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Evidence for rain triggered seismicity at Mt Hochstaufen, SE Germany

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The 2002 seismicity of Mt. Hochstaufen, SE-Germany, is characterized by several swarm-type earthquake sequences that follow above average rainfall events. First investigations have recently provided indication, that the rain events triggered this swarm-type activity. We performed a detailed relocation of the 2002 seismicity, which is composed of (1) cluster analysis, (2) multi-event semi-automatic phase repicking, (3) probabilistic location in a pseudo-3D-velocity model with topography and (4) master event relocation. Furthermore, focal mechanisms of selected events were derived by taking into account the first-motion polarities of P, SV and SH-waves. We introduce a simple methodology to test the stability and estimate the variance of the focal mechanisms solutions.
Here we present evidence that the rain events triggered the earthquake swarms. We statistically model the relocated seismicity by means of point process modeling and pore-pressure diffusion assuming a rate-state friction fault stability law. Although, seasonal variability of seismicity related to ground water recharge and precipitation has been previously observed on regional scales, a statistically significant causal relationship between rainfall and earthquake activity for an isolated region can be shown here for the first time. The analysis yields clear evidence that tiny pore pressure changes induced by rainfall are able to trigger earthquake activity even at 4 km depth via the mechanism of fluid diffusion. This might be an universal feature which can, however, only be seen in the rare occasion of an isolated but critical system, like the study area.