Laurea Magistrale
Atmospheric Science and Technology (LMAST)

SUBJECT TITLE	URBAN CLIMATOLOGY
TEACHER NAME(S)	Paolo Monti
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Teacher meeting	Monday, h 10-12
Teacher office address	DICEA-Uniroma1. Via Eudossiana 18, 00184 Roma.
DISCIPLINE (SSD)	ICAR-01 (Hydraulics)
Semester (1-4) and location	(2) @ Rome, Via Eudossiana 18.
Credits (CFU/ECTS)	6
Lecture hours (h)	45h lectures. 15h numerical exercises.
Prerequisite and learning activity	Physics. Fluid Mechanics.
Teaching language and method	English. Lectures.
Assessment method	Oral exam
SUBJECT WEBSITE	https://www.dicea.uniroma1.it/user/60/

OBJECTIVES

Main goals are to:
- provide a general background on the basic concepts of the atmospheric boundary layer;
- provide insights into the urban boundary layer;
- provide tools that help the student in analysing air flows in urban environments;
- illustrate and apply data processing procedure for urban boundary layer description.

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

Acquired Knowledge: the students who have passed the exam will be able to:
- use the most appropriate methodologies for climatic characterization of the territory and to identify governing variables of the urban heat island (with particular reference to the urban boundary layer) and to identify tools and methodologies suitable for their assessment;
- design procedures for the mitigation of the urban heat island as well as to use mathematical models suited to its simulation;
- to conduct surveys and experiments, as well as to understand the impact of solutions in the social and physical environment and to use tools and methods to control this impact;
- work both autonomously and as part of a team and relate to people skilled in different disciplines

PROGRAM CONTENT

THERMODYNAMICS. Equation of state for air and liquids. Integral Lagrangian formulation of I and II law of thermodynamics. Fourier law. Balance of thermal energy. Speed of sound in isoentropic flows. Wave equation. EFFECTS OF EARTH ROTATION. Non-inertial reference frame. Momentum balance and Coriolis Force. VORTICITY DYNAMICS. Circulation equation. Kelvin and Helmholtz theorems. Vorticity equation in a rotating frame. Compressibility effects. Non-dimensional form of the conservation laws. SCALINGS. Non-dimensional numbers. Boussinesq approximation. TURBULENCE. Reynolds equation. Turbulent flux of momentum. Mean heat and scalar equations. Kinetic energy budget of mean and turbulent flow. The closure problem. Boussinesq approximation. Turbulent diffusivity. First order closure. K-epsilon models. Static and dynamic stability. Richardson number. ATMOSPHERIC BOUNDARY LAYER. Radiative balance. Geostrophic flows and Taylor-Proudman theorem. Ekman layer. Monin-Obukhov similarity. URBAN BOUNDARY LAYER. Main characteristics. Thermal internal boundary layers. Vertical structure. Urban heat island: causes and effects. Urban morphology characterization. Urban canyons. Similarity laws. Urban heat island monitoring. Pollutant dispersion in cities.

REFERENCES AND MATERIAL

Kundu KK, Cohen IM, Dowling DR (2012). Fluid Mechanics. Elsevier.
Stull RB (1988). An Introduction to Boundary Layer Meteorology. Kluwer Academic Publishers.
Oke T (1987) Boundary-Layer Climates. Routledge.