**Postdoctoral researcher or research engineer at Météo-France, CNRM - UMR 3589**

# "Numerical Analysis of Atmospheric Turbulence in urban settings"

Applications are invited for a postdoctoral or research engineer position dealing with meso- and microscale meteorological interactions in the urban atmosphere using LES models.

**Duration: 18 months**; Closing date for application: **15 December 2018**
**Expected start of contract:** 1st February 2019
**Salary:** The net annual salary is about 36550 euros before income tax, depending on qualification.
**Location:** Météo-France, CNRM, Toulouse, France.

## Project objectives and partners

The PPM project (Ensemble Prediction of atmospheric Pollutant dispersion for Micro-meteorological applications) focuses on the formulation of velocity and turbulence boundary conditions for micro-meteorological models. A particular interest is on the mesoscale contribution to the uncertainties at microscale for application to atmospheric dispersion of air pollutants. The goal is to design a strategy to produce tracer concentration maps from an ensemble of Large Eddy Simulations (LES) carried out at micro-scale with varying boundary conditions that are influenced by the mesoscale. Ensemble simulations will be conducted using different LES models and one Lattice Boltzmann Method (LBM) code. The sensitivity of the model results to the boundary conditions will be analysed using uncertainty quantification and data science methods. The goal is to show the added value of LES and uncertainty quantification to better assess individual exposition to air pollution while estimating related uncertainties. The methods will be applied to the idealised Mock Urban Setting Test (MUST), a real urban environment (Empalot neighbourhood, Toulouse) and an airport site.

The project involves 4 main partners.

- The CERFACS (European Centre for Research on Computational Science; https://cerfacs.fr/en/) will conduct the ensemble LES and LBM simulations and perform work on uncertainty quantification.
- The CNRM (French National Centre for Research in Meteorology; https://www.umr-cnrm.fr/) and ONERA (The French aerospace lab; https://www.onera.fr/en) will employ the version of the mesoscale atmospheric model MesoNH with Immersed Boundary Method (MesoNH-IBM) to investigate the coupling between meso- and microscale for the airport site (ONERA) and the MUST and urban site (CNRM). The grid nesting method implemented in MesoNH allows to investigate the interactions between the meso- and the microscale.
- The CEREA (Centre for Research in Atmosphere and Environment; https://www.cerea-lab.fr/) has notable experience on atmospheric dispersion modelling and is developing the CFD Code_Saturne.

## Objectives of postdoctoral researcher or research engineer

The contractual work will be part of CNRM's contribution to the PPM project. There will be scientific and technical tasks.

The scientific tasks will be related to the coupling and self-consistency between the meso- and the microscale. MesoNH-IBM (Lafore et al., 1998; Lac et al., 2018; Auguste et al., 2018) simulations will be conducted for the MUST and the Empalot urban setting for realistic meteorological conditions. Large Eddy Simulations at mesoscale (horizontal resolution of 100 m x 100 m; D100M) will be conducted for relatively large domains to ensure fully developed turbulence. Grid nesting

will be employed to downscale the mesoscale simulation to an obstacle resolving (horizontal resolution of 2 m x 2 m; D2M) simulation covering the MUST containers or the Empalot urban district. Buildings will be explicitly resolved via IBM in D2M whereas their effect will be parametrised via a drag force approach in D100M. Two main research questions will be addressed in this framework.

- To which degree the temporal evolution of the mean wind at mesoscale and the turbulence resolved at the mesoscale influence the mean wind and turbulence at microscale. This can help to develop guidelines on how often the lateral boundary conditions have to be adjusted (mean wind) or whether turbulent fluctuations at the mesoscale need to be considered.
- The self consistency between the mean wind profile and turbulent kinetic energy between D100M (buildings represented by drag force) and D2M (buildings represented by IBM) will be investigated.

Technical tasks to enhance MesoNH-IBM will have to be conducted. The main task will be the adaptation of MesoNH-IBM for obstacles in non-flat areas. MesoNH uses terrain following coordinates. For obstacles in non-flat areas, the reconstruction of the IBM ghost and image points has to be made by taking into account the coordinate transformation. Idealised test cases will be performed to verify for the correctness of these enhancements. Minor technical tasks will be to combine the IBM with grid nesting and to improve the initialisation of building masks.

### Required qualification and skills

Strong professional experience in the fields of fluid dynamics, urban modelling, and numerical model development is required for the position.

For a recruitment as a postdoctoral researcher, a PhD thesis, and a proven record of about one peer-reviewed scientific publication per year after the completion of the PhD is required. Applications from candidates having defended their PhD thesis outside Toulouse Metropolitan Region are particularly welcome. For candidates having accomplished their PhD inside Toulouse Metropolitan Region, at least one year of postdoctoral experience outside Toulouse is required.

### Recruitment process and place of work

The project is funded by the aeronautic and space science foundation (STAE; http://www.fondation-stae.net/). Successful candidates will be contracted by the Institute of Technology Antoine de Saint Exupéry (IRT Saint Exupéry; http://www.irt-saintexupery.com/) based in Toulouse. Place of work will be the French National Center for Research in Meteorology (CNRM; https://www.umr-cnrm.fr/) the research laboratory of the French weather service (Météo-France).

### Application

To apply for the announced position, send a cover letter and a complete scientific Curriculum Vitae including education, professional experience, technical skills, list of publications and conference presentations to:

robert.schoetter@meteo.fr ; valery.masson@meteo.fr

### References

**Auguste, F., G. Réa, R. Paoli, C. Lac, V. Masson, and D. Cariolle, 2018**: Implementation of an Immersed Boundary Method in the Meso-NH model: Applications to an idealized urban like environment, Geoscientific Model Development Discussions, https://doi.org/10.5194/gmd-2018-7, in review.

**Lac, C., and Coauthors, 2018:** Overview of the meso-nh model version 5.4 and its applications. Geoscientific Model Development, 11 (5), 1929–1969, doi:10.5194/gmd-11-1929-2018, URL https://www.geosci-model-dev.net/11/1929/2018/.

**Lafore, J. P., and Coauthors, 1998:** The meso-nh atmospheric simulation system. part i: adiabatic formulation and control simulations. Annales Geophysicae, 16 (1), 90–109, doi:10.1007/s00585-997-0090-6, URL https://doi.org/10.1007/s00585-997-0090-6.