PAST VARIATIONS IN AMAZON BASIN CLIMATE

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Summary

Reconstructing glacial tropical aridity is essential for two reasons: first it is a key physiological control on vegetation distribution. It is, therefore, essential to testing the Pleistocene tropical rain forest refuge hypothesis and thus understand the immense diversity and species endemism of the Amazon Basin. Second tropical wetlands are a major source of atmospheric methane and glacial tropical aridity has also been suggested as the primary control on variations in the ice core atmospheric methane records. To investigate these questions we have reconstructed the Amazon River out-flow using marine sediments and compared this to the precipitation records in Peru reconstructed from Lake Junin sediments. We speculate about the affects these effective moisture changes would have on the atmsospheric methane record.

Introduction

In 1542 Francisco de Orellana lead the first European voyage down the Amazon River. Not only did this intrepid voyage give the Amazon River its name but it started an almost mystical wonder of the greatest river in the world, something we still feel today. The Amazon River discharges approximately 20% of all freshwater carried to the oceans and its basin covers an area of 7,050,000 km^2, making it the world's largest. The Amazon River freshwater discharge is over 6300 km^3/yr (~0.2 Sv) and carries with it nearly one Gt of sediment per year, over 80% of which originates in the Andes. This massive output of sediment to the Atlantic Ocean is the primary reason for the long extended continental shelf and the Amazon deep-sea fan complex. These sediments can provide a unique insight into variation in the climate of the Amazon Basin, particularly in reconstructing the level of cooling and aridity during the last glacial periodt. These parameters are essential if we are to test the Pleistocene tropical rain forest refuge hypothesis and thus understand the reasons for the immense diversity and species endemism of the Amazon Basin.

Overall Conclusions

The outflow history of the Amazon River was examined using ODP Site 942 which was drilled to the west of the Amazon Fan. This site provides continuous monitoring of the mixing of the Amazon River discharge and the North Brazilian Coastal Current. The planktonic foraminifera oxygen isotopes can thus provide a quantitative estimate of the palaeo-Amazon River discharge over the last 14 ka (see Figure 1). This record bears striking resemblance to the Peruvian Lake Junin $\Delta\delta^{18}O$ another measure of effective moisture in equatorial South America. Consider in combination these records show the Amazon Basin to be extremely dry during the Younger Dryas, with the River discharge reduced by 40% compared with today. We speculate that the Younger Dryas glacial-like zonal wind system prevented the penetration of the ITCZ into the Amazon Basin, thus the precipitation bearing Atlantic air was curtailed. This aridity would have also reduced the amount of wetlands found in the Amazon Basin and may have made significant contribution to the sharp reduction seen in the atmospheric methane ice core records.

Subsequent to the Younger Dryas, there is a meltwater driven discharge event and then the effective moisture for the Amazon Basin shows a steady increase throughout the Holocene. This increase is coeval with the intensification of Southern Hemisphere summer insolation which would increase convection and thus the penetration of Atlantic moist air into the Amazon Basin, bring with it ever increasing amounts of rainfall. The Holocene effective moisture records also imply that the two deglacial peaks in the atmospheric methane record can not be attributed to expansion of Southern Hemisphere tropical wetlands. Instead it is suggested that enhance methane production between 12 and 8 ka must, thus be due to either high-latitude sources and more likely gas hydrate release.

Site 942 also provides evidence that the sediment input to the western part of the Amazon Fan ceased between 9900 and 9500 ^{14}C years BP (see Figure 1) which in terms of sea level is 40-50 m below the current level. If this represents the switch off of sedimentation to the majority of the Amazon Fan it is far more extreme than the 30 m switch previously suggested.