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CBC Workshop on Tsunami Modelling – June 3-4, 2010

This two day workshop is dedicated to the subject of Tsunami Modelling. Several scenarios causing tsunamis, methods of simulation, and other related problems will be covered by a range of highly respected speakers. The workshop is open for all interested attendees, and throughout the workshop there will be plenty of time for discussions.

Total number of participants: 23
Total number of guests outside of CBC: 10
Number of different nationalities represented: 10
Total number of speakers: 11
Total number of talks: 10

Please register for the workshop here.

Practical information

- For information on how to get to Simula, reimbursement of expenses, hotel information and places to eat, please visit: Practical information for guests

Agenda

Thursday, June 3rd
1255-1700: Opening, talks and discussions

1800-2200: Dinner

Friday, June 4th
0900 - 1245: Talks/discussion

1245 - 1345: Closing lunch

We have tried to arrange the talks in groups, with time slots for discussions. In the following detailed agenda some topics for discussions are proposed, but new are welcome.

Thursday, June 3rd

1255-1300: Welcome

1300-1345: Computational Modelling of Huge Tsunamis from Asteroid Impacts. Prof. Hans Petter Langtangen, Simula Research Laboratory

1345-1430: Modelling tsunami propagation and runup; some key issues. Prof. Geir Kleivstul Pedersen, ICG/NGI

1430-1445: Coffee break

1445-1515: Landslide generated tsunamis and methods for early warning. Dr. Sascha Brune, GFZ Potsdam

1515-1545: Recent tsunami modelling and consulting at ICG/NGI. Dr. Finn Løvholt and Dr. Carl B. Harbitz, ICG/NGI

1545-1600: Discussion. Landslide and fjord scenarios, methods for early warning

1600-1615: Coffee break

1615-1645: Labscale and mathematical modelling of great subduction earth- quakes and their tsunamis with reference to the 2010 Chile event. Dr. Matthias Rosenau, GFZ Potsdam

1645-1700: Discussion. New modelling approach, significantly new/better results?

Friday, June 4th

0900-0930: Comparisons between the runup-models MOST and GEO- CLAW in 2HD. Rolv Erlend Bredesen, Simula Research Laboratory

0930-1000: DOLFWAVE - Use of FEniCS for surface waves modelling. Nuno David Lopes, FUL-CMAF

1000-1015: Discussion. Using Dolfwave as an easy modelling tool, is it easy? Runup models, are they that different?

1015-1030: Coffee break

1030-1100: Modelling sediment transport near the seabed. Dr. Lars Erik Holmedal, NTNU

1100-1130: A lumped particle modeling framework for the transport of particle. Dr. Omar al-Khayat, Simula Research Laboratory

1130-1145: Discussion. Improving sediment models; ways forward

1145-1215: Calculations of landslide-induced tsunamis: dependence on rheology and resolution. Dr. Galen Gisler, PGP at UiO

1215-1245: Discussion. Landslide tsunamis and rheological effects. Impact generated tsunamis

1245-1315: Closing lunch

Confirmed Speakers, and Abstracts

Prof. Geir Kleivstul Pedersen, ICG/NGI

Modelling tsunami propagation and runup; some key issues

After a brief introduction the various hydrodynamic equations used in tsunami modelling are briefly presented. The applicability of the equations for tsunami propagation is discussed in view of the physical phenomena of wave dynamics as they appear in examples on historic and potential cases. Finally, the attention is turned to runup on beaches and overall modelling strategies.

Prof. Hans Petter Langtangen, Simula Research Laboratory

Computational Modelling of Huge Tsunamis from Asteroid Impacts

The talk starts with a brief introduction to tsunamis (overview of tsunami types, characteristics of tsunamis, and commonly used mathematical models). Then we address tsunamis arising from Earth-asteroid collisions, in particular the Mjølnir tsunami in the Barents Sea, 142 million years ago. Finally, we outline some research ideas on largescale computational modelling of tsunamis.

Dr. Galen Gisler, PGP at UiO

Calculations of landslide-induced tsunamis: dependence on rheology and resolution

I present calculations done with the Sage multi-material hydrocode of the generation of tsunamis by landslides. Lagrangian tracer particles are used to obtain characteristics of the induced waves as well as the disposition of the seafloor landslide relict. Rheologies from fully inviscid to plastic flows of varying stiffness are considered. Naturally, runnier flows produce greater turbulence, stronger initial waves, and longer, rougher, seafloor deposits. Landslides that produce runouts that are both long and smooth probably do not induce large tsunamis.

Dr. Sascha Brune, GFZ Potsdam

Landslide generated tsunamis and methods for early warning

Submarine landslides constitute the second most frequent cause of tsunamis after earthquakes. While tsunami early warning for earthquake-generated tsunamis is well established in several systems around the world, the rapid detection of tsunamigenic submarine landslides still poses large problems. First, I summarize available information on size, failure mechanism, and frequency of submarine slope failures in the North Atlantic and the Sunda Arc. I present the results of numerical tsunami modelling studies and describe the applied simulation methods. Further, I discuss two methods for landslide tsunami early warning, one involving an array of coastal tiltmeters, while the other applies conventional systems of buoys and ocean bottom units. The tiltmeter approach is promising for huge slides like they are found at formerly glaciated margins such as off Norway or volcano slopes like at Hawaii. It is based on the fact that large mass movements cause an elastic deformation of the earth's surface that is measurable with present day highly sensitive tiltmeters at distances of more than hundred kilometers. These data can be used to invert for main landslide parameters and predict the generated tsunami. While this method is in the stage of development and still needs testing before it can be implemented in a warning system, the second approach relies on the well established technique of wave measurements. It involves a database of many precomputed landslide scenarios and a selection technique that yields a set of possible scenarios for the given buoy data. Thereby, the wave has to reach at least two buoys before the slide location can be confined and a warning pronounced. This leads to fundamental constraints on the area where a timely warning is possible. I exemplify the advantages and drawbacks of this approach for the case of the Lesser Sunda Islands in Indonesia.

Dr. Finn Løvholt and Dr. Carl B. Harbitz, ICG/NGI

Recent tsunami modelling and consulting at ICG/NGI

Norwegian Geotechnical Institute (NGI) and Dept. of Mathematics, University of Oslo (UiO), have a long tradition for studies of tsunamis generated by rock slides and submarine slides in lakes, fjords, and the open sea. Since 2003 NGI and UiO have both been partners in the International Centre for Geohazards (ICG), a Centre of Excellence established by the Research Council of Norway. This has enabled joint and enhanced tsunami research focusing on numerical models for tsunami generation by earthquakes, dispersive wave propagation, regional runup height assessment, and local inundation. Simultaneously, modelling and laboratory experiments of rock slide tsunamis in complex fjord geometries - considered the largest tsunami hazard in the North East Atlantic – have been intensified. Finally, the inundation models have been combined with methodologies and data for quantification of likelihood, vulnerability, and mortality in tsunami hazard and risk studies. Since the 2004 Indian Ocean tsunami NGI has also had several international consulting projects comprising regional exposure and local risk assessment of tsunamis. Examples of model results and consulting projects will be discussed.

Dr. Lars Erik Holmedal, NTNU

Modelling sediment transport near the seabed

Sediment transport in shallow and intermediate water depths, i.e. in coastal zones and on the continental shelf, occur predominately as a result of the combined action of waves and currents. The waves are the principal cause of the entrainment of the sediments which are diffused into the water by turbulent processes, and subsequently transported by the current. This sediment transport is important for erosion and scour around offshore structures such as wind turbines, and for erosion of the coast line. In this presentation a simple modelling approach will be given, and comparisons between predictions and measurements will be shown. The effect of random waves as well as the effect of asymmetric waves, including streaming will be discussed and results will be presented.

Dr. Matthias Rosenau, GFZ Potsdam

Labscale and mathematical modelling of great subduction earthquakes and their tsunamis with reference to the 2010 Chile event

Subduction zones are disaster hotspots with giant (M9) megathrust earthquakes. Their tsunamis are of global reach posing an increasing risk to coastal communities. Whilst far-field tsunami impact from subduction zone earthquakes can reasonably well predicted in advance of arrival based on first-order source parameters (location, magnitude, mechanism) early warning in the near-field suffers from the short travel times (< 30 min) of local tsunamis and their sensitivity to details of the source (slip heterogeneity, splay faulting). In the absence of knowledge of the cycle-to-cycle variability of such second-order source parameters in nature, we started simulating subduction megathrust earthquake sequences using labscale models of subduction zones in order to constrain tsunami model input. In combination with analytical and numerical tsunami models we investigate the scaling of local tsunamis with earthquake moment and slip as well as their variability due to slip heterogeneity over multiple events. We apply the inferred scaling "laws" and intrinsic variability to subduction zones around the world and describe their susceptibility to tsunami thread in terms of probability of exceeding certain tsunami heights for the maximum earthquake size that the specific subduction zone might be capable to generate. Accordingly, tsunami potential disaster hot spots occur mainly on so-called accretionary convergent margins like Cascadia, Alaska, Sumatra and Southern Chile. The latter generated a M8.8 earthquake on February 27th 2010 and a tsunami which killed more than 500 people. Preliminary survey reports suggest a highly variable runup and inundation profile along the coast in the near-field with a mean runup of about 5-6 m and local runup maxima of up to 30 m. I will show how the event, which has been an important test for our model, has been anticipated based on historical and geodetic observations.

Dr. Omar al-Khayat, Simula Research Laboratory

A lumped particle modelling framework for the transport of particle

The lumped particle model is a flexible framework for modelling particle flows, embodying fundamental features that are intrinsic in particle laden flow, including advection, diffusion and dispersion. Instead of tracking the individual dynamics of each particle, a weighted spatial averaging procedure is used where the external forces are applied to a "lump" of particles, from which an average position and velocity is derived. The temporal evolution of the particles is computed by partitioning the lumped particle into smaller entities, which are then transported throughout the physical domain. These smaller entities recombine into new particle lumps at their target destinations. For particles prone to the effects of Brownian motion or similar phenomena, a symmetric spreading of the particles is included as well. For dense particle flows, a collision procedure is added to the model. This is based on a binary collision model combined with concepts from kinetic theory. To show the flexibility and the promising features of the model, a series of numerical results are presented. Future development and applications of the model will be discussed.

Rolv Erlend Bredesen, Simula Research Laboratory

Comparisons between the runup-models MOST and GEOCLAW in 2HD

Two tsunami inundation models, GEOCLAW and MOST, are compared. Convergence tests for maximum runup in 1HD (1 horizontal dimension) is performed before we analyze the 2HD inundation heights computed by the two models for a rock slide tsunami in a Norwegian fjord. For the 1HD test, the models produce similar results for maximum runup. In the tsunami rock slide scenario the leading wave is comparable during runup, but limitations in the MOST model due to water loss and unphysical oscillations associated with high draw-down speeds along steep slopes reduce the confidence in the MOST model with time. The GEOCLAW model handles bores in a better way than the MOST model as the MOST model also introduces unphysical ripples near steep gradients in the surface elevation.

Nuno David Lopes, FUL-CMAF

DOLFWAVE - Use of FEniCS for surface waves modelling

In this talk we present DOLFWAVE, a library for solving surface water waves problems. It is based on two of the core components of the FEniCS project, namely DOLFIN and FFC. We discuss some of the implemented models as well as the numerical methods used for their discretization. In particular, we use a nonlocal continuous/discontinuous Galerkin finite element method (C/DG-FEM) with inner penalty terms to approximate the solutions of a fourth-order improved Boussinesq-type model. Dissipative effects and wave generation due to time dependent varying sea bed are included. Thus, high-order source functions are considered. To demonstrate the applicability of the libraries, several test cases are considered.

What	• Workshop
When	Jun 03, 2010 01:00 PM to Jun 04, 2010 01:00 PM
Where	Storstua @ Simula
Contact Name	Tor Gillberg
Contact Phone	+47 404 23 383
	Anders Logg Andre Massing Carl B. Harbitz Finn Løvholt Galen Gisler Geir Pedersen

Attendees	Halvard Moe Hans Petter Langtangen Lars Erik Holmedal Lyudmyla Vynnytska Matthias Rotenau Nuno Lopes Ola Skavhaug Omar Al-Khayat Rainer Nerlich Rolv Erlend Bredesen Sascha Brune Stuart Clark Tim Dorscheidt Tor Gillberg Wenjie Wei Widodo Pranovo Xing Cai
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