General information

Modelling nitrogen fluxes at the surface-atmosphere interface in a coupled regional climate-chemistry model. Application to the study of the west African nitrogen cycle variability and related impacts.

Duration : 24 months

Location : Laboratoire d'Aérologie, 14 avenue Edouard Belin, 31400 Toulouse, France

Academic level: PhD in environmental sciences (physical chemistry of the atmosphere, biogeochemistry)

Experience: 0-2 years max after PhD defence

Demanded skills: Prior experience in continental surface and biogeochemical (carbon nitrogen) cycle modelling (an experience with CLM4/5 would be highly appreciated). Familiarity with code development, HPC environment and model output post-processing and analysis; Fluency in English or/and French.

Salary: 2600 – 3000€ per month before taxes depending on experience

Beginning: Early spring 2024

Full-time job

Context

The post doc will work in the context of the ANR project NitroAfrica (2023-2026), under the supervision of Fabien Solmon and the coordination team (Claire Delon, PI of the project, Dominique Serça and Corinne Galy-Lacaux). The overall objective of NitroAfrica is to study the relationships and retroactions between atmospheric N deposition, N cycling in the soil-vegetation system, emissions of reactive N forms by the surface to the atmosphere, atmospheric chemistry and regional climate. We posit that the changes of wet N deposition that characterize West African agricultural and natural ecosystems over the 21th centuries will induce important changes in biogenic emissions from the ecosystems to the atmosphere with implications for regional atmospheric chemistry and climate over West Africa. We will analyse these feedbacks considering current and projected N depositions in West Africa based on land use change, fertilisation and anthropogenic emission increase.

Foreseen Organization of the work

I- 1D modelling of soil N cycling processes, N compounds and CO_2 emissions

Local scale modelling will be performed using the Community Land Model Version 5 (CLM5, Lawrence et al., 2019) in stand-alone mode for all the experimental study plots of NitroAfrica (where measurements will be available for model validation). The objectives are (i) to assess the suitability of CLM5 for capturing relevant soil-vegetation N-C processes leading to gas emissions (mineralization, nitrification, denitrification, N_2-fixation, respiration); (ii) to improve/upgrade the existing CLM5 parameterizations (e.g. NH_4^+ / NO_3^- speciation in deposition flux and related soil processes), and (iii) to perform 1D sensitivity experiments in order to characterize the model emission response to changes in factors depending on land use type, moisture, and external N inputs.

II- Upscaling of surface atmosphere nitrogen fluxes and impacts at the regional scale.

There will be 2 rather independent tasks for this activity, which consist in:

i)- Producing regional total atmospheric N deposition maps for West Africa using results of the Model Measurement Fusion Total Atmospheric Deposition (MMF TAD, Fu et al., 2022) and integrating measurements from the INDAAF sites. These tasks (expected to last no more than 6 months) will be performed in close collaboration with Pr Joshua Fu (University of Tennessee, Department of Civil and Environmental Engineering), who will provide data and insights for the analysis and development of region-specific maps for West Africa. This product will be used for regional scale evaluation/ comparison in the second part of the activity.

ii) Quantifying and analysing N fluxes and cycle at the regional scale: This task aims at the upscaling of plot/ecosystem scale processes to regional and multi-annual scale, by backporting stand-alone CLM5 modifications emerging from activity 1 into the broader RegCM5-CLM5 coupled framework (collaboration with ICTP, Trieste). These specific developments will then be used in coupled, multi-year, regional climate simulations for carrying out regional nitrogen budget analysis in terms of variability, identification of key drivers and sensitivity studies to climate change and anthropogenic N perturbations. Time permitting, the evaluation of these developments on the regional atmospheric chemistry and associated radiative forcings will be also studied.