Tellus (1978), *30*, 240–251

Large-scale Tropical Atlantic surface circulation patterns associated with Subsaharan weather anomalies

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(Manuscript received December 22, 1976; in final form May 23, 1977)

ABSTRACT

Identification is made of the Tropical Atlantic (30° N–30° S) surface atmospheric and oceanic patterns of a data set composited for 5 years which were very dry in Subsaharan West Africa (11–20° N). Patterns for a counterpart wet composite data set are also presented. Sixty-year (1911–70) average fields constitute a background reference.

For the rainy season (July–September) of the dry composite, the Tropical Atlantic near-equatorial pressure trough, kinematic axis separating Northern and Southern Hemisphere Trades, and zone of maximum sea surface temperature (SST) are located 200–300 km south of their 60-year average positions. Concurrently, the North Atlantic subtropical high (NAH) extends further equatorward than average, although its centre lies up to 150 km north of its mean latitude. Both Northeast and Southeast Trades are stronger than average, and negative and positive SST anomalies occur north and south of approximately 10° N, respectively. Some of these anomalies evolved during the preceding January–June, which offers encouragement that Subsaharan droughts may be predictable 3 to 6 months in advance.

Patterns for July–September of the wet composite contain fewer and less pronounced anomalies. The NAH is centred 100–150 km further north and extends less equatorward than average, the kinematic axis lies 100–150 km north of its mean latitude, and the Trades are weak in many areas. Except for the northward displacement of the NAH centre, these anomalies are opposite to those for the dry composite July–September. The wet composite July–September anomalies did not evolve during preceding seasons.

1. Introduction

Subsaharan Africa has experienced pronounced climatic variation in the past (e.g., Grove, 1972, 1973; Davy, 1974; Landsberg, 1975a). It took the disastrous 1968–1974 drought, however, to focus attention on this problem. Previous discussion of the recent drought has often attributed it to Northern Hemisphere extratropical cooling causing an expansion of the circumpolar vortex and an equatorward displacement of the subtropical high pressure belt, thus restricting the northward extent and intensity of the tropical circulation systems controlling Subsaharan rainfall (e.g., Bryson, 1973; H. H. Lamb, 1973; Landsberg, 1973; Winstanley, 1973a, b; Angell and Korshover, 1974). Predictions of deficient Subsaharan rainfall for much of the rest of this century have been based on the above interpretation (e.g., Bryson, 1973; H. H. Lamb, 1973; Winstanley, 1973b; Wood and Lovett, 1974). On the other hand, data analysis by Miles and Follard (1974), Tanaka et al. (1975), and Bunting et al. (1976) failed to support these suggested relationships between the large-scale circulation and Subsaharan precipitation. Furthermore, Landsberg (1975a, b) and Bunting et al. (1976) consider the recent drought to be the product of a reversible climatic fluctuation, rather than an indication of climatic change. Charney (1975) and Charney et al. (1975) have suggested Subsaharan drought may be initiated or reinforced by a biogeophysical feedback mechanism occurring within the zone, but this has been challenged by Ripley (1976a, b).

Attempts to relate the recent drought to large-scale circulation anomalies have been handicapped by the lack of pertinent observational data, an

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unfamiliarity with the role of the Southern Hemisphere circulation, and an incomplete understanding of the behaviour of the tropical atmosphere. The present paper identifies the Tropical Atlantic (30° N–30° S) surface atmospheric and oceanic patterns of a data set composited for 5 years which were very dry in Subsaharan West Africa (11–20° N). Comparison is made with the patterns for a counterpart wet composite data set. The evolution of rainy season features during preceding months is studied for both composites. This research is thus intended as a contribution to the "comprehensive diagnostic study of the circulation affecting West Africa" Landsberg (1975a) considers necessary for identifying the mechanisms of Subsaharan weather anomalies, but saw precluded by inadequate data. The need for improved understanding of tropical climatic fluctuations has been frequently stressed of late (e.g., Sawyer, 1974; World Meteorological Organisation—ICSU, 1975, pp. 1–6).

2. Data and data processing

2.1. *Marine data*

For the Tropical Atlantic and Eastern Pacific, individual monthly mean values of various meteorological elements were obtained on magnetic tape from the National Climatic Center, Asheville, North Carolina, for the period 1911–72 and one-degree latitude–longitude square areas. Almost 3.5 million sets of ship observations were available for the area east of 60° W considered here; spatial variations in the data amount are indicated in Hastenrath and P. J. Lamb (1977). Averages of sea-level pressure, surface wind, and sea surface and air temperature (SST and AT) for data sets composited for five very dry Subsaharan years, five very wet Subsaharan years, and the 60-year (1911–70) mean constitute the basis of the present paper. Subdivision of the year into the January–March, April–June, July–September, and October–December quarters, rather than 1- or 2-month periods, enhanced data stability and permitted concise presentation of results. Choice of the above groupings resulted from the Subsaharan rainy season being concentrated in July–September (e.g., Jackson, 1961), and monthly charts showing these quarters to possess distinct patterns.

Data were quality controlled when taped, with values beyond physically reasonable limits being excluded. Wind speed was converted from original Beaufort estimates. Verploegh (1967) found wind force data obtained by simple observation to be as accurate as ships' wind measurements. Shipboard measurements of SST and AT are likely to be overestimations (e.g., Saur, 1963; Ramage et al., 1972); because of the uncertainty of these errors, however, no corrections were applied. The large-scale departure patterns of SST and AT considered here should be little affected. Fields were smoothed with a symmetrical 25-weight filter function derived by R. Bleck; Hantel (1970) has provided a complete discussion of this objective filtering procedure, including a demonstration of its effectiveness. The large-scale features of interest in the present study remain substantially unaltered from the raw to the filtered fields.

Hastenrath and P. J. Lamb (1977) made a limited investigation of the variability in this data set for the period 1911–70. Typical standard deviations of individual monthly mean values for five-degree squares are: 1–2 mb for sea-level pressure, 1–2 m s^{-1} for resultant wind speed, and 0.5–1.0 °C for SST. Smaller standard deviations could be expected for coarser time-space resolutions.

2.2. *Northern Hemisphere historical weather map data*

Monthly/fortnightly mean sea-level pressure charts for the Northern Hemisphere north of 15° N, compiled from the Historical Weather Map series of the U.S. Weather Bureau, were obtained on microfilm from the National Climatic Center for the period 1899–1972. The latitude and value of the highest monthly mean subtropical surface pressure were determined for selected meridians between 170° W and 20° W.

2.3. *Subsaharan rainfall data*

Monthly rainfall totals for Subsaharan stations were obtained from Smithsonian Institution (1927, 1934, 1947), U.S. Weather Bureau (1957–65, 1959), ESSA (1966–70, 1967), NOAA (1971–74), and various national and regional Meteorological Services for the entire period of available records.

3. Subsaharan rainfall

A synopsis of Subsaharan rainfall variation during 1941–74 is presented in Fig. 1. The rainfall

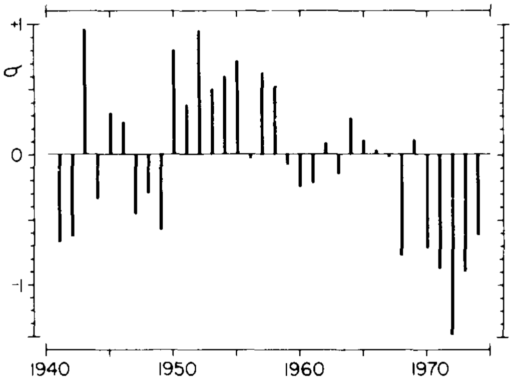

Fig. 1. 1941–74 time series of the yearly average of the normalized rainfall departures for 14–20 Subsaharan stations west of 10° E. Stations used are located by dots in Fig. 2.

data used consist of yearly April–October totals for individual stations, expressed as normalized departures (σ's) from their 1941–74 station means. The April–October interval includes the entire rainy season for all of Subsaharan West Africa (Jackson, 1961). A particularly conspicuous feature of Fig. 1 is the very low rainfall in 1968 and during 1970–74. Other marked dry years during 1941–74 were confined to the 1940s; 1950–58 was very wet, while 1959–67 experienced near-average rainfall. The few available pre-1941 rainfall data (e.g., Jenkinson, 1973; Davy, 1974), a variety of historical sources (e.g., Grove, 1973), and hydrological data for the Senegal and Niger rivers suggest that years around 1921, 1926, and especially 1913 were also very dry.

Table 1. *April–October rainfall departure statistics and marine data coverage for the seven driest Subsaharan years during 1941–72. Marine data for the asterisked years were combined to form the dry composite data set*

Year	Fraction of stations with rainfall departure ⩾ −1.0σ from 1941–74 mean	Fraction of stations with rainfall departure ⩾ −0.6σ from 1941–74 mean	Average of all station standard deviations	Number of surface marine meteorological observations in Tropical Atlantic east of 60° W
1972*	17/20	19/20	−1.39	20,410
1942*	7/14	8/14	−0.63	8,518
1971*	9/20	15/20	−0.88	26,379
1970*	8/20	13/20	−0.72	41,867
1949*	5/14	7/14	−0.58	46,077
1968	7/20	14/20	−0.78	188,803
1941	4/14	7/14	−0.67	4,882

Table 2. *April–October rainfall departure statistics and marine data coverage for the six wettest Subsaharan years during 1941–72. Marine data for the asterisked years were combined to form the wet composite data set*

Year	Fraction of stations with rainfall departure ⩾ +1.0σ from 1941–74 mean	Fraction of stations with rainfall departure ⩾ +0.6σ from 1941–74 mean	Average of all station standard deviations	Number of surface marine meteorological observations in Tropical Atlantic east of 60° W
1943*	9/14	11/14	+0.96	10,255
1950*	8/20	13/20	+0.80	56,387
1952*	7/20	13/20	+0.95	56,658
1957*	7/20	11/20	+0.63	35,313
1954*	7/20	10/20	+0.60	63,129
1955	5/20	9/20	+0.72	49,919

The normalized rainfall departures for the stations contributing to Fig. 1 were summarized for each year by tabulating the average of the station departures, as appears in Fig. 1, and the fraction of the stations where the departure was at least $+1.0\sigma$, $+0.6\sigma$, -0.6σ, and -1.0σ. Also included in the tabulation, portions of which appear in Tables 1 and 2, was the number of surface meteorological observations made each year in the Tropical Atlantic east of 60° W. The dry composite data set studied in this paper was created by combining the data for 1942, 1949, 1970, 1971, and 1972, and the wet composite by combining data for 1943, 1950, 1952, 1954, and 1957 (Tables 1–2). The dry and wet composites are hereafter referred to as DRY and WET, respectively. 1968 was excluded from DRY, as its excellent data coverage (Table 1) permitted case study treatment. Results of this are presented in a companion study (P. J. Lamb, 1978) where comparison is made with the patterns for 1967, a very wet year in the Western Subsaharan zone (e.g., Landsberg, 1973, 1975a) if not for the region as a whole (Fig. 1). In the choice of the 5 years for DRY, 1949 was preferred over the possibly drier 1941 because of its superior marine data coverage; for WET, 1954 was used instead of 1955 due to it having more stations with rainfall departures of at least $+1.0\sigma$ and more marine data.

The formation of these composites produced relatively stable data ensembles from anomalous years lacking the observational base to be studied individually (Tables 1–2). In making composites there exists, in principle, the possibility that dissimilar patterns may be combined. Because individual composite years possessed different data coverages, investigation of their variance by standard statistical methods did not seem appropriate. The validity of composite patterns presented below was, however, confirmed by inspection of spatial displays of the data for several constituent years and 1911–72 time series of various parameters for large ocean areas.

The large-scale atmospheric and oceanic conditions for DRY and WET are here compared with 60-year (1911–1970) average patterns, full details of which appear in P. J. Lamb (1977).

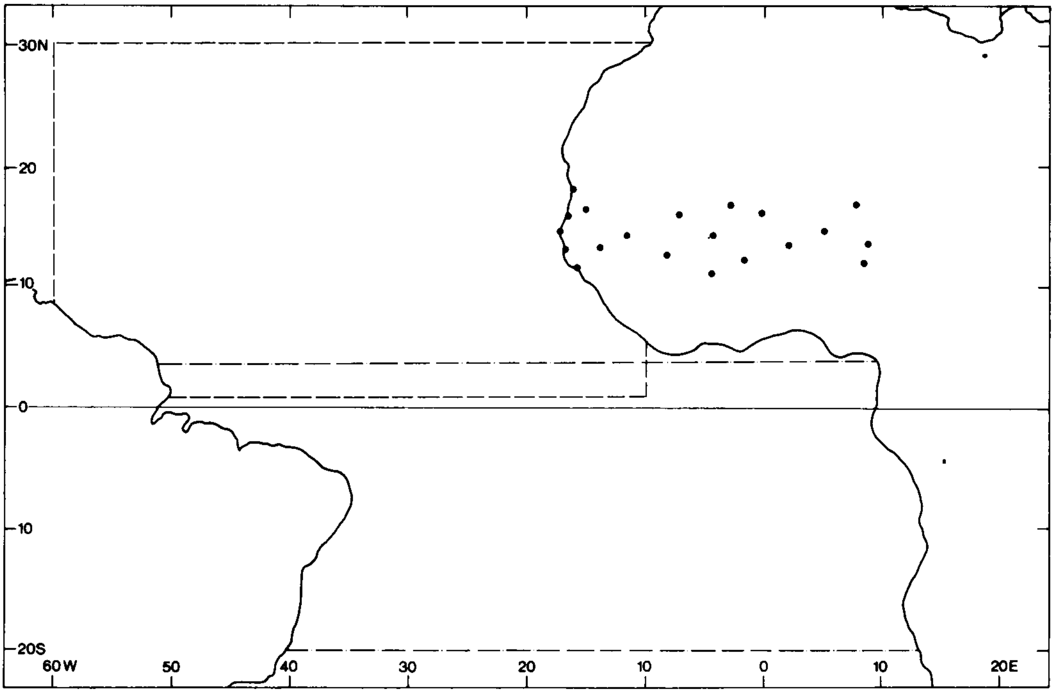

Fig. 2. Orientation map. Dots indicate the rainfall stations used in the construction of Fig. 1. Broken and dash-dot lines are boundaries of the marine areas for which the northern and southern transects in Fig. 3 were respectively computed.

4. Atmospheric-oceanic patterns for dry composite

4.1. *Sea-level pressure*

Seasonal mean values of sea-level pressure for one-degree squares (data source (2.1)) were reduced to meridional transects for the northern and southern marine areas in Fig. 2 for DRY and WET and the 1911–70 average (Fig. 3). These transects contain a value for every degree of latitude between 28° N and 18° S; each value was obtained by averaging the pressures for all one-degree squares within a zone four degrees latitude in width centred on the latitude concerned. The southern transects terminate at 18° S, due to the uneven data distribution south of 20° S.

The Subsaharan rainy season is concentrated during July–September (Jackson, 1961), when the features of the Tropical Atlantic surface pressure, wind, and temperature fields reach their northernmost locations (P. J. Lamb, 1977). During July–September of DRY (Fig. 3), the near-equatorial pressure trough was about 200 km south of and markedly deeper than that for the long-term mean. This coincided with the North Atlantic subtropical high (NAH) extending further south than normal. However, the related configuration of the South Atlantic subtropical high (SAH) is not clearly indicated by the southern transect.

This southward displacement of the trough and greater than normal southward extension of the NAH for the DRY July–September did not characterize preceding seasons (Fig. 3). During April–June of DRY, the trough is in fact slightly north of its mean location. However, a strong 20–12° N pressure gradient occurred in both the DRY July–September and earlier quarters, separating higher than normal pressure further north from the opposite further south. The southern transect for April–June indicates a less than normal northward extension of the SAH, but there is no clear evidence of it persisting to July–September.

4.2. *Centre of North Atlantic subtropical high*

As indicated in the introduction, some disagreement exists concerning the relation between the latitude of the NAH centre and Subsaharan rainfall. Since Fig. 3 does not extend far enough north to locate the NAH centre, the latitude and pressure at the west–east axis of the NAH for longitudes 50° W and 30° W were retrieved from the microfilm monthly sea-level pressure maps described in Section 2.2. Longitude-averaged values for months of DRY, WET, and the 60-year mean are displayed in Fig. 4. During July–September of DRY, a weaker than normal NAH was centred either close to its long-term average latitude position, or about 150 km further north. Similar relative positions of the NAH centre occurred during the preceding half-year, except in February and May when this axis was 300–350 km further north than normal. During the DRY

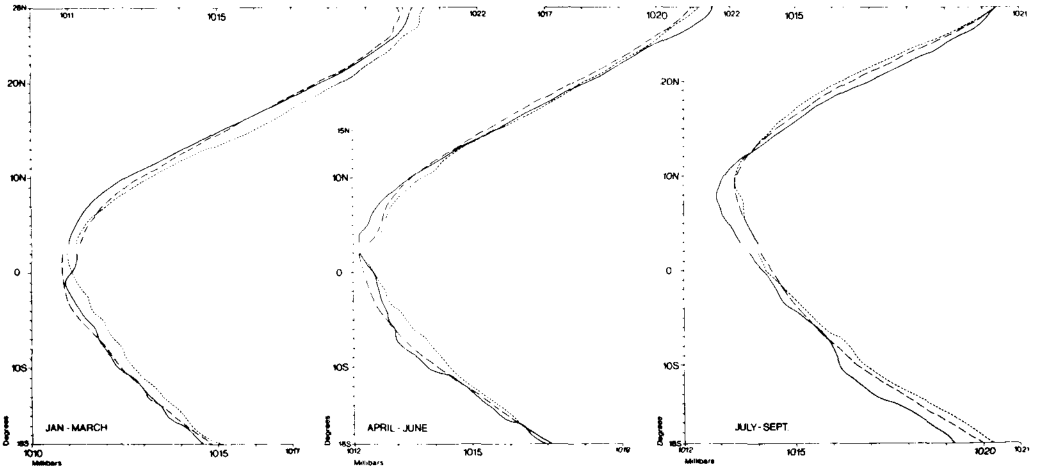

Fig. 3. January–March, April–June, and July–September meridional transects of surface pressure for the northern and southern marine areas in Fig. 2. Solid line is dry composite, broken line wet composite, and dash-dot line the 1911–70 mean. Data used were from source 2.1.

January–June, the central pressure of the NAH varied irregularly about the 60-year average.

4.3 *Wind*

Seasonal fields of resultant wind vectors for two-degree squares for DRY and WET were expressed as speed and direction departures from the 60-year mean patterns presented in P. J. Lamb (1977). Results are given in Figs. 5 and 7. The direction departures shown are limited to those exceeding 30° in areas where the directional steadiness of wind exceeds 40% (P. J. Lamb, 1977). They indicate abnormal locations of the chaotic resultant directions of the NAH–SAH centres and the near-equatorial kinematic axis between Northern and Southern Hemisphere Trades (P. J. Lamb, 1977), and are henceforth termed "significant direction departures". The South Atlantic area not analysed in Fig. 5 and succeeding maps possessed poor data coverage.

For July–September of DRY (Fig. 5), a southward displacement of the kinematic axis is apparent. The wind direction discontinuity is up to 200 km south of its mean position, positive and negative speed anomalies lie to its north and south, respectively, and a band of significant direction departures occurs south of the 40% isopleth of directional steadiness. During the DRY July–

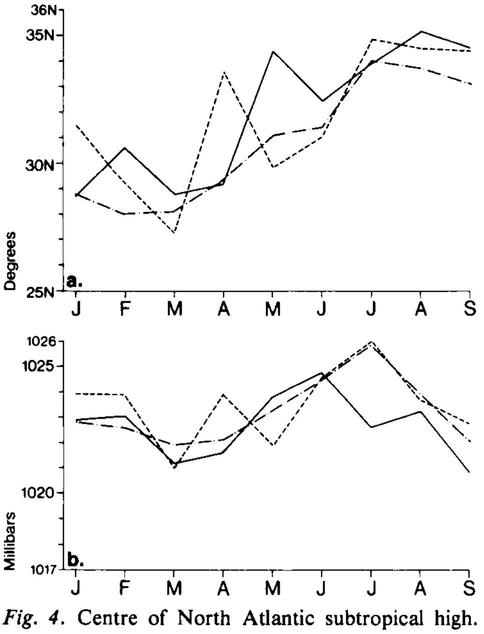

Fig. 4. Centre of North Atlantic subtropical high. (a) monthly mean latitude, (b) monthly mean pressure. Solid line is dry composite, broken line wet composite, and dash-dot line 1911–70 average. Data used were from source 2.2.

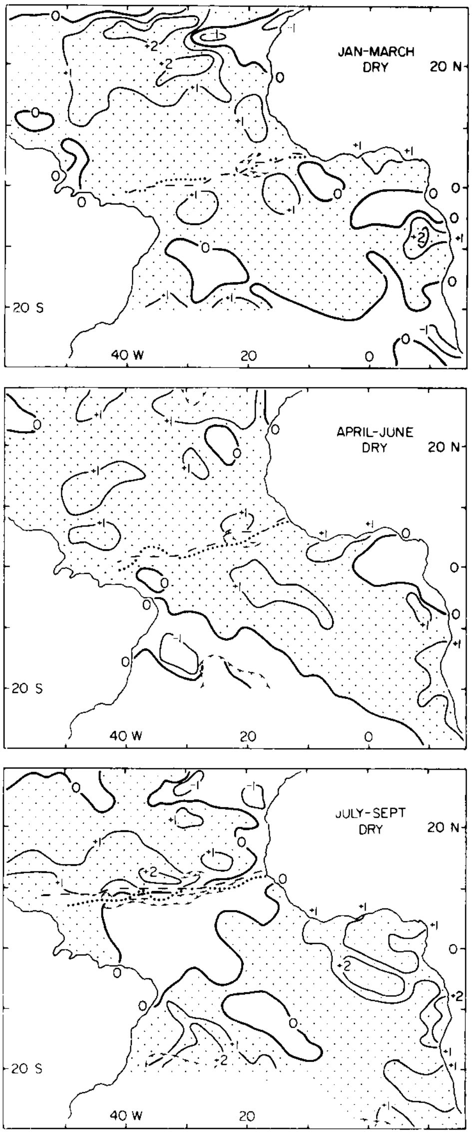

Fig. 5. January–March, April–June, and July–September resultant wind fields for the dry composite expressed as departures from the 1911–70 average patterns. Solid lines are departure isotachs (m s^{-1}), positive values shaded; dotted line is discontinuity between northerly and southerly resultant wind directions for dry composite, with broken line giving its 60-year mean position; barbed line encloses resultant wind direction departures of more than 30° in areas where the directional steadiness of wind exceeds 40%.

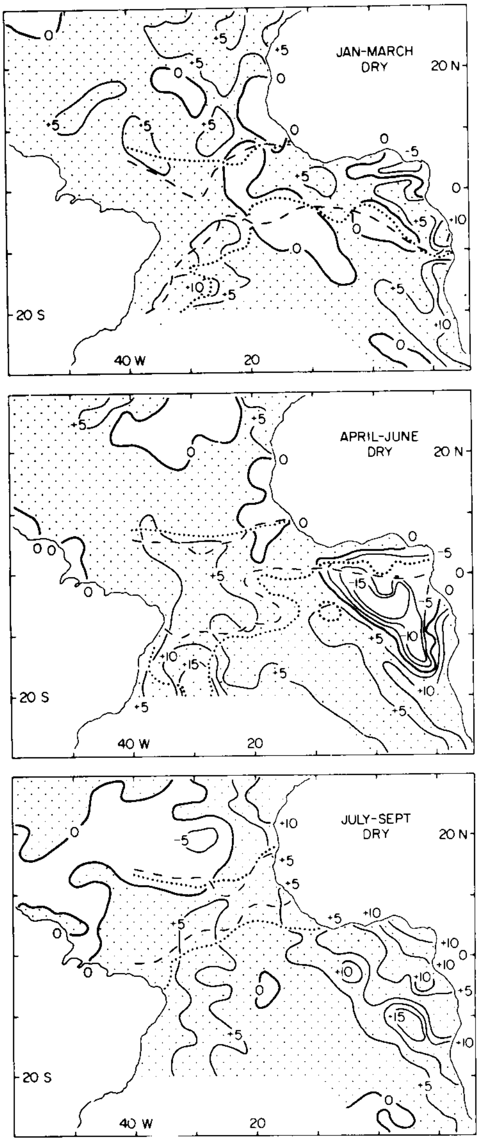

Fig. 6. January–March, April–June, and July–September sea surface temperature fields for the dry composite expressed as departures from the 1911–70 average patterns. Solid lines are departure isotherms (tenths of 1 °C), positive values shaded; dotted lines enclose area of maximum sea surface temperature east of 40° W for dry composite (>27.0° C for January–March, >27.2 °C for April–June, >26.7 °C for July–September), with broken lines doing likewise for the 1911–70 mean.

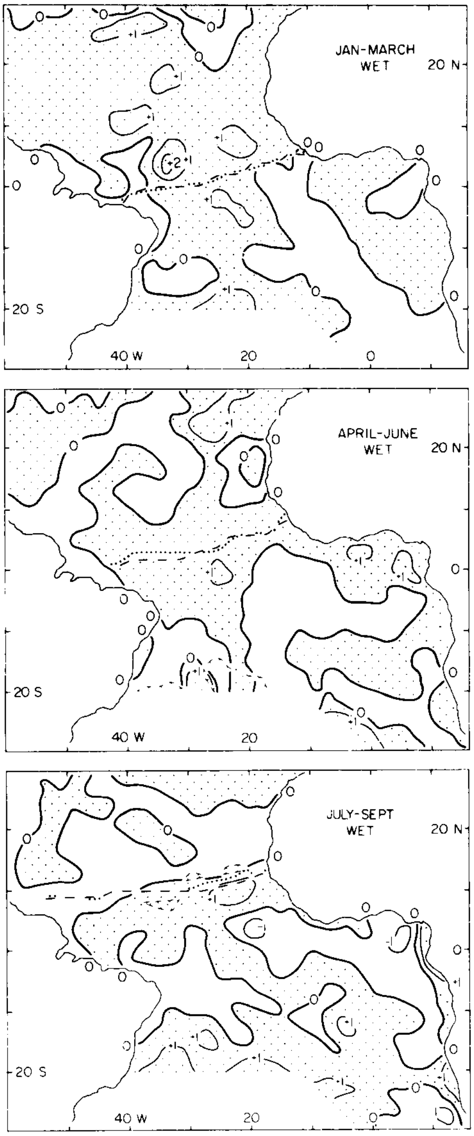

Fig. 7. January–March, April–June, and July–September resultant wind fields for the wet composite expressed as departures from the 1911–70 average patterns. Symbols are as in Fig. 5.

September (Fig. 5), speed anomalies are largely positive in the Northeast and Southeast Trades. Fig. 5 gives no indication of a southward displacement of the NAH centre for this season and agrees with pressure data in Figs. 3–4.

The southward displacement of the kinematic axis during the DRY July–September is partially apparent for the preceding April–June (Fig. 5). While the direction discontinuity is again south of its mean location and a small area of significant direction departures lie south and southwest of the

40% isopleth of directional steadiness, negative speed anomalies do not occur south of the direction discontinuity. Instead, positive speed deviations characterize virtually the entire confluence region. Positive Trade Wind speed departures during the DRY January–March and April–June preceded those of July–September. The Northeast Trades are especially strong for January–March.

4.4. *Temperature*

Seasonal mean fields of SST and AT for DRY and WET were expressed as deviations from their 60-year average counterparts presented in P. J. Lamb (1977). The AT departure patterns virtually replicated those for SST, and therefore are not reproduced: SST departures appear in Figs. 6 and 8.

For the DRY July–September (Fig. 6), the SST anomalies are predominantly positive, except west of 24° W and north of 10° N where they are largely negative. This departure pattern was accompanied by the zone of maximum SST being displaced 200–300 km south of its mean location. During the preceding half-year (Fig. 6), however, the zone of maximum SST was expanded both northward and southward at most longitudes east of 10° W by positive anomalies between 20° N–10° S. The cold anomaly between 10–20° N for July–September had not yet developed, although one was present further north in April–June. However, the positive SST deviations south of 10° S for July–September existed from January–March onward.

5. Atmospheric-oceanic patterns for wet composite

5.1. *Sea-level pressure*

During the WET July–September (Fig. 3), the latitude of the pressure minimum (10° N) is one-degree further north than in the mean. Apart from this, however, the configuration and location of the overall trough zone closely resemble that for the 1911–70 average. The NAH for this season does not extend as far equatorward as in the mean, while the SAH is largely similar to that for 1911–70.

A near-average trough zone likewise existed in the WET January–March and April–June (Fig. 3). On the other hand, the less than normal southward extent of the NAH during the WET July–September was not characteristic of earlier seasons.

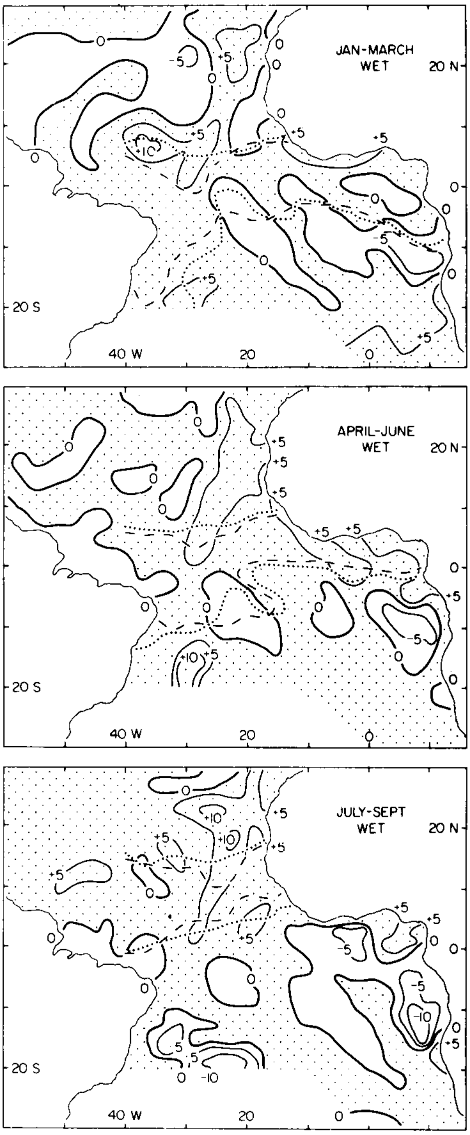

Fig. 8. January—March, April–June, and July–September sea surface temperature fields for the wet composite expressed as departures from the 1911–70 average patterns. Symbols are as in Fig. 6.

5.2. *Centre of North Atlantic subtropical high*

During the WET July–September (Fig. 4), the centre of the NAH was 100–150 km north of its mean location, but of near normal pressure. Considerable variation about the long-term average pressure and latitude occurred in the preceding half-year.

5.3. *Wind*

For July–September of WET (Fig. 7), a slight northward displacement of the kinematic axis is evident between 15–30° W. The wind direction discontinuity here is up to 100 km *north* of its average location, negative and positive speed anomalies occur to its north and south, respectively, and significant direction departures are found north of the 40% isopleth of directional steadiness. During this season the Trades were weak in many areas. These wind anomalies for the WET July–September show little evidence of characterizing earlier seasons (Fig. 7).

5.4. *Temperature*

During July–September of WET (Fig. 8), the SST departures are positive in most areas, except for the negative anomaly south of the Gulf of Guinea. This departure pattern produced an expansion of the zone of maximum SST toward the north and south, leaving its axis close to the mean location. Fig. 8 shows that a similar situation characterized the preceding April–June; negative SST departures are more evident for the WET January–March, but again little change in the axis of maximum SST resulted.

6. Summary and discussion

The recent Subsaharan drought has most frequently been attributed to Northern Hemisphere extratropical cooling displacing the components of the general circulation equatorward. However, this work has been handicapped by a lack of relevant data, and an incomplete understanding of possible active roles of tropical and Southern Hemisphere circulation regimes. The present study identified the Tropical Atlantic (30° N–30° S) surface atmospheric and oceanic patterns of a data set composited for five very dry years in Subsaharan West Africa (DRY). Comparison was made with the patterns for a counterpart wet composite data set (WET).

During the rainy season (July–September) of DRY, the Tropical Atlantic near-equatorial trough (Fig. 3), kinematic axis (Fig. 5), and zone of maximum SST (Fig. 6) were all displaced 200–300 km south of their 60-year mean locations. Concurrently, the NAH extended further equatorward than average (Fig. 3), both the Northeast and Southeast Trades were stronger than in the mean (Fig. 5), and negative and positive SST anomalies occurred north and south of approximately 10° N, respectively. The centre of the NAH (Fig. 4) was up to 150 km north of its mean position, an opposite displacement to those for the trough and kinematic axis. Many of these anomalies are less pronounced duplications of those for July–September 1968, a very dry individual Subsaharan rainy season (P. J. Lamb, 1978). The most notable exception is that the 1968 NAH centre was up to 500 km further south than average, whereas for DRY it is up to 150 km north of its 60-year mean latitude. Similar results were obtained by Tanaka et al. (1975), who found the 700 mb NAH centre to be 5–6° further north in the Augusts of 1970–73 than in August 1968; 1970–73 includes 3 years contained in DRY. The DRY July–September also shows less evidence of the near-equatorial zones of maximum convergence, cloudiness, and precipitation being displaced south of their mean locations (not shown), than characterized 1968 (P. J. Lamb, 1978).

Some of the atmospheric-oceanic anomalies experienced during the DRY July–September evolved prior to this season. These included positive Trade Wind speed departures during the preceding January–June (Fig. 5), some evidence of a southward displacement of the kinematic axis during April–June (Fig. 5), positive SST anomalies south of about 10° N in January–June (Fig. 6), and a northward displacement of the NAH centre during most of January–June (Fig. 4). In contrast to July–September of DRY, however, the preceding half-year also experienced positive SST departures between 10–20° N (Fig. 6), an expansion of the zone of maximum SST towards both the north and south (Fig. 6), and near-average divergence, precipitation, and cloudiness fields in the Equatorial Atlantic (not shown). Furthermore, during the DRY April–June the trough was displaced slightly north of its mean position, the opposite of the following July–September (Fig. 3). In contrast to DRY, almost all of the July–September 1968 departure features evolved earlier in the year (P. J. Lamb, 1978).

For the WET July–September, in contrast to its DRY counterpart, few atmospheric-oceanic anomalies occurred in the Tropical Atlantic. They were restricted to the NAH centre being 100–150 km further north than average (Fig. 4), the southern flank of the NAH extending less equatorward than in the mean (Fig. 3), the kinematic axis being displaced 100–150 km north of its mean location (Fig. 7), and the Trades being weak in many areas (Fig. 7). Except for the northward displacement of the NAH centre (Fig. 4), these anomalies are opposite to those experienced during the DRY July–September. They are less pronounced versions of some of the July–September 1967 anomalies (P. J. Lamb, 1978); this very wet rainy season in the Western Subsaharan zone, but not for the strip as a whole (Fig. 1), was associated with additional Tropical Atlantic surface atmospheric-oceanic anomalies.

The few anomalies occurring during July–September of WET did not evolve earlier than this season (Figs. 3, 4, 7). This again contrasts with DRY. The 1967–68 case study (P. J. Lamb, 1978) also showed the July–September drought (1968) patterns to evolve earlier than those for the wetter rainy season (1967).

Relatively small changes in the conditions at the surface of the Tropical Atlantic thus appear to be significant for Subsaharan rainfall. Many of the DRY and WET departures are probably about 0.5–1.0σ from 60-year mean values for the same time-space resolution (see Section 2.1). They are slightly smaller than for the 1967–68 case study (P. J. Lamb, 1978), which probably results from the compositing procedure. Confirmation of the validity of the foregoing results is offered by the substantial consistency between the departure patterns for the various elements studied.

Hastenrath (1976) found a moderate positive correlation between Caribbean and Subsaharan rainfall. Accordingly, the Tropical Atlantic surface departure patterns for dry and wet Subsaharan rainy seasons described here and in P. J. Lamb (1978) possess some similarity to those presented by Hastenrath (1976) for Caribbean rainfall anomalies of the same sign.

The results presented above suggest that distinctive SST departure fields accompany the anomalous Tropical Atlantic surface atmospheric circulation patterns of deficient Subsaharan rainy seasons. July–September of DRY was characterized by a greater than average equatorward extension of the NAH over negative SST anomalies, and both the trough and zone of maximum SST being displaced south of their 60-year mean positions. Similar results were obtained for the 1968 drought (P. J. Lamb, 1978). This coincidence of meteorological and oceanographic departure patterns suggests they may be related. Several authors have considered near-equatorial troughs as heat troughs coinciding with areas of maximum SST (e.g., see Ramage, 1974). Similarly, negative SST anomalies may enhance the equatorward expansion of the NAH. Numerical modelling by Rowntree (1976) points to such thermal forcing of surface pressure over tropical oceans. In view of the near-equatorial kinematic axis experiencing a similar displacement to the trough during DRY and 1968, the origin of Tropical Atlantic SST anomalies is of particular interest. Work on this topic is progressing.

An ability to forecast the general character of Subsaharan rainy seasons might allow the effects of future droughts to be reduced by appropriate human and natural resource management. Time series analysis of Tropical Atlantic surface data for 1911–72 (not reproduced) did not show extreme rainy seasons to be signalled by, or represent the culmination of, any long-term atmospheric-oceanic trends. However, the evolution of the DRY July–September patterns during the preceding January–June, a feature even more characteristic of the 1968 drought year studied in P. J. Lamb (1978), offers encouragement that Subsaharan droughts may be predictable 3 to 6 months in advance. Given the lack of prior development of the July–September patterns for WET and 1967 (P. J. Lamb, 1978), the capability of forecasting abundant Subsaharan rainy seasons may be more remote.

7. Acknowledgements

I am most grateful to Professor Stefan Hastenrath for providing guidance and encouragement throughout this work. Helpful advice and comments were also given by Professors L. H. Horn, J. E. Kutzbach, H. H. Lettau, and W. M. Wendland. Mr Peter Guetter provided valuable computer programming support and assistance. This research was supported by the Office for Climatic Dynamics of the National Science Foundation.

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КРУПНОМАСШТАБНАЯ ПРИЗЕМНАЯ ЦИРКУЛЯЦИЯ В ТРОПИЧЕСКОЙ АТЛАНТИКЕ, СВЯЗАННАЯ С ПОГОДНЫМИ АНАМАЛИЯМИ В ОБЛАСТИ ЮЖНЕЕ САХАРЫ

Построена циркуляция на уровне поверхности в атмосфере и океане в тропической Атлантике (30° с.ш.–30° ю.ш.) по данным за пять лет, которые были очень сухими в области южнее Сахары в Западной Африке (11–20° с.ш.). Представлены также соответствующие примеры для влажного периода. Поля, осреднённые за 60 лет (1911–1970 гг.), образуют систему для сравнения. Для дождливого сезона (июль–сентябрь) сухих лет приэкваториальный гребень давления в тропической Атлантике, зона максимальных температур поверхности моря (ТПМ) и кинематическая ось, разделяющая пассаты северного и южного полушарий располагаются на 200–300 км южнее их средних за 60 лет положений. К тому же, североатлантическая субтропическая область высокого давления (САСОВД) простирается дальше к экватору, чем в среднем, хотя её центр лежит на 150 км к северу от средней широты. Как северовосточный, так и юговосточный пассаты сильнее, чем в среднем, и отрицательные и положительные аномалии ТПМ встречаются, соответственно, к северу и к югу от, приблизительно, 10° с.ш. Некоторые из этих аномалий развивались в течение предшествующих январей–июней что указывает на возможность того, что засухи в области к югу от Сахары могут быть предсказаны за период от трёх до шести месяцев вперёд. Поля для июлей–сентябрей во влажные годы содержат меньшее количество аномалий, которые к тому же слабее выражены. САСОВД центрирована на 100–150 км дальше к северу и меньше простирается к экватору, чем в среднем, кинематическая ось лежит на 100–150 км севернее её средней широты и пассаты слабы во многих областях. За исключением смещения к северу центра САСОВД, эти аномалии противоположны тем, которые наблюдаются в засушливые годы. Аномалии влажных лет не развиваются в предшествующие сезоны.