

MAT330 Topics in Applied Mathematics (Data Assimilation)

University Course for BSc, MSc and PhD students
Department of Mathematics – University of Bergen

Course's synopsis (Emne):

Data Assimilation designates all the techniques that can incorporate measurements into a numerical model in order to improve its predictions. Data assimilation has been the key behind the skillful weather predictions services and is also used in operational oceanography, climate predictions and reservoir history matching among other applications.

The course will go through the theoretical background underpinning modern data assimilation techniques. The focus will be on probabilistic methods such as the Kalman Filter and its extensions for non-linear systems (The Ensemble Kalman Filter).

The necessary notions of spatial-temporal statistics and system dynamics will be introduced. The course will also complement the students with an introduction to dynamical systems concepts and tools and on the problem of designing efficient data assimilation for chaotic dynamics such as the weather and climate.

Teachers' team: **Geir Evensen** – GE (IRIS/NERSC)

Laurent Bertino – LB (NERSC)

Alberto Carrassi – AC (NERSC)

Patrick Raanes – PR (NERSC)

- **LB** – *From statistics to geostatistics. Geostatistics (variograms, Kriging and non-linear geostatistics) and example of operational data assimilation for oceanography. (12 hours)*
- **GE** – *Theory of variational and sequential Gaussian data assimilation, ensemble-based methods, from a Bayesian perspective. (12 hours).*
- **AC** – *Introduction to dynamical systems and data assimilation for chaotic dynamics. (12 hours).*
- **PR** – *Practical exercises on data assimilation using Python (8 hours).*

Suggested essential bibliography (Pensum):

- G. Evensen. Data assimilation: the ensemble Kalman filter. Springer Science & Business Media, 2009. Sections 2-to-7, 9, 12 and 13.
- H. Wackernagel. Linear Geostatistics. Lecture notes. Sections 1 to 12 and Section 15.
- M. Asch, M. Bocquet, and M. Nodet. Data assimilation: Methods, algorithms, and applications, Fundamental of Algorithms (SIAM, Philadelphia) 2016. Section 4, 5 and 7
- E. Ott. Chaos in dynamical system. Cambridge University press 2002. Section 1, 3 and 4.

