PhD in Polar Sciences
Academic year 2025/26 Courses

N	CU	Course title	Hrs	Syllabus	Lecturer	Email contacts
1	Biology, Ecology, and Biodiversity	Conservation and Management of Polar Biodiversity	15	This course is dedicated to the conservation and management of biodiversity in polar regions. It explores the unique challenges and conservation strategies specific to these areas. Topics may include the identification and monitoring of key species and habitats, ecosystem-based management approaches, the role of indigenous communities in conservation, and the impact of human activities (e.g., tourism, fishing, climate change) on polar biodiversity.	Luigia Donnarumma	luigia.donnarumma@uniparthenope.it
2	Biology, Ecology, and Biodiversity	Climate Change Impacts on Polar Ecosystems	15	This course focuses on the effects of climate change on polar ecosystems and their associated biodiversity. It examines the physical and biological changes occurring in polar regions as a result of global warming and associated environmental shifts. Topics may include the melting of polar ice caps, altered ocean currents, changes in species distributions and abundance, phenological shifts, and the cascading effects of these changes on ecosystem functioning. Students may explore various climate change impact assessment methods, modeling approaches, and potential mitigation strategies.	Maurizio Azzaro	maurizio.azzaro@cnr.it
3	Biology, Ecology, and Biodiversity	Adaptation and Evolutionary Processes in Polar Organisms	15	This course delves into the adaptation and evolutionary processes of organisms living in polar environments. It explores the unique characteristics and physiological adaptations that enable species to survive and thrive in extreme cold, low-light, and variable conditions. Topics may include genetic adaptations, physiological responses, and behavioral adaptations of polar organisms. Students may also understand the role of biological adaptation of polar species to multiple stressors, such as the presence of contaminants in a climate change scenario	Benedetta Turchetti	benedetta.turchetti@unipg.it
4	Biology, Ecology, and Biodiversity	Polar Field Methods and Data Analysis in Biological Research	15	This course is designed to provide students with the elements for the analysis of biodiversity in polar areas. Specifically, the course illustrates the study methodologies and tools used in the field to measure biodiversity and the statistical techniques to be applied in data analysis. Various field sampling techniques (e.g. photogrammetry, barcoding) will be covered, together with experimental designs and data collection protocols specific to polar ecosystems.	Stefano Schiaparelli	stefano.schiaparelli@unige.it
1	Solid Earth	Geographical and geomorphological setting of Polar Regions	15	This course will cover i) the principles of polar geography and geomorphology; ii) the role of different geomorphic processes in shaping the landscape; iii) the response of the earth system to climate changes through time as recorded by rocks, sediments, and landforms. The course will provide an extensive overview of: - the role of the dynamic earth system in setting the background of polar regions (geographical and geomorphological setting of polar regions); - geomorphologic evidence of past glacial history; - impact of climate changes on the glacial geological record and on landforms assemblages of polar regions.	Carlo Baroni	carlo.baroni@unipi.it
2	Solid Earth	Geology of the Polar Regions	15	The course will provide the basic knowledge of the geological features of the Polar Regions of the Earth - Antarctica and Arctic. Lectures will focus on the geology under the ice and the interactions between lithosphere and cryosphere. Students will get also an overview of the main geological methods applied for the study of remote areas and case studies from lecturers' direct experiences.This course will focus on: the geological history of the Polar Regions from Paleozoic to recent times; the lithological and tectonic features of the main geological provinces; interaction processes between lithosphere and cryosphere; exploration and scientific research expeditions; main geological methods of investigation applied in remote areas.	Laura Crispini Paola Cianfarra	laura.crispini@unige.it paola.cianfarra@unige.it
3	Solid Earth	Stratigraphic correlation of polar continental margins	15	The course aims to provide an up-to-date overview of the principles of stratigraphy and the various stratigraphic methods, including lithostratigraphy, biostratigraphy, and chronostratigraphy. It will also introduce the use of multiproxy data for paleoclimatic and paleoceanographic reconstructions, as well as for defining depositional processes associated with past ice-sheet dynamics. The course is divided into five parts: •Part 1: Overview of marine polar depositional systems in comparison with those at lower latitudes; •Part 2: Basic principles of stratigraphy; •Part 3: Geological data acquisition in marine environments; •Part 4: Multiproxy approaches and their application in stratigraphic correlations and paleoceanographic/paleoclimatic reconstructions; •Part 5: Classroom exercises.	Caterina Morigi Renata Giulia Lucchi	caterina.morigi@unipi.it, rglucchi@ogs.it
4	Solid Earth	Principles and practical applications of the transmission electron microscope	15	Topics of the course: Brief review of crystallography and diffraction. Principles of electronmicroscopy. Technical description of transmission electron microscope. Sample preparation methods. Imaging in TEMand STEM modes. Conventional and advanced electron diffraction techniques (SAED, NED, 3DED, ASTAR).Chemical analysis via energy-dispersive X-ray spectroscopy (EDX/EDS). Laboratory activities: remote TEM sessions and on-line data analysis.	Enrico Mugnaioli	enrico.mugnaioli@unipi.it

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1	Climate System	**Analysis of pollutants to determine their fate and transport in polar regions**	15	This course will teach the students about the problems related to the transport and fate of persistent inorganic and organic pollutants in polar regions. These compounds affect climate change, and the health of the overall environment by accumulating in polar regions and then passing through the food web, eventually to man. The course will also introduce the concepts of trace analytical chemistry specifically applied to Polar areas and focusing on sampling and experimental design.	Andrea Spolaor	andrea.spolaor@cnr.it
2	Climate System	**Climate of the past**	15	This course is designed to provide students with a comprehensive understanding of the methods and applications of paleoclimatology, including data collection and analysis, modeling, and interpretation of climate records from the past. The course will cover various proxy records, such as ice cores, tree rings, and sedimentary archives, and their use in reconstructing past climate changes, including those associated with glacial-interglacial cycles and abrupt climate events. Students will also gain an understanding of the tools and techniques used in paleoclimate modeling, including how to assess model performance and uncertainty. • methods for detecting climate change, including proxies, ice cores, instrumental records, and time series analysis • physical and chemical processes in climate, including primordial atmosphere, ozone chemistry, carbon and oxygen cycles, and heat and water budgets • internal feedback mechanisms, including ice, aerosols, water vapor, clouds, and ocean circulation • climate forcing, including orbital variations, volcanism, plate tectonics, and solar variability • climate models and mechanisms of variability, including energy balance, coupled models, and global ocean and atmosphere models.	Jacopo Gabrieli	gabrieli@unive.it
3	Climate System	**Ice core science**	15	This course will cover the principles of ice core science and how this new research field has been born. We will examine how the ice cores from both polar and non-polar regions allowed us to understand the climate of the past and the role of greenhouse gases in the climate system. The course will provide an extensive overview of: - How the climate of the past may be reconstructed from this unique natural archive; - How the climate records from the two hemispheres can be synchronized; - How the coupling between climate and greenhouse gases can be studied.	Barbara Stenni	barbara.stenni@unive.it
4	Climate System	**Introduction to climate dynamics**	15	The course provides for a basic understanding of the functioning of the Earth's climate. Focus is especially on the physical components of the climate system, especially linked with dynamics of atmosphere, ocean and the polar regions. After a brief introduction on the definition of climate, we will use simple models to understand some of the fundamental processes that operate within the climate system. The course will provide elements to understand natural and anthropogenic climate changes, with emphasis on amplification mechanisms in polar regions. The students will become familiar with the diverse tools used in contemporary climatology, including instrumental observations, climate proxies and numerical climate models.	Davide Zanchettin	davidoff@unive.it
1	Ocean and Cryosphere	**Dynamics of the Southern and Arctic oceans**	15	This course covers the fundamentals of the Southern and Arctic Ocean dynamics, and aims to put these in the context of climate change in the 21st century. The lectures focus on the physical mechanisms responsible for large-scale atmospheric and oceanic circulation, the global energy balance, and the global hydrological cycle. It introduce fundamental concepts of fluid dynamics and apply these to the vertical and horizontal motions in the Southern and Arctic Oceans, as well as to the coastal polar seas with particular focus on the Ross Sea role in the global ocean circulation. Particular attention will be paid also to the importance of the Atlantification process, the interactions between fjords and oceans and between Arctic and sub-Arctic regions. Finally, part of the course will be devoted to providing information on active ocean observing programmes in both polar areas and useful databases from which information can be extracted for scientific purposes.	Giorgio Budillon Manuel Bensi	giorgio.budillon@uniparthenope.it mbensi@inogs.it
2	Ocean and Cryosphere	**Ice Sheets and Glaciers in the Climate System**	15	Ice sheets are an important component of the climate system. Their vulnerability conditions climatic changes over polar to mid-latitude as well as global sea level change. This class focuses on understanding the ice sheet dynamics and their physical interactions with atmosphere and ocean and how they contribute to the ongoing and future sea level variations. The course aims to give also a current review of recent research into processes and dynamics of the past interaction between the ice sheet and the Ocean. Lectures will cover arguments linked to glacial dynamics focusing on ice sheets (e.g. Antarctica, Greenland and the paleo Eurasian and Laurentide ice sheets). The course will explore those aspects: paleo ice sheet and marine depositional systems from observations (geophysical data and geological records) and paleo ice sheet and circulation modelling.	Florence Colleoni Laura De Santis	fcolleoni@ogs.it ldesantis@inogs.it

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3	Ocean and Cryosphere	**Remote Sensing in polar areas**	15	The course aims to introduce the principles of remote sensing in general and in particular the methodologies and techniques that can be used for monitoring and studying polar regions. The course will start with the description of available systems from both ground and satellite; then it will introduce, by means of dedicated lectures, specific topics of interest for polar regions. Measurements' principles and physical interpretation of acquired data will be discussed also by using geophysical models. An overview of retrieval techniques, able to translate remote sensing measurements in observables, and examples on the use of the data for climate studies will be part of the course. The last part of the course will be dedicated to the description of different available data sources and to practical examples of data processing. At the end of the course it is expected that students will be able to use some of these techniques for addressing some of the topics that will be developed along theirs PhD studies.	Giovanni Macelloni Alcide Di Sarra	g.macelloni@ifac.cnr.it alcide.disarra@enea.it
4	Ocean and Cryosphere	**Ocean observations: methods and data analysis**	15	The course aims at providing the basic principles of oceanographic data collection and analysis. In a first part of the course, the main physical and biological properties of the water column will be described. After that, a selection of oceanographic instruments will be introduced and the principles of their functioning and measurements will be analyzed. A number of case studies focused on the oceanography of the Southern Ocean will be presented and students will face the issues of instrument selection according to the scientific aims of an oceanographic cruise. Last part of the course will be dedicated to an overview of dataset freely available that will also be used for practical examples of data processing through Ocean Data View. General knowledge of water column properties, as well as the capability to plan in situ observations and realize basic data analysis are the take home message we expect to successfully transmit to the students.	Yuri Cotroneo Pasquale Castagno	yuri.cotroneo@uniparthenope.it pasquale.castagno@unime.it
1	Human Impacts	**Chemical Processes and Transport Model in Atmosphere**	15	Overview: The lesson provides some basic information on the transport mechanisms of the main pollutants in the atmosphere and chemical processes occurring during the transport. Program: Basic physical and chemical structure of the atmosphere; time and spatial scales and resolutions of the relevant physical and chemical processes; Lagrangian, Eulerian and Gaussian models; biogeochemistry of the troposphere; biogeochemistry of the stratosphere.	David Michele Cappelletti	david.cappelletti@unipg.it
2	Human Impacts	**Polar Marine Environment: ecology and pollution**	15	Overview: This course centers around the study of pollution in polar marine environments, including both chemical and plastic pollution. Program: Basics on the marine environment: marine biology and ecology with a particular focus on the polar marine environments. Principal characteristics of the Arctic Ocean and the Southern Ocean (polar ecosystems, species adaptation, biodiversity). Basics on marine pollution: main marine pollutants in the Arctic and Antarctic oceans (metals, microplastics, POPs). Sources, transport mechanisms, and impacts of pollutants in the Polar marine environments (habitat degradation, invasive species, climate change). Students will learn about monitoring techniques, risk assessment.	Nicoletta Ademollo	nicoletta.ademollo@cnr.it
3	Human Impacts	**Analytical approaches, Monitoring and Conservation of Polar Marine Environment**	15	In the context of polar marine environments, the presence of emerging pollutants poses a significant threat to the delicate ecosystems. This doctoral course aims to address the intricate challenges associated with the sampling, detection and quantitative analysis of these emerging contaminants in polar seawaters. The identification and quantification of pollutants such as pharmaceuticals, personal care products, UV filters and industrial chemicals in these extreme environments are crucial for understanding their impact on the polar ecosystems and, by extension, global environmental health. Participants will explore cutting-edge sampling techniques, including passive sampling, tailored to capture ultra-low concentrations of contaminants in cold and remote polar seas. The course emphasizes the significance of representative sample collection for a comprehensive understanding of the distribution and fate of emerging pollutants in these vulnerable ecosystems, taking also into account the practical difficulties encountered in such extreme environment. In this framework, another important and difficult step is the development of robust analytical methods capable of detecting these pollutants at ultra-low concentrations, nonetheless the sample matrix variability; therefore, the course will focus on state-of-the-art analytical techniques and instrumentation necessary to achieve reliable quantification and the inherent sensitivity required for detection. In conclusion, this course will delve into the forefront of analytical techniques, discussing advancements in methodologies and instrumentation tailored to overcome all the mentioned challenges.	Emanuele Magi	emanuele.magi@unige.it

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N	CU	Course title	Hrs	Syllabus	Lecturer	Email contacts
4	Human Impacts	**Geopolitics and Governance in Polar Regions**	15	This course examines the policy and governance frameworks relevant to the management of polar regions. It covers international agreements, legal frameworks, and governance structures addressing issues such as resource exploitation, shipping, tourism, and conservation in the Arctic and Antarctic. Students will analyze policy processes, stakeholder engagement, and the challenges of balancing environmental protection with economic development in these regions.	Alessandro Vitale	alessandro.vitale@unimi.it
1	Astronomy, Space and Earth Observations	**Sun-Earth relationship and Space Weather: the role of polar regions - Part I**	15	The objective of this course is the development of a deep understanding of the Sun-Earth relationship, and its implications for polar regions, with particular attention to the effects of solar activity on the near Earth space. The course will consists of the following sections: Introduction on the Sun: from interior to corona The active Sun: Solar flares and coronal mass ejections (CMEs) Solar corona Solar radio emission High-frequency radio observations of the Sun in polar regions and Space Weather applications (https://sites.google.com/inaf.it/solaris)	Alberto Paolo Pellizzoni	alberto.pellizzoni@inaf.it
2	Astronomy, Space and Earth Observations	**Sun-Earth relationship and Space Weather: the role of polar regions - Part II**	15	The objectives of this course are the development of a deep understanding of the Sun-Earth relationship, and its implications for polar regions, focussing on the solar wind intercation with the magnetosphere-ionosphere sytem. The course will also allow the student to explore the potential advantages and the criticalities of polar regions as locations for observations of the ionosphere and magnetosphere dynamical state. The course will consiste of the following sections: Solar Wind - Magnetosphere-Ionosphere coupling and central role of polar regions. Space Weather phenomena due to SW-magnetosphere-ionosphere interaction and their impacts on polar regions Observables: geomagnetic magnetic field variations; ionospheric convection; aurorae.	Giuseppe Consolini	giuseppe.consolini@inaf.it
3	Astronomy, Space and Earth Observations	**Optical instrumentation in extreme environments**	15	The course aims at giving the students a deep understanding of the fundamentals of optical methods and optical instrumentation, spanning the whole electromagnetic spectrum with the specific features of each wavelength bands. Stemming from the basics of Fourier Optics, the course covers the main items of imaging and diffractive optical systems, with elements of spatial and temporal coherence and their relevance in astronomical observation. Examples of applications and practical issues will be extensively discussed, with particular attention to operate optical systems in extreme environments. The student will be focused on the criteria to fix the requirements for the instrumentation to be operated in Antarctica and the experimental strategies to achieve robust experimental results.	Marco Potenza	marco.potenza@unimi.it
4	Astronomy, Space and Earth Observations	**Astronomical observations from Antarctica**	20	This course is designed to provide in-depth knowledge and practical skills in conducting night-time and day-time astronomical observations from Antarctica, taking advantage of the unique and favorable conditions offered by the polar region. Students will learn about the challenges and opportunities associated with conducting research in Antarctica, including the effects of extreme cold, isolation, and logistics. The course will cover various observational techniques and instruments employed in Antarctic astronomy, data analysis, and interpretation, as well as current research topics in the field. In particular, a first part of the course will focus on the advantages of the observations in the visible and near IR part of the spectrum from Antarctica. The second part of the course will focus on observations of the Cosmic Microwave Background (CMB) from Antarctica, including the following topics: -introduction to cosmology and the CMB -relevant observables -the effect of the atmosphere on astronomical observations -receivers and techniques for cosmology -telescopes and infrastructures for cosmology	Paolo De Bernardis	paolo.debernardis@uniroma1.it