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Glacial Isostatic Adjustment as a process of deformation but not seismicity in Western Alps: Coupling geodetical strain rate and numerical modeling

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In the last decade, geodetic data has become fundamental in studies of active faults, seismicity and seismic hazard. In particular, GNSS strain rates and velocities are used to constrain fault-slip rates and seismicity parameters, on the premise that these short-term (ca. 10 yr) measurements are representative of long-term (10^4–10^6 yr) fault activity. The Western Alps are a good example of such development in a very-low-strain region with a high-density ongoing seismic activity. There, the first-order agreement between GNSS strain rates and earthquake deformation patterns suggest that a large part of the geodetic deformation observed in the area is seismic. This correlation also suggests that geodetic strain rates can provide constraints on seismicity and seismic hazard. With a numerical modeling approach, we point out the similarities between strain rates predicted for Glacial Isostatic Adjustment (GIA) from the Last Glacial Maximum and the geodetic strain rate field, suggesting that a large part of the GNSS signal is related to GIA. However, we show that the apparent compatibility between geodetic strain rates and seismicity hides a strain rate - stress paradox. In fact, stress perturbations due to GIA are not compatible with observed seismicity, and even tend to inhibit fault activity (as observed from focal mechanisms). Thus, the Western Alps present a typical example of a tectonic system where a transient deformation process precludes, or at least strongly complexifies, the use of geodetic strain rates in seismicity and seismic hazard analyses.