Course title: Earth's climate and its past, present, and future changes

Modality: CFA- Advance Training Course

Orientation:
Ocean Observation and Global Change

Dates: from February 3rd to 28th 2020.

Timetable: Lectures on Monday, Wednesday, and Friday (2 hours each lecture, from 10:00 am to 12:00 pm). Practicals on Tuesday of week 2 and 3 (2 hours each practical, from 3:00 pm to 5 pm).

Duration: lectures (22 hours), practicals (4 hours).

Location: DOMAR Videoconference Room, Torre-CACTI building, Campus As Lagoas Marcosende, Universidade de Vigo

Language: English.

Academic coordinators:

Name	Institution	e-mail
Gianluca Marino	University of Vigo	gianluca.marino@uvigo.es

Lecturers:

Name	Institution	e-mail
Gianluca Marino	University of Vigo	gianluca.marino@uvigo.es

General description: Climate change poses major scientific, economic, and societal challenges. For example, climate scientists are striving to discern the natural climate variability from the one that arises from human activities. Our ability to address this problem hinges on advancing the knowledge of how: (i) the climate system as a whole operates; (ii) the atmosphere, hydrosphere, cryosphere, land surface, and biosphere change and interact with one another; (iii) the various forcing, feedback, and response mechanisms that operate on different timescales and shape the Earth's climate and promote its variability. Although there is a substantial amount of direct observations that document current climate variability (i.e., the instrumental record), the somewhat more fragmented and proxy-based evidence of past climate change (i.e., the palaeoclimate record) has proven essential to identify the amplitude and main patterns of natural (pre-anthropogenic) changes, thereby helping projections of future climate. This doctoral course covers a broad suite of topics in climate science. It provides an overview of how the climate system operates based on evidence from both instrumental and palaeoclimate records and shows how this wealth of information is used in the projections of future climate change.

Contents:

Part I: Introduction to Climate Science

1. Climate science principles and methods;
2. Earth's climate and energy budget;
3. Forcing, feedback, and response mechanisms;
4. The global carbon cycle;
5. Main patterns of current climate change.

Part II: Historical Climate Change

6. Humans and preindustrial climate;
7. Climate changes during the last two millennia;
8. Climatic changes during the last two centuries;
9. Climatic changes during the last five decades;

Part III: Tectonic-Scale Climate Change

10. Plate tectonics, weathering, CO2, and long-term climate
11. From greenhouse to icehouse: the last 50 million years

Part IV: Orbital-Scale Climate Change

12. Astronomical control of solar radiation;
13. Insolation control of ice sheets;
14. Insolation control of monsoons;
15. Orbital-scale forcing, feedbacks, and responses;
16. The Plio-Pleistocene 40,000- and the 100,000-year cyclicities;

Part V: Millennial- and centennial-scale climate variability

17. Climate change since the Last Glacial Maximum;
18. Dansgaard-Oeschger and Heinrich events during the last glacial cycle;
19. Centennial-scale climate change during the Holocene;

Part VI: Future climate change

20. The 1.5°C warming problem;
21. CO2 emissions and ocean acidification;
22. Climate projections and climate sensitivity.

Teaching methodologies: The course includes lectures and practicals with class exercises.

Evaluation system: Compulsory practicals (40 %) and a final oral presentation (60 %) on a topic related to the course contents. Both parts need to be graded as "passed" to get final assessment in the course.

Brief CV of the lecturers: Gianluca Marino (GM) is a Distinguished Researcher at the University of Vigo, within the framework of the programme of that university to attract excellent research talent. He is also Honorary Senior Lecturer at the Research School of Earth Sciences (RSES), the Australian National University (ANU, Australia). Previously, he has worked as postdoctoral researcher at the Institute of Environmental Science and Technology (ICTA) of the Autonomous University of Barcelona (UAB, Spain), at the RSES of the ANU, and has been visiting scientist at several world-class academic institutions, such as the Lamont-Doherty Earth Observatory of the Columbia University (USA).

In his research, GM uses a wide portfolio of geochemical, micropaleontological, and sedimentological tools as well as probabilistic statistics to quantitatively determine the timing, magnitude, and rates of (past) ocean and climate change. His interest primarily pertains to the episodes of climate variability that occurred on timescales of hundreds to hundreds of thousands of years. This research activity centres on three overarching topics: (i) the variability of the global ocean circulation and role that it plays in climate and in the ocean-atmosphere carbon exchange; (ii) the global monsoon variability; and recently (iii) the response of global surface temperature to climate forcing, the so-called 'climate sensitivity'. To investigate these topics, GM uses marine sediment cores from different sectors of the global ocean (Atlantic, Indian, Pacific, and Southern Oceans) as well as from the Mediterranean Sea.

GM has (co)authored 32 publications in refereed journals (88% in the first quartile; 75% in the first decile of the impact factor distribution), including 3 in the multidisciplinary journal Nature (2 as leading author), 4 in other journals of the Nature group (Nature Geoscience, Nature Communications, Nature Scientific Reports), 1 review in Annual Review of Marine Science (leading author), and 1 review in Earth-Science Reviews. He has presented 26 communications as leading author at international congresses, including 3 keynote lectures, and has been invited to present his research at 8 topical workshops and to give 15 lectures at universities and other research institutions in Europe and overseas.

Finally, GM has supervised students and has taught courses across all levels of academic education (Bachelor, Master, and PhD) and is currently engaged with promoting climate-related research within the popular science media and non-academic public, such as school students and members of cultural forums and organisations.

Relevant references: Recommended but not essential texts are:

Archer, D., The Global Carbon Cycle, Princeton University Press, 2010.

Rohling, E.J., The oceans: a deep history. Princeton University Press, 2017.

Ruddiman, W.F., Earth's Climate: Past and Future, Freeman and Company, New York, 2001.