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Mathematical and Algorithmic Aspects of Atmosphere-Ocean Data Assimilation

Organised by
Andreas Griewank, Berlin
Sebastian Reich, Potsdam
Ian Roulstone, Surrey
Andrew Stuart, Coventry

2 December – 8 December 2012

Abstract. The nomenclature "data assimilation" arises from applications in the geosciences where complex mathematical models are interfaced with observational data in order to improve model forecasts. Mathematically, data assimilation is closely related to filtering and smoothing on the one hand and inverse problems and statistical inference on the other. Key challenges of data assimilation arise from the high-dimensionality of the underlying models, combined with systematic spatio-temporal model errors, pure model uncertainty quantifications and relatively sparse observation networks. Advances in the field of data assimilation will require combination of a broad range of mathematical techniques from differential equations, statistics, probability, scientific computing and mathematical modelling, together with insights from practitioners in the field. The workshop brought together a collection of scientists representing this broad spectrum of research strands.

Mathematics Subject Classification (2000): 65C05, 62M20, 93E11, 62F15, 86A22, 49N45.

Introduction by the Organisers

The workshop *Mathematical and Algorithmic Aspects of Atmosphere-Ocean Data Assimilation*, organised by Andreas Griewank (Berlin), Sebastian Reich (Potsdam), Ian Roulstone (Surrey), and Andrew Stuart (Warwick) was held 2 December – 8 December 2012. The meeting was attended by over 45 participants representing a broad range of mathematical subject areas as well as practical aspects of atmosphere-ocean data assimilation.

A total of 23 talks were presented during the workshop. The talks were selected both to cover novel mathematical developments and to point towards practical advances and challenges in atmosphere-ocean data assimilation. Talks relating to mathematical developments include those on, e.g., Lagrangian data assimilation (Chris Jones, Amin Apte), particle filters (Chris Snyder, Dan Crisan, Wilhelm Stannat), ensemble Kalman filters (Georg Gottwald, Lars Nerger, Tijana Janjic-Pfander, Roland Potthast), statistical inference (Youssef Marzouk, Andreas Hense, Illia Horenko), variational techniques (Eldad Haber, Philippe Toint, Jim Purser, Arnd Rösch, Michael Hinze), model/representativity errors (Nancy Nichols, Alberto Carrassi) and mathematical fluid dynamics (Edriss Titi). Talks relating to practical advances and challenges in atmosphere-ocean data assimilation include those by Chris Jones, Roland Potthast, Andreas Hense, Chris Snyder, Hendrik Elbern, Georg Craig, Alberto Carassi, Patrick Heimbach). A poster session was held on Tuesday evening which gave the attending PhD students and postdocs the opportunity to present and discuss their work.

Throughout the workshop a large number of spontaneous discussion groups arose triggered by the many different facets of data assimilation presented during the talks. The following discussion groups in the central lecture hall of the MFO shall be mentioned in particular: (i) filter stability (inspired by the talks by Wilhelm Stannat and Roland Potthast), (ii) Bayesian inference and optimal transportation (inspired by the talk by Youseff Marzouk), and (iii) high-dimensional particle filters (inspired by the talks by Chris Snyder and Dan Crisan). These examples also reflect the actuality and broad scientific appeal of data assimilation.

Workshop: Mathematical and Algorithmic Aspects of Atmosphere-Ocean Data Assimilation

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