

ECMWF Seminar on Data assimilation for atmosphere and ocean

6 - 9 September 2011

Contents

Introduction	iii
<i>Andrew C. Lorenc</i> Developments of variational data assimilation	1
<i>Jeffrey S. Whitaker</i> Developments in ensemble data assimilation	17
<i>D.M. Barker and A.M. Clayton</i> Hybrid variational-ensemble data assimilation.....	31
<i>F. Rabier</i> Pre- and post- processing in data assimilation.....	45
<i>Saroja Polavarapu</i> Stratospheric and mesospheric data assimilation.....	51
<i>M. Rienecker, R. Gelaro, S. Pawson, R. Reichle, W. McCarty</i> The Global Observing System in the data assimilation context	71
<i>John C. Derber and Andrew D. Collard</i> Current status and future of satellite data assimilation	81
<i>Gérald Desroziers</i> Observation error specifications	95
<i>Jean-Francois Mahfouf</i> Data assimilation of the hydrological cycle.....	109
<i>Patricia de Rosnay, Gianpaolo Balsamo, Joaquín Muñoz Sabater, Clément Albergel, and Lars Isaksen</i> Land surface data assimilation.....	121
<i>Massimo Bonavita</i> Ensemble of data assimilations and uncertainty estimation.....	135
<i>Chris Snyder</i> Particle filters, the “optimal” proposal and high-dimensional systems	161
<i>Peter Jan van Leeuwen</i> Nonlinear large-scale data assimilation: the potential of particle filters.....	171

Contents

<i>Mike Fisher and Harri Auvinen</i>	
Long window 4D-Var	189
<i>Andrew M. Moore</i>	
Some challenges and advances in regional ocean data assimilation	203
<i>P. Poli</i>	
Data assimilation for atmospheric reanalysis	231
<i>K. Haines</i>	
Coupled atmospheric-ocean data assimilation	249
<i>Susan P Ballard, Bruce Macpherson, Zhihong Li, David Simonin, Jean-Francois Caron, Helen Buttery, Cristina Charlton-Perez, Nicolas Gaussiat, Lee Hawkness-Smith, Chiara Piccolo, Graeme Kelly, Robert Tubbs, Gareth Dow and Richard Renshaw</i>	
Convective Scale Data Assimilation and Nowcasting	265
<i>Lars Isaksen</i>	
Data Assimilation on future computer architectures	301
<i>Carla Cardinali and Sean Healy</i>	
GPS-RO at ECMWF	323
Annex I: List of Participants	AI-1
Annex II: Seminar programme	AII-1

Introduction

The 2011 ECMWF Seminar was on Data Assimilation for Atmosphere and Ocean. It has been eight years since the previous seminar on the same topic, although this field has seen major advances during that period.

Data assimilation is indeed at the core of ECMWF numerical weather prediction activities. Increasing the accuracy of the forecast relies on the provision of increasingly accurate initial states for the prediction system. Variational data assimilation has been successfully developed and used operationally at ECMWF, today the variational system is a pre-requisite for the assimilation of satellite data and effective use of conventional observations in the atmosphere. Ocean data assimilation is also an integral part of the monthly and seasonal forecast systems. An extension of variational techniques including longer assimilation windows and weak constraint methods to allow for inclusion of model error estimates are current research areas. Ensemble based assimilation systems are currently under development and combined with the variational technique to allow for a flow dependent estimation of background error variances and covariances. The Ensemble Kalman Filter method has been applied to operational NWP and Extended Kalman Filter methods have been developed for surface parameter assimilation. The development of ensemble based assimilation techniques implies that initial state perturbation methods and the representation of model error are essential elements of data assimilation systems thus providing close links with ensemble prediction methods.

The seminar gathered almost a hundred participants, and 21 lectures were given by world leading experts (including 7 ECMWF speakers) in this area. They gave a pedagogical review of the principles behind data assimilation techniques and provided detailed descriptions of the currently used assimilation techniques. A wide variety of more specific topics was covered and led to very active exchanges between the speakers and the audience. These topics included overviews of the observation data sources and their intrinsic properties, outlooks on future developments in data assimilation such as ensemble based methods and weak constraint variational method, and also challenges related to the design of efficient data assimilation schemes on future computer architectures.

ECMWF thanks all the lecturers for their stimulating talks and their written contributions to these proceedings.