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Real-time forecasting of sample failure in laboratory rock deformation experiments

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The ability to accurately forecast catastrophic failure in rocks is likely to be a key component in reliable eruption forecasting models. The processes controlling the approach to failure produce highly non-linear behaviour, with a large stochastic component due to material heterogeneity. In the laboratory, mechanical, hydraulic, and rock physical properties are known to change in systematic ways prior to catastrophic failure. The effectiveness of such signals in real-time forecasting has never been tested before in a controlled laboratory setting; previous work has often been qualitative in nature, and subject to retrospective selection bias. Here we describe a collaborative experiment in real-time data assimilation to explore the limits of predictability of rock failure in a best-case scenario. Data are streamed from a remote rock deformation laboratory to a user-friendly portal, where several proposed physical/stochastic models can be analyzed in parallel in real time, using a variety of statistical fitting techniques, including least squares regression, maximum likelihood fitting, Markov-chain Monte-Carlo and Bayesian analysis. The results are posted and regularly updated on the web site prior to catastrophic failure, to ensure a true and verifiable prospective test of forecasting power.