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The potential of continuous near-field recording of infrasound produced by volcanoes in Vanuatu for probing the the state of the atmosphere.

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Active volcanoes in the Vanuatu archipelago are a natural source of infrasound, which can be used to monitor the propagation of the waves in the atmosphere, recorded at several hundred of kilometers away. While Lopevi is only producing significant infrasonic waves when an eruptive column of several kilometers high is emplaced in the atmosphere, Marum and Benbow both on Ambrym island and Yasur on Tanna island are permanently generating infrasonic waves.

We initially installed, in 2008, an acoustic triangular network on Ambrym volcano to detect strong volcanic explosions, relatively close to the vents, at 2 km. The lack of strong explosions during our 6 months of recordings, with recorded acoustic pressure < 10 Pa, prevented us to use these explosions as natural sources for tracing the propagation path in the atmosphere towards the station IS22 installed at Noumea (New Caledonia), at several hundred of kilometers away. However, the comparison between measurements performed at 2 km with those performed for 3 days at a few hundred of meters from Benbow quantifies the potential of using a triangular acoustic network at a safe distance for monitoring volcanic activity even when very small.

Yasur volcano is an outstanding source of infrasonic waves, as its explosions are always sufficiently strong to be recorded at Noumea (New Caledonia). One microbarometer, installed at 300 m from its crater since october 2003, has now recorded several years of activity. The volcanic sound reaches the station IS22 at Noumea during the austral summer, allowing us to compare near-field and far-field signals for a very long period. Our observations in the far-field shows that its volcanic activity is relatively stable, as confirmed by our near-field measurements. We have also performed for a week infrasonic measurements almost directly above the crater to further explore the quality of our continuous measurements in a safe location at a distance of 300 m.

In the absence of appropriate modelling of the sound wave, we have used a dimensionless analysis, which relates acoustic power and the velocity of gas-ejecta mixture. Our multi-years recordings show several sudden increases in gas flux over one week as well as a more progressive evolution, over several months. The gas flux varies between 280 m3/s and 1100 m3/s, in agreement with visual observations.

The acoustic time series is analysed by detecting explosions with a method based on wavelet decomposition. The frequency is remarkably constant, showing that the gas volume at the vent does not change significantly over the years. However huge variations exist in the number of explosions (up to a factor 5) and in the mean acoustic pressure (up to a factor 4). Furthermore three different regimes can be distinguished and a sharp transition exists between them (less than a day). In the first one, the activity is quiet with both a low number of explosions (20 per hour) and a low acoustic pressure (50 Pa). The second regime is characterised by a high acoustic pressure and a low number of explosions, while the third one is exactly the opposite. Regimes 2 and 3 are found in alternation, showing that the transition is reversible. We suggest that the different regimes reflect sudden variations of the gas volume fraction in the conduit.

Our near-field and far-field measurements, when combined, show the potential of infrasound from volcanoes as a natural and continuous source of sound to estimate more precisely how large the errors in the upper wind models are, in a region where there is a lack of routine measurements.