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# The Watch of ITCZ Migrations over the Tropical Atlantic Ocean as an Indicator in Drought Forecast over the Sahelian Area

The Inter-Tropical Convergence Zone (ITCZ) as a major component of the rainy season in western Africa has been studied by numerous workers drawing more or less attention to ITCZ locations during various wet and dry episodes of western Africa. Among others, Hastenrath (1984) found that the most abundant rainfall over the sub-Saharan area is associated with a far northerly position of the near-equatorial, low-pressure trough and associated features in wind, cloudiness, and SST fields,with lesser rainfall being observed with opposite conditions (data used cover the 1911-1982 period). Nicholson (1981;1983) observed that only the monthly northernmost position of the 25-mm isoyet (assimilated to the ITCZ position) may account for wetter years (data used cover the 1900-1980 period).

In the light of the preceding works (even if the longitude of the ITCZ location may differ), the aim of the present note is to assess the level of significance that may be attached to the ITCZ migrations in the scheme of a (qualitative) analysis of wet or dry periods during the last 16 years in the Sahelian area, over a more recent and complete time series.

In this work, ITCZ locations along 28°W have been followed from 1971 to 1987, from available satellite imagery, using either the photographic support (for the NOAA satellite series) or the numerical data-set for the Meteosat series archived at the Center de Météorologie Spatiale de Lannion (France), which concerns the nearest period (1982-

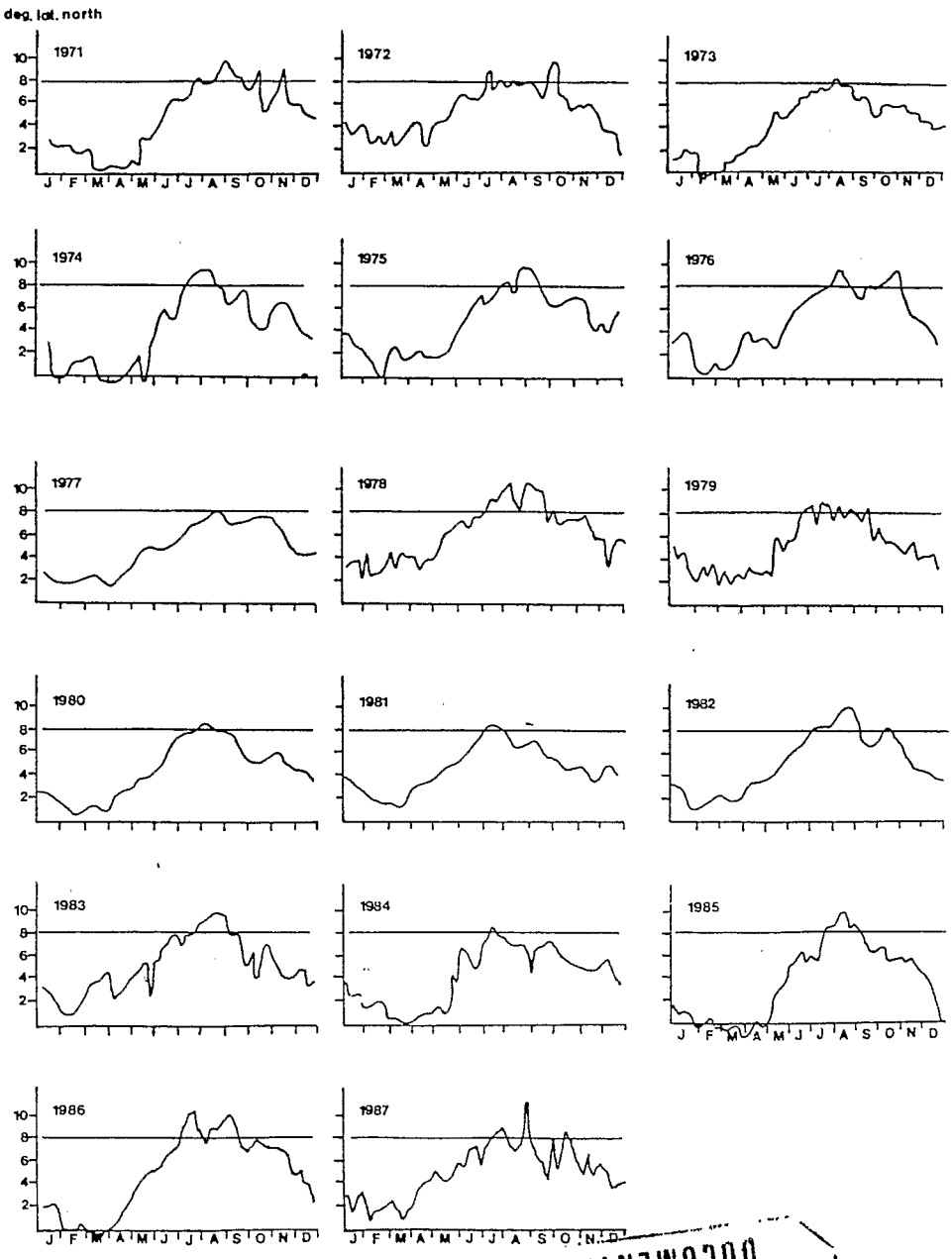


FIGURE 1 (Citeau, et al.)
*Observed positions of the ITCZ along 28°W over the period 1971-1987.*

1987). A detailed analysis of methods used and relationships attempted between the ITCZ and wind field at sea level, or between ITCZ and SST, is contained in Citeau, *et al.* (1986).

Over the Atlantic Ocean, the ITCZ can frequently be observed as a unique structure, close to the definition given by Frank (1983) as "the prevailing east-west line of maximum convection," instead of the double or sometimes triple convergence zones commonly observed over the Pacific and Indian oceans. Without disregarding the occasional existence (mainly during the first half of the year) of the South Atlantic convergence zone, we have limited our work here to the northern ITCZ branch.

From Figure 1, which represents the observed positions of the ITCZ along 28°W, some tropical situations are seen: the ITCZ follows the apparent movement of the sun, it appears that its northern displacement can be observed either early in the year (around February-March, as observed in 1973, 1976, 1982, or 1983), or later (around April-May as observed in 1974, 1984, and 1985).

Another characteristic which has been frequently studied by the authors cited (and several elsewhere) is the northernmost position reached by the ITCZ during summertime (for the Northern Hemisphere). We see that this was located at a rather low latitude in July-August of the years 1972, 1973, 1977, 1979, and 1984, and at a higher one in 1974, 1976, 1982, 1983, and 1985. As the different years of the first of these groups also coincide more or less with severe drought periods, they agree with previous studies. In contrast, no evident answer is available for the latter group, where the northernmost ITCZ positions (during the boreal summer) were observed both for wet years (1974, 1985) and dry ones (1976, 1982, 1983). In other words, if the characterization of typical (wet or dry) years fits with the observed northernmost ITCZ position during the 1970s, this parameter can no longer explain the dry or wet years observed during the 1980s.

Because the qualifying terms "wet or dry" are often relative to a period of continuous drought, we compared (Citeau, 1986) two different indices available for the Sahelian area, namely the rainfall index of Lamb (1985), and the normalized departure of runoff of the Senegal River, which we computed from data provided by Olivry (1983). In Figure 2 where these two indices are represented, generally good agreement appears if we except the year 1974, which seems to have been underestimated by Lamb's index; otherwise, 1984 indicates a steady drought year if we refer to the Senegal River index. In fact, at the end of that continuous and very severe drought period, the available rainwater has been first used to refill underground layers (Gac, *pers. comm.*), and the value of the Senegal River runoff here underestimates the rainfall amount; the change in tendency of the rainy season is more realistic in 1984 with the Lamb index.

To extract some typical pattern for the ITCZ migration during dry or wet episodes, and to avoid the smoothing effect of mean-value computation, we draw the envelope of the ITCZ positions for the characteristic driest years, as in 1972, 1982, and 1983 (Figure 3a) and, similarly, for the characteristic wettest years as in 1974, 1985, and 1986 (Figure 3b).

The timing difference of the ITCZ northward movement previously mentioned between wet or dry years remains evident on these figures. Based on the northernmost position reached by the ITCZ during the boreal summer, we draw the mean of the curves which define the envelope for the same dry and wet episodes: the resulting curves (Figure 3c) displays no significant difference for the ITCZ position during these different periods.

As a preliminary conclusion, it seems that the ITCZ migrates more during February-May, which may indicate some large-scale climatic anomaly, which can last several months, and apparently is well correlated with the quality of the forthcoming rainy season, roughly three or four months later.

nother method is to compute the mean value of the ITCZ speed during its northward movement, February-May: Figure 4 shows this speed (in hundreds of degrees of latitude per day). A detailed description of the method used is found in Citeau, *et al.* (1986). If we compare Figures 2 and 4, a fairly good parallel appears between the speed of northward migration of the ITCZ to the anomaly of the standardized Senegal River runoff.

Finally, to assess if this ITCZ description was due not only to the local configuration (of the wind or pressure field), but which may also represent a larger scale phenomenon, we similarly analyzed ITCZ migration over the Indian Ocean (60°E). The first results (*in* Citeau *et al.*, 1988) confirm that the ITCZ movement displayed very similar behavior over both oceans, with a northward migration in 1972, 1982, and 1983, and a later one in 1974 and 1984.

As a preliminary conclusion , the observations of the ITCZ along 28°W may reveal larger-scale phenomena, which would be

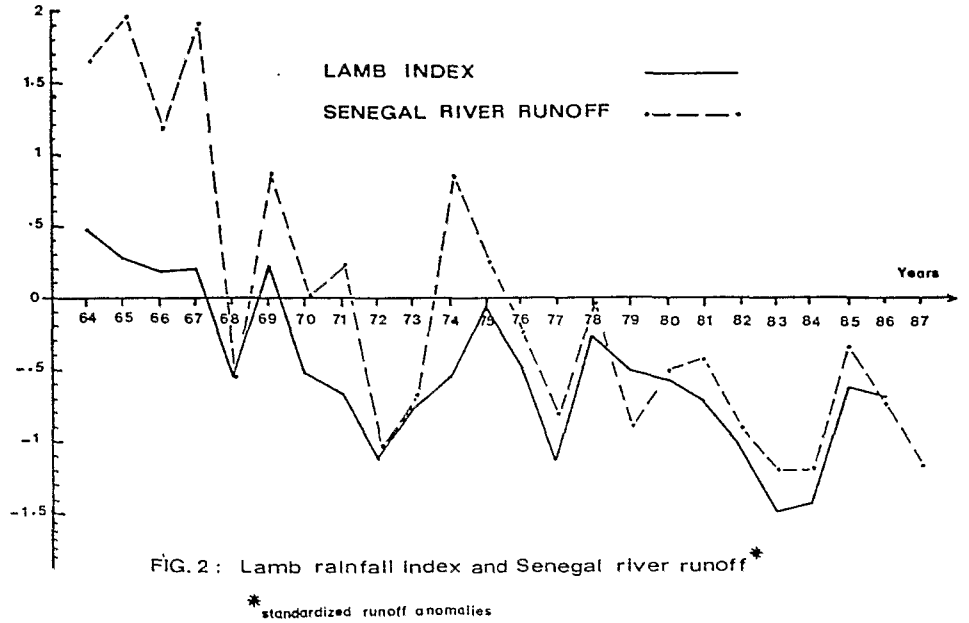


FIG. 2 : Lamb rainfall index and Senegal river runoff*

*standardized runoff anomalies

FIGURE 2 (Citeau, et. al.)
Lamb rainfall index and standardized anamolies of the Senegal River runoff.

connected to the general circulation. This idea of a planetary signal contained in the migration of the ITCZ supports the possibility of a relationship between the ITCZ observed along 28°W and Sahelian rainfall (which is at the eastern longitudes). The rainfall anomalies related to the period 1971-1987 seemed more linked to the timing of the northward movement of the ITCZ than to the northernmost position reached during the northern summer. Each time that the northern migration occurs early in the year (from a statistical point of view), a rather bad rainy season is observed several months later over the Sahelian area.

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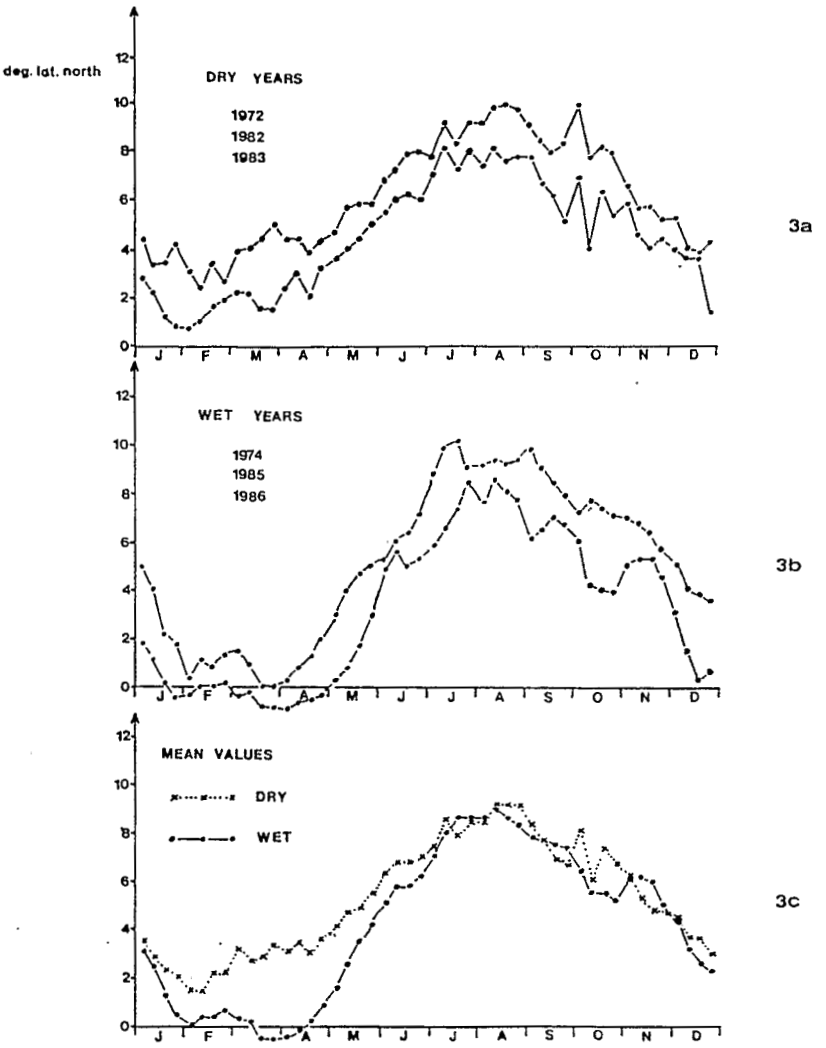


FIGURE 3 (*Citeau* , et al.)
*Envelope of positions of the ITCZ for the driest years (a) for the wettest years (b) , and mean values (c).*

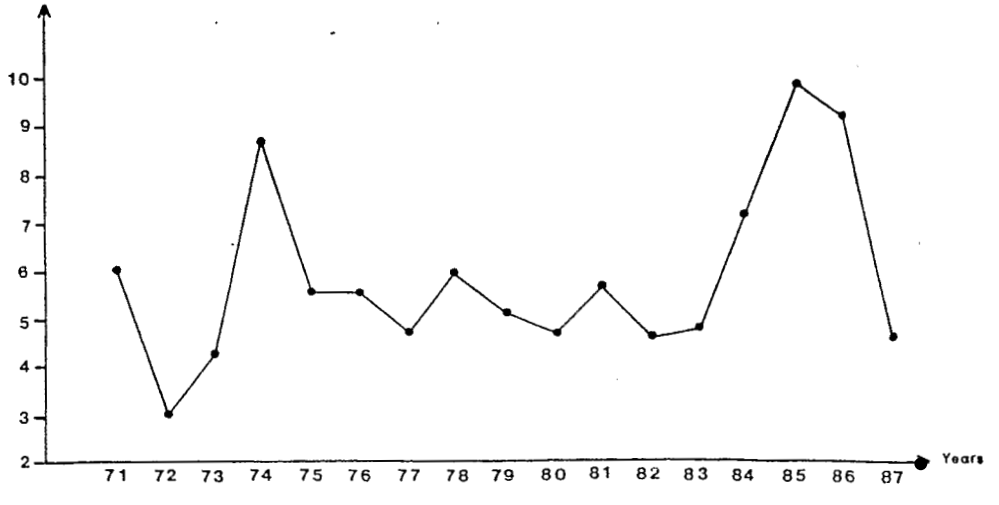


FIGURE 4 *(Citeau, et al.)*
*Mean value of the meridonial speed of the ITCZ during northward migration.*