CIVIL AND ENVIRONMENTAL ENGINEERING

DIATI - Representation of Extreme Precipitation Events and of Mesoscale Convective Systems in Very High-Resolution Global Climate Models

Funded By	Dipartimento DIATI
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Context of the research activity	This PhD project will analyze data from next-generation global climate models with extremely high resolutions (5 km), focusing on their ability to represent intense precipitation and Mesoscale Convective Systems (MCS). It will examine improvements in the models' representation of MCS structure, distribution, and statistics, the physical mechanisms at work, the impacts on spatial and temporal precipitation characteristics and on precipitation extremes, including a focus on the Mediterranean Area.
Objectives	National and local government administrations urgently need accurate climate data to implement mitigation and adaptation policies for the ongoing climate change. In this context, a recent and significant innovation in climate research is the development of a new generation of global climate models with extremely high spatial and temporal resolution, capable of reaching scales previously unattained, in the order of a few kilometers (currently 5 km globally). Specifically, the NextGEMS and the Destination Earth Climate Adaptation Twin projects (with the participation of PoliTO/DIATI to the latter) are providing simulations of global models that, for the first time, include both long historical simulations and future climate projections at extremely high resolution. These innovative models have the potential, through the explicit representation of processes which were typically parameterized in previous climate models, to lead to significant improvements in the ability to represent various aspects of the water cycle, particularly convective processes, regional precipitation biases, and related extreme events. This PhD project will have the unique opportunity to analyze (among the first in the world) the data from these climate simulations. The proposed research will focus on analyzing the ability of these models to represent intense precipitation phenomena, precipitation extremes, and in particular, Mesoscale Convective Systems (MCS). These systems, insufficiently resolved in lower-resolution models, represent a fundamental component of convective precipitation in much of the world and are responsible for extreme weather events even in mid-latitudes, including significant events associated with flash flooding in the Mediterranean area.

	The improvements in the models' ability to represent the structure, distribution, and statistics of MCS, the physical mechanisms at work, the impacts on local-scale representation of spatial and temporal precipitation characteristics, and the representation of precipitation extremes will be analyzed. The project will also analyze the effect of better water cycle representation in these models concerning impacts in the Mediterranean Area, particularly extreme phenomena such as drought or extreme precipitation, including the analysis of future projections. The proposed PhD research will greatly benefit from the existing connection with the Destination Earth Climate Adaptation Digital Twin project and in the EC-Earth modeling development consortium, exposing the candidate to a rich international scientific and technical network including ECMWF, high-performance computing centers, climate and meteorological services, and research institutions. The research will also be able to use innovative diagnostic software tools specific to high-resolution modeling, already developed within Destination Earth with the contribution of the proposing group.

Skills and competencies for the development of the activity	Master degree (Laurea Magistrale) in relevant fields (engineering, physics or mathematics). Possible experience/training/studies on climate dynamics, climate change or fluid dynamics; experience in the analysis and post-processing of meteorological or climate data (e.g. NetCDF) and using or writing associated diagnostic software. Possible knowledge of relevant programming languages (e.g. python, julia, Fortran, R) and experience in the usage of HPC environments and tools (Linux, bash scripting, CDO, Git).