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Temporal Changes in the Eruption Behaviour of the Old Faithful Geyser, Yellowstone National Park: Statistical Description and Implications for Dynamical Models

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For a long time, the durations and intervals of eruptions of the Old Faithful geyser (Yellowstone National Park, USA) have been serving as an illustrative text-book example for different clustering and regression problems. However, during the last years, the formerly bimodal structure of the probability distribution functions of both, eruption lengths and intervals, has been successively changed towards a more unimodal one.

In this contribution, we analyze data from logs of the Old Faithful Visitor Center (1995-2006) as well as time series from an electronic monitoring of the geyser (2000-2006) which have been made publically available by the Geyser Observation and Study Association (GOSA). We demonstrate that the changes in the eruption behaviour of the geyser over the last decade have been more or less discontinuously. The statistical features of the eruptions are described by fitting two-component Gaussian mixture models to data from different time intervals and compared to earlier records. In addition, the calculation of entropies from the continuous electronic monitoring time series yields a nonlinear characterization of the complexity of the corresponding dynamics. Data from different North American earthquake catalogues are used to test for a potential interrelationship of the discontinuous changes in the eruption behaviour with tectonic activity related to the giant magma chamber beyond the Yellowstone region.

We briefly illustrate potential sources of the observed dynamics by considering two

different modelling approaches: (i) stochastically forced transitions in a bistable potential with temporally varying shape and (ii) two coupled integrated-firing systems, which would correspond to the existence of two coupled reservoirs.