

<b>TITOLO DEL CORSO</b>			
CLIMATOLOGY			
<b>Settore Scientifico - Disciplinare: GEO/12</b>		<b>CFU: 6 (4 LF + 2 LAB)</b>	<b>Ore: 56</b>
<b>Ore di studio per attività:</b>	<b>Lezioni frontali:</b>	<b>Laboratorio:</b>	<b>Attività di campo:</b>
	2	1	0
<b>Tipologia di attività formativa:</b> a scelta libera			
<b>SYLLABUS</b>			
<b>Prerequisiti:</b> Physics, Mathematics, Chemistry			
<b>Lezioni frontali</b>			
numero di ore 2	<u>Argomento:</u> Introduction to Climatology: Difference between Weather and Climate; The Earth's History of Climate Change; Why Does Climate Change? Do we understand climate change? Observing Climate Change: Changes in Temperature; Changes in Sea Level; Greenland and Arctic Temperature; Permafrost; Mountain Glaciers; A Typical Glacial Advance and Retreat; Antarctic Subglacial Lakes; Lake Vostok.		
numero di ore 2	<u>Argomento:</u> Meteorological Concepts: Physical Units, and Instrumentation; The Atmosphere, its Composition and Structure; Temperature, Humidity, Pressure, Precipitations, Clouds and Winds; Temperature Scales; Differential Heating of Land and Water; World Distribution of Temperature; Adiabatic Heating/Cooling; Adiabatic Cooling of Rising Air; Orographic Lifting; Stability of Air; Condensation and Cloud Formation; Fog; The Coriolis Effect; The Geostrophic Wind; Cyclones, Typhoon and Hurricanes; Air Masses; Albedo.		
numero di ore 2	<u>Argomento:</u> The Sun and its Harmonics: Solar Activity and its Correlation with Climate; Total Solar Irradiance Reconstructions; Seasonal Effects; Milankovitch Theory and the Orbital Cycles of the Eccentricity, Axial Obliquity and Precession. Effects on Paleoclimates. Glacial Periods and Interglacials.		
numero di ore 2	<u>Argomento:</u> Electromagnetic Waves; Elements of Quantum Mechanics; Emission of a Black Body; Absorption and Emission Spectra; Solar radiation and its Spectral Analysis; Planck's law; Wien's law; Stefan-Boltzmann law; First law of thermodynamics.		
numero di ore 2	<u>Argomento:</u> Greenhouse Effect of the Atmosphere: Incoming and Outgoing Radiation; Greenhouse Gases (H <sub>2</sub> O, CO <sub>2</sub> , CH <sub>4</sub> , O <sub>3</sub> , ecc.); Detailed Analysis of the Absorption and Emission Spectra of the Earth's Atmosphere; Near and Far Infrared Radiation. Radiative Forcings.		
numero di ore 2	<u>Argomento:</u> The Earth's Energy Balance and its Climate Feedbacks: Clouds; Water Vapor; Albedo; Vegetation; Other Feedbacks; Concept of Climate Sensitivity to Radiative Forcings; Debate on the Large Uncertainty Regarding the Equilibrium Climate Sensitivity.		
numero di ore 2	<u>Argomento:</u> The Circulation of the Atmosphere; The major wind system; The Three Cells Model; The Climatic Zones of the Earth; The Circulation of the Ocean; Air-Sea		

	Interaction; Thermohaline Circulation; Conveyor Belt Circulation; Monsoon Climates, Temperate Climates, Tropical Climates, Subtropical Climates; Arctic Climates; Mediterranean Climates.
numero di ore 2	<u>Argomento:</u> The Main Climate Indices: SOI = Southern Oscillation Index; NOI = Northern Oscillation Index; ENSO = El-Nino Southern Oscillation; PDO = Pacific Decadal Oscillation; AMO = Atlantic Multidecadal Oscillation; NAO = North Atlantic Oscillation; QBO = Quasi Biennial Oscillations; MJO = Madden-Julian Oscillation; MOI = Mediterranean Oscillation Index.
numero di ore 2	<u>Argomento:</u> Revealing Ancient Climate: Ice Cores; Sedimentary structures; Coal deposits; Carboniferous forests; Organic-rich marine clays; Chalk; Volcanic activity; Ancient desert sediments; Glacial sediments; Evaporite deposits; Stable oxygen isotopes in water 18O - 16O; Stable oxygen isotopes in carbonate (CaCO <sub>3</sub> ); Stable isotopes of carbon 12C-13C; Solar proxies, 14C and 10Be; Cosmic Ray; Fossils as indicators of climate; Estimate CO <sub>2</sub> concentration in the atmosphere (Stomata VS. Ice cores); Fossil pollen; Foraminifera; Tree rings; Coral growth.
numero di ore 2	<u>Argomento:</u> Climate History: Late Proterozoic; Carboniferous Period; Permian world; Triassic Period; Cretaceous world; 65M - asteroid impact; Cretaceous-Tertiary (K-T iridium) event; Paleogene and Neogene Periods; Paleogene tectonics; Paleocene-Eocene Thermal Maximum; Oligocene Epoch; Miocene Epoch; Pliocene Epoch; Over last 4 million years; Pleistocene Epoch; Pleistocene climate cycles; Cycles in ice sheet growth and decay; Ice sheet dynamics End of the last Pleistocene glacial maximum; Bølling-Allerød interstadial stage; Younger Dryas event.
numero di ore 2	<u>Argomento:</u> The Climate of the Holocene: The Holocene Optimum; The Great Millennial Cycles; Effects of Climate Changes on Past Civilizations; Roman Warm Period; Dark Ages; Medieval Heat; Little Ice Age.
numero di ore 2	<u>Argomento:</u> Climate Change since 1850: Global Surface and Oceanic Temperature records; Issues regarding the Climatic Records; Urban Heat Island Effects and Climate Records Contaminations; Natural and Anthropogenic Climatic Forcings; Climatic Natural Oscillations; Volcanic Eruptions; Climate Models, their Uncertainty and Scientific Limitations; Debate on Contemporary Climate Change, Global Warming and Predictive Scenarios.
numero di ore 2	<u>Argomento:</u> Various Climatic Issues: Global Climate Impacts; Water resources; Coral reefs; Coral bleaching; Climate Changes in the Oceans; Organisms Threatened by Increased Marine Acidity; Rising Sea Level. Climate and Disease; Arctic Warming; Ozone Hole.
numero di ore 2	<u>Argomento:</u> Sea Level: Sea Levels During the Glacial Periods; Historical Evolution of the Sea Level during the Holocene; Contemporary Global and Local Sea Level changes; Climate Change and Sea Level Hazards.
numero di ore 2	<u>Argomento:</u> Solar and Astronomical Origin of the Climate Oscillations; Planetary Resonances of the Solar System; Cosmic Ray and Meteoric Dust Forcing the the Cloud System.

numero di ore 2	<u>Argomento:</u> The Energy Debate: Kyoto Protocol; Energy consumption; Greenhouse gas emissions; Energy consumption; Primary fuels; Coal; Natural gas; Oil; Nuclear power; Renewable energy; Hydroelectric power; Geothermal power; Wind energy; Concentrated solar towers; Photovoltaic cells; Solar updraft towers; Tidal and wave power; Bioethanol; Algal bioreactors; Hydrogen; Is Green Energy Efficient?
<b>Laboratorio</b>	
numero di ore 24	<u>Attività:</u> The students will use <b>KNMI Climate Explorer</b> and other climatic databases to download various climatic data and learn how to perform basic statistical analyses.
<b>Laboratorio</b>	
<b>Risultati di apprendimento attesi</b>	
<b>Knowledge and understanding</b> The student must demonstrate that he/she understands the problems related to the all main aspects of Climatology.	
<b>Applying knowledge and understanding</b> The student must show that he/she is able to interpret various climatic data, understand the operation and use of common instruments used in climatology.	
<b>Making judgements</b> The student should be able to independently evaluate various climatic processes.	
<b>Communication</b> The student must be able to explain to non-expert people the basic notions relating to climatic processes.	
<b>Learning skills</b> The student must be able to expand his/her knowledge using various textbooks and scientific articles. The course provides the student with indications and suggestions necessary to allow him/her to address other topics similar to those in the program.	
<b>Modalità di verifica dell'apprendimento</b>	
<b>Esame finale:</b> Oral exam. Grades in 30/30.	