# Data-driven and physically-based models for characterization of processes in hydrology, hydraulics, oceanography and climate change

7 – 25 January 2007
Institute of Mathematical Sciences
National University of Singapore

Jointly organized by

Institute of Mathematical Sciences
and
Pacific Institute of Mathematical Sciences, UBC

Co-organizers: Tropical Marine Science Institute; Singapore-Delft Water Alliance

## Organizing Committee

### Co-chairs

Sylvia Esterby (University of British Columbia)
Hans-Rudolf Künsch (ETH Zurich)
Shie-Yui Liong (National University of Singapore)

### Members

Vladan Babovic (National University of Singapore)
Wolfgang Kinzelbach (ETH Zurich)
Pavel Tkalich (National University of Singapore)
Jim Zidek (University of British Columbia)

# A. Overview

The 3-week program consisted of seminars/lectures and research discussions aimed at developing research collaboration. A total of 23 overseas and 5 local lecturers shared their expertise in this workshop. 22 overseas graduate students/professionals (China, Korea, Vietnam, Thailand, Malaysia, Indonesia, Germany) and 17 local graduate students/professionals took part in the workshop. A technical field trip to PUB's two most current projects, "Deep Tunnel Sewerage System" and "Recycle Water Plant" were conducted on the last day of the workshop.

A description and the focus of the workshop are given in Section (A). A complete workshop program is listed in Section (B). Section (C) gives a consolidated list of topics for future collaborations among the participants. Section (D) lists the overseas and local workshop lecturers and participants.

Three main topics were covered in the program. They are:

1. "Development of a fully integrated data driven and physical-based models for water resources management"
2. "Dynamic and Statistical Downscaling on Climate Change Study"
3. "Nonlinear Wave Dynamics and Tsunami Modeling"

*Physically based modeling* maps natural phenomena to a computer simulation program. There are two basic processes in this mapping: *mathematical modeling and numerical solution*. The mathematical modeling concerns the description of the natural phenomena by mathematical equations. The *numerical solution* involves computing an efficient and accurate solution of the mathematical equations. Models are essential tools for synthesizing observations, theory, and experimental results in order to investigate the physical phenomena which govern the behavior of water in the system under study, and to understand how the system is affected by human activities. Models can be used in both a retrospective sense, to test the accuracy of modeled changes in the system by comparing model results with observations of past change, and in a prognostic sense, for calculating the response of the system to projected future changes.

This part of the program focused on improvements of description of physical, environmental and water quality processes through hydrodynamics, morphology, hydrology, water quality, ecology as well as numerical methods and techniques such as finite difference methods, finite element methods and boundary element methods, with applications to physically based modeling of lakes and reservoirs, prediction of runoff in poorly gauged catchments using physically based models, and flood modeling.

*Data driven modeling and computational intelligence:* In situations when knowledge about the processes to be modeled is limited, physically based model cannot be built, or they are inadequate. There are situations, however, when at least some of the variables characterising a particular process have been measured, and there is enough data to represent the input-output relationships associated with the process. In such cases data-driven models (DDM) can be built that make it possible to model and forecast some output variables. An example is the modelling of a rainfall-runoff relationship using statistical models or artificial neural networks. Typically, in order to build a DDM, methods of computational intelligence would be used. Research here is concentrated on testing various methods and their combinations in different types of modelling problems, and, developing new modelling methods.

Often, physically based models do not exhibit the needed accuracy, or are inadequate to model

particular situations, e.g. those of very high flows for the purpose of flood forecasting. On the other hand, there may not be enough data to train data driven models alone. In this case combinations of models of different types (i.e., hybrid models) could be a solution. Research in hybrid modeling is aimed at developing algorithms to ensure optimal combinations of physically based and data-driven models, and testing the resulting models in various situations. This paradigm will explore a number of approaches and techniques, such as data assimilation based on Kalman filtering, model-error characterization and its correction; data-model integration techniques, data-driven knowledge discovery and finally adaptive and learning modeling environments under which models adapt their internal structure on the basis of observed data.

The program also considered recent development in statistics relevant to the topical areas described in the following subsections. Considerable efforts have been made to assess uncertainty by comparing and combining different physical models (especially in weather prediction and climate modeling) and on calibrating complex computer models with observations, taking non-identifiability and structural model deficits into account. It should be noted that these topics are currently the object of a program at SAMSI (Statistical and Applied Mathematical Sciences Institute).

The program concentrated on bridging the gap and establishing the bridges between the two approaches (and two scientific communities) by addressing several specific topical areas: water resources management, down-scaling in climate change and non-linear wave and tsunami modeling.

**Development of fully integrated data driven and physical-based models for water resources management**

Developing an effective and efficient computational tool for water resources management of water-scarce regions or countries like Singapore is of utmost importance. The program covered the chain from real time monitoring of storms, reservoir and sea levels via forecasting of runoff and flooding to decision making on reservoir operation. Both water quantity and water quality were discussed and the applications of smart sensing technologies were brought up in discussion as well.

This topic concentrated on forecasting storms, surface runoff and downstream tidal levels in advance of their actual arrival in a holistic and integrated manner. First various deterministic models including atmospheric, rainfall-runoff, reservoir, and coastal hydrodynamics are first integrated. After calibrating and validating the system, a database containing simulated relevant data resulting from representative scenarios are then set-up. This database is used to train some data driven models which are known to be computationally of many orders of magnitude faster than their deterministic counterparts.

**Dynamic and Statistical Downscaling in Climate Change Study**

There is an emerging scientific consensus that human action, especially the release of man-made greenhouse gases, is leading to global climate change. Some of the most current research activities are the study of dynamic and statistical downscaling of climate parameters (e.g. rainfall, sea level) and extreme weather and climate events. Their impacts particularly on small islands such as Singapore are of grave concerns.

This topic focused on dynamic and statistical downscaling methods and issues of climate parameters (e.g. rainfall, sea level). Analytical results from different General Circulation Models are

known to differ significantly. Taking the more conservative results would result in prohibitively high cost in adaptation measures while the other extreme will certainly be catastrophic for small island states like Singapore.

**Nonlinear wave dynamics and tsunami modeling**

Nonlinear waves are observed in all branches of science and engineering, and are present in different aspects of our daily life. Physics and biology, road traffic control and structure of the universe, electronic and communication systems are affected by the same phenomenon at different spatial and temporal scales, namely nonlinear wave dynamics. Nonlinear waves can be significant in an act of creation or destruction, and be simultaneously fascinating and tragic. Indian Ocean (2004) Tsunami is a pure example of a series of events dominated by nonlinear wave dynamics, starting from tectonic movements and up to tsunami run-up on shore. The focus of this topic was placed on the application of the theories to nonlinear wave dynamics in the ocean.

# B. Workshop Program

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| **Monday, 7 Jan 2008** | |
| 08:30am - 09:00am | Registration |
| 09:00am - 09:05am | Opening remarks<br>*Louis Chen, Institute for Mathematical Sciences*<br>*Jim Zidek, University of British Columbia, Canada* |
| 09:05am - 10:30am | Reconciling physical & statistical approaches to modelling (PDF)<br>*Jim Zidek, University of British Columbia, Canada* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Tsunami Modelling in Indian Ocean and South China Sea<br>*Pavel Tkalich, National University of Singapore* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Internal solitary waves in the atmosphere and ocean (PDF)<br>*Roger Grimshaw, Loughborough University, UK* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |
| **Tuesday, 8 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Statistics for ordinary and stochastic differential equation models<br>Part I: Modeling issues and offline estimation (PDF)<br>*Hans-Rudolf Künsch, ETH Zürich, Switzerland* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Multiscale techniques for porous media flows (PDF)<br>*Yalchin Efendiev, Texas A&M University, USA* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | The numerical simulation of hydrostatic free surface flows<br>*Guus Stelling, Delft University of Technology, The Netherlands* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |

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| **Wednesday, 9 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Modeling of heterogeneous datasets (PPT)<br>*Yosihiko Ogata, The Institute of Statistical Mathematics, Japan* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Regional climate model downscaling of USA present climate and future projection: Uncertainty and dimension reduction<br>*Xin-Zhong Liang, Illinois State Water Survey Illinois State Department of Natural Resources and*<br>*University of Illinois at Urbana-Champaign, USA* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Web based Online Tsunami warning for Thailand Andaman coastline<br>*Seree Supratid, Rangsit University, Thailand* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |
| **Thursday, 10 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | The numerical simulation of hydrodynamic free surface flows<br>*Guus Stelling, Delft University of Technology, The Netherlands* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Uncertainty quantification using coarse-scale models (PDF)<br>*Yalchin Efendiev, Texas A&M University, USA* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Data driven techniques<br>*Vladan Babovic, National University of Singapore* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |

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| **Friday, 11 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Standard point-process models for prediction and diagnosis of earthquake activity<br>*Yosihiko Ogata, The Institute of Statistical Mathematics, Japan* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Solitons interactions of two traids of the Kadomtsev-Petviashvili equation<br>*Chee Tiong Ong, Universiti Teknologi Malaysia, Malaysia* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Korteweg-de Vries equation: applications (PDF)<br>*Roger Grimshaw, Loughborough University, UK* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |
| **Monday, 14 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Modeling annual precipation outputs from a deterministic model: the problem of extremes (PDF)<br>*Jim Zidek, University of British Columbia, Canada* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Models for environmental extremes I (PPT)<br>*Abdel El-Shaarawi, The National Water Research Institute, Canada* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Integrated water resources management<br>*Shie-Yui Liong, National University of Singapore* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |

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| **Tuesday, 15 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Statistics for ordinary and stochastic differential equation models<br>Part II: Filtering and sequential estimation (PDF)<br>*Hans-Rudolf Künsch, ETH Zürich, Switzerland* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Physically-based models for the generation, propagation and impact of water waves - part 1 (PDF)<br>*Frédéric Dias, Ecole Normale Supérieure de Cachan, France* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Numerical simulation of shallow flows: 1D approach<br>*Pilar Garcia Navarro, University of Zaragoza, Spain* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |
| **Wednesday, 16 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | A framework for uncertainty quantification combining detailed computer simulations and experimental data<br>*David Higdon, Los Alamos National Laboratory, USA* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Physically-based models for the generation, propagation and impact of water waves - part 2 (PDF)<br>*Frédéric Dias, Ecole Normale Supérieure de Cachan, France* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Numerical simulation of shallow flows: 2D approach<br>*Pilar Garcia Navarro, University of Zaragoza, Spain* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion Topic 1: Development of a fully integrated data driven and physical-based models for water resources management<br>Discussion Topic 2: Dynamic and statistical downscaling on climate change study<br>Discussion Topic 3: Nonlinear wave dynamics and Tsunami modeling |

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| **Thursday, 17 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Models for environmental extremes II<br>*Abdel El-Shaarawi, The National Water Research Institute, Canada* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Towards entwining computing, modeling and analysis<br>*David Higdon, Los Alamos National Laboratory, USA* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Trend analysis: considerations for water quality management (PPT)<br>*Sylvia Esterby, University of British Columbia, Canada* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion Topic 1: Development of a fully integrated data driven and physical-based models for water resources management<br>Discussion Topic 2: Dynamic and statistical downscaling on climate change study<br>Discussion Topic 3: Nonlinear wave dynamics and Tsunami modeling |
| **Friday, 18 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Determining homogeneous regions: considerations for water quality management (PPT)<br>*Sylvia Esterby, University of British Columbia, Canada* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Numerical study of wave and submerged breakwater interaction (PPT)<br>*Dang Hieu Phung, Institute of Meteorology, Hydrology and Environment, Vietnam* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Discussion Topic 1: Development of a fully integrated data driven and physical-based models for water resources management<br>Discussion Topic 2: Dynamic and statistical downscaling on climate change study<br>Discussion Topic 3: Nonlinear wave dynamics and Tsunami modeling |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion Topic 1: Development of a fully integrated data driven and physical-based models for water resources management<br>Discussion Topic 2: Dynamic and statistical downscaling on climate change study<br>Discussion Topic 3: Nonlinear wave dynamics and Tsunami modeling |

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| **Monday, 21 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:00am | Downscaling methods for climate-related impact assessment studies (PPT)<br>*Van-Thanh-Van Nguyen, McGill University, Canada* |
| 10:00am - 11:00am | Applying data assimilation methods in Delft-FEWS to improve real time forecasting<br>*Albrecht Weerts, WL \| Delft Hydraulics, The Netherlands* |
| 11:00am - 11:30am | *--- Coffee Break ---* |
| 11:30am - 12:30pm | Dynamical and statistical downscaling of New Zealand climate and linking to impact assessment studies (PPT)<br>*Brett Mullan, National Institute of Water and Atmospheric Research, New Zealand* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Analyzing input and structural uncertainty of a hydrological model with Stochastic, time-dependent parameters (PPT)<br>*Peter Reichert, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Earthquake and tsunami scenarios in the South China Sea (PPT)<br>*Vu Thanh Ca, Vietnam Institute of Meteorology, Hydrology and Environment, Vietnam* |
| **Tuesday, 22 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | A spatial-temporal downscaling approach to construction of intensity duration frequency relations in consideration of GCM-based climate change scenarios (PPT)<br>*Van-Thanh-Van Nguyen, McGill University, Canada* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Physical-based emulation of dynamic models - concept and application in hydrology (PPT)<br>*Peter Reichert, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | Measuring uncertainty in spatial data via Bayesian melding (PDF)<br>*Matthew Falk, Queensland University of Technology, Australia* |
| 03:30pm - 04:00pm | *--- Coffee Break ---* |
| 04:00pm - 05:15pm | Discussion on topics of the day |

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| **Wednesday, 23 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Mixtures of experts approaches in rainfall runoff modelling (PDF)<br>*David Nott, National University of Singapore* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 12:30pm | Routes of transition to turbulence<br>*Hua-Shu Dou, National University of Singapore* |
| 12:30pm - 02:00pm | *--- Lunch Break ---* |
| 02:00pm - 03:30pm | An event driven model framework for water distribution systems based on transient flow analysis (PPT)<br>Development of integrated models for urban drainage systems (PPT)<br>*Yu-Wen Zhou, Bejing University of Technology, China* |
| **Thursday, 24 Jan 2008** | |
| 08:45am - 09:00am | Registration |
| 09:00am - 10:30am | Biases and uncertainties in regional climate predictions (PDF)<br>*Hans-Rudolf Künsch, ETH Zürich, Switzerland* |
| 10:30am - 11:00am | *--- Coffee Break ---* |
| 11:00am - 11:45am | Introduction to tropical marine science institute<br>*Pavel Tkalich, National University of Singapore* |
| 11:45am - 12:30pm | Introduction to Singapore-Delft water alliance<br>*Vladan Babovic, National University of Singapore* |
| 12:30pm - 02:00pm | Discussion Topic 3: Nonlinear wave dynamics and Tsunami modeling |
| 02:00pm - 03:30pm | *--- Lunch Break ---* |
| **Friday, 25 Jan 2008** | |
| 01:30pm - 05:30pm | Visit to Changi WRP and NEWater Visitor Centre (NVC) |

# C. Consolidated Topics for Possible Collaboration

Various issues surfaced and discussed in the workshop. The following list some main issues and consolidated topics derived from the daily workshop discussions. The consolidated topics are meant to give to all participants the platform for possible future collaborations.

**A. Main issues:**

1. Providing measures of uncertainty on deterministic output
2. Data simulation within a statistical framework.
3. Statistics in model assessment, uncertainties in data.
4. Upscaling/downscaling of models
5. Emulation of deterministic models, e.g. response surfaces vs. artificial neural networks.
6. Knowledge discovery and adaptive experimental designs.
7. Signal propagation in space-time models.
8. Domain discovery, process understanding.
9. Calibration of wave propagation models with buoy data.

**B. Consolidate Topics:**

***B.1 Climate change:***

1. Combining ensembles of models (global, regional, different emission scenarios).
2. Statistics for assessing different climate models from control runs.
3. Uncertainty in coefficients, boundary, forcing and initial conditions.
4. Error bands on climate model forecasts.

***B.2 Tsunami forecasting:***

1. Improving wave height forecasting with seismic signal inversion and sensors.
2. Estimating uncertainty
3. Offline analysis for different initial conditions, models.

***B.3 Hydrological and hydraulic models: Networks***

1. Forecasting floods in distributed fresh water systems
2. Conjoining deterministic simulators and statistical emulators
3. Role of data assimilation
4. Input uncertainty of rain amounts, subsurface flow, or run-off.
5. Uncertainty about friction coefficient: Make it stochastic and/or variable in space (and time).

***B.4 Extreme values***

1. Incorporating physical models in forecasting extremes
2. Multivariate extreme value theory
3. Poisson approximation and errors of approximation

***B.5 Design:***

1. Monitoring networks to detect extremes
2. Multiple, correlated responses to extreme events

***B.6 Risk management:***

1. Incorporating uncertainty
2. Communicating uncertainty

# D. List of Visitors

| NAME & AFFILIATION | PERIOD OF VISIT | TENTATIVE TITLE OF TALK |
|---|---|---|
| **OVERSEAS LECTURERS** | | |
| Sujit K. Bose<br>S.N. Bose National Centre for Basic Sciences, India<br>sujitkbose(AT)yahoo.com | 6 - 25 Jan 2008 | Basic equations of open channel flows<br><br>Some equations of sediment transport with application to sand waves (PPT1, PPT2, PPT3, PPT4) |
| Vu Thanh Ca<br>Vietnam Institute of Meteorology, Hydrology and Environment, Vietnam<br>vuca(AT)vkttv.edu.vn | 20 - 23 Jan 2008 | Earthquake and tsunami scenarios in the South China Sea (PPT) |
| Frédéric Dias<br>Ecole Normale Supérieure de Cachan, France<br>dias(AT)cmla.ens-cachan.fr | 13 - 19 Jan 2008 | Physically-based models for the generation, propagation and impact of water waves - part 1<br><br>Physically-based models for the generation, propagation and impact of water waves - part 2 |
| Yalchin Efendiev<br>Texas A&M University, USA<br>efendiev(AT)math.tamu.edu | 5 - 14 Jan 2008 | Multiscale techniques for porous media flows (PDF)<br><br>Uncertainty quantification using coarse-scale models (PDF) |
| Sylvia Esterby<br>University of British Columbia, Canada<br>sylvia.esterby(AT)ubc.ca | 12 - 20 Jan 2008 | Trend analysis: considerations for water quality management (PPT)<br><br>Determining homogeneous regions: considerations for water quality management (PPT) |
| Matthew Falk<br>Queensland University of Technology, Australia<br>m.falk(AT)qut.edu.au | 14 - 26 Jan 2008 | Measuring uncertainty in spatial data via Bayesian melding (PDF) |
| Pilar Garcia Navarro<br>University of Zaragoza, Spain<br>pigar(AT)posta.unizar.es | 13 - 16 Jan 2008 | Numerical simulation of shallow flows: 1D approach<br><br>Numerical simulation of shallow flows: 2D approach |
| Roger Grimshaw<br>Loughborough University, UK<br>R.H.J.Grimshaw(AT)lboro.ac.uk | 6 - 12 Jan 2008 | Internal solitary waves in the atmosphere and ocean (PDF)<br><br>Korteweg-de Vries equation: |

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| | | applications (PDF) |
| David Higdon<br>Los Alamos National Laboratory, USA<br>dhigdon(AT)lanl.gov | 14 - 19 Jan 2008 | A framework for uncertainty quantification combining detailed computer simulations and experimental data<br><br>Towards entwining computing, modeling and analysis |
| Hans-Rudolf Künsch<br>ETH Zürich, Switzerland<br>kuensch(AT)stat.math.ethz.ch | 6 - 27 Jan 2008 | Statistics for ordinary and stochastic differential equation models<br>Part I: Modeling issues and offline estimation (PDF)<br>Part II: Filtering and sequential estimation (PDF)<br>Biases and uncertainties in regional climate predictions (PDF) |
| Xin-Zhong Liang<br>Illinois State Water Survey<br>Illinois State Department of Natural Resources<br>and University of Illinois at Urbana-Champaign, USA<br>xliang(AT)uiuc.edu | 6 - 12 Jan 2008 | Regional climate model downscaling of USA present climate and future projection: Uncertainty and dimension reduction |
| Brett Mullan<br>National Institute of Water and Atmospheric Research, New Zealand<br>b.mullan(AT)niwa.co.nz | 20 - 23 Jan 2008 | Dynamical and statistical downscaling of New Zealand climate and linking to impact assessment studies (PPT) |
| Van-Thanh-Van Nguyen<br>McGill University, Canada<br>van.tv.nguyen(AT)mcgill.ca | 21 - 25 Jan 2008 | A spatial-temporal downscaling approach to construction of intensity duration frequency relations in consideration of GCM-based climate change scenarios (PPT1)<br><br>Downscaling methods for climate-related impact assessment studies (PPT) |
| Yosihiko Ogata<br>The Institute of Statistical Mathematics, Japan<br>ogata(AT)ism.ac.jp | 6 - 11 Jan 2008 | Modeling of heterogeneous datasets (PPT)<br><br>Standard point-process models for prediction and diagnosis of earthquake activity |
| Chee Tiong Ong<br>Universiti Teknologi Malaysia, Malaysia<br>ong(AT)mel.fs.utm.my | 7 - 12 Jan 2008 | Solitons interactions of two traids of the Kadomtsev-Petviashvili equation |

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| Dang Hieu Phung<br>Institute of Meteorology, Hydrology and Environment, Vietnam<br>phungdanghieu(AT)vkttv.edu.vn | 8 - 20 Jan 2008 | Numerical study of wave and submerged breakwater interaction (PPT) |
| Peter Reichert<br>Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland<br>peter.reichert(AT)eawag.ch | 21 - 26 Jan 2008 | Analyzing input and structural uncertainty of a hydrological model with Stochastic, time-dependent parameters (PPT)<br><br>Physical-based emulation of dynamic models - concept and application in hydrology (PPT) |
| Abdel El-Shaarawi<br>The National Water Research Institute, Canada<br>Abdel.El-Shaarawi(AT)ec.gc.ca | 12 - 20 Jan 2008 | Models for environmental extremes I (PPT)<br><br>Models for environmental extremes II |
| Guus Stelling<br>Delft University of Technology, The Netherlands<br>g.s.stelling(AT)tudelft.nl | 6 - 14 Jan 2008 | The numerical simulation of hydrostatic free surface flows<br><br>The numerical simulation of hydrodynamic free surface flows |
| Seree Supratid<br>Rangsit University, Thailand<br>supratid(AT)yahoo.co.th | 6 - 11 Jan 2008 | Web based Online Tsunami warning for Thailand Andaman coastline |
| Albrecht Weerts<br>WL \| Delft Hydraulics, The Netherlands<br>albrecht.Weerts(AT)wldelft.nl | 21 Jan 2008 | Applying data assimilation methods in Delft-FEWS to improve real time forecasting |
| Yu-Wen Zhou<br>Bejing University of Technology, China<br>zhouyw68(AT)bjut.edu.cn | 19 - 25 Jan 2008 | An event driven model framework for water distribution systems based on transient flow analysis (PPT)<br><br>Development of integrated models for urban drainage systems (PPT) |
| Jim Zidek<br>University of British Columbia, Canada<br>jim(AT)stat.ubc.ca | 3 - 25 Jan 2008 | Reconciling physical & statistical approaches to modelling (PDF)<br><br>Modeling annual precipation outputs from a deterministic model: the problem of extremes (PDF) |
| **LOCAL LECTURERS** | | |
| Vladan Babovic<br>National University of Singapore<br>vladan(AT)nus.edu.sg | 6 - 28 Jan 2008 | Data driven techniques<br><br>Introduction to Singapore-Delft water alliance |

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|---|---|---|
| Hua-Shu Dou<br>National University of Singapore<br>tsldh(AT)nus.edu.sg | 21 - 25 Jan 2008 | Routes of transition to turbulence |
| Shie-Yui Liong<br>National University of Singapore<br>tmslsy(AT)nus.edu.sg | 6 - 28 Jan 2008 | Integrated water resources management |
| David Nott<br>National University of Singapore<br>standj(AT)nus.edu.sg | 6 - 28 Jan 2008 | Mixtures of experts approaches in rainfall runoff modelling (PDF) |
| Pavel Tkalich<br>National University of Singapore<br>tmspt(AT)nus.edu.sg | 6 - 28 Jan 2008 | Introduction to tropical marine science institute<br>Tsunami Modelling in Indian Ocean and South China Sea |
| **OVERSEAS GRADUATE STUDENTS/PROFESSIONALS** | | |
| Tobias BUSSE<br>Berlin University of Technology, Germany<br>tobias.busse(AT)tu-berlin.de | 4 - 25 Jan 2008 | |
| Yupa CHIDTHONG<br>Rangsit University, Thailand<br>chidthong_y(AT)yahoo.co.th | 6 - 27 Jan 2008 | |
| Salimun ESTER<br>National University of Malaysia, Malaysia<br>ester.coal(AT)gmail.com | 6 - 25 Jan 2008 | |
| Jin Gui JOO<br>Korea University<br>civilguy97(AT)hanmail.net | 6 - 25 Jan 2008 | |
| Ming Kew LEE<br>Universiti Sains Malaysia, Malaysia<br>leeming_kew(AT)hotmail.com | 6 - 28 Jan 2008 | |
| Keewook KIM<br>Korea University<br>kkw5287(AT)korea.ac.kr | 6 - 25 Jan 2008 | |
| Fajar Adi KUSUMO<br>Bandung Institute of Technology, Indonesia<br>f_adikusumo(AT)yahoo.com | 6 - 25 Jan 2008 | |
| Wei Tian LOH<br>National University of Malaysia, Malaysia<br>piresloh7(AT)gmail.com | 6 - 25 Jan 2008 | |
| Halimatun Binti Muhamad | 6 - 25 Jan 2008 | |

| | | |
|---|---|---|
| National University of Malaysia, Malaysia<br>halimatunmuhamad(AT)gmail.com | | |
| Nur Akmarina Binti Abd Rahman<br>National University of Malaysia, Malaysia<br>iena83(AT)yahoo.com | 6 - 25 Jan 2008 | |
| Azua Hanim Binti Mohd Said<br>National University of Malaysia, Malaysia<br>ahms82(AT)yahoo.com | 6 - 25 Jan 2008 | |
| Khai Shen SOW<br>National University of Malaysia, Malaysia<br>shannie_ks(AT)yahoo.com | 6 - 25 Jan 2008 | |
| Mongkonkorn SRIVICHAI<br>Rangsit University, Thailang<br>mongkonkorn_s(AT)yahoo.com | 6 - 28 Jan 2008 | |
| Lei WANG<br>Beijing University of Technology, China<br>leiwater(AT)emails.bjut.edu.cn | 19 - 25 Jan 2008 | |
| Ming Ming WANG<br>Beijing University of Technology, China<br>wangmm(AT)live.com | 19 - 25 Jan 2008 | |
| Yishu WANG<br>University of Science and Technology Beijing, China<br>tcwys_ren(AT)163.com | 19 - 25 Jan 2008 | |
| Shanbin XIE<br>Beijing University of Technology, China<br>xsb(AT)emails.bjut.edu.cn | 19 - 25 Jan 2008 | |
| Doguen YOO<br>Korea University<br>godqhr425(AT)korea.ac.kr | 6 - 25 Jan 2008 | |
| Qing ZHOU<br>Tsinghua University, China<br>qingzhou.tsinghua(AT)gmail.com | 19 - 25 Jan 2008 | |
| Huy Hoang BACH<br>Hydraulic Engineering Consultant Company of Vietnam<br>BhhoangWRU(AT)gmail.com | 6 - 28 Jan 2008 | |
| Dr. Chun Woo BEAK | 6 - 25 Jan 2008 | |

| | | |
|---|---|---|
| Korea University<br>chunoo(AT)korea.ac.kr | | |
| Thanh Hai Nguyen<br>nguyenthanhhaiwru(AT)gmail.com | 6 - 28 Jan 2008 | |
| **LOCAL GRADUATE STUDENTS/PROFESSIONALS** | | |
| Dr. DOAN Chi Dung<br>Tropical Marine Science Institute<br>tmsdcd@nus.edu.sg | 6 - 25 Jan 2008 | |
| NGUYEN Hoang Huy<br>Tropical Marine Science Institute<br>tmsnhh@nus.edu.sg | 6 - 25 Jan 2008 | |
| HE Shan<br>Tropical Marine Science Institute<br>tmshs@nus.edu.sg | 6 - 25 Jan 2008 | |
| VU Minh Tue<br>Tropical Marince Science Institute<br>tmsvmt@nus.edu.sg | 6 - 25 Jan 2008 | |
| Sundarambal PALANI<br>Tropical Marine Science Institute<br>tmssp@nus.edu.sg | 6 - 25 Jan 2008 | |
| Michele ROMANO<br>Tropical Marine Science Institute<br>tmstv8@nus.edu.sg | 6 - 25 Jan 2008 | |
| Rajeevan PROKATATH<br>Tropical Marine Science Institute<br>tmsrp@nus.edu.sg | 6 - 25 Jan 2008 | |
| Dr. LEE Myung Eun<br>Tropical Marine Science Institute<br>tmslme@nus.edu.sg | 6 - 25 Jan 2008 | |
| DAO My Ha<br>Tropical Marince Science Institute<br>tmsdmy@nus.edu.sg | 6 - 25 Jan 2008 | |
| Md. Jabed BHUIYAN<br>Tropical Marince Science Institute<br>tmsmjanb@nus.edu.sg | 6 - 25 Jan 2008 | |

| | | |
|---|---|---|
| | | |
| Shobha YADAV<br>Tropical Marine Science Institute<br>tmssky@nus.edu.sg | 6 - 25 Jan 2008 | |
| Pavlo ZEMSKYY<br>Tropical Marine Science Institute<br>tmspz@nus.edu.sg | 6 - 25 Jan 2008 | |
| SUN Yabin<br>Civil Engineering Department | 6 - 25 Jan 2008 | |
| CHEN Haoliang<br>Civil Engineering Department<br>G0403261@nus.edu.sg | 6 - 25 Jan 2008 | |
| Dr. Mark FIELDING<br>Statistics and Applied Probability<br>stafmj@nus.edu.sg | 6 - 25 Jan 2008 | |
| Assoc Prof. Mathias ROTH<br>Geography Department | | |
| LIM Tian Kuay<br>National Environment Agency<br>boxky@pacific.net.sg | | |
| | | |