



An Improved Source Model for the Mw 7.1, October 23, 2011 Van (Turkey) Earthquake: New Insights from SAR Pixel Offsets and Coastal Uplift Measurements

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The October 23rd, 2011, Mw 7.1, Van earthquake is the largest instrumentally recorded thrust faulting event in Turkey. The absence of a clear prominent surface rupture also marks this earthquake as the most recent case of blind faulting in the country. The Van earthquake has already been extensively studied by many researchers, with many of them relying only on the available InSAR data. However, due to limited coherence and data coverage and also due to the fact that the available coseismic data came only from descending satellite orbits, it proved difficult to constrain the parameters of the causative fault.

Pixel offsets calculated in the flight (azimuth) and range directions are byproducts of SAR imaging and can provide a secondary perspective of the surface displacements when accurate. With the introduction of high resolution X-band SAR satellites it became possible to benefit more from the pixel offset information due to the increase in accuracy. We use offset information from a raw Cosmo-SkyMed SAR image pair, where the slave image was acquired only 4 hours after the October, 23rd, 2011 Van (Turkey) earthquake, which enables us to extend the coverage and to minimize the contribution of postseismic motion after the event. The pixel offsets are calculated using a novel technique that only considers reliable point-like scatterers for the offset measurements to increase their accuracy. The introduction of this new dataset helped us to minimize unwrapping errors due to loss of coherence around the surface projection of the causative fault, which the amplitude information is independent of.

In addition to SAR pixel offsets, we also incorporate a new set of measurements of the uplift along the Lake Van coast due to the earthquake using dead algae levels as biological markers. Although sparse, these measurements were crucial to improve our final source model of the earthquake since the InSAR measurements only provide the relative displacement between two points on the ground. Our modelling results suggest thrust faulting with a minor left lateral component on a fault dipping 45° NNW and striking N 75° E between Lake Van to the west and Lake Erçek to the east. Most of the slip appears to have taken place at depths deeper than 10 km with maximum of over 5 m at a depth of 15 km.