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Systematic classification of seismicity patterns in microearthquake sequences of Switzerland

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Earthquakes tend to cluster in space and time forming earthquake sequences. Each sequence shows a different spatiotemporal occurrence behavior, which often can roughly be classified as mainshock-aftershock, foreshock-mainshock-aftershock or swarm-like. While many ruptures are followed by a significant number of aftershocks, foreshocks seem to be rare, and their underlying mechanisms are still debated. The controversy on foreshock mechanisms is fostered by inconsistency and incompleteness of many earthquake catalogs and by the lack of a consistent definition and identification of foreshocks. In the past decades, immediate foreshocks have been studied intensively on the centimeter scale in laboratory experiments. However, for real earthquakes, only a few high-resolution observations are available today, mainly limited to magnitudes above M4. Due to the big observational gap between laboratory and field scale, it is not fully understood if and how results can be transferred between the two different scales.

We want to overcome these obstacles by studying the seismicity patterns of microearthquake sequences in Switzerland, which has one of the densest and most sensitive seismic networks in the world. To further assure the highest data quality, our study concentrates on the operation period of the digital broadband network (2002 to present). We start with a systematic analysis of the earthquake catalog of the Swiss Seismological Service to consistently identify and classify all earthquake sequences. In a next step, we enhance the earthquake catalog by a matched filter analysis that ensures a uniform detection sensitivity and consistent magnitude estimation for each sequence. To better resolve the spatiotemporal behavior of the seismicity, we perform a high-precision relative relocation and a high-resolution statistical analysis of the enhanced catalogs for significant sequences. Based on these improved data sets, we plan to systematically investigate the occurrence and behavior of foreshocks.

In this presentation, we show the results of the systematic analysis of the Swiss catalog and the identification and classification of the seismic sequences. We will discuss the differences in their occurrence patterns considering geological and seismotectonic conditions, and hypocentral depth. For selected sequences, we will present the first results of the high-resolution analysis of the enhanced catalogs.