

## SHORT PAPER

# Astronomical Forcing of Contrasting Rainfall Changes in Tropical South America between 12,400 and 8800 cal yr B.P.

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Today, precipitation over tropical South America is largely controlled by the seasonal movements of the Inter-Tropical Convergence Zone (ITCZ). During the summer, the ITCZ is shifted southward due to the warming of the continent. Paleoclimate data from southeastern Amazonia and the central Andes indicate that these two areas evolved similarly during the last 30,000 yr. However, between 12,400 and 8800 cal yr B.P., eastern Amazonia received substantial moisture whereas the Bolivian Altiplano was arid. This suggests that the ITCZ during summer was then farther north than it is today. © 1997 University of Washington.

The quantity, distribution, and variation through space and time of precipitation are factors that contribute to the climatic differentiation of tropical regions. Thus, the reconstruction of precipitation patterns through time should provide a faithful image of climatic change in the tropics. Here, we reconstruct the rainfall regimes from two sedimentary records in South America that exhibit contrasting characteristics (i.e., southeastern Amazonia and the northern part of the Bolivian Altiplano). The paleoclimatic reconstructions are compared

with present-day climatic conditions in the two regions and with other tropical South American records (Table 1).

Sedimentological (Sifeddine *et al.*, 1994b; Sifeddine *et al.*, 1994a) and palynological (Absy *et al.*, 1991) studies of a set of cores retrieved from lakes in the Serra dos Carajás in the southeastern part of Brazilian Amazonia (6°S; 50°W; Figs. 1a and 1b) yielded a precipitation record for the past 60,000 yr. The Serra dos Carajás is a narrow plateau about 800 m high, emerging above the Amazonian rainforest. The wet, tropical climate has two contrasting seasons. The dry season lasts for three months, from July to September (Fig. 1). During the past 60,000 yr, paleoenvironmental reconstructions reveal several wet and dry phases based on changes in the presence of forest around the plateau and on lake-level fluctuations. The pollen spectra and the extremely low percentage of detrital sediments in the record (Fig. 2) show that the 12,400–8800 cal yr B.P. (Stuiver and Reimer, 1993) period was characterized by maximum forest development (Absy *et al.*, 1991) and little erosion in the drainage basin. Furthermore, the good preservation of organic matter in the sediments confirms the presence of a permanent water



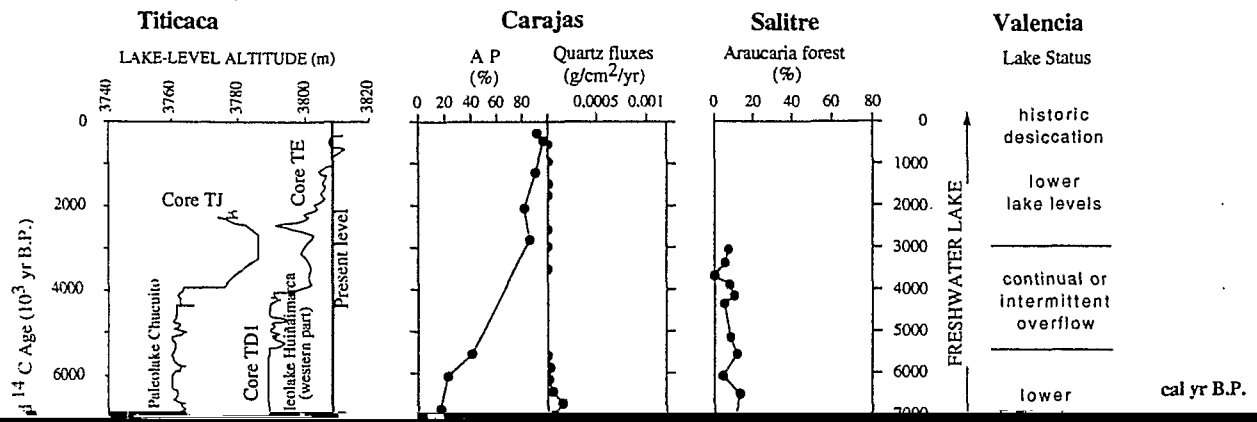
TABLE 1  
Location of the Records Used for Paleoclimatic Reconstructions

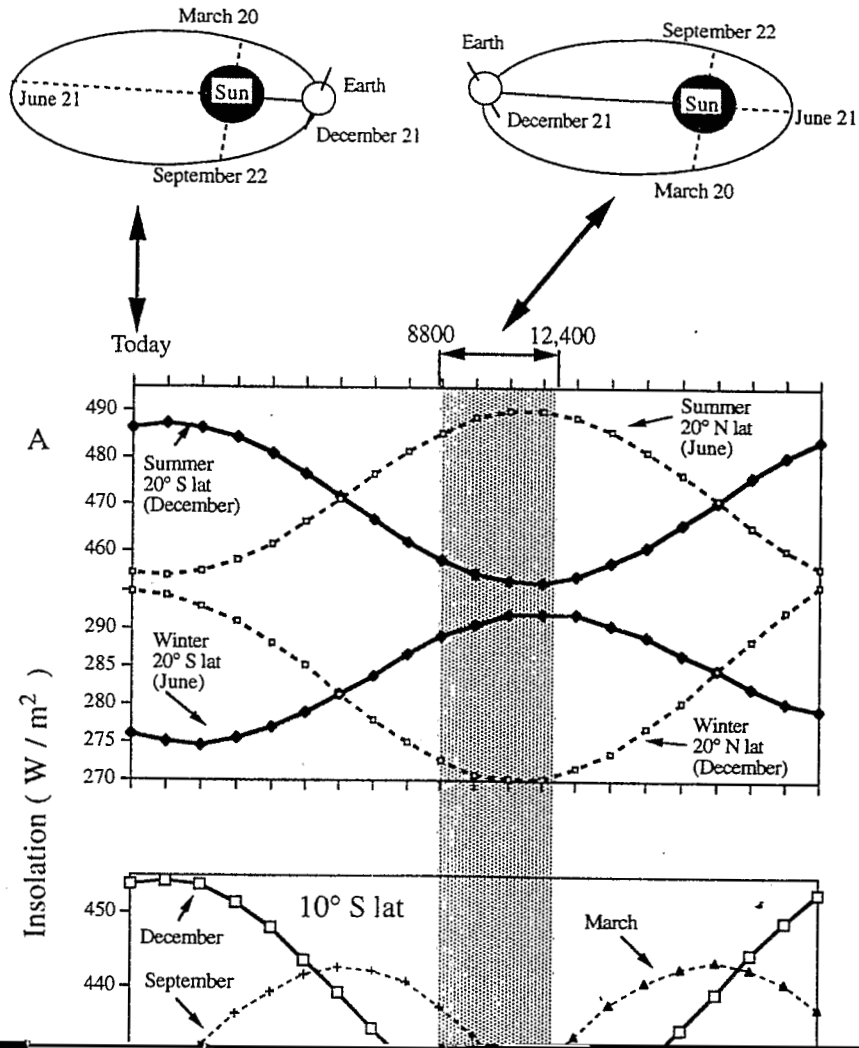
Site number (Fig. 1)	Name	Country	Latitude	W longitude
1	Serra dos Carajás	Brasil	6°S	50°
2	Lake Titicaca	Bolivia	16°S	69°
3	Lake Valencia	Venezuela	10°N	67°
4	São Gabriel da Cachoeira	Brasil	0°S	67°
5	Rio Caqueta	Colombia	1°S	72°
6	Upper Rio Doce	Brazil	17–18°S	42–43°
7	Brasília	Brasil	16°S	48°
8	Atacama Desert	Chile	19–27°S	69°
9	Junin Plain	Peru	11°S	76°
10	Salitre	Brasil	19°S	47°

body. The climatic environment favorable for the development of the forest, which appeared about 15,500 cal yr B.P. (Van der Hammen and Absy, 1994; Markgraf, 1989), was still present between 12,400 and 8800 cal yr B.P. The full

development of the tropical rainforest between 12,400 and 8800 cal yr B.P. implies that rainfall was abundant and that, like today, the dry season did not exceed three months. It can then be conjectured that, during this time interval, the







of Lake Titicaca where extremely rare rain showers also originate from the Amazon lowlands (Messerli *et al.*, 1993); the period 12,400–8800 cal yr B.P. was marked by an environment wetter than today (Grosjean, 1994; Grosjean *et al.*, 1995). North of Lake Titicaca, in the area

Der Hammen Th. (1991). Mise en évidence de quatre phases d'ouverture de la forêt dense dans le sud-est de l'Amazonie au cours des 60.000 dernières années. Première comparaison avec d'autres régions tropicales. *Comptes Rendus Académie des Sciences Paris série II* 312, 673–678.

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