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2nd YEAR MASTER'S INTERNSHIP

Academic year 2024-2025

Company: finres

TITLE OF THE INTERNSHIP PROPOSAL: Downscaling of ERA5 data for a better representation of local climate extremes in an agricultural context

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TYPE OF SUBJECT :

Theory	A little
Numerical modeling	A little
Experimentation	Not at all
Data science and analysis	A lot
Instrumentation	Not at all

SUBJECT :

Climate change is intensifying extreme weather events such as heat waves, droughts and extreme rainfall (IPCC, 2021). This affects many economic sectors, including agriculture, which is highly dependent on climatic conditions. finres is an innovative start-up developing services to support agricultural adaptation to these risks and for that, needs high spatial resolution climate data. However, the reference climate data available for most countries are very often provided at resolutions of tens of kilometers, limiting their potential for local climate analyses that are essential for decision-making.

To improve the relevance of these reference data at the local scale, downscaling techniques are applied to refine their resolution to account for local scale climate variability. Some of these methods are based on statistical or machine learning approaches (Rampal et al. 2024). Among these reference climate data is the ERA5 meteorological reanalysis dataset. This dataset is developed by the European Centre for Medium-Range Weather Forecasts (ECMWF) and has a resolution of about 25 to 31 km (Hersbach et a. 2020). It has the advantage of covering a wide range of climate variables continuously over the temporal and spatial domains, and several decades into the past.

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The aim of this internship is to develop, test and improve a machine-learning (ML) based downscaling method for ERA5 data at a resolution higher than 10 km. Key climate variables include precipitation, temperature and humidity. Given that the relationships between these climate variables are nonlinear and complex, the scientific challenge of the internship is that the method developed should be able to capture these interactions between variables, in order to avoid physical inconsistencies that could affect climate risk analyses. Under the guidance of senior supervisors, the intern will base the work on published methodologies in the scientific literature that are deemed suitable for finres.

This study could initially be carried out over France, where good quality data are available, which could facilitate the development and validation of the method. However, the country of study could be adjusted according to the needs defined at the start of the internship. The trainee will build on existing work and benefit from the support of a team with experience in machine learning and climate science.

Tasks:

1. Conduct literature review to identify machine-learning-based downscaling methodologies relevant to the study.
2. Use ML models integrating high resolution observational data from Météo-France to improve the resolution of ERA5 over France.
3. Evaluate, test and refine the model using the different reference climate datasets, to ensure it accurately represents local climate extremes and variability.
4. Write a comprehensive report on the method.

References:

IPCC (2021). Climate Change 2021. The Physical Science Basis. Cambridge University Press. https://doi.org/10.1017/9781009157896.

Hersbach et al. (2020). The ERA5 global reanalysis. Quarterly Journal of the Royal Meteorological Society. https://doi.org/10.1002/qj.3803.

Rampal et al. 2024. "Enhancing Regional Climate Downscaling through Advances in Machine Learning." Artificial Intelligence for the Earth Systems.https://doi.org/10.1175/AIES-D-23-0066.1

REMARKS:

Duration: 4 months minimum