GNIP STATIONS IN BRAZIL: IMPORTANCE, PAST AND CURRENT DEVELOPMENTS

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RESUMO

Face aos impactos produzidos pelas mudanças climáticas, a utilização de isótopos estáveis na precipitação como traçadores do ciclo hidrológico, torna-se importante. Nesse contexto a GNIP (Global Network of Isotopes in Precipitation) constitui a única base de dados compreensível e confiável no monitoramento da composição isotópica da precipitação. Atualmente apenas duas estações estão em operação em território brasileiro: CDTN - Belo Horizonte/MG e UNESP - Rio Claro/SP. Pretende-se com a ampliação da rede de estações GNIP em território brasileiro, fornecer subsídios para uma melhor compreensão da variabilidade da composição isotópica da precipitação, associando a fenômenos climáticos.

ABSTRACT

Stable isotopes in precipitation are widely used as tracers of the water cycle; with applications in many environmental disciplines: hydrology, (paleo)climatology, atmospheric sciences, ecology, forensics, food authentication and climate change studies. In this context the GNIP (Global Network Isotope in Precipitation) represents the primary global and regional source of isotope information required to build the baseline on spatial and temporal variability of water isotopes in precipitation. Only two stations are in operation in Brazil: CDTN - Belo Horizonte/MG and UNESP - Rio Claro/SP nowadays. The reactivation of GNIP stations in Brazil would represent a major contribution to improve the coverage of GNIP stations in South America, contributing to a more generalized and sound use of isotope tools in many environmental disciplines.

Keywords – Stable isotopes, Rainfall, GNIP (Global Network of Isotope in Precipitation)

INTRODUCTION

The first compilation of isotopic composition data in meteoric waters was carried out by H. Craig (1961), when the linear relation between $\delta^{18}O$ and $\delta^{2}H$ contents in meteoric

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waters was established. In the same year, the International Atomic Energy Agency (IAEA), in collaboration with the Worldwide Meteorological Organization (WMO), initiated a worldwide monitoring program for stable isotopes in precipitation: the Global Network of Isotopes in Precipitation (GNIP). The systematic sampling and isotope analysis of rain water at global scale provided the basis for the use of using tritium to estimate groundwater ages and the use of stable isotopes in hydrology, paleoclimatology and other fields (Rozanski et al., 1993).

Between the 1960s and the 1980s about 200 GNIP were providing monthly precipitation samples for isotope analysis, including about 15-20 stations Brazil (Rozanski et al, 1993). However, for different reasons, all of them were shut down in the 1980s and the 1990s, despite the extensive use of the isotope data. The loss of the Brazilian station made a significant impact of the isotope coverage of GNIP station in South America. For many years and due to the demand expressed by many GNIP users, the IAEA encouraged Brazilian institutions to reactivate or create new GNIP stations in order to reconstruct the GNIP network in Brazil. Only recently, two Institutions have responded to the IAEA invitation: the Nuclear Technology Development Center (CDTN/CNEN), in Belo Horizonte/MG, and the Center for Environmental Studies at the Universidade Estadual Paulista (UNESP), in Rio Claro/SP. These stations are operative since October 2008 and March 2013, respectively.

AVAILABLE DATA FROM BRAZILIAN GNIP STATIONS

The initial survey of the isotopic composition of precipitation in the Amazon region provided important information about the water balance and atmospheric circulation over the forest. The importance of recycled water derived from the transpiration or re-evaporation over the Amazon was assessed using isotopes. The isotopic content of precipitation on stations located further inland along the Amazon basin showed far less depletion as expected from the classical rainout effect of water vapor moving from the coastal sites to the inland stations. The limited isotope depletion observed was explained as the result of the important contribution of transpiration and evaporation fluxes, which were isotopically different from those derived from the marine water vapor. Isotopes allowed to have an independent estimate fo the fraction of recycled at the basin scale. (Salati *et al.*, 1979; Matsui *et al.,* 1983, Gat & Matsui, 1991, among others).

According Rozanski and Araguás (1995), the spatial variability of isotopes in precipitation over the central portion of Brazilian territory is directly related to the relative importance of moisture recycling over the Amazon Basin, especially in northern part, close to the equatorial area; and the influence on the regional atmospheric circulation derived from the regular displacement across South America of the Intertropical Convergence Zone (ITCZ), which is responsible by seasonal fluctuations observed in the isotopic composition precipitation.

Figure 1 presents the relationship between the δD and $\delta^{18}O$ contents of precipitation (expressed as ‰ vs. VSMOW) for the GNIP stations in Brasília and Cuiabá, defining the Local Meteoric Water Lines (LMWL). The preliminary LMWL for the Belo Horizonte-CDTN station is also shown in Fig. 1 (sampling period: Oct 2008 and Dec 2011). For this station it is worth noticing the similar slope to that of the Global Meteoric Water Line (GMWL; $\delta D = 8\ \delta^{18}O + 10‰$), but a significantly higher intercept and mean deuterium-excess value for this station (~14‰).

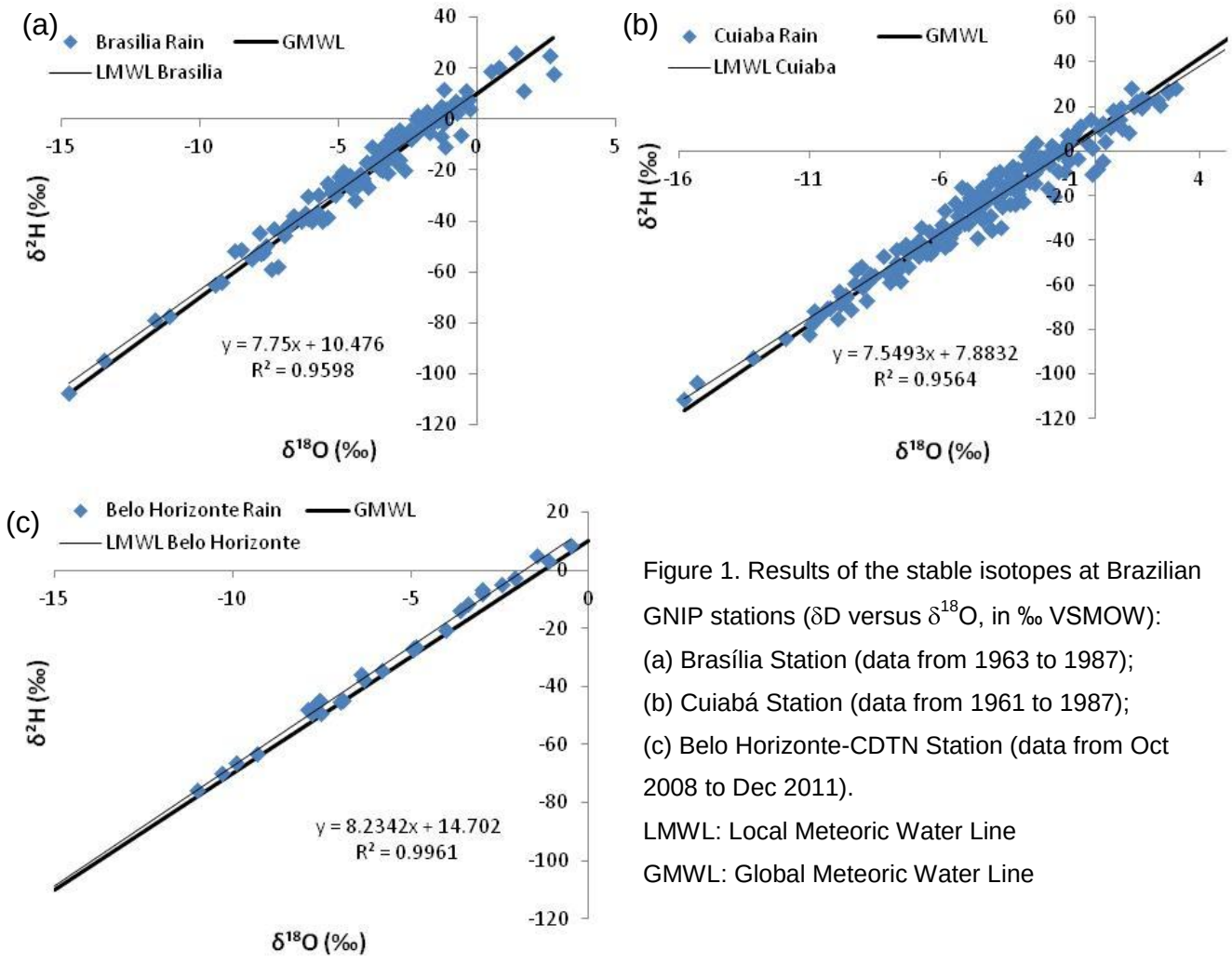

Figure 1. Results of the stable isotopes at Brazilian GNIP stations (δD versus $\delta^{18}O$, in ‰ VSMOW):
(a) Brasília Station (data from 1963 to 1987);
(b) Cuiabá Station (data from 1961 to 1987);
(c) Belo Horizonte-CDTN Station (data from Oct 2008 to Dec 2011).
LMWL: Local Meteoric Water Line
GMWL: Global Meteoric Water Line

Concurrent changes in precipitation patterns and the associated isotopic contents may indicate changes in atmospheric circulation and sources of water vapour in the region, highlighting the importance of regular monitoring in the context of climate change impact on water resources.

CONCLUSIONS

The factors controlling the changes in the isotope content of precipitation in mid-latitudes are relatively well understood, where temperature seems to play a major role. However, understanding isotope variability in tropical regions remains a major challenge, both for present day studies as well as for paleoclimatic investigations. This is partly due to poor spatial and temporal coverage of isotope studies and monitoring efforts in tropical regions. Therefore, efforts to expand isotope monitoring in the tropics are required, providing much needed recent data for climate, atmospheric circulation studies, paleoclimatology, hydrology, etc.

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