CIVIL AND ENVIRONMENTAL ENGINEERING

ASI/OGS/DIATI - Tuning and climate sensitivity of the EC-Earth global climate model with simulation of synthetic radiances

Funded By	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale [P.iva/CF:00055590328] A.S.I. - AGENZIA SPAZIALE ITALIANA [P.iva/CF:03638121008]
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Context of the research activity	The research will focus on the tuning of the EC-Earth global climate model, aiming to improve climate projections and understand climate sensitivity, with novel tuning targets and methodologies. It will assess the impact of different tuning setups on climate sensitivity and warming patterns. A key focus will be on analyzing spectral radiative responses in the far-infrared spectrum using a spectral emulator to validate the model against satellite measurements, assessing tuning sensitivity.
	Modern global climate models have become more and more complex both in terms of the number of processes represented and the number of its components, while at the same time being associated with increasing computational costs due to increasing resolutions. One of the major sources of uncertainties is represented by different physical parameterizations, particularly those related to convection, cloud microphysics and aerosols, with a direct impact on the radiative balance in the models, their capability to accurately describe important climate feedbacks and their overall climate sensitivity to changes in forcing. The process of tuning the models, by reducing biases and possibly increasing the fidelity of projections, reducing or constraining uncertainties, requires both identifying suitable fields and metrics to constrain the models and, at the same time, due to the increasing computational costs, requires the development of efficient strategies and experimental tuning protocols and tools. EC-Earth is a state-of-the-art global climate model, including several Earth-System components, which participated in the CMIP5 and CMIP6 model comparison projects. A robust version (EC-Earth3) exists for current scientific studies and its latest next-generation version (EC-Earth4) is currently under development by a large European consortium in which Politecnico di Torino is participating. The proposed PhD research will specifically focus on the the investigation of the sensitivity of the EC-Earth model to changes in tuning parameters,

Objectives	considering in particular novel tuning targets and methodologies. The goal is to go beyond simple bulk radiative balance, by investigating a range of tuning targets and assessing in particular the impact of different tuning setups on the transient climate sensitivity of the model and on the warming pattern. An important area of investigation will be dedicated to the radiative response of the model to changes of parameterization parameters, going beyond simple bulk radiative balance by investigating a full spectral response by considering the use of a satellite measurement emulator, in particular the s-IASI/FORUM emulator in the far-infrared spectrum. Far-infrared wavelengths are currently unexplored from space despite covering a large fraction of the longwave radiation emitted by the planet. This spectrum contains the signatures of several climate forcings and related feedbacks, while also being highly sensitive to upper-tropospheric water vapor and cirrus clouds, and thus it's crucial for assessing Earth's radiation budget. This novel approach will provide a unique and original perspective on the validation of model simulations and on the evaluation of climate feedbacks, analyzing the sensitivity of spectral model radiances to changes in tuning parameters, in different scenarios. The development of emulators allowing to evaluate the climate model responses offline will also be considered. This project is being cofunded and will be performed in collaboration with two projects: • MC-FORUM (Meteo and Climate exploitation of FORUM), an ASI-funded project to evaluate the impact of measurements by the future FORUM mission in the climate field. • HPC-TRES ("High Performance Computing Training and Research for Earth Sciences") Joint Research Unit, dedicated to advancing capacity building and advanced formation in the fields of Earth-System modelling and of numerical methods in an HPC setting, with co-funded by HPC-TRES (through OGS - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) The research will expose the candidate also to the wider HPC-TRES community (with participation in the annual HPC-TRES workshop), to the pan-european EC-Earth development community (with an active development community and yearly meetings) and to frequent scientific exchange with the partners of the MC-FORUM ASI project.

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).