Europlanet TA Scientific Report

PROJECT LEADER

Project number: 22-EPN3-128
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TA Facility visited: Isotoptech Stable/Clumped Isotopes Laboratory (ISIL), Debrecen, HU

Project Title:

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

The goal of the 2023 visit to the TA Facility was to measure rainwater $\delta^{2}H$ and $\delta^{18}O$ values sampled at daily and monthly resolution from October 2022 to May 2023 in three different monitoring sites at North, South and Valley sites in Quito-Ecuador. Due to the complex orography, the sites experience varying intensities of rainfall and hailstorms. These measurements are part of a project aiming to understand the dynamical processes that contribute to the observed heavy and extreme precipitation events in the Tropical Andes, specifically in Quito. Understanding these isotopic data will help the interpretation of the variations in $\delta^{2}H$ and $\delta^{18}O$ during intense rainfall events and subsequent fractionation due to local and upstream convection, orographic lift and moisture recycling. In addition to the measured isotopic signals, rainfall amount, pH, conductivity, and Total Dissolved Solids (TDS) data will be statistically analysed from the sites. Similarly, instrumental daily precipitation and cloud coverage information from instrumental and satellite data will be examined for convective rainfall (thunderstorms) and moisture provenance characterization.

Full Scientific Report on the outcome of your TNA visit

1. Study site and sample collection

This research aims to understand convective processes that can lead to heavy rainfall in the Tropical Andes, specifically in the city of Quito. For this, a monitoring campaign has been established on October 2022 (ongoing) for the measurement of the amount of rainfall and its isotopic variation, particularly Deuterium and Oxygen-18 (expressed as δ^2H and $\delta^{18}O$ VSMOW). Additionally, pH, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) values are also measured *in situ*. The collection of daily rainwater samples is carried out in three different places in the city (North, South and Valley; Figure 1) with distinctive concentration of clouds producing intense precipitation, hailstorms, and thunderstorms. The validation of the monitoring was carried out with data from the Quito Metropolitan Atmospheric Monitoring Network (REMMAQ, Table 1), the National Institute of Meteorology and Hydrology (INAMHI) and satellite data.

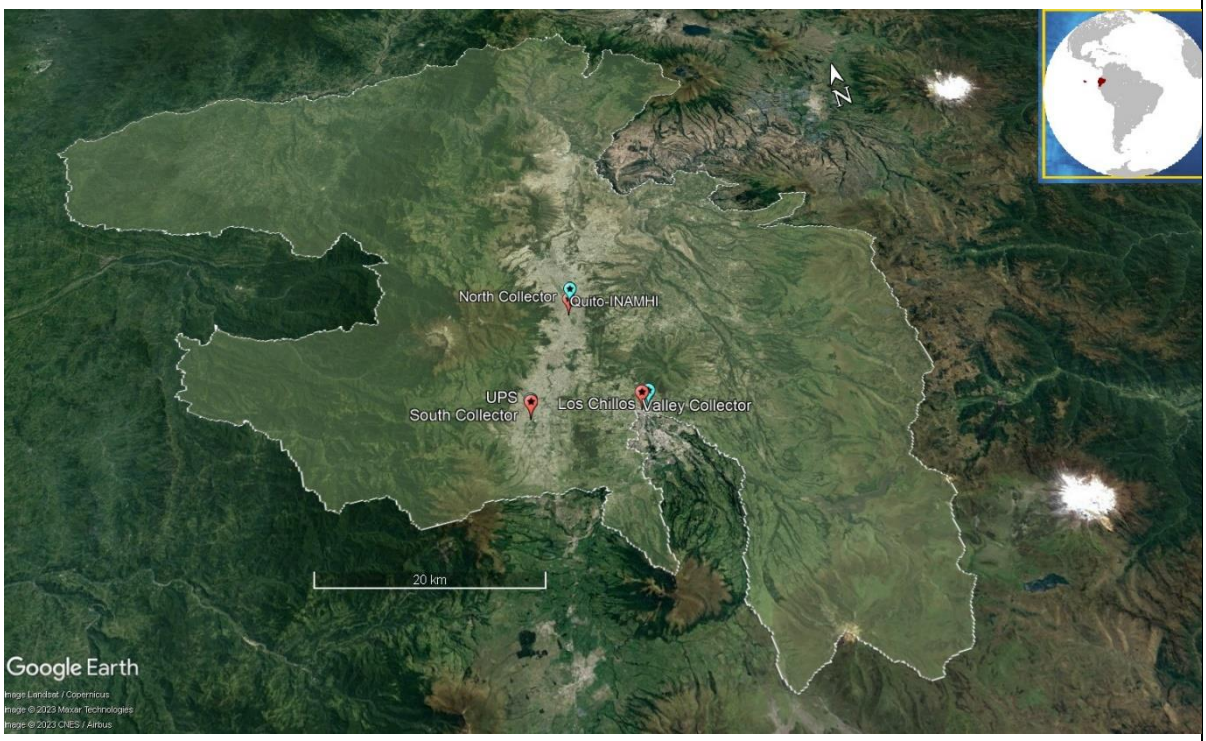


Figure 1. Location of the installed rainfall collectors (red) and nearby meteorological REMMAQ stations (cyan). The borders of the city of Quito are marked by the white line.

Table 1. Location of the instrumental REMMAQ and installed monitoring stations

	Station	Latitude	Longitude	Altitude [m a.s.l.]	Period	Parameters
Instrumental	Quito-INAMHI	-0.17	-78.48	2789	01 October – 10 May	Rain [mm]
	UPS	-0.28	-78.55	2886		
	Los Chillos	-0.30	-78.45	2453		
Installed	North	-0.21	-78.48	2789	01 October – ongoing	Rain [mm] pH EC [ppm] TDS [uS/cm] Temperature[°C]
	South	-0.28	-78.55	2887		
	Valley	-0.29	-78.49	2625		

Daily rainfall samples were collected in pluviometers twice a day, at 7 am and 7 pm. On the other hand, monthly composite samples were collected in a 12 L plastic container by adding 300 ml of paraffin oil to prevent evaporation following the standard procedure for the totalizer paraffin-based method of the International Atomic Energy Agency (IAEA). Until the visit to the ISIL TA laboratory on 22nd May, a total of 68 daily samples were collected from the North; 73 from the South, and 69 from the Valley, along with 22 monthly composite samples of half a liter each one, giving a total number of 232 samples.

2. ISIL analytical methods

2.1 δ^2H and $\delta^{18}O$ measurements and transportation

The stable hydrogen and oxygen isotope composition of rainwater samples were determined by laser spectroscopy. The samples collected in 2022-2023 campaign were analysed by a Liquid Water Isotope Analyzer (LGR LWIA-24i, ABB-Los Gatos Research) at the ISIL, Debrecen, Hungary (Fig. 2). The spectrometer operates on the principle of laser-based absorption spectroscopy, which is a precise optical absorption technique for measuring isotopologues ($H_2{}^{16}O$, $H_2{}^{17}O$, $H_2{}^{18}O$, ^2HHO) within a single gas matrix. The samples and laboratory standards were pipetted into 1.5 mL vials and 1 µL water was injected into the vaporizer of the laser analyser where the water was evaporated at 80 °C in low vacuum. Although 9 injections were made from each vial, only the latest 5 measurements were used to determine the final isotope composition of the samples to minimize the memory effect. All samples were measured at least two times. The laboratory standards, which were calibrated to international standards W-15, W-16 and W-21 are characterized by the following composition: δ^2H = –0.02‰; –126.59‰; –70.2‰; and δ18O = –0.03‰; –16.99‰; –9.98‰, respectively. The isotopic compositions of the water samples are expressed as δ^2H and $\delta^{18}O$ in ‰ relative to V-SMOW (Vienna Standard Mean Ocean Water). The uncertainty (1 sigma) based on the control samples (over 1 year) is better than 0.6‰ and 0.08‰ for δ^2H and $\delta^{18}O$, respectively.

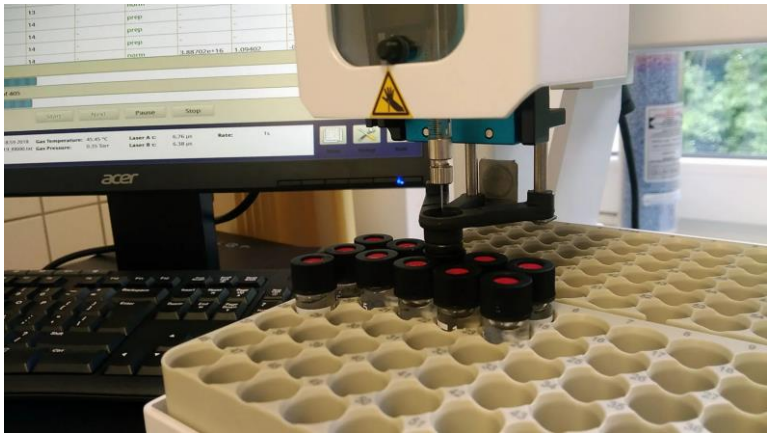
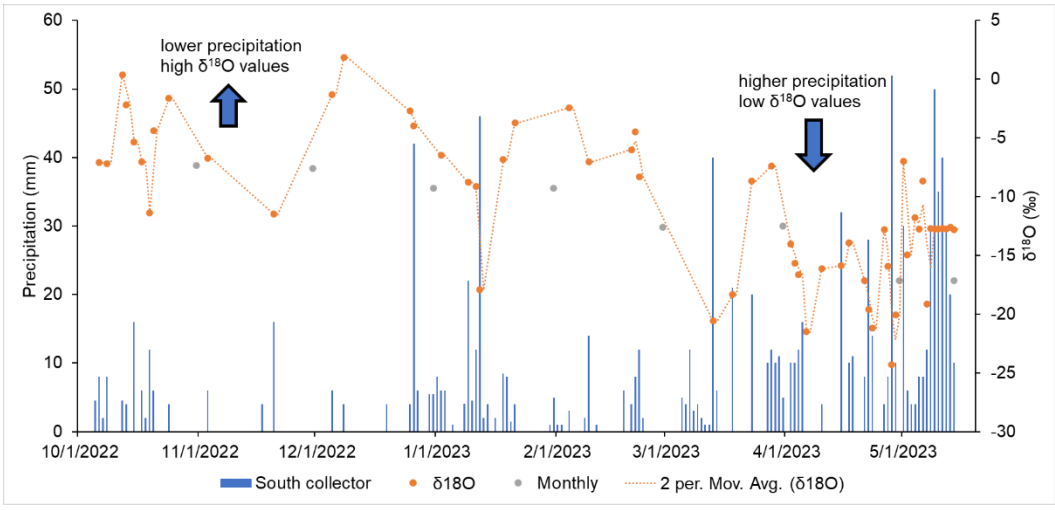


Figure 2. Los Gatos spectrometer at the ISIL

3. Preliminary results

The meteoric relationship for ^{18}O and ^2H in precipitation for the North, South and Valley stations follow the well-established $\delta^{18}O$- δ^2H linear correspondence indicating a pure rainfall signal. The mean $\delta^{18}O$ values for North, South and Valley stations is -12.72‰, -11.05‰, and -12.05‰ respectively. The time-series in Fig. 3 indicates sharp drops towards more negative $\delta^{18}O$ values (orange line), corresponding to strong rainfall events (blue bars). It is also clear, that the onset of the stronger rainy season starts from the end of March to May (austral autumn), where more intense precipitation events and a decreasing $\delta^{18}O$ trend is observed in all the graphs. Furthermore, more intense precipitation events tend to occur in the Southern and Valley zones of the city. The measured isotopic results are important as they point out to be connected to the Intertropical Convergence Zone (ITCZ) excursion during this time of the year. A monsoonal pattern seems to have minimal influence. These tropical features were already presented and discussed with the research colleagues during the visit to the ISIL (Fig. 4). The second part of the work will focus on the study of cloud dynamics, in particular the cloud processes related to the fractionation of stable isotopes and moisture provenance during intense precipitations events.



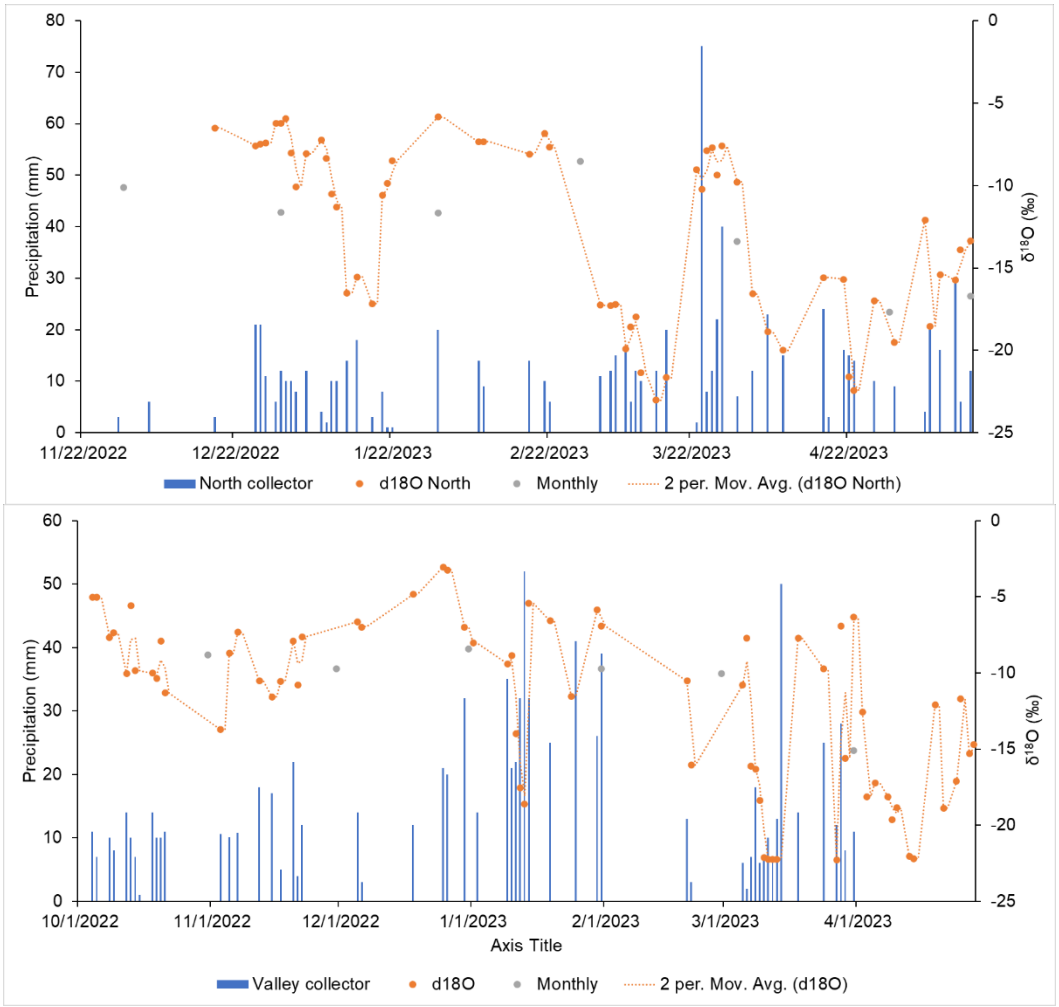


Figure 3. Event (orange dots) and monthly (gray dots) $\delta^{18}O$ values for the installed South (top), North (middle) and Valley (bottom) stations from October 2022 to May 2023. Blue bars correspond to the monitored daily precipitation amount in the sites.

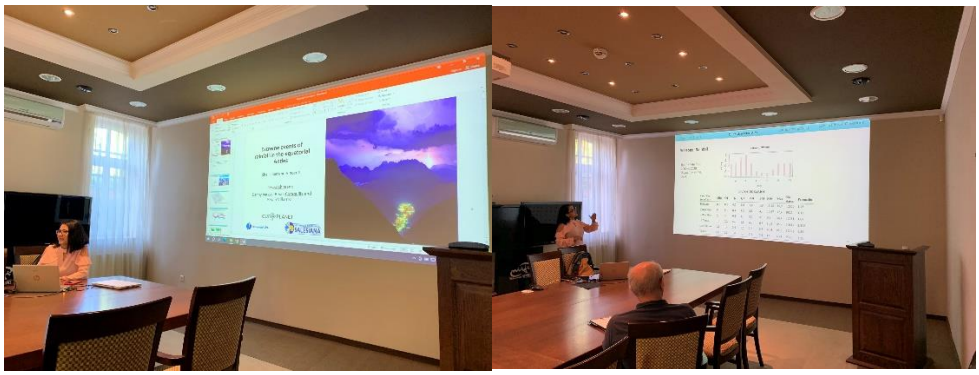


Figure 4. Lecture "*Extreme events of rainfall in the equatorial Andes*" carried out on 23rd May

- Expected publications

We plan to pursue a publication of the measured $\delta^{18}O$ values in precipitation in the *Journal of Hydrology* with the preliminary title "*Rainwater Isotopic Composition of Extreme Events in Quito, Ecuador*".

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 20-05-23 Arrived: 21-05-23	22-05-23	0	5	1	26-05-23	Departed: 28-05-23 Arrived: 29-05-23

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	László Rinyu Isotoptech Stable/Clumped Isotope Laboratory
Host Signature	
Date	15-06-2023

- Project Leader confirmation

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Project Leader Name	Sheila Serrano-Vincenti Universidad Politécnica Salesiana (UPS-Quito)
Project Leader Signature	
Date	21-06-2023