Effect of seasonal snow load on earthquake occurrence in the Pamir Mountains

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The Pamir mountain region is among the seismologically most active areas in the world and has, in the past several decades, had many strong earthquakes, primarily of reverse and strike-slip mechanisms. By using earthquake catalogue data from the International Seismological Center (ISC) and the United States Geological Survey (USGS), we find significant seasonal tendency in earthquake occurrence for events of $M^3$5.5 and shallower than 50 km, with a clear peak in earthquake frequency in July and August. The study area is covered by snow and glaciers, whose mass exhibits large seasonal variability. This is reflected in the GRACE satellite MASCON data that indicate the surface seasonal load increases from mid-September to mid-April and then decreases during the rest of the year. The seasonal load variation corresponds to ~25 cm of Equivalent Water Table (EWT) change. In accordance to this, Global Precipitation Measurement (GPM) satellite data indicate that the average thickness of seasonal snow cover is around 80 cm. In addition, GPS data in the region also show seasonal oscillations with an amplitude of ~3 cm in the vertical component, where the timing of vertical low points coincide with the peak seasonal load. This temporal variability of the seasonal snow load directly alters fault-normal stresses in the region by a few kPa. The seasonal peak in earthquake frequency occurs before the peak unloading and coincides better with the time of the maximum unloading rate. Together the results suggest that the seasonal snow load significantly modulates the tectonic stress build-up and the rate of earthquake occurrence in this region.

Keywords: Seasonal Load, Satellite Data, Earthquakes

