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The source characteristics and tsunami resonance effect of the 2020 Samos earthquake in Eastern Aegean

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On October 30 2020 11:51 UTC, a Mw 6.9 normal fault earthquake occurred off the northern coasts of Samos Island, Eastern Aegean, Greece. Over a 120 people were killed and more than 1000 people were injured during the seismic sequence. The quake produced a moderate tsunami that swapped the coastal areas of Izmir (Turkey) and Samos (Greece) with inundation heights up to ~3 m. Finding the source of such a tsunami has been puzzling as a normal fault earthquake with Mw 6.9 would not be considered significant enough to generate metric-scale waves. Furthermore, the lack of near-field observations has made the identification of the seismogenic fault responsible for the mainshock difficult. In this study, we infer the source characteristics from multiple observation data, including InSAR, GPS, teleseismic waves and tsunami waves. We first generate two Sentinel-1 co-seismic interferograms with a maximum Line of Sight (LOS) change of 8 cm on the coastal areas at the Samos island. We obtain a north-dipping fault model, which can slightly better explain the geodetic observations and teleseismic P waves. To understand the potential tsunami source, we use several earthquake slip models collected from different research groups to conduct tsunami simulations. Comparing simulated tsunami waveforms with those measured at 6 local tide gauges, we show that the north-dipping fault can fit tsunami records better than the south-dipping fault. The north-dipping fault hypothesis is also further supported by the spatial distributions of the aftershocks. The spectral analysis of tsunami waveforms at selected tide gauges suggests that the tsunami period band is within 4.6 ~ 21.3 min and the primary wave period is ~14.2 min. Using this wave period as an indirect constraint, we show that the source dimension of our slip model can produce tsunami waveforms with similar wave period. We also find high-energy wave of the Samos earthquake that lasted 20 h, and fundamental oscillation periods of Sığacık Bay are remarkably close to some dominating tsunami periods. We infer the coseismic seafloor displacement alone is not enough to create disastrous effects on coastal cities; therefore we suggest that the tsunami waves may have been amplified by local coastline and tsunami resonance with local bay, or another source, e.g. triggered landslides.