Deep Clustering of Tremor Episodes Can Reveal Different Eruptive Periods during the 2021 Fagradalsfjall Eruption, Iceland

Zahra Zali[1], Eva P S Eibl[1], Matthias M Ohrnberger[1], Fabrice Cotton[1], S Mostafa Mousavi[1], and Frank Scherbaum[1]

[1]Affiliation not available

March 28, 2023

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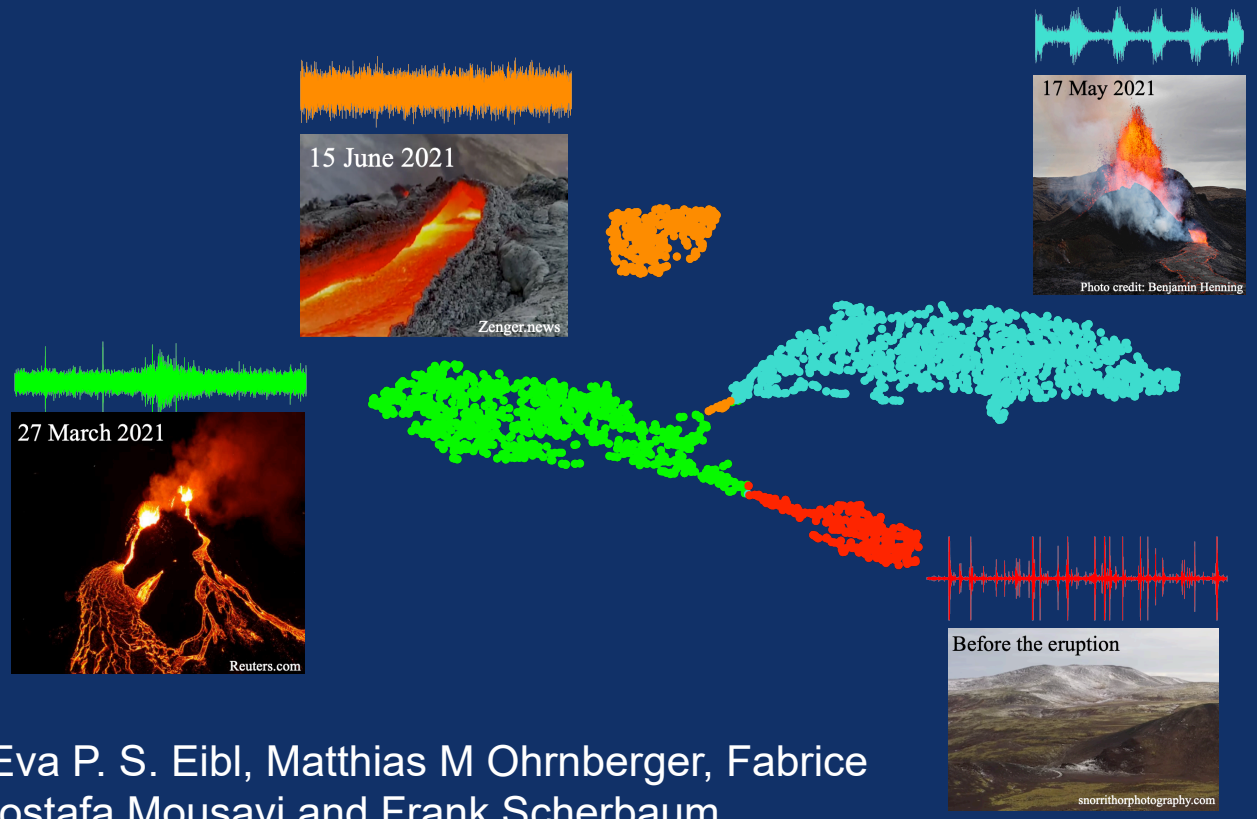

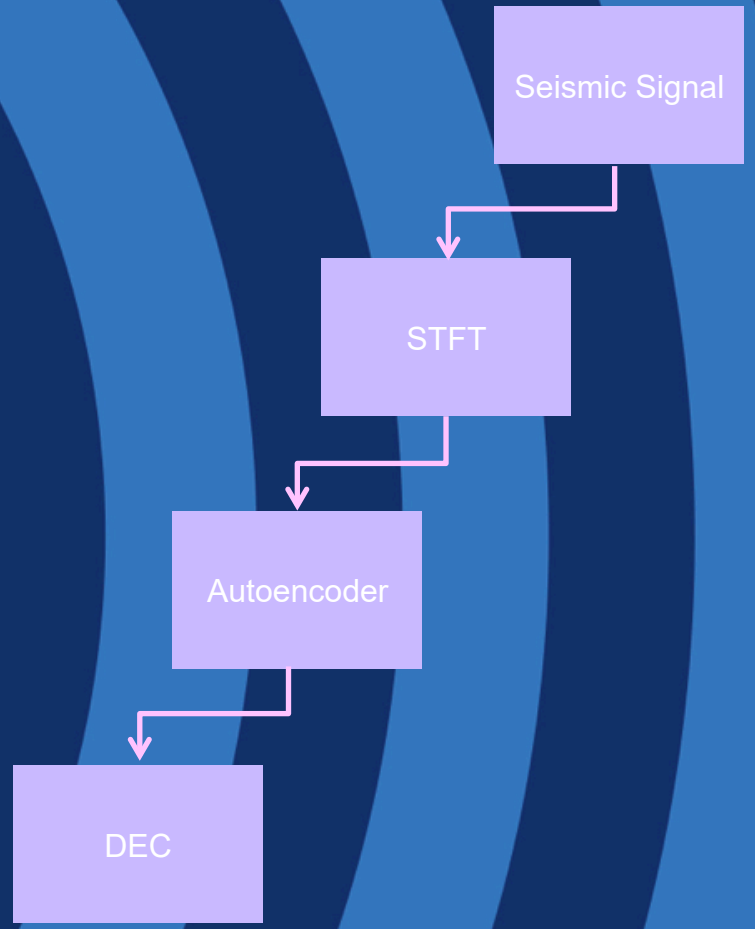

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December 2022

AGU FALL MEETING

GFZ Helmholtz-Zentrum Potsdam

Universität Potsdam

Natural Hazards and Risks in a Changing World

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SCIENCE LEADS THE FUTURE

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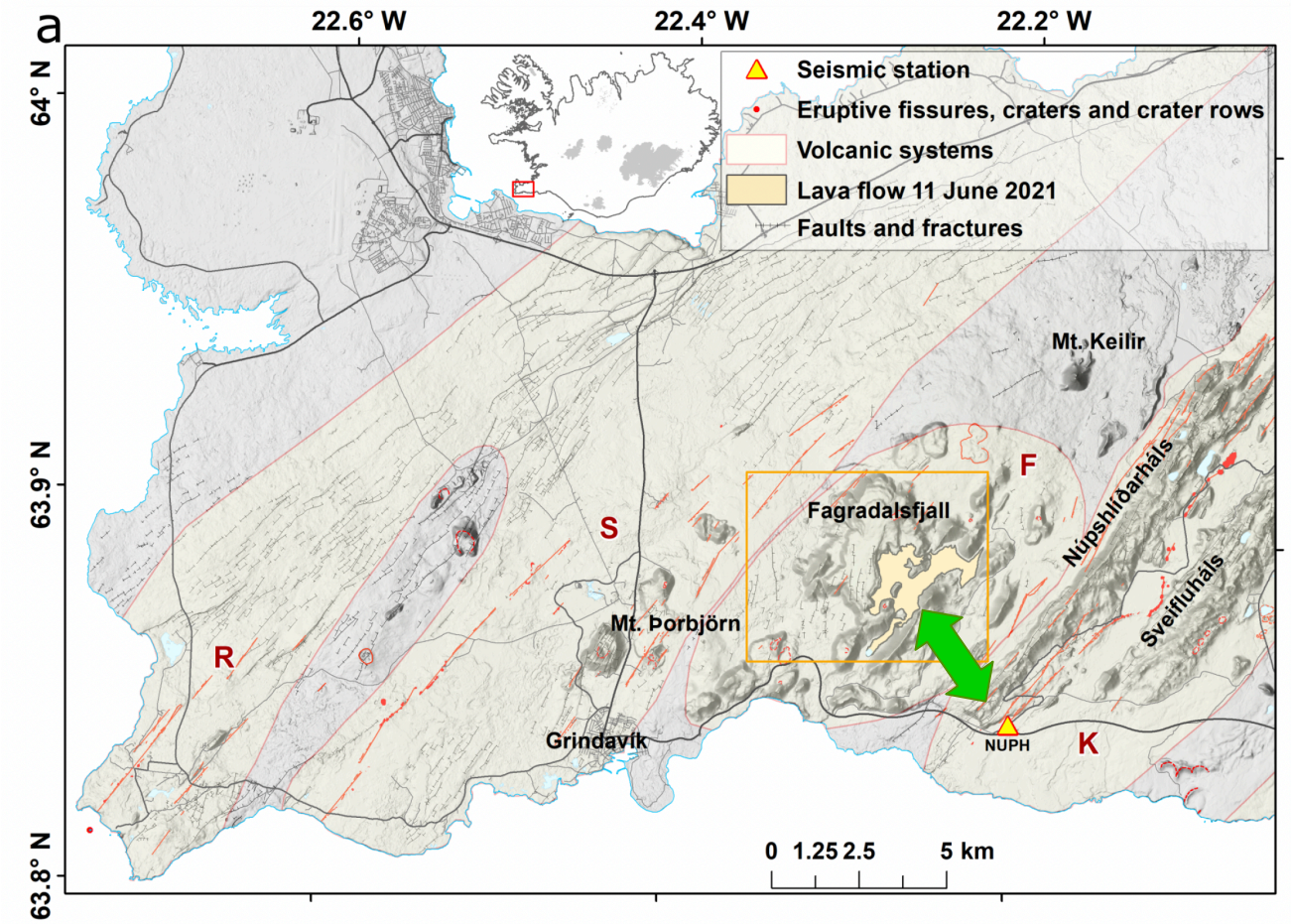
2021 Fagradalsfjall Eruption, Iceland



Eruptive site and instrument location

Eibl et al. (2022)

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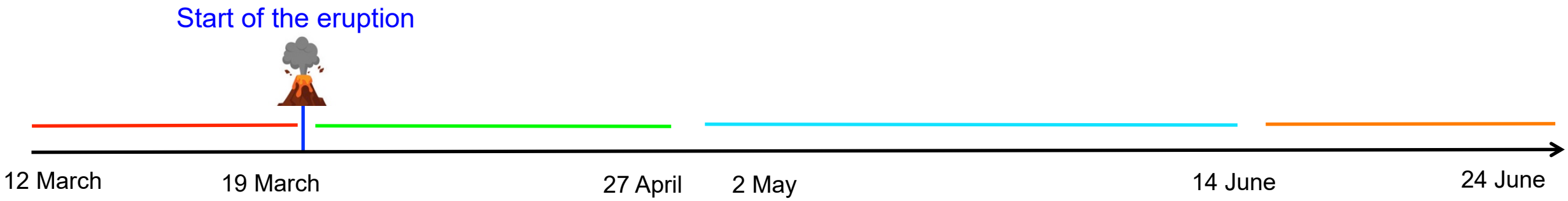
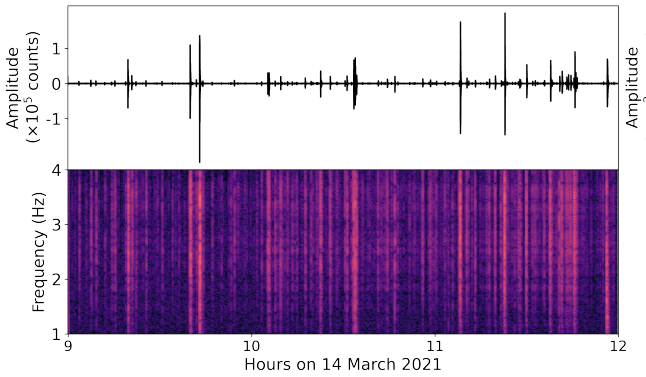
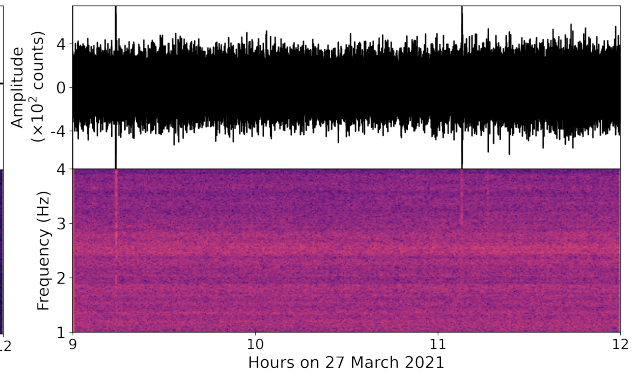
Different phases during the eruptive activity



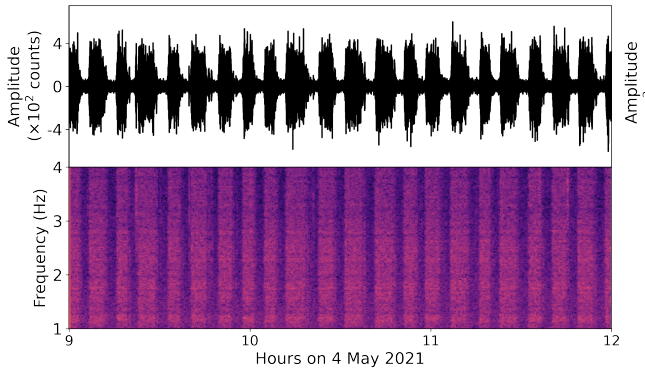
Earthquakes



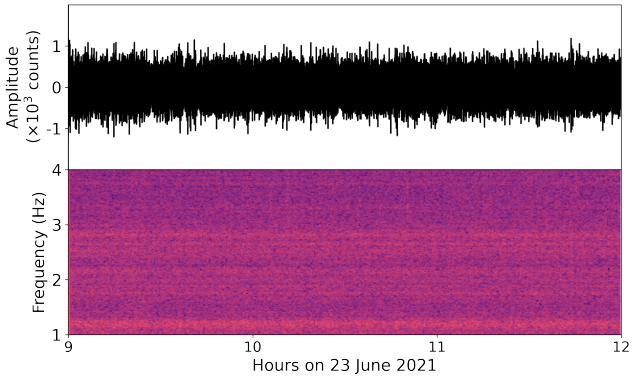
Continuous tremor



Pulsating patterns



Continuous tremor
(different frequency & amplitude)



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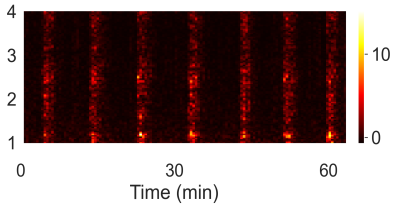
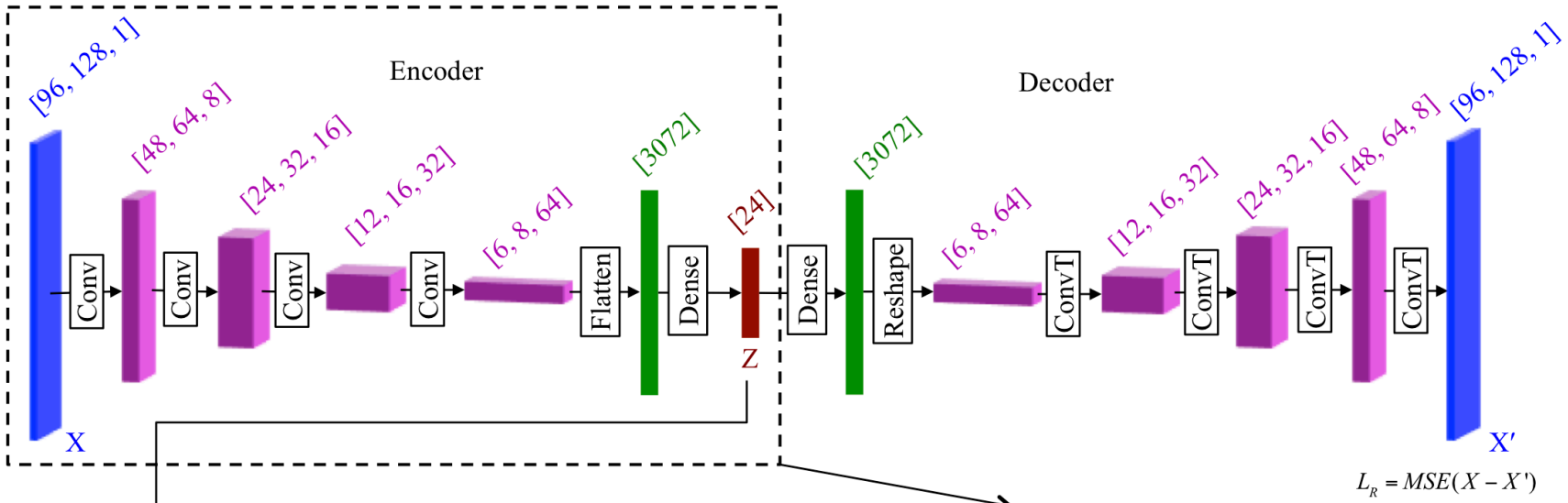
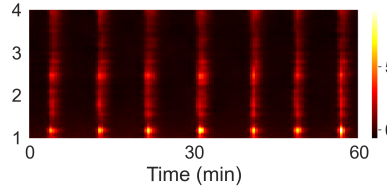
Deep embedded clustering



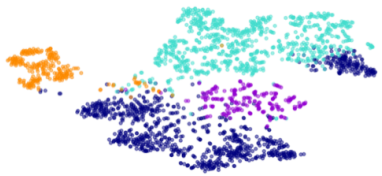
Input (1 hour spec)



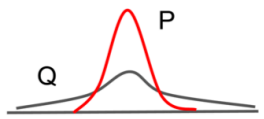


Output

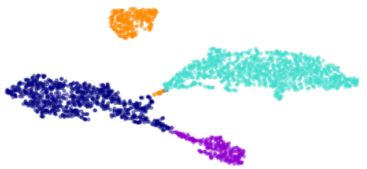
Clustering Layer
K-means



DEC:



$L_C = D_{KL}(P \| Q)$



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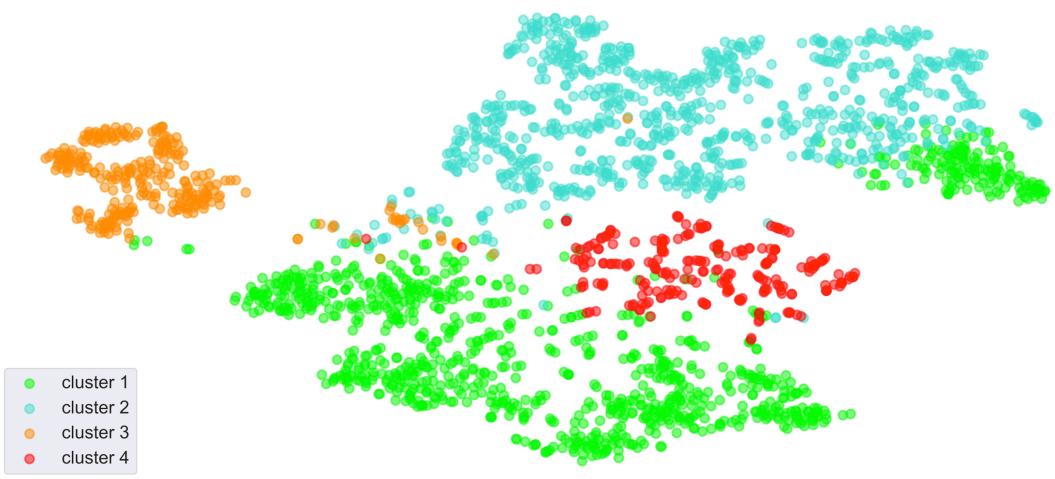
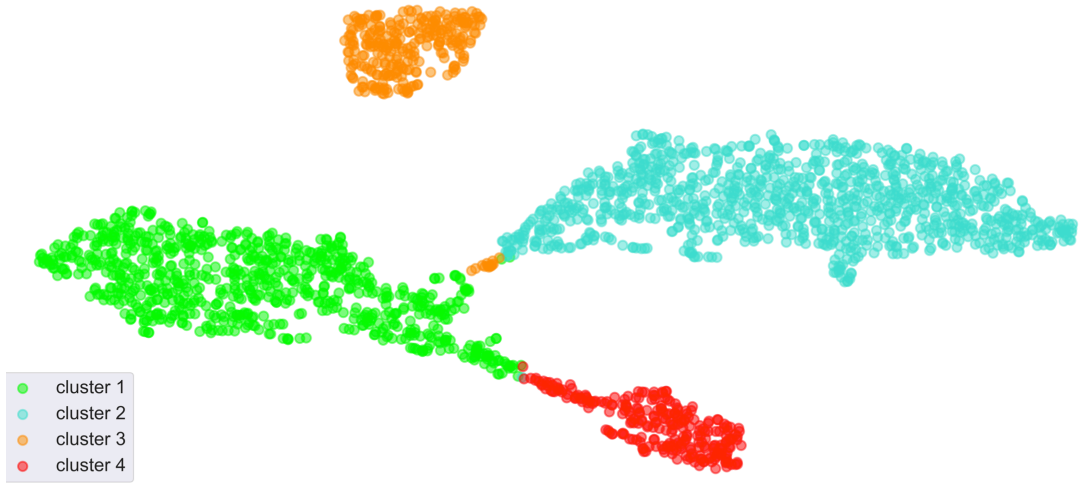
T-sne visualizations in feature domain

Number of clusters: 4
Selected based on the Sum of Square Error (SSE) value which has a significant and elbow-shaped decrease.



After pretraining



After 25000 iteration during the fine-tuning

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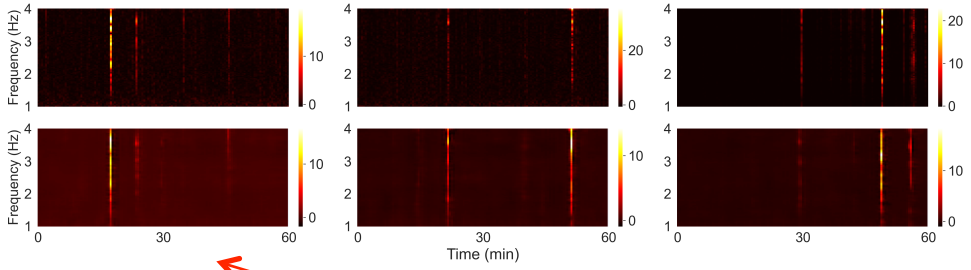
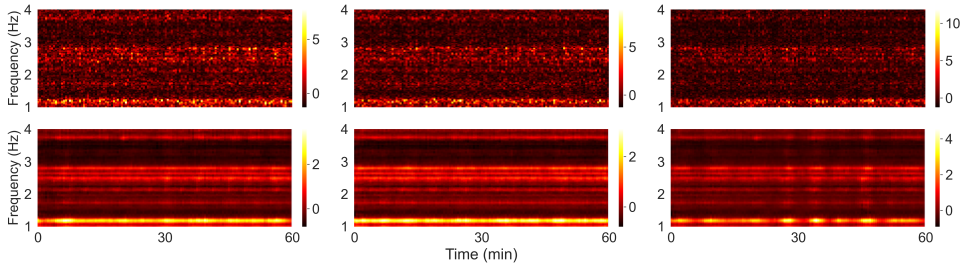
Deep clustering reveals different eruptive phases





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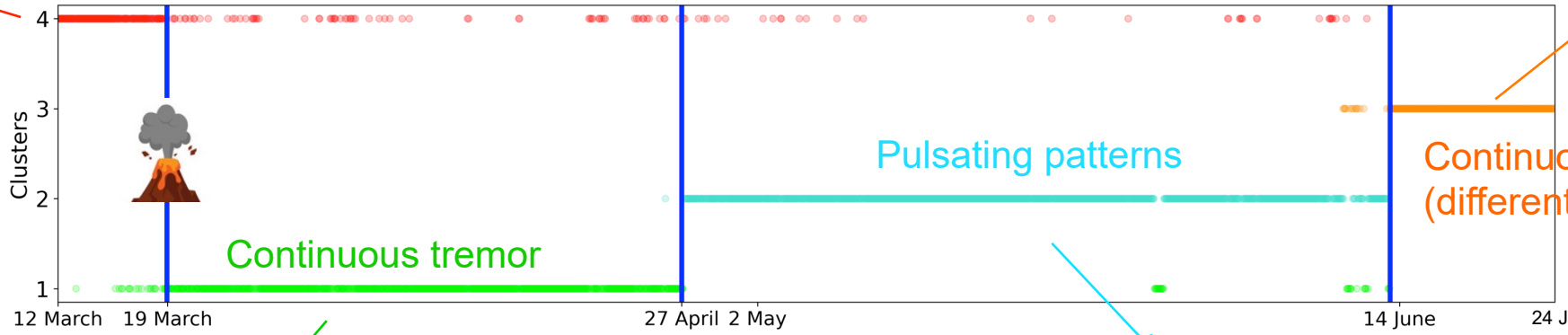
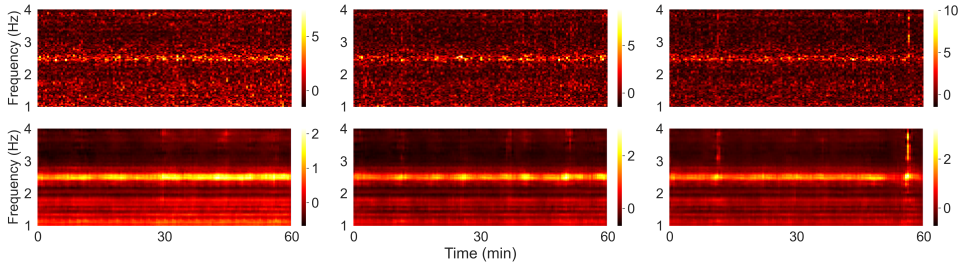
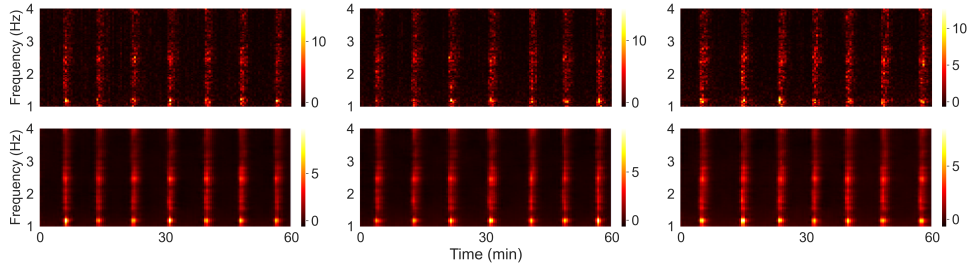


Pulsating patterns

Continuous tremor

Continuous tremor
(different frequency & amplitude)





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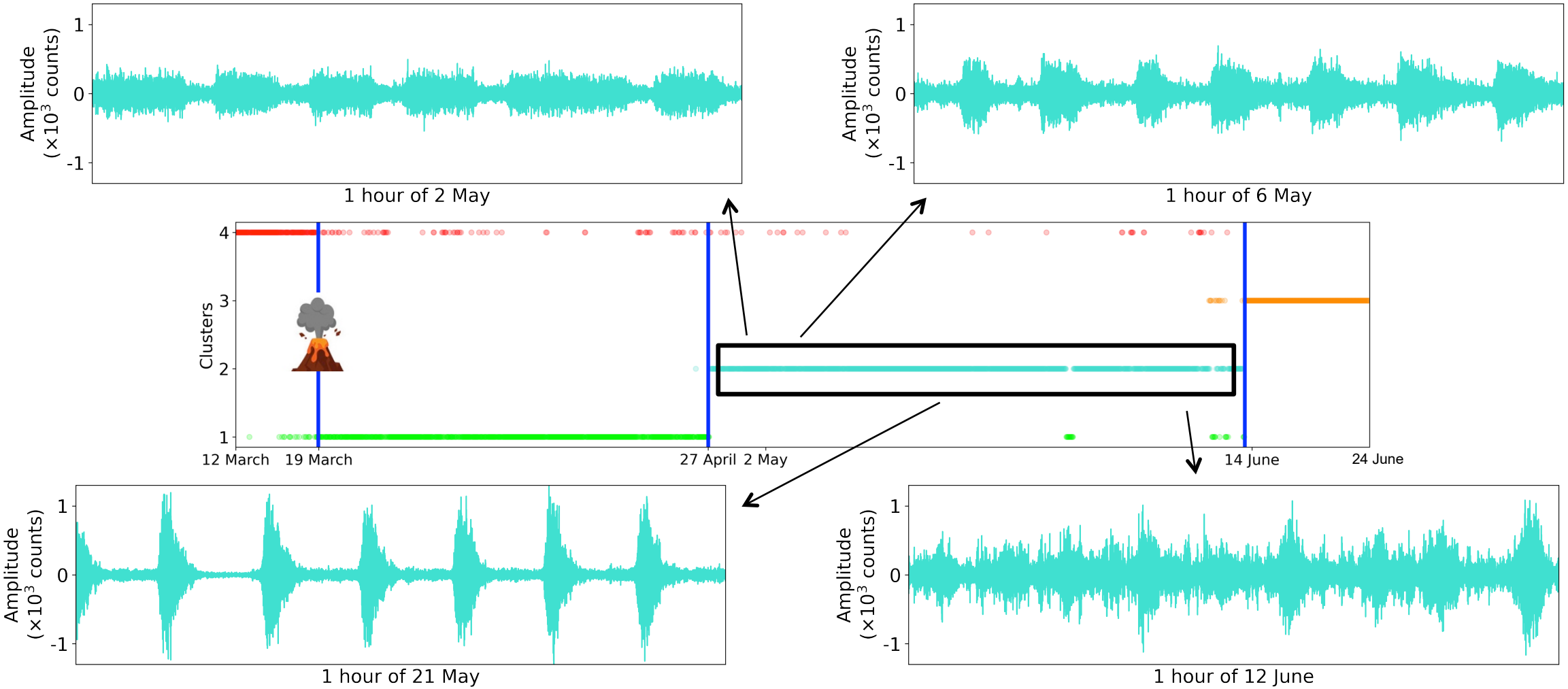
Clustering of the fountaining patterns



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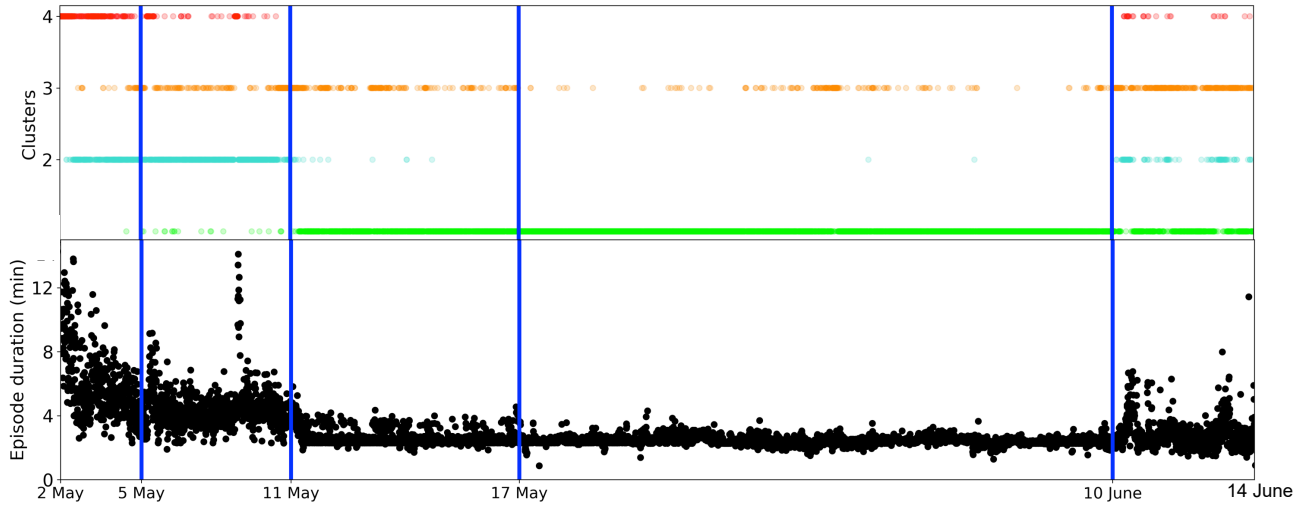
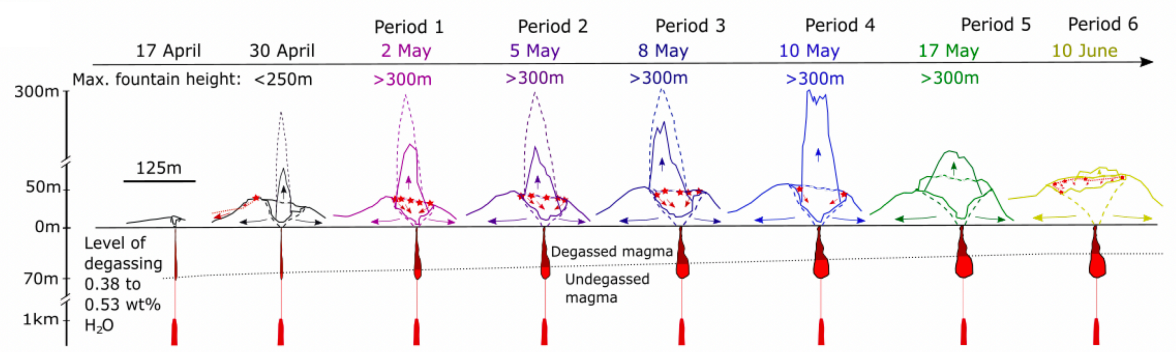
Different periods during episodic lava fountaining



Our clustering result is in line with other studies on the volcanic activity.



Eibl et al. (2022)

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Key takeaways

✔ Deep embedded clustering reveals different phases during the eruptive activity without using any prior information.

✔ This technique can disclose subtle precursors before the eruption.

? Open question: What properties of the volcanic system can be related to the extracted salient features?

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Thank you!