FINAL REPORT PROGRAM LEFE

Program LEFE/ CHAT	Project Title	Years 2020 – 2022
	Etudes des **D**épôts **AT**mosphériques **S**ecs et **H**umides d'**A**érosols désertiques (DATSHA)	

PI: B. Laurent, benoit.laurent@lisa.ipsl.fr Technical coordinator: S. Chevaillier LISA, UMR CNRS 7583, UPCité, UPEC Participating Laboratories : LOG (France), IRA (Tunisie)	Contribution to LISA research activities of the Mineral Dust Cycle group and INDAAF SNO Other funding sources: LISA internal funding, UPCité ED129 PhD contract

Background

The common thread of the DATSHA project is to progress in understanding deposition processes of atmospheric aerosols with a focus on desert dust and urban aerosols. To address these questions, we take benefit of long-term deposition measurements performed by LISA in semi-arid areas and new measurements based on coordinated monitoring of deposition of desert dust in southern Tunisia and of urban aerosol in Paris suburbs.

Objectives / scientific questions

The main objectives are: to study the deposition efficiencies for different environmental conditions (aerosol load and composition, intensity of precipitation, etc.), and to document the evolution of the chemical composition of the wet deposition linked to atmospheric processes (i.e. below- vs in-cloud scavenging, solubility processes).

Methodology

Our approach is based on the study of a long-term deposition dataset acquired by LISA (INDAAF SNO) and on a sampling synergy proposed in DATSHA, with co-localized measurements of atmospheric aerosols, deposition and precipitation. Information on the meteorological situations driving atmospheric deposition of desert dust as well as their size distribution close to source areas can be retrieved by the re-analysis of deposition samples already collected and in progress. Moreover, the strategy is to investigate the intra-event variability of wet deposition using a new automatic sequential rain sampler and concomitant atmospheric measurements (aerosols, meteorology). Due to the 2020 sanitary context, the development of the sequential sampler was delayed by 3 months and the measurement campaigns were postponed and achieved in 2021 and beginning 2022.

Budget

- A staff of 15 colleagues involved in the DATSHA project with an average involvement of 20% /person/year.
- LEFE-CHAT - Air Liquide Foundation funding: € 26,200.
- Funding acquired elsewhere: € 12,000 (LISA internal call for projects); € 105,000 (T. Audoux 3-yr PhD thesis).

Use of grant

- Small equipment: € 8,300 (+ € 12,000 LISA internal call) => 100% used for the development of the sequential collector and the purchase of equipments for in-situ measurements
- Analyzes: € 7,400 => 100% used in 2021-2022 for the development of analytical protocols and first tests, as well as to analyze in-situ samples
- Operation: € 3,000 => 100% used in 2021
- Missions: €7,500 => 100% used in 2021-2022 for measurement campaigns and missions

Main results

- Based on a 9 year dataset of meteorological, aerosols and wet deposition measurements in the Sahel, the washout ratios were calculated for deposition events associated with cold pools. They vary over several orders of magnitude depending on the dilution effect which differs according to the regimes of atmospheric concentrations of mineral dust (Audoux et al., 2022).
- The developed sequential sampler allowed us investigating the time evolution of chemical composition of wet deposition throughout a rainfall event, down to trace levels. The intra-event evolution of the chemical composition of wet deposition revealed the predominant role of meteorological parameters and local sources in the observed mass concentration variability (Audoux et al., 2023a).

- Quantitative analysis of the of the intra-event variability of aerosol deposition and the interpretation of concomitant atmospheric and meteorological measurements allowed us to estimate the relative contributions of in-cloud scavenging (ICS) to wet deposition for selected rain events (Audoux et al., 2023b).

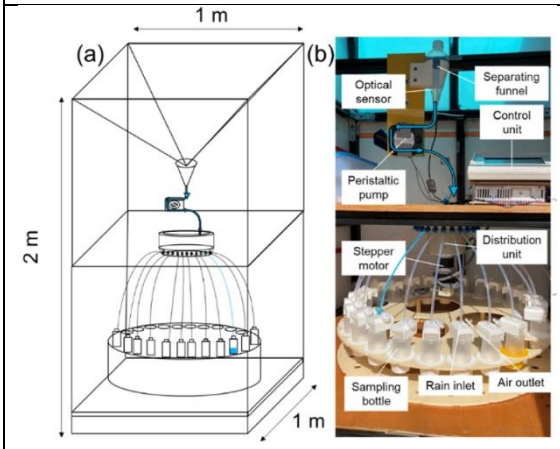

Fig.1. (a) Scheme of the sequential rain sampler and (b) overview of the distribution system of the rain fractions collected.

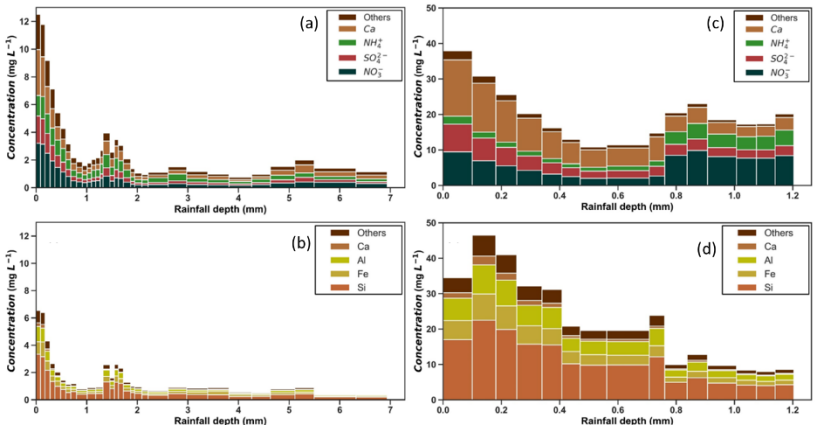

Fig.2. Evolution of dissolved mass concentration (mg L^{-1}; a, c), particulate mass concentrations (mg L^{-1}; b, d), throughout R8 (left panels) and R6 (right panels) rain events.

Figure 1 illustrates the sequential rain sampler developed in the framework of the DATSHA project. Sequential sampling enabled to quantify the evolution of concentrations in the particulate and dissolved deposition phases during sampled rains as presented in Figure 2 for two rain events, R8 (anthropogenic + dust event) and R6 (mineral dust event). Our results highlight the importance of local sources of aerosols, of rainfall characteristics (intensity, droplet size distribution) as well as the relative importance of in-cloud and below cloud scavenging processes to understand the wet deposition variability (Audoux et al., 2023a; 2023b).

Innovation

Based on a large number of in-situ measurements performed over a 9-yr period in two Sahelian stations, we investigated the drivers of the dust wet deposition in relation to meteorological situations and PM10 surface concentrations. Another innovative aspect was the development of an automatic sequential rain sampler used with concomitant measurements on atmospheric aerosols and meteorological parameters during the rain sampling in order to investigate intra-event evolution of elemental and ionic concentrations in wet deposition.

Future of the project

The next steps are to complete the documentation of size distribution of deposited aerosols and to investigate the organic fraction of atmospheric aerosols in deposition and other atmospheric compounds (pollens, microplastics …). Such investigations are essential to unravel the complexities of wet deposition dynamics and deepen our understanding of the intricate interactions between atmospheric particles and wet deposition processes.

Nombre de publications, de communications et de thèses

3 articles (+ 1 to be submitted), 8 communications, 1 PhD thesis

- Audoux T., Laurent B., et al., Trace element solubility in wet deposition: investigating the evolution at the intra-event scale, Atmos. Chem. Phys., to be submitted
- Audoux T., Laurent B., et al., Intra-event evolution of elemental and ionic concentrations in wet deposition in an urban environment, Atmos. Chem. Phys., https://doi.org/10.5194/acp-23-13485-2023, 2023b
- Audoux T., Laurent B., et al., Automatic sequential rain sampling to study atmospheric particulate and dissolved wet deposition, Atmospheric Environment, https://doi.org/10.1016/j.atmosenv.2022.119561, 2023a
- Audoux T., Laurent B., et al., Wet deposition fluxes of mineral dust and their relation with cold pools in the Central Sahel, Geophysical Research Letters, https://doi.org/10.1029/2021GL095005, 2022
- PhD thesis, Audoux T., Approches expérimentales pour l'étude et la caractérisation des dépôts humides d'aérosols atmosphériques par les précipitations, Univ. Paris Cité, 2022