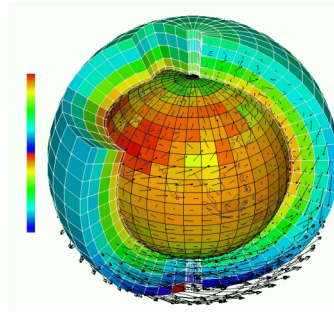
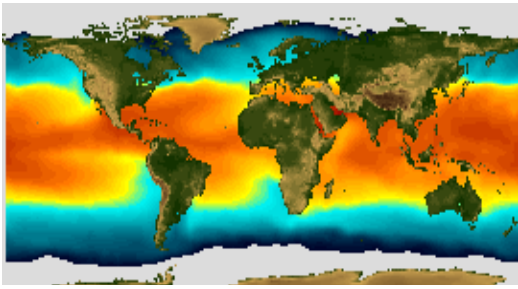




Course AD, NUM-2.2 – Introduction to data assimilation

3 ECTS

Instructor in charge: Marc Bocquet (marc.bocquet@enpc.fr)

Instructors: Sibö Cheng, Tobias Finn, Olivier Talagrand, Emmanuel Cosme, Loïc Berre

Objectives:

Data assimilation is the set of techniques meant to optimally estimate the state of a geophysical system using observations on that system and a numerical model of its dynamics. Because geophysical fluids are chaotic and simulated with imperfect models, data assimilation has become mandatory in meteorological and ocean forecasting, in the re-analysis of the past states of the atmosphere and the ocean, and is increasingly used in many fields of the geosciences (atmosphere, ocean, climate, atmospheric chemistry, air quality, cryosphere, biosphere, etc.). Data assimilation share the same mathematical foundations as modern machine learning. In particular data assimilation now accounts and directly benefits from the ongoing developments in machine learning and more broadly AI.

The objective of this course is to provide an introduction to the techniques of data assimilation and related machine learning techniques. It consists of a general introduction *from numerical modelling to data assimilation*, a block of 3 lectures to present the basics of the theory of data assimilation, a block on its extension with AI techniques, a block of 2 numerical training sessions on laptops, and a double conference with two renowned experts in the use of data assimilation in meteorology and in oceanography.

Syllabus:

1. From numerical modelling to data assimilation
2. Methodological aspects: best linear unbiased estimator
3. Methodological aspects: sequential and variational methods
4. Methodological aspects: ensemble methods
5. Lectures: "Data assimilation in meteorology" & "Data assimilation in oceanography"
6. Computer training session with a "shallow water" model (part I)
7. Computer training session with a "shallow water" model (part II)
8. Introduction to deep learning + computer training session on data assimilation and machine learning
9. Oral exam: scientific article synthesis

Marc Bocquet

Senior researcher and Professor at École nationale des ponts et chaussées, deputy director of CEREAs, joint laboratory with EdF R&D, Institut Polytechnique de Paris and Institut Pierre-Simon Laplace. He is an expert in data assimilation, inverse problems, and machine learning applied to the geosciences.

Web page: <https://cerea.gitlab.enpc.fr/website/marc.bocquet/>