



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Atmosphere Physics

2526-1-F7503Q022

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#### Aims

Knowledge and understanding of atmospheric processes and their influence on the environment.

Ability to apply the acquired knowledge.

Autonomy and ability to communicate what has been learned and processed.

#### Contents

Atmospheric structure and general circulation, dynamic and thermodynamic laws, radiation, balancing and energy, transfer processes in atmosphere, cloud physics, weather charts description.

#### Detailed program

General environmental characteristics

1.1. Genesis of the atmosphere, the importance of the

atmosphere, the composition of the atmosphere, greenhouse gases, reactive gases, aerosols, clean air, air pollution, urban pollution. The role of water vapor in atmosphere.

1.2. Vertical structure Troposphere and its importance on the Biosphere, the Stratosphere, volcanic dust in the Stratosphere and the effects on climate, Mesosphere, Exosphere, Planetary Boundary Layer,

1.3. Layers characteristic Ozonosphere and the Ozone Hole, Ionosphere and Radio influenza, Electrosphere and

genesis of lightning.

#### 1.4. Space Weather

Emissions of the sun to the earth, cosmic rays and

possible influence on Global Warming, the solar wind, magnetosphere, the Van Allen belts, auroras boreales, the sprites, the rise of the sun in relation to Global Warming, effects of solar wind and magnetic storms on space travel, on the biosphere and on the apparatus information

#### 1.5. The general air movement

Hadley model, a model with three cells, the distribution of the field of the pressure and of the wind, global and seasonal movement, meridional and zonal circulation, the Westerlies, the Rossby Waves, the causes of Rossby waves, polar and subtropical jet stream, air masses, the polar front, the genesis of extratropical cyclones, role of the polar jet stream in the genesis of the extratropical cyclones, cold front, warm front, occluded front.

#### 1.6. The atmospheric teleconnections

Teleconnections in field of the pressure: ENSO (El Niño Southern Oscillation), the SO, the Walker circulation and the Warm Pool, AO (Arctic Oscillation), NAO (North Atlantic Oscillation). The periodic oscillations of the tropical convective of the MJO (Madden-Julian Oscillation). The Swing equatorial wind QBO (Quasi-Biennial Oscillation) influence of teleconnections on the earth's climate.

#### Radiation

Radiation, the laws of black body, terrestrial and solar radiation, outgoing longwave radiation, albedo and reflected radiation, greenhouse effect, energy budgets, indirect estimate of the increase of greenhouse gases on global warming, the IPCC theory

#### Atmospheric pressure

Definition, measure, periodic and accidental variations, the air density, the concept of geopotential height, topographic representation of the isobaric surfaces, variation of pressure with height, reducing the pressure at sea level, isobars and sea level pressure charts, the main pattern isobars on the maps and the absolute topography.

#### Thermodynamics of dry air

Equation of state for dry air, the air density, the hydrostatic equation, the concept of geopotential height, thickness equation and applications.

The first principle of thermodynamics, adiabatic transformations for dry air, potential temperature, the stability of the atmosphere, stability and potential temperature, stability and thermal inversions, types of thermal inversions, diurnal pattern of stability, convective motions and stability, mixing height

#### 5. Thermodynamics of moist air

The water vapor pressure, humidity fundamental measures (mixing ratio, specific humidity, relative humidity, dew point, wet bulb temperature, hygrometer and psychrometer, physiological comfort and moisture, latent heat of condensation, adiabatic transformations for moist air, pseudopotential temperature, conditional and convective instability, instability in conditional situations, Föhn effect, thermodynamic diagrams, most common estimate of some atmospheric parameters from thermodynamic diagrams.

#### 6. dynamics of the atmosphere - Concepts General Scale of atmospheric motions, spatial and

temporal scale of turbulence, spatial and temporal density of observations at synoptic scale, analysis of the scale of vertical velocity, of horizontal and vertical gradients, operations with vectors, local and individual variations, the advection, the forces the atmosphere (gradient force, Coriolis Force, force of viscous friction, force of gravity).

#### 7. The air-dynamic equations of motion

The general equation of motion, the equations of motion horizontal geostrophic wind, calculation of geostrophic wind, on map of pressure field at a constant level (isobars) and constant pressure (isohypse) The wind gradient, the equation of vertical motion and the hydrostatic approximation, the thermal wind and its applications (interaction

of thermal field with the field of pressure, genesis of the jet stream, cyclones and anticyclones thermal or dynamical and vertical structure).

#### 8. The Turbulence in the atmosphere

Definition of turbulence, turbulence of mechanical origin (from obstacles or wind shear), thermal and orographic turbulence, the turbulence in the PBL and SL, the Ekman spiral, and the shearing stress and the force of friction, the wind pattern in PBL and SL, the logarithmic law of wind in the SL, the turbulent diffusivity.

#### 9. Urbane climate.

#### 10. The physical and mathematical models for weather forecasts.

### **Prerequisites**

None.

### **Teaching form**

Lessons, 5 cfu - 40 hours

2 lessons of 3 hours with Delivered Didactics in person

10 lessons of 3 hours that alternate Delivered Didactics and Interactive Teaching in person

2 lesson of 2 hour that alternate Delivered Didactics and Interactive Teaching in person

Classes , 1 cfu - 10 hours

5 lessons of 2 hours that alternate Delivered Didactics and Interactive Teaching in person

Lessons take place using multimedia material (slides, videos)

### **Textbook and teaching resource**

1. Manuale di Meteorologia - Centro Epson Meteo – Ed. AlphaTest

2. An introduction to dynamic meteorology -

J.R.Holton – Academic Press. Inc

### **Semester**

First semester

### **Assessment method**

Verification of the basic knowledge of Atmospheric Physics: general characteristics of the Atmosphere, dynamics of the Atmosphere, thermodynamics of the Atmosphere and microphysics of clouds.

Exam modality: oral test, carried out through an interview on the topics covered in class, to check preparation on the exam program and communication skills in the disciplinary field; no intermediate exam tests

Assessment of the exam: grade in thirtieths (18-30/30)

## **Office hours**

Contact by email.

## **Sustainable Development Goals**

AFFORDABLE AND CLEAN ENERGY | CLIMATE ACTION | LIFE ON LAND

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