POLITECNICO MILANO 1863

ENVIRONMENTAL INTELLIGENCE LAB

Thesis title

Emulation of future precipitations under different climate trajectories using machine learning

Short description

Background

Integrated Assessment Models (IAMs) have been developed since the 90s to capture the global-scale macro-interactions in the coupled Human-Earth system. They rely on the integration of different sectoral models to describe the several components of human society and the natural ecosystem.

An example of a possible inter-sectoral integration is the linkage between the main component of the model (core) and a simple climate model (SCM). SCMs are a simplified representation of the much more complex climate system. They can compute changes in radiative forcing and temperature as a response to anthropogenic greenhouse gases emissions. Indeed, they are non-physically based descriptions of the climatic/environmental ecosystem, calibrated to reproduce a large variety of scenarios simulated by Earth-System models (ESMs). SCMs (e.g., Hector, MAGICC) usually emulate variables at the global resolution, such as mean surface temperature or CO2 concentration variations.

Recently, GCAM (Global Change Assessment Model) has been coupled with the SCM Hector (reference GCAM-USA), which includes a modular description of the atmosphere, the land, and the oceans and their changes as a response to GHG emissions.

The possibility for SCM to emulate precipitation is still an open field of research. Precipitations are expected to vary largely in the future since they will be affected by the trajectory of climate change (e.g., varying radiative forcing and temperature). The availability of future precipitations could allow researchers to provide feedback to the core of the model other than temperature and GHG concentrations, for example computing “real-time” water availability (supply) during the execution of the IAM.

Goal and objectives

The thesis’s goal is to produce an emulator for precipitations over a region of interest (case study for the Red River Basin - Vietnam). The project can be subdivided into four steps:

1. Collect data for future temperature and precipitations from the CMIP6 project under different climate and socio-economic scenarios.
2. Downscaling of projections over the region of interest (Red River Basin).
3. Construction and calibration of a deep learning/machine learning model for the emulation.
4. Validation of the emulation (comparison with the projections from CMIP6 in terms of mean/median changes and variability).

Relevant courses and knowledge: Natural Resources Management

Number of Students: 1 or 2

Requisites*:* The student should be comfortable with data handling (Matlab or R) and programming skills (Python or C++).

References

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Weber, T., Corotan, A., Hutchinson, B., Kravitz, B., and Link, R.: Technical note: Deep learning for creating surrogate models of precipitation in Earth system models, Atmos. Chem. Phys., 20, 2303–2317, https://doi.org/10.5194/acp-20-2303-2020, 2020. Aswin et al. 2018

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