Climate and Paleoclimate at Chimborazo - the Point Farthest From the Center of the Earth

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Statement of the Problem

Within tropical mountain regions, and particularly in the Andes of Ecuador, high elevation glaciers are the lifeblood of lower lying areas. Glaciers and melting snow are critical water resources for hydroelectric power generation as well as consumptive use in many mountain regions and adjacent lowlands downstream. Changes in glacier mass will have significant social and economic consequences for cities in Ecuador. Thus, developing an in-depth understanding of current and past climate change in these regions is critical for understanding the future. If adequate adaptation plans and measures are to be put into place, these cities will need reliable sources of data to evaluate the rate and magnitude of ongoing changes.

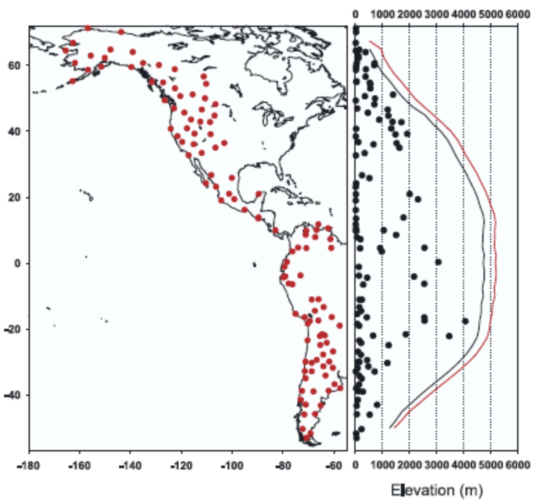

Figure 1: Distribution of planned GCOS surface station network in the western Americas and (on the right, black dots) the elevations of those stations with respect to latitude. Only 3 stations are planned for the sites above 3000 m. Thus, the network fails to monitor those regions that model simulations indicate will have the greatest changes in temperature. Mean annual freezing level heights for control runs and 2x CO_2 simulations are shown at right, in relation to the planned GCOS network. (Bradley, et al, 2004)

Better monitoring of climatic conditions at high elevations in the mountains of the Tropics is urgently needed (Bradley, 2009). While climate models show that temperature increases will be exacerbated at these altitudes, there is currently an inadequate monitoring network in zones higher than 3,000m (Bradley, 2004). These areas are particularly important to monitor as temperatures are expected to rise most rapidly the highest mountain regions (Bradley, 2004).

The World Glacier Monitoring Service currently provides one of the most comprehensive sets of glacier information, but observations are focused predominantly in the Northern Hemisphere and Europe with large gaps in the Tropics (WGMS, 2008). Furthermore, glaciers have been recognized by the IPCC as one of the *Essential Climate Variables (ECV),* information about which is critical to the work of the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC. Developing a system for monitoring, measuring, and evaluating the actual changes in these glaciers represents a priority for identifying the signal and early consequences of anthropogenic climate change.

Approach

Here, we take advantage of a serendipitous opportunity to combine the high elevation technical climbing skills and experience of coPI Jonathan Cain and his Ecuadorian colleague Pablo Puruncajas with the neotropical dendrochronology interests of coPIs Laia Andreu-Hayles and Kevin Anchukaitis. Jonathan and Pablo will climb to the summit Chimborazo, one of the highest peaks in the Andes and the point farthest from the Earth's center. They will collect tree-ring samples from the high elevation conifers *Polylepis* and they will install weather-monitoring equipment along their route, including at the summit. They will do all this with the express support of the national park and a local guiding company.

Chimborazo acts like a water tower for the Bolivar and Chimborazo provinces of Ecuador. Its glacier forms the headwaters of four rivers that serve the immediate domestic, irrigation and hydropower needs of over 200,000 people (La Frenierre, 2010). Most glaciers in the central Andes have been receding rapidly since at least the 1970s and in Ecuador alone there has been 35% glacier loss since 1986 (La Frenierre & Mark, 2010). Chimborazo is the highest mountain in Ecuador at 6,268 meters (20,564 ft). The mountain also has the singular distinction of being the point farthest from the center of the Earth due to its location on the equatorial bulge. This feature makes Chimborazo a particularly attractive but largely inaccessible area for monitoring. As shown in Figure 1 from Bradley et al. (2004), there are currently no meteorological data stations in the proposed area of study at elevations higher than 4,200m and none are planned. Thus, the placement of a weather station at the peak of Chimborazo will be the first ever. The *Polylepis* forests that ring the base of the mountain and intrude even into the high elevation *paramo* have never been studied, and yet this species to the south in Bolivia provides over 1,000 years of climate information from a region vulnerable to increasing temperatures.