COUPLED, PHYSICS-BASED MODELING REVEALS EARTHQUAKE DISPLACEMENTS ARE CRITICAL TO THE 2018 PALU, SULAWESI TSUNAMI

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On September 28, 2018, a Mw 7.5 earthquake struck the North-western part of Sulawesi, Indonesia and induced a localized and sudden tsunami that devastated the Bay of Palu. Devastating tsunamis associated with submarine strike-slip earthquakes are rare, because they displace predominantly horizontally the seafloor. Strike-slip earthquakes can nevertheless source tsunamis, indirectly through landslides or through oblique fault slip. We here suggest that direct earthquake-induced uplift and subsidence could have sourced the observed tsunami within the Palu Bay. To this end, we propose a physics-based scenario of the earthquake tightly constrained by observations, validated against tsunami observations by tsunami and inundation modeling. Our model associates rupture dynamics, seismic wave propagation, tsunami propagation and inundation. The modeled earthquake, featuring sustained supershear rupture propagation, matches key observed earthquake characteristics, including the moment magnitude, rupture duration, fault plane solution, teleseismic waveforms and inferred horizontal ground displacements. In our model, a transtensional stress regime induces up to 2 m of normal slip on a straight fault segment dipping 65^{circ} East beneath Palu Bay, on top of predominant left-lateral slip of up to 6 m. This translates into bathymetry perturbations of about 1.5 m across the submarine fault segment, large enough to trigger a tsunami and to reproduce qualitatively tsunami wave records and field surveys observations. Our results have important implications for submarine strike-slip fault systems worldwide. Physics-based modeling offers rapid response specifically in tectonic settings which are currently underrepresented in operational tsunami hazard assessment.