User Trainings for Hydro-Morphological Simulation Software 2016

Organized by UHM River Engineering, Karlsruhe

Advance in Open Channel Flow Modelling in 2016!

Dear Telemac users, customers, colleagues and friends,

The great response to the *Entry Level Courses* encouraged me to go in the 4th year of user trainings! "Thank you" to all participants who gave a lot of feedback and fruitful discussions. New program versions bring new functions, and new users ask new questions. So I decided to update the Telemac Life Cluster and to update the training examples. As the years before, there will be one public training in German, *Course I* and English, *Course IV*, which can also be held as in-house training for those who miss the date or like an even more private and project based consulting.

Additionally, I could convince some of the best experts you can find to talk about especially interesting topics in depth. Two *Advanced User Trainings* will be held in 2016, as unique events. The preliminary programs are attached. We will update the final time lines on our website the next weeks.

Course II shall give us confidence to answer the omnipresent questions of a modellers working life: Which options shall I take? Am I within the definition range?

Course III shall open the gate to the new range of applications that are now possible with the Adjoints (Sensitivities) generated with TELEMAC-AD. This course shall show early adaptors the mathematics and software techniques behind TELEMAC-AD and provide them exclusively with the first public beta version of TELEMAC-AD.

Don't hesitate to contact us to receive the final program updates and for further information.
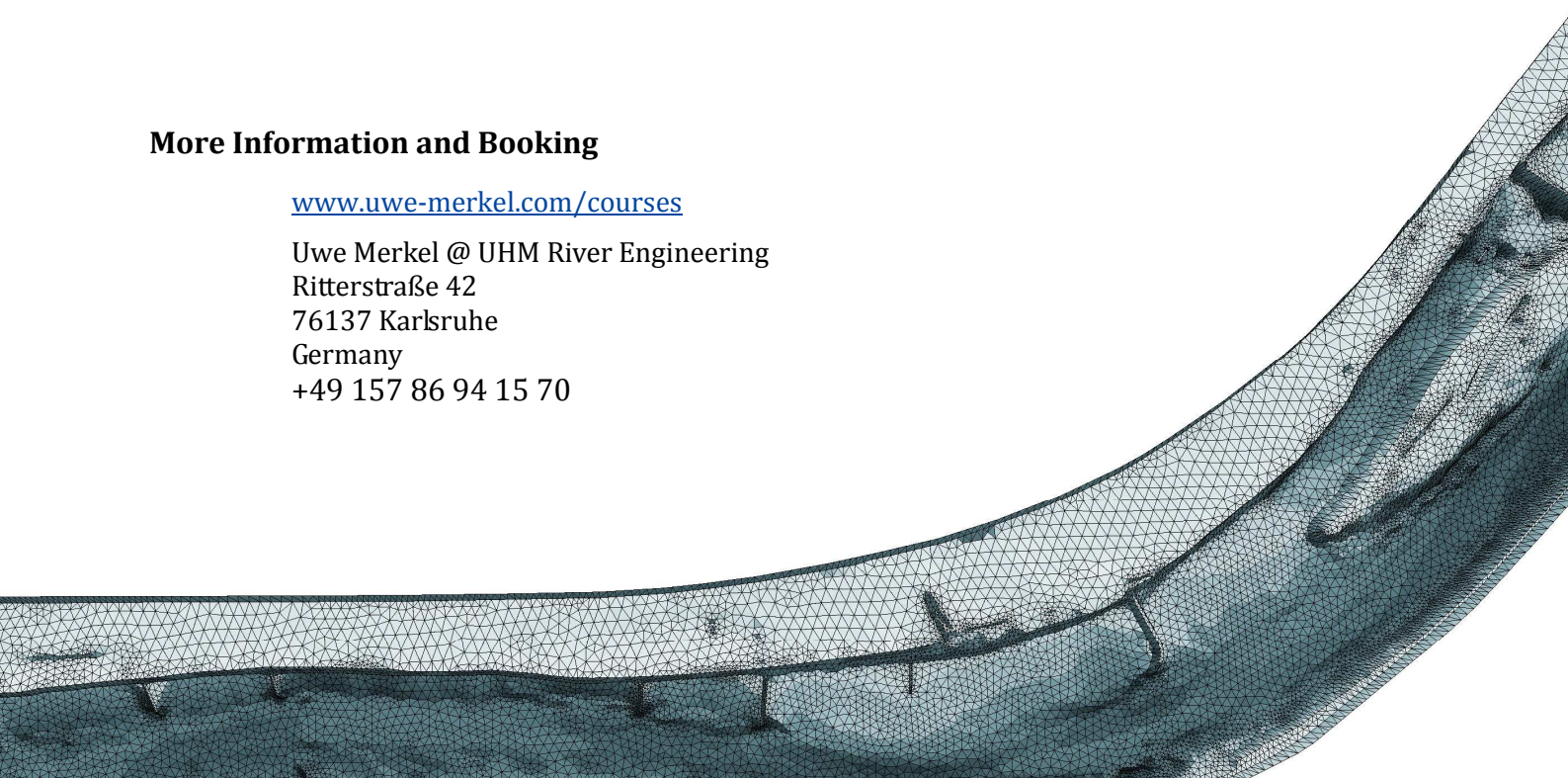
All the best,

Uwe Merkel

More Information and Booking

www.uwe-merkel.com/courses

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Course IV, V: Free Surface Flow Modelling with Open Source Software

Tutor: Uwe Merkel

(4 day intensive user training, entry level, English)

Motivation: The numerical modelling of free surface flows undergoes major changes. Almost every university or major company developed their own source code until only few years ago. But since few years, more and more companies join forces and change their software licenses to open source.

available in German on demand

One motivation is the fact that it was always necessary to provide source code instead of binaries. Unlike to widespread office software, numerical analysis software almost always deals with non standard cases. Therefore, a universal software package can neither be developed nor could a high number of features be paid by only one developing organisation. As most users extend the code to their own needs anyway, through the Open Source Model everybody can benefit from each others developments. This results in a dramatic increase of features.

A second very important motivation to use Open Source is the need for transparency and acceptance to convince both, clients and critics. Every other engineer can check the correctness of the included formulas.

However, due to the mass of features, it is hard to keep track, and even harder to find the right access point if you start from the scratch with Linux setups, pre- & post processing tools, software versions, mathematical methods or the search for suitable hardware. The theories of hydraulic modelling are taught at universities, but an engineer's work provides many additional hurdles that have to be taken economically.

Therefore the main goal of our courses is to show you the easiest possible access to a full tool chain of market leading applications like TELEMAC Suite - PARAVIEW - QGIS - Blue Kenue – MPICH – TorquePBS - GNUFortran and CODE::BLOCKS. Avoid beginner's mistakes, week long trial & error and don't waste too much time configuring Linux. After the course, you will handle all core disciplines and know the ways to head on auto-didactically.

We learn in 3 steps: Explanation -> Demonstration -> Application, on your own PC!

Day 1: First Steps in the Telemac Universe

Not all beginnings are difficult if you know where to look for. We analyse the program structures and interfaces. Your first own models will be started from scratch, calculated and analysed in detail by the end of this day.

o   Features, Possibilities & Limits

- Flow in 2D and 3D
- Sediments, wind & waves

o   Structure of the Telemac Suite

- Don't fear the command line!
- Files & modules
- Common mistakes

o   Demonstration: basic examples

- Analyse datasets with Paraview and an editor
- Start and monitor calculations
- Change your configuration

- o Exercise A-I: Hands on the software!

    - Get used to console and scripts
    - Change values and configuration
    - Make mistakes and learn to understand them!

Lunch break

- o Configurations

    - Overview on 600+ options! Do I have to understand them all?
    - Which turbulence model, advection scheme, et cetera is the right one? (1 min)
    - Troubleshooting

- o Demonstration: Pre & post processing

    - PARAVIEW, BlueKenue, QGIS, BaseMesh, OpenOffice etc.
    - Understand the LOG-files

- o Exercise A-II: Build your own model

    - Meshing
    - Configure and calculate
    - Check results with QGIS & Paraview & log-files

Day 2: Speed up with parallel computing

   To consolidate your new knowledge, we repeat Day 1 tasks, but in higher complexity. Now you will realize: computer power can't be replaced by anything then more computer power. For many practical applications a state of the art office computer with 4 cores or more is good enough. A life demonstration will show you how a simple 128 core Xeon server for less than 5000€ can speed up your calculations more than a 100 times. For even more performance you just rent as much as you need from a cloud service provider by hour and control it from your desktop.

- o How parallel processing works

    - Domain decomposition of a large project in many small projects
    - Distribution over several computers and connection via MPI
    - The right hardware for your purpose

- o Demonstration: Understand desktop, workstation und cluster layout

    - Live demo of the training servers with its 128 Xeon cores.

- o Exercise B-I: Parallel computing

    - Divide and combine projects: Partel & Gretel
    - Run jobs in different configurations and benchmark it
    - Try fast, efficient, decentralised setups

Lunch break

- o Resource efficiency: Queuing with TorquePBS

    - Queuing jobs
    - Priorities jobs overtake the queue
    - Distribute jobs to different computers

- o Demonstration: Calculating online in the rented cloud

- o Group Exercise B-II: Queues

    - We connect some of the trainee's computers to a cluster.
    - We find the fastest combination of our computers with standard office network equipment.
    - We use the cluster and the trainings server to run a Monte Carlo sensitivity study.

Day 3: Modify and extend your software

Special needs for special projects might need special modifications. Time dependent changes of the geometry, new empiric rules or unprecedented boundary conditions can be coded with only few lines. Don't fear to mess with the source code! Understand the architecture of the software and avoid the common errors with this introduction in the development. You don't have to be a programmer to change values. We start at a basic level. But for those who are familiar with FORTRAN we provide advanced exercises.

- o The development environment CODE::BLOCKS

    - The preconfigured environment for Telemac.
    - Little helpers of the IDE

- o Demonstration: Architecture of TELEMAC

    - Find the right variable
    - Working with the mesh (TIN)
    - Basic input & output

- o Exercise C-I: Modify initial and boundary conditions

    - Write your own outputs
    - Roughness and topography modifications
    - Integrate volumes

Lunch break

- o Demonstration: Integrate volumes in parallel computations
- o Compiling

    - Find errors (Debug)
    - Optimize and find bottlenecks (Profiling)

- o Tips, Tricks & Traps

    - Home made accuracy problems (Truncation error)
    - Calculating with mesh arithmetic

- o Exercise C-II: Your own routine

    - Write your own plug-in
    - Working with the mesh
    - Working with the time loop

Day 4: Your preferred topics (Optional)

For those who want to practise more under supervision we offer the optional Day 4. The topics are chosen according to participant's wishes. In the past sessions we focused on mesh generation, sensitivities, uncertainties & professional calibration, post processing with Python, SciPy and MatPlotLib and we designed action plans for real projects participants already have in mind.

Training Material

We provide a bootable 128GB SSD with a preinstalled and preconfigured Ubuntu 16.04 LTS. It includes an extensively tuned collection of programmes, with all manuals and examples . If you work during the training with this disk on your own laptop, we can be sure that all exercises work when you're back at home, without configuration marathons and messed up primary discs. Please understand that we do not sell software, as all included software is free anyway under LGPL and GNU license.

Dates & Cost

We limit the number of participants to 10 for this Entry Level Courses, to guarantee individual support and teaching in dialogue form. The 2016 user trainings will be in

April 2016, 25th -28th	*Fasanenschlösschen, Karlsruhe, Germany.*
November 2016, 28th – Dezember 1st	*Fasanenschlösschen, Karlsruhe, Germany.*

"Early birds" reduced fee for booking until 30 days before the training:	1590€
Regular Fee:	1890€

This includes the course itself, catering and the 128GB Training SSD. The additional VAT is applicable according to the laws in the country of presentation. This equals 19% for trainings in Germany.

Course II - Telemac & Sisyphe in Full Depth

Tutors: Jean-Michel Hervouet, Catherine Villaret

(4 days advanced users training, English only)
COMPLETED! New dates only on demand.

Motivation: Even experienced users always struggle at the same decisions: Do I use the right turbulence model, advection scheme, solvers, transport models, et cetera and how do I understand the options? What happens below the surface? You know from your own tests which option speeds up, increases accuracy or smoothes the surface. But confidence comes with understanding.

To get the best possible insider explanations, I invited Jean-Michel Hervouet and Catherine Villaret, both decade long core developers of Telemac and Sisyphe. They can help you with background information, mathematics and experience.

Program

Telemac below the surface - Usability tips for advanced users (Jean-Michel Hervouet)

- o Session 1
  - Saint-Venant equations and numerical techniques
  - Programming with Telemac subroutines
  - Inside Bief (structures, etc.)
- o Session 2
  - Telemac-3D
  - A few words on turbulence
  - Advection schemes
- o Session 3
  - Tidal flats
  - Parallelism
  - Linear solvers
- o Session 4

- Telemac: Open question & answer session

Sisyphe below the surface - Usability tips for advanced users
(Catherine Villaret)

- o Session 5
  - Basic theory of bed load transport
  - Secondary currents
  - Slope effects
  - Bed forms & banks
- o Session 6
  - Basic theory of suspended load
  - Advection/diffusion
  - Rouse profile
  - Convection velocity
  - Stratification effects,
  - Hindered settling
  - Sensitivity analysis
- o Session 7
  - Long term simulations
  - Coupling with hydrodynamics in 2D-3D
  - Multi-grain sand grading
  - Application examples
- o Session 8
  - Sisyphe: Open question & answer session

Prerequisites

Participants shall come with basic knowledge of TELEMAC.

Training Material

We provide a bootable 128GB SSD with a preinstalled and preconfigured Live Ubuntu/Mint Linux. It includes an extensively tuned collection of programmes, with all manuals and examples plus docs. If you work during the training with this disk on your own laptop, we can be sure that all exercises work when you're back at home, without configuration marathons and messed up primary discs. Please understand that we do not sell software, as all included software is free anyway under LGPL and GNU license. Except the trial version of TECPLOT which are under their own copyright.

Dates & Cost

COMPLETED!

This course was completed in February 2016. Currently there is no further course scheduled. But we might repeat it on demand.

Course III - Reverse Engineering of Interactions with Adjoints
A Hands-On Introduction to Telemac-AD
Tutors: Uwe Merkel, Uwe Naumann, Jan Riehme
(3 days advanced users training, English)

Motivation: Calibration of models, optimisation of geometries, mapping of spatial sensitivities or solving flow interactions mostly leads to complex iterative engineering.

These tasks have in common, that thousands or more parameters influence the hydraulic model results. They normally end up with immense computational efforts and a compromise between accuracy and economic aspects.

The new technique to generate "Adjoints" (sensitivities) with backward interpretation of Telemac results is the best option available so far to exponentiate working speed while reaching a until now unknown spatial accuracy for sensitivities.

The modified Telemac version TELEMAC-AD can quantify dependencies of your desired result to any model point in your Telemac mesh, in one single calculation! TELEMAC-AD is currently only available to research funders and participants of this course.

For further information, test cases and some publications, visit our TELEMAC-AD dedicated website: www.uwe-merkel.com/telemac-ad

About the course: We start the course with teaching you to rethink flow problems backward in time. Then you'll learn mathematics and software engineering behind the technique of backward interpretation with an algorithmically differentiated Telemac. The course is set up for designing and researching engineers with basic hydraulic modelling and TELEMAC knowledge.

When you arrive back home, you will

- o   have a basic understanding of AD and its usability for optimization methods
- o   be able to calculate common hydraulic sensitivity analyses on your PC with your own TELEMAC-AD version.
- o   be able to apply AD software to your own Fortran Code

We learn in 5 steps:

Simple Examples -> Interpretation -> Intermediate Examples -> Mathematical background -> Tough Examples -> Applying the results to optimization strategies

Program

The schedule will be close to the following time line. Please contact us for further details.

Day 1: Understanding Spatial Sensitivities

Step by Step, with examples, we show you what sensitivities, tangents, gradients or adjoints are, we explain what means "backward interpretation" and how you can use this to resolve spatial flow interactions.

- o   Simple Examples for Tangent Linear Problems
  - • Finite Differences of simple equations written in Fortran
  - • Finite Differences with a simple Telemac example
  - • Comparing Sensitivities
  - • Using Sensitivities for Calibration

Coffee

- Exercise A-I: Hands on Fortran!

  - Change values and configurations
  - Make mistakes and learn to understand them!

Lunch break

- Algorithmic Differentiation Examples for Tangent Linear Problems

  - Algorithmic Differentiation of simple equations written in Fortran
  - Algorithmic Differentiation of a simple Telemac example
  - Investigation of accuracy and scalability
  - Tangent AD for parameter calibration

Coffee

- Exercise A-II: Calculate and compare spatial sensitivities with a precompiled Telemac-TLM

Day 2: Software Engineering & Mathematics

Background knowledge torn down to human understandable facts. What is the algorithmically differentiating NAG Fortran Compiler? How does it work under the surface? What is the mathematics behind it. What is check pointing and tape recording?

- Mathematics behind Automatic Differentiation and Adjoints

  - Accurate Backward Sensitivity Analysis and Examples
  - Adjoint AD on simple problem
  - Adjoint AD on simple Telemac example
  - Investigation of accuracy and scalability
  - Adjoint AD for parameter calibration

Coffee

- Exercise B-I: Hands-on Adjoint AD

Lunch break

- Software Engineering: AD-enabled NAG Fortran Compiler Support

  - Compiler under the surface
  - Specific programming basics
  - Examples

Coffee

- Exercise B-II:

  - Advanced example: Differentiating an iterative diffusion solver

- Outlook: Large-Scale Adjoint Parameter Sensitivity Analysis

Day 3: Using TELEMAC-AD Inputs & Outputs for Open Channel Flow Problems

What you can do with adjoints, and how to set up models efficiently.

- Explain the sensitivity problem to your computer

  - What is a Cost Function ?
  - Cost Functions for Open Channel Flow related problems

Coffee

- Exercise C-I:

  - Formulate your own Cost functions

Lunch break

- o Basic Flow Optimization Strategies based on Adjoints

    - The Methods of Least Squares and Steepest Descent
    - Optimization with Scientific Python (SciPy)

Coffee

- o Exercise C-II: Calibrate a model!

    - Manual application of "Steepest Descent" with a spreadsheet program
    - Try SciPy

Prerequisites

Participants shall come with basic knowledge of TELEMAC and basic programming skills. If in doubt, please contact us.

Training Material

We provide a bootable 128GB SSD with a preinstalled and preconfigured Live Ubuntu/Mint Linux. It includes an extensively tuned collection of programmes, with all manuals and examples plus docs. If you work during the training with this disk on your own laptop, we can be sure that all exercises work when you're back at home, without configuration marathons and messed up primary discs. All included software is free anyway under LGPL and GNU license. Except the test version of the NAG FORTRAN compiler and **your personal beta version of TELEMAC-AD**, this is exclusively available for our course participants.

Dates & Cost

The next English user training will be in May 2016, 2 nd to 4th, at the *Fasanenschlösschen ("Pheasant Palace")* in the heart *Karlsruhe, Germany*.

"Early birds" reduced fee for bookings until 14th of April 2016:	1590€
Regular Fee:	1890€

The price includes the course itself, catering and the most valuable thing: a working beta version of Telemac-AD, running on your personal plug and play 128GB Training SSD, which some might already know from the entry level courses. The additional VAT is applicable according to the laws in the country of your residency. This equals 19% for Germany companies.

Tutors for 2016

Dr. Jean-Michel Hervouet

Father of the Telemac Project
and expert on the core numerics
since 3 decades.

Dr. Catherine Villaret

Worked more than 20 years at EDF-LNHE and HR
Wallingford. She was responsible for the
development of 2D and 3D sediment transport
models in the TELEMAC-MASCARET system.

Dr. Uwe H. Merkel (UHM, Karlsruhe)

Researches and develops tailor made solutions for river flow
problems since more than 15 years, including modules for
Sisyphe, QGIS and Telemac-AD. Specialised on model
uncertainties. Organizes the courses.

Prof. Dr. Uwe Naumann (STCE)

Head of the STCE (Software and Tools for
Computational Engineering) institute at the RWTH
Aachen University. Expert on adjoint modelling and
optimization strategies.

Jan Riehme (STCE)

Developer of the algorithmic differentiating NAG Fortran
compiler and core developer of TELEMAC-AD. Expert on
Fortran, software design and optimisation strategies.

N.N. (Genius Graphics)

The German Tecplot experts will show us how to
handle large parameter studies for Course I.