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## Moisture control on high-altitude cooling during the Last Glacial Maximum

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Reconstructing the spatial and temporal variabilities of the vertical atmospheric temperature gradient (lapse rate, LR) is key to predict the evolution of glaciers in a changing climate. Variations in this parameter may amplify or mitigate the future warming at high elevation, implying contrasted impacts on the stability of glaciers. Several regional studies suggested that the tropical LR was steeper than today during the last glacial maximum (LGM) (Loomis et al., 2017; Blard et al., 2007), while another study concluded that the LGM lapse rate was similar than today (Tripathi et al., 2014).

Here we combine published LGM sea surface temperatures (SSTs) data and LGM moraines dated by cosmogenic nuclides to reconstruct the lapse rate along the American Cordillera. To do so, we combined paleo-Equilibrium Line Altitudes (ELAs) of glaciers with independent precipitation proxies to derive high latitude atmospheric temperatures. The whole dataset includes 34 paleo-glaciated sites along a North-South transect in the American Cordillera, ranging in latitude from 40°N to 36°S. Our reconstruction indicates that the lapse rate (LR) was steeper than today in the tropical American Cordillera (20°N – 11°S). The average  $\Delta LR$  (LGM – Modern) for this Tropical Andes region (20°N – 11°S) is  $\sim -1.5$  °C.km<sup>-1</sup> (20 sites). At higher latitude, in both hemispheres (Central Andes, 15°S – 35°S (8 sites); Sierra Nevada and San Bernardino mountains (40°N – 34°N) (6 sites), the LR was constant during the LGM.

Our results show that a drier climate during the LGM is systematically associated with a steeper LR. Modification of LR during LGM was already observed from other tropical regions, in Hawaii-Central Pacific (Blard et al 2007), and in Eastern Africa (Loomis et al., 2017). Similarly, in these regions, precipitation did not increase during the LGM. With this multi-site exhaustive synthesis, we make a case that drier Tropical LGM conditions induce a steeper LR. This corresponds to an amplification of cooling at high altitude during the LGM. These results highlight the necessity to consider LR variations in modelling future climate. In a warmer and wetter Earth, temperature increase may be amplified at high elevation, due to smoother LR. If valid, this mechanism implies that tropical glaciers are more vulnerable than predicted by current climate modelling.

## References

Blard, P.-H., Lavé, J., Pik, R., Wagnon, P., & Bourlès, D. (2007). Persistence of full glacial conditions in the central Pacific until 15,000 years ago. *Nature*, 449(7162), 591.

Loomis, S. E., Russell, J. M., Verschuren, D., Morrill, C., De Cort, G., Damsté, J. S. S., ... & Kelly, M. A. (2017). The tropical lapse rate steepened during the Last Glacial Maximum. *Science advances*, 3(1), e1600815.

Tripathi, A. K., Sahany, S., Pittman, D., Eagle, R. A., Neelin, J. D., Mitchell, J. L., & Beaufort, L. (2014). Modern and glacial tropical snowlines controlled by sea surface temperature and atmospheric mixing. *Nature Geoscience*, 7(3), 205.