Preliminary report on ash fallout measurements during the Cumbre Vieja eruption in La Palma (Canarias, Spain)

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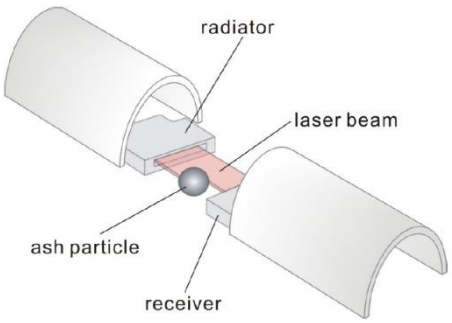
Context and objectives: This field work is carried out in the frame of the EU project EUROVOLC (https://eurovolc.eu/) in order to test the application of disdrometers to the measurements of ash fallout and evaluate their potential for real-time monitoring of explosive eruptions. These sensors are part of the VOLDORAD instrumental platform of OPGC and french national service for volcano observation (SNOV).

Photo : OPGC-UCA team (F. Donnadieu, C. Biensan, T. Latchimy) next to the instruments deployed 1 km SW of the Cumbre Vieja eruption site : Parsivel2 (background) and LPM (middle) disdrometers, along with anemometer and humidity probe (foreground).

DATA : Restricted diffusion only for use during crisis management

Material and methods :

We use two modified disdrometers, originally designed to monitor hydrometeors, to measure the number, diameter and fallout velocity of ash particles sedimenting from volcanic plumes through a laser beam. Each instrument is powered from a car battery, providing several days of recording autonomy.



- a Laser Precipitation Monitor (LPM, Thies Clima) with individual particle detection, diameter range 0.1-20 mm, velocity range (0, >10 m/s)
- a Parsivel2 (OTT) with 5 s time resolution, diameter detection range 0.2-25 mm, velocity range (0-20 m/s).

Acquisition :

Both instruments were first deployed on the same site (Disdrometer 1 station : LPM from Oct. 12 and Parsivel from Oct. 13), about 1 km SW from the plume emission vent, along with an anomometer.

On Oct. 16, the LPM sensor was moved 260 m to SW (Disdrometer2 station) in order to record more distal fallout.

Fig1. Sensor and sampling locations

Ash and small lapilli sampling is also achieved locally to compare with sedimentation rates measured by the sensors. Distal ash samples are also collected in the southern part of the island.

Fig.3 LPM (left) and Parsivel2 (right) disdrometers of OPGC.

Preliminary results

Example of time series

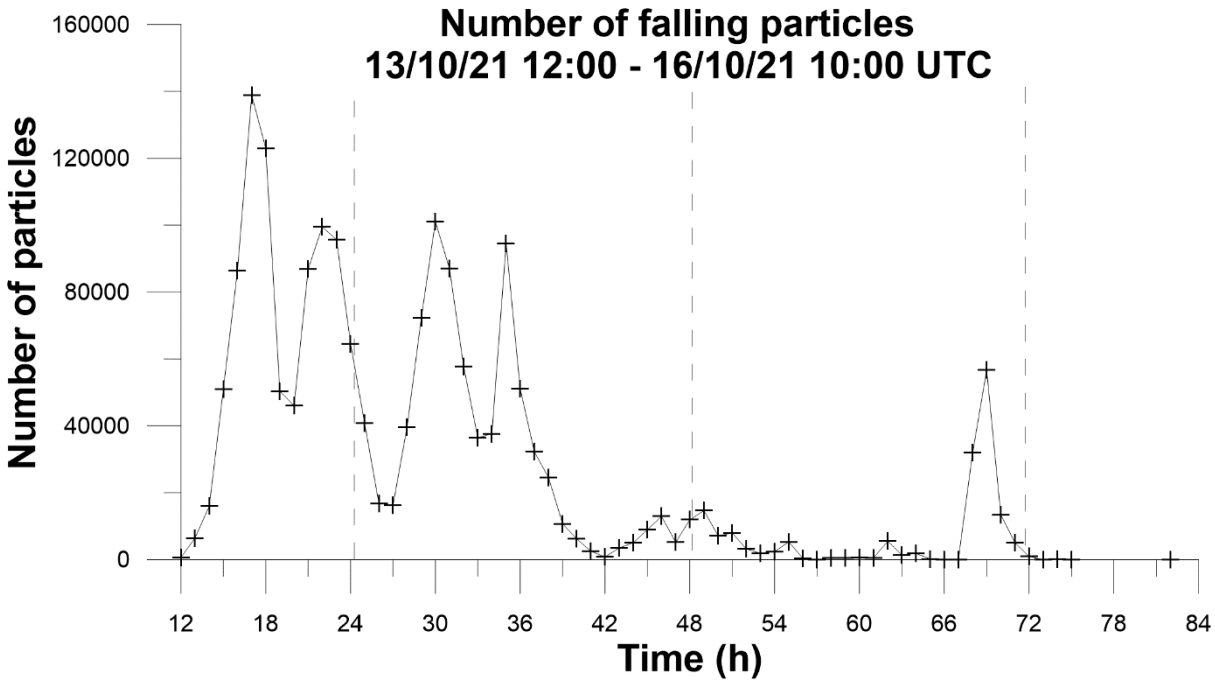


Fig.3 Example of hourly number of falling particles detected by the Parsivel2 disdrometer between Oct. 13 and Oct. 16.

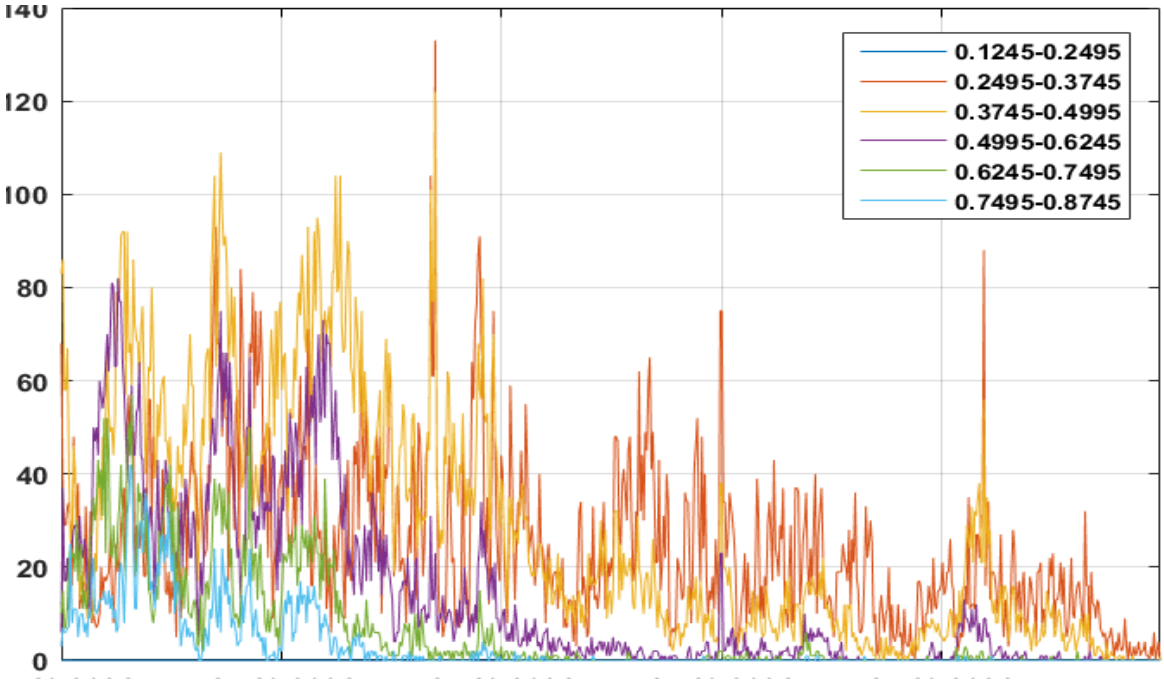


Fig.4 Number of particles between 0.25 and 1 mm recorded during 1h by Parsivel2 (15/10/2021 21:00-22:00 UTC) showing modal particles dominating the first half of the record and taken over by smaller particles during the second half.

Example of Diameter and fall velocity characterization

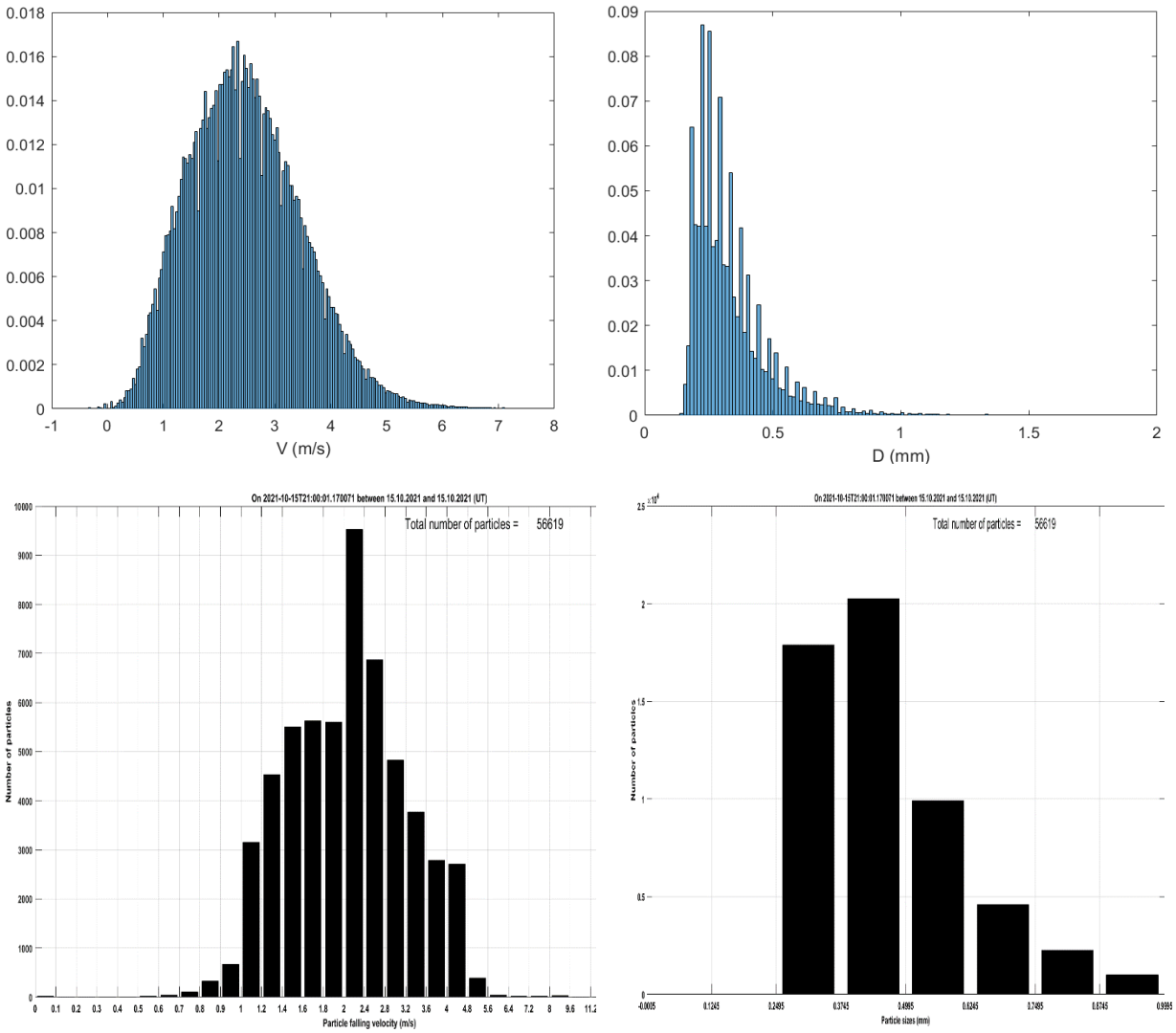


Fig.4 Histograms of ash particle fall velocities and diameters detected by the LPM (top) and Parsivel2 (bottom) disdrometers on 15/10/2021 between 21:00 and 22:00 UTC at site Disdrometer_1 1 km SW from the emission vent.

Table 1 : Intercomparison of disdrometer retrievals (from fig.4)

	LPM	PARSIVEL2
Number of particles	57288	56619
V range (m/s)	0 - 7.7	0 - 9.6
V mode (m/s)	2.2	2.2
D range (mm)	0.15 - 3.53	0.25 - >1
D mode (mm)	~0.3	~0.4

Quantification of sedimentation rates

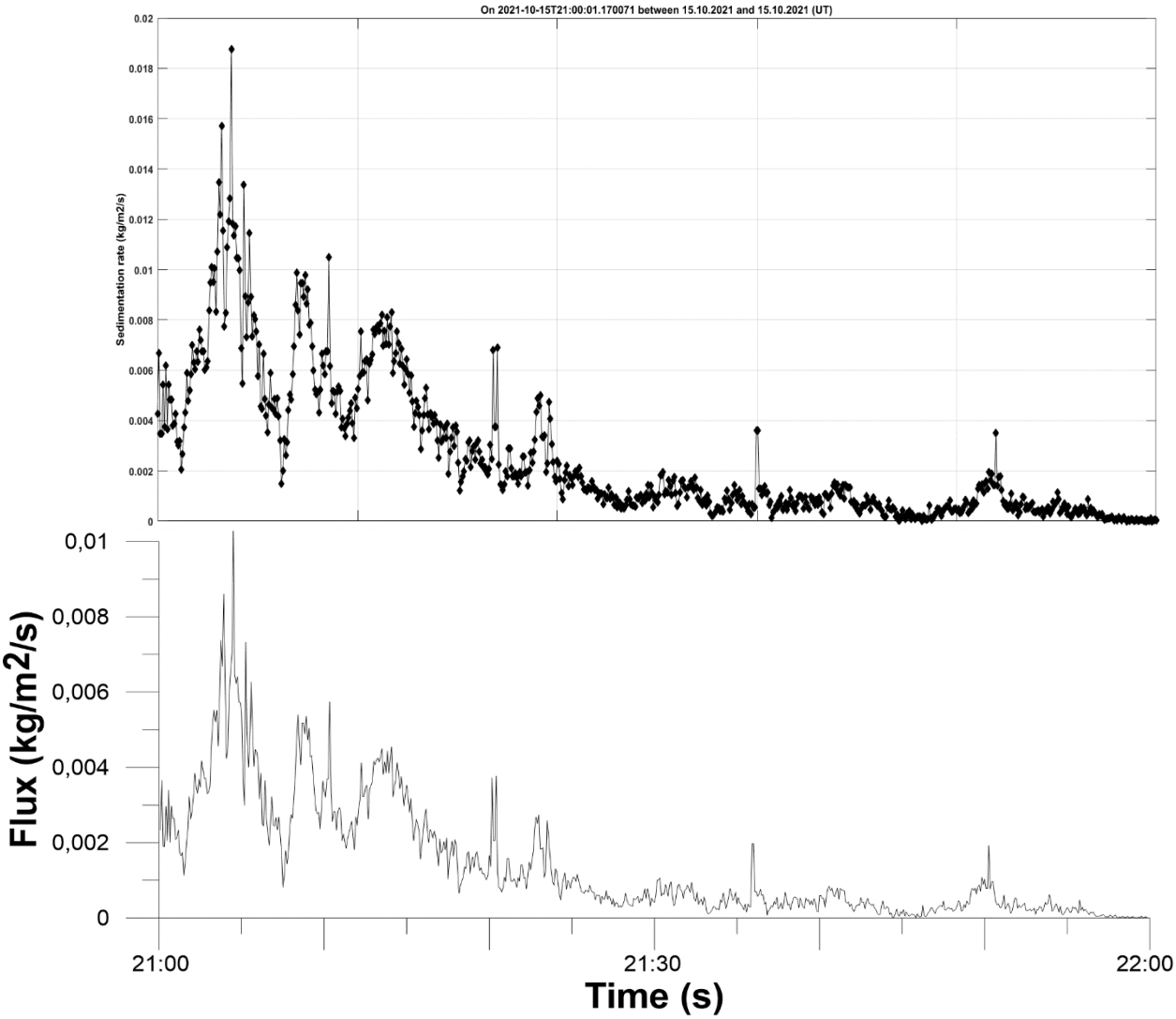


Fig.5 : Intense fallout event on 15/10/2021 between 21:00 and 22:00 UTC showing variations of the sedimentation rate, as infered from Parsivel (top) and LPM (bottom) disdrometer records.

The sedimentation rate shows fluctuations at different time scales in relation with plume direction variations and/or change in dynamics. Although intense fallout episodes typically produce more than 7 kg/m^2/h for several tens of minutes about 1 km from the vent and can briefly reach up to 70 kg/m^2/h (fig.5), sedimentation fluxes over 1 h average 2.7 kg/m^2/h (7.5*10^{-4} kg/m^2/s) in good agreement with values infered from colocated deposits (Table 2).

Table 2: Sedimentation fluxes infered from box-collected deposits at site Disdrometer_1 (~1 km SW of vent) for long time intervals were below 1 g/m²/s (= 36 kg/m²/h).

Samples	Onset time UTC	End time UTC	Flux (kg m^{-2} s^{-1})
LPM0	12/10 at 16:30	13/10 at 17:29	7,88E-04
LPM1	13/10 at 12:30	13/10 at 15:00	2,69E-04
LPM1	13/10 at 15:00	15/10 at 10:16	3,11E-04
LPM2A	13/10 at 13:10	13/10 et 13:18	1,80E-04
LPM2B	13/10 at 13:24	13/10 at 13:29	7,20E-04
LPM2C	13/10 at 13:30	13/10 at 14:06	2,30E-04
LPM2D	13/10 at 14:08	13/10 at 14:27	2,28E-04
LPM2E	13/10 at 14:28	13/10 at 15:05	2,50E-04
LPM2	13/10 at 15:05	15/10 at 10:11	3,17E-04

Sampling site of lava flows

Sparse sampling was also caried out on lava flows emitted on 09-10 oct, and 14 oct (fig.6)

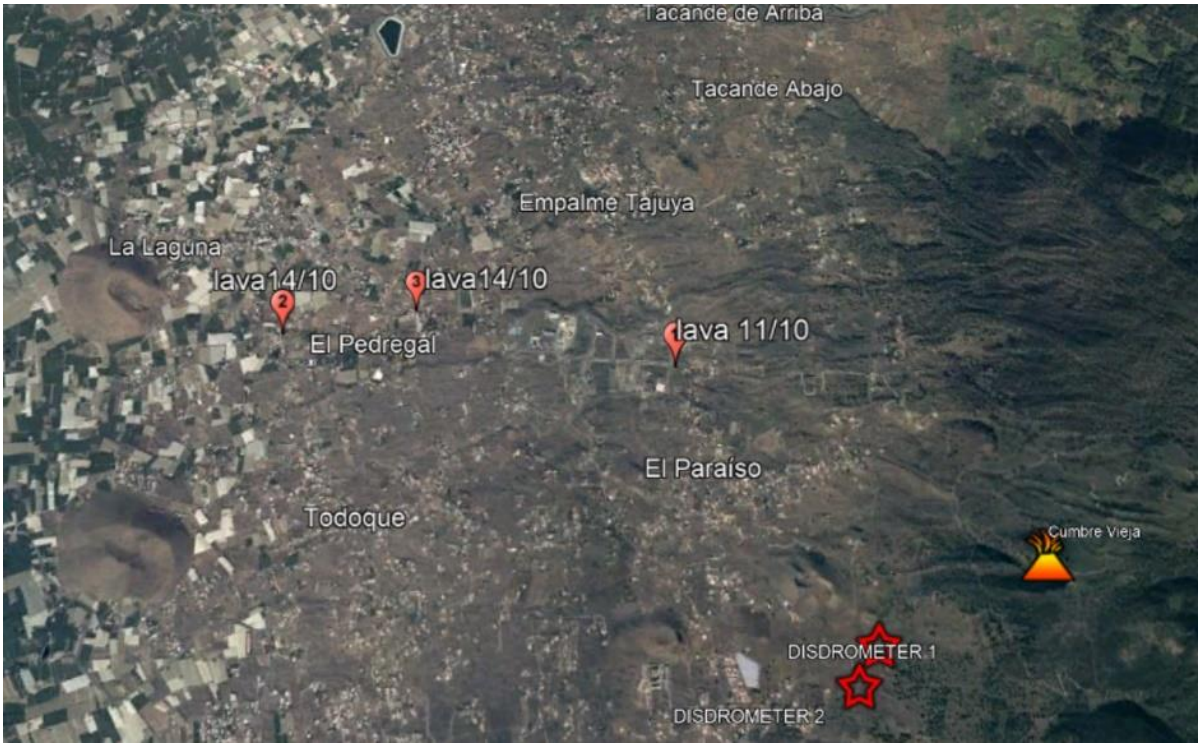


Fig.6 : Map of lava flow sampling