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OpenGeoSys-Tutorial

Computational Hydrology I: Groundwater Flow Modeling

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Foreword

This tutorial on the application of the open-source software *OpenGeoSys* (OGS) in computational hydrology is based on a one-week HIGRADE-course at the Helmholtz Centre for Environmental Research in Leipzig, Germany. The book contains general information regarding hydrological and groundwater flow modelling and the pre-processing and step-by-step model set-up of a case study with *OGS* and related components such as the *OGS Data Explorer*. In addition, it also illustrates the application of pre- and post-processing tools such as *ArcGIS* or *ParaView* for the preparation of input data as well as the optimal presentation of simulation results.

This *OGS* tutorial is the result of close cooperation of the Helmholtz Centre for Environmental Research (UFZ) with partner universities (Technische Universität Dresden, Christian-Albrechts University Kiel, University of Potsdam, University of Tübingen) in the field of hydrological modelling. The UFZ Departments of Environmental Informatics (ENVINF), Catchment Hydrology (CATHYD) and Computational Hydrosystems (CHS) have been involved in the preparation of this *OpenGeoSys* Tutorial. These voluntary contributions are highly acknowledged.

This book is intended primarily for graduate students and applied scientists who deal with hydrological system analysis and hydrological modelling. It is also a valuable source of information for professional hydrologists wishing to advance their knowledge in numerical modelling of coupled hydrological-hydrogeological systems. As such, this book will be a valuable aid in training of hydrosystem modelling.

There are various commercial software tools available to solve complex scientific questions in hydrology and hydrogeology. This book will introduce the user to a non-commercial numerical software code for hydrological and hydrogeological modelling which can even be adapted and extended based on the needs of the researcher.

This tutorial is the first in a series that will present further applications of *OGS* in environmental sciences. The planned tutorial series include:

- Computational Hydrology I: Groundwater flow modelling, Sachse et al. (2015),
- Computational Hydrology II: Density-dependent flow and transport processes (2015*),
- Reactive Transport Modelling II (2015*),
- Geothermal Energy I: Shallow geothermal systems (2015*),
- Geothermal Energy II: Enhanced geothermal systems (2015*),
- OGS Data Explorer (2015*),
- Computational Geotechnics (2016*),
- Multiphase Flow (2016*).

(*publication time is approximated)

Book Overview

Each chapter guides the user through the process of establishing a hydrological and/or groundwater flow model using the software code *OpenGeoSys*. After a short introduction to the scope of the book, Chaps. 1 and 2 give a general overview of hydrology and hydrogeology with important keywords in the sciences that are highlighted. Chapter 3 focusses on hydrological and groundwater flow modelling using the *OGS* framework and gives an overview of the graphical user interface, the *OpenGeoSys Data Explorer*. The benchmark for groundwater flow to a well in a confined aquifer explained in Chap. 4 is one of the important benchmarks for hydrological and hydrogeological modelling systems and is an introductory application of *OGS*. Chapter 5 is concerned with the set-up of a hydrological and hydrogeological model for a catchment study (in this case, the Ammer catchment in Germany). This chapter describes in detail the workflow of modelling hydrological and groundwater flow, starting from GIS data, preparing input files with the *OpenGeoSys Data Explorer*, using the actual groundwater simulator and related post-processing.

The appendix includes information on several special topics in greater detail. Appendix A.1 gives a short overview of the key functionalities of the Geographical Information System *ArcGIS*. A summary of all software which can be coupled with *OGS* is presented in Appendix B, namely the hydrological model *JAMS*, the hydrodynamic model *SWMM* and the multi-scale hydrological model *mHM*. The last part of the appendix includes a short installation guide to *OGS* and some links to further literature and websites.

Leipzig, August 2014 Agnes Sachse and co-authors

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