UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Atmosphere Physics

2627-1-F7503Q022

Aims

Understanding the climate drivers of extreme events (meteorological and climatic aspects) and their impacts on natural and human systems, methods for analyzing extreme events and their changes, analyzing past events to define future scenarios (past-to-future), adaptation methods, and data manipulation for territorial models.

Understanding the composition and chemical reactivity of the atmosphere (natural and in human-generated areas): radical reactions, stratospheric and tropospheric ozone, the formation and chemical composition of particulate matter (PMx), atmospheric transport processes, the effects of air pollutants on the climate, electronic products, and cultural heritage, and indoor/outdoor concentrations in relation to human health.

Understanding climate system and its natural and anthropogenic changes, the physical basis of climate change, feedback mechanisms in the Earth system, the concepts of vulnerability, impacts, adaptation, and mitigation, and the science of climate change in the context of international climate treaties.

Understanding atmospheric processes and the physical laws that regulate them (atmospheric structure and general circulation, atmospheric dynamics and thermodynamics, solar and terrestrial radiation, cloud physics), the dynamics of climate change, the importance of adaptation and mitigation measures, and the interpretation of weather charts.

Be able to apply technical knowledge to the specific understanding of the physical-chemical-modeling aspects related to climate change, critically read the interactions between various environments and climate change (with particular attention to the atmosphere).

Ability to assess weather patterns by analyzing charts and the impact of atmospheric conditions on environmental parameters (pollutant concentration, psychological and physical comfort, hydrogeological stress), recognizing and interpreting weather charts.

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 band Van Allen, 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 and wind, global and seasonal movement, meridional and zonal circulation, the Westerlies, the Rossby Waves, the causes of Rossby waves, polar ad 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-Juliana Oscillation). The Swing equatorial wind QBO (Quasi-Biennal 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, Stau-Föhn, 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 turbolence, 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