Research and Development position on urban surface data improvement for Destination Earth On-Demand Extremes Digital Twin

Applicants are invited for a 12-month engineer position starting on 15 February 2023

The deadline for application is 20th November 2022.

The position is at CNRM (joint METEO-FRANCE and CNRS laboratory) in Toulouse, France.

Context :

Destination Earth (DestinE) is an ambitious initiative of the European Union (EU) to create a digital twin – an interactive computer simulation – of our planet. DestinE will be used to better understand the effects of climate change and environmental disasters and to permit policy makers more effectively respond to these issues. The European Centre for Medium-range Weather Forecasts (ECMWF), the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) are the three organisations entrusted by the EU to achieve this unprecedented endeavour for climate, weather and computing sciences.

A key milestone is the launch of the first two digital twins by December 2023. One of these will be the Digital Twin on Weather-Induced and Geophysical Extremes. Managed by ECMWF, this digital twin will provide capabilities and services for the assessment and prediction of environmental extremes.

Météo-France, contractor and leading partner of a European team composed of 28 environmental institutes and national meteorological/hydrological services, took part in the procurement procedure, launched by ECMWF for the provision of the On-demand Extremes Digital Twin in March 2022. The proposed solution is to make on-demand configurable digital twin engines for forecasting of environmental extremes at sub-km scale. The DE_330 tender was successfully evaluated, negotiated and signed. The 20-month DE_330 contract between ECMWF and Météo-France started on 1st September 2022.

With a majority of the European population living in cities, urban meteorology is an important part of a modern forecasting system. Although strongly influenced by synoptic and meso-scale features, some urban specificities such as large areas covered by buildings, streets and parking areas lead to strengthening of some weather events such as heat waves, and increased pollution also strongly impacts fog forecasting. On-Demand Extremes aims at providing forecasts at a very high resolution, at scales where an accurate description of surface parameters in urban areas is possible. State-of-the-art urban canopy models, such as TEB (Town Energy Balance) which is included in SURFEX are now able to simulate the physics of the urban energetics. Currently in kilometric operational versions of the AROME and HARMONIE-AROME Numerical Weather Prediction (NWP) models (used operationally most countries in Europe), the city is only described using the few land Ecoclimap cover classes at 1km of resolution. The mission of the position is to improve input parameters from TEB model using OpenStreetMap database.

Missions

The objective of this task is to improve the input data of the town model TEB and apply it over highly resolved urban areas, by exploitation of the richness of crowdsourced data. This mission will consist in two tasks:

1) First, the Geoclimate tool will be used over the whole Europe to produce urban parameters at urban block scale. These parameters encompass land cover (road, water, building, vegetation,…) fractions, Local Climate Zones, as well as many morphologic parameters (such as build height, wall density). The new version of the Geoclimate chain will be applied on one fixed dataset of Open Street Map (OSM) data, such as of January 1st 2023 (that will already have been installed on a server at CNRM prior to the start of this mission). Necessary improvements of Geoclimate chain, if any, will be done through an interdisciplinary collaboration between meteorologists at CNRM and geomaticians at LabSTICC (Vannes, France).

2) Then the next step is to ensure that the newly produced urban parameters maps are profitable for Extreme On-Demand high resolution models. Depending on the background of the candidate, this can be done in two different ways (one of which to follow during the mission):

-        Either will be evaluated the positive impacts of the use in atmospheric models of the more spatially precise and accurate urban description of the urban characteristics produced by Geoclimate. The improvement of the Urban Heat Island by the hectometric model will be assessed by several case studies on large agglomerations, but also small cities. The choice of the cities will be defined in the course of the DEODE project in relation with the other partners. Collaborations the Research Development Project Paris 2024 will also allow to have access to fine-scale observations performed during PANAME 2022 summer experimental campaign over Paris and its agglomeration.

-        Or a generalization of the urban database will be performed, in order to facilitate its use by DEODE modelers. This encompasses the inclusion of Geoclimate OSM-made urban data in Ecoclimap-SG (widely used by AROME-HARMONIE models). In order to allow on-demand simulations outside Europe, a prospective work to evaluate the produced urban parameters by the Geoclimate toolsoutside Europe will be performed. If necessary and possible, this could lead to improvements in Geoclimate.

Methods :

    The objectives of the position are to:
• To apply, and if necessary to improve, the geoclimate chain using Open Street-Map data over Europe to produce urban parameters maps for atmospheric models
• Either to evaluate the impacts of the new urban maps in atmospheric models, or to extend the use of geoclimate and its data outside Europe for global use

Required qualifications :

Masters Degree in computer sciences processing/physical geography and GIS/atmospheric sciences or civil engineer diploma, obtained before the date of the application.

Experience and skill required:
• Good experience in Geographical Information Systems
• Good experience in scientific programming

- Knowledge of Geoclimate tool or with Groovy, if not, experience with java or object oriented programming
- Good experience with scripting languages like python or R.
- Experience in using scripts and UNIX-related tools.
- Knowledge on atmospheric models or surface-atmosphere exchange models
- Candidates must be fluent in spoken and written English. The interviews will be conducted in English

Following criteria will be taken into account for the evaluation of candidates:
- Analytical and problem-solving skills
- Initiative and ability to work collaboratively with teams at Météo-France and beyond
- Good interpersonal and communication skills
- Dedication, passion, and enthusiasm to succeed individually and across teams of developers

Practical information :

The successful applicant will be based at the Météopole in Toulouse and will be welcomed by the GMME (MesoScale Meteorology Group, of CNRM). The position will be funded by Météo-France, and will start preferentially on the 1st March 2023 for 12 months. Depending on professional background and experience, the gross monthly salary shall amount from 2552€ to 3890€.

For full consideration, an application letter shall include a detailed statement of research interest, along with a curriculum vitae (including research experience, publications and conferences, computing skills and different language practice) and the names, telephone and email address of 2 referees. The package should be sent by email before the 20th November 2022 to valery.masson@meteo.fr. Same email can be used for any scientific question. Due to spam filters applied in Météo-France, without rapid acknowledgment of receipt by email from one of the two addressees, it is recommended to verify the correct receipt of the candidate's email with a phone call (Valéry Masson: +33 (0)5 61 07 94 64).

References

Geoclimate tool:
Bocher, Erwan and Bernard, Jérémy and Le Saux Wiederhold, Elisabeth and Leconte, François and Petit, Gwendall and Palominos, Sylvain and Noûs, Camille. "GeoClimate : a Geospatial processing toolbox for environmental and climate studies". Journal of Open Source Software https://joss.theoj.org/papers/10.21105/joss.03541

TEB model:
Masson V., 2000 : A Physically-based scheme for the Urban Energy Budget in atmospheric models. *Boundary-Layer Meteorol.*, 94, 357-397

SURFEX:
Masson V., P. Le Moigne, E. Martin, S. Faroux, A. Alias, R. Alkama, S. Belamari, A. Barbu, A. Boone, F. Bouyssel, P. Brousseau, E. Brun, J.-C. Calvet, D. Carrer, B. Decharme, C. Delire, S. Donier, K. Essaouini, A.-L. Gibelin, H. Giordani, F. Habets, M. Jidane, G. Kerdraon, E. Kourzeneva, M. Lafaysse, S. Lafont, C. Lebeaupin Brossier, A. Lemonsu, J.-F. Mahfouf, P. Marguinaud, M. Mokhtari, S. Morin, G. Pigeon, R. Salgado, Y. Seity, F. Taillefer, G. Tanguy, P. Tulet, B. Vincendon, V. Vionnet, and A. Voldoire, 2013 : The SURFEXv7.2 land and ocean surface platform for coupled or offline simulation of Earth surface variables and fluxes, Geoscientific Model Development, 6, 929-960,doi:10.5194/gmd-6-929-2013

Urban parameters for urban climate model:
Masson V., W. Heldens, E. Bocher, M. Bonhomme, B. Bucher, C. Burmeister, C. de Munck, T. Esch, J. Hidalgo, F. Kanani-Sühring, Y-T Kwok, A. Lemonsu, J.-P. Lévy, B. Maronga, D. Pavlik, G. Petit, L. See, R. Schoetter, N. Tornay, A. Votsis, J. Zeidler, 2020 : City-descriptive input data for urban climate models : Model requirements, data sources and challenges, *Urban Climate*, 31, doi:10.1016/j.uclim.2019.100536

Urban climate review:
Masson V., A. Lemonsu, J. Hidalgo, J. Voogt (2020) : Urban Climates and Climate Change, *Annual Review of Environment and Resources*, 45, 411-444, doi:10.1146/annurev-environ-012320-083623