Laurea Magistrale
Atmospheric Science and Technology (LMAST)

SUBJECT TITLE	Environ. meteorology: Part 1 - Environmental modeling
TEACHER NAME(S)	Gabriele Curci
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Teacher meeting	Tuesday, h. 14.30-16-30
Teacher office address	Coppito 1 building, ground floor, room 37, Via Vetoio, Coppito, 67100 L'Aquila
DISCIPLINE (SSD)	FIS/06
Semester (1-4)	3-4 (third-fourth) & Coppito, L'Aquila
Credits (CFU/ECTS)	6
Lecture hours (h)	60 (45 lectures + 15 exercises/laboratory)
Prerequisite and learning activity	Atmospheric Physics and Chemistry, Statistics, Programming
Teaching language and method	English & Lectures, exercises, homework
Assessment method	Oral examination and optional dissertation on a selected state-of-the-art topic
SUBJECT WEBSITE	

OBJECTIVES

Main goals are to:
- provide advanced elements of meteorological processes near Earth' surface
- review of impact modeling frameworks for the environment
- overview of phenomenology and numerical methods relevant for atmospheric composition modeling
- apply statistical methods to data analysis, model evaluation, and inverse modelling

OUTCOMES (Dublin descriptors: knowledge, understanding, explain, skill, ability)

After the successful completion of this module, the student should be able to:
- describe the main processes governing atmospheric quantities in the planetary boundary layer (PBL)
- illustrate the mathematical concepts and relationships at the foundation of atmospheric composition understanding and modelling
- setting up a targeted modeling framework for environmental studies
- examine the results of observational campaigns and numerical simulations
- integrate observational and simulated information for a better understanding of specific environmental problems
- make and communicate informed recommendations on new environmental problems

PROGRAM CONTENT

INTRODUCTION TO MICROMETEOROLOGY. Energy budget near the surface. Soil temperature and heat transfer. Air temperature, humidity, and wind in the PBL. Semiempirical theories of turbulence. Momentum and heat exchange with homogeneous surface. Nonhomogeneous boundary layers (urban, agricultural, topography, …).

MODELS OF THE ATMOSPHERIC COMPOSTION AND OTHER ENVIRONMENTAL IMPACTS. Overview of atmospheric chemistry, gases and aerosol, air quality and climate change. Eulerian and Lagrangian models. Box models. Puff and column models. Gaussian models. Trajectory and particle models. Chemistry-transport models. Statistical models. Introduction to numerical methods, operator splitting and numerical artefacts. Emissions of biogenic/natural and anthropogenic origin. Advective and turbulent horizontal and vertical transport. Chemical transformation and production in homogeneous and mixed phases. Dry and wet deposition processes. Atmospheric lifetime. Aerosol interaction with radiation and clouds.

ANALYSIS AND INTEGRATION OF ATMOSPHERIC OBSERVATIONS AND MODELS. Review of statistics and methods for dataset exploration and comparison. Statistical indices for model evaluation, air quality regulations. Bias correction/statistical downscaling techniques. Using model to aid interpretation of observations. Review of basic principles of inverse modelling and sample applications.

REFERENCES AND MATERIAL

1. Arya, P. S.: Introduction to Micrometeorology, Academic Press, 2001
2. Brasseur, G. P., and Jacob, D. J.: Modeling of Atmospheric Chemistry, Cambridge University Press, 2017
3. Jacob. D. J.: Introduction to Atmospheric Chemistry, Princeton University Press, 1999
4. Stull, R. B.: An Introduction to Boundary Layer Meteorology, Kluwer Academic Publishers, 1988
5. Wilks, S.: Statistical Methods in the Atmospheric Sciences, Academic Press, 2011
6. Teacher-provided material and exercises