Activity 3.7 - Training future RIs research staff

Title: Climate and Ocean Change: Physical Foundations and Impacts Lab

Keywords: Radiative balance, greenhouse effect, atmosphere, ocean, cryosphere, feedbacks, internal variability, anthropogenic climate change, impacts, ocean numerical modelling, oceanographic data analysis, Copernicus Marine Service

Short description of the course:

This postgraduate course offers a concise yet comprehensive introduction to anthropogenic climate change and its impacts on the Earth system, with a particular focus on the physical and dynamical processes in the atmosphere and ocean. Starting from the fundamental principles of Earth's radiation budget and geophysical fluid dynamics, the course builds a foundational understanding of the mechanisms driving climate variability and long-term change.

The lectures will explore how the atmosphere and ocean interact within the climate system, highlighting key processes such as ocean circulation, heat transport, and feedback mechanisms. Special attention is given to major indicators of climate change, including sea-level rise, ocean warming, and the intensification of extreme events such as marine heatwaves.

Students will be introduced to Jupyter Notebooks and open-access climate datasets with a focus on those provided by the Copernicus Climate and Marine Services. Guided examples will help them explore recent trends and anomalies in ocean physics and biogeochemical variables.

Training objectives:

- Understand the physical foundations of climate change, including the Earth's radiation budget, geophysical fluid dynamics, and ocean-atmosphere interactions.
- Differentiate between natural climate variability and anthropogenic trends, using conceptual tools and observational evidence.
- Identify and describe the major physical impacts of climate change on the atmosphere, ocean, and cryosphere — such as global mean temperature and mean sea level rise, marine heatwaves, and decline in Arctic sea ice.
- Develop a basic understanding of numerical modelling techniques for ocean systems. Conduct a hands-on session introducing Jupyter Notebook. Learn how to access, interpret, and visualize climate data using open and freely available resources from the Copernicus Climate and Marine Services, and derive key methodologies for analysing ocean data.

Location: Lecce

Period: May 27 - June 6, 2025

Duration (days): 7 class days

Course delivery method (online course/in-person/mixed): in-person

Number of the speakers: 2

Name of the speakers:

- Gianandrea Mannarini
- Salvatore Causio

Short introduction of the speakers:

- Gianandrea Mannarini is a senior scientist at CMCC. His research activity focuses on the climate impacts of maritime trade, and he leads the development of the open-source ship routing model VISIR-2. He is actively involved in education and outreach on anthropogenic climate change and its impacts, with a particular focus on engaging high-school students. He has taught a postgraduate course in Meteorology within the OTTIMA program and holds the academic title of “Cultore della materia” in General Physics I at the University of Salento. He holds a Master degree in Physics from Università degli Studi di Pisa, Italy, and a PhD in Physics from the Humboldt-Universität zu Berlin, Germany.

- Salvatore Causio is a junior scientist at the CMCC Foundation and Head of the Advanced Coastal Modelling and Application Research Unit. He holds a Master’s degree in Coastal and Marine Biology and Ecology, and a Ph.D. in Geophysics from the University of Salento. His research focuses on numerical wave and circulation modelling, wave-current interactions, and the application of artificial intelligence in the marine environment. He is actively involved in developing augmented-reality numerical modelling frameworks to integrate Nature-based Solutions and assess marine hazards. He is actively involved in the dissemination of CMCC studies and activities, and has served as a lecturer, tutor, and member of the final commission for the International Sustainable Coastal Growth and Resilience CO-GROWTH School (DCC-CR – IOC/UNESCO). Salvatore is a member of the Modelling Working Group of MonGOOS and serves as the Early Career Ocean Professional contact point for the IOC/UNESCO Decade Collaborative Centre for Coastal Resilience.

Training modules

1. **Fundamentals of Climate and Ocean Dynamics (8 hours)**. Earth’s energy balance, radiation laws, and greenhouse effect. Basic principles of atmospheric and oceanic circulation. Geophysical fluid dynamics for large-scale motion. Ocean-atmosphere interactions and feedbacks. Natural climate variability vs anthropogenic drivers.

2. **Observed and Projected Climate Change (8 hours)**. Observed trends: surface temperature, sea level, cryosphere. Marine heatwaves: drivers, metrics, and impacts. Interpreting climate time series and anomalies. Climate models, future projections, and key uncertainties.
3. **Ocean numerical modelling and data analysis (8 hours):** Gain a foundational understanding of ocean numerical models. Learn to install Jupyter Notebook, set up the Python environment, and use essential libraries. Perform computations of anomalies, climatologies, spatial maps, time series, and vertical profiles for both the blue and green ocean.

Extra logistical needs: the classroom should be equipped with a video projector and, if possible, recording equipment; for the laboratory sessions the room should be equipped with internet connection and the students should carry their own laptops. The classroom should be well-ventilated or equipped with air conditioning.

Notes: -

Calendar:

	1st week				2nd week				
	27/05 Tue	28/05 Wed	29/05 Thu	30/05 Fri	3/06 Tue	4/06 Wed	5/06 Thu	6/06 Fri	
AM	10-12 Mannarini		10-13 Mannarini		10-13 Mannarini	10-12 Mannarini		10-12 Mannarini	
PM				15-17 Mannarini			14-18 Causio	14-18 Causio	
hours	2	0	3	2	3	2	4	6	22