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Seasonal active landsliding and hillslope activity in the southern Central Andes of NW Argentina

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The eastern Central Andes of northwestern Argentina is characterized by a steep topographic gradient with elevations ranging from 1000m in the foreland to more than 6000m in the eastern Andean Cordillera. This setting furthermore shows high topographic relief with deeply incised river valleys that are frequently impacted by strong rainfall events driven by the South American monsoon. Additionally, a strong vegetation cover contrast from dense coverage in the low elevation foreland to sparse coverage at high elevation defines the environmental gradient in this area. This area is impacted by several types of hillslope instabilities and landsliding: at some high elevations above 5000m hillslope instability are related to solifluction processes, whereas shallow and deep seated landsliding affect geologically preconditioned areas.

Here we use a combination of different radar sensors and wavelengths to describe the 3D deformation signal of instable hillslopes: TerraSAR-X, Sentinel-1, and ALOS2. To mitigate the tropospheric delay from InSAR measurements, phase-based and weather model approaches are applied to improve the spatial and temporal variations of displacement signals. We use persistent and small baseline subsets (SBAS) category of distributed scatterer approaches to derive deformation fields and we invert for 3D deformation fields using several look angles in combination with GNSS data under different assumptions including that the horizontal component has a motion parallel to the downhill slope. We analyze Line-of-sight (LOS) time series and combine deformation fields with temperature and rainfall measurements to better understand driving forces of high-elevation hillslope instabilities We describe two deep-seated landslides with downslope velocities exceeding 5-10 cm/yr and we exploit image-cross correlation techniques of optical data to monitor seasonal and inter-annual changes. The periodic changes of InSAR deformation and temperature time series show freeze-thaw processes of the active layer thickness of the permafrost areas at elevations exceeding 5000m. We document that deep-seated, fast moving landslides are related to geologic preconditioning. The combination of SAR and optical approaches helps to describe hillslope regimes in steep and difficult to access terrain.