

## **Oberwolfach Seminar:**

### **Data Assimilation: The Mathematics of Connecting Dynamical Systems to Data**

#### **Date:**

May 15-21, 2016

#### **Organizers:**

Jana de Wiljes (Potsdam)  
Sebastian Reich (Potsdam and Reading)  
Andrew Stuart (Warwick)

#### **Programme:**

The seamless integration of large data sets into computational models provides one of the central challenges for the mathematical sciences of the 21st century. When the computational model is based on dynamical systems and the data is time ordered, the process of combining data and models is called data assimilation.

The seminar will provide an introduction to the mathematical and algorithmic foundations of modern data assimilation methodologies. The first part of the seminar will cover the mathematical principles of deterministic and probabilistic approaches to state estimation in the context of filtering and smoothing. The classical variational and control theoretic viewpoints will be described and then their probabilistic counterparts developed, using an underpinning Bayesian formulation. The second part will be devoted to recent algorithmic advances on sequential Monte Carlo methods for state and parameter estimation, together with an overview of the analysis of importance sampling based methods, especially in the high dimensional or small noise regimes when the computational complexity is high. The final third part will introduce the concept of model error and describe methods for dealing with misspecified models and model comparison.

#### **Literature:**

The first two references will provide most of the course content. The remaining three provide useful background reading.

- [1] Kody Law, Andrew Stuart, Konstantinos Zygalakis, Data Assimilation - A Mathematical Introduction, Springer-Verlag, 2015.
- [2] Sebastian Reich and Colin Cotter, Probabilistic Forecasting and Bayesian Data Assimilation, Cambridge University Press, 2015.
- [3] J. Kaipio, E. Somersalo, Statistical and Computational Inverse Problems, Springer-Verlag, 2005.
- [4] A. Jazwinski, Stochastic Processes and Filtering Theory, Academic Press, 1970.
- [5] A.J. Majda J. Harlim, Filtering Complex Turbulent Systems, Cambridge University Press, 2012.

**Deadline for applications:**

March 13, 2016