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The Acoustic Signal of a Helicopter can be Used to Track it With Seismic Arrays

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We apply traditional frequency domain methods usually applied to volcanic tremor on seismic recordings of a helicopter. On a volcano the source can be repeating, closely spaced earthquakes whereas for a helicopter the source are repeating pressure pulses from the rotor blades that are converted through acoustic-to-seismic coupling. In both cases the seismic signal is referred to as tremor. As frequency gliding is in this case merely caused by the Doppler effect, not a change in the source, we can use its shape to deduce properties of the helicopter. We show in this analysis that the amount of rotor blades, rotor revolutions per minute (RPM), flight direction, height and location can be deduced.

The signal was recorded by a seven station broadband array with an aperture of 1.6 km. Our spacing is close enough to record the signal at all stations and far enough to observe traveltime differences. We perform a detailed spectral and location analysis of the signal, and compare our results with the known information on the helicopter's speed, location, height, the frequency of the blades rotation and the amount of blades. This analysis is based on the characteristic shape of the curve i.e. speed of the gliding, minimum and maximum fundamental frequency, amplitudes at the inflection points at different stations and traveltimes deduced from the inflection points at different stations. The helicopter GPS track gives us a robust way of testing the method. This observation has an educative value, because the same principles can be applied to signals in different disciplines.