JONSMOD 2012 WORKSHOP

BREST 21-23 MAY 2012

16th biennial WORKSHOP
JOINT NUMERICAL SEA
MODELLING GROUP
Brest , France 21-22-23 May 2012

BOOK OF ABSTRACTS

Ifremer

<u>ACCESS TO IFREMER's WiFi</u>

SSID :

Openifr

WEP KEY :

AABBCCDDEEFF00112233445566

Internet Access

Browser settings :

Automatically detect settings

Or

Proxy Server : ***134.246.166.168***

Port : ***3128***

Or

Use automatic configuration script :

http://wpad.ifremer.fr/autoconfig/web.js

PRATICAL INFORMATIONS / JONSMOD 2012 IFREMER BREST 21-22-23 MAY

Timetable of the Shuttle AIRPORT-BREST (ticket = 4.80 euros on board / taxi = 20-30euros):
http://www.brest.aeroport.fr/wpfichiers/1/1/ressources/File/Navettes-GrillehoraireHIVER20112012-1.pdf

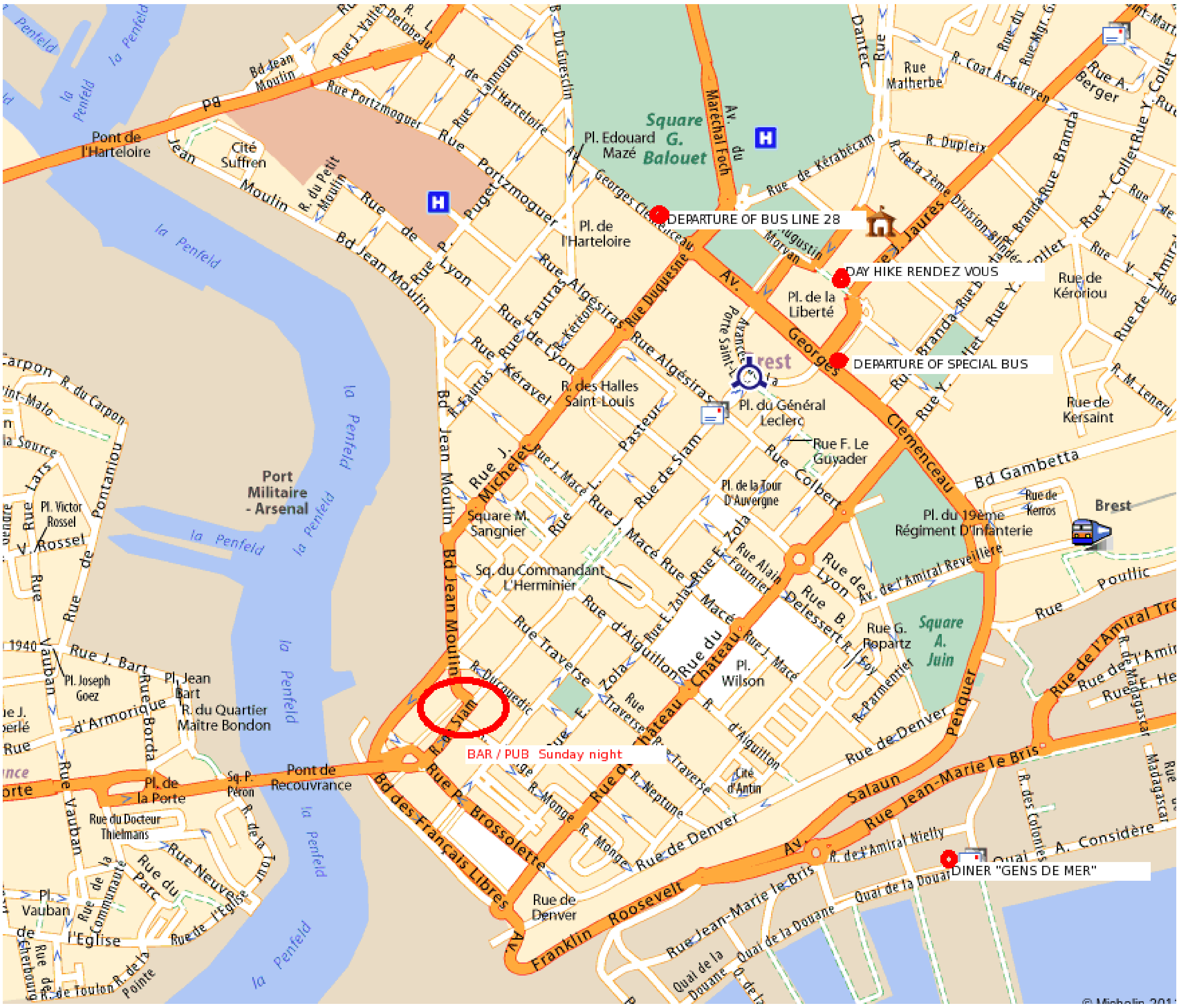
The JONSMOD workshop will hold at **IFREMER Campus** near BREST.

A special JONSMOD coach will leave Brest every morning from "**place de la Liberté**", front of the shop called « LES ENFANTS DE DIALOGUES » (less than 15mn from the hotels).
Monday 21 Morning at **08h00**
Tuesday 22 Morning at 08h30
Wednesday 23 Morning at 08h30
In case of serious difficulties you can call on the cell phone of the laboratory : +33 (0)6 73 58 35 35.

For people arriving Sunday afternoon : suggestion for meeting for drinks around 18:00:
in and around Pub Tír na nÓg (21 Rue Siam) or café La Sampdoria (19 Rue Siam).

For people arriving saturday nigth, a day hike along the coast is planned Sunday. The rendez-vous is Sunday morning 09h30 on the stair of the City Hall (place de la Liberté). Possibility to walk 5,10,15 km (or more !) - Picnic on a beach - The way is easy but good shoes, raincoat and swim suit are recommended. Please send me an e-mail if you attend to participate to this walk. (pierre.garreau@ifremer.fr)

Wednesday afternoon there is no coach, but we can organize collective taxis for the airport or take the regular buses.



You can also visualize the meeting positions on google earth using the attached file jonsmod.kmz.

How to catch the regular Bus... If you miss the special Bus !
Ticket = 1.35euros (on board)
The Bus line is 28 (Plouzané Technopole).
Departure : Liberté Ségalen (front of University)
Arrival : Sation Piccard
Duration : about ½ h
Informations : http://www.bibus.fr

Regular Bus line 28 : (Ifremer is in the South-West corner)

Timetable from Liberté Ségalen (downtown) to Piccard (Ifremer)

06h	07h	08h	09h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h
32[1]	14[1]	25[1]	08	10	13	20	21	21	20	32	00	20	10	12
	25[1]	53	45	40	43	36	57	56	33		23	45	30	
	58[1]								57		45			

Timetable from Piccard (Ifremer) to Liberté Ségalen (downtown)

06h	07h	08h	09h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h
41[1]	01	00	03	12	11	23	23	30	01	07	12	16	01	10
	14	20	27	52	44	51	40		41	42	29	39	30	40
	33	29								52	44			

Jonsmod 2012
Programme (09 May 2012)
BREST, France
21th – 23th May 2012

MONDAY 21 May

08:00	Coach leaves Brest downtown for IFREMER
08:30 – 09.00	Registration (Coffee, tea available)
09.00 – 09.15	Welcome

SESSION I – [CHAIR – **Eric Deleersnijder**]

09.20 – 09.40 Speaker 1-1
Assimilation of Sea Surface Temperature in the MARS3D regional modelling system using Ensemble Kalman Filter
Catherine Heyraud[1], **Stéphane Raynaud[1]**, Philippe Craneguy[2]**,** Franck Dumas[3], Guillaume Charria[3]
1) Actimar, Brest, France 2) ACRI-ST, Brest, France 3) IFREMER, Plouzané, France

09.40 – 10.00 Speaker 1-2
Operational numerical modeling of the Southeastern Brazilian Shelf circulation
Carlos A. de S. França[1], Patrick Luyten[2] and Edmo J. D. Campos[1]

10.00 – 10.20 Speaker 1-3
Numerical simulation of flow and aquaculture waste **dispersion in a curved channel**
Alfatih Ali[1,2]**,** Øyvind Thiem[1] and Jarle Berntsen[2]**Tomas Torsvik**
1)Bergen Center for Computational Science, Norway**.**
2)University of Bergen, Norway

10.20 – 10.40 Speaker 1-4
Coastal dispersion model reliability in accidental situation (Fukushima,Japan), how to make the most of in-situ measurements?
Bailly Du Bois P.[1], Laguionie P.[1], Garreau P.[2], Theetten S.[2]
1) IRSN/PRP/SERIS/LRC Rue Max Pol Fouchet - BP10, Cherbourg-Octeville, 50130, France
2) IFREMER/DYNECO/PHYSED Technopôle de Brest-Iroise, Plouzané, 29280, France

10.40 – 11:00 Speaker 1-5
Numerical Modelling of Wind-Driven Circulation Behind a Large Wind Farm In the presence of Surface Gravity Waves
Mostafa Bakhoday Paskyabi and Ilker Fer
University of Bergen, Geophysical Institute, Allegaten 70, 5007 Bergen, Norway.

11.00 – 11.20 BREAK

11.20 – 11.40 Speaker 1-6
The typhoon season of 1971 in the coastal area of the Red River delta in North Vietnam
K. Baetens, **P. Luyten**, T. Tran Anh and V. Vu Duy
MUMM, Belgium

11.40 – 12,00 Speaker 1-7
Hurricane-induced bottom stirring on the Louisiana-Texas continental shelf
João Lima Rego[1], Katherine Cronin[1], Patrick Hesp[2], Deepak Vatvani[1], Amanda M. Evans[3] and Matthew E. Keith[3]
1)Marine and Coastal Systems Unit, Deltares (Delft, The Netherlands) 2)Geography and Anthropology Dept., Louisiana State University (Baton Rouge, La, U.S.A) 3)Tesla Offshore LLC. (Baton Rouge, La, U.S.A)

12:20 – 12:40 Speaker 1-8
Analysis of the atmospheric influence in water level modelling along the Iberian Atlantic coast
Francisco J. Campuzano[1], Ligia Pinto[1], Rodrigo Fernandes[1], Paulo Chambel[2],Luís Fernandes[3] and Ramiro Neves[1]
1) Maretec – Instituto Superior Técnico, Lisbon (Portugal) 2) HIDROMOD, Modelação em Engenharia, Lda., Lisbon (Portugal) 3) Freelance consultant

12:40 – 13:00 Speaker 1-9
On the predictability of nearshore and harbors sea levels.
Carlo BRANDINI[1], Francesco PASI[1], Stefano TADDEI[1], **Maria FATTORINI**[1]**,**Alberto ORTOLANI[1]**.**
CNR Ibimet & Consorzio LaMMA, Via Madonna del Piano 10 Sesto Fiorentino (FI) Italy.

13.00 – 14.20 LUNCH

MONDAY 21 May
SESSION II – [CHAIR – **Nataliya Stashchuk**]

14.20 – 14.40 Speaker 2-1

Morphological modelling of an intertidal flat nourishment in the Eastern Scheldt, The Netherlands

Katherine Cronin[1]**,** Bas Borsje[1], Harriëtte Holzhauer[1], Ilse de Mesel[2], Tom Ysebaert[2] and Anneke Hibma[3]
1)Marine and Coastal Systems Unit, Deltares, PO Box 177, 2600 MH, Delft, The Netherlands;
2)IMARES – Institute for Marine Resources & Ecosystem Studies, PO Box 77, 4400 AB Yerseke
3)Ecoshape | Building with Nature, Van Oord Dredging and Marine Contractors BV, PO Box 8574, 3009 AN Rotterdam, The Netherlands

14.40 – 15.00 Speaker 2-2

Modelling the fate and transport of suspended sediments and contaminants in the Scheldt River and Estuary with the finite element model SLIM

Olivier Gourgue*, Anouk de Brauwere, Benjamin de Brye, Eric Deleersnijder*
Institute of Mechanics, Materials and Civil Engineering (iMMC)Université catholique de Louvain

15.00 – 15.20 Speaker 2-3

Modelling wave propagation and hydrodynamics in the East-Frisian Wadden Sea

Sebastian Grashorn, Karsten Lettmann, and Jörg-Olaf Wolff
University of Oldenburg, ICBM, Carl-von-Ossietzky-Str. 9-11, 26111 Oldenburg, Germany

15.20 – 15.40 Speaker 2-4

Data assimilation in coastal ocean modelling and forecasting

Herman Gerritsen[1], Martin Verlaan[1,2], Julius Sumihar[1], Firmijn Zijl[1]
1)Deltares, P.O. Box 177, 2600 MH, Delft, Netherlands
2)Technical University Delft, Faculty of Applied Mathematics

15.40 – 16.00 BREAK

16:00 – 16.20 Speaker 2-5

Realistic high resolution modeling of the Northern Mediterranean Current (NC) using the NEMO code : impact of model parametrisation at lateral and open boundaries and validation with observations.

Karen GUIHOU MIO,CNRS Université de Toulon et du Var

16.20 – 16.40 Speaker 2-6

Sea Surface Temperature (SST) modelling in the Sea of Iroise. Assessment of boundary conditions.

Nicolas Guillou[1], Georges Chapalain[1] and Eric Duvieilbourg[2]
1) LGCE, CETMEF, Technopôle Brest-Iroise, 29280 Plouzané, France
2) LEMAR, IUEM, Technopôle Brest-Iroise, 29280 Plouzané, France

16.40 – 17.00 Speaker 2-7

Short internal waves trailing strong internal solitary waves in the South China Sea studied by a numerical model and Envisat synthetic aperture radar images

Chuncheng Guo [1,3], Vasiliy Vlasenko [1], Werner Alpers [2], Nataliya Stashchuk [1], Xueen Chen [3]
1) *School of Marine Science and Engineering, University of Plymouth, Plymouth, UK*
2) Center for Marine and Atmospheric Sciences, Institute of Oceanography, University of Hamburg, Hamburg, Germany
2) College of Physical and Environmental Oceanography, Ocean University of China, Qingdao, China

17.00 – 17.20 Speaker 2-8

Progress in the development and use of a finite element hydrospheric model

Eric Deleersnijder[1], Fernando Andutta[2], Sébastien Blaise[1], Sylvain Bouillon[1], Hans Burchard[3], Anouk de Brauwere[1], Benjamin de Brye[1], Thomas De Maet[1], Philippe Delandmeter[1], Eric Delhez[4], Thierry Fichefet[1], Olivier Gourgue[1], Emmanuel Hanert[1], Hidayat Hidayat[5], Ton Hoitink[5], Ozgur Karatekin[6],Tuomas Kärnä[1], Jonathan Lambrechts[1], Vincent Legat[1], Samuel Melchior[1], Jaya Naithani[1], Alice Pestiaux[1], Chien Pham Van[1], Jean-François Remacle[1], Maximiliano Sassi[5], Bruno Seny[1], Karim Slaoui[1],Sandra Soares Frazao[1], Benoît Spinewine[1,] Christopher Thomas1, Martin Vancoppenolle[7], Bart Vermeulen[5], Eric Wolanski[2]
1)Université catholique de Louvain, Louvain-la-Neuve, Belgium 2) James Cook University, Townsville,Australia 3) Baltic Sea Research Institute, Warnemünde, Germany 4) Université de Liège, Belgium 5) University of Wageningen, The Netherlands 6) Royal Observatory of Belgium, Brussels, Belgium 7) Institut Pierre Simon Laplace, Paris, France

17.20– 17.40 Speaker 2-9

Spatial Pattern of Hits to the Nearshore from a Major Marine Highway in the Gulf of Finland

Bert Viikmäe ,Institute of Cybernetics at Tallinn University of Technology; Estonia

18:30 – 20:30 Icebreaker: drinks and warm and cold snacks (in IFREMER)
20:30 Departure of coach from IFREMER to Brest Centre

TUESDAY 22 May

08:30 Coach leaves Brest downtown for IFREMER

SESSION III – [CHAIR- **Lars Peter ROED**]

09.00 – 09.20 Speaker 3-1
A study of the fresh water plume and its interaction with barotropic tidal currents in Liverpool Bay using an unstructured-mesh model
Jiuxing Xing and Alan Davies ;National Oceanography Centre, Liverpool, UK **Philippe Fraunie**
Mediterranean Institute of Oceanography, University of Toulon Var, France

09.20 – 09:40 Speaker 3-2
Calibration of a New Generation Flood Forecasting Model for the Northwest European shelf and North Sea using data assimilation techniques (OpenDA)
Firmijn Zijl, Martin Verlann, Herman Gerritsen
Deltares, P.O. Box 177, 2600 MH Delft, The Netherlands

09.40 – 10.00 Speaker 3-3
Coastal circulation response to physical forcing; Application of MARS-3D model for studying dispersal processes in the eastern English Channel .
N. Jouanneau, A. Sentchev
Laboratoire d'Océanologie et de Géosciences (UMR8187 du CNRS), Wimereux, France F. Dumas DYNECO/PHYSED, Ifremer, Centre de Brest, Plouzané, France

10.00 – 10.20 Speaker 3-4
Modelling the Krakatoa tsunami propagation on the European Atlantic Shelf.
M. KARPYTCHEV, D. CHEVAILLIER, H. HEBERT
LIENSs CNRS UMR 7266 - University of La Rochelle (France)

10.20 – 10.40 Speaker 3-5
Modelling the dynamics of a large-scale river plume and Their effect on nutrient distribution
Robert McEwan[1], Maeve Lohan[2], Nataliya Stashchuk[1]and Vasiliy Vlasenko[1]
1)School of Marine Science and Engineering,
2)School of Geography, Earth and Environmental Sciences,
University of Plymouth, Plymouth, Devon, PL4 8AA, UK

10:40 – 11.00 BREAK

11.00 – 11:20 Speaker 3-6
Modelling larval dispersal of the great scallop in the English Channel
A. Nicolle[1], F. Dumas[3], E.Thiébaut[1,2]
1) CNRS, UMR 7144, Adaptation et Diversité en Milieu Marin, Station Biologique de Roscoff, 29680 Roscoff (France)
2) UPMC Univ Paris 06, UMR 714**4, Station Biologique de Roscoff, 29680 Roscoff, France**
3) IFREMER, Plouzané (France)

11.20 – 11.40 Speaker 3-7
NW Mediterranean sea model toward the study of the climate change impacts on the coastal ecosystems
I. Pairaud[1], P. Garreau[2], N. Bensoussan[3], J. Garrabou[4]
1) LER PAC, Centre IFREMER Méditerranée, zone portuaire de Brégaillon - BP330, 83507 La Seyne sur Mer Cedex, France.
2) DYNECO/PHYSED, Centre IFREMER de Bretagne - BP 70, 29280 Plouzané, France.
3) IPSO FACTO, SARL, Pôle Recherche Océanologie et Limnologie,
37 rue Saint-Sebastien, 13006 Marseille, France.
4) Institute of Marine Sciences (ICM-CSIC), passeig Maritim de la Barceloneta 37-49, 08003 Barcelona, Spain

11.40 – 12,00 Speaker 3-8
Data Assimilation and Efficient Model Order Reduction for Morphodynamical Modeling
Garcia I. , Elserafy G., Schuttelaars H., Michellete H. and Ranasinghe R.
Dept. of Applied Mathematics T.U. Delft

12:20 – 12:40 Speaker 3-9
3D coupled physical-biogeochemical modeling in a coastal area: Study of Rhone River diluted water intrusion in Marseille's Bay
Fraysse M., Pairaud I.L., Faure V. and Pinazo C**.**
IFREMER Mediterrannée -LER/PAC (FRANCE)

12-40 – 13.00 Speaker 3-10
Processes analysis in the Channel of Toulon: model/measures
Christiane Dufresne
IRSN - Zone Portuaire de Brégaillon, BP330, 83507 La Seyne sur Mer, France

13.00 – 14:20 LUNCH

TUESDAY 22 May –

SESSION IV – [CHAIR - **Erik de Goede**]

14.20 – 14.40 Speaker 4-1
Evaluation of results from eddy resolving models: Methods and examples
Lars Petter Røed and Nils Melsom Kristensen
Norwegian Meteorological Institute and Department of Geosciences, University of Oslo; Norway

14.40 – 15.00 Speaker 4-2
An Ensemble based time-local H_infty filter for efficient storm surge forecasting
M. U. Altaf[1,,2], T. Butler[3], I. Hoteit[2] , X. Luo[2] , C. Dawson[3] ,T. Mayo[3]
[1]Delft Institute of Applied Mathematics, Delft University of Technology, Delft, The Netherlands,
[2]King Abdullah University of Science and Technology, Saudi Arabia
[3]Insitute for Computational Engineering and Sciences (ICES), University of Texas at Austin, Austin, USA

15.00 – 15.20 Speaker 4-3
Shelf break Frontal Circulation near the Sable Gully of Nova Scotia
Shiliang Shan[1], Jinyu Sheng[1], Blair Greenan[2]
1)Department of Oceanography, Dalhousie University **Halifax, Canada, B3H4R2**
2)Ocean Sciences Division, Bedford Institute of Oceanography
Department of Fisheries and Oceans Dartmouth, Canada, B2Y4A2

15.20 – 15.40 Speaker 4-4
3D numerical simulations of the baroclinic tides in the Celtic Sea
Nataliya Stashchuk and Vasiliy Vlasenko
School of Marine Science and Engineering, University of Plymouth, Plymouth, Devon, PL4 8AA, UK

15.40 – 16.00 BREAK

16:00 – 16.20 Speaker 4-5
Characterization of local transport properties in ocean models
Tomas Torsvik
Institute of Cybernetics,; Tallinn University of Technology, Tallinn, Estonia

16.20 – 16.40 Speaker 4-6
Salinity response to forcing changes in the Charente estuary 3D numerical modeling and observations
F. Toublanc[1], I. Brenon[1], I.Bernard[2] and O. Le Moine[3]
1) University of La Rochelle, UMR 7266 CNRS – LIENSs,
2 rue Olympe de Gouges, 17000 La Rochelle.
2) IFREMER, Center of Brest, 29280 Plouzané.
3) IFREMER, Center of La Tremblade, Ronce-les-bains, 17390 La Tremblade.

16.40 – 17.00 Speaker 4-7
Numerical study of circulation, hydrography and sea-ice conditions In the Gulf of St. Lawrence and Scotian Shelf using a coupled ocean-ice model
Jorge Urrego-Blanco and Jinyu Sheng
Dalhousie University, Halifax, Canada

17.00 – 17.20 Speaker 4-8
On the mechanism of A-type and B-type internal solitary wave generation in the northern South China Sea
Vasiliy Vlasenko[1,] Chuncheng Guo[1], Nataliya Stashchuk[1], and Xueen Chen[2]
1) Scchool of Marine Sciences and Engineering, Plymouth University, UK
2)College of Physical and Environmental Oceanography, Ocean University of China

17.20 – 17.40 Speaker 4-9
3D-Flow Flexible Mesh: a showcase of hydrodynamical applications on flexible unstructured grids
Van DAM Arthur, **Erik de Goede** ; Deltares Netherlands

18:30 Departure of coach from IFREMER to Brest

20:00 Conference dinner in “Gens de Mer” on Brest harbour

WEDNESDAY 23 May

08:30 Coach leaves Brest downtown for IFREMER

SESSION V – [CHAIR: **Patrick Luyten**]

09.00 – 09.20 Speaker 5-1
Classification of water masses using empirical orthogonal functions
Karina Hjelmervik[1] , Karl Thomas Hjelmervik[2]
1)Vestfold University College, P.O. Box 2243, NO-3103 Tønsberg, Norway
2)Norwegian Defence Research Establishment, P.O. Box 115, NO-3191 Horten, Norway

09.20 – 09:40 Speaker 5-2
Improving Storm surge modeling along the French (Atlantic and English Channel) coast
Idier D., **Muller H.**, Dumas F., Pineau-Guillou L., Paradis D., Créach R., and R. Pedreros
BRGM , METEOFRANCE, IFREMER/DYNECO/PHYSED ; FRANCE

09.40 – 10.00 Speaker 5-3
Study of the seasonal cycle of the biogeochemical processes in the NW Mediterranean sea using a 3D coupled model Mars3D-Eco3M.
Elena Aleksenko, Virginie Raybaud, Benedicte Thouvenin, Pierre Garreau, Melika Baklouti
IFREMER DYNECO-PHYSED BP 70 ; 29280 Plouzané / Université de Marseille, France

10.00 – 10.20 Speaker 5-4
A generic approach to the concept of water renewal timescales
Benjamin de Brye1, Anouk de Brauwere1,2,
Olivier Gourgue1,2, Eric Delhez3, Eric Deleersnijder1
1 Université catholique de Louvain (UCL), Louvain-la-Neuve, Belgium
2 Vrije Universiteit Brussel (VUB), Brussels, Belgium
3 Université de Liège, Liège, Belgium

10.20 – 10.40 Speaker 5-5
How to reduce salinity intrusion in rivers, with application to the Rotterdam Waterway?
Erik de Goede, Yann Friocourt; Deltares, Delft (NL)

10:40 – 11.00 BREAK

11.00 – 11:20 Speaker 5-6
On the use of a depth-dependent barotropic mode for free surface ocean models
J. Demange, L. Debreu INRIA and Laboratoire Jean Kuntzmann, Grenoble, France P. Marchesiello IRD and LEGOS, Toulouse, France
E. Blayo University of Grenoble and Laboratoire Jean Kuntzmann, Grenoble, France

11.20 – 11.40 Speaker 5-7
Why the Euler-scheme in particle-tracking is not enough: The shallow- sea pycnocline test case
Ulf Gräwe[1]**,** Eric Deleersnijder[2], S. Hyder A. M. Shah[3], Arnold W. Heemink[3]
1) Leibniz Institute for Baltic Sea Research (IOW), Seestraße 15, 18119 Warnemünde, Germany
2) Institute of Mechanics, Materials and Civil Engineering (IMMC), Université catholique de Louvain, 4 Avenue G. Lemaître, 1348, Louvain-la-Neuve, Belgium
3) Delft Institute of Applied Mathematics (DIAM), Delft University of Technology, Mekelweg 4, 2628CD Delft, the Netherlands

11.40 – 12,00 Speaker 5-8
On the wave-current interactions
A.-C. Bennis[1,2,3], F. Ardhuin[3,2], F. Dumas2, B. Blanke[1]
1- University of Western Brittany, LPO, 6 avenue Le Gorgeu, Brest, France.
2- Ifremer, DYNECO/PHYSED, Technopole pointe du diable, Plouzané, France.
3- Ifremer, LOS, Technopole pointe du diable, Plouzané, France.

12:20 – 12:40 Speaker 5-9
On the effects of surface waves on three dimensional near-shore hydrodynamics
Saeed Moghimi ;Institute for Baltic Sea Research , Rostock

12-40 – 13.00 Speaker 5-10
Drift forecast with Mercator-Océan velocity fields in the Western Mediterranean Sea and the Angola offshore zone
Law Chune Stéphane
Mercator-Océan : 8/10 rue Hermes Parc Technologique du Canal

13.00 – 14:20 LUNCH

WEDNESDAY 23 May

SESSION VI – [CHAIR: **Franck Dumas**]

14.20 – 14.40 Speaker 6-1

Intercomparison and validation of operational high resolution coastal scalemodels between the Tyrrhenian and Ligurian Sea.

Carlo BRANDINI[1], Sylvain COUDRAY[2], Stefano TADDEI[1], Maria FATTORINI[1], Letizia COSTANZA[1], Chiara LAPUCCI[1], Pierre GARREAU[2], Pierre POULAIN[3], Riccardo GERIN[3], Luca CENTURIONI[4].
1) CNR Ibimet & Consorzio LaMMA, Via Madonna del Piano 10 Sesto Fiorentino (FI) Italy.
2) IFREMER, France.
3) OGS, Trieste, Italy.
4)Scripps Institution of Oceanography, San Diego, US

14.40 – 15.00 Speaker 6-2

Simulating the Hydrodynamics of San Quintin bay.

Isabel Ramírez, R. Blanco, R. Vázquez and G. Ramírez
CICESE ; Mexico

15.00 – 15.20 Speaker 6-3

Multi-scale coupled modelling along the Catalan coast

Manel Grifoll
Laboratori d'Enginyeria Maritima / Universitat Politècnica de Catalunya C. Jordi Girona, 1-3, 08028 Barcelona

15.20 - 15.40 Speaker 6-4

Spectral nudging : application to downscaling in Mediterranean Sea

Pierre Garreau ; Garnier Valérie ; IFREMER/DYNECO/PHYSED Brest ; FRANCE

15.40 – 16.00 BREAK

16.00 – 16.20 Speaker 6-5

Prediction of Ocean State Estimate by assimilation of temperature and salinity data. A case study for the southern North Sea Joanna Staneva, **Johannes Schulz Stellenfleth**
Institute for Coastal Research, HZG ; Germany

16.20 – 16.40 Speaker 6-6

Peculiarity of thermohaline structure of high-latitude seas covered with ice: observations and modelling

A. Morozov, Marine hydrophysical institute ;Ukraine

17.00 – 18.00 Closing remarks

Assimilation of Sea Surface Temperature in the MARS3D regional modelling system using Ensemble Kalman Filter

CATHERINE HEYRAUD1, STÉPHANE RAYNAUD1, PHILIPPE CRANEGUY2, FRANCK DUMAS3, GUILLAUME CHARRIA3

1 Actimar, Brest, France

2 ACRI–ST, Brest, France

3 IFREMER, Plouzané, France

A study of sequential data assimilation of satellite derived sea surface temperature (SST) in the free surface hydrodynamic model MARS–3D [Lazure and Dumas, 2008] using Ensemble Kalman Filter [Evensen, 2003] is presented with application to the English Channel and the shelf of the Bay of Biscay. We focused our efforts on summer 2006, when observations are numerous and variability is high.

We first identified uncorrelated key parameters of the model using a generalized sensitivity study. We found that the forecast ensemble generated by perturbations of those key parameters (extinction and turbulence closure coefficients, bottom roughness) is statistically consistent with model errors, but provide an ensemble with underestimated spread. Introducing errors in the initial conditions and in the atmospheric forcing (thanks to the ECMWF ensembles) significantly increases the ensemble variance.

However, remote ensemble correlations highly suggest the needs of covariance localization spatially variable during the analysis: it is noticeable that a larger radius of localization (from 25 to 100 km) in the Channel than over the Continental Shelf of the Bay of Biscay (about 25 Km) is required.

In our SST assimilation experiments, we played the radius of localization, the observation errors, and the availability of satellite–derived SST. Results show that corrections generally persist several days. The thermocline is enhanced and salinity is corrected far from the coast on the shelf. During assimilation cycles, a sufficient amount of ensemble variance is preserved and regenerated to allow consistent analyses.

REFERENCES

Lazure,P. and Dumas F., 2008. An external–internal mode coupling for a 3D hydrodynamical Model for Application at Regional Scale (MARS3D), Advances in water Resources, 31, 233–250.

Evensen, G., 2003. The Ensemble Kalman Filter : theoretical formulation and practical implementation, Ocean Dynamics, 53, 343–367.

Operational numerical modelling of the Southeastern Brazilian Shelf circulation

Carlos A. de S. França[1], Patrick Luyten[2] and Edmo J. D. Campos[1]

The Southeastern Brazilian Shelf (28°S to 22°S; 49°W to 40°W) needs an operational model of the sea circulation due to its important economical activities – both navigation and oil exploitation.

COHERENS is a state of the art numerical model for coastal and estuarine circulation with modules also for sedimentation and biology studies. It was forced by NCEP atmospheric fields at the surface and AG95 tidal heights at the open boundaries. WOA05 temperature and salinity are used to initialize the model and constrain open boundaries during climatological simulations.

Tides are well reproduced as compared to coastal sea level data. Storm surges variance is underestimated while sea surface temperature is above the climatological data in the domain leading to the conclusion that the atmosferic forcing fields available are not adequate to operational simulations in the area.

Numerical simulation of flow and aquaculture waste dispersion in a curved channel

Alfatih Ali[1,2], Øyvind Thiem[1] and Jarle Berntsen[2]

1) Bergen Center for Computational Science, Norway
2) University of Bergen, Norway

The aim of this study is to investigate the effect of the horizontal grid resolution on the dispersion and deposition of the particulate organic matter from a fish cage located in a curved channel with 90° bend.

A three–dimensional, random–walk particle tracking model coupled to a terrain following ocean model is used. The particle tracking model is a Lagrangian particle tracking simulator which uses the local flow field, predicted by the ocean model, for advection of the particles and random walks to simulate the turbulent diffusion. The falling of particles through the water column is modeled by imposing a settling velocity for each particle in the particle tracking model.

The results show that, as the water flows through the bend in the channel, a cross–channel secondary flow is developed. The motion of this flow for a homogeneous fluid is similar to a spiral motion where the water in the upper layers moves towards the outer bank and towards the inner bank in the lower layers. The intensity of the secondary flow increases as the horizontal grid resolution decreases, which has quite significant effects on the particles distribution on the channel bed. In this case, it is found that most of the particles settle close to the inner bank of the channel. For a stratified fluid, the cross–channel secondary flow becomes very weak which results in a very weak cross–channel particles dispersion.

Coastal dispersion model reliability in accidental situation (Fukushima, Japan), how to make the most of in–situ measurements?

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Abstract

Coastal models are now key components of operational forecast systems deployed during crisis such as point–source pollution incidents. Model reliability can be assessed with field–based data that can be difficult to obtain when phenomena are involved on a one hour to month time–scale and tens to hundreds of kilometers spatial scale. In this context, artificial radionuclides are unique validation tools because they can be measured at all scales and source–terms are generally well known.
Fukushima accident in march 2011 resulted in direct release and deposit at sea of large amounts of radionuclides. The MARS (Model for Applications at Regional Scale) model was used to reproduce and forecast the behavior of contaminated waters. Dissolved caesium–137 measurements allowed assessing model reliability in this low energetic tidal environment (currents of 1 $m.s^{-1}$), but strong general circulation (Kurushio and Oiashio currents). In–situ radionuclide measurements were used as well to quantify the amount and flux of radionuclide released and to appraise the model reliability. Results of matching between measurements and model predictions are presented. Comparison between simulations and radionuclide measurements allowed improving modelling and demonstrating how data provided by hydrodynamic models in such situations are beneficial and what are their limits.

Keywords: Fukushima, accident, dispersion, radionuclides, Cs–137, coastal circulation model, model assessment, validation.

Numerical Modelling of Wind–Driven Circulation Behind a Large Wind Farm in the Presence of Surface Gravity Waves

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In this study, the main objective is to introduce an appropriate and simple theoretical and numerical frame to study the upper ocean response in the shallow water regions in the presence of a large wind farm by including the surface gravity wave forcing effects. We modify the two–dimensional shallow water wave equations by including wave stress and Stokes drift to study the wind–driven circulation. For numerical simulation, we implemented a finite volume technique and applied the Regional Ocean Modelling System (ROMS) to confirm the skill of the developed numerical technique to capture the physical behavior of the upper ocean response in the presence of a large offshore farm.

The typhoon season of 1971 in the coastal area of the Red River delta in North Vietnam

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Vietnam is one of the most rapid growing economies in Asia with an annual growth rate between 7.0 and 9.0 %. The Catba Halong and Red River Delta coastal region is located along the northeastern coast of Vietnam. By its richness in marine resources and an advantageous position in the northern focus of the economic triangle Hanoi – Haiphong – Quangninh, the region has become attractive for economical development. The government is looking for tools to predict and understand the impact of typhoons. The typhoon season in the region is in August and September. This article presents the hydrodynamics of the severe typhoon season of 1971. The Red River flooded during that year and caused the death of 100 000 people. With the Vietnam war going on, little information is known of this disaster that is ranked as a 250 year storm event by the NOAA. The region of interest is situated between 105.6° till 107.71° longitude and between 19.3° and 21.01° latitude. There is a diurnal tidal regime and the 4 most influential tides are M2, S2, K1 and O1. The maximum depth in the region is 40 m. The area knows two distinctive seasons, a rainy season and a dry season. The red river delta has a huge number of river mouths in the coastal area, the 9 most important rivers are implemented (with the Ba lat the most studied and well known river branch). The hydrodynamic–physics of the region were modeled in 3D with COHERENS V 2.0. The model set–up was tested and validated in a previous study. The wind velocities and direction measurements at a coastal meteorological station (Hon Dau station) are available every 6 hours during the typhoon season of July 1971. Though the newspapers reported heavy rainfall, the river discharges and river morphology during the studied period are not available. River discharges measured during the rainy season of 2010 are implemented as boundary conditions. Figure 1 shows that the residual surface currents had a landward direction. The model was able to provide a general idea about the situation during the typhoon of July 1971. Refinement in both input measurements and model set up will give a more accurate view. Future work includes the implementation of an inundation scheme

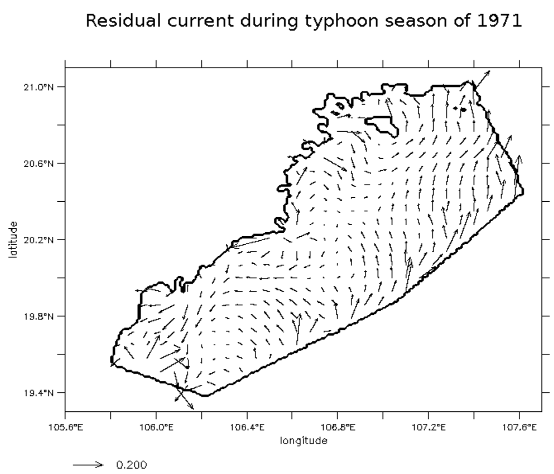

Figure 1: Residual surface currents during the typhoon season of July 1971

Hurricane-induced bottom stirring on the Louisiana-Texas continental shelf

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The coastal modeling presented here was conducted in support of a US federally-funded study, addressing morphological impacts to historic shipwrecks in the northern Gulf of Mexico. Submerged artifacts become incorporated into the local seabed following the wrecking event. Morphological processes and flow over and around the wreck can alter the shape and subsequently the interpretation of the archeological site. They also impact the long-term preservation potential of sites, as shipwreck components buried underneath seafloor sediments are well protected from deterioration. In this context, it is important to understand sediment accretion and seafloor scour patterns in order to determine the long-term stability of a given site. Our modeling study offers an estimate of the range of thicknesses of bottom sediment that can be disturbed during the passage of strong tropical storms, in three specific sites on the upper Texas-Louisiana continental shelf. Three local models, nested in a larger regional model, were set up to simulate the hydrodynamics, waves and scour of cohesive bottom sediment, subsequent transport and sedimentation during two events, Hurricanes Rita and Ike of September 2005 and September 2008, respectively. Delft3D-FLOW (with sediment) was run in 2D depth-averaged mode, coupled with Delft3D-WAVE. Data from NOAA, the ADCIRC group and local sediment surveys were used to force the models. Using limited field data to calibrate and validate the models, results provide a thickness range that varies considerably, from 0.003 m to 1.5 m, depending on the degree of consolidation (or the depth of the strongly consolidated sediment layer). Two ends of the spectrum were simulated: very loose and extremely consolidated fine sediments, modelled as different sets of values for Erosion parameter and Critical shear stress. It is shown that, for loose fine sediment of unlimited thickness, the scour depth peaks at 0.6-1.5m (varying with storm and location) but due to resedimentation is reduced to only 0.1-0.3 m one week after the event. Therefore we estimate that observed values for net scour (typically measured days after the event) underestimate the thickness of the disturbed bottom sediment. The sites are very dynamic, with strong scour occurring during the hurricane passage but also considerable re-sedimentation occurring after the storms have passed. Hurricane Ike, being the largest hurricane, caused the most scour at the three sites. A few days post-storm, positive net sedimentation is verified at some areas near the coast (in all three local models), which is consistent with the literature e.g. Turner et al. (2006). Important recommendations are given, focusing on how different field data (e.g. information on the bulk density of the sediment, vertical profiles of the bed properties from cores) might improve future modeling efforts. Due to the number of sites to be examined and budgetary constraints, the sampling strategy here had been designed to maximize the available data and only one trip per site was possible for collection of basic sediment properties.

Analysis of the atmospheric influence in water level modelling along the Iberian Atlantic coast

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Abstract:

The observed sea level in a coastal area is the resultant of the interaction of the astronomic tides with the local bathymetry and the influence of other forces such as wind and barometric pressure changes. In order to reproduce the observed water levels is essential to take into account these different forces. Numerical models allow the isolation of each force to study its importance and also the resultant of their combination.

In order to improve the degree of agreement with the observed water levels in the Iberian Atlantic coast, the PCOMS (Portuguese Coast Operational Modelling System) domains where forced following different strategies. The PCOMS consists of two nested domains WestIberia (2D) and Portugal (3D) covering the Iberian Atlantic coast and its contiguous ocean. The 3D model is a downscaling of the Mercator-Ocean PSY2V4 North Atlantic solution that run the Mohid model in full baroclinic mode with a horizontal resolution of 5.6 km and with 50 vertical levels with a resolution of down to 1 m near the surface.

The PCOMS was forced with “virtual tidal gauges” obtained from the FES95.2 and FES2004 global tide solution at different allocations along the ocean open boundary. Additionally, it was studied the effect of including new harmonic components through tidal admittance computation. The effect of the atmospheric pressure in the resultant sea levels was imposed using the inverse barometer correction at the virtual tidal gauges and including the atmospheric pressure in the model simulations. Atmospheric pressure and wind forcing were simulated using the results of a 9 km resolution MM5 model run at IST.

Modelling results were compared with observed tidal gauge data collected along the coast by the Spanish and Portuguese administrations and also with the harmonic analysis performed to one year period timeseries at each station.

The results of the present work summarise and quantify the improvements achieved in coastal sea level modelling using different open boundary conditions implementations and with the inclusion of atmospheric forces in an open ocean coastal area.

On the predictability of nearshore and harbors sea levels.

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The nearshore sea level forecast is very useful to assess a wide range of phenomena and related problems such as the evaluation of downstream boundary conditions near rivers' mouth or water level assessment for the operational management of commercial ports.
The dynamics of the nearshore sea level depends on different factors, in part strictly deterministic (tidal), in part related to weather and sea conditions, such as the effects induced by barometric pressure (the so-called inverse barometric effect), wind, nearshore waves, and circulation at regional scale. The sea level in a particular site can be estimated quite accurately by means of tide gauges well distributed along the coast, but those information cannot be extrapolated in order to obtain sea levels in other sites, also if they are not too far away, since the dynamical factors mentioned above act differently.
Many methods have been proposed to evaluate the sea level near the coast. One of the most basic approach is based on simplified models that take into account mainly the local tide effects and the atmospheric pressure, with an appropriate reduction and parameterization of all other factors (Faggioni et al., 2010). Other approaches that have been proposed are based on stochastic models, that do not consider the physical processes generating a surge, but usually use autoregressive methods to relate, through a series of characteristic coefficients, the predicted sea level values from the knowledge of various predictors (Walton, 2005; Ferla et al., 2010). However the most complete approach, that tries to take into account most of the physical phenomena involved in determining the sea level, is based on the implementation at the local scale of numerical hydrodynamic models. Unfortunately these models suffer from a number of uncertainties, some intrinsic to the model (e.g. non-linearity, representation of the tidal boundary conditions), others induced by the uncertainty of the forcing (wind, atmospheric pressure,waves).

In this work the predictive capabilities of different methods are compared, starting from the simplest tidal and barometric model, passing through a stochastic approach, ending with a more sophisticated hydrodynamic ROMS-SWAN coupled model. First a comparison is done in some pilot sites, identified in port areas where continuous sea level measures are available; then comparisons in other sites are presented, by using data based on coastal altimetry and in-situ hydrometric measures done during campaigns for data calibration.

Morphological modelling of an intertidal flat nourishment in the Eastern Scheldt, The Netherlands

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Erosion of intertidal flats may occur as a result of human activities, sea level rise, infrastructure developments and subsidence by gas extraction. The reduction in tidal flat area and elevation results in loss of valuable habitats for flora and fauna, and at the same time coastal defenses become more vulnerable to wave and current action. In the Netherlands, the intertidal flats of the Eastern Scheldt estuary have been eroding for decades. As a result of the construction of the Eastern Scheldt storm surge barrier and other dams in the late 1980's, the tidal volume and current speeds within the estuary decreased considerably. The dynamic balance between the accretion and erosion of tidal flats, salt marshes and mudflats was disturbed. As a result, the elevation and size of the intertidal flat is decreasing. Innovative and sustainable solutions are needed.

In this paper we investigate ecodynamic solutions to mitigate tidal flat degradation on the Galgeplaat, an eroding intertidal flat in the middle of the estuary. In order to reduce erosion a nourishment of 150,000 m^2, with a total volume of 130,000 m^2 was constructed in autumn 2008. This resulted in short-term negative impacts on the ecology however over the longer-term the nourishment will supply sand to the surrounding intertidal area, thus reducing the erosion of areas important for the biota.

An extensive monitoring campaign and modelling study were set up in order to study the impacts of the nourishment on both the ecology and morphology. In order to gain more understanding about the processes of sedimentation and erosion on the flats and the morphological influence of the nourishment, a depth-averaged (2DH) Delft3D-FLOW hydrodynamic model of the Galgeplaat, coupled with Delft3D-WAVE, was set up. This coupled model was nested in a larger model simulating the hydrodynamics (including waves) of the southern part of the North Sea, Western Scheldt and Eastern Scheldt. Non-cohesive sediment transport in the Eastern Scheldt was simulated with morphological bed-updating for different periods and different nourishment locations. A series of sensitivity tests were carried out in order to examine, a) the processes responsible for sediment transport on Galgeplaat, b) the influence of meteorological forcing on morphological development, c) the effect of biological structures, such as oyster reefs, on sediment transport and d) the behaviour of the nourishment in the model.

Current velocities and significant wave heights compare well with measurements done on and around the intertidal flats. The model shows that locally generated waves play an important role in the transport of sediments around and on the flats. Linking the morphological change of the nourishment with the impact on biota and vice versa is complicated by both temporal and spatial scale issues. Results show that the inclusion of biological features, such as oyster and mussel beds improves the simulation of current magnitudes and hence affects patterns of sedimentation and erosion. In addition, patterns of morphological change on and around the nourishment concur with measurements. Therefore the model is a useful tool to examine different nourishment strategies, both in terms of nourishment location and nourishment design and to examine the conditions that have most impact on the spreading of the nourishment.

Modelling the fate and transport of suspended sediments and contaminants in the Scheldt River and Estuary with the finite element model SLIM

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The Scheldt River has it source in the north of France, crosses Belgium and ends in The Netherlands before discharging in the North Sea. During its journey, the Scheldt water is contaminated by the different agricultural, industrial and domestic activities which are characteristic of this densely populated area. In order to model the fate and transport of different contaminants along the Scheldt River, Estuary and the North Sea, the finite element model SLIM[1] (1D–2D version) has been extended with environmental modules. The particularity of the model set–up is that a 1D river network is coupled to a 2D model of the estuary and a part of the North Sea (de Brye et al., 2010). The first environmental module is concerned with suspended sediments, which are essential in environmental studies because the particulate phase carries an important fraction of the contaminants in the water column. The suspended sediment module is designed to be as simple as possible in order to facilitate long–term environmental simulations. We will present the features of this module and demonstrate its good performance by comparing with field observations and simulations by the more complex 3D LTVmud model (van Kessel et al., 2011). Two contaminant modules will also be presented, simulating the concentrations of fecal bacteria (*Escherichia coli*) and trace metals. Both are tightly linked to the suspended sediment module which governs the transport of the contaminants' fraction attached to particles.

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1Second-generation Louvain-la-neuve Ice-Ocean Model (www.climate.be/slim)

Modelling wave propagation and hydrodynamics in the East–Frisian Wadden Sea

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Key words: Numerical modelling, Wadden Sea, wave propagation, tidal currents

Within the research project „Climate Impacts – Scenarios for Adaptation (KLIFF)" funded by the ministry for science and culture of the federal State of Lower Saxony in Germany, consequences of the potential future climate change on hydro– and sediment dynamics in the area of the East–Frisian Wadden Sea are to be estimated with the use of spatial high–resolution numerical models.

The most important physical factors influencing the sediment dynamics in coastal areas are wind– and tidally–driven currents, surface gravity waves and currents driven by current–wave interaction. In preliminary studies, the performance of the three–dimensional, unstructured grid modelling system FVCOM–SWAVE, which is a 'combination' of the hydrodynamical model FVCOM and the wave model SWAV, is tested.

This modelling system is applied to the Barrier Islands of the East Frisian Wadden Sea with a fine resolution in regions of high interest and with a coarser resolution towards the open North Sea. The processes of wave propagation, wave–current interaction and energy transport are tested for artificial atmospheric and boundary conditions as well as for a real storm surge which happened in November 2006.

The results are compared to measured hydrodynamic and wave data of a permanent time series station close to the Island of Spiekeroog and to ADCP data obtained during ship cruises within the study area.

Data assimilation in coastal ocean modelling and forecasting

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"Data assimilation" comprises a large range of techniques for structured integration of models and data with the objective of improving the model per se or to improve or enhance the forecasts made by applying the model. The first objective is associated with techniques for parameter estimation / optimisation or model calibration, while filter techniques such as Kalman filtering, particle filtering are applied for the second objective. Techniques such as variational techniques can be used for both objectives.
Data assimilation techniques are furthermore easily used for model sensitivity analysis, analysis of observation network sensitivity (OSSE's), uncertainty propagation in models, etc.

The open source model environment OpenDA (www.openda.org) is a generic modular environment that provides a range of data assimilation techniques, plus modules for interfacing, experiment configuration, algorithm configuration, uncertainty prescription, ensemble generation, etc. OpenDA can be used for any process model given an OpenDA – model interface ("wrapper") for the exchange of model states and parameters between the two. Since its launch during Jonsmod2010, wrappers have been developed for modelling systems for surface hydrodynamics such as SWAN, Delft3D–Flow, SOBEK, HBV, WANDA, WAQUA, air pollution models, and others.

While the systems will run in automated mode, the results will depend on judicious user configuration of OpenDA control settings and output analysis. This is guided by process understanding and clear definition of experiment objective and should not be automated. In terms of parameter optimisation results: a physically well defined optimum, not just a mathematical optimum.

In the presentation the authors will focus on the practical user aspects based on analysis of 2D and 3D model applications in South east Asian and European waters, for model parameter optimisation, Kalman filtering experiments and observation sensitivity analysis.

Realistic high resolution modeling of the Northern Mediterranean Current (NC) using the NEMO code : impact of model parametrisation at lateral and open boundaries and validation with observations.

The shelf topography of the north–western Mediterranean sea is very complex, with a sharp shelf–break featuring numerous deep canyons. The shelf is narrow from the Ligurian Sea to the Var coastline, and then widens to form the Gulf of Lions (GL) shelf. The major current of the area, named the northern current (NC) is known to be constrained by the bathymetry (typically following the shelf break). Its dynamics, strongly influenced by the topography, exhibits a strong seasonal variability: from a wide, shallow and relatively weak current in summer, it gets narrower deeper and stronger in winter periods, flowing closer to the coast. This current is known to feature mesoscale processes, such as meanders giving birth to eddies, and current intrusions onto the GL shelf.

The NC dynamics and variability is studied through a numerical approach, aiming at realistically representing the NC features and its associated mesoscale field. The quality and the pre–conditionning impact of different open boundary datasets are studied. The horizontal and vertical resolution impact on the simulations is also assessed. In addition, bottom and lateral friction parametrisation tests are performed in order to evaluate the topography control on the NC path.

This work uses a high resolution numerical model, named GLazur64 (for Gulf of Lion côte d'AZUR) (Ourmières et al., 2011). It is a NEMO based downscaling of 1/64° resolution (about 1.25 km on a horizontal regular mesh), with 130 vertical levels (from 1 m at the surface to 30 m at the bottom for the reference configuration). Two different datasets, derived from basin scale models have been used to provide open boundary conditions: MED12 (no data assimilation; Béranger et al., 2010) and PSY2V3 (including data assimilation; MERCATOR). The modeled region extends from 2.09°E to 7.97°E and 41.26°N to 43.9°N, allowing to include the whole French Mediterranean coast, from the Italian border to the Catalan area (Spain).

Good agreement between the numerical simulations and available observations is reached. The high resolution of the model allows validation with spatial–temporal high–resolution observations, such as ADCP and CTD profiles. The strong influence of the velocity and hydrological informations brought by the open boundary datasets on the NC representation has been assessed. The baroclinicity and energy of the current are strongly conditioned by the quality of the boundary datasets. The parametrisation of lateral conditions, as well as the vertical grid, also have a significant impact on the current speed and position.

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Sea Surface Temperature (SST) modelling in the Sea of Iroise. Assessment of boundary conditions.

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Numerical ocean modelling systems are traditionally exploited to prescribe open boundary conditions (OBC) of coastal models in terms of sea surface elevation, currents, temperature and salinity. The present study investigates the performance of COHERENS model (Luyten et al., 1999) applied in the Sea of Iroise and driven by different OBC by comparing SST predictions with observations.
The sensitivity of COHERENS predictions to daily operational OBC of temperature is analysed. Two sources of OBC are considered, derived from numerical products of MyOcean european project (http://www.myocean.eu) : (i) the Mercator Global Ocean (MGO) and (ii) the Iberian Biscay Irish (IBI) ocean analysis and forecasting systems delivering predictions at resolutions of 1/12 and 1/36 degrees, respectively.
Models predictions are compared with offshore recently available remote sensing data products. Further comparisons are performed against data gathered in the framework of the ferry-based water quality monitoring program SIRANO ("Surveillance des eaux de surface en mer d'Iroise et Rade de Brest par Navire d'Opportunités") (Duvieilbourg et al., 2012).

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Short internal waves trailing strong internal solitary waves in the South China Sea studied by a numerical model and Envisat synthetic aperture radar images

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Three–dimensional generation of internal solitary waves (ISWs) in the northern South China Sea (SCS) was studied using the fully nonlinear, nonhydrostatic MIT general circulation model (MITgcm). Large amplitude first (120 m) and second (80 m) mode ISWs are modeled, which are beyond the capability of traditional weakly nonlinear theory. What is intriguing of the runs is the simulation of some short internal waves, which have wavelengths of the order of 1.5 km and amplitudes of 20 m. They ride on second mode concave ISWs and only appear in the upper 800 m but decay rapidly below that level. The existence of these short internal waves, which also always follow a first mode ISW, can be explained by the Taylor–Goldstein equation which includes a shear in the background current. The simulations predict that the short internal waves occur in two distinct areas, one close to the Luzon Strait (LS) and the other further west. In the first area, they are generated by the disintegration of a baroclinic bore, which is generated by the interaction of the tidal current with the steep topography in the LS. In the second area they are generated when the faster first mode ISW overtakes the frontal second mode ISW.

Whether these short internal waves can cause strong enough surface water divergence/convergence and thus can be detected by satellite sensors remains to be answered. Fortunately, after screening the Advanced Synthetic Aperture Radar (ASAR) archive of the European Space Agency (ESA), many SAR images acquired over the northern SCS were found to feature sea surface signatures of such short internal waves trailing a much longer first mode strong ISW. The detailed analysis of these SAR images shows good correlation between modeled and observed internal wave fields.

Progress in the development and use of a finite element hydrospheric model

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The hydrosphere is made up of a number media, such as groundwater, oceans, shelf seas, estuaries, rivers, sea ice — which, for the sake of simplicity, is considered herein to be part of the hydrosphere. The processes taking place in these domains are vastly different in nature and are characterised by a wide range of space- and time-scales.

The components of the hydrosphere interact with each other. For instance, the shallow marine and estuarine regions, though accounting for less than 1% of the volume of the oceans, have a biomass far from negligible as compared to that of the oceans, suggesting that they play a significant role in global biogeochemical cycles. This is one of the reasons why models are now needed that deal with most, if not all, of the components of the hydrospheric system.

Numerical models of each of the components of the hydrosphere already exist. However, an integrated model of the whole hydrosphere has yet to developed. Building such a model is a daunting task, requiring the development of multi-scale/physics simulation tools.

Numerical methods for dealing with multi-scale problems are developing rapidly. Unstructured meshes offer an almost infinite geometrical flexibility, allowing the space resolution to be increased when and where necessary. In addition, time steppings for dealing with a wide spectrum of timescales while retaining a high order of accuracy have been developed over recent years (e.g. multi-rate schemes).

Taking advantage of the abovementioned progress in numerical methods, various teams over the world have started developing models for simulating in an integrated manner a significant number of components of the hydrosphere. One of these groups is building the Second-generation Louvain-la-Neuve Ice-ocean Model (SLIM, www.climate.be/slim). The latter solves the equations governing geophysical, environmental and groundwater phenomena by means of the (discontinuous Galerkin) finite element method on 1D, 2D or 3D unstructured meshes. To take advantage of state-of-the-art developments, SLIM is also being interfaced with existing tools (often based on radically different numerical methods), such as the well-known and widely-used General Ocean Turbulence Model (GOTM, www.gotm.net).

A brief review of the current status of SLIM will be presented, as well as developments planned in the near future. It will be seen that space-time mesh adaptivity pays off. Idealised test cases will be reported on, including a well-known three-dimensional ROFI benchmark. Realistic problems will also be dealt with, in particular the application of SLIM to the Great Barrier Reef, Australia.

Spatial Pattern of Hits to the Nearshore from a Major Marine Highway in the Gulf of Finland

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The Baltic Sea has probably the most intense ship traffic in the world. The largest threat to the environment is oil transportation that has increased more than by a factor of two in 2000–2008. An area that is highly vulnerable to ship pollution is the nearshore that usually has the largest ecological value.

While the probability of coastal pollution for open ocean coasts can be reduced by shifting ship routes farther offshore, the problem for narrow bays, like the Gulf of Finland, is how to minimize the probability of hitting any of the coasts. A convenient way to address this problem is to use statistical analysis of a large number of Lagrangian trajectories of test particles representing the potential pollution and passively carried by surface currents.

In this paper, we make and attempt to quantify the link between potential sources of pollution along an existing fairway and the sections of the coast reached by current-driven pollution. The problem is analysed by means of considering hits to the nearshore from a major fairway in the Gulf of Finland and by making sure whether certain parts of the coast are hit by pollution particles most frequently and whether or not these pollution particles stem from certain specific parts of the fairway. Trajectories are simulated in the Gulf of Finland by placing tracers among a line that follows one of the major fairways from the Baltic Proper to Saint Petersburg.

The probabilities for the hit to different parts of the nearshore and the ability of different sections of the fairway to provide coastal pollution have extensive seasonal variability. The potential impact of the fairway is roughly proportional to its distance from the nearest coast. A short section of the fairway to the south of Vyborg and a segment to the west of Tallinn are the most probable sources of coastal pollution. The most frequently hit coastal areas are short fragments between Hanko and Helsinki, the NE coast of the gulf to the south of Vyborg, and longer segments from Tallinn to Hiiumaa on the southern coast of the gulf.

A study of the fresh water plume and its interaction with barotropic tidal currents in Liverpool Bay using an unstructured–mesh model

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We have recently developed an unstructured–mesh, finite–volume model of the Irish Sea and part of the Celtic Sea based upon FVCOM (Finite–Volume Coastal Ocean Model). The Irish Sea and Celtic Sea FVCOM (IS–FVCOM) has been successfully used to study bartropic tides, tide–surge interaction, temperature evolution, fronts and eddies in the stratified western Irish Sea region. In this talk, we shall present some recent results of the model application to the fresh water plume and its interaction with bartropic tidal currents. With IS–FVCOM, we can refine the model resolution to an order of 100s metres in the Liverpool Bay region to achieve better representation of coastal dynamics. Finer model resolution enables us to model the sharp fresh water front accurately (Fig 1). We can also see how barotropic tidal currents are modified by the interaction of tidal currents with the fresh water–induced horizontal density gradient; the process termed strain–induced periodic stratification (SIPS, Fig.2). The effect of wetting/drying on the fresh water plume is also investigated.

Fig.1. Distribution of salinity in Liverpool Bay, left: surface, right: bottom.

Fig.2. Tidal currents at a location in Liverpool Bay under the influence of fresh water (left) and without the influence of fresh water (right). Top (bottom) panels are surface (bottom) currents.

Calibration of a New Generation Flood Forecasting Model for the Northwest European shelf and North Sea using data assimilation techniques (OpenDA)

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Keywords: flood forecasting model; model calibration; data assimilation

The paper discusses a new generation operational flood forecasting model for the Northwest European shelf. Upon completion, this new version of the Dutch Continental Shelf Model (DCSM v6) will be used 6 times daily by the Dutch Stormvloedwaarschuwingsdienst SVSD ("Storm Surge Warning Service"), for its operational water level forecasting.

DCSM v6 is a 2D (horizontal) application of SIMONA, the framework for hydrodynamic modelling of free-surface water systems used for Rijkswaterstaat modelling. The DCSMv6 domain covers a much larger part of the Atlantic Ocean, internal tide generation is included, while its resolution has been increased by a factor 5 by 5 The new DCSM v6 hydrodynamic model grid is spherical with a uniform cell size of 1.5' (1/40°) in east-west direction and 1.0' (1/60°) in north-south direction, leading to more than 10^6 grid cells. Tidal water levels at the open boundaries are specified in the frequency domain, i.e., the amplitudes and phases of a number of tidal constituents are specified. The tidal constants of the eight main constituents have been optimised using Topex-Poseidon altimetry data for the open ocean plus a dataset derived from the GOT00.2 global tidal model. Additionally, 16 smaller diurnal and semi-diurnal constituents have been derived by means of the admittance method.

Well distributed water level measurements at more than 100 coastal locations allowed for a thorough calibration of the shelf areas. To control the optimisation and allow assessment per subarea, data assimilation methods available in the open source data assimilation toolbox OpenDA were applied. Given the model and data size, its parallel computing functionalities proved essential. A restart functionality facilitated successive refinements of the calibration.

A series of built-in Goodness-of-Fit (GoF) measures (in frequency and time domain) was configured to quantify the quality of various aspects of the water level representation per sub-region and for the model as such. This structured calibration of the water level representation in DCSM v6 has resulted in a reduction in errors at stations along the Dutch coast of more than 40 % in comparison with the previous operational flood forecasting model DCSM v5, and a reduction of more than 60 % if only tide is considered.

COASTAL CIRCULATION RESPONSE TO PHYSICAL FORCING: APPLICATION OF MARS 3D MODEL FOR STUDING DISPERSAL PROCESSES IN THE EASTERN ENGLISH CHANNEL.

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This work has been done to assess effects of physical forcing (such as tide, wind or freshwater inputs), on passive tracers transport and dispersal in the ROFI system of the eastern English Channel (EEC). The MARS–3D model coupled with the particle tracking module Ichthyop is used to study circulation and tracers dynamic under different forcing conditions at different spatial scales: from regional – EEC, to small scale – Boulogne–sur–Mer harbour. Results of hydrodynamic modelling are validated against tidal gauges, VHF radar derived surface velocities, ARGOS drifters and ADCP measurements. Numerical Lagrangian tracking experiments are performed with passive particles to study tracer dispersal along the northern French coast, with special emphasis to circulation and tracer dynamics inside Boulogne–sur–Mer harbour. The experiments revealed that the strongest accumulation of tracers occurs during ebb, when tracers are released 6 hours after the high water in Boulogne–sur–Mer. Particles release moment (tidal cycle phases) seems to be the most important parameter controlling the trapping. In case of an accidental river release, the residence time of particles released during ebb can be 8 times more than during flood, with significant fortnight tidal cycle. During ebb, tidal forcing induces a maximum trapping, nevertheless, wind and fresh water inputs reduce the residence time. During flood, south–west wind increases the trapping but north–east wind and river inputs induce a faster flushing (up to only few hours).

An anticyclonic eddy has been identified and could be responsible for important sedimentation toward the inner basins of the harbour and along the southern seawall.

For a better understanding of tracers dynamic inside Boulogne-sur-Mer harbour, simulations have been done to assess hydrodynamic response to seawalls implementation/ removal or extremes forcing.

MODELLING THE KRAKATOA TSUNAMI PROPAGATION ON THE EUROPEAN ATLANTIC SHELF.

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The explosion of Krakatoa volcano in 1883 generated one of the highest tsunami ever observed. We have modelled the tsunami propagation by using a unstructured finite element grid and TELEMAC software to resolve the shallow water equations. The finite element grid has been densified on the European Atlantic shelf in order to capture the amplification of the tsunami and its modifications in shallow coastal regions of the Bay of Biscay and of the English Channel. The model predictions have been compared to the tide gauges records available from the Royal Society report (Symons, 1888) and to those found recently in the French Navy archives (Daubord, 2011). As the Krakatoa tsunami amplitude is rather small along the European coasts, the constructed high resolution numerical model turns out to be very useful in distinguishing the tsunami signature from spurious fluctuations recorded by tide gauges.

Modelling the dynamics of a large–scale river plume and their effect on nutrient distribution

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The distribution of ecologically important nutrients transported into the marine environment by large rivers is governed by the processes of river plume; circulation, propagation, interaction with coastal currents and mixing with shelf waters. Numerical modelling allows detailed investigations of the physical processes controlling these nutrient distributions and compliments in situ observations.

The Columbia River is the largest source of fresh water to the North West Pacific and is the dominating coastal feature of the Oregon and Washington shelf. The 3–dimensional MIT general circulation model (MITgcm) has been used to simulate the Columbia River Plume over a period of several tidal cycles. Variable wind forcing, representative of observed meteorological conditions, has been used to induce upwelling, downwelling, steering of the plume and mixing processes. Realistic river flow and bathymetry have also been used, producing a model that represents the observed system well.

Passive tracers have been incorporated into the model to represent micro and macro nutrients such as silicate, nitrate and iron within the plume and surrounding waters. The results of the modelling investigation have been compared with extensive data collected from the area as part of the River Influences on Shelf Ecosystems (RISE) project. It was found that MITgcm reproduces the process of passive tracer dispersion well, especially in the near–field plume. The model has also generated good approximations of plume propagation under the variable forcing conditions.

Modelling larval dispersal of the great scallop in the English Channel

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The great scallop (Pecten maximus) is one of the most important benthic species of the English Channel as it constitutes the first fishery in landings in this area. While the knowledge of larval dispersal pathways and population connectivity is an essential prerequisite for defining effective strategies of spatial fishery management (e.g. delineation of management units), quantifying dispersal and connectivity among benthic populations remains a major challenge in marine ecology. In this context, the aim of the present study supported by the French program 'ANR COMANCHE' is to develop a high–resolution biophysical model of scallop dispersal for two bays in the English Channel: the Bay of Saint–Brieuc and the Bay of Seine. They are chosen for three reasons: (i) the distribution of the scallop stocks of these areas are well known, (ii) these two bays harbour important fisheries, and (iii) scallops in these two areas present some differences in terms of reproductive cycle and spawning duration.

To assess the English Channel circulation, hydrodynamics are simulated for 10 years (2000–2010) with the MARS–3D code. The hydrodynamic model is validated in terms of sea surfacetemperature (satellite data versus model) and in terms of tidal amplitude and phase (tidal gauge observations versus model).The simulated currents and temperature are then used by the Lagrangian module of MARS–3D to model the transport of Pecten larvae into the English Channel. To understand the processes that control Pecten transport, we have tested different wind scenario and different tidal conditions during spawning on dispersal, first for passive particles with a mean planktonic larval duration (PLD) of 30 days, and second for 'biological' particles. Two biological parameters (i.e. the swimming behaviour and the relationship between the PLD and the temperature) are consequently added to the model.

Keywords: Scallop, Channel Sea, numerical model, PLD, Lagrangian transport.

NW Mediterranean sea model toward the study of the climate change impacts on the coastal ecosystems

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The project ClimCares is devoted to assess the potential impacts of climate change on biodiversity conservation of coastal areas of the NW Mediterranean region. Shifts in species' geographical distributions and mortality events have been linked to a significant regional warming and positive anomalies occurred during the last decades (1999, 2003 and 2006). Under the actual climate projections, the NWM sea surface temperature may experience an average warming of 2 to 4°C by the end of the century along with a very likely increase in the occurrence of heat waves and changes in wind regimes. However, the spatial resolution (50 to 10 km) of global to regional models used so far for the development of warming scenarios remains inappropriate for the coastal areas.
High resolution hydrodynamical modelling addressing (sub)mesoscales processes – MARS3D/MENOR – will be used to assess the vertical profiles of temperature over the last 10 years measured at sensitive sites (http://www.tmednet.org). Evaluating the occurrence of impacting events (heat waves, wind burst sequences), we will link the temperature changes with a range of biological responses. Biological responses will be compiled from in situ data obtained during mass mortality events as well as from thermotolerance experiments on affected species.

Data Assimilation and Efficient Model Order Reduction for Morphodynamical Modeling

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Twenty years after De Vriend et al (1993) stated that long-term modeling of coastal morphology was “still in its infancy", the field has experienced significant improvements but “*long-term forecasting*” is still out of grasp. Models are still limited in their capacity to reconstruct natural processes associated to sediment transport and deposition. In particular, accurate quantitative morphodynamic estimations in the nearshore area show poor results even in state of the art numerical models. The difficulties stem from two closely interrelated issues: the nature of the process and its mathematical representation. The complexity and the number of the associated natural processes limit our capacity to implement reliable numerical models. For this, data assimilation could make a significant contribution to optimize the quality of nowadays estimations.

In the present study a data assimilation technique called reduced-model 4DVar has been implemented to optimize a morphodynamical model by means of parameter estimation. The scheme implements a parameter optimization over a reduced order model (ROM). The ROM is a linear approximation of the full morphodynamical model.

The Delft3D suit (Swan, D3D-Flow, D3D-MOR) was used to reconstruct the morphodynamic evolution observed in a laboratory experiment on rip current circulations over a moveable bed (Castelle et al, 2010). The laboratory experiment provides detailed and accurate information about the forcings, hydraulic characteristics and boundaries of the system. Highly reliable measurements of bathymetry were used to estimate 18 model parameters ranging from wave characteristics, to hydraulic and numerical parameters.

The 18 parameters were successfully estimated and the overall performance of the model showed a significant improvement in relation to the bathymetric evolution of the system. Surprisingly, parameters updates in the order of 1% of the initial value have a very significant effect on the morphodynamical model. In the case of wave direction, for example, changes in the order of 1 degree already show nonlinear effects in the bathymetric evolution. The partial results indicates a high sensitivity of the model to horizontal eddy viscosity, in particular, and to the morphodynamic parameters (numerical and physical). On going work focused on minimizing the computational expense of the data assimilation technique has shown very encouraging savings in the order of 20% of model executions. Finally, the results produced in this study constitute a data assimilation system for morphodynamical models and are a middle step towards a more comprehensive operational forecasting system that includes, for example, observation network optimization and optimal control strategies for dredging operations.

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3D coupled physical-biogeochemical modeling in a coastal area: Study of Rhone River diluted water intrusion in Marseille's Bay

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The eastern part of the Gulf of Lions is a coastal environment strongly influenced by physical processes (upwelling, intrusions of the Northern Current, wind vertical mixing, stratification by heat fluxes) and biogeochemical inputs (Rhone River, Marseilles city inputs). Under specific conditions, the Rhone River dilution zone can extend eastwards (Gatti et al, 2006) near the Bay of Marseille. However, this area remains mainly an oligotrophic ecosystem. The aim of this study was to develop, validate, and use a three-dimensional physical-biogeochemical coupled model, in order to better understand the functioning of this coastal ecosystem. **In the present work, we were particularly interested in the processes, duration, frequency, spatial extent and the biogeochemical impact of the Rhone river intrusion in the Bay of Marseille.**

The 3D hydrodynamical model MARS3D (RHOMA configuration) validated by Pairaud et al (2011) was coupled 'online' with the biogeochemical model ECO3M (Faure et al, 2010a). The initial biogeochemical model was adapted with a new parametrization (Fraysse et al. 2011). The new model version (ECO3M-MASSILIA) is based on the Carbon, Nitrogen and Phosphorus cycles and has 17 state variables. The model also takes into account variable stoichiometry of elements in each biological compartment. The modeling area spreads from the Rhone River to the Cap Sicié with a horizontal resolution of 400 m. In order to evaluate 3D coupled model results, statistical indicators were used to compare *in situ* and satellite data with models results.

Realistic 3D simulations for the period spanning from 2007 to 2011 highlighted the importance and complexity of Rhone river diluted water intrusion in the Bay of Marseille. Indeed, intrusion events were highly variable in duration, horizontal and vertical extension. Rhone river discharges, wind and coastal circulation were studied to better understand processes inducing/driving Rhone river diluted water intrusion. Then, the impacts of these waters on the oligotophic ecosystem of Marseille were investigated. During each event, rich nutrients water issued from the Rhone River led to an increase of the biological production, but the thickness of the impacted layer depends on the intensity of the intrusion event. Finally, Self Organizing Maps were used to quantify occurrence and spatial extension of the Rhone River diluted water intrusion in Marseille coastal area.

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Processes analysis in the Channel of Toulon: model/measures

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French Institute for Radiological Protection and Nuclear Safety has developed a 3D coastal ocean model of the Toulon's Bay as a part of a post-accidental tool in order to simulate radionuclide's dispersion. Duffa and al (2011) showed that the first model's results were consistent with measures, but the model still needs to be validated.

The Bay of Toulon is situated in a Mediterranean urban area and is separated in two basins by a 1.4 km long seawall. The Little Bay is a semi-enclosed basin connected to the Large Bay via a channel. This channel witnesses a significant water masses exchange and is also an important transport area, where the water flow is conducted by both wind and depth. It is hence a strategic point in marine contamination.

As a first step of validation for Toulon's model, but also to understand the water transport and

currents, devices have been moored in the channel. A 600-kHz RDInstrument Acoustic Doppler Current Profiler (ADCP) has been set up from June 2009 to June 2010. Some CTD profiles have also been carried weekly during summer 2010. This study analyzes in situ data to understand the phenomenon of current inversion and current intensity and direction. This flow reversal is highly correlated to meteorological forcing. Northwest wind induces southeast surface current and northwest bottom current whereas eastern wind pushes the surface layer into the Little Bay while the bottom layer exits. We compared measures to model simulations with graphical representations and statistical comparisons. Furthermore, we try to identify some parameters that could modify the model's results to fit measured data.

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Evaluation of results from eddy resolving models: Methods and examples

Lars Petter Røed and Nils Melsom Kristensen

We evaluate results from eddy resolving, numerical ocean simulations in Norwegian waters. The model we use is the Regional Ocean Modeling System (ROMS). The grid size is slightly above 800 m which is about one tenth of the Rossby radius. To this end we use available current meter moorings and observations from CTD casts. We note that no data assimilation was performed. Although the evaluation shows that the model's forecasts skill is poor, its statistical skill is fairly good to excellent. We therefore conclude that the model is useful for studying particular dynamic processes such as eddy generation and instabilities, but that it is less useful as a prediction tool, e.g., to forecast the actual timing of eddy generation and high current events at particular locations at a given time. Given its statistical skill the model is well suited for making extreme current statistics of importance for, e.g., the offshore industry. Finally, we note that model is also useful for generating statistics on transport and spreading of, e.g., nutrients, larvae, and contaminants such as oil and toxic substances.

An Ensemble based time-local H_infty filter for efficient storm surge forecasting

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Accurate sea water level forecasting due to hurricanes and tropical storms is a crucial and challenging problem. Recent years have seen considerable progress in the development of high-fidelity numerical wind-driven hydrodynamical models used to accurately forecast currents and sea water levels. These numerical models are still subject to uncertainty especially in the case of extreme events such as hurricanes. To improve hurricane storm surge forecasts, we consider different data assimilation methodologies.

We will present a more robust ensemble filtering methodology for storm surge forecasting based on the use of the ensemble time-local H_infty filter (EnTLHF) within the framework of singular evolutive interpolated Kalman filter (SEIK). By design, the H_infty filter is more robust than the Kalman filter in the sense that the estimation error in the H_infty filter has, in general, a finite growth rate with respect to the uncertainties in assimilation. The numerical hydrodynamical model used in this study is the Advanced Circulation (ADCIRC) model. We use data obtained from Hurricanes Katrina and Ike as test cases. Hurricane Katrina made landfall in Louisiana and Mississippi in August 2005, and Ike hit the upper Texas coast in September 2008. The results show that a modified SEIK filter based on the time-local H_infty filter with an inflation factor provides more accurate forecasts of storm surge resulting from these hurricanes as compared to the traditional SEIK filter.

Keywords—Data Assimilation, Storm Surge Forecasting, SEIK, EnKF

Shelfbreak Frontal Circulation near the Sable Gully of Nova Scotia

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The Sable Gully is a broad deep underwater canyon located on the edge of Scotian Shelf to the east of Sable Island. Being the home of many marine species including the endangered Northern Bottlenose whale, the Gully was designated as a Marine Protected Area (MPA) in 2004. Better understanding of physical environmental condition in this MPA is needed for sustainable ecosystem management. Due to the complex topography and highly varying circulation over the Gully, detailed three–dimensional numerical simulations have not been made for this area. In this study, a multi–nested model is used to simulate the three–dimensional circulation in the Gully. The model is driven by tide, wind and surface heat fluxes. The model results are validated by comparing against year–round current observations from four moorings deployed in the Gully from April 2006 to July 2007. The model results show a shelfbreak jet flows from northeast to southwest throughout the year. The circulation in the Gully has a complex vertical structure and varies from season to season. A persistent northward flow occurs in the deep layer of the Gully, indicating the cross shelf transport of deep ocean water onto the shelf.

3D numerical simulations of the baroclinic tides in the Celtic Sea

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Numerical investigations of baroclinic tides in the Celtic Sea were conducted using a three–stage approach: preliminary linear analysis, setting the barotropic tidal forcing, followed by a series of 3D numerical experiments with stratified fluid.

The linear analysis is based on the concept of tidal “body force” introduced by Baines in 1982 (Baines, 1982). It appears in the right–hand side of the momentum balance equations as a forcing term which generates the baroclinic tides. Spatial distribution of this “body force” can indicate the potential places where the strongest sink of barotropic tidal energy into internal waves takes place. It was found that in the Celtic Sea the maximum of the generation force is not localised. There are a number of “hot spots” randomly distributed across the shelf–slope area, and not necessary located on the continental slope.

Analysis of barotropic tidal ellipses was conducted using TPXO7.1 global inverse tidal model (Egbert and Erofeeva, 2002). Great variability of tidal characteristics across the model domain was found, especially in the areas predicted by the linear theory as potential sources of internal wave generation. To initialize MITgcm, the code was modified by inclusion of an extra package which reproduces the tidal forcing correctly. The new code was run in a barotropic mode, and a good agreement was found between the MITgcm output and TPXO7.1 model predictions.

The numerical experiments with stratified fluid were conducted on a relatively coarse grid (one nautical mile) in order to reproduce the general structure of baroclinic tides in a big part of the Celtic Sea (rectangle 298x335km^2). It was found that internal waves generated in a shallow water zone on the shelf in the areas of local banks with depth < 200 m (local “hot spots”) are comparable with that generated over the continental slope. This result was predicted by the linear theory. The wave field on the shelf is a complex three–dimensional superposition of the wave systems generated locally and arriving from the shelf break. Strong “reverse” energy flux from the shelf area to the shelf break is predicted.

Characterization of local transport properties in ocean models

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Transport processes in the ocean are of interest for many practical applications, and the Lagrangian viewpoint provides a natural framework for the investigation of such processes. Particle trajectories are used to visualize flow patterns, and statistics based on resident time or age of particles within a model domain provide important information when applied to pollution control or primary production of biomass. Lagrangian particles are also useful when analyzing the probability of transport between two or more locations within a model domain, which is an important question for coastal management, if we wish to protect a specific site from pollution from a specific source, or for the fish farming industry who wish to avoid disease agents from spreading between farm locations.

The characterization of local transport properties can be analyzed from Eulerian velocity fields with the use of Okubo−Weiss or Hua−Klein criteria, or from Lagrangian trajectories with the use of finite scale or finite time Lyapunov exponents. We investigate the ability of these techniques to identify coherent flow structures and barriers for flow dispersion.

Salinity response to forcing changes in the Charente estuary 3D numerical modeling and observations

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Estuaries present a meeting point for fresh and salted waters. From the mouth to more upstream positions, salinity depends on several parameters, which include the geomorphologic characteristics of the estuary, but also different forcing (tide, river flow, wind). Both horizontal and vertical salinity gradients are expected, the highest salinity levels being usually measured at the mouth and near the bottom. Saline intrusion is the main concern associated with these dynamics. Previous studies investigated numerically the incidence of forcing variations on salt intrusion and vertical stratification. Prandle (2004) showed, for example, that for partially mixed estuaries, an increase in tidal currents provoked a decrease in density related mixing, and an increase in mixing due to tidal straining. Jiang et al. (2009) proved that the salinity response to forcing changes depended on the portion of the estuary considered. Gong et al.(2011) showed that the salt intrusion length depends greatly on the river discharge.

The Charente estuary is located in the middle of the French Atlantic coast. This is a small, shallow estuary, characterized by the presence of large intertidal flats. The river flows into the Marennes–Oléron Bay, a macrotidal basin under the influence of a semi–diurnal tide. The salinity variations in the estuary represent a very important issue, since the Charente River is a source of fresh drinkable water for the area. During low water periods (generally in the summer), the river flow is very small and the salinity can enter further in the estuary and affect the drinkable water intakes.

This study is focused on the evolution of the salinity in the water column, and along the estuary, in response to different hydrodynamic and atmospheric conditions. The investigations are conducted using a 3D numerical model with nested structured grids (MARS3D). The effect of the neap/spring tidal cycle, the seasonal variability of the river flow, and the impact of the wind are considered in the model. Different simulations will allow us to determine the relative impact of each parameter on the salinity distribution. Preliminary results obtained from observations suggest that the salinity, even during low water periods, does not affect the water intakes, upstream from the Saint–Savinien dam (47 km from the mouth).

Keywords : estuary, hydrodynamics, saline intrusion, vertical stratification, numerical 3D modeling

Acknowledgments : FEDER, Conseil Général of Charente–Maritime.

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Numerical study of circulation, hydrography and sea–ice conditions in the Gulf of St. Lawrence and Scotian Shelf using a coupled ocean–ice model

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A coupled ocean–ice numerical model based on the NEMO modelling system is applied to the Gulf of St. Lawrence and the Scotian Shelf. The model uses version 9 of the Océan Parallélisé System (NEMO–OPA9) as the ocean circulation component, and version 2 of the Louvain–la–Neuve Ice Model (NEMO–LIM2) as the sea–ice component. The coupled ocean–ice model has two components with different horizontal resolutions. Both components are forced by the atmospheric reanalysis fields produced by Large and Yeager (2004). An outer component of the outer model has horizontal resolution of ~1/4o for the northwest Atlantic Ocean between 32oW and 81oW and between 33oN and 57oN and is also forced at the lateral open boundaries by ocean reanalysis data produced by Smith et al. (2010). The inner component of the coupled model has a horizontal resolution of ~1/12o for the Gulf of St. Lawrence and the Scotian Shelf. The two–way nesting technique is used for the interaction between the two components. In this study the performance of the coupled model is assessed and model results are used to investigate the physical processes affecting the circulation, hydrography and ice conditions at different time–scales over the Gulf of St. Lawrence and the Scotian Shelf.

On the mechanism of A–type and B–type internal solitary wave generation in the northern South China Sea

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Internal solitary waves (ISWs) in the northern South China Sea (SCS) are investigated using historical observational data, linear theory, global inverse tidal model, and a fully–nonlinear nonhydrostatic numerical model. It was found on the basis of mooring data that appearance of ISWs in the northern SCS is strongly correlated with the maximum of semidiurnal barotropic tidal forcing in the Luzon Strait (LS), but not with the largest peaks of tidal diurnal currents. The role of the latter lies in the modulation of the baroclinic tidal signal in such a way that the diurnal intermittency of ISW characteristics known as A–type waves (large–amplitude rank–ordered ISW packets) and B–type waves (single weak ISWs) is introduced into the internal wave fields.

Both A and B waves were reproduced in a series of numerical experiments. It was found that due to the neap–spring variability of the tidal forcing, a permanent transition of A type waves into B type waves and vice–versa takes place. This effect is treated in terms of a multi–harmonic approach which assumes that the internal wave field in the SCS is a superposition of radiated from the LS progressive semidiurnal and diurnal internal tidal waves which are characterized by an alternation in space of large and small troughs. In the course of nonlinear steepening and ultimate disintegration large and small troughs give rise to type A and type B internal wave packets, respectively. The neap–spring variability of tidal forcing alters the specific contribution of diurnal and semidiurnal constituents and leads to the wave transition from one type to another.

Classification of water masses using empirical orthogonal functions

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Oceanographic data used for acoustic modelling purposes need to represent the vertical gradients as close to reality as possible since underwater propagation of acoustic waves is particularly sensitive to vertical variability in ocean temperature and salinity.

This work presents an efficient method for comparing and classifying oceanographic profiles based on their vertical behaviour. Empirical orthogonal functions (EOF) are combined with k–means clustering to divide a large group of oceanographic profiles into smaller groups or classes of profiles with similar vertical characteristics.

The method is illustrated and presented using measurements of salinity and temperature. Each oceanographic profile is represented by a set of EOF coefficients. The coefficients are used as input to a k–means clustering algorithm which completes the division.

This manner of classification has a range of potential uses. Examples include classification of water masses, ocean model validation, and generation of climatology.

Improving Storm surge modeling along the French (Atlantic and English Channel) coast

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Research on storm surge modeling along the French coast was conducted in the framework of the PREVIMER project aiming at providing observations, modeling tools and real-time forecasts for coastal zone uses and management. One of PREVIMER project's deliverable is the development of a coastal operational forecasting system providing hydrodynamics and hydrological data in French maritime areas.

The objective of this study is to better understand the storm surge dynamics along the French coasts, as well as to improve high frequency sea level variations modeling (and specifically storm surge) within the PREVIMER system, based on the regional ocean Model for Applications at Regional Scale (MARS 2D).

First, storm surge generation and propagation processes (tide and surge interaction, contribution of wind and pressure to the storm surge) are studied. Comparisons between modeled storm surges issued from MARS with or without tides shows that interactions can reach about several tens of centimeters (up to 63 cm at Dunkerque). They can be positive - and amplify surges implied by wind and pressure - or negative. The analysis shows that most of the French coast is submitted to non-negligible interactions between storm surges and waves, at the exception of some islands, Brittany, and a part of the Aquitania coast. The areas where wind and pressure terms are predominant in storm surge signal are also identified. It appears that the areas where storm surge and tide interactions are negligible correspond to the areas where pressure-induced storm surge is dominant, compared to wind-induced storm surge. Such result allows designing a modeling strategy to forecast the water level (tide and storm surge), optimizing computational time and water level prediction using the better tidal data available.

Besides, a sensitivity study on sea surface drag parameterization, based on comparisons with 4 tidal gauges data (Dunkerque, Saint-Malo, Le Conquet and La Rochelle), during 4 storm events and over about 7.5 years are performed to evaluate the quality of the modeled storm surge. Tidal gauges data are post processed using the same pattern as with MARS results (tidal component analysis), so as to obtain measured storm surge data. The tested surface drag coefficient parameterizations are mainly a constant one, Wu (1982) and Charnock (1955). Charnock's parameterization, relying on a full statistical description of the sea state (wavewatch III simulations) provided by the IOWAGA project, enables to reproduce satisfying storm surges with 10 cm differences between the storm surge peak and with the ones obtained with the other drag coefficient formulations. For the events where the meteorological inputs are the closest to spatial observations, the model predicts storm surges quite close (differences about a few centimeters) to the observations.

The results of this study allow not only to improve the existing storm surge model used in the PREVIMER system, but also to provide a modeling strategy to optimize computational cost and water level forecast along the French Atlantic and English Channel coast.

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Study of the seasonal cycle of the biogeochemical processes in the Mediterranean Sea.

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This work is dedicated to the study of the seasonal biogeochemical cycles using ECO3M (Ecological Modular Mechanistic Model) model coupled with the model of hydrodynamics MAR3D (Model for Application at Regional Scale, IFREMER), and applied to the specifics of the North-Occidental part of the Mediterranean Sea.

The model has some advances, which permit to analyze physical, biogeochemical and biological processes. The interest of such model for the Mediterranean specifics is that it is suitable for both oligotrophic (large) and eutrophic (coast) zones and allows to study the particular stoichiometry of the Mediterranean.

Taking into account the effect of a multi-limited growth(C and/or N, and/or P) and advection of all contains of organisms in dependent manner are also another novel features of the model.

So in this work showed, that model reproduces the principal characteristics of the biogeochemistry of the Mediterranean in comparison with measured and observed data, allow to compute the dynamics of organisms and nutrients, and to analyze a complex mechanism of its interactions and its limitations for two contrasted situations: the spring bloom period with well-mixed waters and the summer stratified period.

A generic approach to the concept of water renewal timescales

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Timescales in oceanography are diagnostics able to summarize the dynamics of a system. Nowadays, one cannot anymore study timescales in oceanography without having recourse to first principles. The Constituent–oriented Age and Residence time Theory(CART, www.climate.be/CART) provides a consistent framework to compute timescales based on the advection–diffusion equations for semi–enclosed domains.

The concept of water renewal refers to the processes by which water initially located in the domain of interest (the “original water”) is progressively replaced by water originating from its environment (the “renewing water”). Determining the rate at which water renewal is achieved is of use in many hydrodynamical, pollution and ecological studies.

Starting from simple and idealised examples, the timescales available in CART (residence time, exposure time and age) are explained in domains of increasing complexities. The theory is finally applied to study the water renewal in the Scheldt Estuary (Belgium/The Netherlands) and the Mahakam Delta (Indonesia).

How to reduce salinity intrusion in rivers, with application to the Rotterdam Waterway?

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The Rotterdam Waterway is an estuary where saline water from the North Sea mixes with the fresh water from the lower branches of the Rhine and Meuse. Due to sea level rise and possible future measures in this Rhine–Meuse estuary, it is expected that salinity intrusion will increase in upstream direction. Consequently, the freshwater intake points are potentially affected by a slightly more saline Rotterdam waterway. Taking into account that the drinking water criterion is very strict in The Netherlands, with maximum chlorine concentrations of 0.25 g/l, it is evident that this drinking water criterion might be exceeded at certain periods throughout the year. This especially holds for dry periods, at which relatively low river discharges occur.

The Dutch government has come up with tens of ideas to restrict the salinity intrusion into the Rotterdam Waterway. Possible measures are changes in the bathymetry via a stair–case pattern or a fixed or moveable structure near the bed. The most promising ideas have been examined in more detail, in order to quantify the effectiveness of each measure. This often was done through numerical simulation.

One measure seems to perform better than all other alternatives. This involves air–injection near the bed. A so–called “air curtain”, consisting of tens of relative small air–injections near the bed, yields air bubbles that rise to the surface. This air curtain of bubbles is able to delay the transport of salinity and thus the salinity intrusion. In the past, these air curtains were originally developed to reduce mixing of saline and fresh water at sluices, where many ship passages occur every day. This concept of air bubbles appears to be effective in river systems as well.

It’s not straightforward to represent the small scale phenomenon of air bubbles into larger scale (far field) three–dimensional modelling. Furthermore, these air bubbles operate in strongly stratified conditions. The presentation will address the major conceptual and numerical aspects of air curtain modelling and the effectiveness of the modelled air curtain in the application to the Rotterdam Waterway.

On the use of a depth–dependent barotropic mode for free surface ocean models

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It is well known from the linear theory that the strongest stability constraint on a numerical ocean model is given by the propagation of the barotropic mode. The rigid lid approximation removes this constraint at the price of the solution of an elliptic system with barotropic streamfunction or surface pressure as unknown. In the rigid lid approximation, the barotropic mode is vertically constant and so the barotropic part of the flow can be identified to the depth integrated flow. When, for physical motivations, a free surface is introduced, the modification of the surface boundary condition renders the barotropic mode slightly non constant [3]. However since the first introduction of a free surface in an ocean model ([1], [4]), the barotropic mode is still assumed to be vertically constant in order to simplify the derivation of the barotropic system, which is then treated either using a time splitting method with small time steps or implicitely [2]. This assumption has two trade–off effects. First, the loss of orthogonality and aliasing between the barotropic and baroclinic modes results in the need for filtering [5] even in the linear case, albeit this is not theoretically required. This filtering can greatly alter the propagation of several physical signals (e.g. tidal waves). Second, again due to non orthogonality of the modes, the additional diffusion put on the approximated barotropic mode also alters the vertical structure of the baroclinic parts of the flow. In this presentation, these two issues are illustrated in the case of the propagation of either a barotropic or baroclinic mode over a flat bottom ocean using linearized primitive equations, i.e. when the modal decomposition is valid. The continuous approach is recalled and the discrete implementation of a time splitting scheme based on a depth–dependent barotropic mode is introduced. This noticeably includes a 3D correction of the density field by its 2D barotropic counterpart. The extension to the nonlinear case is obviously non trivial. Nevertheless, we propose to solve an approximate barotropic system which conforms to the theory when linearized. Numerical simulations of the propagation of internal gravity waves are showed and perspectives are drawn.

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On the wave–current interactions

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Wave breaking has been observed to impact the bottom boundary layer in surf zones, with potential impacts on bottom friction. Observations in the inner surf zone have also shown a tendency to an underestimation of the wave–induced set–up when using usual model parameterizations. The present study investigates the possible impact of wave breaking on bottom friction and set–up using a recently proposed parameterization of the wave–induced turbulent kinetic energy in the vertical mixing parameterization of the wave–averaged flow. This parametrization proposed by Mellor (2002) allows us to take account the oscillations of the bottom boundary layer with the wave phases thanks to some additional turbulent source terms. First, the behavior of this parameterization, is investigated by comparing phase– resolving and phase–averaged solutions. The hydrodynamical model MARS (Lazure et Dumas, 2008) is used for this, using a modified k–epsilon model to take account the Mellor (2002) parametrization. It is shown that the phase averaged solution strongly overestimates the turbulent kinetic energy, which is similar to the situation of the air flow over waves (Miles 1996). The waves inhibits the turbulence and the wave–averaged parametrization is not able to reproduce correctly this phenomenom. Cases with wave breaking at the surface are simulated in order to study the influence of surface wave breaking on the bottom boundary layer. This parametrization is applied in the surf zone for two differents cases, one for a planar beach and one other for a barred beach with rip currents. The coupled model MARS–WAVEWATCH III is used for this (Bennis et al, 2011) and for a realistic planar beach, the mixing parameterization has only a limited impact on the bottom friction and the wave set–up, unless the bottom roughness is greatly enhanced in very shallow water, or for a spatially varying roughness. The use of the mixing parametrization requires an adjustement of the bottom roughness to fit the observations probably due to the expression of the additional source of turbulent kinetic energy. For an idealized barred beach, the results given by the mixing parametrization are compared with others from parametrizations that take account the wave effects on the bottom friction via the wave orbital velocity, and no via the turbulent kinetic energy as in Mellor (2002). The vertical profile of the rip current is significantly modified by the bottom friction parametrization, while the feedback of the waves on the flow (ie. Two–way mode) changes the pattern of the rip currents in comparison with the one–way mode.

On the effects of surface waves on three dimensional near–shore hydrodynamics

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In this research state–of–the–art parallel programming tools have been utilized to create a coupled wave and circulation modeling framework. The coupled system includes, the three–dimensional coastal circulation model General Estuarine Transport Model(GETM) and the third generation wind wave model Simulating Wave Near–shore (SWAN). The main goal of this research were to include the effects of surface waves in the coastal ocean contributing to momentum and energy exchange between atmosphere, wave and ocean. One of the main concerns was dedicated to implement of the Vortex Force (VF) and dissipated wave momentum as driving forces together with Generalized Lagrangian Method (GLM) as wave averaging operator to be able to perform an efficient simulation of three–dimensional structure of hydrodynamics of wave–current interaction in the surf zone and shelf area. A comparison of VF method with an implementation of three dimensional radiation stress (RS) formulation were discussed. It has been shown that taking into account wave energy flux due to wave dissipation at the surface as flux of turbulent kinetic energy increase the eddy viscosity through out the water column especially close to the surface, therefore the vertical gradient of across–shore velocity decreased. Some doubtful results regarding across–shore velocity profile in case of relatively long period surface waves at high gradient bottom profile regions in case of RS method has been pointed out. Applicability of both VF and RS methods were checked through comparison with lab test cases and a natural barred beach hydrodynamics measurements.

Drift forecast with Mercator–Océan velocity fields in the Western Mediterranean Sea and the Angola offshore zone

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Predicting the fate of sea pollutions or drifting objects has always been a very challenging task for any ocean general circulation model. This study focuses on the forecast error ranges obtained with operational–oriented models/tools in the reproduction of surface buoys trajectories collected in two specific areas: the Western Mediterranean sea and the southern part of the Guinea gulf along the Angola coast.

Drift forecasts have been computed with surface currents produced by Mercator Océan operational 1/12° system (PSY2V3R1) and some regional nested configurations (1/12° and 1/36°) specially developed to perform sensitivity tests in this framework. Météo France's crisis response drift model MOTHY was also assessed, supplied with a background information on large and meso–scale oceanic features provided with the latter oceanic configurations. Forecast errors were estimated with a time to time comparison procedure between the model trajectories and lagrangian observations from oil emulating drifters tracked by satellite.

Results suggest that rapid wind induced currents and external wind related surface drift processes like the Stokes drift or the buoys windage are critical for the Mediterranean drift scenario which is subjected to a strong Mistral–Tramontane situation. In addition, the mean transport by the slope current was particularly well reproduced, but some rotative trajectories linked with mesoscales features off the Catalan sea could not be modeled with satisfactory realism, still emphasizing prediction difficulties in turbulent regimes. Concerning the Angola scenario, the offshore circulation is modulated by complex interactions between the Congo River's plume and the propagation of coastal trapped waves, making oceanic prediction very tricky in that area. Our focused forecast period goes from a few hours up to three days of transport, covering typical time scales useful to Météo France which is on forecast duty in case of pollution.

Intercomparison and validation of operational high resolution coastal scale models between the Tyrrhenian and Ligurian Sea.

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The need to implement operational systems for the sustainable management of coastal waters often lead to the implementation of coastal measurement networks and to the construction of computational models that cover different oceanographic basins without falling in the classic definition of regional/coastal models. Such models can have considerable advantages and highlight relevant issues, such as the role of narrow channels, straits and islands in coastal circulation, as both in physical and biogeochemical processes. In this work some models of this type, made in the context of the cross–border European project MOMAR, will be compared: two different operational models on the same area (the Tuscan Archipelago sea) and one around the Corsica coastal waters, which are both located between the Tyrrhenian and the Algero–Ligurian–Provençal basins. Although these models are based on different computer codes (ROMS and MARS3D), they have several elements in common, such as a 400 m resolution, boundary conditions from the same “father” model, and an important area of overlap, the Corsica channel, which has a key role in the exchange of water masses between the two oceanographic basins.
The validation of such different ocean forecasting systems in response to different weather and oceanographic forcing will be discussed, and a systematic comparison between the forecast/hindcast based on such hydrodynamic models, and those of operational models available at larger scale. In this context we will also present the results of two oceanographic cruises in the marine area between Tuscany and Corsica, named MELBA (May 2011) and MILONGA (October 2011).
In both campaigns, in addition to standard oceanographic measurements (profiles, samples), currentmeter data were collected using vessel mounted ADCPs, which have allowed us to identify some of the most interesting hydrodynamic features of the area. During MELBA, such current measurements were also carried out through the use of an Autonomous Underwater Vehicle (AUV), while during MILONGA a large survey of the area and a mapping of currents and water masses were carried out by a large number of Lagrangian instruments (drifters and floats). First results allow a hydrodynamic characterization of the Corsica channel, highlighting the three– dimensional structure of the currents along the channel, and characterizing the current reversals in dependence to different oceanographic and weather conditions. The same occurs for the Piombino channel, between the Isle of Elba and the Tuscan coast. Collected data provides a basis for a first validation of such operational high resolution models, and allow the evaluation of their relative reliability under different conditions.

Simulating the Hydrodynamics of San Quintin bay.

Isabel Ramírez, R. Blanco, R. Vázquez and G. Ramírez

A three–dimensional model (ELCOM) was used to simulate the hydrodynamics of San Quintin Bay (SQB) sited in the Pacific Coast of Baja California in Mexico. SQB is an inverse estuary sited at 30.3 N Lat and 116.1 W Long. It has two internal bays, one of them parallel to the line coast and the second one perpendicular to the line coast. The motivation for this study was to predict the productivity levels in the lagoon and to know about the better places and times for oysters and algae aquaculture.

We measured the bathymetry and used CTD data for the initial conditions of the bay, and then we used local meteorological station data, and sea level prediction to force the model. We tried different size of grids from 500 m to 100 m, and we present only the 100 meter results.

We used several lines of thermographs and an acoustic current meter to validate the model results. The model reproduced very well the currents at the entrance of the estuary, and give good results about the gyres produced by the Tidal currents.

Multi-scale coupled modelling along the Catalan coast,

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Catalan shelf circulation is characterized by a background along-shelf flow to the southwest perturbed with episodic storm driven patterns. To investigate these dynamics, a coupled multi-scale modeling system is applied to the Catalan shelf (North-western Mediterranean Sea). The implementation consists of a set of increasing-resolution coupled and nested models, based on ROMS and SWAN as part of the COAWST modeling system, covering from the slope and shelf region (~1 km horizontal resolution) to a local area (~40 m). The system is initialized and driven with daily MyOcean products in the coarsest outer domain, and uses atmospheric forcing from other sources for the finer increased resolution inner domain.

Correlations of 0.6 and 0.8 are obtained between the modeled currents with measurements and are a function of the model configuration (resolution and wave coupling). Results of the finer resolution domain exhibit improved agreement with observations when compared to the coarser models. Several hydrodynamic configurations were simulated to determine dominant forcing mechanisms and hydrodynamic processes that control the coastal area. Numerical results reveal the short term inner-shelf variability is strongly influenced by local wind, while sea-level slope, baroclinic effects, wave-driven flows and regional circulation constitute second-order processes. MyOcean products are revealed suitable to provide boundary conditions for the local models. Furthermore an increasing of the temporal resolution would be desirable according to the physical process appreciated within Catalan inner-shelf. Additional analysis identifies the significance of shelf/slope exchange fluxes, continental discharges and the effect of higher-resolution atmospheric fluxes.

Spectral nudging : application to downscaling in Mediterranean Sea

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In the framework of operational coastal oceanography, the downscaling modeling method is widely performed. An oceanic global circulation model (OGCM resolution 6 to 10 km) – covering for instance the whole Mediterranean Sea or the Northwest Atlantic – provides initial and boundary conditions for regional or local model (resolution 500–1000 m).

Because of higher resolution (smaller than to the first radius of deformation) the embedded model is able to generates his own dynamics that can be different than the parent model. When the extension of the local model is large and when the time integration since the initial condition is long, both parent and child model can diverge significantly.

To overcomes this drawback, solution currently performed are :

- limiting the size of the embedded zoom (but if the size of the domain is too small and the dynamics is heavily constrain by the boundary condition)
- restart the run frequently (once a week) from new initial condition provided by OGCM (but the spin–up is to short for fully meso–scales dynamics)

Another method already used in atmospherical downscaling is the spectral nudging. The local model is relaxed towards the OGCM at global scale only. Then the local model is constrained to follow the general circulation proposed by the OGCM but is able to develop his own high resolution dynamics taking indirectly advantage from the data assimilation generally performed in global modeling. Preliminary results of this technics applied to the MENOR configuration (North–Western Mediterranean Sea) will be discussed.

Prediction of Ocean State by assimilation of temperature and salinity data. A case study for the German Bight

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Integrated ocean observing systems closely link in-situ and remote measurements with numerical models enabling the reconstruction and forecast of key state variables with full spatial coverage. Such a nowcast/forecast model system has been developed for the North Sea-Baltic Sea as an integral component of the COSYNA (Coastal Observation System for Northern and Arctic seas) project. It is used to produce nowcasts and short-term forecasts of the circulation and physical properties in the German Bight. One of the expectations is that the model can provide consistent temperature and salinity three-dimensional fields to fill in the gaps in observation and satellite observations and eventually produce reliable physical components to be used in further bio-geochemical/management/fishery applications.

The three-dimensional primitive equation model GETM ("General Estuarine Transport Model") is used to simulate the circulation and salinity and temperature fields for the nested North Sea/Baltic Sea and German Bight system. The horizontal resolution is ca. 5km for the North Sea/Baltic Sea and ca 900 m for the German Bight model. The atmospheric data from the German Weather Service (DWD) are used for the metereological forcing. This work presents a framework of the nowcast/forecast system, which includes an algorithm to assimilate temperature and salinity derived from measurements (such as FerryBox, MARNET stations, etc.) as well as satellite derived sea surface temperature (SST) in the German Bight

For the assessment of forecast skill of the regional ocean model we compare the free run and assimilation run with independent data from observations. The benefit of using FerryBox data for data assimilation compared to other observations will be critically assessed. Model-data comparison shows that the reanalysis produced by the data assimilation fairly well represents the physical properties in the German Bight. The overall root-mean-square errors between temperature and salinity fields of reanalysis and observation are significantly reduced after the assimilation of the FerryBox data. Furthermore, seasonal variation in temperature is well reproduced and the predicted synoptic variation is significantly correlated with its counterpart from the mooring measured temperature Of particular interest is the question how long the information from the measurements used in the model predicted system has an influence on the forecast.