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Potential and limit of LiDAR data for earthquake recurrence characterization

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The characterization of earthquake (EQ) recurrence –assessing timing and size of past EQs along a given fault (section)– has proven difficult, largely due the relatively short time span that is covered by instrumental seismic observations. While major EQs along a given fault are inferred to occur roughly on centennial to millennial time scales, seismographs to record them emerged little more than 100 years ago. Thus, recurrence of major EQs has essentially not yet been observed instrumentally. Stratigraphic and geomorphic evidence is used instead to describe and constrain recurrence of surface rupturing EQs. In the 1980s, analysis of such data sets culminated in the formulation of now classical EQ recurrence models. The debate about the correctness and thus applicability of these in part contradicting models is still ongoing.

Over the last 10 years or so Light Detection and Ranging (LiDAR) technology became available to paleoseismic and tectono-geomorphic investigations. High spatial resolution, precision, and accuracy –the key features of LiDAR data– revealed details in the tectono-geomorphic record that could not be resolved previously by field investigation or air photo analysis. As a result LiDAR data sets contributed and continues to contribute to improvements in the recurrence characterization of (surface rupturing) EQs.

Here, I will present an overview on LiDAR data implementation in paleoseismic and tectono-geomorphic studies, including trench-based LiDAR, terrestrial LiDAR, and airborne LiDAR and I will discuss the impact of LiDAR data on constraining EQ recurrence characteristics as well as their relation to the classical EQ recurrence models. Additionally, I will discuss the intrinsic limits (that even LiDAR data cannot overcome) that arise when investigating geomorphic and stratigraphic evidence for EQ recurrence characterization. The natural complexity of the rupture process itself and its imprint on the analyzed data sets puts an unavoidable limit on the respective model fidelity. It is important to identify this limit to avoid over-interpretation of the otherwise very rich LiDAR data sets.