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Leveraging geophysical time series forecasting for monitoring volcanic systems: can we use machine learning?

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Monitoring the activity of volcanic edifices is central to the mitigation of volcanic risks and hazards. It implies to monitor and analyse multivariate data which can have complex natures and behaviours. Consequently, observatories need to communicate about the state of the volcano in understanding terms for the population and the decision-makers. The difficult task of analysing large amounts of data could be improved by using machine learning.

Machine learning may be a key method to perform time series analysis on volcanic edifices. Its use could bring new insights and improve the anticipation of eruptions. Indeed, these algorithms are particularly effective in analysing and forecasting time series. Such algorithms are already in use to monitor volcanic activity at Colima (Mexico) and Whakaari (New Zealand) by analysing seismic signals. Yet, the detection of precursor remains a challenging task since volcanoes and their eruption have non-linear evolution.

In this study, we test if and how signals from seismicity and ground deformation can be combined to detect and forecast volcanic eruptions at Piton de la Fournaise. The idea behind is to leverage possible unknown correlations between geophysical signals. We analyse height signals from the past twenty years using various machine learning algorithms (XGBoost and deep neural networks) to predict the current and future state of the volcano.

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