

Electrical Signals Generated by Pyroclastic Density Currents at Stromboli Volcano



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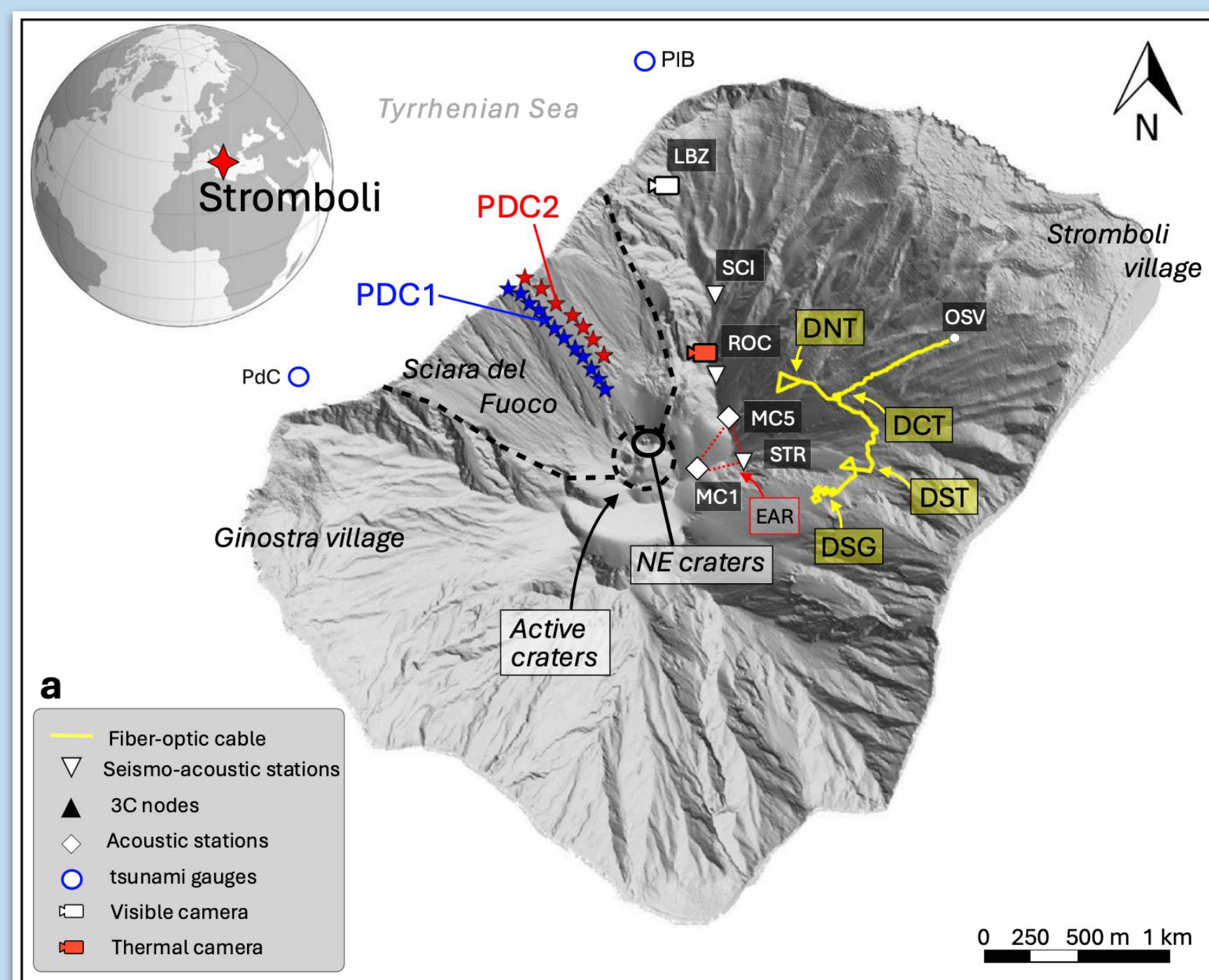
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1 Ash electrification & lightning

Volcanic lightning is generated during explosive eruptions, by fragmentation- and friction-induced charging of volcanic ash particles^[1]. Experiments and monitoring of active volcanoes show correlations between detectable variations in the atmospheric electric field, eruption magnitude and style^[2-4].

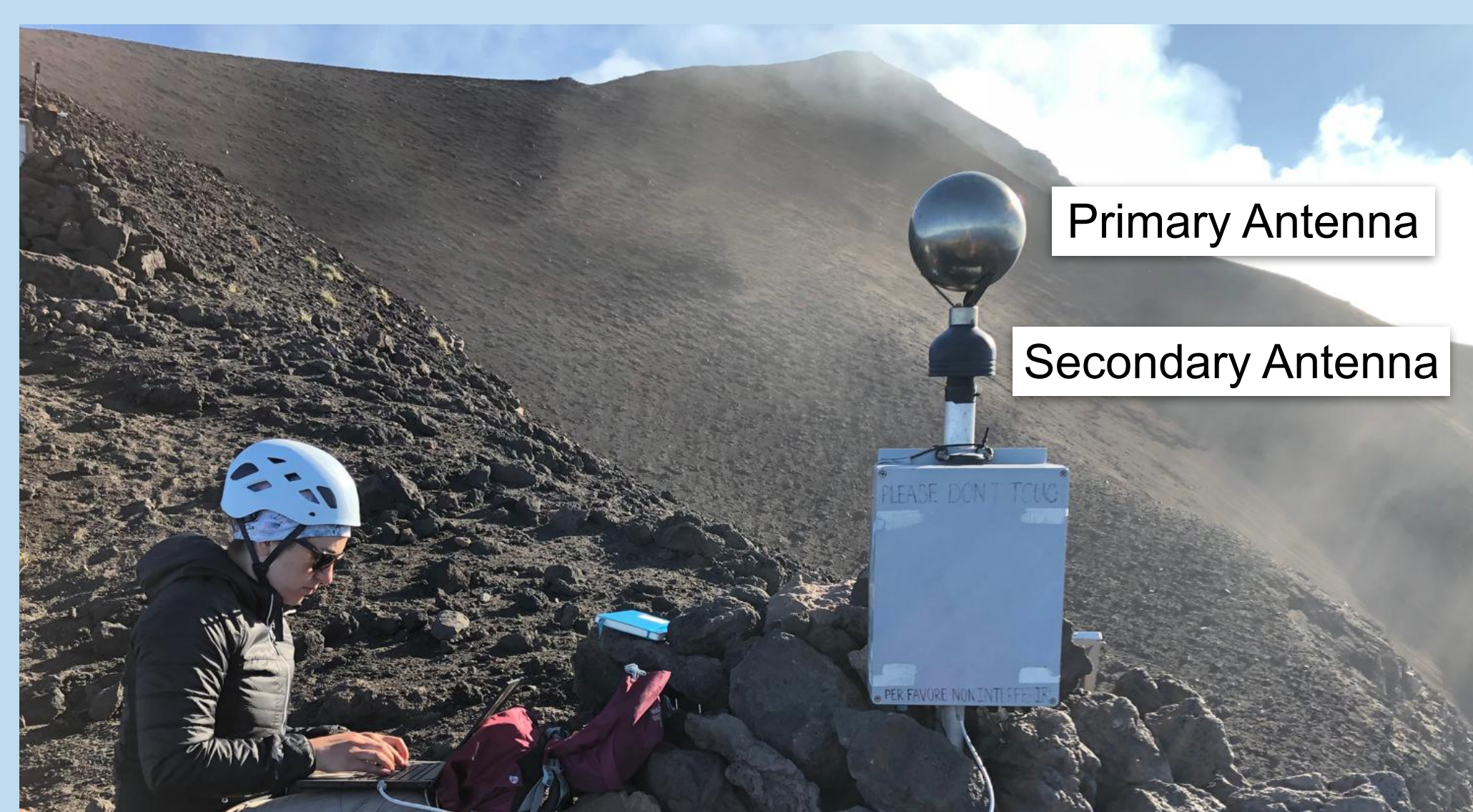
2 PDC event at Stromboli



Map of Stromboli with path of „PDC2“. Figure from [5].

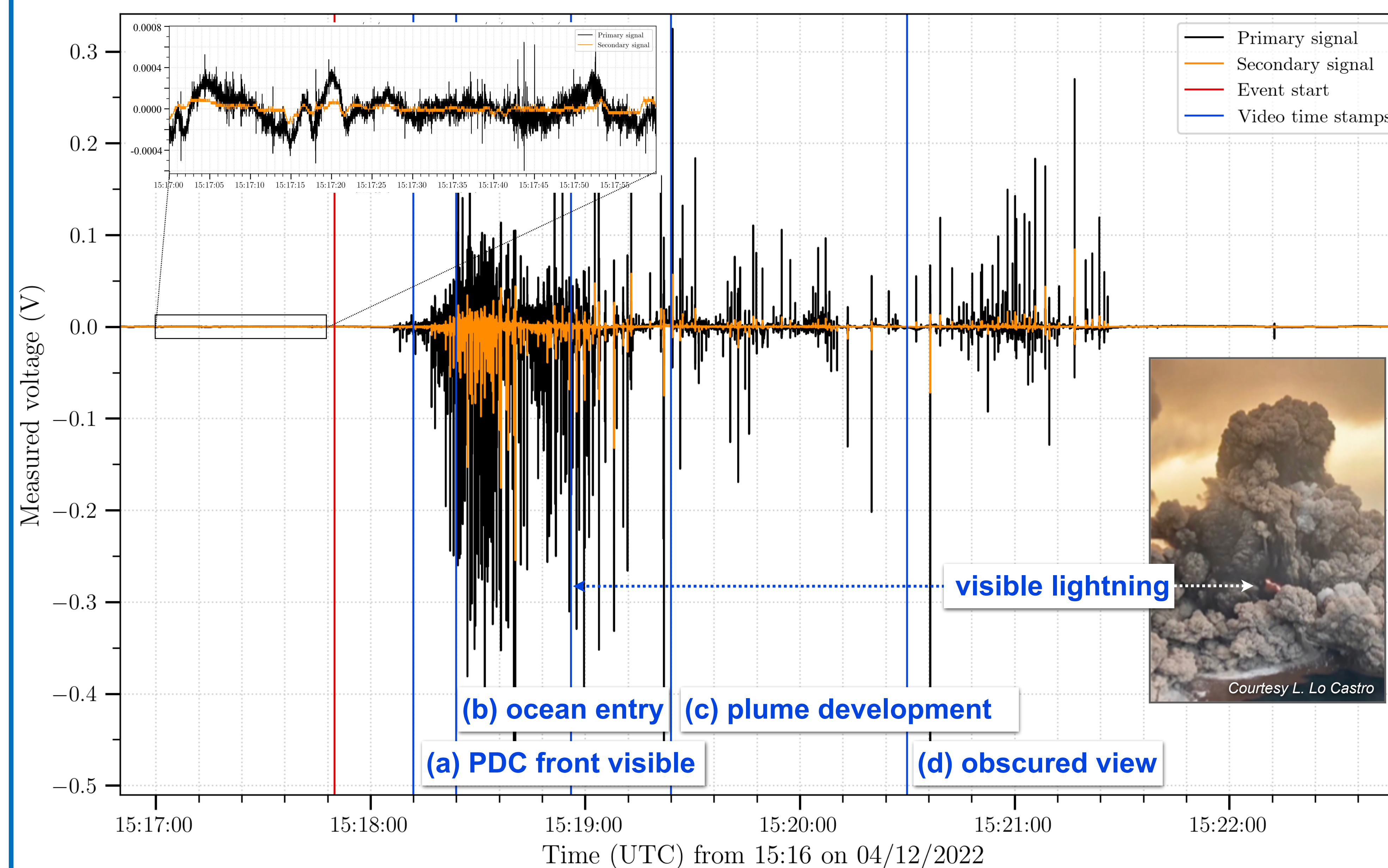
- 04/12/2022 ~15:17:50 UTC: Collapse of NE crater wall
- Deposit-derived PDC along Sciara del Fuoco (SdF)
- Forming turbulent plume at ocean entry
- Florence University visual camera (0.5 fps) at LBZ^[5]

3 Biral Thunderstorm Detector

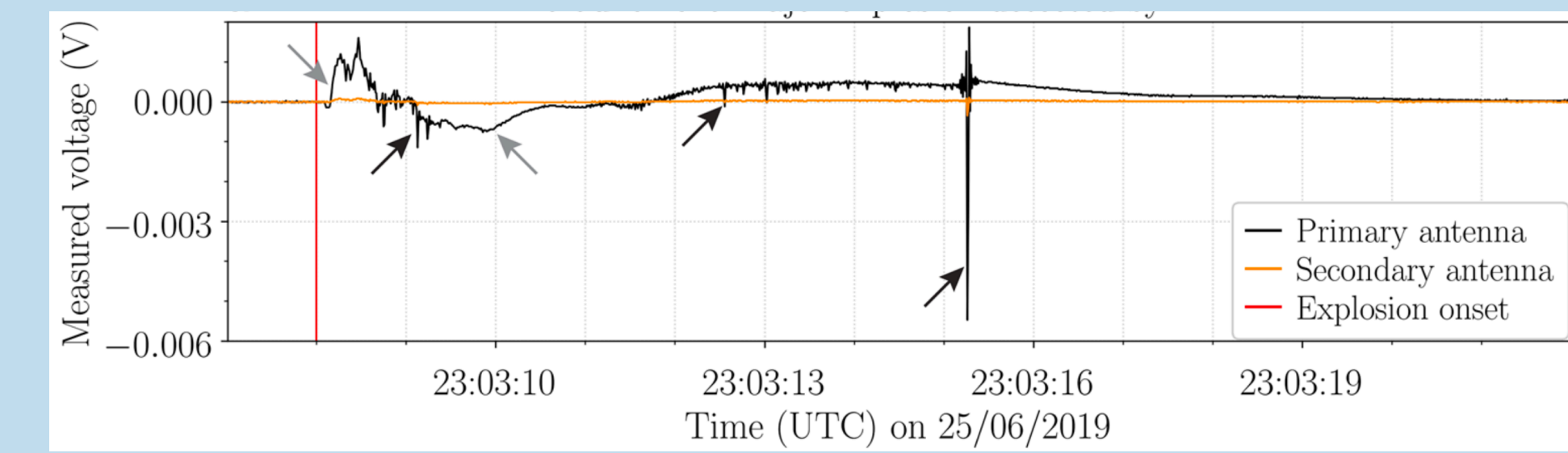


- Dual-antenna system placed at ROC
- Measures current induced by changes in ambient electric field (ELF: 1-45 Hz; 100 Hz sample rate)

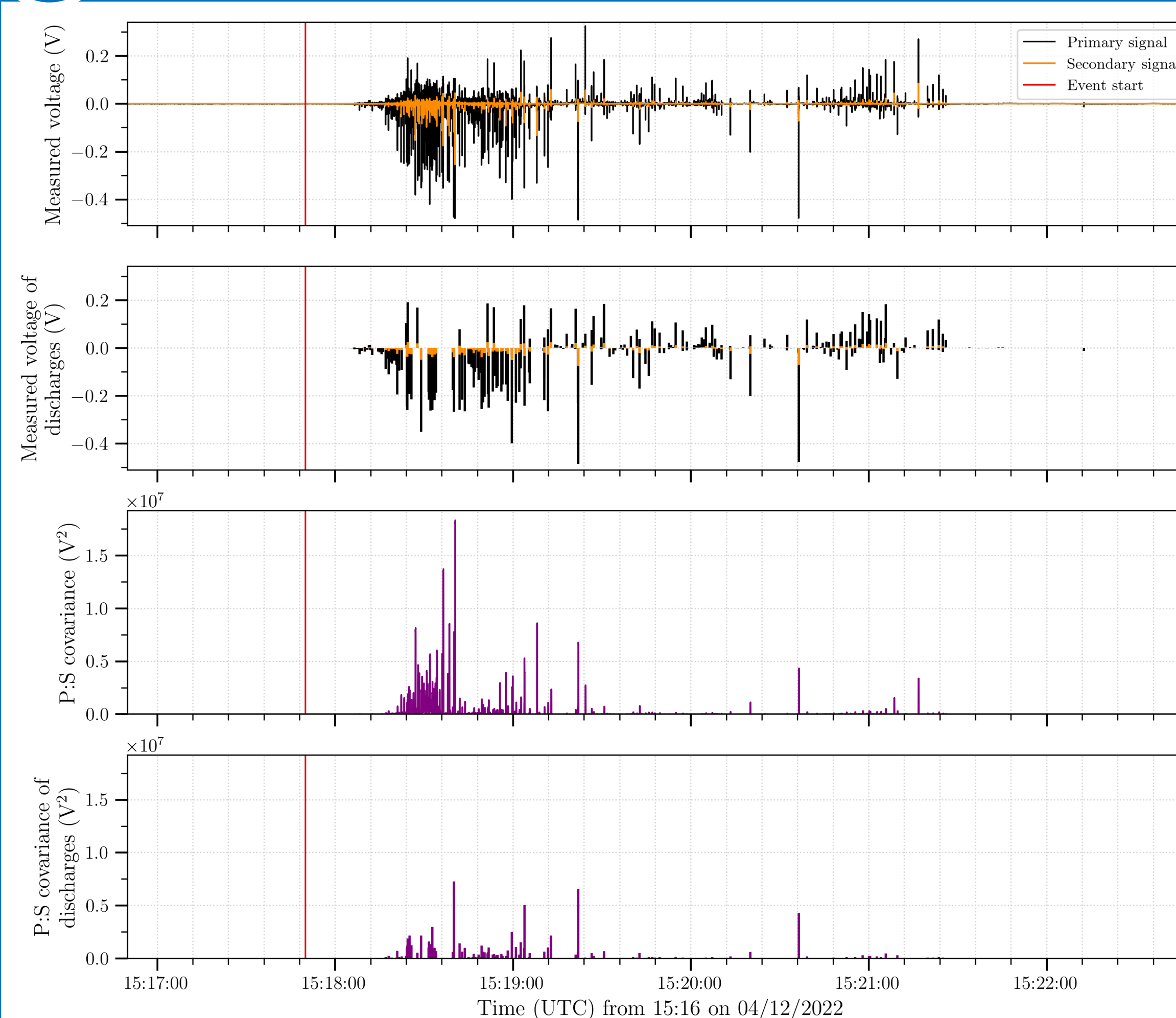
4 Temporal evolution of electrical activity



Comparison: BTD-200 signal during major explosion on 25/06/2019 [3]



5 Results of lightning detection



• 322 discharges detected over 6-min window (-1min/+5 min) from event start at 15:17:50:00 UTC

	a to b	b to c	c to end	full window
Num discharges	36	83	201	322
P-Signal (mean)	0.036 V	0.147 V	0.035 V	0.062 V
P-Signal (max)	0.196 V	0.486 V	0.478 V	0.486 V
S-Signal (mean)	0.004 V	0.017 V	0.004 V	0.007 V
S-Signal (max)	0.025 V	0.075 V	0.072 V	0.075 V

Number of discharges, absolute mean & maximum output voltage of identified discharges for both signals.

- Pre-collapse: 2 discharges just above noise level → preceding explosions or false positives
- Increasing discharge amplitude with extending PDC (a to b) and after ocean entry (b to c)

The lightning detection supports the observations during the evolution of the PDC along SdF

6 Conclusion & Outlook

The BTD-200 detected the onset and evolution of the PDC along Sciara del Fuoco on 04/12/2022.

The distinct electrical signature is characterized by rapid sequences of closely timed discharges, in contrast to the more isolated signals observed during major explosions and paroxysms. PDC interaction with seawater and subsequent plume formation produced higher-magnitude discharges, distributed over a longer period of time.

Next steps:

- Comparison with other geophysical signals (i.e., seismicity)
- Further PDC events at Stromboli (e.g., on 19/05/2021)

References

- [1] Cimarelli, C., et al., *Bull. Volcanol.* 84, 78 (2022).
- [2] Vossen, C. E., et al., *Earth Planet Sci Lett.* 570, 117084 (2021).
- [3] Vossen, C. E., et al., *Scientific Reports* 12.1, 9049 (2022).
- [4] Vossen, C. E., et al., *Communications Earth & Environment*, 5(1), 367 (2024).
- [5] Biagioli, F., et al., *Communications Earth & Environment*, 7, 111 (2026).