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Perspective

Isotopic content of rainfall as climatic indicators

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Despite the frequent scientific and political discussions about greenhouse gas emissions, the society forgets that the most important greenhouse gas is water vapour. It regulates and regulated in the past the global climate and the general atmospheric circulation. Changes in the energetic balance of the atmosphere control changes in water fluxes: upward (evaporation) or downward (precipitation). At present, like in the past, the main forcing over rainfall is the dynamics of air masses circulation, which significantly controls the moisture provenance.

Stable isotopes of water molecule label movements and also provide information about cloud condensation temperature, atmospheric vapour source and hence the wind direction [1, 8, 12].

The isotopic signal of precipitation associated to the displacement of the Intertropical Convergence Zone (ITCZ) and the Azores anticyclone represents an excellent methodology for a correct reconstruction of present-day atmospheric circulations and climatic changes suffered by Sahelian regions.

The isotopic content of rainfall measured in Niamey (Niger) over a period of eight years (1992–1999) [15] shed new light on the origin and on the movement of air masses through Sahelian zones. The isotopic information, referred to the long-period observation and to the event scale, allows explaining different phenomena taking place during rainfall.

At the annual scale, rainfall isotopic composition is not correlated to any regional climatologically characteristic, as observed in Africa [3, 5] and in other areas of the world [5, 9].

At the monthly scale, the beginning and the end of the rainy season, marked by low rainfall, high temperatures and low relative humidity, control the isotopic enrichment. In the middle of the rainy season, heavy rainfall, low temperatures and relative humidity close to 100%, lead to isotopically depleted contents because of the mass effect [6, 7, 9]. Nevertheless, results match with satellite information. Moreover the latitude reached by the Intertropical Front during its movement northward determines the quality of the rainy season and influences the isotopic contents [8, 12, 13].

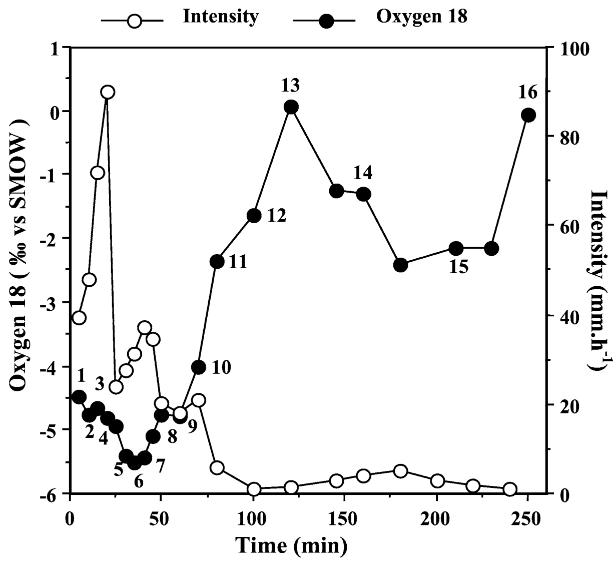

Figure 1. Variability of oxygen-18 and of rainfall intensity during meteorological event collected at Niamey [13].

The application of isotopes as climatic indicators to reconstruct the climate changes has been done, up to now, starting from the mean isotopic composition of monthly rainfall [9–11]. Therefore, in regions where the weather is marked by two extreme seasons rain samples do not completely represent the characteristics of wet air masses, because precipitations are not isotopically in equilibrium with the atmosphere, as indicated, for instance, in samples collected at the end of rainy season [15]. Conversely, event scale (Fig. 1) indicates and documents the local state of wet air masses [13]: mass effect clouds empty, local recycled vapour, altitude effect and altitude convection [1, 2, 4, 7, 14, 15]. In other words, the local effects, such as lithology, hydrographic network, vegetation cover, elevation and continentality of meteorological stations, conditioning the contribution of recycled vapours, as-

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sume a more important role on the control of rainfall isotopic composition.

Identifying and better defining the interactions between climatic conditions and isotopic composition of rainfall aim at assessing the relative contribution of climatic parameters to global climatic changes. Moreover, knowledge of today's climatology with the isotope of water allows one to reconstruct the climatology of the past and to characterise the palaeorecharge of aquifers.

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