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# Glacier mass balance variability in the Cordillera Blanca, Peru and its relationship with climate and the large-scale circulation

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## Abstract

A 41-year-long reconstructed annual mean glacier mass balance record from the Cordillera Blanca, Peru, was investigated for its climate sensitivity toward temperature, humidity and precipitation, and its links with the large-scale atmospheric circulation. On interannual timescales precipitation variability appears to be the main driver for glacier mass balance fluctuations in the Cordillera Blanca. This is corroborated by an analysis of the relationship between mass balance variations and local- to regional-scale precipitation variability. Temperature tends to enhance precipitation in driving the mass balance signal, as dry years are often characterized by warm conditions, while wet years usually coincide with cold anomalies. In some years, however, warm and wet or cold and dry conditions coincide, under which circumstances temperature minimizes or even neutralizes the effects of precipitation. Surface energy balance studies have shown that changes in atmospheric humidity significantly affect the melt rates of tropical glaciers, but the lack of long and high-quality in-situ measurements precludes a detailed quantitative assessment of its role on interannual timescales in the Cordillera Blanca. Sea surface temperature anomalies (SSTA) in the tropical Pacific exert the dominant large-scale forcing on interannual time scales, leading to negative mass balance anomalies during El Niño and above average mass balance during La Niña episodes. In general the teleconnection mechanism linking ENSO with glacier mass balance is similar to what has previously been described for the Bolivian Altiplano region. Changes in the upper-tropospheric zonal flow aloft associated with ENSO conditions determine the amount of snowfall during the wet season and thereby significantly affect the glacier mass balance.

Because this teleconnection mechanism is spatially unstable and oscillates latitudinally along the subtropical Andes, it affects the Cordillera Blanca in most, but not all years. The relationship between ENSO and glacier mass balance is therefore characterized by occasional ‘break downs’, more common since the mid-1970's, when El Niño years with above average mass balance and La Niña events with negative mass balance have been observed.