VOlcanic pLume chAracterization using sounNDing balloOns - VOLANDO

Final Meeting 19 March 2026, INGV-Rome

Volcanosondes sensors measurements Validation – The April 2025 Vulcano Island field campaign

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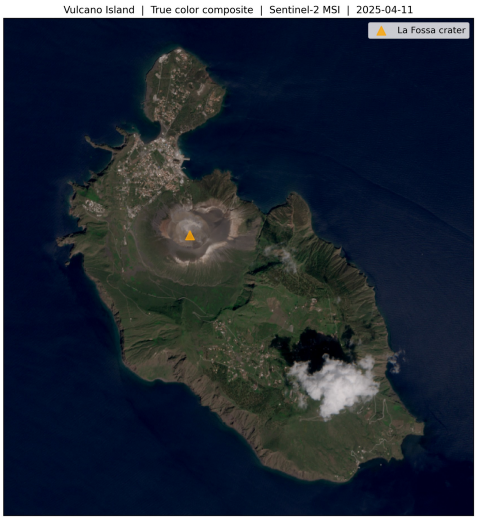
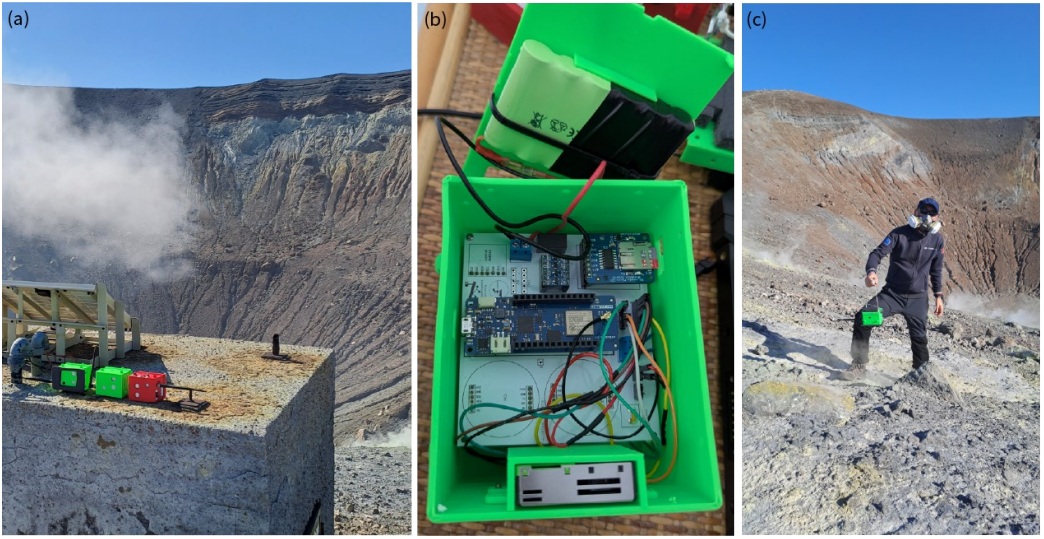
Introduction



Vulcano Island field campaign, 8–10 April 2025:

- Three days
- Five instruments
- Four institutions

Volcanosonde



Characteristics of the sensors in the volcanosondes used during the field campaign.

Date	Volcanosonde	Sensors	Notes
8 April 2025	7D	SO_2, CO_2, HCl , Temp, Humidity	SO_2 calibrated CO_2 not calibrated HCl not calibrated
9 April 2025	7D	SO_2, CO_2, H_2S, Temp, Humidity	SO_2 calibrated CO_2not calibrated H_2S not calibrated
10 April 2025	3D	SO_2, CO_2, HCl, Temp, Humidity	SO_2 calibrated CO_2 calibrated HCl not calibrated
	7D	SO_2, CO_2, HCl, Temp, Humidity	SO_2 calibrated CO_2 calibrated HCl not calibrated

The instruments that were present for the cross-comparison

University of Costa Rica
University of Palermo
INGV Osservatorio Nazionale Terremoti (ONT)
INGV Osservatorio Etneo (OE)

MiniGas NTX-PRO

HAPSITE SCOUT miniGAS

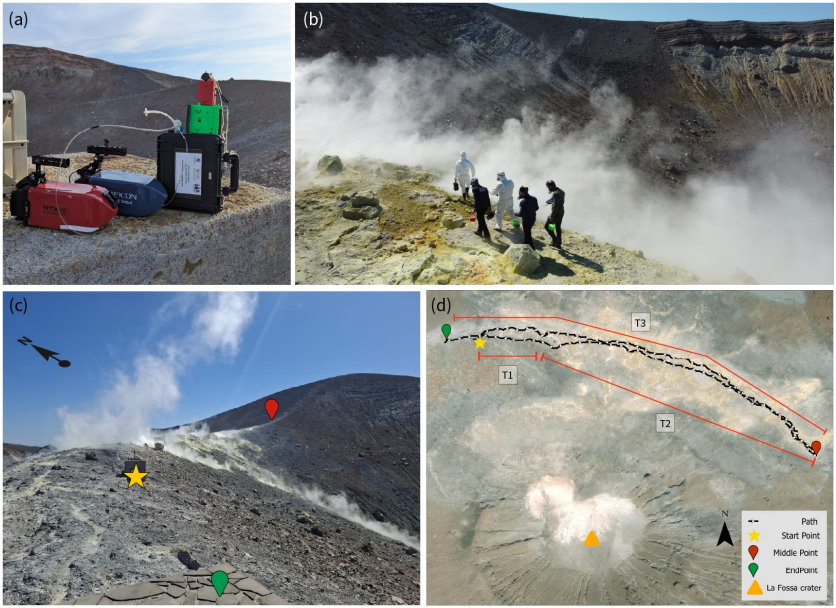
Multi-Gas Labvulc

Multigas Drone PP

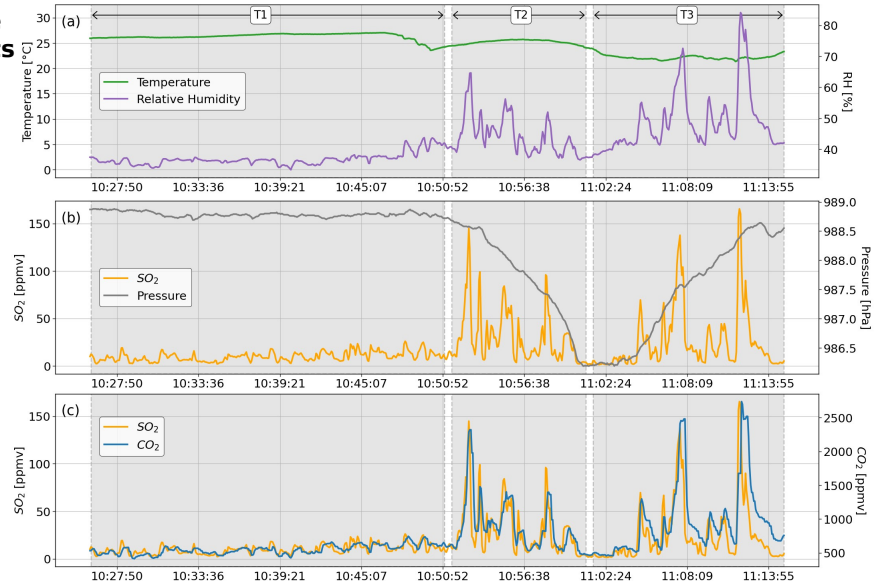
The instruments that were present for the cross-comparison

8 April 2025	Volcanosonde MiniGas - NTX
9 April 2025	Volcanosonde MiniGas – NTX SCOUT miniGAS Multi-Gas Labvulc Multigas Drone PP
10 April 2025	Volcanosonde MiniGas – NTX SCOUT miniGAS Multi-Gas Labvulc Multigas Drone PP

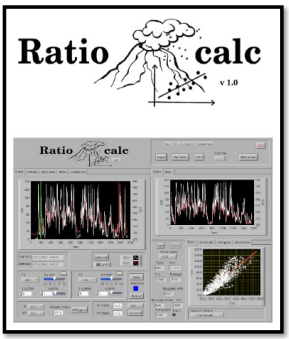
Experiment
10 April 2025



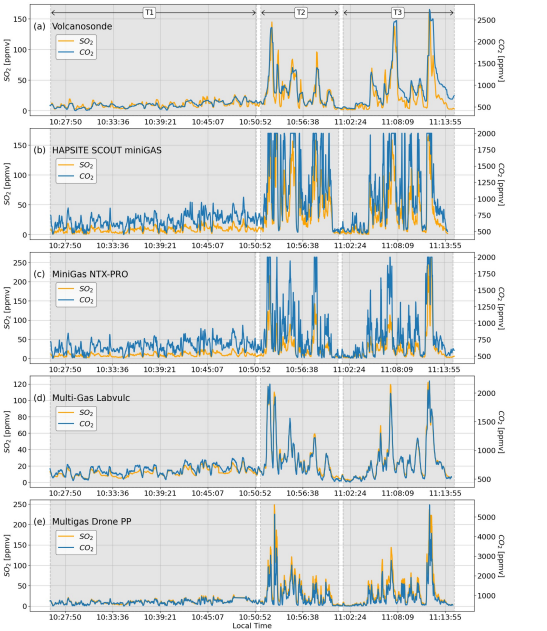
Volcanosonde measurements



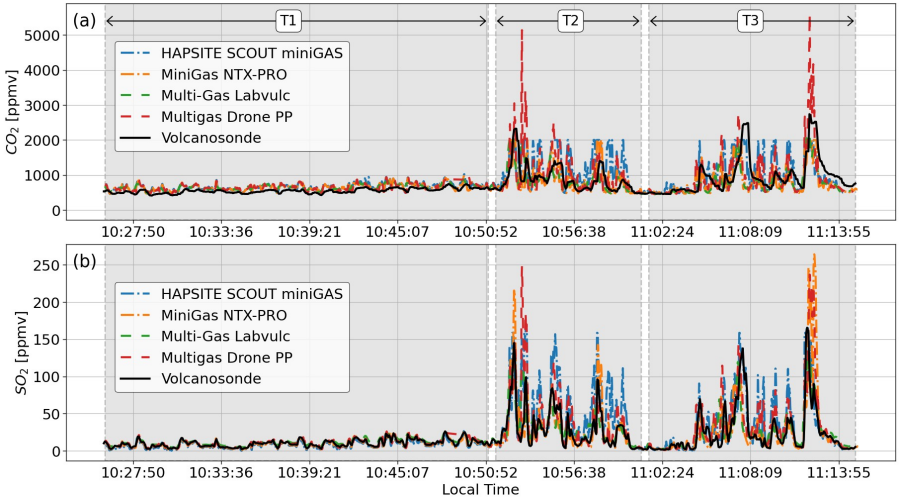
SO_2 and CO_2 comparison and cross-comparison between instruments



(Tamburello, 2015)



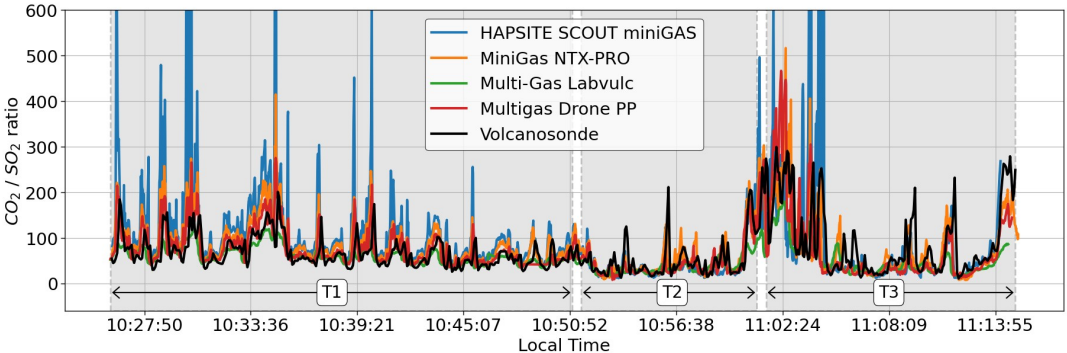
Measurement Comparison



Mean CO2 and SO2 concentrations (in ppm) obtained from each instrument

Variable	Time interval	Instruments				
		Volcanosonda	HAPSITE SCOUT miniGAS	MiniGas NTX-PRO	Multi-Gas Labvulc	Multigas Drone PP
CO2	*T1*	548.0 ± 17	658.9 ± 7	646.9 ± 6	649.9 ± 13	649.4 ± 6
	T2	891.4 ± 28	1088.2 ± 11	823.4 ± 8	860.8 ± 17	1011.2 ± 10
	T3	966.1 ± 30	880.5 ± 9	754.2 ± 8	778.6 ± 16	927.9 ± 9
	Total time series	727.8 ± 23	787.9 ± 8	707.3 ± 7	724.9 ± 14	797.7 ± 8
SO2	*T1*	10.0 ± 2	8.2 ± 0.2	9.2 ± 0.2	11.8 ± 0.2	10.2 ± 0.2
	T2	30.8 ± 6	40.1 ± 0.8	26.7 ± 0.5	31.4 ± 0.6	39.5 ± 0.8
	T3	25.9 ± 5	24.6 ± 0.5	21.6 ± 0.4	25.0 ± 0.5	33.3 ± 0.7
	Total time series	18.2 ± 3	17.6 ± 0.4	15.8 ± 0.3	19.2 ± 0.4	22.5 ± 0.5

Instantaneous CO_2/SO_2 ratio comparison.

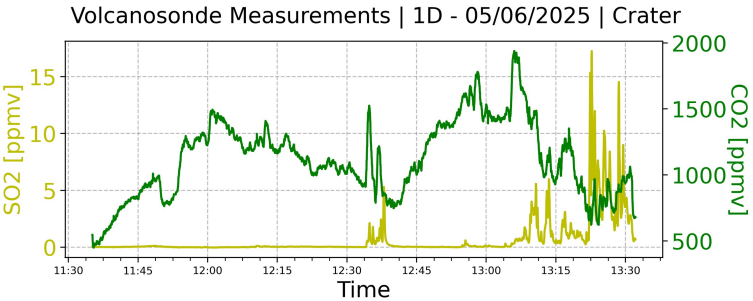


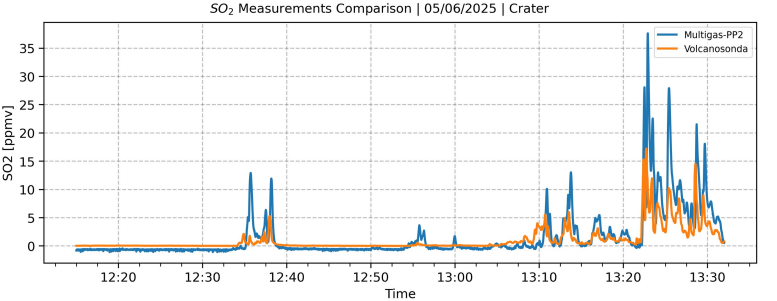
Summary of CO_2/SO_2 ratios for each instrument.

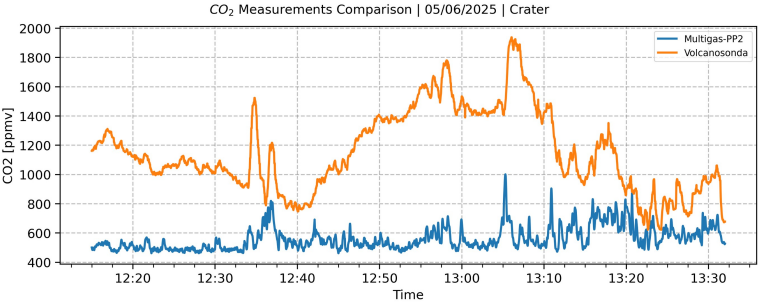
Time interval	Instruments				
	Volcanosonda	HAPSITE SCOUT miniGAS	MiniGas NTX-PRO	Multi-Gas Labvulc	Multigas Drone PP
T1	11.12	19.52	17.11	16.47	17.75
T2	12.56	13.62	13.67	14.48	14.52
T3	14.64	15.62	11.54	13.97	14.87
Total time series	14.89	15.05	12.10	13.61	14.35

Accuracy and time response of the CO_2 sensor, which becomes critical during rapid changes in concentration.

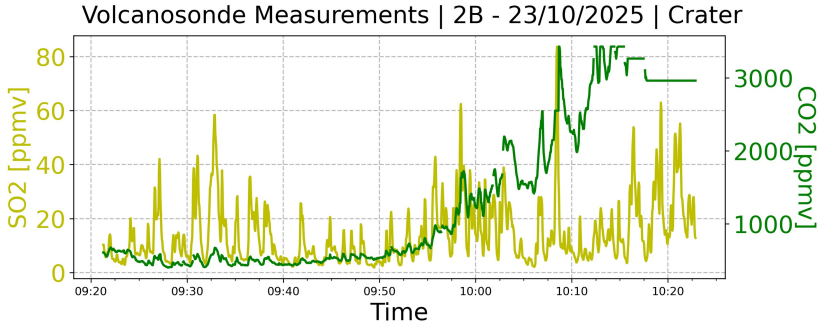
Etna experiments

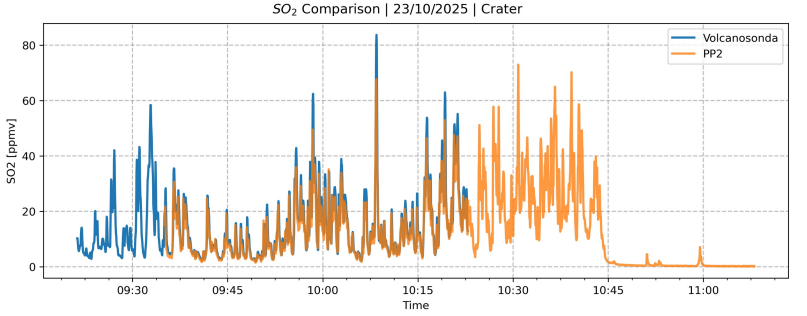


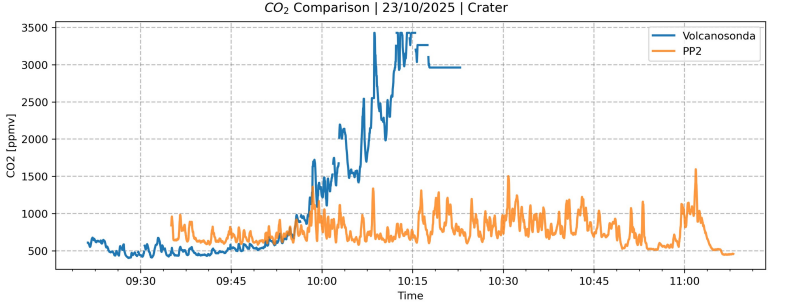

SO_2 Measurements Comparison | 05/06/2025 | Crater
Multigas-PP2
Volcanosonda
SO2 [ppmv]
0
5
10
15
20
25
30
35
12:20
12:30
12:40
12:50
13:00
13:10
13:20
13:30
Time

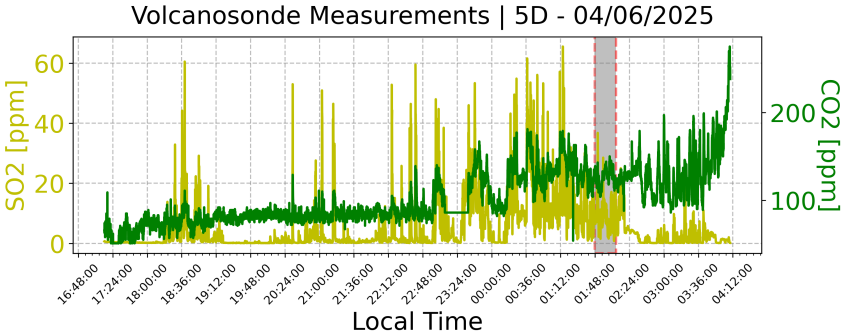

CO_2 Measurements Comparison | 05/06/2025 | Crater
Multigas-PP2
Volcanosonda
CO2 [ppmv]
400
600
800
1000
1200
1400
1600
1800
2000
12:20
12:30
12:40
12:50
13:00
13:10
13:20
13:30
Time

Etna experiments




SO_2 Comparison | 23/10/2025 | Crater
Volcanosonda
PP2
SO2 [ppmv]
0
20
40
60
80
09:30
09:45
10:00
10:15
10:30
10:45
11:00
Time


CO_2 Comparison | 23/10/2025 | Crater
Volcanosonda
PP2
CO2 [ppmv]
500
1000
1500
2000
2500
3000
3500
09:30
09:45
10:00
10:15
10:30
10:45
11:00
Time


Volcanosonde Measurements | 5D - 04/06/2025
SO2 [ppm]
CO2 [ppm]
0
20
40
60
100
200
16:48:00
17:24:00
18:00:00
18:36:00
19:12:00
19:48:00
20:24:00
21:00:00
21:36:00
22:12:00
22:48:00
23:24:00
00:00:00
00:36:00
01:12:00
01:48:00
02:24:00
03:00:00
03:36:00
04:12:00
Local Time

Conclusions

- The SO_2 sensor demonstrates reliable performance.

Preprint: Available for public review and discussion
Naranjo, C., Bitetto, M., Buongiorno, M. F., Corrales, E., Diaz, J. A., Filippeschi, A., Gemignani, M., Giudice, G., Guerrieri, L., Marsili, I., Merucci, L., Silvestri, M., Stelitano, D., Vitale, A., Biondi, R., Marcuccio, S., and Corradini, S.: Volcanosonda: A Novel, Lightweight and Low-Cost Instrument for In-Situ Characterization of Volcanic Clouds – A Cross-Comparison Experiment, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2026-226, 2026.