

FINAL REPORT PROGRAM LEFE

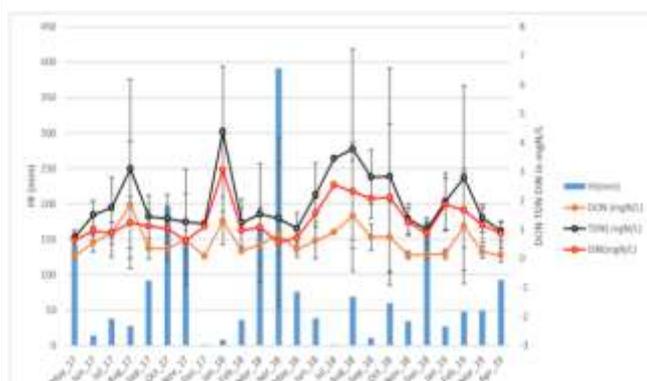
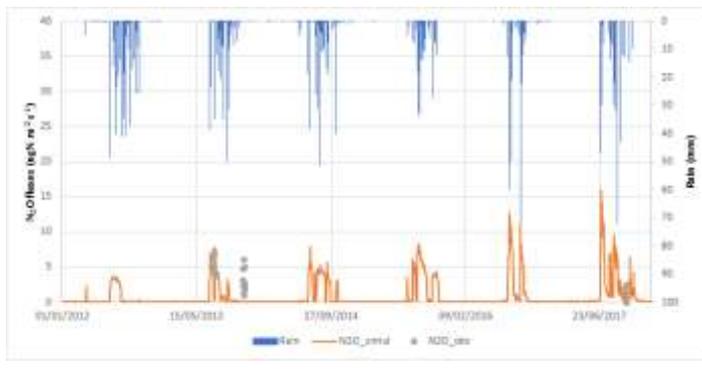
Programs LEFE-CHAT/EC2CO- BIOHEFECT	Project Title : Nitrogen Cycle between the Surface and the Atmosphere in Africa (CASAQUE)	Years 2017-2018
<p>PI: Claire Delon, Claire.delon@aero.obs-mip.fr, Laboratoire d'Aérodologie, UMR5560 CNRS-UPS</p> <p>Partners : GET (UMR5563), ECOLAB (UMR5245), INRA Rennes, INRA Grignon</p>		<p>Contribution to : <i>Global Environment Facility – United Nations Environmental Programme International Nitrogen Management System (GEF-UNEP INMS)</i></p> <p>Other funding sources : Team local funding.</p>
<p>Context : Exchanges of nitrogen compounds between the surface and the atmosphere have an impact on air, water, soil quality and ecosystems. In tropical regions, especially in Africa, estimating nitrogen budget remains uncertain, due to a lack of data. CASAQUE proposes experimental and modeling studies on nitrogen exchanges.</p> <p>Objectives / scientific questions : i) Understand mechanisms of nitrogen transformation in the soil, leading to emissions and deposition of nitrogen compounds; ii) Assess the seasonal variability and the impact of exchanges on atmospheric chemistry, in two contracted ecosystems, a semi-arid grazed pasture and a tropical humid agricultural area.</p> <p>Main results : Measurements were performed according to 2 different temporal scales: long term measurements and intensive campaigns (September 2017 in Dahra, Senegal and January and November 2018 in Mbita, Kenya). Long-term measurements involved nitrogen compounds wet and dry deposition, nitrates and ammonium contents in soil solution (measurement of leaching fluxes). For the first time, Dissolved Organic Nitrogen (DON) concentration was estimated in rain and soil solutions in Mbita, Kenya. Results show that DON contributes around 30% to total (organic + mineral) Nitrogen wet deposition (Fig. 1). Intensive field campaigns allowed measurements of reactive nitrogen compound fluxes from terrestrial and aquatic surfaces in Mbita, Kenya (agricultural soils, lake and river) and from soils in Dahra, Senegal. A N₂O emission module was implemented in the STEP-GENDEC-NOFlux (Delon et al., 2019) model to simulate N₂O fluxes from soils in Dahra, Senegal. Results show a good order of magnitude for simulated fluxes, except during the dry season where fluxes are underestimated (Fig. 2), due to underestimated microbial activity in the model. 3D modeling of N₂O fluxes is being tested with RegCM-CLM model and shows a good seasonal variation at the regional scale in West Africa. Contrasted climate and land use in Dahra and Mbita involve differences in the magnitude of N₂O emissions from soils, with lower natural emissions in Dahra due to drier conditions. Soil management (closely linked to climate conditions) strongly impacts denitrification processes and further N₂O emissions to the atmosphere.</p>		
		
Fig 1		Fig 2

Figure 1: Monthly trends of Total Dissolved Nitrogen (TDN, black line), Dissolved Inorganic Nitrogen (DIN, red line), Dissolved Organic Nitrogen (DON, orange line) and rainfall amount (blue bars) over the study period 2017-2019 in Mbita, Kenya (PhD Adama Bakayoko)

Figure 2: 1D modeling of N₂O fluxes (ngN m⁻² s⁻², orange line) in a semi-arid grazed pasture in Senegal (Dahra site), compared to observations (ngN m⁻² s⁻², grey points). Rain is represented by blue bars in mm (PhD Laurent Bigaignon).

Future of the project: CASAQUE allowed to strengthen collaborations with European and African colleagues working in East Africa, while collaborations with West African colleagues was already established through the INDAAF network (part of ACTRIS-Fr). CASAQUE was one of the necessary steps to propose a new European project, H2020-MSCA-RISE Integrated Nitrogen Studies in Africa (INSA), which begun on 01/02/2020 and is funded for 4 years (1,242,000 €, coordinator: Claire Delon). INSA will raise awareness of challenges, risks and opportunities for improved nitrogen management in Africa. A network of scientists from Europe (7 participants) and Africa (8 participants) will drive a preliminary nitrogen assessment for Africa.

In parallel, experimental and modeling experiments on current and future nitrogen wet deposition in West Africa and its impact on ecosystems and atmospheric chemistry will be the subject of a proposal called NitroAfrica, which will be submitted to the ANR next year. These projects are in the same thematic as the CASAQUE project.

Nombre de publications, de communications et de thèses

2 PhD running, directly using CASAQUE results:

Laurent Bigaignon, 2018-2021 : Rôle du climat et des pratiques agricoles dans les émissions de Gaz à Effet de Serre (N₂O/CO₂) issues des sols des agro-écosystèmes en régions tempérée et tropicale

Adama Bakayoko, 2019-2022 : Etude des interactions surface atmosphère des composés azotés : cas des écosystèmes africains.

4 publications in preparation, 7 Communications (4 for 8th Global Nitrogen Initiative Conference INI2020, 3rd -7th May 2020, Berlin, Germany, 1 INMS4, 29 April 2 May 2019, Nairobi, Kenya, and 2 AMMA –CATCH Conference, 12-14 Novembre 2018, Niamey, Niger

5 publications linked to the project

Delon, C., Galy-Lacaux, C., Serça, D., Personne, E., Mougin, E., Adon, M., Le Dantec, V., Loubet, B., Fensholt, R., and Tagesson, T.: Modelling land atmosphere daily exchanges of NO, NH₃, and CO₂ in a semi-arid grazed ecosystem in Senegal, *Biogeosciences*, 16, 2049–2077, <https://doi.org/10.5194/bg-16-2049-2019>, 2019.

Diawara M.O., P. Hiernaux, **E. Mougin**, **M. Grippa**, **C. Delon** et H.S. Diakité, Effets de la pâture sur la dynamique de la végétation herbacée au Sahel (Gourma, Mali) : une approche par modélisation, *Cah. Agric.*, 27, 15010, <https://doi.org/10.1051/cagri/2018002>, 2018.

C. Delon, C. Galy-Lacaux, D. Serça, B. Loubet, N. Camara, **E. Gardrat**, I. Saneh, R. Fensholt, T. Tagesson, V. Le Dantec, B. Sambou, C. Diop, **E. Mougin**, Soil and vegetation-atmosphere exchange of NO, NH₃, and N₂O from field measurements in a semi arid grazed ecosystem in Senegal, *Atmospheric Environment* 156, 36-51., 2017.

M. H. Assouma, **D. Serça, F. Guerin**, V. Blanfort, P. Lecomte, I. Traoré, A. Ickowicz, R.J. Manlay, M. Bernoux, and J. Vayssières, Livestock induces strong spatial heterogeneity of soil CO₂, N₂O, CH₄ emissions within a semi-arid silvo-pastoral landscape in West Africa, *Journal of Arid Land*, 10 doi: 10.1007/s40333-017-0001-y, 2017.

Tagesson T., R. Fensholt, I. Guiro, F. Cropley, C. Mbow, S. Horion, A. Ehammer, **E. Mougin, C. Delon, C. Galy-Lacaux**, J. Ardö, Very high carbon exchange fluxes for a grazed semi-arid savanna ecosystem in West Africa, *Geografisk Tidsskrift-Danish Journal of Geography*, <http://dx.doi.org/10.1080/00167223.2016.1178072>, 2016.