

INTERNSHIP OFFER

Effect of small scale rainfall variability on radon and its decay products scavenging

Host Laboratory	CEREA — Centre d'Enseignement et de Recherche en Environnement Atmosphérique
Location	ENPC 6 et 8 avenue Blaise-Pascal - Cité Descartes - Champs-sur-Marne - 77455 Marne-la-Vallée cedex 2
Duration	5 to 6 months
Preferred period	Ideally 03/2027
Level / Educational background	M2 (MSc) or Engineering School
Supervisor(s)	Auguste Gires (auguste.gires@enpc.fr), Yelva Roustan (yelva.roustan@enpc.fr), Arnaud Quérel (arnaud.querel@asnr.fr)
Application deadline	01/12/2026

Scientific context

Rainfall exhibits an extreme variability across a wide range of spatial and temporal scales, from a few seconds to a few years in time and a few meters to planetary scale in space. This variability plays a crucial role in atmospheric processes, particularly in the removal of trace gases and aerosols through scavenging yielding wet deposition. Radon and its decay products provide an interesting case study due to the existence of a large database of observations with the Teleray network (<https://teleray.asnr.fr/>). Radon is a radioactive gas exhaled from the ground, transported in the atmosphere by wind and dispersed by turbulence. Its radioactive decay leads to short-lived products associated with the atmospheric particles. All these compounds can be removed from the atmosphere by precipitations, which is one of the main processes determining their atmospheric lifetime.

Objectives

The relationship between rainfall and particles scavenging is highly non-linear (Quérel et al., 2021), meaning that considering an average rainfall over large areas as commonly done in simplified approach can significantly affect scavenging efficiency. This project aims to quantify the impact of small-scale rainfall variability on radon scavenging processes.

In order to explore this complex issue, the student will rely on rainfall data and radon concentration from a model output with an observation scale of 10 km in space and 1 hour in time. Then, he / she will compute radon wet deposition using two approaches: (1) Considering uniform rainfall over the 10 km pixels; (2) Stochastically downscale rainfall fields at higher resolution enabling to simulate local time series of radon deposition. Such stochastic process enables to simulate numerous realistic downscaled fields and ultimately

compute a probability of distribution for the radon total deposition at larger scale, to be compared to uniform case. Stochastic downscaling will be performed using tools relying on Universal Multifractals, which have been widely used to characterise and simulate extremely variable geophysical fields such as rainfall. The specific tool along with historical references for the theoretical framework can be found in Gires et al. (2020). A preliminary analysis relying on purely synthetic data for rainfall and radon concentration will be carried out to identify key parameters.

Wanted background

- Currently in M2 (or MSc) or last year of engineering school in environmental science or physics
- Some basic knowledge in Python

References

- Gires, A.; Tchiguirinskaia, I. and Schertzer, D. Blunt extension of discrete universal multifractal cascades: development and application to downscaling. Hydrological Sciences Journal, Taylor and Francis, 2020, 0, 1-17.
- Quérel, A.; Quélo, D.; Roustan, Y. and Mathieu, A. Sensitivity study to select the wet deposition scheme in an operational atmospheric transport model, Journal of environmental radioactivity, 10/2021, Volume 237, <https://doi.org/10.1016/j.jenvrad.2021.106712>