Ekkehard Holzbecher

Environmental Modeling

Using MATLAB

Second Edition

Springer

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Dedicated to
my children Gesa and Gero

Foreword

The book has two aims:

(a) To introduce basic concepts of environmental modeling and
(b) To exercise the application of current mathematical software packages

To the target group belong all natural scientists who are dealing with the environment: engineers from process and chemical engineering, physicists, chemists, biologists, biochemists, hydrogeologists, geochemists, ecologists . . .!

As the book is concerned with modeling, it inevitably demands some mathematical insight. The book is designed to

1. Be a door opener to the field for novices without any background knowledge of environmental modeling and of MATLAB®, and
2. To surprise those, who have some expertise, with advanced methods which they have not been aware of

For this book MATLAB® was chosen as the computer tool for modeling, because

1. It is powerful, and
2. It is available at most academic institutions, at all universities and at the research departments of companies

Other mathematical products could have been selected from the market, which would perform similarly well for most application problems presented in the various chapters. But MATLAB® is rather unique in it's strong capabilities in numerical linear algebra.

There are 20 chapters in the book. The first chapters are concerned with environmental processes and their simulation: (1) transport, consisting of advection, diffusion and dispersion, (2) sorption, (3) decay or degradation, (4) reaction, either kinetic or thermodynamic. Following aim (b) there are sub-chapters inserted for the introduction of MATLAB® modeling techniques. The first part of the book ends with chapters on ordinary differential equations and parameter estimation (inverse modeling).

The second part of the book starts with chapters on flow modeling. Flow, if present, is an important, but mostly also complex part within an environmental compartment. Core MATLAB® allows simple flow set-ups only. Therefore the focus is on potential flow, which has applications in hydro (water) and aero (air)-dynamics as well as in porous media (seepage and groundwater). Concepts of MATLAB® are deepened within these chapters. At the very end special topics appear: image processing and geo-referencing, graphs, linear systems, the phase space and graphical user interfaces.

Berlin

Foreword to the Second Edition

The consistently commendatory and positive reactions that I obtained unanimously for the first edition of 'Environmental Modeling' encouraged me to work on a second improved and extended version of the book and the accompanying software, which is available herewith. The reader may allow me to cite some surely exaggerating voices from the Internet:

> Excellent work. It will be more helpful for the younger researchers also for the sr. scientists for understanding basics and applications of MATLAB in environmental engg. It is THE BEST book.
> I love this book, because you wrote it in a programming manner and I love programming, so I learnt advection and diffusion excellent. Because after I read the equation I modeled it in Matlab and saw the results. And it remains in my mind. I want to thank you because of writing this book. It helps a lot to the students and researchers to learn environmental modeling deeply.

Special thanks to my students at the Georg-August Universität, Göttingen, and at Freie Universität, Berlin, who gave me clues on how the mathematical viewpoint, taken in this book, is conceived by an audience that is usually not especially trained in topics as mathematical physics. Some of the improvements directly result from the work with the students.

A new chapter was added, in which an introduction into numerical methods is given – an important topic that was missing in the first edition, as I was told by some readers.

Special focus has been laid to extend the capability to use 'Environmental Modeling' as a reference book. The list of keywords in the MATLAB® command index, although not covering the complete list of commands, has been extended significantly. Personally I think that this is the major improvement in relation to the first edition. I hope that in that way the book will help readers and modelers to understand the commands quickly and to apply them correctly.

Final thanks to all people at the mentioned universities, the publishers at Springer Verlag, Heidelberg, and the people of the bookprogram of MathWorks.

Göttingen