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Geodetic deformation rates and driving processes in metropolitan France and neighboring Western Europe

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We constrain present-day deformation rates and styles in metropolitan France and neighboring Western Europe using a dataset of ca. 1200 GNSS horizontal and vertical velocities from continuous and semi-continuous stations. The characterization and correction of network-scale common-mode noise, combined with two independent network analysis technics allow the resolution of very small horizontal velocities (resp. strain rates) with a 95% confidence ca. 0.1–0.2 mm/yr (resp. ca. 1 x 10^{-9} yr^{-9}) on a spatial scale of 100–200 km. The resulting velocity and strain rate fields show regional coherent patterns that can be associated with features that have been previously identified (e.g., orogen-normal extension in the Pyrenees and Western Alps), but also with new deformation patterns such as North-South shortening in northeastern France - southwestern Germany north of the Alpine Front (Vosges - Rhine Graben - Black Forest). A joint analysis of these new geodetic data with seismicity and focal mechanism catalogs allows the definition of regional seismo-tectonic models that can be compared with the numerous models of deformation processes proposed for Western Europe, from plate tectonics to erosion or Glacial Isostatic Adjustment. We show that plate and micro-plate tectonics play a minor (probably negligible) role in present-day deformation in metropolitan France and that alternative non-tectonic processes must be considered to better understand the origin of recent moderate earthquakes such as the March 2019 Ml=4.9 Montendre earthquake in the Aquitaine Basin or the Nov. 2019 Mw=4.8 Teil earthquake in the Rhone Valley.