Applicants are invited for a 12-month engineer position starting on 1st January 2023 on the following subject: "Modelling 3D turbulence in numerical weather prediction model”

The deadline for application is 15th November 2022.

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.

Missions

The AROME model is a kilometre Numerical Weather Prediction (NWP) model used operationally in the whole Europe. It was first designed by the CNRM (Centre National de Recherches Météorologiques, UMR 3589) to improve short-range forecasting of dangerous phenomena such as heavy Mediterranean rains, violent storms, fog or urban heat islands during heat waves. AROME will see its resolution increase to reach sub-kilometre scales.

Hectometre resolutions require specific developments in NWP models. In particular, the representation of unresolved physical processes in the atmosphere, such as sub-grid turbulent motions demands the implementation of additional horizontal terms. Large-eddy simulations already use 3D turbulence schemes. However, AROME is an optimized code organized in columns, which makes horizontal exchanges tricky and therefore 3D effect computation. Horizontal gradients have been recently computed via the Semi-Lagrangian halo. The long-term objective is to integrate three-dimensional effects in AROME turbulence scheme and to assess the impact of these effects depending on the horizontal resolution.

Methods :

The 1D form of the TKE prognostic equation considers only the contributions to the shear production from the vertical gradients of the horizontal winds and underestimates the TKE in the mountain zone. Goger's scheme propose to complete this equation with another contribution depending on horizontal gradients and an additional advection term. At hectometre scales, the turbulence is underestimated in deep clouds, related to an underestimation of thermal production. Moeng's scheme, based on Leonard terms, gives a better representation of the thermal production in the clouds. Both these schemes use horizontal gradients computed via the Semi-Lagrangian halo and are already implemented. The successful applicant will evaluate in the AROME model these two schemes in mountainous areas. This is a first step towards a full 3D turbulence scheme in AROME. Based on the experience the successful applicant will gain by handling the two first schemes, he/she will be in charge of working on implementing horizontal turbulent flows in AROME operational model.

Required qualifications:

Masters Degree in atmospheric sciences/computer sciences processing or engineer diploma, obtained before the date of the application. Following criteria will be taken into account for the evaluation of candidates:

- expertise in Fortran, Unix/Linux,
- experience in numerical computation, Python,
- experience in atmospheric science will be highly appreciated,
- fluency in English, with ideally notions in French,
- human and relational qualities necessary for teamwork.

Practical information:

The successful applicant will be based at the Météopole in Toulouse and will be welcomed by the GMAP (Groupe de Modélisation et d'Assimilation pour le Prévision) of the CNRM. The position will start preferentially on the 1st January 2023 for 12 months. Depending on professional background and experience, the gross monthly salary shall amount from 2552€ to 3280 €.

For full consideration, an application letter is required, along with a curriculum vitae (including research experience, 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 November 15, 2022 to rachel.honnert@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 (Rachel Honnert: +33 (0)5 61 07 85 19).