**Load/Unload Mechanisms of the Seismically Active Mt. Hochstaufen, Bad Reichenhall (Germany) - Identified by Seismological, Geodetic and Meteorological Aspects**

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The Mt. Hochstaufen region is one of the few microseismically active areas in Germany and the Northern Alps. Earthquakes with magnitudes up to M3.2 (historically M4.2) occur as single events or in irregularly swarm type sequences. Most of the swarms occur during summer, often accompanied by strong precipitation (Fig. 1), suggesting a direct correlation of seismicity and rainfall. But the behaviour over time of the seismicity in the Mt. Hochstaufen/Bad Reichenhall region seems to be variable and more complex. Models that only take tectonic loading and over-average rainfall into account are often over-predicted with respect to rain-earthquake interaction. Consequently, precipitation and tectonic background stress cannot be the sole explanation for the local seismicity. Our current lack of understanding regarding the complete loading mechanism of the fault system at Mt. Hochstaufen as well as possible other ways for releasing stress more slowly (i.e., creeping) leads to incomplete and therefore wrong models and forecast estimates.

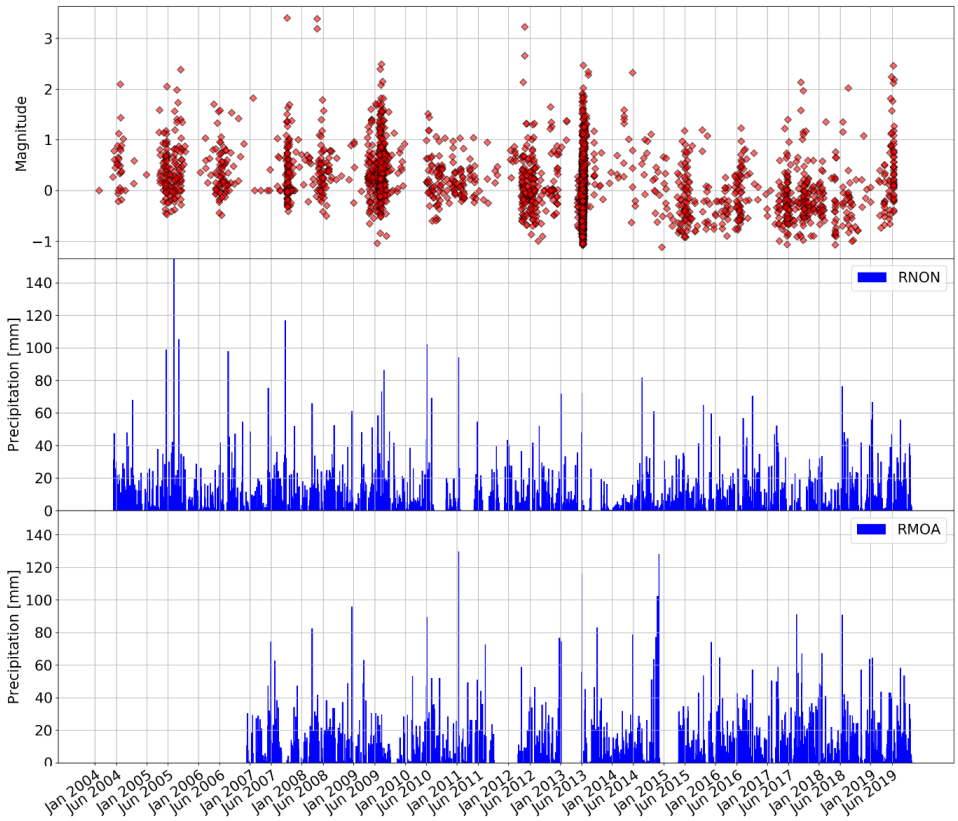


*Figure 1: The temporal occurrence of earthquakes (top) from the Bavarian earthquake catalog compared to the precipitation rate (bottom), registered by the meteorological stations RNON (southern flank of Mt. Hochstaufen) and RMOA (northern flank) of the Bavarian network (BW). Every year the number of earthquakes increase during the summer season, mainly in June, often accompanied by high precipitation rates (2005, 2007, 2009 and 2013). Swarms in 2012 and 2015 comprised many earthquakes but synchronous strong rain events were missing. The earthquake swarm in June 2019 comprised several earthquakes with many high magnitudes (up to M2.4), but is also not accompanied by a prominent rain event. Other years show high peaks in the precipitation rate (e.g. 2010, 2014 and 2018), but no dramatic increase in the number of earthquakes. Since 2013, no swarm comprises such a high number of earthquakes like the 2009 or 2013 swarms.*

The main goal of this study is to identify the complete set of load/unload mechanisms of the fault system on Mt. Hochstaufen by combining seismological analysis, meteorological and geodetic observations of the last decade.
Seismological observations provide insight on the characteristic of the geological structure in the area. Accurate hypocentres enable us to identify event clustering, which can be related to Karst formations and fracture zones. By comparing these clusters of temporally different swarms, we will be able to identify constantly reactivated sources or movements of those.
Space-borne and ground-based Synthetic Aperture Radar Interferometry (InSAR) will be used to measure the ongoing deformation of the Alpine crust and the main structures in the study area. The combination of the respective results enables us to monitor the prevailing stress field and the deformation of the Mt. Hochstaufen before and after swarm and earthquake occurrence. Consequently, we might be able to identify the coupled and cascading processes for possible loading and unloading mechanisms. Subsequently, we will be able to specify a time scale necessary for the crust to reach a critical state. This directly addresses the second research theme (Surface and crustal responses to changes in mountain structure on different time scales) of the second call of the SPP 4D-MB.

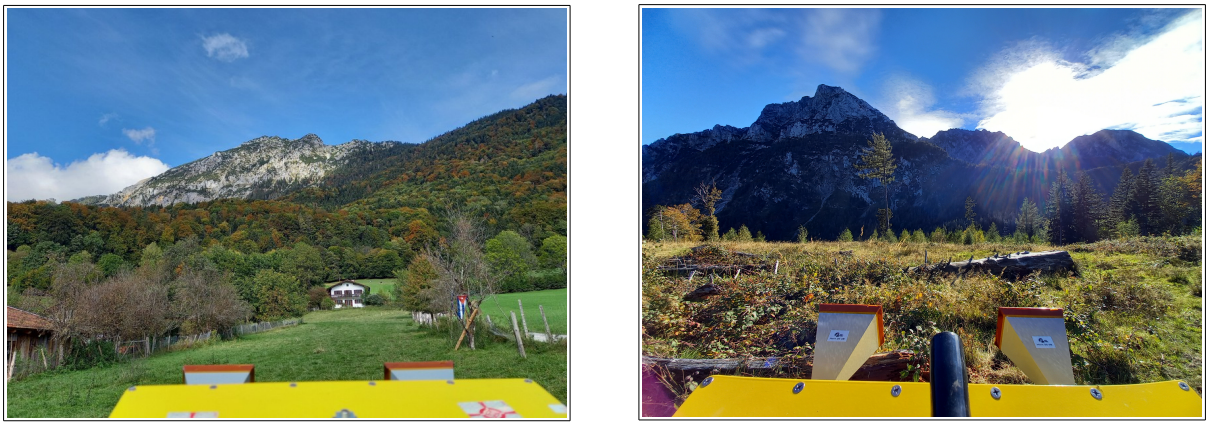

*Figure 2: Georadar measurements of the southern flank (left picture: 06.10.2020 Nonn, Bad Reichenhall) and northern flank (right picture: 08.10 2020, Steiner Alm, Piding) of Mt. Hochstaufen.*