CATRINE

Carbon Atmospheric Tracer Research to Improve Numerics and Evaluation

Deadline for applications: 31/12/2023
Department: Centre National de Recherches Météorologiques (CNRM), GMAP group
Location: Météo-France, 42 avenue Coriolis, Toulouse, France
Publication date: 21/11/2023
Contract Duration: from employment date to 31/12/2026 (end of CATRINE project)
Salary: The salary will be in accordance with Météo-France salary rates. Depending on the candidate's experience, the gross monthly salary will range from €3445 to €4087.

How to apply: contact sylvie.malardel@meteo.fr and michail.diamantakis@ecmwf.int with a covering letter outlining your reasons for applying and a curriculum vitae in English.

Your role:

This job presents a great opportunity for those interested in working with numerical solvers for atmospheric dynamics to develop new and innovative methods for improving the accuracy and mass-conservation of cutting edge atmospheric composition models used in the new Copernicus anthropogenic CO2 emissions Monitoring and Verification Support capacity **CO2MVS**. The Integrated Forecasting System (IFS) at ECMWF constitutes the core of the global CO2MVS. It benefits from its state-of-the art capacity to integrate many different types of observations, its Earth system modelling approach, its multiple applications and support to operational services in NWP, climate and atmospheric composition (CAMS and CS3 re-analyses). The capability of estimating fluxes and anthropogenic emissions of CO2, CH4, and relevant tracers has also been implemented in the IFS, through the developments in the previous CHE and CoCO2 projects. The accurate estimation of emissions and absorptions requires mass conservation and high accuracy in the representation of transport at global and local scales, the latter for instance around emission hotspots.

These developments will also benefit all global and limited area models for NWP and climate which share code with the IFS for their dynamical core, in particular those used in Météo-France and in the ACCORD consortium (ARPEGE, ARPEGE-Climat, AROME, HARMONIE...).

Most numerical developments will be done in the framework of ARPEGE/IFS. Simplified toy models will also be used to evaluate new ideas. The new methods will then be tested following the developed validation protocols which is one of the deliverables of the CATRINE project.

About the CATRINE project and its Work Package 1 and 2

The Carbon Atmospheric Tracer Research to Improve Numerical schemes and Evaluation (CATRINE) project (HORIZON-CL4-2023-SPACE-01-31: Copernicus for Atmosphere and Climate Change,including CO2) is a project financed by European Union for 3 years, with a planned starting date on the 1st of January 2024. The coordinator of the project is the European Centre for Medium range Weather Forecasts (ECMWF). 8 partners will contribute to CATRINE with actions distributed between 10 WPs. This job mainly concerns WP1 and WP2, but interaction between WPs is strongly encouraged in CATRINE. WP1 and WP2 are lead by ECMWF and Météo-France.

The aim of CATRINE is to evaluate and improve the numerical schemes for tracer transport in the new Copernicus anthropogenic CO2 emissions Monitoring and Verification Support capacity (CO2MVS) and more widely in the Copernicus Atmosphere Monitoring Service (CAMS). Tracer transport errors can emanate from various error sources: (1) errors in winds from Numerical Weather Prediction (NWP) analyses; (2) representativity errors associated with the lack of vertical/horizontal and temporal resolutions of the simulation; (3) numerical errors associated with the numerical schemes used to represent the transport processes, including temporal/spatial truncation errors; (4) assumptions in the parametrizations of the unresolved transport processes at the model grid scale (e.g. turbulent mixing and convection).

The main objective of WP1 and WP2 of CATRINE is to deliver improved methods to simulate resolved transport of tracers by the winds, focusing on the reduction of systematic errors and the improvement of mass conservation.

In WP1, the advection scheme of the IFS will be carefully evaluated and ideas for improvement of its algorithmic components will be tested. Then, in WP2, an improved tracer advection scheme will be implemented in the global CO2MVS model. Recommendations and further tests towards locally mass conserving approaches will also be explored.

Your tasks in CATRINE:

(i) test and improve the currently used semi-Lagrangian tracer advection schemes of the IFS focusing on aspects of mass conservation and accuracy;
(ii) work on modifying the formulation of the continuity equation (mass conservation) of the IFS to improve the consistency between observation and modelling;
(iii) experiment with off-line conservative tracer advection methods and their interface with a global non-formally conserving dynamical core;
(iv) validate and inter-compare the best new solutions for tracer transport in CO2MVS following the CATRINE validation protocol.

About CNRM and GMAP:

CNRM is a joint research unit (UMR 3589) under the joint supervision of Météo-France and CNRS. The CNRM conducts research in the field of meteorology and climate, from the observation, understanding and modeling of processes to the development of weather forecasting and climate projection systems that can be transferred to Météo-France's operational services.

The GMAP (Groupe de Modélisation et d'Assimilation pour la Prévision) is one of CNRM's 6 research groups or centres. Its mission is to maintain and develop Météo-France's operational numerical weather prediction systems, and to conduct research in preparation for future versions.

What we're looking for :

- Good team player with initiative and ability to work collaboratively in an interdisciplinary environment but also ability to work independently.
- Excellent analytical and problem-solving skills with a proactive and constructive approach.
- Flexibility to adapt to existing operational systems and their constant evolution.

Education : **Advanced level degree (EQF Level 7 or above) in Earth System Science, Physics, Applied Mathematics, Computer Science, or a related discipline or equivalent experience.**

Experience, Knowledge and Skills :

- Experience with numerical modelling of geophysical fluids. Knowledge of methods for solving the transport equations in weather and climate models would be an asset.
- Some knowledge in dynamical meteorology.
- Experience using Fortran, Python.
- Some experience with communicating scientific results to a general audience and the writing of scientific reports would be beneficial.
- Candidates must be able to work effectively in English.