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Monitoring pre-seismic activity changes in a domestic animal collective in Central Italy

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Animal behavior may change just prior to a natural catastrophe, as reported in numerous anecdotal reports and also through increasing scientific observations. However, these observations are still highly controversial, as it is often difficult to establish statistically significant, quantifiable, testable, and repeatable experimental measurements. This is also the case for anomalous animal behavior in the context of earthquake forecasting. Many studies compiled accidental observations or post-event recollections of information, but no systematic and pro-active investigation on animal behavior near earthquake epicenters has been conducted so far. The sequence of large earthquakes in Italy in the period August to November 2016 provides us with a natural experiment to monitor – if it exists – pre-seismic activity changes in a domestic animal collective. For this purpose, we continuously recorded 53Hz-3D-acceleration behavior of domestic animals in the epicenter of the October 30, 2016, M6.6 earthquake in Italy, from two days before to seven days after this disaster. In addition, we monitor animal behavior in a control period (January-April 2017) in which no large earthquake occurred. We detected how animals collectively react directly to earthquakes, but we also found anticipatory activity prior to earthquakes. The animals significantly increased their collective body accelerations over background levels between 2-18h before an earthquake, depending on the distance to the subsequent earthquake hypocenter. Through a number of statistical tests, we verify our observations, which, to first order, imply that a longer “warning time” may be given for earthquakes that are farther away from the animals. We note that we operating in the near-to-intermediate-field regime of earthquakes (distance range less then $\sim$60 km). As such, anomalous animal behavior may be triggered by physical preparation processes in the source rock of the earthquake. We suggest an experimental earthquake forecast system testing whether a distributed network of animal collectives could supplement current seismic forecast systems.