France

Master's Program (M2) in Environmental Fluid Mechanics
2021-2022

Each student should choose courses amounting to 30 ECTS.
Note that 12 ECTS already correspond to three mandatory courses :
Turbulence, Scientific computing and a foreign language course.

LECTURES

Atmospheric Boundary Layer I : from fundamentals to air quality

Duration: 24h, 3 ECTS
Lecturers: Dr. Jean-Martial Cohard, IGE, Grenoble
Dr. Eric Chaxel, Engineer in air quality modelling, Lyon
Dr. Hubert Gallée, IGE, Grenoble
Summary : Physics of the Atmospheric Boundary Layer: role in the climate system, vertical structure and simple models. Microphysics of cloud formation and of aerosols. Application to air quality from an operational view point. Numerical modelling of the atmospheric boundary layer.

Atmospheric Boundary Layer II : large-scale and mountain meteorology

Duration: 24h, 3 ECTS
Lecturers: Dr. Olga Zolina, IGE, Grenoble
Pr. Chantal Staquet, LEGI, Grenoble
Summary **:** Overview of large scale atmospheric dynamics. Basics of mountain meteorology : terrain-forced flows, lee waves, the atmospheric boundary layer in complex terrain under stable conditions with application to the alpine Arve river valley.

Exchanges across air-water interface

Duration: 24h, 3 ECTS
Lecturers: Pr. Sergey Gulev, P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences
Summary : Why study exchanges across air-water interface. Common models of the scalar fluxes involved. The role of sea surface satellite measurements. Dissolved gas transfer across air / water interface.

Free-surface hydraulics and sediment transport

Duration: 24h, 3 ECTS
Lecturers: Dr. Philippe Frey, IRSTEA, Grenoble
Summary : Scope of sediment transport processes (from steep mountain flow to coastal waters); models of flow / sediment coupling processes; transport processes of sediment mixtures (mud / sand mixtures, gravel beds). Focus on steep mountain flows and coastal waters.

Ocean dynamics*

Duration: 24h, 3 ECTS
Lecturer: Dr. Achim Wirth, LEGI, Grenoble
Summary: After a short introduction to the observations of the world oceans in the past and present, the forces acting on the ocean are discussed. We will then see how the forcing put the water masses of the ocean into motion. An important question is: how can the forcing, which acts on the surface of the ocean, influence the motion in the deep ocean? This leads to a discussion of the two principal types of basin scale ocean circulation: the gyre and the overturning circulation. We then discuss small scale processes of the ocean dynamics including their importance on the large scale ocean circulation.

Renewable marine energy

Duration: 26h, 3 ECTS (14h lectures, 12h lab)
Lecturers: Dr. Thierry Maître, LEGI, Grenoble
Summary: This course aims at understanding marine and wind energy systems, from design to the computation of performance. It will also involve a review of marine energies. Three tutorials /labs will complement the course.

Turbulence in fluids
(mandatory course)

Duration: 42h, 6 ECTS
Lecturer: Dr. Joël Sommeria, LEGI , Grenoble
Summary : Fundamentals of fluid mechanics, vector analysis and tensor analysis. General questions on turbulence, multi-scale statistical description. Models of turbulent transport and turbulent mixing. Influence of rotation and density stratification effects. Numerical modeling of turbulence: first and second-order closure models, Reynolds averaged equations.

Waves in fluids and applications

Duration: 24h, 3 ECTS
Lecturers: Dr Gaël Richard, IRSTEA, Grenoble (Surface gravity waves)
Pr. Chantal Staquet, LEGI, Grenoble (Internal gravity waves)
Summary: Introduction to surface and internal gravity waves in fluids. Nonlinear and dissipative effects and associated wave impact on the medium. Wave-current interaction. Examples in natural media (such as coastal waters in the ocean and lee waves in the atmosphere).

TOOLS AND METHODS

Data assimilation

Duration: 15h + 9h personal project, 3 ECTS
Professor responsible for this course: Dr Emmanuel Cosme, IGE, Grenoble
Summary : This course provides an overview of the most popular data assimilation methods in geophysics, based on estimation theory and control theory. A 4h practical work on computers comes in support of the lectures.

Flow-measurement science and technology

Duration: 20h + 8h practical work, 3 ECTS
Lecturers: Dr. David Hurther, LEGI, Grenoble

Dr. Laure Vignal, LEGI, Grenoble

Summary : - Context and objectives of flow measuring science
- Point-wise measuring probes (hot wire, hot film probes, Pitot tubes)
- Acoustical measuring systems (Acoustic Backscattering Systems, Ac. Doppler Profiler, Ac. Concentration and Velocity Profilers)
- Optical measuring systems (LDA, LDV, PIV, PTV, LIF, OBS)
The class ends with a 4h practical work to compare different measurement techniques on a test flow.

Foreign language
(mandatory course)

Duration: 24h, 3 ECTS
Professor responsible for the English class : Mrs Margaret Jameson
Each student will be proposed to follow either an English class or a French class depending upon his/her level in English (< B2 or > B2, respectively). Other languages are possible if your level in both French and English is very good.

Machine learning for environmental sciences

Duration: 24h, 3 ECTS
Lecturer: Dr. Bruno Deremble, IGE, Grenoble
Summary : The objective of this course is to provide an introduction to statistical analysis and machine learning in order to help the students apply relevant methods to analyze specific datasets. Different families of unsupervised and supervised methods will be covered, while also providing a general approach to validate and test results. We illustrate this course with examples from environmental sciences. The datasets correspond to concrete cases of analysis presented in the form of ipython notebook.

Scientific computing
(mandatory course)

Duration: 24h, 3 ECTS
Professor responsible for this course: Dr. Pierre Augier, LEGI, Grenoble
Summary: Introduction to Python, application to classical examples in numerical analysis. Introduction to Machine Learning methods using the library Scikit-Learn.

Signal and information processing in fluid mechanics

Duration: 24h, 3 ECTS
Lecturer: Pr. Nicolas Mordant, LEGI , Grenoble
Summary : Description of the main tools for data analysis : Correlation, image processing, signal transformation, correlation function, filtering. Programming with Matlab using examples from turbulent flows.