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## Preface to the second edition

The second edition of this book provides a more consistent presentation of the square root algorithm in Chap 13. The presentation in the first edition is less mature and there has been a significant development and enhanced understanding of the square root algorithm following the publication of the first edition.

A new chapter “Spurious correlations, localization, and inflation” is included and discusses and quantifies the impact of spurious correlations in ensemble filters caused by the use of a limited ensemble size. The chapter suggests and discusses inflation and localization methods for reducing the impact of spurious correlations and among others presents a new adaptive inflation algorithm.

The improved sampling algorithm in Chap. 11 is improved and takes into account the fact that sampling using too few singular vectors can lead to physically unrealistic and too smooth realizations.

The experiments in Chapters 13 and 14 are all repeated with the updated square root algorithms. In Chap. 14 a new section on the validity of the analysis equation, when using an ensemble representation of the measurement error covariance matrix, is included.

Finally the material in the Appendix is reorganized and the list of references is updated with many of the more recent publications on the EnKF.

I am grateful for the interaction and many discussions with Pavel Sakov and Laurent Bertino during the preparation of the second edition of this book.

Bergen, June 2009

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## Preface

The aim of this book is to introduce the formulation and solution of the data assimilation problem. The focus is mainly on methods where the model is allowed to contain errors and where the error statistics evolve through time. So-called strong constraint methods and simple methods where the error statistics are constant in time are only briefly explained, and then as special cases of more general weak constraint formulations.

There is a special focus on the Ensemble Kalman Filter and similar methods. These are methods which have become very popular, both due to their simple implementation and interpretation and their properties with nonlinear models.

The book has been written during several years of work on the development of data assimilation methods and the teaching of data assimilation methods to graduate students. It would not have been completed without the continuous interaction with students and colleagues, and I particularly want to acknowledge the support from Laurent Bertino, Kari Brusdal, François Counillon, Mette Eknes, Vibeke Haugen, Knut Arild Lisæter, Lars Jørgen Natvik, and Jan Arild Skjervheim, with whom I have worked closely for several years. Laurent Bertino and François Counillon also provided much of the material for the chapter on the TOPAZ ocean data assimilation system. Contributions from Laurent Bertino, Theresa Lloyd, Gordon Wilmot, Martin Miles, Jennifer Trittschuh-Vallès, Brice Vallès and Hans Wackernagel, on proof-reading parts of the final version of the book are also much appreciated.

It is hoped that the book will provide a comprehensive presentation of the data assimilation problem and that it will serve as a reference and textbook for students and researchers working with development and application of data assimilation methods.





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Data Assimilation

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