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Late-Quaternary equilibrium-line altitude and climate reconstruction from the Cordillera de Merida, Venezuela

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Glacial extent in the Venezuelan Andes has been highly variable during the late Quaternary. As part of a comprehensive paleoclimate investigation, the underlying causes of these variations are being examined. Modern glaciers are out of equilibrium with the local climate and are rapidly retreating. Modest glacial advances occurred during the Little Ice Age (LIA) while glacier area was dramatically larger during the Last Glacial Maximum (LGM). During the LIA, equilibrium line altitudes (ELA's) were depressed $>$300 m while LGM ELA's were 1000 to 1200 m lower. Interpretation of the LIA ELA depressions with a combined energy and mass balance equation (Kuhn, 1989) requires a temperature depression of 2.3 to 3.4 $^{\circ}$C and a precipitation increase of 25 to 70%. Applying the same equation to LGM ELA's requires a temperature depression of $\sim$8 to 10 $^{\circ}$C. Steeper than modern lapse rates and reduced precipitation values during the LGM require an additional $\sim$2 $^{\circ}$C temperature increase to explain the ELA values. Using remotely sensed high-resolution topographic data, LGM ELA's were reconstructed for nine valley glaciers across the Venezuelan Andes. The spatial distribution of these ELA's suggest that there was an altitudinal gradient of glacial deposits of up to 500 m, with the lowest ELA's in the SE and the highest in the NW. This pattern is consistent with the modern observed precipitation gradient and the local asymmetry in regional cloud cover.