GRACE Science School

Hydrodynamic modelling with Delft3D

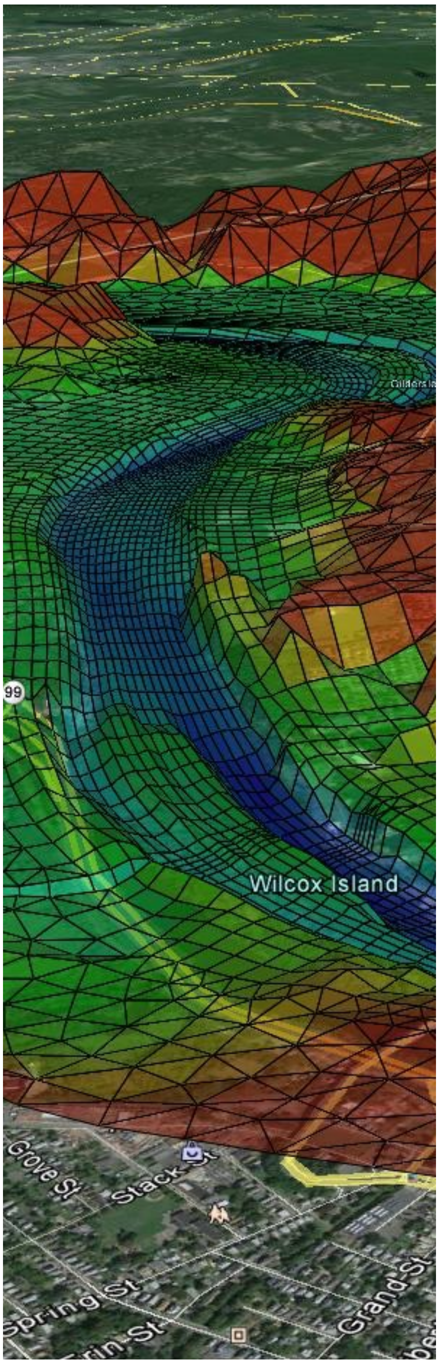
Date: weekly appointments from 03/11/2020 to 15/12/2020

Place: online course

Lecture times: Tuesdays and Fridays from 13:30 – 16:30 (German time)

Lecturer: Prof. Tobias Bleninger (UFPR, Curitiba)

Credits: 3



This course is offered as joint international course, hosted by GRACE in cooperation with PPGERHA (Graduate Program on Water Resources and Environmental Engineering), PPGEA (Graduate Program of Environmental Engineering) from the Federal University of Paraná (UFPR), Curitiba, Brazil, and Environmental Physics course, from the University Koblenz-Landau (Germany).

Context and Background

Hydrodynamic modelling is an essential method to study scenarios for hydro-environmental problems, such as pollutant or cooling water discharges, sediment transport, lake eutrophication, river training, etc. Delft3D is a world leading 3D modelling suite to investigate hydrodynamics, sediment transport and morphology and water quality for fluvial, estuarine and coastal environments. Since 2011, the Delft3D flow (FLOW), morphology (MOR) and waves (WAVE) modules are available in open source. The hydrodynamic module Delft3D-FLOW is a multidimensional hydrodynamic simulation program that calculates non-steady flow and transport phenomena resulting from tidal and meteorological forcing. The primary purpose of the computational model Delft3D-FLOW is to solve various one-, two- and three-dimensional, time-dependent, non-linear partial differential equations related to hydrostatic free-surface flow problems on a structured orthogonal grid. The equations are formulated in orthogonal curvilinear coordinates on a plane or in spherical coordinates on the globe. The hydrodynamic module is based on the shallow water equations. The equations are solved with a robust and highly accurate solution procedure.

Some supported features are

- Propagation of long waves (barotropic flow)
- Density gradients due to a non-uniform temperature and salinity concentration distribution (density driven flows)
- Transport of dissolved material and pollutants
- Transport of sediments, including erosion, sedimentation and bed load transport
- Many options for boundary conditions, such as water level, velocity and discharge boundaries
- Simulation of drying and flooding of inter-tidal flats
- Turbulence modelling to account for the vertical turbulent viscosity and diffusivity
- Online visualisation of model parameters enabling the production of animations.s

Topics

Review of governing equations of fluid mechanics for environmental systems. Revision of numerical methods and stability, as well as data handling. Introduction into grid generation. Introduction on bathymetry interpolation. Modelling hydrodynamics and density effects. Post-processing. Introduc-

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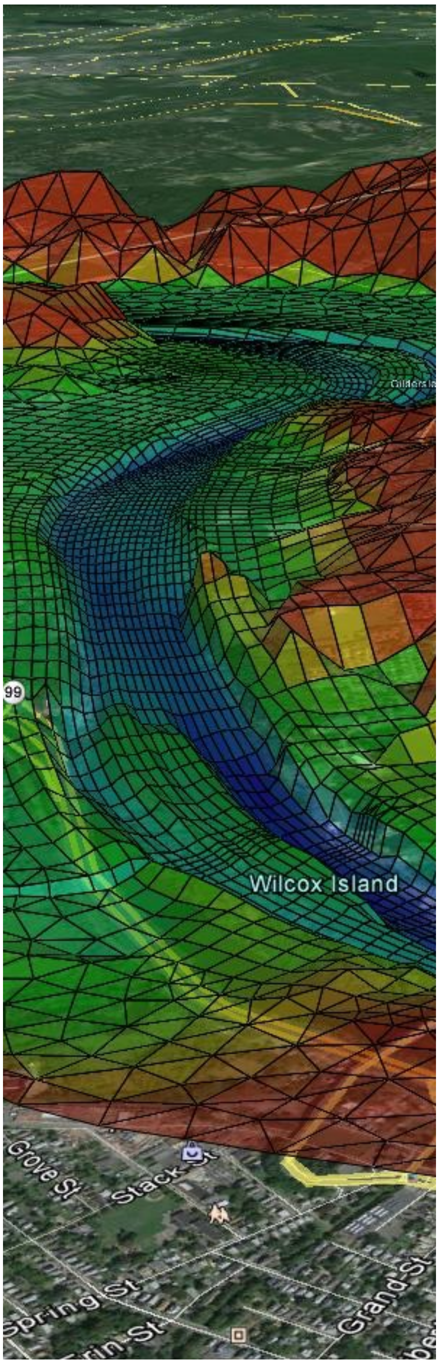

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tion to pre-processing tools for universal model setups for coastal waters. Revision of governing processes of sediment transport and water quality modelling. Applications for coastal waters, rivers and lakes.

Objectives

Create the ability to plan, setup and execute 2D and 3D hydrodynamic simulations with Delft3D, and using post-processing features.

Course format

Due to the COVID-19 crisis, and due to the international format of the course, all activities will be offered remotely, without any physical meeting. Technical requirements are thus listed as follows:

- Internet connection
- Up to date PC or notebook with Windows Operational System (the course only provides compiled software executables for Windows)
- Webcam and headphone for videoconferencing

The course will be offered within the platform Microsoft Teams, where files will be provided and shared and chats, conferencing and scheduling will be handled. For details on the schedule and further preparation for this course, please follow the link to the course website.

Recommended pre-requisites

Participants should have a background on fluid mechanics, hydraulics and mathematics.

Certificate

The course certificate requires a group work (mixed international group) for a specific flow simulation project (data provided by course or own data can be used too). The work should be summarised in an online document and presentation (e.g. using Sway or any other platform for online reporting and presentation), including the following items:

- site description
- available data and boundary conditions
- model description and setup
- model simulations for at least 4 scenarios (high and low resolution grid with 2 different boundary conditions or forcings)
- post-processing (figures, graphs, animations, comparison of scenarios)
- being summarised in a project report, and presented during the last lecture.

Grading as follows:

70%: Online report/presentation (one grade per group)

10%: Presentation (individual grade)

20%: Oral examination (replying questions after presentations, individual grade)

Participation: students should participate at least 75% of the lectures and participate the reporting, the presentation and discussion to receive a course certificate

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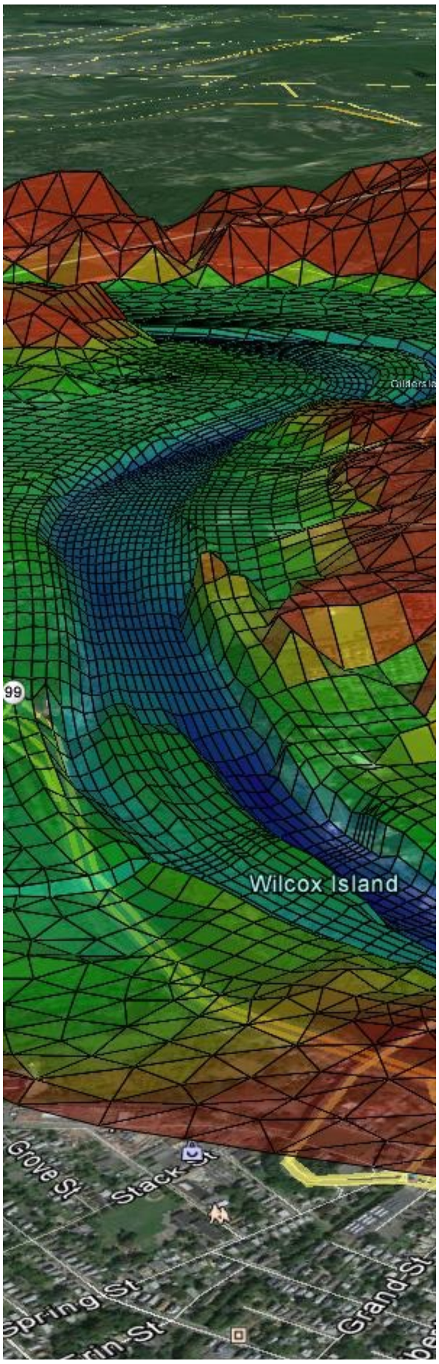

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About the lecturer

Tobias Bleninger, is Professor (2011) for Environmental Fluid Mechanics, and Applied Mathematics at the Department of Environmental Engineering of the Federal University of Paraná (UFPR) in Curitiba, Brazil. He is a Civil Engineer (2000) from the Karlsruhe Institute of Technology (KIT), Germany, where he did his Doctor in Environmental Fluid Mechanics (2006) and lead the research group of Environmental Fluid Mechanics of the Institute for Hydromechanics (2007-2011). Tobias Bleninger has experience in Hydraulics and Fluid Mechanics, with focus on physical and numerical modelling of Mixing and Transport Processes of Environmental Fluid Systems. A special topic are mixing studies for submarine outfalls using and coupling the models CORMIX and Delft3D, as well considering transport phenomena in hydropower reservoirs, and waterway fluvial hydraulics, and coastal sediment transport projects.
Contact and further information: Tobias Bleninger at UFPR

References

More information on Delft3D: http://oss.deltares.nl/web/delft3d/home
For more references and additional information check the course website.

Registration

1. Please register for this course via the online form.
2. Please register also for the free Open-Source Licence at: https://oss.deltares.nl/web/delft3d/source-code before the course (further instructions on installation will be provided throughout the course).