Laurea Magistrale
Atmospheric Science and Technology (LMAST)

SUBJECT TITLE	**Environ. meteorology: Part 1 - Environmental modeling**
TEACHER NAME(S)	Gabriele Curci
Teacher e-mail (s)	gabriele.curci@aquila.infn.it
Teacher phone	+39.0862.433708
Teacher meeting	Tuesday, h. 15.00-17-00
Teacher office address	Coppito 1 building, ground floor, Via Vetoio, Coppito, 67100 L'Aquila
DISCIPLINE (SSD)	FIS/06
Semester (1-4)	3 (third) & 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 atmospheric composition phenomenology
- review of modeling frameworks for the environment
- overview of numerical methods relevant for atmospheric composition modeling
- apply statistical methods to model evaluation
- introduction to inverse modeling for atmospheric composition

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

After the successful completion of this module, the student should be able to:
- setting up a targeted modeling framework for environmental studies
- combine observations and models to investigate atmospheric composition
- have capacity to plan new developments of environmental models
- understand, summarize, and communicate existing and new knowledge

PROGRAM CONTENT

ATMOSPHERIC GASES AND AEROSOL. Review of atmospheric chemistry, air quality and climate change. 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.

MODELS OF THE ATMOSPHERIC COMPOSTION. Eulerian and Lagrangian models. Box models. Puff and column models. Gaussian models. Trajectory and particle models. Chemistry-transport models. Statistical models.

MODEL EQUATIONS AND NUMERICAL METHODS. Model grids. Finite difference, finite volume, finite elements and spectral methods. Operator splitting and numerical artefacts. Numerical methods for advection. Sub-grid scale parameterizations, turbulence closure, boundary layer schemes. Chemical mechanisms and solvers, radiative, chemical and aerosol rates. Surface fluxes, emission and dry deposition.

ATMOSPHERIC OBSERVATIONS AND MODEL EVALUATION. Review of statistics and methods for dataset comparison. Statistical indices for model evaluation. Use of observations from different platforms (ground, upper level, aircraft, satellite; in-situ, remote sensing). Model evaluation criteria, air quality regulations. Bias correction techniques. Using model to aid interpretation of observations.

INVERSE MODELING FOR ATMOSPHERIC COMPOSITION. Review of basic principles of inverse modeling. Analytical solutions. Adjoint-based modeling. Data assimilation.

REFERENCES AND MATERIAL

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