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Kopmann, Rebekka; Schäfer, Monika

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Rebekka Kopmann[1]

Monika Schäfer[1]

[1] Bundesanstalt für Wasserbau
Federal Waterways Engineering and Research Institute
Kußmaulstr. 17
76187 Karlsruhe, Allemagne
Rebekka.kopmann@baw.de

Abstract:

Multi-dimensional numerical modelling of hydrodynamic and morphodynamic processes is widely used in river engineering. Nevertheless the modellers need to have base knowledge of the physical phenomena and good expertise in numerical modelling. Due to inconsistent, uncertain or even missing input data and insufficient numerical reproduction of the significant physical processes data assimilation and calibration must enhance the modelling. For multi-dimensional modelling with a lot of input parameters this part of the modelling needs much experience and time.

Automatic calibration promises better and faster results especially for less experienced users. Gradients of all uncertain parameters due to the command variables form the basis. These gradients can be calculated very efficiently and accurate with the so called adjoint mode of a simulation program. With help of algorithmic differentiation (AD) an adjoint version of TELEMAC were developed by STCE, RWTH Aachen in the last years. The gradients were used by some reasonable optimization algorithms (line search algorithms) for automatic calibration of various input parameters.

Six different optimization algorithms were tried for some flume applications and a river application. One to 72 different input parameters could be calibrated automatically and synchronously. The needed time or the number of iterations for the optimization process is dependent to the optimization algorithm, the target function, the initial values and the significance of the input parameter. In all applications three of the optimization algorithms (SLSQP, TNC and BFGS) achieve good and fast results. All of them can be used with given limits, which helps in case of TNC, but not necessarily for the others, especially if (as usual) the initial value is not so far from the final value. Furthermore, defining the target function is of great importance, as there a weighting between the different input parameters as well as between different measurements are done. Not well balanced target functions could lead to non-solvable optimization duties. Problems occur, if the measurements for comparison contain great inconsistences, so no solution can be found, or if the input parameter is (at some areas) not sensitive and the command variables cannot be reached.