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Comparison between the coseismic surface displacement during the 29 December 2020 Mw 6.4 Petrinja earthquake (Croatia) from optical image correlation and long-term geomorphological observations of cumulative displacements

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The Petrinja-Pokupsko fault-system is a NW-SE right-lateral fault system that ruptured during the 29 December 2020 Mw 6.4 earthquake (~40km south-east of Zagreb, Croatia). Field analysis revealed opening of cracks and offsets of several centimeters (3 to 40 cm) along a ~20 km long fault zone extending from the Kupa river (in the northwest) to the Petrinjčica river (in the southeast). Optical image correlation based on WorldView satellite images has been used to document the first-order near-field rupture signal. The pre-event image was acquired on 7th December 2017, and the post-event image on 15th January 2021. The first results indicate a right-lateral displacement of ~75 cm with a small (<10 cm) extensional dip-slip component localized on the Petrinja fault. Using 1:5,000 topographic maps, a WorldView-derived DEM (1 m), and field observations, we identified and quantified cumulative dextral offsets along the central and southern section of the fault (south of Župić). Right-lateral offsets range from 5 to 200 m near Križ and Cepeliš (central sector). Diverted streams also extend southeast of the Petrinjčica river, where no surface ruptures have currently been reported to date. To the northwest, perched valleys, wind gaps, and karst features all testify to ongoing uplift across NW-SE-trending anticlines. It is unclear if the primary component of faulting changes from strike-slip (in the SE) to reverse (in the NW), or if these folds merely record a transpressive component across the fault. The activity of this fault system is poorly known. The region experienced a magnitude Mw 5.8 in 1909, ~30 km northwest of Petrinja, which may have been associated with the Petrinja-Pokupsko fault system. The recent 29 December 2020 earthquake confirms the seismic potential of this fault system to generate Mw>6 earthquakes. Since the fault extends farther NW and SE, from the Vukomeričke Gorice hills to Mount Kozara (Bosnia), for a total length of about 100 km, it could generate potentially larger events. It is also noteworthy that the 2020 Petrinja event occurred only 9 months after the Zagreb March 2020 (Mw 5.3) earthquake. This event occurred on an ENE-WSW-trending thrust fault, broadly orthogonal to the right-lateral Petrinja-Pokupsko fault system, ~45 km north of Petrinja,

and raises the prospect of potential interplay between strike-slip and thrust faults in moderate strain-rate intra-plate settings. To address this problem, future works will aim at constraining the geometry of this fault network and its seismogenic potential.