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Transient fluvial incision as an indicator of active faulting and surface uplift in the Moroccan High Atlas.

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Quantifying the extent to which geomorphic features can be used to extract tectonic signals is a key challenge for the Earth Sciences. Here, we analyse the long profiles of rivers that drain southwards across the Southern Atlas Fault (SAF), a segmented thrust fault that forms the southern margin of the High Atlas Mountains in Morocco, with the aim of deriving new data on the recent activity of this little known fault system. River long profiles were extracted for the 32 major rivers that drain southwards into the Ouarzazate foreland basin. Of these, twelve exhibit concave-up river profiles with a mean concavity (Θ) of 0.61 and normalized steepness indices (Ksn) in the range 42-219; these are interpreted as rivers at or near steady-state. By contrast, 20 rivers are characterised by the presence of at least one knickpoint upstream of the thrust front. Knickzone height (the vertical distance between the knickpoint and the fault) varies from 100 – 1300 m, with calculated amounts of uplift at the range bounding fault ranging from 1040 – 80 m. In map view, knickpoint locations generally plot along sub-parallel lines to the thrust front and there are no obvious relationships with specific lithological units or boundaries. Furthermore, drainage areas upstream of the knickpoints range over several orders of magnitude indicating that they are not pinned at threshold drainage areas. Therefore, these features are interpreted as a transient response to base-level change. However, three distinct populations of knickpoints can be recognised based upon knickpoint elevation, these are termed K1, K2 and K3 and channel reaches are universally steeper below knickpoints than above. K1 and K2 knickpoints share common characteristics in that the elevation of the knickpoints, calculated incision and ksn all increase from west to east. Whereas, K3 knickpoints show little systematic variation along the range front, are observed at the lowest altitudes with calculated incision of < 200 m. Therefore, the K3 knickpoints are interpreted as the youngest forcing event possibly related to the regional capture of the Dades River by the Draa River < 300 ka. However, prior to this time the channels would have drained into an internally draining basin, so eustatic sea level fall cannot be a driving mechanism for the higher and therefore, older knickpoints. Thus it is more likely that these knickpoints have developed in response to Quaternary tectonic forcing along the SAF where rock uplift is greater in the east.