Observed and Future Changes in the Tropical Andes

The retreat of glaciers in the region has been one of the most striking changes to take place in the tropical Andes in the last 50 years [1, 2], with smaller glaciers retreating more than larger ones. Precipitation in the region did not display any significant trend over the last century.

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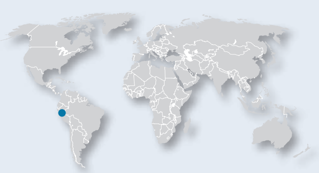
View from Mount Chacaltaya, Bolivia (M. Andrade)

Sixty years' worth of observations (1950–2010) from three surface stations in the Bolivian Altiplano indicate long, alternating periods of relative dryness or humidity [3]; no clear trends in annual precipitation or changes in the length of the rainy season were found. Based on a shorter period (1960–2009) and a greater number of surface observations, studies [4] have suggested that humid periods may be associated with warmer ocean temperatures off the Pacific Coast of South America – i.e. with positive phases of the Pacific Decadal Oscillation (PDO)[1] – while dry periods may be associated with colder ocean temperatures (i.e. with negative phases of the PDO). Two SDC-funded projects, CLIMANDES and DECADE, aim at improving climate services and at strengthening university education and research capabilites in climatology in Peru and in Bolivia.

Despite the complexity of the processes determining Andean glaciers' mass balance [5], there is a consensus that temperature increases are driving glacial retreat over the long term. However, surface observations do not always show a clear positive trend. Scarcity of surface data and issues of data quality have made it difficult to discern trends reliably in the tropical Andes. At the same time, there have been efforts to produce a consistent dataset of surface observations for the Andean region. These observations point to an increase in average temperature over the last 60 years. What is more, observations of air temperatures along the American Cordillera from Alaska to Tierra del Fuego indicate that temperatures have increased at high-altitude locations at rates generally exceeding those found



near sea level [6–8]. These indications of warming are consistent with other types of observations made throughout the American Cordillera [9–13]. For instance, a study using satellite imagery of Sajama Mountain (Bolivia, 6 542 m) in the Andes suggests that vegetation has shifted to higher elevations in the last 30 years [14]. A recent study of the Peruvian Andes using aerial photographs and satellite imagery shows a similar pattern [15]. Given the suggested relationship between PDO and temperatures in the tropical Andes, the regional effects of global warming could be exacerbated in the near future when the PDO shifts from a negative to a positive phase.

Looking further into the future, projections (Figure 1.4) suggest that the freezing level – an important threshold for maintenance of mountain glaciers – may rise several hundred metres by the end of this century. This phenomenon is expected to affect tropical regions more strongly than regions at mid and high latitudes. The magnitude of projected change highly depends on the level of radiative forcing, such that predicted changes under a strong emissions scenario (RCP8.5) are about 50 percent greater than under a weaker emissions scenario (RCP4.5) (Figure 1.4). The marked difference between possible scenarios underscores the need for implementation of effective policies that slow the growth of anthropogenic greenhouse gases in the atmosphere. Even in the absence of significant changes in precipitation, a warmer climate will likely lead to higher water stress in the Andean region, bearing consequences for the availability of water for both humans and ecosystems.

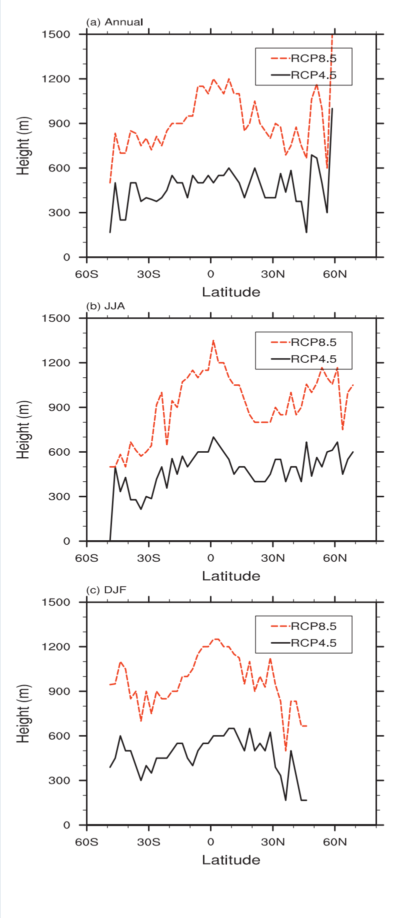


Figure 1.4. The projected rise of freezing levels along the American Cordillera in the current century (from 1981–2000 to 2081–2100) on an annual basis (a); for boreal summer (June, July, August) (b); and for boreal winter (December, January, February) (c); under low (RCP4.5, black) and high (RCP8.5, red) emissions scenarios. For example, under a high emissions scenario (red), the freezing level would rise by 1 200 m near the equator (0 latitude) for all three time periods concerned. Source: [8]

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[1]The PDO is a basin-wide change of sea-surface temperature in the Pacific best described as a long-lasting El Niño-like pattern of Pacific climate variability.