Diagnosing climatic variability of tropical South America at annual to orbital timescales

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There is now a wide variety of paleoclimatic time series available for tropical South America. Many of these exist on the Altiplano of Bolivia and Peru, where the most important archives include sediment cores from fluvial, lacustrine, and salar (salt flat) environments, as well as ice cores from tropical glaciers. These records reveal large amplitude climate changes with a range of periodicities. There is good evidence on the Altiplano that (generally speaking) the last glacial maximum (LGM) was very wet; the early and middle Holocene were drier than today; and the late Holocene was wet. These changes were most likely forced by orbitally-induced changes in insolation that brought about changes in the intensity of the South American "summer monsoon," (SASM). The 8% full-cycle change in top-of-atmosphere (TOA) insolation (January, 15°S) over the past 20,000 years can be compared with the approximately 30% full-cycle change in TOA insolation during an annual cycle -- orbitally controlled insolation changes are significant. The SASM was further modulated by land-sea temperature gradients and equatorial Atlantic SST variability. There is evidence in both the glacial and Holocene portions of the records for millennial-scale climatic variability on the Altiplano that occurred in phase with SST anomalies in the equatorial and high-latitude North Atlantic. Cold SST anomalies in these regions are associated with wet conditions on the Altiplano. For example, Heinrich events 1-3, the Younger Dryas, the Little Ice Age, and other cold events of high northern latitudes, are all manifested as wet events on the Altiplano. Evidence for persistent quasi-decadal variability of precipitation, is also present in the Quelccaya ice core record -- again associated with anomalously cold SST's and the known quasi-decadal variability of equatorial Atlantic SST. Finally, modern instrumental records on the Altiplano show that there is significant correlation between annual precipitation amounts on the Altiplano and equatorial Atlantic SST variability.

There are still many unresolved issues that are relevant to our conclusions. Are our paleoclimatic data from the Altiplano relevant to the paleoclimate of Amazonia? We believe that large-amplitude precipitation changes are synchronous and of the same sign for the Altiplano and Amazonia (Baker et al., in review). For instance, we believe that the LGM was wetter than today in Amazonia, whereas, most other recent studies have concluded that Amazonia (and even the global tropics) were arid (e.g. Betancourt et al., 2000; Argollo and Mourguiart, 2000; Heine, 2000; Thompson et al., 2000). Whereas we believe that millennial variability of the North Atlantic region is synchronous with millennial changes in tropical South America (Baker et al., in press), recent studies have concluded that the Younger Dryas, for example, was only a northern hemisphere event (Bennett et al., 2000). And, even if we are correct that there was a Younger Dryas wet period in tropical South America, a recent study concluded just the opposite: that Amazonia was arid during the Younger Dryas (Maslin et al., 2000). Whereas we believe that there is evidence for a persistent relationship between Atlantic SST anomaly patterns and rainfall variability on the Altiplano, a detailed modern climatological study (Vuille et

al., 2000) concluded the opposite: that rainfall variability in the central Andes was not correlated with Atlantic SST.

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