JONSMOD 2014

RBINS, Brussels

12 – 14 May 2014

Programme

Monday 12 May

08:30 – 09.15 Registration

09:15 – 09:30 Welcome

Session I – Chair: Patrick Luyten

09:30 – 10:00 **Lars Jonasson**

Next generation pan-European coupled Climate-Ocean Model

10:00 – 10:30 **Torleif Lothe and Rachel Furner**

Numerical Modelling of Sea Bottom Temperatures in the North Sea

10:30 – 11:00 *Break*

11:00 – 11:30 **Pierre Garreau, Valérie Garner, and Gaelle Herbert**

Numerical modeling of the North Western Mediterranean Sea

11:30 – 12:00 **Jørgen Bendtsen, John Mortensen and Søren Rysgaard**

Model simulations of seasonal surface layer dynamics and sensitivity to runoff in a high Arctic fjord (74°N)

12:00 – 12:30 **Erik De Goede and Reimer de Graaff**

Modelling of ice growth and transport on a regional scale, with application to the North Sea and to lakes

12:30 – 14:00 *Lunch*

Session II – Chair: Pierre Garreau

14:00 – 14:30 **Geneviève Lacroix, Dimitry Van der Zande, Léo Barbut and Filip.A.M. Volckaert**

Impact of projected wind and temperature changes on larval recruitment of sole in the North Sea

14:30 – 15:00 **Olivia Gérigny, S. Coudray, P.-A. Bisgambiglia, C. Lapucci, D. Le Berre and F. Galgani**

Systemic approach in a Marine Protected Area (Strait of Bonifacio – South of Corsica). Modeling and hydrodynamics for applied research (larval dispersion, marine litter, chlorophyll)

15:00 – 15:30 **Eric Deleersnijder, Anne Mouchet, Anouk de Brauwere, Eric Delhez and Emmanuel Hanert**

The concept of partial age, a generalisation of the notion of age: theory, idealised illustrations and realistic applications

15:30 – 16:00 **Tomas Torsvik**

Eddy diffusivity in the Gulf of Finland based on drifter data and numerical modelling

16:30 – 17:00 *Break*

16:30 – 17:00 **Valérie Dulière, Nathalie Gypens, Xavier Desmit and Geneviève Lacroix**

Tracking nutrients in the Southern North Sea

17:00 – 17:30 **Christopher Thomas**

Biophysical modelling to study multi-scale connectivity in the Great Barrier Reef

17:30 – 18:00 **Mikhail Karpytchev**

Modeling the amplification of the AD365 tsunami along the ALexandria coast

18:30 – 20:00 *Icebreaker*

Tuesday 13 May

Session III – Chair: Jørgen Bendtsen

09:00 – 09:30 **Valentin Vallaeys, Y. Le Bars, E. Deleersnijder and E. Hanert**

Preliminary results of an unstructured mesh model of the Congo River, estuary and ROFI

09:30 – 10:00 **Karina Hjelmervik**

Refined ocean models for the Oslofjord systems

10:00 – 10:30 **Kevin Delecluyse**

A strategy for calibrating the roughness value of tidal floods and tidal marches in a threedimensional tidal model for the Scheldt estuary

10:30 – 11:00 *Break*

11:00 – 11:30 **Stefano Taddei**

Short scale dynamics of contamination events in coastal waters: observations and models for the Costa Concordia site

11:30 – 12:00 **Christèle Chevalier** , **Jérôme Aucan, Jean Blanchot, Jean-Luc Devenon, Marc Pagano, Vincent Rey, Gilles Rougier and Damien Sous**

Impact of cross-reef fluxes on the Ouano lagoon circulation

12:00 – 12:30 **Bartolomeo Doronzo**

Extensive analysis of potentialities and limitations of a Maximum Cross-Correlation technique for surface circulation by using realistic ocean model simulations

12:30 – 14:00 *Lunch*

Session IV – Chair: Erik De Goede

14:00 – 14:30 **Arnold Van Rooijen, Arthur Van Dam, Gerben de Boer, Jebbe van der Werf and Herman Kernkamp**

Numerical modelling of flow in intertidal basins using an unstructured grid; application of D-Flow Flexible Mesh to the Dutch Wadden Sea

14:30 – 15:00 **Firmijn Zijl, Julius Sumihar and Martin Verlaan**

Application of data assimilation for improved operational water-level forecasting on the Northwest European Shelf and North Sea

15:00 – 15:30 **Olivier Gourgue, Margaret Chen, Rosalia Delgado, Eshan Sarhadi, George Schramkowski and Joris Vanlede**

An unstructured grid model for the Belgian continental shelf and the Scheldt estuary

15:30 – 16:00 **Thorger Brüning, Frank Janssen, Eckhard Kleine, Hartmut Komo, Silvia Massmann, Inge Menzenhauer-Schuhmacher and Stephan Dick**

Status of BSH's operational ocean circulation forecasting model for German coastal waters

16:00 – 16:30 *Break*

16:30 – 17:00 **Martin Verlaan, Herman Kernkamp and Andrea Lalic**

A global tide and storm-surge model

17:00 – 17:30 **Herman Kernkamp, Sander van der Pijl, Arthur Van Dam, Wim van Balen, Willem Ottevanger and Guus Stelling**

One- two- and three-dimensional hydrodynamic modelling with F-Flow Flexible Mesh

17:30 – 18:00 **Joana van Nieuwkoop, Peter Baas, Sofia Caires and Jacco Groeneweg**

On the consistency of the drag between air and water in meteorological, hydrodynamic and wave models

19:00 *Conference Dinner*

Wednesday 14 May

Session V – Chair: Eric Deleersnijder

09:00 – 09:30 **Mostafa Bakhoday Paskyabi**

Wave-current-turbulence interaction near the sea surface

09:30 – 10:00 **Chien Pham Van**

Simulations of suspended sediment transport in the continuum river-delta-coastal system, East Kalimantan, Indonesia

10:00 – 10:30 **Héloïse Müller**

Storm Impact on a French coastal dune system: morphodynamic modeling using X-beach

10:30 – 11:00 *Break*

11:00 – 11:30 **Qilong Bi and Erik Toorman**

A New Sediment Transport Model for Western Scheldt

11:30 – 12:00 **Philippe Delandmeter**

A 3D baroclinic model of the Burdekin River Plume

12:00 – 12:15 Closing remarks

12:30 – 14:00 *Lunch*

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Abstracts

Next generation pan-European coupled Climate-Ocean Model

Lars Jonasson (laj@dmi.dk)

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Aiming at developing next generation coupled climate models for pan-European scale, we have recently extended an operational, coupled ocean-ice model HBM (HIROMB-BOOS model) from the Baltic-North Sea to cover the entire European coastal-shelf seas (Baltic, North Sea, N. Atlantic Shelf, Mediterranean Sea and Black Sea). In order to resolve inter-basin water exchange through straits (e.g. the Danish, Gibraltar, the Dardanelles and the Bosporus Straits) and narrow coastal currents, the model is set up with three two-way nested layers with horizontal resolution ranging from 0.1 nautical miles (nm) to 3nm. This exposes significant challenges for High Performance Computing (HPC) on multi-core architectures. This presentation introduces preliminary model configuration and simulation results in different basins, as well as optimization of the computational performances in different multi-core super computers.

Numerical Modelling of Sea Bottom Temperatures in the North Sea

Torleif Lothe[1,2] and Rachel Furner[3]

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[2]University of Bergen, Geophysical Institute, Allégaten 70, N-5007 Bergen, Norway
[3]Met Office, FitzRoy Road, Exeter, Devon, EX1 3PB, United Kingdom

Sea Bottom Temperature (SBT) from the Met Office's 7 km resolution Atlantic Margin Model (AMM7) is used by the Norwegian oil and gas industry in subsea gas pipeline modelling. The Norwegian natural gas transport network includes 8000 km of pipelines laid out on the sea bottom, spanning the entire North Sea. The temperature of the gas, and hence the volume and pressure is highly sensitive to the SBT due to heat exchange with the sea water. The transport capacity, leakage detection and all other computations performed on the gas is hence highly sensitive to SBT. The SBT modeling capability of the AMM7 is assessed. Model data is compared to unique observation data from moorings and temperature transects acquired during Remote Underwater Vehicle (ROV) inspections of the pipelines. The sensitivities of the SBT as modeled by the AMM7-system to the Generic Length Scale Parameters (GLS), Sea Surface Temperature (SST) Assimilation and Smagorinsky lateral diffusion is investigated. Experimental runs of the AMM 7 have been conducted at Met Office. A visual/manual procedure was applied to shape and determine the areas. Two different models were used to produce a film showing the daily difference in modeled bottom temperatures. The areas were defined by looking at this film whilst trying to visually identify the characteristic model SBT areas in terms of temperature change and difference between the models. Based upon the visual impression, the areas were drawn up and shaped visually in a pixellated image editor. The pixellated images where then converted to numerical matrices and applied back to the data. Thereafter, objective criteria as closely as possible matching the visually derived areas were made.

The model performance and the sensitivity in terms of SBT for each area is presented and discussed.

Numerical modeling of the North Western Mediterranean Sea

Pierre Garreau (pierre.garreau@ifremer.fr)**, Valérie Garnier, Gaelle Herbert**

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A numerical model covering the North-western Mediterranean Sea has been performed for a few years in Ifremer and now currently used for both applications and research activities. Nevertheless, progress in numerics (fifth order scheme and “macho” technics in advection), informatics (on-line zooming using the Agrif package*), operational chain (spectral nudging technics), post-processing tool (validation using the Vacumm package**) allow to investigate a broader spectrum of oceanic and coastal processes and to propose more robust results for application as MEDES4MS (Oil spill monitoring in Mediterannean Sea).

First an intensive comparison between the high resolution MENOR configuration (1.2 km resolution; extension 0^0:16^0E, 39.5^0:44.5^0N) is done pointing out the benefits of a high resolution at regional scale.

One of the most important processes in the North-Western Mediterranean Sea is the dense water formation occurring during winter on the abyssal plain, in front of the Gulf of Lion and in the Ligurian Sea. This dense water production is necessary to maintain a cyclonic circulation in the basin. To achieve this goal, attention must be paid on the vertical mixing parameterization to obtain both a strong vertical mixing (sometimes over the whole water column) under particular atmospheric conditions in winter and a small vertical mixing of a particular water mass (the Levantine Intermediate Water) lying around 600 meter depth. Increasing the horizontal resolution using zooming is necessary to describe the formation of another water masse (the Winter Intermediate Water) resulting mainly of isopycnal subduction of cooled surface water along the North-Current front.

Modeling the circulation for a long time (i.e. a few months or years) requires a minimum of control of the runs. Instead of implementing data assimilation in our code, we prefer to take advantage of the assimilation already performed in Global Oceanic Model (OGCM), using a spectral nudging method.

An effort of in situ measurements has been done in the Occidental Mediterranean (Sea Glider deployment, Argo float monitoring,TSG …). Collocation and statistical approach for validation will be presented.

Agrif package : http://hal.inria.fr/inria-00069912
vacumm : http://www.ifremer.fr/vacumm/

Model simulations of seasonal surface layer dynamics and sensitivity to runoff in a high Arctic fjord (74 °N)

Jørgen Bendtsen[1,2], John Mortensen[3] and Søren Rysgaard[1,3,4]

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[4]Centre for Earth Observation Science, Department of Environment and Geography, University of Manitoba, Winnipeg, MB R3T 2N2, Canada.

A model setup based on the COHERENS model is applied for quantifying the runoff from surrounding areas and the Greenland Ice sheet into a high-Arctic long (~120 km) and narrow fjord located at 74°N at the north-eastern coast of Greenland. The fjord is ice-covered from about November to mid-July and during the ice-free summer period large amounts of freshwater enters the fjord via many rivers. A model sensitivity study constrain a runoff estimate to the area where model solutions are in good accordance with observed surface salinities and calculated freshwater content in the fjord. Model simulations of passive and age tracers are applied for analyzing the residence time of the river water in the fjord during the summer period.

Modelling of ice growth and transport on a regional scale, with application to the North Sea and to lakes

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Numerical modelling of ice growth and transport on regional scales such as lakes, estuaries or coastal seas, can provide crucial input for the planning and design of offshore structures in arctic, sub-arctic or even mid-latitude regions. It is in these regions that the total loading of ice on for instance platforms, sea defence structures, sub-sea pipelines or wind turbines, may exceed the total loading of waves and currents, hence determine the design of the water-based structure. Besides, the interaction of ice with for instance waves, water quality, suspended sediment and the seabed may be significant, and should be properly studied. There is however a general lack of ice models that can be applied to study these complex integral physical processes at regional scales. Typically ice modelling focusses either on ocean scales using climate models, or on local scales to study for ice-structure interactions. A regional scale ice model can bridge the gap between the ocean and the local scale ice models.

This paper describes the implementation of an ice module in Delft3D. Delft3D is a flexible integrated modelling suite, which simulates two- and three-dimensional flow, sediment transport, morphology, waves, spills, water quality and ecology, and is capable of handling the interactions between these processes. By dynamically coupling an ice module with these other Delft3D modules, it becomes possible to not only predict the growth, melting and transport of open-water ice and the hydrodynamics around the ice, but also to studying the interaction of ice with for instance a river bank, seabed, water quality or spills of suspended sediments or oil. A prototype of Delft3D with the ice module presented in this paper addresses the major concepts of the new ice module and its applicability to modelling ice growth and transport will be presented for a case study in the North Sea and the Wadden Sea for the winter of 1962-1963, which was one of the coldest winters recorded in The Netherlands. Also validation of ice growth and melt in Dutch lakes will be presented.

Impact of projected wind and temperature changes on larval recruitment of sole in the North Sea

Geneviève Lacroix (G.Lacroix@mumm.ac.be)**, Dimitry Van der Zande, Léo Barbut and Filip.A.M. Volckaert**

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The impact of climate change on larval dispersal remains poorly known. The case of sole (Solea solea) is of particular interest because it is one of the most valuable commercial species in the North Sea. It is important to understand how the retention/dispersal of larvae would be affected by climate change in order to propose appropriate measures for stock management. The transport of sole larvae from the spawning grounds to the nurseries is driven by hydrodynamic processes but the final dispersal pattern and larval abundance may be affected by behavioural and environmental factors. A temperature increase could affect for instance the spawning period, the duration of the pelagic stage, the mortality of eggs and larvae, and the match-mismatch with prey fields. Modifications in the magnitude and direction of the wind regime might affect egg and larval retention and dispersal through changes in the hydrodynamics. We compare scenarios of a particle-tracking transport model (IBM) coupled to a 3D hydrodynamic model (COHERENS) to investigate the impact of climate change through temperature increase and change of wind regime.The model has been implemented in the area between 48.5°N-4°W and 57°N-10°E over the period 1995 to 2011. A larval mortality parameterization based on remote sensing of algal bloom timing is tested. Sensitivity of larval recruitment to climate change is assessed by estimating the impact of a hypothetical (i) temperature increase and (ii) changes in wind magnitude/direction following IPCC scenarios.The results of projections will be discussed relatively to interannual variability.

Systemic approach in a Marine Protected Area (Strait of Bonifacio – South of Corsica). Modeling and hydrodynamics for applied research (larval dispersion, marine litter, chlorophyll)

Olivia Gérigny (gerigny@univ-corse.fr) **, S. Coudray, P.-A. Bisgambiglia, C. Lapucci, D. Le Berre and F. Galgani**

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The strait of Bonifacio (south of Corsica) is a key area in the Mediterranean Sea connecting both Tyrrhenian and Liguro-provencal basins. Its economic weight depends on many activities such as tourism, diving or fishing and the local environmental constraints are very important due to the presence of a Marine Protected Area, which will soon become an International Marine Park. This area is also well known for its strong hydrodynamic fluxes and its complex marine ecosystem, exposed to a great combination of pressures. In such an area, ecologic issues as connectivity and recruitment are therefore of particular relevance for management processes.

In the first half of august 2012, an oceanographic cruise has been conducted by IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer) and STELLAMARE project (Sustainable Technologies for Littoral Aquaculture and Marine Research, University of Corsica) in order to collect planktonic larvae and neustonic micro-particles, in addition to current and hydrologic data (ADCP and CTD profiles). The aim of the following study is now to understand the interactions between larval behaviour and hydrodynamic parameters during the dispersion processes.

To achieve this goal, a hydrodynamic model based on MARS3D code with a 400 m mesh size has been operated prior to the field experiment in order to

support spatial interpretation of field data. Conversely, measured data have been used to calibrate simulations and detect bias in the model results. Furthermore, satellite data and argo-buoy were used at the same time to better identify and reference some meso-scale structures. An interpretation of the main features (local and meso-scale) was then possible, enabling a better understanding of key processes such as connectivity and larval fish recruitment.

With this presentation, our goal is to explain how the multidisciplinary approach adopted by the use of modelling tools, a multi-platform cruise at sea and satellite data is important for the scientific management of the ecosystem (AMP in our case). This approach helped us to (i) enhance our knowledge of hydrodynamics processes in the area, (ii) estimate the quality of results obtained by the 400m-Corsica-Model, (iii) provide scientific basis for further monitoring of the larval dispersion and (iv) better understand the patterns of micro-waste's distribution.

The concept of partial age, a generalisation of the notion of age: theory, idealised illustrations and realistic applications

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The age, a measure of the elapsed time, is a characteristic timescale that has been used over the past two decades to help understand the results of complex geophysical and environmental fluid flow models. A generalisation of this concept is introduced, namely the partial age. The latter records the time spent in a subdomain of the whole domain of interest. Naturally, the sum of the partial ages is equal to the classical age.

It is seen that partial ages may be obtained from partial differential equations similar to those from which the classical age is derived. Analytical solutions are examined for simple flows, allowing one to gain insight into the concept of partial age. Next, the new diagnostic tool is applied to a model of the Scheldt Estuary. Results of an ocean general circulation model are also dealt with.

The new diagnostic timescale provides a detailed diagnosis of transport processes taking place in complex geophysical and environmental flows. Further research is needed so as to progressively learn how, where and when the new age concept is to be used.

Eddy diffusivity in the Gulf of Finland based on drifter data and numerical modelling

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The combination of Lagrangian stochastic models coupled with Eulerian circulation models has numerous applications related to ocean transport and dispersion processes. Lagrangian stochastic models simulate the movement of particles, where the displacement of the particle at any given time can be considered as a combination of average drift and random fluctuations. Whereas the average particle drift can be computed directly from the the Eulerian circulation model velocity fields, it is often problematic to connect the fluctuating particle movement with the sub-grid scale diffusion parameters used in numerical models. In this study we focus on dispersion of substances at the sea surface, and write the sub-grid scale particle diffusion in terms of a horizontal eddy diffusivity.

In order to quantify the eddy diffusion parameter, we study the motion of surface drifters deployed in the Gulf of Finland in the period 2011-2013. Analysis of individual tracks revealed a velocity distribution for the entire area close to 0.1 m/s. A Lagrangian integral time scale was calculated based on the auto-correlation of the drifter velocity, revealing that the persistency of movement was less than 10 hours for most tracks, but in some cases reaching up to 20 hours. Analysis was also made for the relative dispersion of drifter clusters. At small separation scales the speed of drifter separation appears to follow the Richadson Law, where the relative diffusivity increases with the separation distance to the 1/3 power. However, a transition takes place with separation distances from 2.5 to 5 km, after which the relative diffusivity decreases with increasing separation distance. A numerical particle tracking model has been

implemented for the study area, and demonstrate a considerable impact of eddy diffusivity on individual particle tracks.

Tracking nutrients in the Southern North Sea

Valérie Dulière[1] (v.duliere@mumm.ac.be)**, Nathalie Gypens[2], Xavier Desmit[1] and Geneviève Lacroix[1]**

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The Southern North Sea faces eutrophication problems. They result from growing anthropogenic pressure in the river watersheds, and subsequent increase in nutrients (nitrogen and phosphorus) loading to the sea. Establishing the link between human activities and eutrophication problems requires the identification of the major nutrient sources and the ecological response of the coastal ecosystem to these nutrient alterations. This information is crucial to mitigate eutrophication in coastal zones by applying appropriate dual-nutrient reduction strategies, therefore achieving the Good Environmental Status of EU marine waters by 2020.

Very recently, MIRO&CO has been upgraded to MIRO&CO V2 (Lancelot et al. 2005; Luyten 2013). A nutrient tracking approach (Ménesguen et al. 2006) has been adapted and implemented in MIRO&CO V2. Here, we will present the tracking approach and illustrate the potential of this new tool for assessing the current eutrophication status in the Southern North Sea and the impacts of realistic nutrient reduction scenarios on eutrophication problems.

This work is done in the framework of the EMoSEM EU project (www2.mumm.ac.be/emosem/) that aims at providing support to eutrophication management in the North Atlantic Ocean, using state-of-the-art modelling tools.

References

Lancelot C, Spitz Y, Gypens N, Ruddick K, Becquevort S, Rousseau V, Lacroix G, Billen G. 2005. Modelling diatom and Phaeocystis blooms and nutrient cycles in the Southern Bight of the North Sea: the MIRO model. Marine Ecology Progress Series 289:63-78.

Luyten P, (Editor) 2013. COHERENS -- A coupled hydrodynamical-ecological model for regional and shelf seas: user documentation, RBINS-MUMM report, Royal Belgian Institute of Natural Sciences, Brussels.

Ménesguen, A., Cugier, P. and Leblond, I., 2006. A new numerical technique for tracking chemical species in a multisource, coastal ecosystem, applied to nitrogen causing Ulva blooms in the Bay of Brest (France). Limnology and Oceanography, 51(1, part 2): 591-601.

Biophysical modelling to study multi-scale connectivity in the Great Barrier Reef

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The dispersal process of coral larvae is vitally important for coral reef ecosystems, but remains poorly understood and hard to gauge. We employ a numerical modelling approach to simulate larval dispersal through a large section of Australia's Great Barrier Reef (GBR), comprising over 1,000 reefs, and use a novel community detection approach from network science to look for patterns in the resulting connectivity network.

Water circulation in the GBR is modelled using a depth-integrated high-resolution finite-element ocean model (SLIM), whose multi-scale capabilities make it ideal to model a highly topographically complex area such as the GBR. Larval dispersal is then modelled using an Individual Based Model (IBM) which accounts for simple biological functions such as mortality and competency. Connectivity matrices, quantifying the strength of larval dispersal between each pair of reefs, are then obtained.

We show how we can use a community detection method from network science to partition reefs into clusters – so-called “reef communities” – allowing us to infer the presence of boundaries to larval dispersal, and to look at connectivity at different length scales. Finally we discuss possible consequences for the optimal placement of Marine Protected Areas (MPAs) to maximise connectivity with surrounding reefs.

Modeling the amplification of the AD365 tsunami along the Alexandria coast

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The AD 365 Crete earthquake and the associated tsunami was one of the most devastating events ever impacted the human societies in the Eastern Mediterranean (Guidoboni, et al, 1994). The tsunami induced by this earthquake destroyed much of Alexandria and hit apparently the whole East Mediterranean coast. In this study, we simulate numerically the AD365 tsunami propagation by building up a high resolution finite-element grid of the Mediterranean coast of Egypt with a special focus on the city of Alexandria. TELEMAC software is employed to model the tsunami propagation from the seismic fault to Alexandria. We analyze the processes controlling the run-up and the polarity of the tsunami as well as extension of the flooding it produced.

Preliminary results of an unstructured mesh model of the Congo River, estuary and ROFI

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With the second largest river outflow in the world and one of the widest hydrological basins in the world, the Congo River is of major importance both locally and globally. However, relatively few studies have been conducted on its hydrology, as compared to other great rivers such as Amazon, Nile, Yangtze or Mississippi rivers.

The Congo river estuary contains important natural resources, like oil and gas, whose extraction could benefit from ocean currents simulations. To model this area, we are using the hydrodynamical model SLIM http://www.climate.be/slim), a finite elements model using unstructured grid, solving shallow water equations.

There are many challenges to accurately model such a complex area. These include the river bathymetry that alternates very shallow (less than 5 m) and very deep (more than 500 m) areas. The river fan is the only river fan of this importance still active nowadays. The Congo river being located in a very remote region, datasets are sparse and setting boundary conditions or validating the model is thus particularly challenging.

In this talk, we will present the first model runs of the Congo river-estuary-coastal sea continuum with a high-resolution model. Model results are validated with respect to tidal gauges and satellite altimetry data. We also simulate the water age evolution under various hydrodynamical regimes.

Refined ocean models for the Oslofjord systems

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The Oslofjord is one of Norway's busiest shipping lanes, and the region is one of the densest populated areas in Norway. The increasing risk for unwanted accidents is of concern for both leisure and professional activities.
We present ongoing work in which we are developing a fjord model able to resolve the many narrow sounds and islands of the fjord. To this end we have developed various versions based on both finite difference (ROMS) and finite element models (FVCOM), including a curvilinear version of ROMS. Various forcing data (atmospheric, tidal river, etc.) are also tested. Preliminary results from the various model runs will be shown and compared.
The work is carried out in close cooperation with the users of the model results and benefits from local knowledge of the ocean weather conditions.

A strategy for calibrating the roughness value of tidal floods and tidal marches in a threedimensional tidal model for the Scheldt estuary

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The NEVLA model is a 3-D curvilinear model of tidal dynamics and salinity in the Scheldt estuary. The model covers the entire tidal region of the estuary, with its seaward boundary located on the Belgian Continental Shelf, and is actively used in Flemish-Dutch research projects. The model has been calibrated in the past for the large-scale tidal hydrodynamics. In a second phase of the calibration, special attention is being paid to the small-scale hydrodynamics through a detailed study of velocities on tidal flats and tidal marshes. In order to determine the roughness values in these areas, a calibration strategy was developed that divides the flow domain into three height classes - i.e. sublitoral, litoral and supralitoral - based on the inundation frequency.

Short scale dynamics of contamination events in coastal waters: observations and models for the Costa Concordia site

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The dynamics of contamination phenomena in coastal waters is usually studied by applying hydrodynamic and diffusion models for tracers/pollutants. Such models are rarely supported by continuous measurements that allow to represent the spatial and temporal dynamics at the appropriate scale. Instead, in this work we had the opportunity to have continuous data of hydrodynamic and water quality near the Costa Concordia site at Isola del Giglio.

The removal of this wreck is the biggest operation of its kind in maritime history, and the complexity of the salvage operation has required continuous and accurate environmental monitoring procedures. For this reason a quite large number of instrumental devices has been concentrated in this restricted area. This has permitted to have a large amount of information to represent the short scale dynamics in this coastal area, and to calibrate and validate numerical models for waves, currents and pollutant dispersion.

In particular, here we discuss the case of a small pollution event that occurred during the parbuckling operation. The modeled data have been obtained by the operational meteo-marine forecasting chain implemented at LaMMA, that is constituted by a suite of state of the art numerical models (WRF, WW3, ROMS). This chain has been validated by the instrumental data obtained by two weather stations, buoys, tide gauge and an X-band radar installed in the Costa Concordia site; the latter instrument is particularly suitable to represent high-resolution current maps and wave spectra in a coastal site. Then the models above and the GNOME modeling tool have been used to follow the dynamical evolution of a contamination event that has been observed by a UV-fluorometer for PAH (polycyclic aromatic hydrocarbons) detection,

installed in the desalinisation water treatment plant of the island, close to the Costa Concordia site.

The results have shown the capability of such an observing and modelling system to reproduce the trajectory of this pollutant in shallow water.

Impact of cross-reef fluxes on the Ouano lagoon circulation

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In meso-tidal lagoons, the coral reef barrier can be temporarily submerged by water at high tide and partially exposed at low tide, which can cause particular lagoon dynamics. To gain insight into the importance of cross-reef fluxes on lagoon dynamics, a coupled study with numerical and in-situ experiments was conducted on Ouano Lagoon (New Caledonia). The field survey combined measurements on reef passages taken by moored Acoustic Doppler Current Profiler (ADCP) with measurements of wave and current on moorings along a cross-reef transect. Then, these data were used to set a numerical model of the water dynamics in this lagoon.

The main current was found to be tidally driven in reef passage. It is northward during the flood, with inward flows through the reef passages and the reversal usually occurs during the ebb. As expected, the cross-reef current is mainly inward and mainly wave-driven. Therefore, the tidally-averaged fluxes in reef passages and in lagoon are also correlated with the intensity of wave breaking on the reef. Finally, numerical tests were made on the impact of cross-reef fluxes on this circulation and we discuss the role of cross-reef fluxes on the lagoon circulation.

Extensive analysis of potentialities and limitations of a Maximum Cross-Correlation technique for surface circulation by using realistic ocean model simulations

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As shown in literature, ocean surface circulation can be estimated from sequential satellite imagery by using the Maximum Cross-Correlation (MCC) technique. This approach is very promising since it offers the potential for acquiring a synoptic-scale coverage of the surface currents on a quasi-continuous temporal basis. However MCC has also many limits due, for example, to the cloud coverage or the assumption that SST or other surface parameters from satellite imagery are considered as conservative passive tracers. Furthermore, as MCC can detect only advective flow, it could not work properly in shallow water, where local heating and cooling, upwelling and other small-scale processes have a large influence.

An analysis of the accuracy and reliability of the MCC can be done by comparing the estimated velocities with those measured by in-situ instrumentation, but the low number of experimental measurements does not allow a systematic statistical study of the potentialities and limitations of the method. Instead, an extensive analysis of these features can be done by applying the MCC to synthetic imagery obtained from a realistic numerical ocean model which takes into account most physical phenomena.
Here a new approch to MCC technique is shortly described and its application to synthetic imagery obtained by the Regional Ocean Modeling System (ROMS) model is discussed. Finally, an application of this MCC algorithm to a real case and a comparison with experimental measurements are shown.

Numerical modelling of flow in intertidal basins using an unstructured grid; application of D-Flow Flexible Mesh to the Dutch Wadden Sea

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The Dutch part of the Wadden Sea is a large intertidal area (~2400 km^2) characterized by a large number of channels and tidal flats with spatial scales ranging from the meters up to kilometers. It is challenging to capture such a complex bathymetry in a computational model grid using the traditional rectangular or curvilinear grid methods, especially in combination with acceptable computation times.

In the past, hydro- and morphodynamic models based on traditional structured (rectangular or curvilinear) grids have been set up for the Wadden Sea, but they all suffer from the issue that either the resolution is not high enough or computation times are (too) long. In order to create a more accurate model while maintaining acceptable computation times, an unstructured grid is required.

The Wadden Sea model discussed here is based on a flexible mesh grid, and combines curvilinear parts and (mainly triangular) unstructured parts. This grid choice combined with a finite volume approach yields an accurate and efficient method for numerical modeling in areas with complex bathymetries. This method has recently been implemented in the D-Flow Flexible Mesh software system. This new modeling system of Deltares allows for 1D, 2D and 3D (un)structured grid modeling into one system.

This presentation describes the setup and verification of a 2DH model using water levels from a number of tidal gauges within the Wadden Sea. The accuracy and efficiency will be compared with the previous generation Delft3D benchmark model. Furthermore, an analysis of the process of wetting and drying of the tidal flats is carried out. This process is of major importance for fine sediment deposition and requires a range of physical scales.

Here, we will only focus on (depth-averaged) hydrodynamic modeling. However, the ultimate goal of this work will be a 3D (fine) sediment transport model for the Wadden Sea that is able to capture the vertical distribution of Suspended Particulate Matter (SPM) concentrations and baroclinic residual flows, while maintaining acceptable computation times.

Application of data assimilation for improved operational water-level forecasting on the Northwest European Shelf and North Sea

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For the Netherlands, accurate water-level forecasting in the coastal region is crucial, since large areas of the land lie below sea level. During storm surges, detailed and timely water-level forecasts provided by an operational storm surge forecasting system are necessary to support for example the decision for closure of the movable storm surge barriers in the Eastern Scheldt and the Rotterdam Waterway. This presentation discusses recent advances in the continuous development of the Dutch operational tide–surge models for the northwest European Shelf, which provide 6-hourly water-level forecasts at stations along the Dutch coast, with a 48-h lead time.

In the past years a new generation tide-surge model (Dutch Continental Shelf Model version 6) has been developed covering the northwest European continental shelf, with a uniform cell size of about 1×1 nautical miles. While this model has a tide representation that is substantially better than comparable models of this scale, increased model resolution in coastal regions (such as the Dutch estuaries and shallow seas like the Wadden Sea) is essential for improving the representation of higher harmonics and non-linear tide–surge interaction there. This increased grid resolution is now achieved through a domain decomposition approach.

To reduce uncertainty in bathymetry and bottom friction coefficients, and consequently, minimize the differences between modelled water levels and observed water levels, we have applied a well-structured and theoretically sound approach to sensitivity analysis and parameter optimisation (available in the open source data assimilation toolbox OpenDA), with more than 150 control variables. Historic DCSMv6-ZUNOv4 model simulations are compared against shelf wide tide gauge observations and previous models for a full calendar year.

Furthermore, a steady-state Kalman filter is implemented to increase the predictive quality for the shorter lead times (up to approximately 12 h). Besides evaluating the model quality for a year-long hind cast simulation, the predictive value of the Kalman filter is determined by comparing the forecast quality for various lead-time intervals against the model without steady-state Kalman filter. This shows that improvements in predictive quality of around 50% are possible.

An unstructured grid model for the Belgian continental shelf and the Scheldt estuary

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Unstructured grid models present several advantages compared to those using structured grids. Firstly, multiscale processes are simulated using one only grid, with a high flexibility to increase mesh resolution in areas of interest. Secondly, coastlines with complex geometry can be represented more accurately.

Those interesting properties led us to start the setup of an unstructured grid model for the Belgian marine waters. The objective is to start with a two-dimensional horizontal model, and to progressively include wave and sediment dynamics, and upgrade to a three-dimensional model. The aim is to eventually replace our operational nested structured grid models currently in use.

To achieve our goals, we use the suite of solvers TELEMAC. It is based on the finite element technique to solve the governing equations on triangular grids, and it provides the modules to satisfy our needs (2D and 3D hydrodynamics, wave propagation in coastal areas, sediment transport and bed evolution). We also use Gmsh to generate triangular grids.

With this presentation, we want to share our experience in using those open source tools. We will also present some of the main achievements reached during the first year of this project, in terms of pre-processing, mesh generation and 2D hydrodynamic model calibration.

Status of BSH's operational ocean circulation forecasting model for German coastal waters

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Germany was among the first European countries that developed and used numerical ocean models in the coastal area. Development of operational ocean forecasting models started in the early 1980's at the predecessor institution of the Federal Maritime and Hydrographic Agency (BSH) and was in the beginning focussed on the North Sea coast. Later on the region of interest was extended to include the Baltic Sea. The models – especially the circulation models – at BSH were considerably advanced in several directions over the years and still are under permanent revision.

Today the 3-dimensional baroclinic circulation model provides a full ocean state forecast for the next 3 days including the variables water level, currents, temperature, salinity and sea ice. The model region covers the whole North and Baltic Sea with a horizontal resolution of 5.5 km and the German Bight and the western Baltic Sea is simulated with a 2-way nested grid of 900m resolution. Recently, a third level of grid nesting was introduced in order to improve the forecast for Elbe estuary. The model grid spans the part of the river Elbe under tidal influence with a horizontal resolution of 90 m. Open boundary values are provided by a 2-dimensional depth-integrated model of the North East Atlantic with a horizontal resolution of 10 km.

An overview of the model system developed and applied at BSH will be presented with the focus on the circulation model. The forecast quality will be demonstrated on the basis of validation results for the most important model variables. The latest model developments, including the transitioning towards the new HBM (HIROMB-BOOS-MODEL) model code, coupled

wave+circulation models, and ecosystem and data assimilation components will be highlighted.

A global tide and storm-surge model

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When a hydrodynamic tide or storm-surge model covers a much larger area than the North Sea some additional physical processes become relevant. This is most clear on a global scale, where there are no open-boundary conditions to force the model any more, but instead the tides are forced by the gravitational potential within the model.

We will present the first version of a global 2D-hydrodynamic model for the purpose of modeling tides and storm-surges. The main goals of the model are to provide boundary conditions for nested more detailed models and to study the impact of various assumptions in our regional models.

We apply the hydrodynamics code D-Flow FM on an unstructured grid representing the coastal areas in more detail than the open oceans. This is important since much of the tidal energy is dissipated on the shelf, even on a global scale. Moreover, much of the interest is often close to the coast.

The model results are compared to sealevel observations from tide gauges and satellite altimeter, for calibration and validation. The preliminary results are encouraging, but more research is needed to develop the model further. Finally, we have plans to develop an operational version of the model for storm-surge forecasting.

One- two- and three-dimensional hydrodynamic modelling with F-Flow Flexible Mesh

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At Deltares, we are in the process of integrating our 1D2D hydrodynamic code SOBEK-1D2D with the 2D3D code Delft3D. At the same time, we wish to increase model flexibility by allowing curvilinear meshes in combination with unstructured meshes that may consist of triangles, quadrilaterals, pentagons or hexagons, possibly in combination with 1D networks.

A beta version of the 1D2D part of this code has been supplied to several consultants and experts in the field of hydrodynamic modelling with Delft3D and their results seem promising so far. One specific feature of this code is its shock capturing capacity which makes it suitable for dynamic flows that may occur at dike breaches and floods. Because of the higher order discretization of advection, this scheme also proved well applicable for more complicated flows such as gyres at river junctions, meandering of eddies behind groynes, etc.

In the vertical, we want to achieve model flexibility as well. For some applications sigma-coordinates are better, for others z-coordinates are better. We are currently implementing a system that allows a user to specify the vertical layering type and the number of layers depending on local hydrodynamics and bathymetry features. In this way, one can combine a few layers at sea with many layers in the saline-fresh water interface area in estuaries, and with only one or a few layers in the well mixed river area. Alternatively, in more stagnant areas such as lakes, fixed layers can be used.

We use an analytical subgrid method to achieve fast grid convergence in depth-averaged mode. We will demonstrate the crucial importance of this subgrid method in a combined 1D2D rainfall runoff model. For 3D modelling, we have implemented the K-epsilon and the K-tau turbulence models. We will highlight the vertical grid convergence of these implementations. Applications for salinity intrusion and 3D temperature stratification will be shown. All of the above functionality is available in a parallel version with satisfactory scaling.

On the consistency of the drag between air and water in meteorological, hydrodynamic and wave models

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For the design, assessment and flood control of water defences, water levels and wave conditions from numerical models are required. To obtain reliable computed waves and surges, accurate atmospheric forcing is required to drive the hydrodynamic and wave models.

Waves and surges are forced by surface stress. However, in most cases the input for these models consists of 10m wind velocities that are internally converted to surface stress by applying a particular drag relation. When wind fields from an atmospheric model are used, this procedure generally leads to inconsistencies and errors, since the hydrodynamic, wave and atmospheric models often apply different drag relations. By means of a case study, we explored the consequences of this inconsistency in the drag formulation for North Sea storm waves and surge hindcasts. This was done by forcing the models using both the wind velocity and the wind stress fields computed by the atmospheric model.

The models considered are the operational Coastal Shelf Model schematization (CSM) of the shallow water flow model WAQUA, the operational Dutch North Sea SWAN wave model and the Dutch atmospheric model HARMONIE. This is a high resolution numerical weather forecast model that is one of the operational models of the Dutch meteorological institute (KNMI).

Our study was designed as follows: The HARMONIE wind stress was directly imposed on the SWAN and WAQUA models so that a difference in drag formulation between the models does not influence the results. Subsequently, the SWAN and WAQUA models were forced with the wind velocities. Finally, the results of the models using both forcings and measurements were compared. In addition to the stress computations, computations were performed with a so-called ‘pseudo-wind’, which is a translation of the wind stress to the 10m wind speed using a reference drag relation. The results of

the pseudo-wind computations are the same as those of the stress computation, since these have been computed with the drag relation implemented in the hydrodynamic and wave models, respectively. The use of a pseudo-wind ascertains that the model is fed with the stress as computed by the atmospheric model, while keeping the more intuitive interpretation of wind over stress.

Our study results show significant differences between the waves and water levels computed with surface stress (or pseudo-wind) input and wind velocity input. With this study we would like to plea for the use of a consistent drag relation in meteorological and hydrodynamic models. We note further that, in our case study we assume that the drag relation used in the considered atmospheric model is valid. This is not necessarily true and a proper modelling of the drag between air and sea can in our opinion only be achieved if hydrodynamic, wave and atmospheric models are coupled.

Wave-current-turbulence interaction near the sea surface

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The wave–turbulence interactions in the presence of near the sea surface current have been the subject of many theoretical, experimental, and numerical works during the past several decades. However, this complicated coupled dynamical system have been understood rudimentary due to mainly lack of both many precise measurements of TKE and efficient formulations of this interaction in the upper ocean boundary layer. In this study, we give an overview of theoretical and measurement progresses are carrying out in the Geophysical institute, University of Bergen. Different measurement challenges are examined and some signal processing algorithms are developed to decontaminate the wave-induced noises due to orbital wave velocity and platform motion. It is worth to be noted that all measurements have been collected using a new designed autonomous moored platform. Furthermore, to support and interpret the observations, numerical calculations are conducted using a second-order turbulence closure scheme modified to incorporate the near-surface processes such as Langmuir circulation and wave breaking. The results from a run forced by observed wind and wave field compared favorably with the observations.

Simulations of suspended sediment transport in the continuum river-delta-coastal system, East Kalimantan, Indonesia

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Suspended sediment is an inherent component of riverine and marine waters. However, in a continuum such as a river-delta-coastal system, understanding of suspended sediment transport processes is limited by the lack of field measurements and the difficulty to obtain such measurements due to the high spatial and temporal variability of the phenomena. This variability results from various factors, e.g. human activities, availability of sediment sources, changes of land use and soil texture in contributing area, water discharge, tides, in the system. As regards the modelling of such processes, a global system approach, which allows a presentation of the transfer of sediment from the river to the coastal ocean and the deep margin, is essential and still a challenging task. Whereas existing studies primarily investigate sedimentary processes locally, it is becoming computationally feasible to adopt such a global system approach, without excessive simplification of the physical processes resolved by the model.

The Second-generation Louvain-la-Neuve Ice-ocean Model (SLIM, www.climate.be/slim) is an unstructured mesh, finite-element model of environmental and geophysical fluid flows, which is under development to include the simulation of suspended sediment transport in the continuum river-delta-coastal system. This model allows coupling of a 1D model for the riverine environment with a more complex 2D depth-averaged model for the coastal environment. It was applied in the present study to the transport of suspended sediments and their transformation at the interface between freshwater and ocean of the Mahakam land-sea continuum. The 2D depth-averaged model was applied to the Mahakam Delta, the adjacent ocean, and

to three lakes in the upstream region of the delta while the 1D section-averaged model was employed for the Mahakam River and its four tributaries.

Using the available observations of suspended sediment concentration at five locations in the system, a sensitivity analysis regarding the choice of the suspended sediment transport formulations, including fine-grained and non-cohesive sediments models was performed. The modelling parameters were first determined in a calibration step by using the field observed sediment data at all five locations, for a given period of time. Then, a validation step was performed using data related to another period of time. From there, the best sediment formulation to reproduce the observed suspended sediment distribution in the delta is determined. The spatial distribution of sediment concentration in the delta and the temporal variation of sediment concentration are finally presented and discussed.

Storm Impact on a French coastal dune system: morphodynamic modeling using X-beach

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Recent major meteorological events like Katrina (2005) or Xynthia (2010) were at the origin of erosion periods, overwash phenomena and also breaching processes in the coastal shore. Such storm events have caused flood damage with disastrous consequences. The associated hydrodynamic and morphological phenomena which modify the beach and coastal dunes morphology during storm events are still not widely enough known to be able to evaluate the level of protection offered by this natural defense system. In this study we focus on the processes which contribute to sand dune systems and destruction/breaching induced by storm events. These processes are linked to the structure type and morphology of the coastal shore and the hydraulic loading (due to tides, waves and surges) which is exerted on it. To investigate the morphological damages on the coastal dune system induced by the different hydrodynamical and morphodynamical processes, we use the X-beach morphodynamical model (Unesco-IHE, Delft University and Deltares, Roelvink et al, 2009). X-beach solves short wave energy, flow and long wave propagation, sediment transport and bed update. This model is applied on a French site (Atlantic coast) where dune breaching has been observed during the Xynthia storm event (2010). After a comparison with observations for this event, a sensitivity study of the coastal dune behavior is done regarding: the hydraulic forcing, the sediment transport parametrisation ((resistance to erosion (McCall et al, 2010), dry and underwater bed slope for avalanching,…), the contribution of longshore processes and wave-current interactions. This leads to a qualitative and quantitative estimation of the different possible answers from the coastal shore tackled in that study to storm events. Finally some thresholds linked to the morphological answers of the studied dune system, such as sediment transport, dune retreat or breach initiation, are proposed. These thresholds are compared to the criteria defined by Donnelly (2006) to predict cross-shore profile response to overwash event.

A New Sediment Transport Model for Western Scheldt

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In this study, the main object is to investigate the flow and morphological processes in the Western Scheldt estuary using a new approach based on the Generalized Mixing Length (GML) Theory (Toorman, 2011).

In order to deal with the complexity within the research domain, and improve the prediction accuracy, a 2D depth-averaged model has been set up as realistic as possible, i.e. including two-way hydrodynamic-sediment transport coupling, mixed sand-mud sediment transport (bedload transport as well as suspended load in the water column) and a dynamic non-uniform bed composition.

A newly developed friction law is also implemented, with which the new bed shear stress closure is constructed as the superposition of the turbulent and the laminar part, it allows the simulation of both transient conditions and the transition during drying or wetting of tidal flats and the drying and flooding of intertidal flats can now be modelled without specifying an inundation threshold. The benefit is that intertidal morphodynamics can now be modelled at great detail for the first time. Erosion and deposition in these areas can now be estimated with much higher accuracy, as well as their contribution to the overall net fluxes.

Wave effects are important in the coastal area around the mouth, as they mobilize fine sediments found in the high turbidity area around Zeebrugge, which may be imported by the tide into the estuary. Therefore, wave effects have also been incorporated in the latest version of the model. With waves included, the model is able to represent the wave-current-sediment interactions, also called three-way coupling, as well as the mechanisms mentioned above.

Another feature of the model is the new dynamic deposition criterion. The critical shear stress for deposition is no longer taken constant, but related to the available energy for suspending particles. Its instantaneous value is obtained from a local suspension capacity condition (Toorman, 2000).

At current stage, the model has been partially calibrated and results show considerable differences in sediment fluxes, compared to a traditional approach and the analysis also reveals that the concentration effects play a very important role. The new friction law with concentration effects can considerably alter the total sediment flux in the estuary not only in terms of magnitude but also in terms of erosion and deposition patterns.

References

Toorman, E.A. (2000). Some thoughts on the modeling of erosion and deposition of cohesive sediments: contribution to Task D.5 of the COSINUS project. HYD/ET/00/COSINUS7. Katholieke Universiteit Leuven. Hydraulics Laboratory: Leuven. 10 pp.

Toorman, E.A. (2011). Low-Reynolds modelling of high-concentrated near-bottom suspended sediment transport. IAHR Symposium on Two-phase Modelling for Sediment Dynamics in Geophysics

A 3D baroclinic model of the Burdekin River Plume

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The Burdekin River is the largest single source of sediment delivered to the Great Barrier Reef (GBR), Australia. Understanding its dynamics is crucial for studying the evolution of the ecological system in the GBR. A recent study has shown that, according to field data, most sediment deposits within 50 km of the river mouth, which contrasts with previous theories. A simulation of the Burdekin dynamics can support this new theory.

SLIM 3D is a baroclinic dg finite element model, developed to study coastal flow dynamics. Up to now, it has only been applied to simple test cases. Applying it to the Burdekin river is a challenge due to the complexity of the geometry and the physical processes occurring there.
During this presentation, the challenge of modelling the Burdekin dynamics without losing accuracy, consistency or stability will be presented and the first results of this study will be expounded.