## Open questions regarding the influence of topography on the terrestrial water cycle



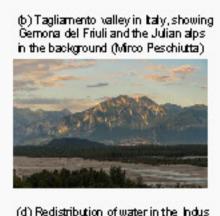
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## **Motivation**

- Topography affects the movement of water above, at, and below the land surface
- However, exciting puzzles remain and new discoveries continue to surprise us
- Here we discuss some open questions regarding the influence of topography on the terrestrial water cycle, based on a mix of literature review and data synthesis

(a) Orographic lift of moist air along the Santa Lucia Mountains, California, leads to cloud formation (Robert Schwernmer)

(c) Vegetation zonation on Tanzania's Mount Klimanjaro, spanning an elevation



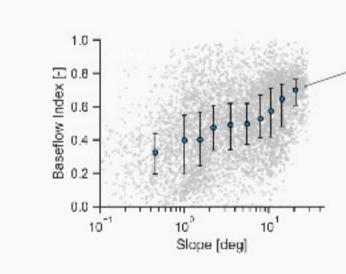


## Conclusion

- Topographic gradients interact with other environmental gradients, making them a great playing field for studying hydro-systems
- Gradients can structure our search for new empirical patterns and allow us to test hypothesized patterns using observations
- Empirical patterns, ideally underpinned by process understanding, can then be used to evaluate, constrain and improve models

How do elevational gradients in water and energy supply translate into gradients in evaporation? How are these gradients modulated by lateral moisture redistribution? Sierra Nevada (37 °N End would increase precipitation with elevation being water-to energy-  $E_{\mathsf{act}}$  at elevations that water availability, and to more uniform  $E_{act}$ Based on these gradients, we can Tropical mountains hypothesize how patterns in 2000 4000 6000 0 /1000 2000 3000 often show peak precipitation at low (here for mid-latitude mountains) to mid elevations

How much baseflow is generated in complex terrain such as mountains – the world's water towers? How will this change with melting snowpacks and glaciers?

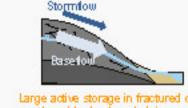


Round on CHELSA, Karger et al., Sc. Oala 4, 170 (22 (2017)

More baseflow in regions
with steeper topographic
slopes, likely because they
are better drained, allow for
deeper infiltration, and
have better groundwaterstream connectivity



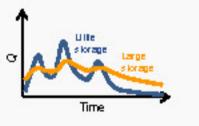
Large fractions of baseflow in steep catchments suggest an important role of groundwater in the mountain water cycle potentially mitigating storage loss due to melting snow packs and glaciers



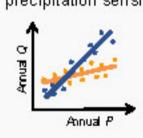
weathered bedrock and alpine sediments



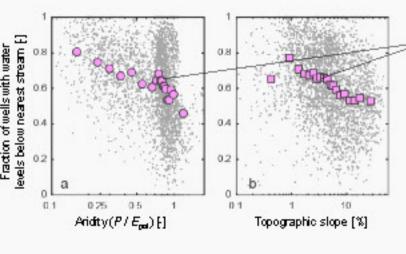
More baseflow should lead to greater buffering of streamflow between events and seasons



More baseflow should lead to less variability between years, i.e. lower precipitation sensitivities



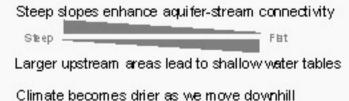
How does the interplay of topography, climate and geology influence groundwater's connection to the surface, i.e. where are streams gaining or losing?



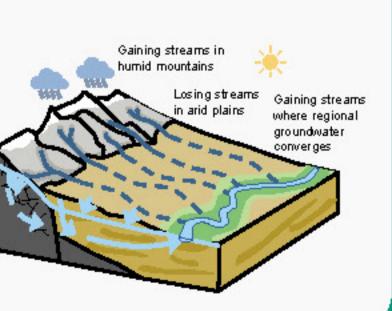
Jasechko et al. (2021) ⇒ found that water levels are more often below stream levels in dry and flat regions



Interacting gradients of topography, climate and geology lead to typical patterns of groundwater-stream connectivity from mountains to plains Interacting gradients from mountains to plains
Sediments in plains provide more storage space
Bedrock Sediment



Climate becomes drier as we move downhill



What are your open questions? Do you have any comments?





ikan hom Japandiko et al., Nalwe 591, 991–995 (2021).