PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU1.01

Curriculum: 1. Earth System and Environment

Chasing convective storm evolution with swarms of space-borne Ka-band radars

Reference Person: Battaglia Alessandro (alessandro_battaglia@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Radar remote sensing
	Convection
	Cloud resolving models
Reference ERCs:	PE10_14 Earth observations from space/remote sensing
	PE10_2 Meteorology, atmospheric physics and dynamics
	PE10_3 Climatology and climate change
Reference SDGs:	GOAL 13: Climate Action

Description of the research topic

Deep convection has a profound influence on Earth's climate system. Updraft plumes in deep convective clouds are in the tropics the principal pathway by which heat, moisture, mass and trace gases are transported into the upper atmosphere. Observations of the occurrence and magnitude of vertical transport in deep convection are simply not available over the tropical oceans and sparsely available over land. Monthly to seasonal prediction of weather is heavily influenced by the role of deep convection on important modes of variability, such as the Madden-Julian Oscillation, El Nino/Southern Oscillation, and tropical waves. Convection is therefore central to prediction of severe weather both at sub-seasonal and seasonal time scales. The sign and nature of changes to convective storms in a warming climate are also difficult to predict. While moisture convergence is expected to increase at about 7% per degree of warming following the Clausius-Clapeyron law, storms are likely to become deeper and narrower and to produce heavier precipitation at a rate which is still debated. It also remains unclear whether or not the increased transports will result in more moistening of the high troposphere and more cirrus clouds or will be compensated by heavier precipitation.

Ground-breaking novel observations of convective clouds are expected from the NASA's Earth Venture Program Investigation of Convective Updrafts (INCUS) mission (https://www.Nasa.Gov/press-release/nasa-selects-new-mission-to-study-storms-impacts-on-climate-models) with the launch (2027) in low Earth orbit of a constellation of satellites equipped with Ka-band (35 GHz) radars and microwave radiometers in close formation (Dt separation of the order of few minutes). This observing system will allow to

globally observe the explosive evolution of storms as never done before and should therefore provide new observables to test the realism of convection-permitting cloud resolving models. These models will represent the backbone of future operational weather forecast models, which are currently run at or near 5 km but will soon move to finer resolution capable of resolving convection.

Scope of the PhD is to perform ancillary studies in preparation of the mission with three main goals:

1) To simulate the radar and radiometer measurements by using fine temporal (sub-minute) and spatial (sub-km) resolution outputs from the WRF model. The study will capitalize on advanced radar and radiometer simulators (accounting for the viewing geometry, the radar sensitivity, the antenna pattern, the pulse compression schemes, etc) developed in the past ten years within the research team.

2) To investigate the sensitivity of the INCUS measurements to the different parametrizations and schemes of the WRF model). Stochastic schemes are capable to represent model uncertainty in ensemble simulations by applying a small perturbation at every time step to each member and very suitable for the convective clouds scale studies of this project

3) To refine algorithms for the derivation of convective-related quantities (updrafts, condensed mass vertical fluxes) based on the Dt measurements (collaboration with NASA INCUS PI, Prof. S. Van den Heever at Colorado State University).

Research team and environment

This project offers an excellent opportunity to develop and apply novel radar techniques to remote sensing of clouds and precipitation. The student will be trained in a wide range of topics including radar meteorology, cloud physics, radiative transfer and precipitation remote sensing. The PhD student will be supervised by Prof. A. Battaglia, who currently has a joint appointment at Politecnico of Turin and at the University of Leicester, UK. A. Battaglia is a world leader in spaceborne radars and forward modelling of space-borne microwave sensors with direct involvement in all international missions with cloud and precipitation microwave observing instruments. He was involved with the NASA INCUS team in the successful proposal to the NASA's Earth Venture Program led by Professor Susan van den Heever (PI) at Colorado State University.

The PhD student will be able to collaborate with the international INCUS team when refining the algorithms for the characterization of convection (specifically there will be weekly teleconferences with the INCUS PI and Prof. Kollias at Stony Brook, City College of New York).

The student will benefit from the collaboration with the CIMA foundation group led by Dr. A. Parodi who will provide consolidated experience in the execution of cloud-resolving numerical experiments at kilometric scale by combining different microphysics and radiative schemes as well by using stochastic parameterization schemes.

Suggested skills for this research topic

Applicants should have a science or engineering degree. Knowledge of meteorology would be beneficial. Programming skills in matlab/idl/Python/C/Java/C++ and knowledge of radar systems, signal processing and numerical modelling could also be beneficial. Team working attitude and excellent knowledge of spoken and written English are highly desirable.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.02

Curriculum: 1. Earth System and Environment

Mechanisms and impacts of the Atlantic Multidecadal Variability

Reference Person: Bellomo Katinka (katinka.bellomo@polito.it)

Host University/Institute: Politecnico di Torino

Research Keywords:	Climate impacts
	Climate change
	Machine learning
Reference ERCs:	PE10_3
	PE10_2
	PE10_8
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The Atlantic Multidecadal Variability (AMV) is the leading mode of climate variability over the North Atlantic on decadal and multidecadal timescales. Previous studies have shown that the AMV influences hurricanes, storm tracks, precipitation, and extreme events over the European and American continents, but despite its dramatic societal and economic effects, the mechanisms driving the AMV are still poorly understood. In this context, the role of ocean circulation is unclear because while in some models it seems to be strongly coupled with the sea surface temperatures, in others this coupling is weaker. In the models in which the ocean-atmosphere coupling is weaker, the atmospheric forcing from the North Atlantic Oscillation (NAO) prevails. In addition, from the industrial revolution, human emissions of aerosols and greenhouse gases have strongly contributed to the changes in sea surface temperature, further complicating the interplay between the ocean and the atmosphere in driving the AMV, and the attribution of the AMV's large-scale climate impacts to human emissions.

We plan to hire a Ph.D. Candidate to address some pressing research gaps regarding the mechanisms driving the AMV and its impacts on societies. More specifically the Ph.D. Candidate would examine the output of coupled global climate models archived in the Coupled Model Intercomparison Project phase 6 (CMIP6), which hosts at the moment ~40 models, and analyze the preindustrial and historical simulations to investigate the coupling of the ocean and the atmosphere in driving the AMV. While the preindustrial simulations are integrated without external forcing, thus entirely driven by internal variability, the historical simulations include the external forcings and can be used to attribute the residual variability

to human emissions when compared to the relative preindustrial simulation. In addition, the Ph.D. Candidate will analyze the Single Model Initial conditions Large Ensemble (SMILE), which is an archive of ~8 models that provided an ensemble of simulations integrated with the same external forcings boundary conditions but initialized from different initial conditions in the atmosphere. The SMILE models provide a unique dataset that, albeit exploiting a smaller sample of models, allows for accurate identification of the role of human and natural emissions from the internal variability.

Special attention will be given to climate impacts due to the AMV in the above set of model simulations and available observations. While some previous studies have found significant correlations of temperature and precipitation patterns due to the AMV in some single model studies and single observational datasets, there is a gap in understanding the impacts of the AMV on societies, especially over the European continent. In addition, since the ocean circulation (namely, the AMOC ocean current) and the AMV are believed to be strongly coupled and the AMOC is a tipping element of the climate system, it is plausible that abrupt changes in the AMOC could lead to drastic changes in the impacts of the AMV. Hence, the Ph.D. Candidate will be the first one to systematically investigate a very large archive of publicly shared data and observational datasets, with a special focus on societal impacts. For this purpose, we plan to leverage the machine learning and the big data expertise in our group and at Politecnico di Torino to build a novel approach for analyzing big datasets and extract meaningful information of AMV impacts to better prepare societies for future changes in the climate.

Research team and environment

The reference person (Katinka Bellomo) is a Marie Curie Individual Fellowship holder for 2021-2023 with a related project ('CliMOC: Climate Impacts of the Atlantic Meridional Overturning Circulation). Katinka holds a Ph.D. In Meteorology and Physical Oceanography from University of Miami and has previously worked as a postdoctoral scientist at Columbia University and the National Research Council of Italy (CNR). She has documented expertise in the proposed topic, including a publication that was published on Science. She has experience collaborating on projects and also supervising Ph.D. Students. In addition she maintains active collaborations with several research groups in Italy, Europe and the United States. Jost von Hardenberg, full professor at Politecnico di Torino would be the official supervisor to the Ph.D. Student, and there would be a group of close collaborators: Oliver Mehling who is a Ph.D. Student working at Politecnico and funded by the ITN Ph.D. Program ('Critical Earth'), and additional collaborators from the National Research Council-Institute of Atmospheric Science and Climate (CNR-ISAC) in Torino and Bologna (Paolo Davini, Virna Meccia and Susanna Corti) who are leading experts of climate variability and change. Additional funding that is related to this topic comes from H2020 project TiPES (Tipping Elements in the Climate System) and ROADMAP (The Role of ocean dynamics and Ocean-Atmosphere interactions in Driving cliMAte variations and future Projections of impact-relevant extreme events): both of these projects were funded to a consortium of international research centers and universities, with whom the Ph.D. Candidate would be able to collaborate during their Ph.D.

The Ph.D. Candidate would therefore be exposed to a large and vibrant research community through existing funded projects and networks from the supervisors, nationally and internationally.

Suggested skills for this research topic

- computation skills: python, matlab, ncl or similar language

- familiarity with shell scripting and unix environment

- background in physics, earth system science, meteorology, oceanography, engineering, math or similar

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.03

Curriculum: 1. Earth System and Environment

The Urban-Water-Food-Energy NEXUS for resilience against global, and climate change

Reference Person: Bocchiola Daniele (daniele.bocchiola@polimi.it)

Host University/Institute: Politecnico di Milano

Research Keywords:	Urban resilience to climate change Water food energy nexus. Nature Based Solutions
Reference ERCs:	PE10_17 PE10_3 PE10_14
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 7: Affordable and Clean Energy, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Cities worldwide experience unprecedented increasing urbanization, and despite the significance of cities and mega-cities in our societies, our ability to sustainably design urban systems is limited. The New Urban Agenda, adopted by the United Nations Conference on Housing and Sustainable Urban Development in 2016, acknowledged that cities "if well-planned and well-managed" can be a "powerful tool for sustainable development for both developing and developed countries", but there is a need, among others, for "nature-based innovations", i.E. For green based resilience measures, or nature based solutions NBSs.

Global and climate change affect livability of cities in several ways, i.E. I) extreme weather events and hardly manageable water cycle (floods, droughts), ii) thermal discomfort (Urban Heat Island UHI), and health risk (heat waves), iii) loss of food security and famine (e.G. Developing countries, cash-crops), and iv) energy shortage (e.G. For conditioning).

Sustainable development goals SDGs by UN, among others explicitly call for i) Sustainable Cities, and Communities (11), ii) Climate Action (13), iii) Zero Hunger (2), and iv) Affordable, and Clean Energy (7).

United Nations recently set forward the Water-Food-Energy WFE Nexus approach, considering the connection between these three resources, as a central tool for sustainable

development. At the urban scale, demand for these resources is increasing, more largely in cities, driven by rising population, rapid urbanization, changing diets, and economic growth.

Objectives of the proposal are

1) Investigating the Urban-Water-Food-Energy UWFE potential to aid urban resilience in the face of ever increasing demand for water/food/energy, under global/climate changes.

2) Investigate 2-3 representative cities worldwide, and design UWFE based resilience plans in the face of global/climate change.

Research activity, and methods adopted will include

1) Assessment of present key literature, including i) urban scale impacts of global and climate change, physical reasons, and magnitude, ii) potential countermeasures adopted, iii) state of the art for notable case study towns worldwide.

2) Choice of at least 2-3 representative (mega)cities worldwide. Such cities will be both in Europe (e.G. Italy, Milan), and in developing countries (e.G. Asia-Singapore, Africa-Nairobi), to cover at least three continents, i.E. With different impacts at the urban scale, and a wide array of different socio-economic conditions.

3) Conceptual modeling of the interconnected processes of the UWFE Nexus. Physically based, spatially distributed modeling of the UWFE process, including e.G. I) urban thermal regimes, urban heat island UHI, ii) urban water cycle, precipitation, runoff (surface water depth), evapotranspiration (e.G. Using Poli-Hydro model, or others, daily scale), iii) Potential for urban agriculture, and yield, rain-fed, and with irrigation, and food supply thereby (e.G. Using Poli-Crop model, or others), iv) assessment of energy demand, price, and potential for energy supply, e.G. Peri-urban hydropower (run-of-river plants, using Poli-Power, Poli-Price models, or others).

4 Development of urban development scenarios, including climate/demographic/land use changes (scenarios from IPCC AR5/6, and other models, with proper local validation/downscaling), and subsequent depiction of the impact thereby upon the UWFE Nexus.

5) Assess countermeasures for urban resilience using NBS solutions under the UWFE approach.

Research team and environment

Politecnico di Milano is a public University, strongly oriented towards scientific and technological research, ranked as the 1st Italian Technical University, and one of the top technical universities in Europe. The team contributing to this project (POLIMI unit) the Department of Civil and Environmental Engineering DICA, and to the Water Science and Engineering (SIA) section. The department has 14 laboratories, including the “Gaudenzio Fantoli” hydraulic laboratory with several measuring, modeling and computational facilities and devices. The research activities of the Water Science and Engineering Groups (SIA

Section, 9 permanent staff, 10+ PhD students, 3+ Temporary Research Assistants) cover the study of climate change, hydrometeorology, design and construction of water structures, such as irrigation canals, river defenses, aqueducts and sewers, inland and maritime waterways, hydroelectric plants, reclamation and water management. With Daniele Bocchiola as the coordinator, Climate-LAB is the Interdepartmental Climate Change Laboratory of Politecnico. The C-Lab (https://www.Climatelab.Polimi.It) has a dedicated space within Politecnico, a staff of 10+ professors from four participating departments, 5 people (PhD students) dedicated to the management of the Lab, and has a reservoir of expertise in the field of water resources, climate change science, mitigation and adaptation strategies, IPCC data handling, and scenario making.

Suggested skills for this research topic

The candidate should have general skills in the field of

1) Basics of Mathematics, and Physics, Earth Sciences (geology, climate, hydrology), and Climate Change.

2) Basics of programming, and use of scientific soft-wares (e.G. Matlab, Excels, ARCGISs, Python, etc..)

3) Acceptable knowledge of English, spoken, written.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.04

Curriculum: 1. Earth System and Environment

ARCTIC AMPLIFICATION AND EXTREME EVENTS IN THE MEDITERRANEAN REGION

Reference Person: Bordoni Simona (simona.bordoni@unitn.it)

Host University/Institute: University of Trento

Research Keywords:	Climate change Extremes Polar amplification
Reference ERCs:	PE10_3 PE10_2 PE6_12
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Over the past few decades, Arctic surface temperatures have increased at roughly twice the rate as the global mean surface temperature, through a phenomenon referred to as Arctic amplification. One of the most evident and dramatic manifestations of this accelerated warming in the Arctic is the loss of sea ice, which is causing a decrease in the planetary albedo with significant impacts on the Earths climate both at the local and global scales.

This research project will investigate mechanisms of both Arctic amplification and of its remote influences. More specifically, it will explore the possible impacts of high-latitude warming on the position, strength and waviness of the jet stream. It has in fact been hypothesized that a less intense jet stream, as a result of the weakened meridional pole-to-equator temperature gradient, might be more wavy, with potential significant impacts on the frequency and duration of extreme events, such as blocking, over Europe and the Mediterranean region. This is at however at odds with the future decline of blocking projected by climate models, and exact mechanisms remain debated.

The project will begin with a careful and systematic evaluation of blocking events in the ERA5 reanalysis and other observed data and their possible relation to Arctic temperatures and circulation patterns. Hypotheses emerging from this observational analysis will then be tested with numerical simulations in the model hierarchy. These will include simulations with

idealized and realistic atmospheric general circulation models, in which ice albedo effects will be parameterized in simple ways and in which sea surface temperature anomalies will be imposed in the Arctic region and/or elsewhere, as well as analysis of Earth System Model outputs in the CMIP6 archive and Large Ensemble simulations. This hierarchical approach will help shed light on the underlying processes behind future changes in blocking and reduce the associated uncertainty. It will also better quantify projected changes in the impacts of blocking, such as those related to temperature extremes, that have enormous societal relevance.

Research team and environment

The PhD candidate will work in the vibrant and diverse environment provided by the atmospheric physics group at the University of Trento, with skills and interests ranging from mountain meteorology to climate and largescale atmospheric dynamics. Unitn is the home of the recently established Masters of Science program in Environmental Meteorology joint with the University of Innsbruck, Austria, and offers a wide range of training and seminar activities. The projects supervisor has recently returned to Italy after twenty years in the United States, and is involved in several international collaborations and activities, including panels, workshops and summer schools. Worth of notice is her involvement in a European project aimed at developing and applying Storm-Resolving (that is, very high resolution) Earth System Models to the study of anthropogenic climate change. As they become available, these global simulations at unprecedented resolution will be leveraged as part of the research project. The PhD candidate will be fully immersed in and will greatly benefit from the very active, international and broad research program led by the supervisor.

Suggested skills for this research topic

The PhD candidate is expected to have a background in physics, math, earth and environmental sciences or related disciplines, as well as experience in the analysis of observational data and/or numerical simulations. Previous training in meteorology, atmospheric physics, oceanography and/or climate dynamics will be considered a plus.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.05

Curriculum: 1. Earth System and Environment

Multi-risk assessment and sustainable adaptation of marine coastal environments

Reference Person: Critto Andrea (critto@unive.it)

Host University/Institute: University Ca' Foscari Venice

Research Keywords:	Multi-risk assessment
	Marine coastal environments
	Machine and learning
Reference ERCs:	PE10_3 Climatology and climate change
	PE6_11 Machine learning, statistical data processing and applications using signal processing (e.G. Speech, image, video)
	PE4_18 Environment chemistry
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Marine Coastal Ecosystems (MCEs) worldwide, their services and the societal goods and benefits they provide, play a central role in the achievement of Sustainable Development Goals and biodiversity targets.

However, located at the land-sea interface, they result to be highly threatened by the complex interplay between human-induced (e.G., e increasing populations and coastal development, exploitation and use of marine space and resources) and climate change pressures (e.G., rising sea temperature, coastal extreme events). All these pressures lead in concert to severe multi-risk scenarios affecting MCEs ecological status and resilience and their capacity to deliver services for human well-being. In this setting, Nature-based solutions have gained increase attention as a tool for sustainable climate adaptation and mitigation that can rise biodiversity while providing benefits to people. They play a pivotal role in facing physical impacts affecting coastal areas (e.G., shoreline erosion), mitigate water quality degradation of seas, while reducing disaster risks arising from extreme events through the enhancement of the ecosystems' adaptive capacity and resilience.

Despite the recognized importance of MCEs as contributors to human well-being, little is known about their potential in mitigating climate-related risks, and very few nature-based solutions have been implemented so far in the marine environment. This is mainly due to the complexity and limited access to MCEs and the lack of empirical approaches able to frame

and model spatio-temporal dynamics of MCEs response to climate change, and the mid and long-term effects of such adaptation measures to face with them.

Progress in understanding and predicting these dynamics represents a priority for coastal and marine researchers to design and up-scale ecosystem-based management and conservation strategies for MCEs to face climate change and human-made pressures. In recent years, the exponential growth in digital data released by multiple sources and sensors for environmental applications and monitoring (e.G., earth observations, drones, social media), has boosted the research community to test machine and deep learning algorithms, leveraging the potential of big data to model MCEs response to climate change and provide support to sustainable climate adaptation and mitigation.

The here proposed research topic addresses the challenge of multi-risk assessment and adaptation planning in marine coastal areas, trying to unravel and model most relevant ecosystem processes under an integrated appraisal framework embracing physical, environmental and human aspects. Particularly, we will try to connect climate hazards and ecosystem-based management of MCEs with data science and machine/deep learning technologies, to provide effective decision-making tools for management and planning bodies.

Particular attention will be paid to machine learning-based models (e.G., Artificial Neural Network, Graph Neural Networks) and innovative digital technologies (e.G., big data applications, geospatial visualization tools) unlocking new opportunities for a significant transformative change in the way we assess, and then adapt, to climate-related risks, safeguarding MCEs while transforming society.

Research team and environment

We will make available to the PhD candidates the laboratories, tools and infrastructures of the CMCC@Ca'Foscari. CMCC@Ca'Foscari is the research centre on climate change of Ca'Foscari University of Venice, the result of a strategic partnership with the CMCC Foundation, ÄîEuro-Mediterranean Center on Climate Change (CMCC). CMCC@Ca'Foscari is today the most important climate research centre developed by an Italian university. Its multidisciplinary task force includes climatologists, economists, chemists, and statisticians, conducting national and international research on the interaction between the climate, the environment, the economy, and society. The Fellow will benefit from CMCC's computational modelling infrastructure, including one of the most powerful supercomputers in Europe, dedicated to the climatic modelling and forecasting and to the assessment of the economic repercussions of climate change. The Fellow will be provided with a workstation with his own desk (fully equipped with PC, printer, Wi-Fi access, etc.); full access to the infrastructures, services, equipment, libraries and laboratories to carry out the project; Free access to various academic courses; access to University and Council Libraries; a personal e-mail; profile on Ca'Foscari and CMCC website; access to online scientific journals, and access to international and EU professional databases. Ca'Foscari provides classrooms, boardrooms, and main halls for meetings seminars, lectures, conferences, and exhibitions. The efficient

research management will be comprised of administrative and financial execution of projects, personal assistance, and support for the organization of meetings, and implementation of dissemination, communication, and outreach activities. Ca'Foscari and CMCC observes high-level health, safety, and security standards at the workplace, in conformity with national legislation. The beneficiary will be offered with an international and multi-disciplinary environment that is non-discriminatory and transparent in its recruitment and professional advancement. Furthermore, professional supervision and career mentorship, a periodic research review and evaluation, and a stimulating research and training atmosphere are all guaranteed for the Fellow's career advancement.

For this scholarship it is planned a period of internship at *Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici - CMCC, Venezia*

Suggested skills for this research topic

- Knowledge of the impacts of climate change and extreme events on marine coastal areas;
- Knowledge of environmental risk assessment frameworks and methodological approaches;
- Experience in data compilation and handling;
- Experience in the development and validation of Machine Learning models (e.G. Neural Networks) for the spatio-temporal analysis of environmental systems dynamics and detection of environmental patterns in marine coastal areas;
- Programming skills in R and Python;
- Good knowledge of GIS tools.
- Excellent communication and writing skills in English.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.06

Curriculum: 1. Earth System and Environment

Assessing fresh water availability under climate change

Reference Person: Deidda Roberto (rdeidda@unica.it)

Host University/Institute: Università di Cagliari

Research Keywords:	Stochastic and hydrological modelling
	Droughts and climate change
	Water management
Reference ERCs:	PE10_3 Climatology and climate change
	PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
	SH7_6 Environmental and climate change, societal impact and policy
Reference SDGs:	GOAL 1: No Poverty, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Climate change is heavily affecting several meteo-hydrological processes, and primary rainfall and temperature regimes, with consequent impacts on the future availability of fresh water.

In such context, this PhD research project will focus on the reconstruction (in the past) and the projection (in the future) of the hydrological balances in the major catchments in Sardinia (Italy). Sardinia is an island in the centre of the Mediterranean Sea, which was affected in the past by prolonged drought periods, that are expected to exacerbate in frequency and severity under climate change.

Specifically, the research will be aimed at a better understanding of the meteo-hydrological dynamics and at a characterization of the intra- and inter-annual variability of the main hydrological fluxes. While the projected temperature increase will be one of the main causes for the increase of rainfall extremes rainfall, according to Clausius-Clapeyron equation, the occurrence of rainfall events will be more intermittent and annual rainfall amounts are expected to decrease. Moreover, the increase of evapotranspiration, driven by changes in temperature, will alter the soil moisture dynamic, with impact in the agriculture and the availability of fresh water.

The PhD candidate will develop and apply different and complementary approaches to characterize the dynamics of water partitioning and the statistical properties of the main hydrological flux components impacting frequency and severity of droughts. Such methods include e.G. Statistical analyses of available meteo-hydrological time series, exploitation of remote sensing observations, stochastic and hydrological modelling.

Results from this PhD research will contribute to the assessment of the future availability of fresh water in Sardinia and will provide the knowledge base to regional water agencies and policy makers. Outputs are expected to be employed for planning and designing new water reservoirs and new infrastructures (e.G. Water pipelines and interconnections among reservoirs to cope with local water deficits), and to help decision makers in implementing policies of water exploitation, that can effectively cope with drought risks.

Research team and environment

The research team will involve researchers of the Hydrology Group at the Department of Civil and Environmental Engineering and Architecture (DICAAR) at the University of Cagliari (Italy). Further cooperation is foreseen with other research bodies and universities, in Italy and abroad (e.G., Arizona State University, University of Reading, University of Patras, University of Quebec, the Center for Advanced Studies, Research and Development in Sardinia, among others; as well as water management authorities and civil protection agencies). The research activities include hydraulic and hydrologic modelling, statistical hydrology, climate change impacts and are supported by several national and international grants.

For this scholarship it is planned a period of internship at *Ente Acque della Sardegna*

Suggested skills for this research topic

Background on global and local water cycle and hydrological processes.

Background on statistics and probability: experience in the treatment and analysis of meteo-climatic and hydrological data will be positively evaluated.

Familiarity with programming languages such as MATLAB, R, Python, etc.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU1.07

Curriculum: 1. Earth System and Environment

Global warming and natural disasters

Reference Person: Di Carlo Piero (piero.dicarlo@unich.it)

Host University/Institute: University 'G. D'Annunzio' of Chiti-Pescara

Research Keywords:	Climate change
	Atmospheric events
	Climate scenarios
Reference ERCs:	PE10_3
	PE10_1
	SH1_1
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The proposed research is focused on the analysis of the impact of global warming and changes of the precipitation regimes on severe meteorological events such as tornados, flooding and drought, in the last decades. The analyses will range from the regional to the European scale and will be completed with future projections under different scenarios. The socio-economic consequences will be a further research activity.

Research team and environment

The research team includes a full professor of atmospheric physics, a full professor of business administration and climate, 2 assistant professors and a post doc.

Suggested skills for this research topic

Candidates with good skills in programming and data analysis are appreciated. Background in physics, engineering, environmental science, chemistry is desirable.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of

University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.08

Curriculum: 1. Earth System and Environment

Mathematical modeling of green energy transition

Reference Person: Flandoli Franco (franco.flandoli@sns.it)

Host University/Institute: Scuola Normale Superiore

Research Keywords:	Interacting agent models
	Stochastic models and methods
	Mathematical study of Extreme events
Reference ERCs:	PE1_13 Probability
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The PhD candidate will be addressed to investigate modeling of a community of agents (like people or companies) which respond to a variety of inputs related to the green energy transition: moral issues, governmental rules, subsidies and taxes, reciprocal influences and people-companies feedbacks. The tools will include agent based models, mean field models, games and mean field games, stochastic dynamics, differential equations and Markov chains. This is a very interdisciplinary research direction with existing collaboration between the group of Scuola Normale Superiore and members of other Curricula of the PhD program, in particular "Theory, Institution and Cultures". Among the mathematical and conceptual challenges, We shall investigate the link between the agent-based dynamics described above and concepts like tipping points and extreme events, other topics in climate dynamics which are under investigation by the research group of Scuola Normale Superiore.

Research team and environment

The team is composed by the PI (Franco Flandoli), two structured researchers (Giulia Livieri and Alessandra Caraceni), three post doc (Ruojun Huang, Milo Viviani, Leonardo De Salvo), 7 PhD candidates (Umberto Pappalettera, Andrea Papini, Alessandro Bondi, Eliseo Luongo, Silvia Morlacchi, Tommaso Cortopassi and Gianmarco Del Sarto). The environement, namely the Scuola Normale Superiore is extremely rich of opportunities. The project will profit of the collaboration with Scuola Sant'Anna of Pisa and IUSS of Pavia

Suggested skills for this research topic

Good background on probability, stochastic analysis, differential equations; some background on numerical computations, mathematical statistics, mathematical physics.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.09

Curriculum: 1. Earth System and Environment

Role of the air-sea coupling and small-scale ocean processes on regional climate along coastal areas.

Reference Person: Fosser Giorgia (giorgia.fosser@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Sea-atmospheric interaction
	Ocean and atmospheric modelling
	Coastal areas
Reference ERCs:	PE10_21 Earth system modelling and interactions
	PE10_2 Meteorology, atmospheric physics and dynamics
	PE10_3 Climatology and climate change
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The relevance of air-sea interactions on climate variability and climate change at large scale is widely documented; however, little is known on the impact those interactions on the regional climate, especially over coastal areas.

Convection-permitting models (CPMs) are km-scale atmospheric model that explicitly represent deep convection without the need for a convective parameterization, which is a known source of model error and uncertainties in regional climate models (RCMs). It has been showed that CPMs provide a more realistic representation of local processes thus improving, among the others, the inland advection of showers coming from the sea and the sub-daily precipitation statistics and extremes. This leads to a greater confidence in their projections of future changes. However, CPMs are often not coupled with the ocean models and use sea surface temperature (SST) as boundary conditions at much lower spatial resolutions than the RCMs or CPMs grid mesh.

The Mediterranean Sea is often referred to as an ocean in miniature due to the variety of processes occurring therein. These include strong air-sea interactions, active mesoscale and sub-mesoscale dynamics and a permanent thermohaline overturning circulation. Moreover, this area is very well covered by both observational network of meteorological

stations and regular oceanographic campaigns providing observations of the ocean-atmosphere coupled system. Ocean mesoscale in the Mediterranean Sea is characterized by a Rossby deformation radius of 5-10 km. In consequence, the SST often shows narrow and sharp fronts with associated strong temperature gradients that can significantly modify the air-sea interaction and affect the climate evolution. Ocean mesoscale also plays a crucial role in the main mechanism of heat uptake by the ocean, namely dense water formation, which modelling requires both atmospheric and oceanic high spatial resolution.

This research aims to investigate the added-values of a more realistic air-sea interaction on the regional climate especially along the coastal areas of the Mediterranean Sea at sub-daily scale. Particular emphasis will be pose at the impact of the resolution of the ocean and atmospheric component in the coupled model. Comparison can be done with uncoupled model and validated with observational dataset.

The study will be conducted in collaboration with the Climate Modelling Laboratory of ENEA, that already developed and uses the regional couple model WRF-NEMO. The selected candidate will need to increase the resolution of the atmospheric component of the coupled model to reach to convection-permitting scale and test the ocean-atmosphere coupling strength with sensitivity tests. The selected PhD student will be based in Rome but expected to travel to Pavia when required.

Research team and environment

The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA) within IUSS, Pavia. The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

The research activity will be based at the Climate Modelling and Impact Laboratory of the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) at the Casaccia Research Centre (Rome). The primary mission of the Laboratory is to study and model the climate system for projecting the impacts of climate variability and future scenarios on society and natural resources at spatial scales most relevant to humans, ecosystems and the national productively system. The numerical models developed and applied in the Laboratory are of different complexity and realism spanning from global models to high resolution regional climate models mainly focused on the Euro-Mediterranean area. The Laboratory promotes the development of Climate Services at both national and

international level, implementing climate information transfer protocols and products for the energy, water and coastal region management, food emergency, tourism and agriculture. The laboratory is actively involved in international and national research initiatives on climate, energy and environment.

Suggested skills for this research topic

The ideal candidate should have experience with the FORTRAN language and be familiar with atmospheric or/and ocean modelling. Knowledge of the climate physics, statistical analysis, large climate dataset will be beneficial.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU1.10

Curriculum: 1. Earth System and Environment

Seasonal forecasts for climate impact assessment

Reference Person: Gaetani Marco (marco.gaetani@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Climate variability
	Climate modelling
	Climate predictions
Reference ERCs:	PE10_2
	PE10_3
	PE10_21
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 7: Affordable and Clean Energy, GOAL 12: Responsible Consumption and Production

Description of the research topic

Effective policies for the adaptation to weather and climate related impacts rely on the availability of skilful predictions at diverse timescales. Weather forecasts and climate predictions are nowadays widely used in impact studies, and an increasing focus is being placed on forecasts at seasonal (i.E. Out to several months) forecasts. The seasonal time scale is in fact crucial in the activity planning of several key socio-economic sectors, such as energy, agriculture, and health, among others. Over the last decades the seasonal prediction skill has considerably improved, and it is now considered useful for societal applications. However, seasonal forecasts need to be better exploited/improved further and their economic value need to be quantified properly (depending on the region, season and/or sectoral application).

The objective of this research programme is to determine the usability and value of seasonal forecasts for climate impact assessment in specific socio-economic sectors. Available forecast products, possibly combined and optimized from multi-model ensembles, will be analysed to compute the skill for essential climate variables like precipitation and temperature, circulation patterns and related metrics in targeted regions and seasons. The analysis and evaluation of the seasonal forecast skill need proper observational datasets and high-resolution reanalysis products for comparison. For applications as in agriculture or renewable energy sectors the analysis of climate variables and related metrics will be

extended to the related climate impact indicators (e.G. Renewable energy potentials and drought indices).

Research team and environment

The activities will be carried out in the CARISMA group at IUSS Pavia, in close collaboration with the CNR-ISAC in Bologna.

The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

The Institute of Atmospheric Science and Climate of the National Research Council of Italy (CNR-ISAC) aims at the understanding of the atmosphere, climate and Earth system sciences in a multidisciplinary approach. One of its main research areas, CAMEO (climate and meteorology, modelling and earth observations) combines theoretical, experimental and numerical applications for climate variability and predictability/predictions, from sub-seasonal to multi-annual timescale, on diverse spatial scales (from global large-scale to individual meteorological events).

IUSS and ISAC-CNR are actively committed towards internationalisation, inclusion and diversity.

Suggested skills for this research topic

The ideal candidate should have a strong background in data analysis and statistics (analysis of probability distribution functions, uncertainties, etc.) and be familiar with the management of large datasets. He/she should have basic knowledge of climate dynamics, climate change and the associated impacts. Some knowledge and preliminary understanding of numerical modelling can be an added value.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and

Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.11

Curriculum: 1. Earth System and Environment

Coccolithophore growth rate and calcite production under high CO2 levels

Reference Person: Lupi Claudia (claudia.lupi@unipv.it)

Host University/Institute: University of Pavia

Research Keywords: Coccolithophores
CaCO3 production
Cellular physiology

Reference ERCs: PE10_3 Climatology and climate change
PE10_6
PE10_9

Reference SDGs: GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Coccolithophore, unicellular calcifying microalgae, significantly impact the atmosphere-ocean CO2 exchanges and the carbon cycle since geological time (Monteiro et al., 2016). Despite being only 1% of the Earth photosynthetic biomass, they store as much carbon as terrestrial plants thanks to their fast renovation time (Falkowski, 2012), assessing up to 10% of the global C fixation (Poulton et al., 2013).

Among the 200 living species of coccolithophores, this project focuses on Helicosphaera carteri a species considered resistant to many environmental stressors (≈†upraha et al., 2015) including highly polluted waters (Dimiza et al., 2014). Through a pilot study, we observed that H. Carteri cultivated under high CO2 level (700 ppm) reaches faster growth rates showing better preserved and bigger coccospheres than experiments at lower CO2. Thus, the CaCO3 production, the C uptake and storage, increase with increased CO2 levels. It has been demonstrated that small alterations of growth rate can affect the calcite production up to 50% (Sheward et al., 2017) with significant differences in the geometry and number of coccoliths on the coccosphere. As growth rate and cell size are the main drivers of calcite production, it is very important to understand which environmental parameter mainly affects them, and thus the cellular physiology. Being CO2 the main climate variable attracting the scientific and public interest, in this research we will deepen the CO2 effects on coccolithophore physiology exploring coccolithophores potential towards CO2 biofixation and biomass production under controlled CO2 conditions, studying the impact of climate change on future scenarios for the calcite production and export.

To do so, we will reconstruct the morphological, and thus physiological, variations of H. Carteri induced by different levels of CO2. The experiments on cultures will be carried out at the National Center for Oceanography and Experimental Geophysics (OGS) in Trieste and in the context of international collaborations. A 3D reconstruction of the coccosphere and its coccoliths would allow to identify different cellular development under low to high CO2 scenarios. We will also deepen on past and future climate/environmental drivers studying the geochemical information extracted from cultured H. Carteri. Geochemical analyzes of the trace elements will be performed on coccoliths in collaboration with Elettra synchrotron of Trieste (proposal already approved). The acquisition of the element maps will provide new evidences on the specific-element distribution on the coccolith which is still poorly known, shedding light on both the physiological processes involved in the elements' incorporation and the relationships with the surrounding environmental and climate conditions.

By knowing in depth the repercussions of environmental parameters on physiology will it be possible to understand the impact of future climate change for the production and export of calcite and the role of coccolithophores in the global carbon cycle.

Research team and environment

The selected candidate will be employed for three years at the University of Pavia (Italy) in a young and dynamic team. The PhD candidate will have access to facilities concerning the study of deep marine sediments in the coccolith content at both optical and electronic microscope. Moreover, he/she is expected to collaborate with national and international outstanding institutions such as the National Institute of Oceanography and Applied Geophysics (OGS) of Trieste, the Elettra synchrotron of Trieste or the Tongji University of Shanghai.

Suggested skills for this research topic

Successful candidates are expected to have a background in geology, marine biology or ocean chemistry with interest in biogeochemistry and climate changes. Previous research experience with coccolithophores will be a plus. We are looking for a candidate who knows how to work both in a team and independently, and he/she is willing to test him/herself with pioneering and transdisciplinary researches. The research is in collaboration with the National Center for Oceanography and Experimental Geophysics (OGS) of Trieste.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and

Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU1.12

Curriculum: 1. Earth System and Environment

Impact of European open fire emissions to greenhouse and reactive gas atmospheric variability

Reference Person: Maione Michela (michela.maione@uniurb.it)

Host University/Institute: University of Urbino Carlo Bo

Research Keywords:	Changes in Atmospheric Composition
	Impact on climate
	Impact on health
Reference ERCs:	PE4_18
	PE10_1
	PE10_2
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Open fires (both uncontrolled or prescribed burning of forests and crops) are a global phenomenon mostly related to human practices with a large spectrum of impacts ranging from environment to society and economy and affecting ecosystems as well as human health and property. In the last years, the exceptional wildfires in the Amazon and in the Arctic have raised the public attention and awareness over this phenomenon that affects and consumes large amounts of vegetation across wide regions and modifies Earth surface characteristics.

Although globally, the dominant biomass burning regions are sub-Saharan Africa, South America, and equatorial Asia, an average of approximately 4500 km2 is burn every year in the Mediterranean region. Due to the project increase of average temperatures and more frequent dry conditions, the Mediterranean region is expected to be affected by significant increases in the burned areas under different scenarios of global warming. Some studies indicated that activity of fire suppression and preventive management reduced or stabilized fire occurrence but did not affect the incidence of large (>500 ha) fires, which are less responsive to fire control efforts.

Wildfires emit a large number of greenhouse gases (CO2, CH4, N2O) and reactive gases (e.G. NM-VOC, NOx) which are precursors of aerosols and ozone. At global scale, some studies indicated an average total annual greenhouse gas emissions of 7.3 PgCO2, 16 TgCH4, and 0.9 TgN2O which, using a 100-year time horizon and based on global warming potentials of 34 for

CH4 and 298 for N2O, translates in 8.1 PgCO2 equivalent annually, or 23% of global fossil fuel CO2 emissions .

The main goal of this research project is to investigate the impact of open fires to the atmospheric variability of some of these key-species, finally providing an estimate of GHG and NM-VOCs emissions related to these events. The focus will be the European domain and fires occurring in this region, with a special emphasis on the Mediterranean basin. The project will base on the integration of in-situ observations (like those performed in the framework of atmospheric RIs ICOS and ACTRIS) with atmospheric transport simulations and gridded dataset (like GFED or GFES fire emission inventory).

Since a correct knowledge of the data creation process and of the related physical uncertainties are the prerequisite for a correct utilization of a dataset, during the PhD work, the student will gain confidence with the principal techniques for the observations of greenhouse gas and reactive gases (special emphasis on NM-VOCs). The student will treat massive amount of data provided by European reference networks for the atmospheric observations of these chemical species (like ICOS-RI and ACTRIS-RI), atmospheric transport-chemistry models and gridded dataset. Thus, it is pivotal that the student will gain confidence on advanced tools for the statistical analysis of data. A period (minimum 6 months) of study abroad is advised to one leading laboratory in Europe devoted to the use of atmospheric observations to derive GHG and reactive gas emissions (e.G. LSCE in France, MPI in Gemany or NILU in Norway).

Research team and environment

The training will take place at the University of Urbino Carlo Bo under the supervision of Prof. Michela Maione and Prof. Umberto Giostra from the departments of Pure and Applied Sciences, in strict collaboration the Institute of Atmospheric Sciences and Climate (CNR-ISAC). Research activities carried out at UNIURB that are relevant for the proposal are: chemical and physical basis of climate change, analytical methods for measuring atmospheric composition changes and atmospheric modelling. Michela Maione is professor of environmental chemistry. Her research is in the field of atmospheric composition change in relation to air quality and climate change. She is responsible for the long-term programme for observations of climate altering and ozone depleting substances and of volatile organic compounds at the GAW-WMO station of Monte Cimone. This activity is carried out within international networks, such as AGAGE and ACTRIS. She has authored more than 100 publications and is Lead Author in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Umberto Giostra is professor of climatology. His main activity concerns theoretical, numerical and experimental studies on atmospheric turbulence structure, on meso-scale motions (meandering and gravity waves) and on dispersion modelling. He has authored more than 60 publications in peer-reviewed journals. Has been involved as PI or WP leader in more than 20 research projects. Has supervised more than 30 Master's Degree theses (Physics and Environmental Sciences), more than 20 PhD

theses. He has tutored more than 20 post-doc and CNR (Italian Research Council) research fellows.

Suggested skills for this research topic

Knowledge about atmospheric chemistry and physics

The capability of performing data analyses

Knowledge about analytical techniques for atmospheric trace gases

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.13

Curriculum: 1. Earth System and Environment

Hydropower generation in the Italian Alpine under a changing climate

Reference Person: Majone Bruno (bruno.majone@unitn.it)

Host University/Institute: University of Trento

Research Keywords:	Hydropower generation
	Water resources management and optimization
	Hydrological and human systems interactions
Reference ERCs:	PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
	PE10_21 Earth system modelling and interactions
	PE6_12 Scientific computing, simulation and modelling tools
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 13: Climate Action

Description of the research topic

Water resources are under threat by the combined effect of climate change and overexploitation for agricultural, industrial and human consumption. To gain knowledge and better inform future directions in the water sectors this research topic aims at developing a suite of models, organized as digital twins of the intertwined natural and technological systems, for simulating the complex interplay between water needs and stresses caused by climate change and the uneven distribution of water demand.

In particular, the objective of this research project is to analyse the impact of climate change and the energy market on hydropower production of the Italian Alpine Region (GAR). The analysis will be conducted by means of the multi-scale hydrological model HYPERstreamHS recently developed by the Hydrology group of the University of Trento. The model will simulate the hydropower production and the associated streamflow alterations by modelling explicitly the functioning of relevant hydraulic infrastructures. The main research lines are the following:

- Implementation of a model of hydropower production able to simulate the operation of the hydropower plants according to the modelled water availability (the model will also simulate the altered streamflow downstream of the hydropower plants). This model will be prodromal to the development of a twin digital model of hydropower production.

- Scenario analyses of climate change impact on hydropower production in the Italian Alpine region including assessment of the vulnerability of the main hydropower systems. In addition, the role of reservoirs as energy storage systems complementing other renewable energy sources, namely solar and wind energy, will be investigated also in relation to climate change scenarios. Transition to pumped-storage solutions will be also considered to exploit the transfer of large water volumes in hours of relatively low electricity prices.

- Effect on hydropower production of the evolution of the electricity market as fostered by the development of new storage technologies and projected changes in wind and solar energy production.

- Development of tools for the analysis of the water conflicts and related mitigation strategies for enhancing the resilience of the energy-water nexus.

Research team and environment

The prospective candidate will work in the active and stimulating environment provided by the Hydrology group at the Department of Civil, Environmental and Mechanical Engineering of the University of Trento. The candidate will collaborate with post-docs and temporary researchers hired in the context of several funded national and international projects. In this respect, the candidate will benefit from the active, international and broad research program led by the supervisor.

Suggested skills for this research topic

The candidate is expected to have a background in civil/environmental engineering, earth and environmental sciences or related disciplines. Furthermore, the candidate is expected to have a strong mathematical background, strong programming skills (e.g. C++, FORTRAN, Python, MATLAB) and a desire to perform modelling work within the context of the climate-water-energy nexus. Fluent spoken and written English, as well as good communication skills, are also required.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU1.14

Curriculum: 1. Earth System and Environment

Monitoring of water quality of natural rivers exploiting image processing techniques

Reference Person: Manfreda Salvatore (salvatore.manfreda@unina.it)

Host University/Institute: University of Naples Federico II

Research Keywords:	Image velocimetry
	Image processing
	River monitoring
Reference ERCs:	PE8_11
	PE10_17
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

In the coming years, water management will face critical challenges due to the concomitant impact of global warming, population growth, and pollution. There is therefore an urgent need to identify new strategies for river monitoring to support water budget and quality assessment. The main goal of this project is to develop a new generation of monitoring systems based on RGB, multispectral and thermal cameras combining image processing, Earth Observations (EO), and Artificial Intelligence (AI). The research will build on current knowledge in image-based hydrological monitoring to explore novel advancements in unsupervised computer vision techniques for river monitoring. Camera systems on fixed stations, onboard of drones, and on smartphones will be exploited to collect streamflow observations that will be used to train existing and ad-hoc developed models for the estimation of discharge, solid transport and surface pollutants.

The study will be carried out exploiting camera systems combined with satellite observations to interpret the expected impact of climate and land use changes on the hydrological processes and water quality. Satellite and camera observations along with traditional measurements will be used to develop algorithms based on Artificial Intelligence (AI) which will help the description of river hydrological response and water quality parameters.

The proposed methodologies will be tested a heavily polluted Italian river, which is also a complex environment to install monitoring networks. Our study site will be the Sarno River, which is considered the most polluted river in Europe and one of the ten most polluted rivers in the world.

Research team and environment

HydroLAB coordinated by Prof. Salvatore Manfreda is operating in the department DICEA of the University of Naples Federico II which is a leading institute in hydraulic construction and hydrological studies particularly devoted in the optimization of water management systems. HydroLAB is developing new innovative technologies for environmental monitoring using remote sensing and camera systems. The environment is a stimulating and challenging one with a strong and significant international dimension.

For this scholarship it is planned a period of internship at *Consorzio di Bonifica Integrale, Comprensorio Sarno, Nocera Inferiore (SA)*

Suggested skills for this research topic

Hydraulic engineering, image processing, programming, remote sensing and data processing

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU1.15

Curriculum: 1. Earth System and Environment

Extreme events and associated atmospheric circulation patterns

Reference Person: Martina Mario (mario.martina@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Atmospheric circulation patterns
	Extreme events
	Climate change impact
Reference ERCs:	PE10_3
	PE10_2
	PE8_3
Reference SDGs:	GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Weather-related extreme events may have a strong societal and economic impact on human activities. In the context of the accelerating global warming, the frequency and intensity of extreme events is increasing and projected to further rise in the future. Reliable predictions are then crucial to implement effective actions for impact assessment and mitigation. However, reanalysis products and global climate models still struggle in correctly represent extreme events, because of the intrinsic difficulty in simulating physical processes characterised by low probability . Nonetheless, most of weather-related extreme events are associated with large-scale atmospheric circulation patterns which are generally well represented in climate models, and can be then used to characterise and predict the occurrence of these events.

This research programme will focus on the characterisation of weather-related extreme events through the analysis of the associated circulation patterns. The analysis may target: heat waves, dry spells, atmospheric rivers, heavy precipitation, wind storms, storm surges, and natural and anthropogenic aerosol outbreaks. The scientific objectives are: 1) to identify the atmospheric circulation patterns associated with the occurrence of extreme events; 2) to use them as predictors to reconstruct the event occurrence in the past and project it in the future. To this aim, data from surface observational datasets (E-OBS, CRU), atmospheric reanalysis products (ERA5, CAMS) and climate models (CORDEX, CMIP6) will be analysed. The

results of this research are expected to provide useful insights for the assessment and mitigation of climate change impacts.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development.

For this scholarship it is planned a period of internship at *CRIF SpA, Bologna*

Suggested skills for this research topic

The ideal candidate should be skilled in the fields of Physical and Mathematical Sciences, Earth and Environmental Sciences or Civil Engineering, with a strong background in statistics. Specific skills in the field of climate science will be considered a plus. Moreover, the candidate should be strongly motivated to work in a pluralist and multi-disciplinary environment, collaborating with the STEM and social scientists of the CARISMA research centre.

Type of scholarship and obligations

The type of this scholarship is: Dottorati Innovativi (Innovative PhD course). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.16

Curriculum: 1. Earth System and Environment

Advances in carbon accounting: circularity and responsibility in composite systems

Reference Person: Pulselli Federico Maria (federico.pulselli@unisi.it)

Host University/Institute: University of Siena

Research Keywords:	GHG accounting Life Cycle Thinking Composite processes
Reference ERCs:	SH7_6 Environmental and climate change, societal impact and policy SH7_5 Sustainability sciences, environment and resources PE10_3 Climatology and climate change
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

Systematic monitoring and accounting process are fundamental tools for the control and the mitigation of the greenhouse gas (GHG) emission into the atmosphere. The IPCC provides a well-known method for GHG accounting by means of the 2006 guidelines and 2019 refinement. Its long-standing and widespread adoption for monitoring the emission at national or subnational level (relevant the case of the province of Siena, that reached the Carbon Neutrality already in 2011, also thanks to a systematic monitoring procedure – see Bastianoni et al., 2014), helps identify and quantify, via bottom-up approach, the emission sources that contribute to the anthropogenic greenhouse effect. The progressive adoption and application of these physics-based methods of environmental accounting may help integrate the information more commonly used for policy-making, related and limited to economic growth, financial stability, employment results. Different systems for GHG emission accounting exist and the adoption of each one brings about that, in turn, may generate different implications, solutions and policies at different levels. In fact, the wide debate on how to assign the responsibility of GHG emission plays an important role in the research fields of mitigation of, and adaptation to climate change. The main efforts that have been done so far are focused on the macrosystem (especially country) level, investigating, for instance, how to discriminate between producer and consumer countries, importer from exporter ones, also including phenomena like decentralization, delocalization, or decoupling.

The proposal here presented adapts the responsibility approach to the micro- or the meso-system, introducing significant research perspectives to the use of the traditional methods of GHG accounting. Special attention will be paid to the adoption of the Life Cycle Thinking approach to GHG estimation and accounting, and responsibility assignment, respectively. Specifically, the accounting can be extended to include the indirect emissions (or process emissions), in order to calculate the effects of the production and consumption of goods and services in terms of the so-called Carbon Footprint (namely, accounting the GHG emission throughout the life cycle of the products or flows analyzed) in a system in which a set of subjects (production units, companies) are involved in a composite process made of phases that can be connected with each other. The main aim of the research is to find ways to highlight, measure and increase the mutuality, the cooperation, and the circularity of the whole system and mitigate the impact on the environment (in terms of emission reduction). The investigation will focus on production sectors or macro-sectors in order to highlight (if any) or encourage circularity aspects, measured based on the results deriving from the application of the above-mentioned accounting methods. The approach, first refined theoretically, will be applied to different systems. Examples of great interest are the use, re-use and recycle of agriproducts and agricultural residues, integration of agriculture and rearing activities, the use of timber as material for building to replace concrete, circle closure in industrial districts, and waste management strategies.

Research team and environment

The University of Siena considers sustainability as a strategic task and hosts the UN-SDSN hub for the Mediterranean Area. The PhD candidate will work in the Department of Physical Sciences, Earth and Environment in which many research groups operate in the Environmental and Earth System Science fields. The PhD candidate will work within the Ecodynamics Group, a multidisciplinary research team that has been dealing with sustainability and climate change for three decades. The group has extensive experience in compiling GHG inventories at territorial level, certification tools, Life Cycle Assessment and Carbon Footprint, applied in multiple contexts and to various systems (territorial, productive, etc.). Other projects of the group are based on sustainability assessment of systems and processes, GHG emission responsibility assessment; environmental accounting system development; dissemination and education. The Ecodynamics Group is currently made of 2 full professors, 2 associate professors, 1 technical-administrative staff, 3 technologists, 2 scholarship holders, and 3 PhD students. The Ecodynamics Group has also relevant international collaborations such as Manfred Lenzen from the University of Sydney, Marianne Thomsen from Copenhagen University (DK), Steven J. Davis from the University of California Irvine, Ken Caldeira from Stanford University (USA), Enrico Benetto from the Luxembourg Institute of Science and Technology (LUX), Mathis Wackernagel from the Global Footprint Network (USA).

Suggested skills for this research topic

The PhD candidate is expected to have a background in environmental science, sustainability foundations, assessment and indicators.

The candidate must have proficient English and familiarity with the most common software for data computing. Knowledge of GHG accounting method, Life Cycle Assessment and other environmental accounting methods is seen as a significant merit.

The candidate should be motivated and open-minded, available to develop and share his/her experience in a transdisciplinary environment. He/she must be available to stay in Siena and also travel for both education and research purposes.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.17

Curriculum: 1. Earth System and Environment

Knowledge, citizen awareness and policy of marine shallow-water biodiversity

Reference Person: Rosso Antonietta (rosso@unict.it)

Host University/Institute: University of Catania

Research Keywords: Biodiversity and changes in species occurrence and ranges in relation to global warming and the diffusion of Non-Indigenous Species in Sicily

Communication of science to the public and policy makers

Production of seachable dataset and GIS maps for management

Reference ERCs: LS8_2 Biodiversity

LS8_3 Conservation biology

LS8_13 Marine biology and ecology

Reference SDGs: GOAL 4: Quality Education, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Global change, often associated to and exasperated by particular human activities, is increasingly and dramatically affecting life in the seas with effects that are more relevant and apparent in shallow waters.

In the Mediterranean basin, the global increase in temperature and the persistence of high temperature values for longer and longer time spans during the so-called heat wave events, as well as the increasing frequency of such events has been documented mostly in northern sectors, in the last two decades. The most striking effect is the mass mortality of the most stenothermic and vulnerable species with consequent impoverishment of the local biodiversity and degradation of habitats. Further consequences include the northward shift of the distribution range of thermophilic taxa, with several examples from the north Adriatic and the Ligurian and Provençal seas, and the successful naturalisation of species entering mostly through the Suez Canal from the Indo-Pacific region. In an already compromised state, this flux (often anthropogenically mediated and exasperated) of non-indigenous species (NIS) contribute to banalise habitats that are also and contemporarily subject to further natural/anthropogenic stresses including super exploitation, pollution, perturbation in deposition rate, and so on , ...).

In this context, and owing to the scantiness of data still available for Sicily (that are mostly dispersed in literature including grey literature), it would be relevant to produce a large

dataset and a GIS map of the occurrence of marine benthic and nektonic species, using historical information and new data to evaluate the entity of expected shift in species distribution and the NIS arrival. This could be achieved through special surveys and the involvement of local population (citizen science) contemporaneously promoting awareness of topics related with biodiversity in the public. Whenever possible, historical meteo-marine data will be collated in order to investigate possible relationships with biological information. Molecular analyses could be used to define the state of particular species. The expected output could serve to policy makers as a tool to decide about the opportunity or not to undertake measures to safeguard and maintain biodiversity.

Research team and environment

The research project will be carried out in collaboration with:

Università degli Studi di Catania (UniCT), at the Paleoecological Laboratory of the Dipartimento di Scienze Biologiche, Geologiche e Ambientali where a team of researchers has been engaged for years in studies aboutpresent-day Mediterranean biodiversity, especially focusing on selected benthic groups.

Università degli Studi di Catania (UniCT), at the Paleontological Museum: this structure I manage, could represent one of the sites for exhibitions and events to disseminate achievements to the public.

Agenzia Regionale per la Protezione dell'Ambiente (ARPA Sicilia) e più dettagliatamente con l'Unità Ambiente Marino Costiero: this instituton could provide historical data and collaboration in field activities, in data storage and management.

Stazione Zoologica Anton Dohrn di Napoli which could provide collaboration for taxonomy of particular groups and molecular analysis of selected specimens.

Suggested skills for this research topic

Knowledge in marine animal and plant taxonomy

Knowledge on benthic habitats and environmental factors

Skills in processing large amount of data

Skills in communication of science

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.18

Curriculum: 1. Earth System and Environment

BlogeochemiCal fate of emerging Anthropogenic pollutants in the sedimentary Record

Reference Person: Sabbatini Anna (a.sabbatini@univpm.it)

Host University/Institute: Università Politecnica delle Marche

Research Keywords:	Sedimentary record of anthropogenic impact
	Experimental approach based on Foraminifera
	Experimental approach based on Geochemistry
Reference ERCs:	PE10_9 Biogeochemistry, biogeochemical cycles, environmental chemistry
	PE10_6 Palaeoclimatology, palaeoecology
	PE10_12 Sedimentology, soil science, palaeontology, earth evolution
Reference SDGs:	GOAL 4: Quality Education, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Marine debris is a global environmental issue. The chemistry of water and sediments, thus environmental quality and eventually the whole trophic chain, are affected by the dispersal of plastics and chemicals. Smoked cigarette butts (CBs) are the predominant human coastal litter item together with plastic debris and associated substances that can be bioaccumulated in marine organisms. CBs represent a vector for the transport and introduction of toxicants, including mainly nicotine, harmful metals, total particulate matter and known carcinogens, to aquatic habitats. Additives in plastic, like phthalates, could cause negative impacts on organisms and accumulate along with the food web.

The aim of the project will be to study the impacts of smoked CB and associated toxicants and phthalates on selected species of benthic foraminifera, a group of unicellular eukaryotic organisms, widespread inhabitants of coastal sediments forming part of a key link in marine trophic chains. We want to test the effects of these emerging pollutants on benthic foraminifera using an experimental laboratory approach combined with mesocosms setup.

In particular, foraminiferal cultures of common coastal benthic species will be used to investigate both cellular and metabolic stress after acute and chronic toxicity assays, incorporation of pollutants and potential effects on the biocalcification processes.

Mesocosm experiments will be performed in coastal areas that undergo an important anthropic seasonal pressure (i.E., touristic zones, offshore outfalls).

Furthermore, we will search for the baseline of the CBs and plastic related impact in sediment cores spanning the last hundred years; this will be of huge importance to evidence trends in the accumulation useful to understand what can be expected for the future. Consequently, as CBs and plastic pollution represent an urgent social and economic problem that requires attention from manufacturers, users, authorities, and the public to prevent the ingestion by biota and water pollution from its leachate, a further and even more important aim of this project will be to promote the consciousness at the community level stimulating activities and strategies (i.E., citizen science) for reducing CBs and plastic litter in the environment. To increase the awareness of environmental problems and gain ecological management, to preserve the Earth's well-being, the research outputs not only will be available for the main stakeholders (ISPRA, ARPA, regions, natural parks) but also be converted in social campaigns targeting beach users or beach clean-ups and in take-action projects sensitive to climate change.

Research team and environment

The Stratigraphy Sedimentology and Paleocology laboratory at the Polytechnic University of Marche (UNIVPM - Department of Life and Environmental Science - DISVA), is the laboratory where the project will be developed. The research activities are focused on the study of sediments and their textural and (paleo) ecological content. The Research Team is young and dynamic and it is devoted to the study of foraminifera to understand the ongoing changes either due to anthropogenic or natural changes. In addition, the functioning mechanism behind biomineralization (and the molecules involved) is basic to understanding the biomineralization process from a geochemical perspective. In fact, it is possible to record environmental and climate changes from the shell isotopic and trace element compositions. Coupling geochemical and biological perspectives will enhance the interpretation of the proxies used for climatic reconstructions and improve future modelling efforts. The Research Team collaborates with chemists of the same University working on the cellular effect of natural and synthetic bioactive molecules; it is active, also, a collaboration with physical oceanographers experts on quantitative methods in marine science. The UNIVPM offers the possibility to use the Actea Mobile Laboratory to collect sediment and water samples and hosts the ""Aquarium"" Laboratory representing a unique infrastructure at the National level that could accommodate the experimental culture area for foraminifera. Recently, thanks to the Italian Excellence Department Projects, the DISVA of UNIVPM has developed a well-advanced technical platform fully equipped for chemical analyses of all classes of environmental pollutants and ecotoxicological analyses.

Suggested skills for this research topic

Successful candidates are expected to have a background in geology, marine biology or ocean chemistry with an interest in biogeochemistry and climate change. Previous research experience with foraminifera will be a plus. We are looking for a candidate who knows how to work both in a team and independently, and he/she is willing to test him/herself with pioneering and transdisciplinary researches.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.19

Curriculum: 1. Earth System and Environment

MEDICHANGE - MEDIcanes risk in a climate CHANGE scenario

Reference Person: Scicchitano Giovanni (giovanni.scicchitano@uniba.it)

Host University/Institute: Università degli studi ""Aldo Moro"" di Bari

Research Keywords:	Medicanes risk Coastal flooding Sea level rise scenario
Reference ERCs:	PE10_13 Physical geography, geomorphology
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 14: Life Below Water

Description of the research topic

Under ongoing global warming, a global mean sea-level rise is expected for the 21st century (IPCC, 2021 Bamber et al., 2019; Rahmstorf et al., 2012), this could enhance the effects of extreme marine events that, in the future, will probably impact on the coastal landscapes currently emerged. The vulnerability along some part of the Mediterranean coasts is also increasing in response to the occurrence of tropical-like cyclones, known as Medicanes MEDIterranean hurriCANE, which are able to generate wide flooding. Recent studies conducted along the cost of south-eastern Sicily (Scicchitano et al., 2021) demonstrated that generally Medicanes generate storm surge much higher respect seasonal storms, implying that coastal hazard of areas prone to Medicanes occurrence should be better assessed. The Project MEDICHANGE aims to: i) monitor the development and the impact of Medicanes along the Italian coasts of south ionian basin (Sicilia, Calabria, Basilicata and Puglia), ii) define a specific numerical modelling to describe Medicanes propagation on coastal area and calculate their maximum flooding and storm surge, iii) reconstruct the multi-temporal flooding scenarios at 2050 and 2100, for the studied area, using vertical land movements (VLM) and topographic data together with the Intergovernmental Panel on Climate Change (IPCC 2021) projections of SLR in the Representative Concentration Pathways RCP 2.6 and RCP 8.5 emission scenarios, iv) modelling Medicanes propagation and impact, along the studied coastal areas, for scenarios reconstructed at 2050 and 2100, v) GIS analyses for the assessment of Medicane risk at 2050 and 2100. During the Project MEDICHANGE, detailed field survey will be performed after the impact of Medicanes, along the Italian coasts of south ionian basin, in order to reconstruct the maximum flooding of the events. Detailed morphological and environmental data will be acquired through the use of different terrestrial (Laser Scanner, LIDAR, GPS RTK, Unmanned Autonomous Vehicle) and marine (Multi Beam Echo Sounder, Side Scan Sonar, Sub Bottom Profiler) survey techniques and equipment. Data

will be used to define a numerical model, specific for Medicanes, able to accurately estimates storm surge and maximum flooding. Field survey will also focus on the detection of evidences of past Medicanes, with this purpose will be selected coastal lagoon, in the geographic sector object of study, were to perform cores. The global sea-level rise (SLR) projections for the next few decades will be realized taking into account vertical land movements (VLM), evaluated through the analyses of geodetic data from global navigation satellite system (GNSS), synthetic aperture radar interferometric measurements (InSAR), and sea-level data from tidal stations to show the combined effects of land subsidence and SLR along the studied coastal areas.

Research team and environment

The team is composed by several researchers in the SSD GEO/04, two professors (Giuseppe Mastronuzzi and Giovanni Scicchitano), three researchers (Giovanni Scardino, Angela Rizzo and Antonella Marsico) and one PHd student (Teresa Denora). The team develops its researches within the activities of the Department of Earth and Environmental Science of the University of Bari and of the Interdepartmental Research Center for Coastal Dynamics of the University of Bari. It is specialized in: i) analyses of sea level rise during the Holocene through the use of morphological, sedimentological and archaeological data, ii) reconstruction of the impact of marine extreme event along coastal areas, iii) propagation modelling of marine extreme events, iv) reconstruction of multi-temporal flooding scenarios for coastal plain at 2050 and 2100, v) application of Machine and Deep Learning techniques for the assessment of hydrodynamic parameters from videos, vi) application of terrestrial and marine survey techniques in coastal environment. The group manages a laboratory equipped with several terrestrial (Laser Scanner, LIDAR, GPS RTK, Unmanned Autonomous Vehicle) and marine (Multi Beam Echo Sounder, Side Scan Sonar, Sub Bottom Profiler) survey instruments, and various work stations dedicated to processing, remote sensing and GIS analyses.

Suggested skills for this research topic

The candidate will need the following skills for successful conduct the proposed research: i) knowledge of the geomorphological coastal processes, ii) experienced in terrestrial or marine geophysical survey, iii) experienced with data processing and GIS analyses, iv) predisposition to actively participate to multi-tasking field survey campaigns in costal environment.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.20

Curriculum: 1. Earth System and Environment

Disaster risk reduction in coastal areas affected by climate change

Reference Person: Soldati Mauro (mauro.soldati@unimore.it)

Host University/Institute: Università di Modena e Reggio Emilia

Research Keywords: Impacts of climate-related processes on coastal areas

Understanding coastal processes toward correct land management and conservation

Integrated risk assessment and relevant mitigation/adaptation measures

Reference ERCs: PE10_20 Geohazards

PE10_13 Physical geography, geomorphology

PE10_14 Earth observations from space/remote sensing

Reference SDGs: GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Climate change is heavily impacting coastal areas resulting in both short-term (e.g. storm surges, marine inundation) or long-term processes (sea level rise) that determine disaster risk situations and remarkable socio-economic implications. The land-and-sea interface (the so-called `white ribbon' area) is extremely sensitive to climate change effects and remarkably important for coastal scientists and managers dealing with coastal dynamics. Under the current effects of climate change, it is necessary to draw special attention to this environment, which is often unexplored or not adequately investigated. A sustainable management of coastal shores would be possible through a holistic approach to risk assessment taking into consideration the interaction between subaerial and submarine processes. In this context, this PhD project will foresee integrated geomorphological mapping, monitoring and modelling of selected sites of the Mediterranean, merging ground-based, satellite, aerial remote sensing, as well as marine surveys.

The thesis will focus on the morpho-dynamics of coastal areas enhanced by climate change effects by investigating the whole coastal system, from the cliff edges to the seafloor. The research project may include direct measurements to be carried out in the short- and medium-term, using cutting-edge technology such as X-band radar, multibeam surveys (including back-scatter analysis), ROV and USV mapping, video-monitoring, UAV and TLS surveying, Optical RS and SAR interpretation. Special attention will be given to coastal risk assessment and mapping, by taking into consideration the hazard component, on the one

hand, and the vulnerability component, on the other hand. The frequency and intensity of extreme events have changed drastically over past decades, implying that even recent hazard assessments become unreliable for future decades, and need revision and update.

The outputs of the thesis - including an original methodological approach and newly acquired datasets - can be of interest to managers and end-users, as a tool for a more sustainable and cost-effective management of coastal assets under climate threat. In this respect, the thesis is expected to provide data acquisition and interpretation tools that can serve as a reliable ground for understanding the causes and effects of coastal risks, so as to sensitize relevant authorities to build a collective understanding of how adaptation and mitigation measures can be planned and performed toward an improved governance of coastal risk.

Research team and environment

The PhD student will be part of the Geomorphology Team of the Department of Chemical and Geological Sciences, which is coordinated by the Reference Person of this research topic. The Team comprises 4 staff members (1 Emeritus Professor, 1 Full professor, 1 Associate Professor, 1 Researcher), 2 contract lecturers, 2 contract researchers, 2 PhD students and a number of Master students. The research group has the capacity to provide appropriate training to PhD students and early career scientists thanks to the experience acquired in long-standing national and international research and teaching activities.

The Team has been involved in numerous research projects on coastal risk assessment funded by the Council of Europe in the frame of the EUR-OPA Major Hazards Agreement, and has a long-standing research experience in the field of climate-related geohazards, disaster risk reduction, and land management and sustainable development.

The PhD student will have the chance to interact with the staff in an informal and stimulating atmosphere, and to become part of international research network characterized by an interdisciplinary vocation.

According to the final content of the PhD research, different options for the required stay abroad will be offered to the grantee thanks to the wide network of collaborations with foreign universities and research centres established in recent years by the Reference Person.

Suggested skills for this research topic

The candidate should be able to:

- Recognize and understand geomorphological processes and landforms in coastal areas

- Deal with geological and geomorphological datasets in a GIS environment

- Approach hazard and risk analyses

- Work in a multidisciplinary team and in an international context.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.21

Curriculum: 1. Earth System and Environment

Quantum-chemical approaches to spectroscopy and reactivity for atmospheric chemistry

Reference Person: Tasinato Nicola (nicola.tasinato@sns.it)

Host University/Institute: Scuola Normale Superiore

Research Keywords:	Quantum chemical calculations
	Atmospheric spectroscopy, reactivity and kinetics
	Greenhouse gases, ozone depleting substances
Reference ERCs:	PE4_13 Theoretical and computational chemistry
	PE4_18 Environment chemistry
	PE4_12 Chemical reactions: mechanisms, dynamics, kinetics and catalytic reactions
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The release in the atmosphere of greenhouse gases (GHGs) and ozone depleting substances (ODSs), mainly produced by anthropogenic activities, is the driving force of global climate change. To understand their impacts and eventually plan mitigation actions, different chemical and physical information relevant to their atmospheric chemistry needs to be determined. On the one side, spectroscopic data, very notably in the infrared region, are required for the interpretation of observational measurements carried out through remote sensing techniques, but also to quantify the radiative forcing of GHGs. On the other side, their atmospheric fate needs to be explicitly characterized, to identify possible harmful degradation products, atmospheric sinks, and ultimately atmospheric lifetimes. The spectroscopic characterization, as well as the determination of chemical reaction rate coefficients and product yields, have traditionally been achieved by laboratory experiments. This, however, is a formidable task, very resource demanding and time-consuming, mainly because of the complexity of the experimental techniques (especially when unstable species are present), the number and variety of molecules involved, and the plethora of chemical processes that take place in different atmospheric environments. For those reasons, theoretical and computational quantum chemistry has become an essential tool in the investigation of topics related to atmospheric chemistry in the last years.

In that context, the project aims at developing and applying computational protocols for the determination of spectroscopic properties of GHGs and ODSs, and the understanding of their loss processes. To become effective, the accuracy reached by the applied computational strategies needs to compete with that of the most refined experimental techniques. This ideally means accuracies within 1 cm-1 for vibrational frequencies, 1 kcal mol-1 (at least) for reaction enthalpies and a factor of 2 for rate coefficients. State-of-the-art computations are carried out to investigate the atmospheric gas- and heterogeneous-phase degradation mechanisms and reaction pathways of volatile organic molecules, thus allowing the identification of reaction products and intermediates, from which the corresponding thermochemistry and chemical kinetics can be derived. The outcomes of the research are expected to give insight into the atmospheric degradation mechanisms of the targeted species, and to fill the existing gaps of knowledge concerning rate coefficients of reactions with main atmospheric oxidants. Hence, it is expected that the results will provide new data for improving the atmospheric modelling of those chemical species and for evaluating direct and indirect effects on climate and air quality.

Research team and environment

The research activity is carried out at the SMART Laboratory (https://smart.Sns.It/) of Scuola Normale Superiore. The SmartLab is dedicated to the development of advanced theoretical models for computational chemistry, their implementation in a number crunching simulation software and application to several chemical issues, with particular emphasis on environmental sciences and astrochemistry/astrobiology. The Laboratory has extensive facilities for developing software and running large-scale atomistic simulations and it manages the Avogadro Computational Cluster. This is equipped with more than 100 servers and 3000 CPUs and with storage with up to 300 TB of raw space for long term conservation of data. The cluster also includes three fat nodes with a high number of dedicated cores (80, 160 and 240, respectively) and massive amounts of RAM (from 4 to 6 TB), ideal for running high demanding calculations completely in memory. Several compilers, libraries and calculations suites are installed and maintained both open source or licensed. SMART also hosts an immersive virtual reality (IVR) laboratory equipped with powerful graphic workstations and last-generation IVR hardware and an immersive CAVE3D theater equipped with Optitrack IR sensors. While the SMART laboratory provides the required infrastructure for the theoretical and computational researches, laboratory experiments can be carried out thanks to ongoing collaborations.

The team comprises:

- Vincenzo Barone (Full professor)

- Nicola Tasinato (Associate professor)

- Zoi Salta (Post Doc, SNS)

- Carmen Baiano (PhD)

- Rais Nadjib (PhD)

- Gianluca Rinaldi (PhD)

- Sandra Monica Vieira Pinto (PhD)

Suggested skills for this research topic

Basic knowledge in Thermochemistry, spectroscopy, chemical kinetics, electronic structure and quantum chemistry.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU1.22

Curriculum: 1. Earth System and Environment

Urbanization influence on climate change by remote sensing data

Reference Person: Teggi Sergio (sergio.teggi@unimore.it)

Host University/Institute: Università degli Studi di Modena e Reggio Emilia

Research Keywords:	Urbanization
	Urban Heat Island and Surface Urban Heat Island
	Remote sensing
Reference ERCs:	PE10_3 Climatology and climate change
	PE10_14 Earth observations from space/remote sensing
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The correlation between urbanization and climate change is a current and important topic, still not fully defined and studied in many multidisciplinary research fields.

Urbanization is a very complex phenomenon, characterized by many features such as demographic variations, land use changes in urban areas and the growth of settlements and of infrastructures near urban centres (periurbanization or urban sprawl).

Alterations in urbanization involves variations in several parameters that drive the local climate, as the presence of impervious surfaces, soil albedo, thermal and/or greenhouse gas emissions, vegetated and humid areas. The resulting climatic variations most frequently observed are the increase in air temperature (urban heat island - UHI), the increase in surface temperature (surface urban heat island - SUHI) and the frequency of extreme weather events.

The main goal of this project is the study of the correlation between the urbanization increase, with particular reference to urban sprawl, and some climatic changes in the Po Valley in the last 30 years. In order to analyse this aspect also on a local scale, some cities will be included in the study, starting with Modena, for which a large dataset of meteorological and remote sensing images are available..

To evaluate urbanization, several models found in literature will be considered, focusing on models that involve satellite observations. Remote sensing images allow to characterize the urban fabric using surface albedo, vegetated or non-vegetated surfaces, water bodies, surface texture, artificial night lights. This last parameter represents an aspect that has only

recently been included in urban characterization. Furthermore, other spatial parameters will be used, such as CORINE land cover (Copernicus-EU).

The climate change phenomena studied will essentially be UHI and SUHI. The time series of surface nightly and daily temperature maps, will be obtained from remote sensing images in thermal infrared (such as MODIS on a regional scale and Landsat8 / TIRS on a local scale). The climatology of the air temperature near the ground on a regional scale will be obtained from the reanalysis data of the European Centre ECMWF (ERA5-Land reanalysis), while at the local scale the data of the local meteorological stations will be included. In the case of the city of Modena, data from the Modena Geophysical Observatory will be used.

Other spatial data will also be considered such as greenhouse gas emissions databases and local cartography (e.G. Urban plans, road network).

At the end of the project, a model will be defined to estimate some climate change components related to the urbanization increase. This model will contribute to the sustainable development activities of cities, to the understanding of climate change and to the choice of consequent corrective actions for the mitigation of climate change.

Research team and environment

The research activities will be conducted within the LARMA Laboratory of the Enzo Ferrari Engineering Department (www.Larma.Unimore.It) and at the Modena Geophysical Observatory belonging to the same Department (www.Ossgeo.Unimore.It). The research team is composed by three professors, three research technicians, two postdocs and two PhD students. The team members have expertise in remote sensing, urban heat island and surface urban heat island, geographical information systems, atmospheric modelling and dispersion and numerical simulation. Since 1860, the Geophysical Observatory has been dealing with measurements of meteoclimatic parameters such as temperatures, humidity, wind speed and direction and precipitation (it was recognized in 2020 as ""Long-term Observing Station"" by the World Meteorological Organization). Direct and diffuse solar radiation, and radiation in the UV band are also measured in the Observatory. The LARMA laboratory is equipped with numerous software and tools for processing satellite images (ENVI, Definiens Ecognition) and includes dedicated HPC resources.

For this scholarship it is planned a period of internship at *Istituto Nazionale di Geofisica e Vulcanologia, Roma*

Suggested skills for this research topic

The candidate should have a solid background in physics, earth/environmental sciences or related disciplines, data analysis and processing. Skills in climatology and remote sensing data processing are also useful.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU1.23

Curriculum: 1. Earth System and Environment

Redesigning Deltas in a time of climate change

Reference Person: Tosi Maria Chiara (mariachiara.tosi@iuav.it)

Host University/Institute: Università Iuav di Venezia

Research Keywords:	Sustainable Deltas region Scenario building Long term strategies
Reference ERCs:	SH7_6 SH7_7 SH7_9
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The delta areas in the world are dynamic systems where considerable natural resources interact with high population density and significant production potential. These areas of confluence between fresh and salt water are among the most active and innovative areas on the planet, where fast-growing metropolises compete with wetlands with a high level of biodiversity.

The climate crise affecting the entire planet is radicalized in these regions, so that coastal erosion, the rise in the average sea level, subsidence, the intrusion of sea water with the subsequent salinization of groundwater and irrigation systems, flooding and droughts all reveal the increasing fragility of the deltas, jeopardizing the very survival of the people who live there and the local productive activities.

The PhDs main objective is to explore new conceptual and analytical approaches for develop and implement inclusive and situated pathways to sustainable deltas, testing innovative tools and overcoming the emphasis on short term solutions which constrains options to consider sustainable solutions on the long term. Centered on design and design-based approaches the research will seek to explore new strategies and scenarios that consider the delta a living territory where different forces and materials intertwin. New strategies and projects will be compared with the short and long term climatic forecasts providing scenarios that matters not in just one direction (solely water-related, for example) but consider a variety of issues which could be integrated with visions involving the deltaic environment as a whole.

Research team and environment

The PhD candidate will take advantages of the laboratories, tools and infrastructures of the research clusters based at Iuav University of Venice. Their multidisciplinary task force includes urban designers, planners, economists, ecologist, civic engineers conducting national and international research on the interaction between the environment, the economy, and society in the climate crisis. The candidate will benefit from Iuav infrastructures. Iuav runs among others, PhD programs in Urbanism, Planning and New technologies; therefore the environment is very rich of interaction with other PhD candidates and with professors in several disciplines, with the opportunity to attend seminars and courses of great interest. The group has intense research contacts with other institutions in Italy and abroad.

Suggested skills for this research topic

The PhD candidate is expected to have a background in architecture, urbanism, planning as well as experience in the analysis and design of fragile coastal territories. Previous training in architecture, urban design and urban and territorial planning, will be considered a plus.
GOAL 11, 13, 15

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.