of this study is to investigate the stokes drift in the realistic wave fields.

The vertical distribution of turbulence kinetic energy dissipation in the Yellow Sea

Dejun Dai*, Fangli Qiao, Jingsong Guo, Chuanjiang Huang and Hongyu Ma

Key Laboratory of Marine Science and Numerical Modeling, the First Institute of Oceanography, State Oceanic Administration, 6 Xianxialing Road, Hi-tech Industry Park, Qingdao, 266061, China.

Email: djdai@fio.org.cn

Vertical distribution of turbulence kinetic energy (TKE) dissipation was measured at a station with water depth of 40m in the Yellow Sea from July 12 to July 14, 2010. Three casts of microstructure profiler MSS-60 were continuously launched from the sea surface down to the bottom at every hour. Among the three casts, two similar profiles of TKE dissipation were selected and averaged to denote the vertical distribution of TKE dissipation at the observation time. Finally, 51 profiles of TKE dissipation were obtained from 7:00 of July 12 to 9:00 of July 14. There is a layer of strong TKE dissipation just below the thermocline. The maximum value of dissipation rate in the layer can approach 1x10-6 m2/s3 while the background TKE dissipation is about 1x10-9 m2/s3. The strong dissipation layer exists during the whole observing period. The dissipation rate in the bottom layer changes with the tidal current. The dissipation rate becomes larger during stronger tidal current while the dissipation rate is close to the background value for the weak current velocity. The strong TKE dissipation below thermocline should be attributed to the shear induced by internal waves and the behavior of dissipation rate in the bottom layer corresponds to the velocity shear in the bottom boundary.

Ocean's Impact on the Intensity of Three Recent Typhoons (Fanapi, Malakas, and Megi) – Results from the ITOP Field Experiment

I-I Lin (iilin@as.ntu.edu.tw)

Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan

During the 20 August to 20 October 2010 ITOP field experiment, three typhoon cases, Fanapi, Malakas, and Megi were studied. Using airborne C130 dropwindsonde data, C130 AXBT (Airborne Expendable Bathythermograph) data, in situ upper ocean thermal structure data from the Argo floats, satellite sea surface temperature and altimetry data together with an ocean mixed layer model, the impact of ocean's thermal structure to the intensity of these 3 typhoons are investigated. It is found that all three typhoons passed over regions of similarly warm sea surface temperature (SST) of ~ 29.5°C. However, much distinction is found in the subsurface. Category-2 Typhoon Malakas passed over region of the shallowest subsurface warm layer, as characterised by the depth of the 26°C isotherm (D26) of about 37-40m and Upper Ocean Heat Content (UOHC) of ~ 38-44 kj/cm2. Category-3 typhoon Fanapi passed over region of moderate subsurface warm layer, with D26 of ~ 60-70m and UOHC of ~ 65-78 kj/cm2. Category-5 typhoon Megi passed over region of the deepest subsurface warm layer, with D26 reaching 124-132m and UOHC reaching 136-138 kj/cm2. It is found that this distinction in the subsurface thermal structure played critical role in the intensification of the three typhoon cases. Due to the very deep D26 and high UOHC, very little typhoon-induced ocean cooling negative feedback (typically < 1°C) for Megi was found. This very minimal negative feedback enabled ample air-sea enthalpy flux supply to support Megi's intensification. Based on the preliminary report from the Joint Typhoon Warning Center (JTWC), Megi's peak intensity reached 160kts, a very high intensity not often observed even for category-5 typhoons. In contrast, though with very warm pre-typhoon SST of ~ 29.5°C, the subsurface ocean condition for Malakas and Fanapi was much less favourable. As a result, the subsurface cold water could be much easily entrained and upwelled to the surface to limit the intensification for Malakas and Fanapi. Finally, it was found that the very deep subsurface warm layer and high heat content over the region where Megi passed was about 10-30% higher than the climatological values. Preliminary results suggest the possible contribution of the La Nina event in causing such warm anomaly over the western North Pacific in October 2010.

Measurement and simulation of upper-ocean turbulence dissipation in the South China Sea

Chuanjiang Huang*, Dejun Dai, Fangli Qiao, Hongyu Ma, and Jingsong Guo
Key Laboratory of Marine Science and Numerical Modelling, State Oceanic Administration, 6 Xianxialing Road, Qingdao, 266061, China.
Email: cjhuang@fio.org.cn

The turbulence dissipation rate within the mixed layer has been measured and simulated in the open ocean and the coastal water of the South China Sea under moderate winds of 4.5~8.9 m s-1 using a free fall profiler MSS. The measurements support the parameterization of wave-turbulence interaction obtained by Huang and Qiao (2010). In the open ocean, the profile of the dissipation rate within the mixed layer exhibits an exponential decay with the depth at most of stations, rather than a lognormal decay, which is in agreement with that predicted by the parameterization of wave-turbulence interaction, but deviates from that by the law of the wall. In the coastal water, however, both the parameterization of wave-turbulence interaction and the law of the wall can give approximate simulations to the measured dissipation rate.

The applications of the non-breaking surface wave-induced vertical mixing in different ocean circulation models

Fangli Qiao, Changshui Xia and Dejun Dai
The First Institute of Oceanograhpy, Qingdao, P. R. China
Email:qiaofl@fio.org.cn

Overestimated SST and too shallow model mixed layer are common problems for nearly all ocean circulation models, especially in summer time. To overcome these shortcomings, we have established a new scheme on the non-breaking surface wave-induced vertical mixing (Bv) that will correct the systematic simulation error due to insufficient mixing in ocean circulation models. Different OGCMs such as POM, ROMS, MOM4, POP and HIM show similar improvements in global ocean, which suggests Bv is model- and mixing scheme-independent. All above suggest that the surface wave should be an important source of turbulence, and be a clue to develop new generation ocean models.

Session 2: Ocean circulation variability & their influences on climate: Observations and modeling

Chair: Prof. Bo Qiu

Multi-Decadal Sea Level and Gyre Circulation Variability in the Western Tropical Pacific Ocean Circulation

Bo Qiu* and Shuiming Chen
Department of Oceanography, University of Hawaii at Manoa, 1000 Pope Road, Honolulu, HI 96822, USA.
Email: bo@soest.hawaii.edu

Sea level rise with the trend > 10 mm/yr has been observed in the tropical western Pacific Ocean over the 1993-2009 period. This rate is three times faster than the global mean value of the sea level rise. Analyses of the satellite altimeter data and repeat hydrographic data along 137ºE reveal that this regionally enhanced sea level rise is thermosteric in nature and confined vertically coherently in the upper ocean above the 12ºC isotherm. Dynamically, this regional sea level trend is accompanied by southward migration and strengthening of the North Pacific Current (NEC) and North Pacific Countercurrent (NECC). Using a 1.5-layer reduced-gravity model forced by the ECMWF reanalysis wind stress data, the authors find that both the observed sea level rise and the NEC/NECC's southward migrating and strengthening trends are attributable to the upper ocean watermass redistribution caused by the surface wind stresses of the recently strengthened Walker circulation. Based on the long-term model simulation, it is further found that the observed southward migrating and strengthening trends of the NEC and NECC began in the early 1990s. In the two decades prior to 1993, the NEC and NECC had a weakening and northward migrating trend in response to the decreasing trend in the trade winds across the tropical Pacific Ocean.

The Philippines-Taiwan Oscillation

Y.-L. Chang1,2* and L.-Y. Oey1

1 Princeton University

2 National Taiwan Normal University

Email: lyo@princeton.edu

Tide-gauge and satellite data reveal an interannual oscillation of the ocean's thermoclines east of Philippines and Taiwan forced by a corresponding oscillation in the wind stress curls. These oscillations profoundly affect the circulation of the subtropical and tropical western north Pacific, such as the bifurcation of North Equatorial Current (NEC), the change of vertical shear of Subtropical Counter Current (STCC)-NEC system, eddy activity in STCC regions, the Kuroshio transport off Taiwan, and the inflow trough the Luzon Strait into South China Sea.

A model study of the correlation of the circulation between the Western Pacific and the northern South China Sea

Yinghui He1,2, Shuqun Cai 1, Jianling He1,2

1 State Key Laboratory of Oceanography in the Tropics, South China Sea Institute of Oceanology, CAS, Guangzhou 510301, China,

2 The Graduate University of The Chinese Academy of Sciences, Beijing 100049, China

Email: caisq@scsio.ac.cn;

A global variable-grid ocean circulation model MITgcm is employed to study the correlation between the circulation in the South China Sea (SCS) and the West Pacific (WP). The vertical structure and propagation of the Luzon Cool Eddy (LCE) are studied and the impact of the Kuroshio intrusion is also discussed. By comparison with the experiment in which the Luzon Strait is blocked, the Kuroshio intrusion can maintain the LCE, and the LCE can propagate further distance with a longer duration and a larger radius. The Kuroshio intrusion can generate strong positive potential vorticity to induce and intensify the LCE.

The model results also show a significant correlation between the North Equatorial Current Bifurcation (NBL) and the transport of the Luzon Strait and the Mindoro Strait. When the NBL moves southward, the transport into SCS though the Luzon Strait decreases, and the outflow transport of the SCS through the Mindoro Strait also decreases; when the NBL moves northward, the transport into the SCS though the Luzon Strait increases, and the outflow transport of the SCS through the Mindoro Strait also decrease. The variation of the NBL signal propagates into the SCS and the Sulu Sea through the Luzon Strait and the Sibutu Passage, respectively, and subsequently affects the circulation west of the Luzon Island and that of the entire Sulu Sea.

Seasonal variability of the west-east water mass exchange on the section of central equatorial Indian Ocean and its regional difference

Zhang Yu-hong1,2, DU Yan1*, XU Hai-ming2

（1.Key Laboratory of Tropical Marine Environmental Dynamic，South China Sea Institute of Oceanology，CAS，Guangzhou 510301，China；2. College of Atmospheric Sciences，Nanjing University of Information Science and Technology，Nanjing 210044，China）

Based on the ocean reanalysis data sets and observations, the authors analyze the west-east water mass exchange in the central Indian Ocean. It is find that there are two independent processes in the equatorial Indian Ocean (EIO, 2°S-2°N) and the North Indian Ocean (NIO, 4° - 6°N), respectively. The NIO process is mainly induced by monsoon current, which advects low-salinity water westward from November to March, and during May-September the high-salinity water is carried to the east. The westward advection is stronger than the eastward, so the annual mean shows westward. The EIO process can be divided into the surface and the subsurface process. The surface equatorial process driven by equatorial wind is characterized by a semiannual cycle. During April-May and October-November, the high-salinity water of Arabian Sea is transported eastward, and the low-salinity water of Bay of Bengal westward in the other months. The annual mean advoction is eastward. The high-salinity water is eastward conveyed by subsurface equatorial process all year around.

Seasonal variation of the Luzon undercurrent

Qingye Wang1,2*, Dunxin Hu2

1College of Ocean and Meteorology, Guangdong Ocean University, Huguangyan East, Zhanjiang, 524088

2Key Laboratory of Ocean Circulation and Waves, Institute of Oceanology, Chinese Academy of Sciences, No. 7, Nanhai Road, Qingdao, 266071 Email: wqysnow@yahoo.com.cn

The seasonal variation of the Luzon Undercurrent (LUC) was studied by a climatological simulation using a high-resolution quasi-global Hybrid Coordinate Ocean Model (HYCOM) configured with climatological ECMWF wind and heat forces. The simulation results show that the position of the LUC along 18°N is relative stable, and the maximum velocity is about 6-20cm/s. The seasonal transport of the LUC shows the minimum value in July (-0.36Sv) and the maximum value in March (-2.04Sv), which is exactly out of phase with variation of Kuroshio along 18°N. Local wind stress curl which dominates the seasonal shift of the bifurcation latitude of the North Equatorial Current, results in the seasonality of the Kuroshio and Sea Surface Height along the 18°N, and indirectly affects seasonality of the LUC according to dynamic calculation.

Modulation on the equatorial currents by the two types of El Niño events

Li-Chiao Wang, Chau-Ron Wu,* Lie-Yauw Oey

Simulation outputs based on NCEP Global Ocean Data Assimilation System(GODAS) is adopted to contrast the current variations in the equatorial Pacific between two types of El Niño. The model fully resolves the equatorial currents, and well corresponds with the existing limited observations. We found that CP-El Niño correspond very well with the previous El Niño studies that both the eastward Equatorial Undercurrent (EUC) and westward South Equatorial Current (SEC) weaken. On the contrary, EP-El Niño displays a significantly distinct circulation pattern. Both the North Equatorial Counter-Current and EUC strengthen in the developing phase and persist into the peak of the warm event, while the northern branch of the SEC (SECn) also intensifies during the mature phase and lasts for about half a year. The South Equatorial Counter-Current strengthens during the decaying phase of El Niño. The shifting of the wind stress curl field associated with the thermocline variability is definitely responsible for the unique current performance of EP-El Niño. Moreover, the ocean currents feedback to the atmosphere and intensify the air-sea interaction, greatly affecting the evolution of EP-El Niño. It is worth noticing that the ocean-atmosphere coupling plays an important role on the current variability not only during CP-El Niño, but also during EP-El Niño.

The Kuroshio Extension Northern Recirculation Gyre:

Profiling Float Observation and Numerical Modelling

Bo Qiu, Shuiming Chen*, and Peter Hacker
Department of Oceanography, University of Hawaii at Manoa,
1000 Pope Road, Honolulu, HI 96822.

Mid-depth, time-mean circulation in the western North Pacific Ocean(28-45N, 140-165E) is investigated using drift information from the profiling floats deployed in the Kuroshio Extension System Study (KESS) and the International Argo programs. A well-defined, cyclonic recirculation gyre (RG) is found to exist north of the Kuroshio Extension jet, confined zonally between the Japan Trench (~145E) and the Shatsky Rise (~156E), and bordered to the north by the Subarctic Boundary along ~40N. This northern RG, which is simulated favorably in the eddy-resolving OFES hindcast run model, has a maximum volume transport at 26.4 Sv across 159E and its presence persists on the interannual and longer time scales. An examination of the time-mean x-momentum balance from the OFES hindcast run output reveals that horizontal convergence of Reynolds stresses works to accelerate both the eastward-flowing Kuroshio Extension jet and a westward mean flow north of the meandering jet. The fact that the northern RG is eddy-driven is further confirmed by examining the turbulent Sverdrup balance, in which convergent eddy potential vorticity fluxes are found to induce the cyclonic RG across the background potential vorticity gradient field. For the strength of the simulated northern RG, we find the eddy dissipation effect to be important as well.

What causes the seasonal variation of the upper-ocean Luzon Strait transport?

Yi-Chia Hsin1 and Chau-Ron Wu2,*

1Department of Oceanography, University of Hawaii, Honolulu, USA

2Department of Earth Sciences, National Taiwan Normal University, Taipei, Taiwan Email: cwu@ntnu.edu.tw

The Luzon Strait transport, especially in the upper ocean, being a small difference between the large meander inflow and outflow, is also seasonally varying and subject to large standard deviation. The annual mean Luzon Strait transport, when averaged over a 9-year period, is estimated to be westward (-3.6 ± 5.1 Sv) along 120.75 °E. We have also conducted process of elimination experiments to assess the relative importance of open-ocean inflow/outflow, wind stress and surface heat flux in regulating Luzon Strait transport and its seasonality. The East Asian monsoon winds stand out as the predominant forcing. Without it, the upper-ocean Luzon Strait transport changes from westward to eastward, and with misaligned seasonality, triggering an inflow from the Mindoro Strait to the SCS to replenish the water mass loss.

Interannual and Seasonal Variations of Kuroshio Transport East of Taiwan inferred from 29 Years of Tide-Gauge Data

Y.-L. Chang1,2* and L.-Y. Oey1

1 Princeton University, 2 National Taiwan Normal University

Email: lyo@princeton.edu

Twenty-nine years of tide-gauge data are analyzed in conjunction with wind and satellite-derived sea-surface height and ocean velocity data to study the interannual and seasonal variations of the Kuroshio transport off the northeastern coast of Taiwan. The data reveals an interannual variation of ±0.1 m (transport-variation of approximately ±3.5Sv; 1Sv = 106 m3 s-1), and a much weaker (5-10 times weaker) seasonal fluctuation that is minimum in May and maximum in November. The interannual fluctuations are not directly wind-driven by linear dynamics; rather, the Kuroshio strengthens in years of abundant eddies of the Subtropical Counter Current, which is related to the current's instability state driven by the slow fluctuations of the large-scale wind stress curl in the western Pacific. The seasonal transport fluctuation is also eddy-forced, but has weaker amplitude because the seasonal time scale is of the same order as the eddy-propagation time scale, and transport-producing eddy signals tend to overlap east of Taiwan.

The relationship between the Upwelling and the Pelagic Fish Resource in Indonesia

Rita Tisiana Dwi Kuswardani and Fangli Qiao,
Key Laboratory of Marine Science and Numerical Modeling, the First Institute of Oceanography, State Oceanic Administration, 6 Xianxialing Road, Hi-tech Industry Park, Qingdao, 266061, China.

In Indonesia, approximately 75 percent of total fish stock, or 4.8 million ton/year is pelagic fish (Hendiarti, 2005). Pelagic fish plays an important role for fisheries in Indonesia. The bio-physical characteristics of Indonesia waters such as upwelling influence the abundance of pelagic fishes.The study focuses on the Equator Eastern Indian Ocean/South Java coast and uses fish-catch (fish landings – the quantities of fish caught and brought back to land by fisherman) records at some points in South Java coast. The MASNUM wave-tide-circulation coupled model is used in this study to simulate the upwelling in this area.The results from the coupled model are used to identify the relationship between the upwelling and fish-catch during year 2002 – 2006.

Decadal variability in the sea level and Kuroshio transport in the East China Sea detected by a data assimilation ocean model

* Endro Soeyanto (Ehime University), Xinyu Guo (Ehime University), Jun Ono (Ehime University) and Yasumasa Miyazawa (Research Institute for Global Change, JAMSTEC)

The reanalysis data of a data assimilation ocean model, the Japan Coastal Ocean Predictability Experiment 2 (JCOPE2), during period from January 1993 to December 2009 (17-years) were used to investigate the presence of decadal changes in the sea level and Kuroshio transport in the East China Sea (ECS). The reanalysis results in decadal scale show there are 2 (two) different response periods of Sea Level Anomaly (SLA) and Volume transport (VT) to the Pacific Decadal Oscillation (PDO) index, i.e. periods of January 1993-December 2002 (10 years) and January 2003-December 2009 (7 years) in the ECS and adjacent seas. In sea level variation, the area with negative correlation coefficients (r=-0.4 to r=-0.5) between the SLA and PDO index is found in the 10-year's period, distributing almost the whole ECS except for the adjacent of Changjiang river mouth. Meanwhile, results of the 7-year's period revealed an area with positive correlation coefficients (r=0.3 to r=0.4) almost covering the ECS. In the same time scale, Kuroshio transport along the ECS shelf break gave the immediately positive correlation to PDO index. The largest correlation coefficients (r=0.5 to r=0.6) is also found in the 10-year's period, especially from west of Okinawa to Tokara Strait. After this period, there is no significant correlation between the Kuroshio transports to PDO index. Inside the ECS shelf water on 10-year's period, we also confirmed that the transport through the Tsushima Strait has negative correlation to PDO index, while that through the Taiwan Strait has an opposite response to PDO index. The difference in the transport through two straits has a consistent relation with PDO index as the sea level inside the ECS with the PDO index.

Session 3: Bottom boundary layer and sediment dynamics of muddy coasts and estuaries

Chair: Prof. Xiao-Hua Wang

Dynamics of Chinese Muddy Coasts and Estuaries

Xiao Hua Wang
The Sino-Australian Research Centre for Coastal Management
University of New South Wales
Canberra ACT 2600, Australia
email: hua.wang@adfa.edu.au

A special issue on 'Dynamics of Chinese Muddy Coasts and Estuaries' will be published in Estuarine, Coastal and Shelf Science in May 2011. The special issue is a collection of the papers presented in the workshop 'Dynamics of Chinese Muddy Coasts and Estuaries' held in September 2009 in Guilin, China. The workshop was sponsored by the State Key Laboratory of Ocean Remote Sensing and Dynamics, the Second Institute of Oceanography, SOA, China, as well as the LOICZ and EMECS (the Environmental Management of Enclosed Coastal Seas). There are totally ten papers contributed to this special issue as case studies of Changjiang, Huanghe and Zhujiang estuaries and Chinese muddy coasts in the Bohai, Yellow, East China and South China Seas. These papers represent the most recent advancement in Chinese estuarine and coastal sediment research in the fields including: 1) sediment processes in highly turbid estuaries (Wang, Y. et al.); 2) modeling for sedimentary processes (Qiao et al., Wang, X.H. et al.); 3) fluid mud behavior and processes in benthic boundary layer (Liu et al.); 4) fine sediment related biogeochemical processes in coastal ocean (Li et al., Zhang et al. and Zhu et al.); and 5) in-situ observations and instrument development (Bi et al., Dong et al. and Yang et al.). In this presentation, I will provide a synthesis talk on the importance of studying sediment dynamics of muddy coasts and estuaries and the advances in those studies in China.

Modeling on the dynamics of suspended particulate matter in the East China Sea

Jun Ono* and Xinyu Guo
Center for Marine Environmental Studies, Ehime University, Matsuyama, Japan
Email: jo@sci.ehime-u.ac.jp

A three-dimensional/high-resolution transport model for suspended particulate matter (SPM) has been developed to investigate the dynamics of SPM in the East China Sea. The SPM model was coupled with an ocean circulation model that can reproduce well the realistic physical fields. The model is forced by monthly-averaged wind stress, heat flux, river discharge, and resuspension at the sea bottom. In the present study, we focused on the single-sized cohesive sediment of clay that is dominant in the East China Sea. The model reproduced the distribution and seasonal variation of surface SPM derived from satellite data. The simulated SPM concentrations also changed with spring-neap tidal cycle and high concentration regions were formed in coastal area where tidal currents are strong. Using this model, several numerical experiments were carried out to examine effects on the SPM dynamics of tidal currents and river discharge.

Numerical Modelling of Sediment Transport in the Adriatic Sea

A. Guarnieri* (1), A. Souza (2), N. Pinardi (3)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Gruppo di Oceanografia Operativa, via A. Moro 44, 40128 Bologna, Italy, email: guarnieri@bo.ingv.it

(2) National Oceanography Center, Liverpool, United Kingdom

(3) Department of Physics, University of Bologna, Bologna, Italy

The Adriatic Sea is an elongated semi-enclosed basin, with a shallow shelf in the northern area. Its bottom is mainly sandy, and thus subjected to important activity of sediment transport. High sediment input is guaranteed by its two main rivers – the Po and the Buna/Bojana – the former located in the north-west and the latter in the south-east coasts of the basin. The implementation of a coupled wave-circulation-sediment model on this domain is presented. The sediment transport model is based on the one described by Wang and Pinardi (2002) and by Wang et al (2006), and some corrections to limit the bed erosion have been applied, following Souza et al. 2007. The coupled model was first tested by reproducing the important events of sediment transport occurred in the Po delta area during the strong events of Bora and Scirocco winds of winter 2002-2003. Then it was used to initiate the first investigations of the sediment transport dynamics on the coastal area around the Buna/Bojana river mouth.The results show reliability in the simulation of high frequency events, both in terms of sediment transport and of sediment concentration along the water column, but show also some limits of the model in the reproduction of the longer timescales, such as maps of erosion/deposition patterns, probably due to the over simplification of the sea-bottom submodel, and to simplification assumptions in general.

Three-dimensional sediment transport model for the Pearl River Estuary

Wang Zhili1, Geng Yanfen2

State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Nanjing Hydraulic Research Institute，Nanjing，210024,

Email: zlwang@nhri.cn

2. Transportation College, Southeast University, Najing 210096, Email: geng_y_f@yahoo.com.cn

In this paper, a three-dimensional sediment transport model with staggered C-unstructured grids in the horizontal direction and Z-level grids in the vertical direction has been developed. The model is discretized by semi-implicit finite volume method, in that the free-surface and vertical diffusion are semi-implicit, thereby removing stability limitations associated with the surface gravity wave and vertical diffusion terms. The remaining terms in the momentum equations are discretized explicitly by integral method. The model is closed physically and mathematically using the Mellor and Yamada level-2.5 turbulent closure submodel. The numerical model is used for simulation accumulation process of immersed tube tank of HMZ (Hong Kong-Macau-Zhuhai) bridge. The model is calibrated and its performance extensively assessed against on-site experiment.

Session 4: Estuary, Coastal Ocean and Shelf Sea Modeling Chair: Prof. L.-Y. Oey

Ensemble numerical forecast of Kuroshio water intrusion into the shelf and coastal waters south of Japan

Atsuhiko Isobe

Center for Marine Environmental Studies, Ehime University, 2-5 Bunkyo-cho, Matsuyama, 7908577, Japan,

Email: aisobe@ehime-u.ac.jp

Western boundary currents such as Kuroshio are always accompanied by frontal waves on their shore-side, and the shoreward amplification of these frontal waves results in short-term and drastic changes of marine ecosystem on shelves. The present study attempts to establish an ensemble numerical forecast procedure for the shoreward intrusion process of Kuroshio frontal waves south of Japan (Bungo Channel west of Shikoku Island). The present application adopts a one-way nesting model in which POM-based JCOPE2 data are used for the lateral boundary condition of a coastal circulation model based on FVCOM. Two-month hindcast computations using JCOPE2 reanalysis data are followed by three-month forecast computations using JCOPE2 forecast data. In total, five sets of hindcast/forecast computations are carried out in the course of the former half of 2010. The forecast results are validated by temperature time series observed at a fixed station. Interesting is that the accuracy of forecast computations depends strongly on the amount of ARGO floats flowing south of Japan during the hindcast period. It seems likely that JCOPE2 reanalysis data of which quality is “certified” by ARGO are required for making initial conditions available for the following forecast computations.

Tidal effects on seasonal, spring/neap tidal and intratidal variability of the dispersion, mixing, stratification, and circulation within the plume of the partially-mixed Changjiang River estuary, China

Li-Feng Lu and John Z. Shi*

Department of Harbour and Coastal Engineering, State Key Laboratory of Ocean Engineering, School of Naval Architecture, Ocean and Civil Engineering, The Shanghai Jiao Tong University, 1954 Hua Shan Road, Shanghai 200030, China

*Corresponding author: zshi@sjtu.edu.cn; 86 021 62933027 (phone); 86 021 34206334 (fax)

An improved COHERENS (A COupled Hydrodynamical-Ecological model for REgional and Shelf Seas) model is used to study the dispersal and mixing processes, stratification and circulation within the plume of the partially-mixed Changjiang River estuary under the forces driven by M2, S2, K1, and O1 tidal constituents in the flood and dry seasons, respectively. Results show: (i) The Changjiang River plume spreads southeastwardly into the East China Sea in the form of jet flow, or circular bulge, or fresh water tongue, which depends on the Changjiang river discharge and tidal regime. (ii) There is a two-layer structure along the longitudinal section within the Changjiang River plume: the upper buoyant plume and the lower vertical homogeneous layer. The thickness of the upper buoyant plume is smaller in the flood season than that in the dry season, larger during the spring tide than that during the neap tide, and smaller at the maximum flood tide than that at the maximum ebb tide. (iii) The salinity stratification is stronger in the flood season than that in the dry season, weaker during the spring tide than that during the neap tide, and stronger at the maximum flood tide than that at the maximum ebb tide. (iv) Modeled turbulent kinetic energy is higher during the spring tide than during the neap tide. There is an apparent hysteresis of turbulent kinetic energy with significantly behaviour during the acceleration and deceleration phases of the tide within the plume of the partially-mixed Changjiang River estuary.

High-resolution simulations of flow-topography interactions near coral reefs and potential implications for Caribbean fish spawning aggregations

Tal Ezer*

Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA, USA; Email:tezer@odu.edu

Will Heyman and Chris Houser

Department of Geography, Texas A&M University, College Station, TX, USA

Flow-topography interactions near coral reefs are studied using observations and a high-resolution (50m grid size) numerical ocean model. The model simulations suggest an explanation why Caribbean fish spawning aggregations almost always occur in the days after a full moon and near reefs with unique shapes of sharp horizontal curvatures and steep vertical convex slopes; these sites may be chosen for their high turbulence which helps to disperse eggs and reduce predation. At those locations, at the tip of the reef, small flow variations are amplified and internal waves interact with the bottom slope to generate intense mixing. Sensitivity model experiments examine the role of various mechanisms, such as tides, wind, off shore eddies and internal waves in generating turbulence near the reef and are compared against observations.

Modelling the tidal front and associated cold-water dome in the Irish Sea using an unstructured-grid, finite-volume model

Jiuxing Xing* and Alan M. Davies
National Oceanography Centre, Liverpool, UK.
Email: jxx@pol.ac.uk

The Irish Sea is a semi-enclosed sea with shallow water and strong tides in the east, and relatively deep water (~100m) and weak tides in the west. During summer months, as a result of the differential tidal mixing a tidal front is formed with well-mixed water in the eastern Irish Sea and stratified in the western Irish Sea. In the stratified region, due to weak mixing, the bottom water is significantly colder than the surrounding water, forming a cold-water dome. The dynamics of the tidal front and associated cold-water dome is of importance to local water circulation and the eco-system. In this talk, we will present results of a modelling study on the formation and dynamics of the tidal fronts and associated cold-water dome. We have developed an unstructured-grid model of the Irish Sea and part of Celtic Sea (IC-FVCOM) based upon FVCOM (finite-volume coastal ocean model). The model, with a horizontal resolution about 3 km in the western Irish Sea area, is forced at the open boundaries with bartropic tides, and the observed wind stresses and solar radiation at the sea surface. In general, our model results are in a good agreement with the limited observational data in terms of the temperature evolution and structures. The model results also show the distinct two-layered baroclinic circulations in the cold-water dome region with a down-welling motion in the central area. Taking advantages of the nature of variable grid of the model, we investigate the tidal front and associated cold-water dome by refining the model resolution to less than 1 km in the region. Results show that a finer model resolution is vital to correctly simulate the sharp temperature gradient and possible barclinic instability in the frontal region.

Evaluating Tidal Power and Impacts of Power Extraction in Cobscook and Passamaquoddy Bays

Min Bao1,2 and Huijie Xue1

1. College of Physical and Environmental Oceanography, Ocean University of China, Qingdao 266100, China

Email: minbao1985@gmail.com

2. School of Marine Science, University of Maine, 04469, U.S.

There have been several sites in Cobscook Bay (US) and the connected Passamaquoddy Bay (US and Canada) approved for pilot projects of tidal power development. A coastal ocean circulation model is set up for the study of the selected tidal sites in Cobscook and Passamaquoddy Bays. The model is used to assess the tidal power resource and to examine the feedback from the near field of marine turbines to the tidal currents and possibly the tidal regime of the Quoddy region. The model has a total of 102447 nodes with the highest resolution ~ 20 m near the tidal sites, and there are 15 levels in the vertical. The model simulates both transient and residual eddies of 100 – 1000 m in diameter in the main tidal channels and passages. Eddy activities in relation to tidal phases and wind directions are examined. Additional experiments are conducted by prescribing damping coefficients in the model to represent tidal energy extraction, and feedbacks between turbine wakes and tidal currents are examined.

Local versus remote wind effects on the coastal circulation of a microtidal bay in the Mediterranean Sea

Antoni Jordi1*, Gotzon Basterretxea1 and Dong-Ping Wang2

1IMEDEA (UIB-CSIC), Institut Mediterrani d'Estudis Avançats, Miquel Marqués 21, 07190 Esporles, Illes Balears, Spain

2School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, 11794 NY, USA

Coastal currents in microtidal bays are assumed to be weak and random, promptly responding to variations in wind forcing. However wind effects can act at scales that vary from local to large scales. With the aim of examining the response of coastal flow to local and regional wind forcing and their relative importance as drivers of coastal circulation, current data were collected during five months during the summer 2009 in Palma Bay (western Mediterranean Sea). The data set is jointly analyzed with a primitive-equation model to characterize the circulation in the bay. Moored acoustic Doppler current profiler (ADCP) data shows that currents in the bay fluctuate widely in direction resulting in an almost negligible mean current. This strong variability is mainly attributed to two major wind forced mechanisms interacting in the bay: island trapped waves (ITWs) propagating at an island scale and locally wind-induced mass balance. Wind forced oscillations at periods of 60 and 24 h dominate current variability. The fluctuations at 60 h are associated with the first radial and first azimuthal mode of ITWs generated by remote wind. Weak ITWs are associated with currents flowing parallel to the coast, whereas more intense ITWs form an anticyclonic gyre over the southeastern part of the bay due to flow separation at Enderrocat Cape. At the period of 24 h, the wind has two effects: the first radial and second azimuthal mode of ITWs and a local wind-induced mass balance in response to the sea breeze.

Simulation of the sea surface temperature in Tokyo Bay using a non-hydrostatic model

Li-Feng Lu, Shinichiro Kida, Keiko Takahashi

Earth Simulator Center, Japan Agency for Marine-Earth Science and Technology, 3173-25 Showa-machi, Kanazawa-ku, Yokohama, Kanagawa, 236-0001, Japan. Email: lifeng_lu@jamstec.go.jp

Tokyo city is one of the largest metropolitan areas in the world and undergoing a temperature rise year on year due to the heat island effect. While Tokyo Bay, which is located to the southeast of Tokyo, has been reported to have a potential cooling effect on the Tokyo urban area (Oda and Kanda, 2009). To evaluate the role of Tokyo Bay as a heat sink in lowering the urban air temperature, a numerical simulation of variability of sea surface temperature (SST) in Tokyo Bay has been conducted using MSSG (Multi-Scale Simulators for the Geoenvironment) model. The seasonal variabilities of surface currents and temperature have been obtained.

1D and 2D full coupling model for tidal flow in river networks and estuaries

Yanfen Geng1， Zhili Wang1

1.Transportation College,Southeast University,Najing,210096

Email:geng_y_f@yahoo.com.cn

2. State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Nanjing Hydraulic Research Institute，Nanjing，210024

Email:zlwang@nhri.cn

The interactions of rivers and the ocean with each other in the estuarine areas perform complicated dynamic functions in the fluvial process. In this study, a 1D and 2D full coupling numerical model is developed for simulation the exchange and interaction between the coastal waters and river network, in which the 1D river network numerical model based on solving the St Venant equations using Preissmann box method is used to the long reaches of river network and the 2D model based on the unstructured grid is used for the estuaries and seas. The 1D model and 2D model are implicitly solved in one system。This allows for accurate and mass conserving modeling of complex coastal waters and river network systems, whilst the advantages of both systems are maintained and used in an optimal and computationally efficient way. Three numerical tests are presented in order to assess this new scheme. The results obtained for various representative configurations of 1D and 2D flows show the robustness and the accuracy of the new coupling model.

Coastal transformation of tides at the Yellow Sea and East China Sea

Dong-Young Lee*, Jong-Joo Yoon, Sangik Kim, Sang-Kwon Hyun
College of Engineering, Ocean University of China, 238 Songling-lu, Qingdao, 266100, China.
Email:dylee@ouc.edu.cn
Climate Change and Coastal Disaster Research Laboratory, Korea Ocean Research and Development Institute, Ansan, 426-744 Korea

Tides and tidal currents are important information for a whole range of coastal applications such as the disposal and movement of sediments, tracers and pollutants in the coastal waters. Since the launch of remote sensing satellites, the study of ocean tide has been advanced significantly and relatively accurate ocean tide information is produced by means of global tide models. However, it is still difficult to produce accurate tide and tidal current information for the coastal waters because of rather complicated coastal transformation processes of tidal waves in coastal waters.
Most of the tide observation is performed at coastal stations inside the port where various local effects are included. KORDI has accumulated large amount of sea level data from rather offshore wave stations not much affected by local topography. Surface elevation data have been sampled at 2Hz continuously from about 10 wave stations around Korean peninsula. Transformation of tidal waves at coastal waters due to the non-linear energy transfer and dissipation due to advection and bottom frictional dissipation has been studied by combining such rather offshore water level observation with conventional tide station data and by utilizing numerical model, FVCOM, with unstructured grid that can deal with fine mesh coastal area to handle with processes around coastal tidal stations as well as to cover all the regional sea of Yellow Sea and East China Sea,
Generation of various overtides and compound tides components at shallow water have been examined and more accurate estimation of coastal tide and tidal current information for the East China Sea and the Yellow Sea is discussed at this paper.

Modelling Tidal Dynamics and Flow Patterns over Complex Bottom Topography in Potter Cove, Antarctica, using Unstructured Grid Finite Volume Coastal Ocean Model

Chai Heng Lim*, Karsten Lettmann and Jörg-Olaf Wolff

Physical Oceanography Group, Institute for Chemistry and Biology of the Marine Environment (ICBM), Universität Oldenburg, Carl-von-Ossietzky-Str. 9-11, Postfach 2503, 26111 Oldenburg, Germany. Email: chai.heng.lim@uni-oldenburg.de

Potter Cove (58°41'W, 62°14'S) is a cove indenting the southwest region of King George Island to the east of Barton Peninsula, in the South Shetland Islands, Antarctica. The cove has complex bottom topography with two sectors: the outer cove has water depths exceeding 100 m and the inner cove comprises depths between 30-50 m. Tidal currents flush water in and out of the cove, producing mixing and transporting suspended sediment and nutrients. Hydrodynamic resuspensive processes and fluctuating production processes in the water column may be one of the key factors to provide food to many benthic suspension-feeding communities. Thus, the interactions of the water fluctuations and circulation within the cove and its surrounding hydrodynamics are important to understand the distribution of the nutrients and sediments. However, not much is known about the flow pattern change, both magnitude and direction, with time and location. Even less is known about the influence of currents on the sediment dynamics on the sea floor.

The present work is focused on the numerical modelling of the tidal dynamics and flow circulation in Potter Cove. The high-resolution unstructured grid finite volume coastal ocean model FVCOM has been applied to the Northern Antarctic Peninsula to simulate tidal wave dynamics with a horizontal resolution ranging from 100 m in the Potter Cove to 4 km in the deep ocean. Based on the preliminary investigation, the simulated tidal parameters (harmonic constituents of tidal elevation and currents) are compared with the available observational data as well as with the predicted tides from the global Finite Element Simulation (FES2004) and the Antarctic Peninsula High-Resolution Tidal Forward Model (AntPen04.01).

The influence of various bottom friction parameterizations on the vertical structure of tidal currents by using POM and adjoint assimilation method

Jicai Zhang1,2,*, Xianqing Lu3, Yaping Wang1, Ping Wang2, Jianhua Gao1

1. Laboratory of Coast and Island Development, Nanjing University, Nanjing 210093, PR China;

2. Coastal Research Laboratory, Department of Geology, University of South Florida, Tampa 33620, USA;

3. Laboratory of Physical Oceanography, Ocean University of China, Qingdao 266100, PR China.

Abstract: Based on the simulation of M2 tide in the Bohai, Yellow and East China Seas, the influence of various parameterizations for the bottom friction effect on the vertical structure of tidal current is studied by using the three-dimensional Princeton Ocean Model (POM) and a two-dimensional nonlinear adjoint tidal model. Four methods are used to parameterize the bottom friction effect, including two linear ones (Rayleigh and Ekman) and two nonlinear ones (Quadratic and Slope-dependent). The bottom friction coefficients are supposed to be a constant and spatially varying respectively and optimized by assimilating the Topex/Poseidon satellite altimetry and tidal gauge data in the two-dimensional tidal model. The inverted distributions of bottom friction coefficients are then input to the three-dimensional POM. The validity of the adjoint tidal model is tested by performing twin experiments where the prescribed distributions of bottom friction coefficients are inverted by assimilating the model-generated 'observations'. The following two aspects have been studied in this paper by carrying out the practical numerical experiments. (i) Whether the bottom friction coefficients obtained from the two-dimensional adjoint tidal model can be used in the three-dimensional POM and reduce the discrepancies between modeled and observed tidal currents. (ii) Whether the different types of bottom friction parameterizations would influence the modeled vertical structure of tidal currents and which one is the best to reproduce the vertical structure of tidal currents? The conclusions can enhance the understanding about the bottom friction effect and reduce the discrepancies between model-reproduced and observed tidal currents in marginal shelf seas.

Impact of atmospheric mesoscale convection on waters of Malacca Strait

Chen Haoliang*1, Song Guiting2, Koh Tieh Yong2, Paola Malanotte-Rizzoli3,1

1Singapore-MIT Alliance for Research and Technology

2Nanyang Technological University

3Massachusetts Institute of Technology

Land-sea breeze and associated squall convection in the Straits of Malacca is a dominant weather pattern in our local region. Studies of land-sea breeze often examine a case where there is only one land-sea boundary or where land is flanked on both sides by the sea. In the Straits of Malacca, the sea is flanked on both sides by land and land-sea breeze often trigger squall convection. This offers us a refreshing example of atmosphere-ocean interaction on weather timescales. In this paper, the ocean responses to this coupled interaction will be presented. With atmospheric forcings from WRF real time model, a coastal ocean model, FVCOM (Finite Volume Coastal Ocean Model), is used to numerically investigate the role of atmospheric diurnal wind circulation on the dynamics of currents in the Straits and the role of diurnal wind, evaporation and precipitation cycle on the SST in the Straits.

Title: Modeling the circulation in the Gulf of Tokin and northwestern South China Sea

Jingsong Gao1, 2, Huijie Xue2, and Maochong Shi1
Ocean University of China, Songling Road 238, Qingdao, China
Email address: keytothesuccess@163.com
School of Marine Sciences, University of Maine, Orono, ME 04469-5706, USA
* Jingsong Gao will attend the meeting ; poster

The ECOMSED is used to study the circulation in the Gulf of Tokin and the northwestern SCS in winter. The model considers wind, heat flux, residual elevation and tide. After three months of integration, it can be found that the averaged net volume flux through the Qiongzhou Strait is approximately ~0.1 Sv in winter, and the current is always westward with the velocity ~20 and 10 cms-1 on the northern and southern side of the Strait, respectively. The westward current in the Strait is partly driven by the southwestward Guangdong Coastal Current. The current off the southwestern coast of the Hainan Island is northwestward throughout the water column, which can reach the northeastern Gulf along the western coast of the Hainan Island. These modeled features agree well with the measured currents in 2006 and 2007 and historical observations. In the western Gulf, the discharge from the Red River appears to contribute to both the northeastward Guangxi Coastal current and a southward current along the northern Vietnam coast.

Session 5: Regional Ocean model downscaling for multi-scale interactions and data-assimilative studies, fronts and eddies

Chair: Prof. Yasumasa Miyazawa

Data Assimilative Modeling Study on Shelf-slope Exchange Processes Induced by a Large Warm Core Eddy

Ruoying He* and Ke Chen
Ocean Observing and Modeling Group
Dept. of Marine, Earth & Atmospheric Sciences
North Carolina State University

We will present a data assimilative model hindcast study on the evolution of a large warm core eddy in the Middle Atlantic Bight off U.S. east coast, and its associated significant shelf-slope exchange processes. Observations including satellite remote sensing and subsurface ship and glider data will be described. Model hindcast using 4-dimeionsal variational data assimilation approach will be discussed.

The Kuroshio variation south of Japan detected by the Ensemble Kalma Filter

Yasumasa Miyazawa*, Toru Miyama, Sergey M. Varlamov, Xinyu Guo and Takuji Waseda
Research Institute of Global Change, JAMSTEC, 3173-25 Showamchi, Kanazawa-ku, Yokohama, 236-0001, Japan. Email: miyazawa@jamstec.go.jp

We investigated the feasibility of the Ensemble Kalman Filter (EnKF) to reproduce the Kuroshio variation south of Japan. We have adopted the Local Ensemble Transformation Kalman Filter (LETKF) algorithm based on 20 ensemble members of the parallelized Princeton Ocean Model (sbPOM) with horizontal resolution of 1/36 degree. By assimilating satellite sea surface height anomaly, satellite sea surface temperature, and in-situ temperature and salinity profiles, we reproduced the Kuroshio variation south of Japan for the period from 8 to 28 February 2010. EnKF successfully reproduced the Kuroshio path positions and the water mass property of the Kuroshio waters as observed. Variation of the thermohaline front in the winter Kii Channel, 'Kii Channel Front', due to the intrusion of the Kuroshio water toward the channel was clearly reproduced by the assimilation, suggesting the effectiveness of flow-dependent error covariance represented by EnKF for detection of interactions between coastal seas and open oceans with highly complicated spatiotemporal variability.

A Background error model derived from Wavewatch III considering wave direction in ocean wave data assimilation

Yanyou Guo a,b *, Jie Yang a and Yijun Houc

a Huaihai Institute of Technology, Lianyungang,222005, China; b China University of Geosciences, Beijing, 100083, China;c Institute of Technology, Lianyungang, China institute of Oceanology, Chinese Academy of Sciences, Qingdao, 266071, China.

Email: guoyanyou@gmail.com

How to depict the structure of the background error is one of the key problems in ocean wave data assimilation. A Monte Carlo method was used to determine the background error of Significant Wave Height (SWH) based on Wavewatch III model. To investigate the effect of wave direction on background errors and wave directions, 100 random numbers were added to a grid point (denoted by P) of Wavewatch III. While forced by a steady wind field, Wavewatch III integrates over 5 days and the covariance statistics between arbitrary point I and P were calculated. The results show that the correlation scale length (denoted by L) along the wave direction is much larger than that along other directions. A relationship between L and the angleθ， as: $L = L_0(1 + \frac{1}{2}\cos\theta)$, in which θ is the angle between wave direction of P and the line from P to I and L0 is a constant. To validate that relationship, a regional data assimilation experiment with OI (Optimal Interpolation) scheme has been implemented. The SWH of buoy 22001 which is located in East China Sea was used to assess the experiment result. The result shows that the new background error model with consideration of wave direction works well while wave directions of grids are mostly the same and the rms error decreases about 3% compared with that in case of a homogenous background error model.

Some aspects of tide simulation in regional ocean models

Sergey Varlamov* and Yasumasa Miyazawa
Ocean Downscaled Prediction Research Team, RIGC, JAMSTEC, 3173-25 Showa-machi,Kanazawa-ku, Yokohama, 236-0001, Japan.
Email: vsm@jamstec.go.jp

A regional high-resolution (~3km) tide-resolving ocean prediction system for coastal waters around Japan known as JCOPE-T (Japan Coastal Ocean Predictability Experiment Tide-resolving model) was developed and is operated routinely by JAMSTEC Ocean Downscaled Prediction Research Team. The model provides hourly forecasts of sea level, ocean currents, water temperature and salinity for surface as well as deep waters at a lead time of up to 14 days and is operated daily. The regional model is nested to a semi-global ocean model that assimilates available in-situ and satellite observations. The regional model reproduces non-linearly interacting background ocean currents, tidal and wind generated processes that make it possible to predict cases of sudden current intensifications, storm surges etc.

Validating modeled vise observed sea level variability on about hundred Japanese and Korean tidal stations, it was found that for some of them, but not for all, the sea level variability is overestimated by model. As POM model employs modes splitting technique, it is caused by underestimation of barotpropic mode dissipation or energy transfer to baroclinic modes in some regions. Underlying aspects would be discussed. As a practical solution to optimize the modeled sea level variability on coastal stations the traditional quadratic “bottom radiation stress” dissipation term was introduced for model barotropic mode over the fixed range of model depths mostly corresponding to the steep shelf slopes in the JCOPE-T model domain.

A Shelf Ocean Circulation Model for East Australian Currents (EAC): Nesting to Bluelink and Downscaling Techniques

Donghui Jiang and Xiao Hua Wang

School of Physical, Environmental and Mathematical Sciences, Australian Defence Force Academy, University of New South Wales, Canberra 2600

Bluelink is the Australian National Ocean Forecasting Model whose horizontal resolution is ~10km along New South Wales (NSW) coast. However given that the East Australian Current (EAC) eddies are intensively active in this area and the shelf has a narrow width in order of 20 km, Bluelink is too coarse to resolve the shelf circulation and its oceanic processes along the NSW coast. Thus to provide boundary forcing for a finer resolution coastal model (Jervis Bay, NSW), we have developed a shelf model (based on Princeton Ocean Model) with an advanced downscaling techniques and open boundary conditions to deal with its nesting schemes to the Bluelink. The output of the shelf model was then compared to that of the Bluelink forecast and the Sea Surface Temperature (SST) recorded by the Advanced Very High Resolution Radiometer (AVHRR). It shows that the shelf model reproduced the main features of the EAC and its associated eddies, with much detailed dynamic structure not revealed by the Bluelink.

Validation of Bottom Features on SAR Images Using a Numerical Circulation Model

Taerimkim* and Jong-Jib Park
Dept. of Coastal Construction Eng., Kunsan National Univ., Kunsan, 573-701, Korea
trkim@kunsan.ac.kr

Tidal channels and coastal sand ridges in Gyunggi Bay, Korea often appear on the SAR (Synthetic Aperture Radar) images as linear features. It is because of that the sea surface current convergence/divergence zones generated by the current and bathymetry interaction, modulate wind-generated sea surface wave causing backscatter variations in the radar image. In order to validate that the zones of bright line features in the SAR image are related with the convergence zones of tidal currents, numerical circulation modeling was performed with real bathymetry and boundary conditions of using ROMS (Regional Ocean Modeling System). The intensity of convergence and divergence is calculated based on the continuity equation. The current convergence zones over tidal channels and sand ridges coincide with bright line feature zones on the SAR images and this validates the imaging mechanism of bottom topography under water by con-divergence current fields causing surface modulation.

Sensitive experiments on horizontal mixing and statistical analysis of eddy fluxes

Xunqiang Yin, Fangli Qiao, Yongzeng Yang, Yeli Yuan

1. The First Institute of Oceanography, State Oceanic Administration, China

2. Key Laboratory of Marine Science and Numerical Modeling (MASNUM), State Oceanic Administration, China

The ocean mixing in numerical modeling is generally used to represent those unknown processes which could be not included in the basic equations or those processes which could not be resolved by the grid system of the present ocean model. For the latter processes, the main part of the related mixing is in horizontal direction. In the existing ocean models, the Smagorinsky-type of horizontal mixing is commonly used for eddy viscosity and diffusivity. In this study, different coefficients for this parameterization scheme are employed in the Princeton Ocean Model of North-west Pacific Ocean, for sensitivity tests on the impact from viscosity and diffusivity. The observations of satellite sea surface temperature and Argo data including temperature and salinity profiles are used in this study to obtain the simulated errors. And then the simulated errors from different experiments are being analyzed for demonstrating the results due to parameter schemes of horizontal mixing. The results indicated that the coefficients of horizontal parameterization should be different for those equations of moment, temperature and salinity. In order to understand the performance of the parameterization, the statistical method is used to analyze the eddy fluxes. The analyzed results are compared with the parameterization ones. As the results, the parameterization scheme is being validated based on the numerical results.

Session 6: Air, sea, wave, and biogeochemical Interactions between Tropical Cyclones and Ocean
Chair: Prof. Chau-Ron Wu

Analysis of turbulent flux measurement at coastal waters of eastern Yellow Sea and discussion on the surface boundary condition of regional ocean prediction model

Ki-Cheon Jun*, Dong-Young Lee, Jeong-Woon Choi
Climate Change and Coastal Disaster Research Laboratory, Korea Ocean Research and Development Institute, Ansan, 426-744 Korea, Email: kcjun@kordi.re.kr

The exchanges of momentum, heat, vapour and other gases between air and sea influence weather of the ocean and atmosphere as well. To be able to improve surface boundary conditions of regional ocean prediction model, accumulation of in situ. observation data of the turbulent flux at the air-sea interface is essential, which is not so easy even though technology of direct observation is available.

The efforts and experiences of KORDI in collecting turbulent flux observation data from different platforms such as offshore observation tower, light tower over the underwater rock and coastal pier are introduced. Analysis of turbulent flux observation data collected at Taean coastal pier in the west coast of Korea measured using 3-D sonic anemometer sampled at 20 Hz will be shown. The data was collected during strong winter monsoon. To see the effects of waves on the flux at air-sea interface, wind waves and sea level was measured using Paro-Scientific Pressure Sensor sampled at 2 Hz.

Different method of analysis of momentum flux have been compared and discussed. The assumption of constant coefficients in the bulk formulae that is used in is ocean prediction model is evaluated and the method of improvement of preparation of sea surface boundary condition of regional ocean prediction model for the North East Asia regional seas will be discussed at the workshop.

Atmosphere, ocean and wave simulation during Typhoon using a mesoscale Coupled Ocean-Atmosphere System

Zhizhong Yang*, Youping Xu
Beijing Applied Meteorology Institute. No.8 Minzuyuan Road,
Chaoyang District, Beijing, 100029, China.
Email: yzz472@sohu.com

To study the mesoscale atmosphere-ocean interaction in China adjacent sea, a Coupled Ocean-Atmosphere System (COAS) have been set up based on Advance Region Advance Regional Atmosphere Model (AREM), Princeton Ocean Model (POM) and the third generation wave model WAVEWATCH III(WW3). The system introduces the interaction processes between atmosphere, ocean and wave. Using COAS, the synoptic processes of atmosphere, ocean and wave have been numerically simulated simultaneously in China adjacent sea during the passage of typhoon. For comparison, uncoupled simulation schemes are also examined during typhoon with AREM, POM and WW3, respectively. The simulation results are compared to the observed rainfall, GTSPP temperature and satellite wave height data. The results indicate that the coupling scheme in COAS is reasonable and the coupling between atmosphere, ocean and wave is rather important to typhoon developing.

Upper Ocean's Responses to Tropical Cyclone

Shuwen Zhang*, Hong Cui

Guangdong Provincial Key Laboratory of Climate, Resources, and Environment in Continental Shelf Sea and Deep Sea/College of Ocean and Meteorology, Guangdong Ocean University, East of Huguangyan, Zhanjiang City, Guangdong Prov, China 524088

E-mail: gdouzhangsw@163.com

Upper ocean's response to intense forcing of tropical cyclone has been the subject of considerable theoretical and modeling efforts. However, the observational databases available for such studies are very limited, especially in the South China Sea, because of the operational difficulty of doing shipboard measurements under such adverse conditions and the paucity of moored instrumentation. In this study, the effects of tropical cyclone on upper ocean thermal structure, dynamics structure and energy budget of South China Sea are investigated by ocean POM model and sea waves WWATCH-III model. The result indicates that cross-thermocline heat flux transport is mainly contributed to the vertical turbulent mixing induced by shear instability. Two kinds turbulence mixing processes are driven by wind stress: one is the near-surface wind wave breaking, and the other is the near-inertial wave at the mixed layer base. Wind waves breaking affect on the vertical turbulent mixing only limited to the near-surface layer. The mixing processes induced by near-inertial waves, however, are likely to be the main mechanism in the ocean interior, may play an important role in cross-thermocline energy and nutrients transport.

Hurricane Intensity Change in WRF-HYCOM Coupled Modeling Experiments

Qingnong Xiao*1 and Xin Qiu2

College of Marine Science, University of South Florida, St. Petersburg, FL

School of Atmospheric Science, Nanjing University, Nanjing, China

The Earth System Modeling Framework (ESMF) is used for coupling of the state-of-the-art numerical forecasting models of atmosphere (WRF) and ocean (HYCOM). With this system, the impact of coupling on the intensity change of Hurricanes Rita (2005) and Ike (2008) in the Gulf of Mexico is investigated. The warm water in the Gulf of Mexico (temperatures warmer than 29.5°C) associated with the Loop Current and a Loop Current eddy is believed to be the major mechanism for the hurricane intensification. Hurricane initialization is conducted using WRF 3DVAR with bogus data assimilation (BDA) plus conventional data, satellite-derived cloud-track winds and QuikScat winds. With the initialization, the hurricane track predictions are close to the observed best track, which facilitates the intensity change associate with the two regions of high heat content in the Loop Current and a Loop Current eddy. Numerical simulations with/without ocean coupling is then compared to study the ocean impact on the hurricane's intensification. It is found that the warm ocean plays a major role in hurricane's intensification in the Gulf of Mexico. However, the ocean upwelling with SST cooling could result in hurricane's weakening after maximum intensity. WRF 3DVAR data assimilation improves the hurricane initialization, which lays a good basis for hurricane intensity study using WRF-HYCOM modeling system.

Session 7: Ocean predictions and model developments

Chair: Prof. Tal Ezer

A perfectly balanced method for estimating the internal pressure gradients in sigma-coordinate ocean models

Jarle Berntsen

University of Bergen, Department of Mathematics, Johannes Bruns. gt. 12,N-5008 Bergen, Norway.

Email: jarle.berntsen@math.uib.no

The estimation of the internal pressure gradients in sigma-coordinate ocean modelshas been addressed both in text books and in many research papers.In this paper a perfectly balanced method for estimating internal density and pressure gradients is suggested. The method is perfect in the sense that for cases with rho = rho(z), where rho is density and z the vertical coordinate, the numerical estimates of the density and pressure gradients are zero. The method has in addition another important property: For continuous stratification, the estimates of the internal pressure gradients vary continuously with changes in the stratification. The properties of the method are investigated using two very simple vertical column test cases, the seamount case, and two Nordic Seas test cases, one with rho = rho(z) and another more realistic case with rho = rho(x,y,z). For the seamount case and the simple Nordic Seas case, the errors are orders of magnitude smaller than the corresponding errors reported in earlier papers. For the simple vertical column case with non-zero density gradients, the estimates of the gradients produced with the new method converge quadratically towards the true values as the horizontal and vertical grid sizes both tend to zero. The new method may be regarded as a modified second order method calibrated such that the errors are zero for rho = rho(z).

Optimizing fairways for environmental management in the Baltic Sea

Bert Viikmäe, Tarmo Soomere and Nicole Delpeche-Ellmann

The Baltic Sea has the most intense ship traffic in the world and a major part of it is oil transportation, which poses great threat to many vulnerable coastal regions. A major oil pollution and especially its drift into a coastal zone would be devastating for this particularly vulnerable sea area. We address the possibilities for minimising coastal pollution by means of smart placement of ship routes. From the basic factors affecting pollution transport on sea surface, the properties of transport by wind and waves are relatively well known, but the prediction of current-induced transport is more challenging.

The presence of quasi-persistent patterns of currents and rapid pathways of current-driven transport in the Baltic Sea gives way to the development of a new technology of using the marine dynamics for the reduction of environmental risks stemming from shipping and other offshore activities. The idea is to identify areas (of reduced risk), which are statistically safer to travel to in terms of the probability of the transport of accidental pollution to the vulnerable areas. The main benefit is an increase in the time during which an oil spill reaches the coastal zone. A variation of this problem for narrow bays is how to minimize the probability of hitting either of the opposite coasts. The first order solution to this problem is the equiprobability line, the probability of propagation of pollution from which to either of the coasts is equal. The safe fairway would either follow the equiprobability line or cross an area of reduced risk.

We use a large number of single simulations in order to estimate the pathways of current-induced drift patterns. The trajectories of pollution (particle) propagation are calculated with the use of the Lagrangian trajectory model TRACMASS that uses a linear interpolation of pre-computed Eulerian velocities. Trajectories of particles are simulated for a few weeks and saved for further analysis. Simulations with the same initial positions of particles are restarted from another time instant and the process is repeated over a chosen time period 1987-1991.

Three methods were used for finding the optimum fairway. The first method involved using four particles in each grid cell and tracing which coast the majority of these hit. The second method included local smoothing over clusters of 3x3 grid cells. The third approach was to calculate the average probability and average time (particle age) of pollution released into a grid cell of reaching the nearshore. The calculations were made for the northern Baltic Proper and the Gulf of Finland with 2 nautical mile grid resolution.

All three approaches lead to qualitatively similar results that show substantial seasonal and also certain inter-annual variability. A highly interesting feature of the resulting distributions is that

some open sea regions contain a clear probability gradient while some other regions of basically the same size exhibit extensive areas with very low (and essentially constant) probability of hitting either of the coasts. In the former areas it is possible to clearly define the equiprobability line whereas the latter areas can be identified as areas of reduced risk. The distance between different estimates for the location of the equiprobability line serves as an implicit measure of uncertainty related with this sort of solution.

The equiprobability line roughly follows the geometrical centreline of the Gulf of Finland, with several major meanders from it. The location of this line is substantially shifted to the west from the centreline in the northern Baltic Proper.

The presented results confirm that it is possible to considerably reduce the probability of coastal pollution by adverse impacts released from ships by means of optimising the fairways. The relatively small difference in the location of the optimum fairways obtained by different methods indicates a reasonable level of uncertainty connected with this type of solution. A highly interesting side result is the discovery of substantially different regions in the underlying spatial distributions of the probability of coastal hits. This feature probably reflects

certain intrinsic difference in the dynamics of sea currents and the corresponding pollution transport between different sea areas.

A new hybrid vertical coordinate ocean model and its application in the simulation of the Changjiang diluted water

Wenjing Zhanga,b,c，Shouxian Zhud*，Lixian Dongc，Changkuan Zhangd

aOcean Environment Institute of China Ocean University, Qingdao 266003, China

bMeteorology Institute of the PLA Science and Engineering University, Nanjing 211101, China

State Key Laboratary of Satellite Ocean Environment Dynamics, Hangzhou 310012, China

dCollege of Ocean Engineering, Hohai University, Nanjing 210098, China

Based on the analysis of the advantages and disadvantages of some vertical coordinates applied in the calculation of the Changjiang diluted water (CDW), a new hybrid vertical coordinate is designed, which use σ coordinate for current and σ-z coordinate for salinity. For combining the current and salinity, the Eulerian-Lagrangian method is used for the salinity calculation, and the baroclinic pressure gradient (BPG) is calculated on the salinity sited layers. The new hybrid vertical coordinate is introduced to the widely used model of POM (Princeton Ocean Model) to make a new model of POM-σ-z. The BPG calculations of an idea case show that POM-σ-z model brings less error than POM model. The simulations of CDW also show that POM-σ-z model is better on simulating the salinity and its front than POM model.

The wave-induced mixing scheme and its application in Operational Marine Environment Forecast System in the Seas off China

Wang Guansuo, Qiao Fangli, Xia Changshui and Yang Yongzeng
The First Institute of Oceanography, State Oceanic administration, China

An Operational Coupled Forecast System for the seas off China and adjacent (OCFS-C) is constructed based on the paralleled wave-circulation coupled model, which is tested with comprehensive experiments and operational since May 1st, 2008. The main feature of the system is that the wave-induced mixing is considered in circulation model. Daily analyses and three day forecasts of three-dimensional temperature, salinity, currents and wave height are produced. Coverage is global at 1/2 degreed resolution with nested models up to 1/24 degree resolution in China Sea. Daily remote sensing sea surface temperatures (SST) are taken to relax to an analytical product as hot restarting fields for OCFS-C by the Nudging techniques. Forecasting-data inter-comparisons are performed to measure the effectiveness of OCFS-C in predicting upper-ocean quantities including SST, mixed layer depth (MLD) and subsurface temperature. The variety of performance with lead time and real-time is discussed as well using the daily statistic results for SST between forecast and satellite data. Several buoy observations and many Argo profiles are used for this validation. Except the conventional statistical metrics, non-dimension skill scores (SS) is taken to estimate forecast skill. Model SST comparisons with more one year-long SST time series from 2 buoys given a large SS value (more than 0.90). And skill in predicting the seasonal variability of SST is confirmed. Model subsurface temperature comparisons with that from a lot of Argo profiles indicated that OCFS-C has low skill in predicting subsurface temperatures between 80m and 120m. Inter-comparisons of MLD reveal that MLD from model is shallower than that from Argo profiles by about 12m. QCFS-C is successful and steady in predicting MLD. The daily statistic results for SST between 1-d, 2-d and 3-d forecast and data is adopted to describe variability of Skill in predicting SST with lead time or real time. In a word QCFS-C shows reasonable accuracy over a series of studies designed to test ability to predict upper ocean conditions.

Three-dimensional sediment transport model for the Pearl River Estuary

Wang Zhili1, Geng Yanfen2

1. State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Nanjing Hydraulic Research Institute，Nanjing，210024， Email: zlwang@nhri.cn

2. Transportation College, Southeast University, Najing 210096, Email: geng_y_f@yahoo.com.cn

In this paper, a three-dimensional sediment transport model with staggered C-unstructured grids in the horizontal direction and Z-level grids in the vertical direction has been developed. The model is discretized by semi-implicit finite volume method, in that the free-surface and vertical diffusion are semi-implicit, thereby removing stability limitations associated with the surface gravity wave and vertical diffusion terms. The remaining terms in the momentum equations are discretized explicitly by integral method. The model is closed physically and mathematically using the Mellor and Yamada level-2.5 turbulent closure submodel. The numerical model is used for simulation accumulation process of immersed tube tank of HMZ (Hong Kong-Macau-Zhuhai) bridge. The model is calibrated and its performance extensively assessed against on-site experiment.

Session 8: Coupled physical-biogeochemical models

Chair: Prof. Huijie Xue

A 3-Dimensional Physical-Biogeochemical Model Study of Seasonal and Interannual Variability of Phytoplankton Biomass in the Gulf of Maine

Huijie Xue, School of Marine Sciences, University of Maine, 5706 Aubert Hall, Orono, ME 04469, USA, 1-207-581-4318, hxue@maine.edu
Guimei Liu, Fei Chai, Andrew Thomas

To investigate the seasonal variation of biological productivity in the Gulf of Maine (GoM), a three-dimensional physical-biogeochemical model has been developed and used to estimate the primary production in the GoM. The physical processes are simulated using the Gulf of Maine Ocean Observing system (GoMOOS) nowcast/forecast system with real-time forcing, while the biogeochemical processes are simulated using the Carbon, Si(OH)4, and Nitrogen Ecosystem (CoSiNE) model consisting of silicate, nitrate and ammonium, two phytoplankton groups, two zooplankton grazers, and two detritus pools. The POM-CoSiNE model reveals seasonal and spatial variations of phytoplankton and nutrient concentrations, which compare well with in situ and satellite data. Spring blooms occur after the winter mixing weakens and prior to the establishment of the summer stratification. To examine the dynamic controls on phytoplankton biomass and nutrient transport in the GoM, sensitivity experiments have been performed to determine the potential impact of several key factors including wind, light, and nutrient concentrations in deep water. An increase/decrease in Photosynthetically Active Radiation or nutrient concentrations leads to a more or less linear response in phytoplankton biomass, while wind effects are multi-facets including both mixing and adevction of nutrients and plankton biomass.

Modeling impacts of mesoscale eddies on biogeochemical processes in the South China Sea and Gulf of Alaska

Fei Chai1, Peng Xiu1, Huijie Xue1, Lei Shi1

1 School of Marine Sciences, University of Maine, Orono, Maine, USA

fchai@maine.edu

Numerous mesoscale eddies occur each year in the South China Sea (SCS) and Gulf of Alaska (GoA), but their statistical characteristics and impact on biogeochemical cycles have never been substantially investigated. A Pacific basin-wide three-dimensional coupled physical-biogeochemical model has been developed and the results for the SCS and GoA are used to quantify the eddy activities and the subsequent biogeochemical responses during the period of 1993-2007. Based on sea level anomaly (SLA), the Okubo-Weiss method is used to identify eddies and a connectivity algorithm is used to track eddies in this study. In order to evaluate the model performance, the modeled results are compared with the satellite derived SLA. On average, there are about 32.9+2.4 eddies in the SCS simulated by the model and 32.8+3.4 eddies observed with the satellite each year. There are 13.9+3.0 eddies in the GoA simulated by the model and 13.6+2.7 eddies derived from the satellite SLA. The impacts of mesoscale eddies to the biogeochemical processes are evaluated with the model results. This study suggests that mesoscale eddies in the SCS are important sources of nutrients (nitrate and silicate) to the euphotic zone, which plays a significant role in regulating the biogeochemical cycle in the SCS. The iron transport from the coast to the Gulf will be estimated with the model results. This study suggests that mesoscale eddies in the Gulf of Alaska are important sources of iron to the euphotic zone, which plays a significant role in regulating the biogeochemical cycle in the Gulf of Alaska.

Seasonal and interannual ecosystem variability in the South East Asian region: Results of an eddy-resolving physical-biological ocean model

Yoshikazu Sasai1*, and Hideharu Sasaki2

1. Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, 3173-25, Showa-machi, Kanazawa-ku, Yokohama, 236-0001, Japan. Email:ysasai@jamstec.go.jp

2. Earth Simulator Center, Japan Agency for Marine-Earth Science and Technology, Yokohama, 236-0001, Japan

An eddy-resolving coupled physical-biological ocean model has been employed to investigate physical influences on the marine ecosystem variability in the South East Asian region. The region is characterized by various temporal and spatial oceanic phenomena (e.g., mesoscale eddies, ocean currents, throughflow, coastal upwelling and tidal mixing). Additionally, the Asian-Australian monsoon, El Nino Southern Oscillation (ENSO), and the Indian Ocean Dipole (IOD) also affect this region. The model captures the seasonal and interannual variability of chlorophyll distribution associated with the mesoscale eddies, ocean circulation and upwelling generated by the monsoon. The model reproduces the high chlorophyll concentrations along the northwestern coast of Luzon and Kalimantan during the winter monsoon and along the southern coast of Java-Sumatra, along the coast of Vietnam and in the Arafura Sea during the summer monsoon. In these regions, the upwelling generated by the monsoon uplifts the nutrient-rich waters and increases biological production. During boreal summer-fall, the phytoplankton bloom along the southern coast of Java-Sumatra extends westward by the surface current and to offshore in the southeastern tropical Indian Ocean by the cyclonic eddy. The spreading of phytoplankton bloom is strongly linked to anomalous winds associated with the ENSO and IOD events.

Simulation of the impact of Tropical cyclone on some aspects of the ocean thermal structure of Bay of Bengal (Indian Ocean) using POM

Yashvant Das*, UC Mohanty [1]

*Air Worldwide India Pvt. Ltd., Hyderabad-500082, India, yashvantdas@rediffmail.com

1CAS, Indian Institute of Technology, Hauz Khas Delhi-100016 , New Delhi, India

Princeton Ocean Model (POM) is used to investigate the thermal (surface and subsurface) characteristics of Bay of Bengal (Indian Ocean) due to a very severe tropical cyclone. The model uses orthogonal curvilinear grid with Arakawa C-grid staggering. Model horizontal resolutions vary from 4 to 11 Km with 26 sigma levels in the vertical. Implicit time integration scheme with splitting mode time steps are used for computational efficiency. The external mode short time-step of 12 sec. and internal mode long time-step of 540 sec. are used. Initially the model simulations are conducted for year long run to evaluate real time forecast capability of the model. Idealized synthetic cyclonic vortex is generated and superimposed on the analyzed wind field in order to provide realistic cyclonic vortex to the model as input. Results show considerable changes in thermal structure (surface and subsurface) due to the passage of the cyclone when compared with the observations.

OYSA (Outstanding Young Scientists Award) session 1

Chair: Prof. L.-Y. Oey

Instability and Mixing in Shelf Seas

Zhiyu Liu1,* and S.A. Thorpe2

1State Key Laboratory of Marine Environmental Science, College of Oceanography and Environmental Science, Xiamen University, Xiamen, China (zyliu@xmu.edu.cn)

2School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey, UK

The stability of stratified flows at locations in the Clyde, Irish and Celtic Seas on the UK Continental Shelf is examined. Flows are averaged over periods of 12 – 30 min in each hour, corresponding to the times taken to obtain reliable estimates of the rate of dissipation of turbulent kinetic energy per unit mass, ε. The Taylor-Goldstein equation is solved to find the maximum growth rate of small disturbances to these averaged flows, and the critical gradient Richardson number, Ric. The proportion of unstable periods where the minimum gradient Richardson number, Rimin, is less than Ric is about 0.35. Cases are found in which Ric < ¼; 37% of the flows with Rimin < ¼ are stable, and Ric < 0.24 in 68% of the periods where Rimin < ¼. Marginal conditions with 0.8 < Rimin/Ric < 1.2 occur in 30% of the periods examined. The mean dissipation rate at the level where the fastest growing disturbance has its maximum amplitude is examined to assess whether the turbulence there is isotropic and how it relates to the Wave-Turbulence boundary. It is concluded that there is a background level of dissipation that is augmented by instability; instability of the averaged flow does not account for all the turbulence observed in mid-water. The data do not support the hypothesis that the turbulent flows observed on the UK shelf adjust rapidly to conditions that are close to being marginal, or that flows in a particular location and period of time in one sea have stability characteristics that are very similar to those in another.

Numerical studies of internal waves degeneration initiated by a tilted thermocline

Zhenhua Lin* and Jinbao Song

Key Laboratory of Ocean Circulation and Waves (KLOCAW), Institute of Oceanology, Chinese Academy of Sciences, Nanhai Road 7, Qingdao 266071, PR China, Email: linzhenhua@163.com

The thermocline in a closed domain is tilted by the external wind forcing, and it tends to recover a level position when the wind falls. Previous linear analysis shows that internal seiche is generated and the system is symmetric, while in situ observations show that asymmetric phenomena such as internal surge and internal solitons are also excited. A 2D, non-hydrostatic numerical model embedded with standard $k-\varepsilon$ turbulence model is used to study the restoration process and the numerical results are compared with available laboratory experiments. The numerical results show that internal seiche, internal surge and internal solitons are generated during the restoration process, which could also be observed in the laboratory experiments. Sensitivity studies show that the nonlinear term is necessary for the generation of internal surge and internal solitons, which play vital roles in energy cascading. The vertical lateral boundary reflects the interface oscillations while strong internal wave breaking occurs at inclined boundary. The velocity field accompanying internal surge and internal solitons is much larger than that with internal seiche, which is important for sediment resuspension and ecological processes. The temporal evolutions of total kinetic and potential energy are also analyzed and discussed.

Improvement of the South Asian summer monsoon in climate model by using non-breaking wave-induced mixing

Yajuan Song*, Fangli Qiao and Zhenya Song

Key Laboratory of MArine Environment Science and Numerical Modelling, state oceanic administration, No.6 Xia-xia-ling Road, Qingdao, 266061, China.

Email: songyj@fio.org.cn

Non-breaking wave-induced mixing is incorporated to the LASG/IAP coupled climate system model named FGCM-0 (Flexible General Circulation Model, version 0) to validate the wave effect on the fundamental features of the South Asian summer monsoon (SASM). Comparing the results of "no wave" and "wave" numerical experiments, the model coupled with wave-induced mixing can reproduce more realistic characteristics of the SASM. Water vapor flux in the Bay of Bengal and the South China Sea is significantly enhanced, which is more consistent with observation. The RMS errors between the simulated and observed precipitation in the domain (35E-160E, 30S-60N) reduce from 3.23 to 2.36. Physical processes of the SASM variations under the effect of wave-induced mixing are as follows: Vertical mixing caused by wave effect change the thermohaline structure in upper-ocean. Sea surface temperature (SST) drops in south India Ocean, where the interaction of shallow thermocline and strong mixing make more cold water upward. Nonuniform distribution of SST accompanies by variations in atmospheric circulation. The cyclonic wind vorticity in the Bay of Bengal contributed to the formation of downwelling, which is favorable to warm SST. According to Gill-Matsuno mechanism, the South-North asymmetry heating about the equator produces cyclone anomalous motion over the South Asia and anticyclone anomalous motion in south hemisphere. Members of the monsoon circulation system, such as India low and cross-equatorial flow, are significantly improved by new model. The change of ocean heating as a result of the wave-induced mixing has key effects on the SASM simulation.

The simulation of the observed temperature profiles in the Bashan Reservoir with different mixing schemes.

Hongyu Ma Fangli Qiao, Guansuo Wang and Changshui Xia
Key Laboratory of MArine Environment Science and Numerical Modelling, state oceanic administration, No.6 Xia-xia-ling Road, Qingdao, 266061, China.
Email: mahy@fio.org.cn

Mixing schemes are very important for numerical models, which influence the ability of simulation of numerical models. Depending on field observations in Bashan Reservoir, especial the observations of TKE dissipation rate, we simulate the temperature profiles of the observations with different mixing schemes in order to compare the mixing schemes.

Distinct modes of internal variability in the Global Meridional Overturning Circulation associated to the Southern Hemisphere westerly winds

WEI WEI AND GERRIT LOHMANN

Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, Email: wei.wei@awi.de

MIHAI DIMA

Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, and Faculty of Physics, Department of Atmospheric Physics, University of Bucharest, Bucharest, Romania

The internal variability of the global meridional overturning circulation (GMOC) in long-term integration of a state-of-art coupled general circulation model is examined. Two distinct modes of the GMOC, which are closely linked to the Southern Hemisphere westerly winds (SWWs) anomalies, are found on multi-decadal and centennial time scales. The dominant mode is characterized by Southern Ocean dynamics: strengthening or poleward shifts of the SWWs yield Ekman-induced northward mass transport, including a zonally asymmetric response in the Southern Ocean sea surface temperature, and a cooling in the tropical Pacific Ocean due to large-scale upwelling. The second mode projects more on the Atlantic meridional overturning circulation (AMOC). It affects the high latitude northern hemisphere sea surface temperature. Our results from a mid-Holocene experiment imply that both modes are independent with the climate background conditions in the Holocene. Finally, we argue that the natural modes of GMOC are important to understand trends in ocean circulation with consequences for heat and carbon budgets for past, present and future climate.

The South China Sea Intermediate Water (SCSIW) and its exchange with Northwest Pacific

Xuezhu Wang[1,2*], Peiliang Li[1] and Bo Yang[1]

1.College of Physical and Environmental Oceanography, Ocean University of China, No.238 Song-ling Road, Qingdao, 266100, China.
2 Alfred Wegener Institute for Marine and Polar Research, Bussestrasse 24, D-27570, Bremerhaven, Germany. Email: Xuezhu.Wang@awi.de

Based on the analysis of a total of 13748 temperature-salinity profiles from historical hydrological data set WOD05 and ARGO and the triply nested simulation using HYCOM, the mean characteristics and seasonal variation of the South China Sea Intermediate Water (SCSIW) and its exchange with the Northwest Pacific Intermediate Water (NPIW) are studied in this paper. South China Sea Intermediate Water (SCSIW), which is characterized by the salinity minimum, is located at potential density of 26.5-27.0 σ_θ or neutral density of 26.5-27.2 σ_N layer. It originates from the NPIW, and evolves to be shallower, thicker, warmer and saltier than the NPIW. Both the observational data analysis and model simulation results show that the NPIW has an intrusion into the SCS almost all the year round. The net transport of NPIW into the SCS calculated from simulation is about 0.75Sv on annual mean. The calculated seasonal transport and tracer experiment suggest that strong intrusion tends to occur in spring and summer. The pathway of the NPIW intruding into the SCS is mainly from the northern part of the Luzon Strait.

The study of estuarine turbidity maximum in Yangtze River Estuary

Dehai Song*, Xiao Hua Wang
School of Physical, Environmental and Mathematical Sciences, University of New South Wales at the Australian Defence Force Academy, Canberra, ACT 2600, Australia
dehai.song@student.adfa.edu.au

A suspended sediment transport module is coupled into the Princeton Ocean Model with wetting and drying scheme. It is applied to the Yangtze River Estuary to study the estuarine turbidity maximum (ETM). Field work was conducted in the Deepwater Navigation Channel (DNC) in the North Passage of Shanghai Port, China. Those observed data will be used to calibrate the model. The governing mechanism controlling the formation of ETM and its motion will be discussed by combining the observation and numerical modeling approaches.

A depth-averaged fine sediment transport model for environmental studies in the Scheldt Estuary (Northwestern Europe)

Olivier Gourgue*, Anouk de Brauwere, Benjamin de Brye, Eric Deleersnijder, Vincent Legat
Université catholique de Louvain (UCL), Institute of Mechanics, Materials and Civil engineering (iMMC), avenue Georges Lemaître 4, 1348 Louvain-la-Neuve, Belgium, Email: olivier.gourgue@uclouvain.be

The Scheldt takes its source in France and flows through Belgium and the Netherlands, before discharging into the North Sea. Its catchment basin is one of the most densely populated in Western Europe, comprising important cities such as Brussels, Antwerp, Ghent (Belgium) and Lille (France), and huge industrial parks, the most important being around the port of Antwerp, one of the major European harbors. In 2007, the interdisciplinary network TIMOTHY started with the aim to study the modifications of the Scheldt Basin system in response to natural and anthropogenic changes. The authors of this talk are involved in modeling the tidal part of the basin, using the two-dimensional finite-element model SLIM.

Suspended particulate matter plays an important role on most of biogeochemical organisms in aquatic environments. A good representation of the sediment dynamics is therefore essential for environmental modeling. The hydrodynamic module of SLIM is already validated on the Scheldt Estuary and now widely used for applications not involving sediment dynamics. The aim of this talk is to present the developments of the sediment module that is mandatory before undertaking more challenging environmental studies.

The Scheldt features three estuarine turbidity maxima (ETM) and temporal variations of the turbidity at the tidal, spring/neap cycle and seasonal scales that can not be explained by the only hydrodynamics. The authors identify key processes that are needed to describe the sediment dynamics accurately in the Scheldt Estuary. In particular, flocculation of suspended sediments (influenced by suspended sediment concentration, salinity and biological activity) and biostabilization of the bottom layer (influenced by biological activity) are taken into account.

Inertial oscillations in floe motion near the North Pole - observations and simulation

Qi Shu*, Fangli Qiao and Zhenya Song

Key Laboratory of Marine Environment Science and Numerical Modelling, State Oceanic Administration, No 6 Xian-xia-ling Road, Qingdao, 266061, China.

Email: shuqi@fio.org.cn

The motion of a floe near the North Pole (87°N, 175°W) was observed from 8 to 19 August 2010 by the fourth CHINARE Arctic Expedition. The trajectory of the floe showed circular motion superimposed on straight drift. Each cycle has a period of about 12 h which is the same as the period of inertial oscillation. The circular motion is clockwise and believed to be inertial motion. A simple one-dimensional sea ice-ocean coupled dynamic model is used to study the floe motion. Using observed wind, the oscillations in the floe are reasonably simulated.

Numerical analysis on the wake instability and vortex street in the geostrophic flow

Name: Tsubasa Kodaira*, Takuji Waseda,
Affiliation: Department of Ocean Technology, Policy and Environment, Graduate School of Frontier Sciences, University of Tokyo,
Address: Environment building785 , 5-1-5 Kashiwanoha, Kashiwa-shi, Chiba-ken 277-8561, Japan
Email: kodaira@orca.k.u-tokyo.ac.jp

An Island in a strong oceanic jet, such as the Kuroshio, creates an attractive flow field in its wake. SAR imaging from the satellite, captured eddies shed behind the Mikura islands south of Japan, possibly created due to wake instability. To investigate the instability of the geostrophic wake, we have simulated the barotropic jet flowing through an obstacle with a simple numerical setting using POM's external mode as a numerical solver. The non-dimensional parameters relevant for this study are the Reynolds number and F. F is the inverse of the Burger number. In addition to this, we executed global linear stability analysis and detected growth rates and eigen modes for each Base Flow. The results revealed that increasing F suppresses the instability.

Application on Numerical Simulation in Construction of Offshore Artificial Islands in the East of Laizhou Bay

Likui Zhanga,*, Jianzheng Wua, Yonggen Sunb

1 College of Marine Geoscience of Ocean University of China

2 First Institute of Oceanography, SOA, China

With the rapid development of local economy, Longkou City has been playing a leading role in the county-level economy in Shandong Province. The offshore artificial Islands in the east of Laizhou Bay are to be constructed to enlarge the developing space and ensure the continual increase and sustainable development of the economy. A numerical model is established in the paper to simulate the current and deposition-erosion features in this sea area. The tidal and current verification prove that the simulation results agree well with the observation data. Then the current and deposition-erosion features after the construction of offshore artificial islands are predicted in calm wind condition and NW, SW wind condition upon the numerical model. According to the results of prediction, after the construction of the artificial islands, the current field and deposition-erosion features are obviously changed and the tidal prism of Laizhou Bay deceases. And the deposition rate will increases in the northern sea area of the artificial islands, especially along the channel; the western sea area of the artificial islands will be severely eroded instead of being slightly deposited or slightly eroded; the erosion rate will decreases in the southwestern from Jiehe River. Finally several conclusions and proposals are presented for the ocean engineering.

OYSA (Outstanding Young Scientists Award) session 2

Chair: Prof. Tal Ezer

Numerical study of wave and current dynamics over barred beaches with rip channels

Rui Li* and Changlong Guan

Physical Ocean Laboratory, Ocean University of China, 238 Songling Road, Qingdao, 266100, Shandong, China.

Email: lirui398@gmail.com

The dynamics of waves and currents over barred beaches with rip channels are investigated based on numerical simulations, by using a coupled wave-current model system, which is the combination of wave model REF/DIF 1 and current model SHORECIRC. The relationships of rip velocity vs. wave height, rip velocity vs. wave period, and rip velocity vs. water depth are studied respectively. Model results indicate that rip velocity depends considerably on the location where waves break. As waves break on the bars, the rip current velocity is proportional to incident wave height and wave period, and proportional to water depth inversely. As waves break priori to getting the bars, rip current velocity is decreasing with incident wave height increasing. As the wave breaking location is not over the bars, rip current is weak and decreasing slowly with water depth increasing. A new dimensionless wave height scaled with wave length and wave breaking location, is introduced. It is showed that dimensionless rip current velocity varies linearly with the dimensionless wave height. The dynamic mechanism of the secondary circulations is studied. It is indicated that the secondary circulations is driven by the high water level near the shoreline, which is due to the waves propagating through the rip channel and eventually breaking near the shoreline. An onshore flow always exists in the central line of rip channel, whether the presence of the secondary circulation or not.

Intercomparison of Wind Stress Parameterization Schemes in Different State of Sea Surface Wave

Juanjuan Wang* and Jinbao Song

Key Laboratory of Ocean Circulation and Wave Studies, institute of oceanology, Chinese academy of science， No.7 Nan-hai Road, Qingdao, 266071, China.

Email: wjjhhu2004@126.com

The behavior of six parameterization schemes to estimate sea surface wind stress in different states of surface wave have been evaluated. Under the condition of developing wind wave, all of the six schemes underestimate wind stress for U10>15m/s (U10 is the wind speed at 10m above the sea surface) and the underestimate increases with U10. Wind stress estimated by the scheme of Taylor and Yelland (2001) is shown to agree with field data better than others. In the state of fully developed wind wave, the estimates of six schemes significantly scatter for U10>12m/s and the scatter increases with U10. For sea surface dominated by swell, all of the six schemes underestimate the wind stress for a wide range of wind speed. The swells opposing wind speed, which can enhance the wind stress based on field data, may contribute to the underestimate of six schemes. In order to investigate effects of surface wave on wind stress, a simple physical model in the presence of steady surface waves is constructed and the result shows that surface wave can increase the wind stress by a factor of 1+ O(a2k2), where ak<<1 is the wave slope.

Three Dimensional Hydrodynamics in Darwin Harbour, Northern Territory

Li Li*1, Xiao Hua Wang1, David Williams2, Harvinder Sidhu1

1 School of Physical, Environmental and Mathematical Science, University of New South Wales at Australia Defence Force Academy, Northcott Dr, Canberra, ACT, 2600, Australia

2 Australian Institute of Marine Science, Arafura Timor Research Facility, Casuarina NT 0811, Northern Territory, Australia

Email: li.li@student.adfa.edu.au

The three dimensional hydrodynamics of Darwin Harbour is studied based on RMA (Resource Management Associates/Association) model. The hydrodynamic model bathymetry includes the high resolution Darwin Harbour coastal line, sea surface area and mangroves distribution with a minimum grid cell of 50 m. The model forced by tides at the open boundary. Besides surface and bottom, four horizontal layers were set in the vertical direction, namely 1.0 m, 5.0 m, 7.0 m and 9.0 meter below surface level. Layers will be removed automatically if the water is shallower than their initial depths. The observed sea surface height data (SSH) and the current data from June 20th to July 19th in 2009 were used to calibrate the model. The simulation finds that the tides in the Harbour are dominantly semi-diurnal and the largest tidal range can reach 8 m and M2 is the largest tidal constituent with amplitude around 1.99 m and phase about 249 degrees, followed by S2 with 1.1 m and 299 degrees. The simulated amplitudes and phases of the main tidal constitutions fit very well with that from tidal harmonic analysis of 18 years hourly observation data. At spring tides, the peak flood currents velocity is more than 1 m/s which occurred near the East Arm, and is slightly bigger than the peak ebb currents. For M2 tidal current component in the East Arm, the major semi-axis is 0.34 m/s and 0.31 m/s at the surface and the bottom, respectively. The depth averaged maximum tidal current speed is 0.33 m/s. The rotation direction is counter clockwise at bottom while clockwise at surface and the motion is almost rectilinear.

The Coastal Model for the Tsugaru Strait coupling Tide and Tsugaru Warm Current

Ryota Wada*, Takuji Waseda and Hirotada Nanjo
The University of Tokyo, Graduate School of Frontier Science, Department of Ocean Technology, Policy and Environment, Email: wada@orca.k.u-tokyo.ac.jp

The Tsugaru Strait regional model, based on POM external mode, was developed to study the feasibility of marine current power system. 15 day current observation was conducted at the Benten Island located at the northwest tip of the Shimokita Peninsula, revealing that the spectral energy of diurnal, semidiurnal and over-tide flows were comparable to the magnitude of the steady current. The regional model (140-141.5E, 40.4-42.6N) has 500 m grid resolution and is forced by Nao99 tidal elevation and JCOPE2 Tsugaru warm current at the eastern and western open boundaries. The Nao99 tidal elevation was adjusted to correct the bias of the model from the tidal gauge observations. The relative magnitude of the spectral energy of the modeled diurnal and semidiurnal current did not agree well with the Benten Island observation when the model was forced by tide only. However, the spectral characteristic of the model agreed well with the observation when the model was forced by both tide and current. The result indicates that the energy distribution of each tidal component is advected by the non-periodic Tsugaru warm current. The advective effect was largest in area with complicated topography in the southeast region of the strait, where strong non-linearity is expected. The robustness of this finding is being tested for different open boundary conditions.

An efficient parallel multirate model of the Great Barrier Reef

Bruno Seny*, Jonathan Lambrechts, Vincent Legat and Jean-François Remacle
Université catholique de Louvain (UCL), Institute of Mechanics, Materials and Civil engineering (iMMC), avenue Georges Lemaître 4, 1348 Louvain-la-Neuve, Belgium, Email: bruno.seny@uclouvain.be

The development of fast and suitable time integration methods for ocean modeling constitutes an important challenge. No single time-discretisation works well for all physical processes in a complex marine model, as different subsystems have widely different characteristics in terms of time scales, dynamic behavior, and accuracy requirements.

Our research team has developed a hydrodynamic model of the whole Great Barrier Reef (GBR). A discontinuous Galerkin finite element method based on unstructured meshes is used for the spatial representation. Explicit time stepping schemes are very attractive for the time integration but they are severely constrained by the Courant–Friedrichs–Lewy condition that limits the global time step. Multirate schemes [1,2] present a way to partly circumvent these restrictions by gathering the mesh elements in groups that have a specific stable time step. However, the transitions between these multirate groups have to be accommodated in a clever way. In particular, global consistency and conservation properties are significantly linked with the way groups communicate with each other.

Moreover, applications like the GBR require the use of parallel computers. Since elements have different costs depending on their belonging to a specific multirate group, a load balancing strategy has to be supplied. This problem can be posed as a graph partitioning problem with multiple objectives.

Oceanic CO_2 sink and pH changes over historical time and twenty-first century

BAO Ying*, QIAO Fangli and SONG Zhenya

Key Laboratory of Marine Science and Numerical Modeling, State Oceanic Administration, Qingdao, 266061, China. Email: baoying@fio.org.cn

A three dynamical global ocean carbon cycle model is built based on the global ocean circulation model POP and the ocean biogeochemical model OCMIP-2. The ocean physical processes and biogeochemical processes are well simulated after comparing the model results with the observation data. Then the ocean carbon cycle of the pre-industrial, industrial history period and the 21st century, is simulated under different atmospheric CO2 concentration forcing. The model results tells that the ocean absorbs the atmospheric CO2 in the middle latitude of the south hemisphere and the middle and high latitude in north hemisphere, while the ocean release CO2 to the atmosphere in the equatorial area and the Antarctic Circumpolar Current area. The oceanic CO2 sink is rising during the historical time, but in the 21st century, the oceanic sink reaches a peak then decrease even though the atmospheric CO2 concentration rising all the time. The north Atlantic absorbs the most anthropogenic carbon during the historical and future time. In 2100, the anthropogenic carbon will be transported through the entire Atlantic by the north Atlantic deep water , while it will be transferred to 50° S by the Antarctic bottom water. The pH of sea water decrease 0.1 during the history time and will go on decrease in the 21st century. Under the RCP8.5 scenario, the sea water pH wil be 7.73, and decreases 0.43, while the H+ concentration will be 2.7 times of pre-industrial level.

Sea Surface Temperature feature and Front divided Water Mass feature of Enteromorpha Prolifera Blooms in Yellow Sea

Yuntao Wang1, 2, Shitao Wang2, Shibin Ge3 and Zhongwei Huang2

1. University of Georgia, Marine Science Department, Athens GA, 30605, USA

2. Ocean University of China, College of Information Sciences and Engineering. Qingdao, 266071, China

3. Graduate University of Chinese Academy of Sciences, Beijing, 100049, China

From 2007 to 2009, the continually detected Green Tide, which caused by blooming of Enteromorpha Prolifera(EP) during summer time in Yellow Sea, made a negative influence to fisheries, shipping, and tourism, even the Olympic Sailing Games. There has been published report of how to detect EP with satellite image, which gives us an approach to locate the position of the plant in sea surface. By using multi-channel composition method the EOS satellite data to deal with the EOS satellite data, we have found the distribution and densities of EP. For example, on May 31 2008, the area of EP is 10000km2 roughly 80km to 150km from coast. By gathering statistics of the water temperature pattern of the area where confirmed the distribution of EP, we found they will drift with a group of water that has similar surface temperature, which makes the standard deviation smaller and more significant than other area. To get further information of the temperature feature of the area with EP, we divided the sea into water groups by temperature fronts derived with sea surface temperature (SST) based on OSTIA data. The analysis between water group and EP distribution gives us a general view about the location of the plant. The result shows the EP is restrained in specific water group and drift with it.

Poster Session

Decadal variability in the sea level and Kuroshio transport in the East China Sea detected by a data assimilation ocean model

Endro Soeyanto (Ehime University), Xinyu Guo (Ehime University), Jun Ono (Ehime University) and Yasumasa Miyazawa (Research Institute for Global Change, JAMSTEC)

The reanalysis data of a data assimilation ocean model, the Japan Coastal Ocean Predictability Experiment 2 (JCOPE2), during period from January 1993 to December 2009 (17-years) were used to investigate the presence of decadal changes in the sea level and Kuroshio transport in the East China Sea (ECS). The reanalysis results in decadal scale show there are 2 (two) different response periods of Sea Level Anomaly (SLA) and Volume transport (VT) to the Pacific Decadal Oscillation (PDO) index, i.e. periods of January 1993-December 2002 (10 years) and January 2003-December 2009 (7 years) in the ECS and adjacent seas. In sea level variation, the area with negative correlation coefficients (r=-0.4 to r=-0.5) between the SLA and PDO index is found in the 10-year's period, distributing almost the whole ECS except for the adjacent of Changjiang river mouth. Meanwhile, results of the 7-year's period revealed an area with positive correlation coefficients (r=0.3 to r=0.4) almost covering the ECS. In the same time scale, Kuroshio transport along the ECS shelf break gave the immediately positive correlation to PDO index. The largest correlation coefficients (r=0.5 to r=0.6) is also found in the 10-year's period, especially from west of Okinawa to Tokara Strait. After this period, there is no significant correlation between the Kuroshio transports to PDO index. Inside the ECS shelf water on 10-year's period, we also confirmed that the transport through the Tsushima Strait has negative correlation to PDO index, while that through the Taiwan Strait has an opposite response to PDO index. The difference in the transport through two straits has a consistent relation with PDO index as the sea level inside the ECS with the PDO index.

What causes the seasonal variation of the upper-ocean Luzon Strait transport?

Yi-Chia Hsin1 and Chau-Ron Wu2,*

1Department of Oceanography, University of Hawaii, Honolulu, USA

2Department of Earth Sciences, National Taiwan Normal University, Taipei, Taiwan Email: cwu@ntnu.edu.tw

The Luzon Strait transport, especially in the upper ocean, being a small difference between the large meander inflow and outflow, is also seasonally varying and subject to large standard deviation. The annual mean Luzon Strait transport, when averaged over a 9-year period, is estimated to be westward (-3.6 ± 5.1 Sv) along 120.75 °E. We have also conducted process of elimination experiments to assess the relative importance of open-ocean inflow/outflow, wind stress and surface heat flux in regulating Luzon Strait transport and its seasonality. The East Asian monsoon winds stand out as the predominant forcing. Without it, the upper-ocean Luzon Strait transport changes from westward to eastward, and with misaligned seasonality, triggering an inflow from the Mindoro Strait to the SCS to replenish the water mass loss.

Simulation on the three-dimensional diffusion and climate effect of Pinatubo volcanic aerosols

Jiechen Zhao and Fangli Qiao
Key Laboratory of Marine Sciences and Numerical Modeling, State Oceanic Administration, Qingdao, 266061, China. Email: ppstone@126.com

In this paper, the NCAR CAM3.0 model is used to simulate the migration and spread of volcanic ash and aerosol after the eruption of Mount Pinatubo. With the three-dimensional volcanic aerosol data we get from our experiments, we simulate the response of climate system. Simulation results show that volcanic aerosol cloud in the stratosphere drift westward rapidly under the strong east wind, and surround the latitude circle in 23 days. The aerosol cloud spread mainly to the Northern Hemisphere, but high concentration cloud is always along the low latitude. In troposphere part of aerosols move westward and others drift northward. But high concentration clouds always maintain at Southeast Asia within two weeks. After one month aerosols almost distribute uniformly in the northern hemisphere except for high concentration centers in East Asia. It takes about 20 days to surround latitude circle in troposphere. In addition, the aerosols in the stratosphere only move above 200hPa, no large downward transport; but the aerosols in the troposphere first spread upward and downward along the vertical direction, then move in the horizontal level.

Using the three-dimensional diffusion simulation, we get a three-dimensional volcanic aerosol data and apply to CAM3.0 to study the response of climate. Volcanic aerosols in the troposphere quickly removed with the precipitation process, and can't cause significant climatic effects, so we just consider the stratospheric volcanic aerosols. Simulation results in this paper show that the stratospheric volcanic aerosol significantly reflect solar radiation (maximum 5.0W/ m2), and absorb upward long-wave radiation (max 1.0W/ m2), which cause net solar radiation anomalies of -4.5 W/m2 in the earth surface, but no significant change in the long-wave radiation. Changes in surface radiation caused the maximum 0.8K summer cooling (global average), and the maximum 0.5K winter warming. The observed cooling and warming amplitude is smaller than the simulation; at the same time stratosphere appear 2.0K warming, which is a little larger than the observation (1.6K). We found that summer cooling in high latitudes of the Northern Hemisphere is mainly caused by radiation changes. Winter warming in high latitudes of the Northern Hemisphere is mainly caused by temperature advection anomalies (radiation changes cause the circulation changes), and winter cooling in the low-latitude is mainly caused by

radiation anomalies. This study can help to verify the capacity of CAM3.0 to well simulate atmospheric circulation and tracer transport, deeply understand the three-dimensional diffusion of volcanic aerosol, and its climate impact after the eruption.

Modelling Tidal Dynamics and Flow Patterns over Complex Bottom Topography in Potter Cove, Antarctica, using Unstructured Grid Finite Volume Coastal Ocean Model

Chai Heng Lim*, Karsten Lettmann and Jörg-Olaf Wolff

Physical Oceanography Group, Institute for Chemistry and Biology of the Marine Environment (ICBM), Universität Oldenburg, Carl-von-Ossietzky-Str. 9-11, Postfach 2503, 26111 Oldenburg, Germany. Email: chai.heng.lim@uni-oldenburg.de

Potter Cove (58°41'W, 62°14'S) is a cove indenting the southwest region of King George Island to the east of Barton Peninsula, in the South Shetland Islands, Antarctica. The cove has complex bottom topography with two sectors: the outer cove has water depths exceeding 100 m and the inner cove comprises depths between 30-50 m. Tidal currents flush water in and out of the cove, producing mixing and transporting suspended sediment and nutrients. Hydrodynamic resuspensive processes and fluctuating production processes in the water column may be one of the key factors to provide food to many benthic suspension-feeding communities. Thus, the interactions of the water fluctuations and circulation within the cove and its surrounding hydrodynamics are important to understand the distribution of the nutrients and sediments. However, not much is known about the flow pattern change, both magnitude and direction, with time and location. Even less is known about the influence of currents on the sediment dynamics on the sea floor.

The present work is focused on the numerical modelling of the tidal dynamics and flow circulation in Potter Cove. The high-resolution unstructured grid finite volume coastal ocean model FVCOM has been applied to the Northern Antarctic Peninsula to simulate tidal wave dynamics with a horizontal resolution ranging from 100 m in the Potter Cove to 4 km in the deep ocean. Based on the preliminary investigation, the simulated tidal parameters (harmonic constituents of tidal elevation and currents) are compared with the available observational data as well as with the predicted tides from the global Finite Element Simulation (FES2004) and the Antarctic Peninsula High-Resolution Tidal Forward Model (AntPen04.01).

The influence of various bottom friction parameterizations on the vertical structure of tidal currents by using POM and adjoint assimilation method

Jicai Zhang1,2,*, Xianqing Lu3, Yaping Wang1, Ping Wang2, Jianhua Gao1

1. Laboratory of Coast and Island Development, Nanjing University, Nanjing 210093, PR China;

2. Coastal Research Laboratory, Department of Geology, University of South Florida, Tampa 33620, USA;

3. Laboratory of Physical Oceanography, Ocean University of China, Qingdao 266100, PR China.

Based on the simulation of M2 tide in the Bohai, Yellow and East China Seas, the influence of various parameterizations for the bottom friction effect on the vertical structure of tidal current is studied by using the three-dimensional Princeton Ocean Model (POM) and a two-dimensional nonlinear adjoint tidal model. Four methods are used to parameterize the bottom friction effect, including two linear ones (Rayleigh and Ekman) and two nonlinear ones (Quadratic and Slope-dependent). The bottom friction coefficients are supposed to be a constant and spatially varying respectively and optimized by assimilating the Topex/Poseidon satellite altimetry and tidal gauge data in the two-dimensional tidal model. The inverted distributions of bottom friction coefficients are then input to the three-dimensional POM. The validity of the adjoint tidal model is tested by performing twin experiments where the prescribed distributions of bottom friction coefficients are inverted by assimilating the model-generated 'observations'. The following two aspects have been studied in this paper by carrying out the practical numerical experiments. (i) Whether the bottom friction coefficients obtained from the two-dimensional adjoint tidal model can be used in the three-dimensional POM and reduce the discrepancies between modeled and observed tidal currents. (ii) Whether the different types of bottom friction parameterizations would influence the modeled vertical structure of tidal currents and which one is the best to reproduce the vertical structure of tidal currents? The conclusions can enhance the understanding about the bottom friction effect and reduce the discrepancies between model-reproduced and observed tidal currents in marginal shelf seas.

Impact of atmospheric mesoscale convection on waters of Malacca Strait

Chen Haoliang*1, Song Guiting2, Koh Tieh Yong2, Paola Malanotte-Rizzoli3,1

1Singapore-MIT Alliance for Research and Technology

2Nanyang Technological University

3Massachusetts Institute of Technology

Land-sea breeze and associated squall convection in the Straits of Malacca is a dominant weather pattern in our local region. Studies of land-sea breeze often examine a case where there is only one land-sea boundary or where land is flanked on both sides by the sea. In the Straits of Malacca, the sea is flanked on both sides by land and land-sea breeze often trigger squall convection. This offers us a refreshing example of atmosphere-ocean interaction on weather timescales. In this paper, the ocean responses to this coupled interaction will be presented. With atmospheric forcings from WRF real time model, a coastal ocean model, FVCOM (Finite Volume Coastal Ocean Model), is used to numerically investigate the role of atmospheric diurnal wind circulation on the dynamics of currents in the Straits and the role of diurnal wind, evaporation and precipitation cycle on the SST in the Straits.

Modeling the circulation in the Gulf of Tokin and northwestern South China Sea

Authors: Jingsong Gao1, 2, Huijie Xue2, and Maochong Shi1
Ocean University of China, Songling Road 238, Qingdao, China
Email address: keytothesuccess@163.com
School of Marine Sciences, University of Maine, Orono, ME 04469-5706, USA

The ECOMSED is used to study the circulation in the Gulf of Tokin and the northwestern SCS in winter. The model considers wind, heat flux, residual elevation and tide. After three months of integration, it can be found that the averaged net volume flux through the Qiongzhou Strait is approximately ~0.1 Sv in winter, and the current is always westward with the velocity ~20 and 10 cms-1 on the northern and southern side of the Strait, respectively. The westward current in the Strait is partly driven by the southwestward Guangdong Coastal Current. The current off the southwestern coast of the Hainan Island is northwestward throughout the water column, which can reach the northeastern Gulf along the western coast of the Hainan Island. These modeled features agree well with the measured currents in 2006 and 2007 and historical observations. In the western Gulf, the discharge from the Red River appears to contribute to both the northeastward Guangxi Coastal current and a southward current along the northern Vietnam coast.

Analysis of vertical flow profiles observed from different conditions and discussion on the effects of wind waves on vertical mixing

Bingchen Liang*, Dong-Young Lee, Jong-Joo Yoon

College of Engineering, Ocean University of China, 238 Songling-lu, Qingdao, 266100, China. Email: bingchen@ouc.edu.cn

Climate Change and Coastal Disaster Laboratory, Korea Ocean Research and Dev. Inst. Ansan, Korea

Understanding the processes of vertical momentum transfer from the sea surface is important for prediction of coastal and ocean circulation and mixing of various properties. To study the vertical mixing processes, in situ. measurement of vertical turbulent flux profile has been carried out at the coastal waters of the Yellow Sea. In order to supplement the limitation of such direct field observation of turbulence, vertical profiles of mean flow measured using ADCP at different environments are analyzed using 1D and 3-D numerical models. The observation data from different environment, such as rather deep water with water depth of 130 meters in East/Japan Sea and shallow coastal waters with water depth 15-40 meters at the Yellow Sea and South Sea of Korea measured at different weather conditions including rather steady winter monsoon and rapidly varying typhoon and the detailed 2-D wave spectra analyzed from the ADCP data are used in the analysis. The effects of wind waves such as wave breaking, Langmui circulation, and wave motion on the vertical mixing processes are discussed from the analysis.

The Mechanism of a cyclonic eddy in the South China Sea in winter from a Wave-Tide-Circulation coupled model

Feng Shan Fangli Qiao

Key Laboratory of MArine Environment Science and Numerical Modelling, state oceanic administration, No.6 Xia-xia-ling Road, Qingdao, 266061, China. Email: shanf@fio.org.cn

The results of a Wave-Tide-Circulation coupled model(Control experiment) of the South China Sea show that there exists a robust cyclonic eddy at (110° E,6° N) in winter .The existence of this eddy can be confirmed by observation. Compared with results of sensitive experiments，it is found that at (110° E,6° N) ,there is a steep slope at the bottom, in winter, the slope meets with the southward current (driven by wind), the current is steered to climb upward along the slope ,so the isotherms upon the slope are uplifted and form the cold core. The temperature field can influence the velocity field，the cold core near the bottom induces a cyclonic eddy, which appears both in observations and in the Control experiment.

Simulation of the tide and tidal current in the Qinzhou Bay

Changshui Xia, Xingang Lv and Fangli Qiao

Key Laboratory of Marine Science and Numerical Modeling, the First Institute of Oceanography, State Oceanic Administration, 6 Xianxialing Road, Hi-tech Industry Park, Qingdao, 266061, China.

Email：xiacs@fio.org.cn

Qinzhou Bay is located off the coast of Guangxi Autonomous regions, China. It include the Maowei bay and the outer Bay. The bottom of the Maowei bay is mainly mud. The local government decides dig mud and increase the water depth 2 meter. Princeton Ocean Model (POM) is used to study the tide and tidal current in the Qinzhou Bay and evaluate the impact of the project on the tide, tidal current and the tidal volume of the Maowei Bay and the Qingzhou Bay. The model simulated tide and tidal current agree with the observation well. The result shows that the project can increase the tidal volume of the Maowei bay 18.1%.

The role of different time-scaled Bv in an ocean circulation model

Chang zhao, Fangli Qiao, Guansuo Wang and Changshui Xia

Key Laboratory of MArine Environment Science and Numerical Modelling, state oceanic administration, No.6 Xia-xia-ling Road, Qingdao, 266061, China.

Email: zhaoc@fio.org.cn

A wave-circulation coupled model was incorporated by the MASNUM wave model and the Princeton Ocean Model (POM) base on the non-broken wave induced mixing theory. While do coupling, the wave-number spectrum was calculated first, and then was the wave-induced mixing coefficient (Bv). After that, the Bv was introduced to the circulation model, and the wave-circulation coupled model was then constructed. The wave-circulation coupled model was validated by the comparison of simulated ocean temperature to Levitus data and the objective analysis of simulated ocean current. Then, two couple-model experiments were designed regarding to question raised by our research interest. The couple-model experiments were constructed to compare the results of inputting different time-scaled Bv: daily and monthly. And the results showed that the experiment inputted by monthly averaged Bv could somewhat overestimate the role of wave-induced mixing, and it was particularly evident in summer. Then, the simulated ocean temperature over the northwest Pacific in July was chosen to analyze the causes to the discrepancy.

Instability of the Subtropical Counter Current and the Generation of Eddies

H.-F. Lu*1, L.-Y. Oey 2& C.-R. Wu1

1. Department of Earth Sciences, National Taiwan Normal University, Taipei, Taiwan.

2. Program in Atmospheric and Oceanic Sciences, Princeton University, Princeton, New Jersey.

Email: zyfix.lu@gmail.com

The North Pacific Subtropical Counter Current (STCC) east of Taiwan (18~25N) is a weak zonal current comprising of a weak eastward flow near the surface (with speeds of less than 0.1 m/s, and a thickness of approximately 50~100m) and westward flow (the North Equatorial Current) beneath. Previous studies (e.g. Qiu 1999; JPO) have shown that the STCC is baroclinically unstable consisting of the mixed Phillips-Charney instability modes because its meridional QGPV-gradient changes sign twice, once very near the surface (upper 50m) and another one at the deeper level (z~-200m; Tulloch et al. 2011; JPO, in press). Therefore, despite its weak mean speeds, nonlinear STCC eddies with diameters ~ 300 km or larger and rotational speeds exceeding the eddy propagation speeds develop (Samelson, 1997, JPO; 2011 personal correspondence; Chelton et al. 2011; Prog.Oceanogr., in press). These eddies can have profound influences on the circulation of the Western Pacific marginal seas including the Kuroshio transport east of Taiwan (Chang and Oey, 2011; GRL, in press). In this talk, I will present numerical experiments to describe and explain the instability and eddy-generation processes of the STCC focusing primarily on the seasonal variation.

Simulation of long eccentricity (400-kyr) cycle in ocean carbon reservoir during Miocene Climate Optimum: A box model approach

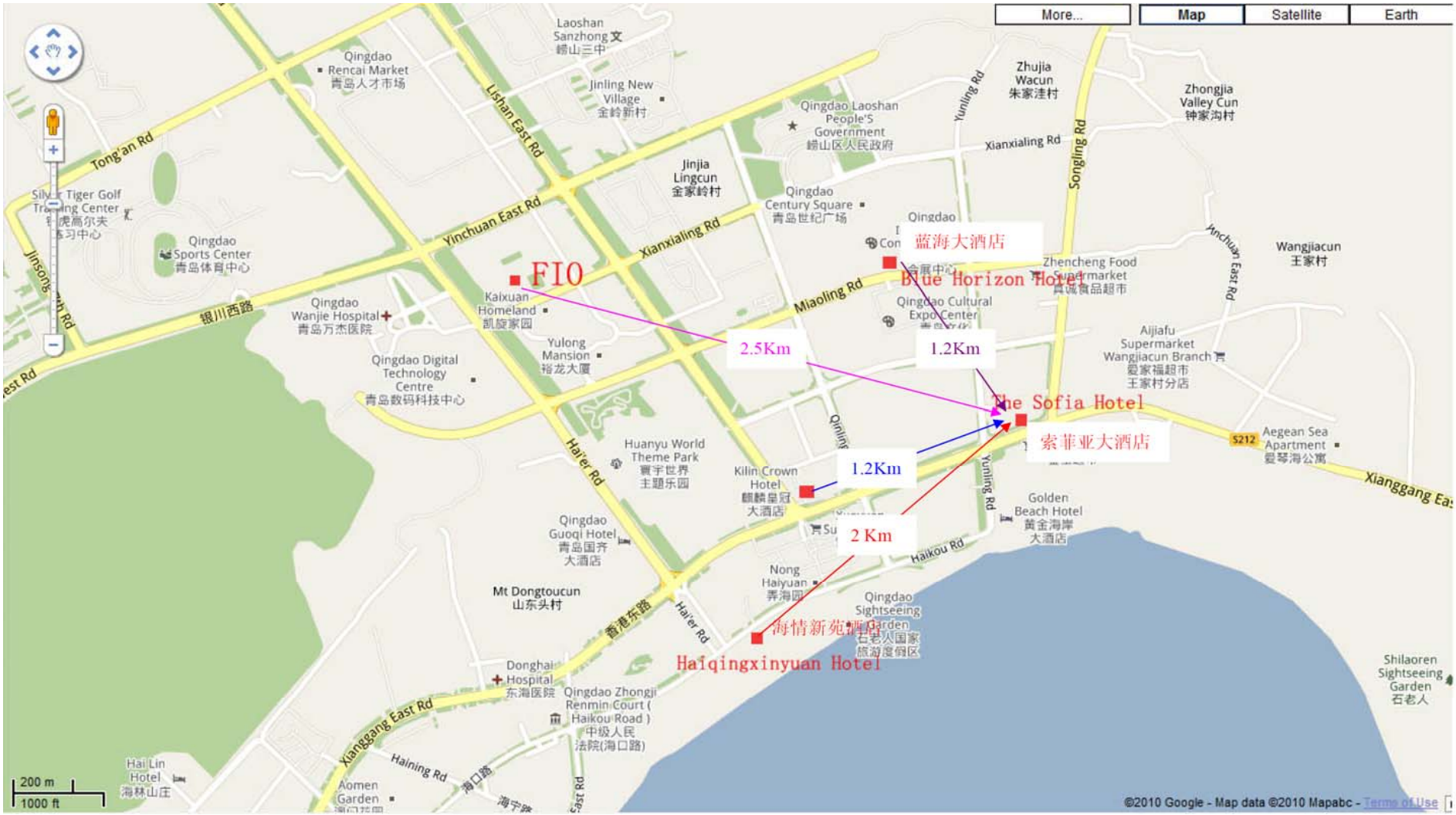
Wentao Ma 1, Jun Tian 1, Qianyu Li 1,2, Pinxian Wang 1

1State Key Laboratory of Marine Geology, TongjiUniversity, Shanghai 200092, China

2School of Earth and Environmental Sciences, The University of Adelaide, Adelaide SA 5005, Australia

Deep-sea foraminiferal 13C records contain abundant 400-kyr cycles indicating a link between eccentricity forcing and ocean carbon reservoir change. Here we simulate the oceanic 13C maxima events forced by the Earth's orbital geometry during the Miocene Climate Optimum (MCO, 17-14 Ma) using a box model. The simulated results of both surface and deep water 13C display co-varying 400-kyr cycle. Modulated by orbital parameters, weathering induced carbon input will change the burial ratio of carbonates to organic carbon and further result in periodic changes in the oceanic 13C. The increase of riverine nutrient input, which is synchronous with riverine carbon input, often stimulates primary productivity and burial of organic carbon. Our results support that eccentricity maxima (minima) enhance (reduce) weathering intensity and nutrient supply, which lead to minima (maxima) of 13C. The prominent 400-kyr cycle of ocean carbon reservoir is interpreted as likely caused by a long memory of carbon in the ocean.

The maps around the Sofia hotel



List of restaurants

1．天天涮火锅 Tiantian tasty Hot Pot (traditional Chinese restaurant)
2．春川铁板鸡 Chunchuan Sizzling chicken (Korean cuisine)
3．中式餐馆区 Chinese food restaurant area
4．本乡饭店 Benxiang restaurant (traditional Chinese restaurant)
5．金友酒楼 Jingyou restaurant (traditional Chinese restaurant)
6．乐天玛特餐厅，西餐区域
Lotte Cafeteria（various kind of food shops) & Western-style food area (Macdonald's，SPR coffee，Champs Western-style food，etc.)
7．肯德基，味子拉面，土大力韩式餐厅，棒约翰等
KFC, Weizi stretched noodles, Tudari restaurant (Korean cuisine), Papa John's Pizza)
8．丽达餐厅 Leader Cafeteria（various kind of foods, 1F & 2F）
9．平价小餐馆 Low-price restaurants
胖子快餐 Fat guy Fast food（Chinese food）
南京灌汤包 Nanjing Steamed Buns (Chinese food),etc.
10．现代粗粮 Modern coarse food grain（coarse food grain, healthy food）
11．浩浩小厨 Sea food restaurant（middle price　restaurant）
12．排骨米饭 Meat&Rice (Traditional Chinese Fast food)
13．SPR Coffee，Sorrento pizza
14．兰州拉面 Muslim Food（stretched noodle，low price）
15．中档小餐馆 Proper-price restaurants area

Restaurants near Sofia Hotel