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# New applications of synthetic aperture radar coherence to map erosional transitions

Stephanie Olen and Bodo Bookhagen
Universität Potsdam, Institut für Erd- und Umweltwissenschaften, Geology, Potsdam-Golm, Germany
(olen@geo.uni-potsdam.de)

Mountain landscapes are shaped by hillslope and fluvial processes that remove and transport material and sediment. These processes act by fundamentally different mechanisms and have correspondingly different impacts on the landscape. The transition from hillslope to fluvial erosional processes depends on several factors, including local geology, climate, and environment. However, precisely mapping where these transitions occur can prove challenging and is limited by the quality and availability of data and observations for a given region. The growing availability of satellite synthetic aperture radar (SAR) observations of Earth's surface provides new opportunities to map and quantify erosional processes over large regions. SAR data, which can track changes on the Earth's surface in the radio spectrum through time, are a valuable addition to established analyses of digital elevation and digital terrain models. Here, we propose a new method that exploits Sentinel-1 SAR interferometric coherence and digital elevation models to identify transitions between hillslope, fluvial, and alluvial erosional processes.

The coherence, or the spatial correlation, between two SAR images is sensitive to changes in both the phase and amplitude of the received radar signal. Therefore, surficial processes such as landsliding, hillslope slump, fluvial cobble movement, or alluvial sediment transport result in loss of SAR coherence. We construct a timeseries of Sentinel-1 coherence images for arid and semi-arid regions of the Argentinian Central Andes, covering multiple wet and dry seasons. We compare the temporally averaged coherence maps to the high-resolution TanDEM-X 12-m DEM and observe two distinct transitions in coherence as a function of increasing drainage area: (1) A hillslope-to-fluvial transition represented by a significant decrease in the range of coherence values and moderate decrease in median coherence. (2) A fluvial-to-alluvial transition represented by a marked decrease in median coherence and a corresponding increase in coherence range. We therefore propose that coherence loss can be used as a proxy for surface sediment movement in hillslope, fluvial, and alluvial settings and provide valuable insight into where these processes transition across a landscape. Mapping these transitions remotely over broad regions allows us to compare morphometrics, such as hillslope length and flow lengths, across differing climatic and geologic environments.