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Correspondence

Dear Editor,

Sea surface temperature anomalies associated with the transition to a year of widespread low rainfall over southern Africa.

The current expansion of interest in broadscale ocean-atmosphere associations and world-wide El Nino Southern Oscillation (ENSO) phenomena has prompted the following re-examination of the results (unfortunately fragmentary) of a data analysis originally commenced in 1982. This analysis was based on two previous investigations. In the first (Streten 1981) a twenty-year (1950-1969) data set compiled by the British Meteorological Office was used to study the variability of monthly mean sea surface temperature (SST) over the southern hemisphere; *inter alia* this indicated similarities in the degree of variability of SST in the waters adjacent to the eastern and western coasts of both continental Australia and southern Africa. In the second study (Streten 1983) the anomalies of SST in the Australian region were examined for the period from 1950 to 1969 in two sets each of three years representing extreme cases where annual rainfall was above normal over more than 80 per cent of continental Australia in one set ('wet' years) or under 20 per cent in the other ('dry' years). In general, the data indicated that:

- wet years over Australia are associated with persisting warm SST extending from the equator to mid-latitudes in the eastern Indian Ocean and the southwest Pacific;
- dry years are associated with a predominantly low SST persisting throughout the year particularly at low latitudes in the same region.

The data further indicated that although the extreme years tend to be related to extremes of the Southern Oscillation Index this was not always the case.

The broad similarities in SST variability in the Australian and southern African regions and the results of the rainfall analysis for Australia suggested the examination of rainfall data for southern Africa for the same (1950-1969) period to identify years which exhibited substantial anomalies and the comparison of these with the concurrent SST sequences in the region of the eastern South Atlantic and western Indian Ocean. A brief account of this investigation so far as it progressed is as follows.

Figure 1(a) shows a network of stations over southern Africa having reliable long-term rainfall data appearing in a detailed southern hemisphere compilation by the US National Center for Atmospheric Research (NCAR). The annual rainfall for each year of the 20-year period for each station was calculated as a percentage of its long-term station mean. The number of stations having above normal rainfall in each year expressed as a percentage of the total number of stations was then determined as a simple broadscale index to identify years of widespread rainfall anomaly over southern Africa. The time sequence of Fig. 1(b) shows variation of this index for the period. Although the index is different to that used for the Australian rainfall analysis because of the different nature of the available data, it is apparent that the broadscale rainfall variability over southern Africa for this period is not as great as was observed in the Australian analysis.

Fig. 1(a) Station network used in the analysis of broadscale rainfall anomalies over southern Africa. Two surrounding ocean regions considered in the analysis of SST are delineated.

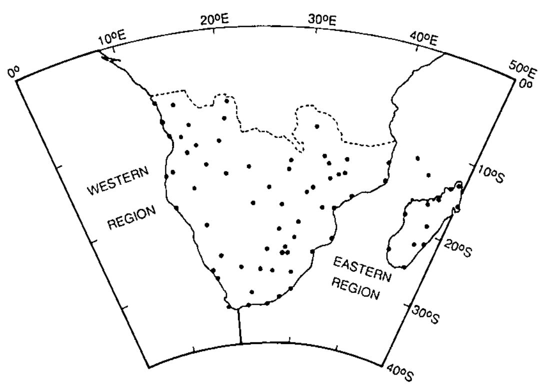


Fig. 1(b) Histograms showing the percentage (P_I) of stations of Fig. 1(a) which have above normal annual rainfall for the indicated years.

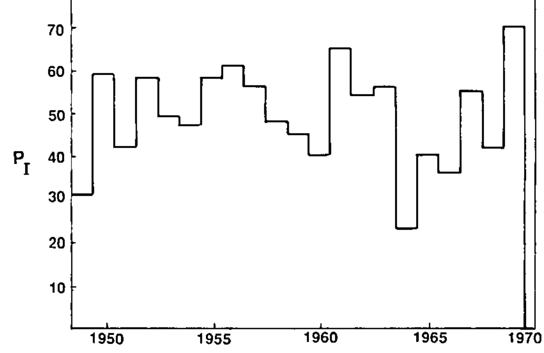
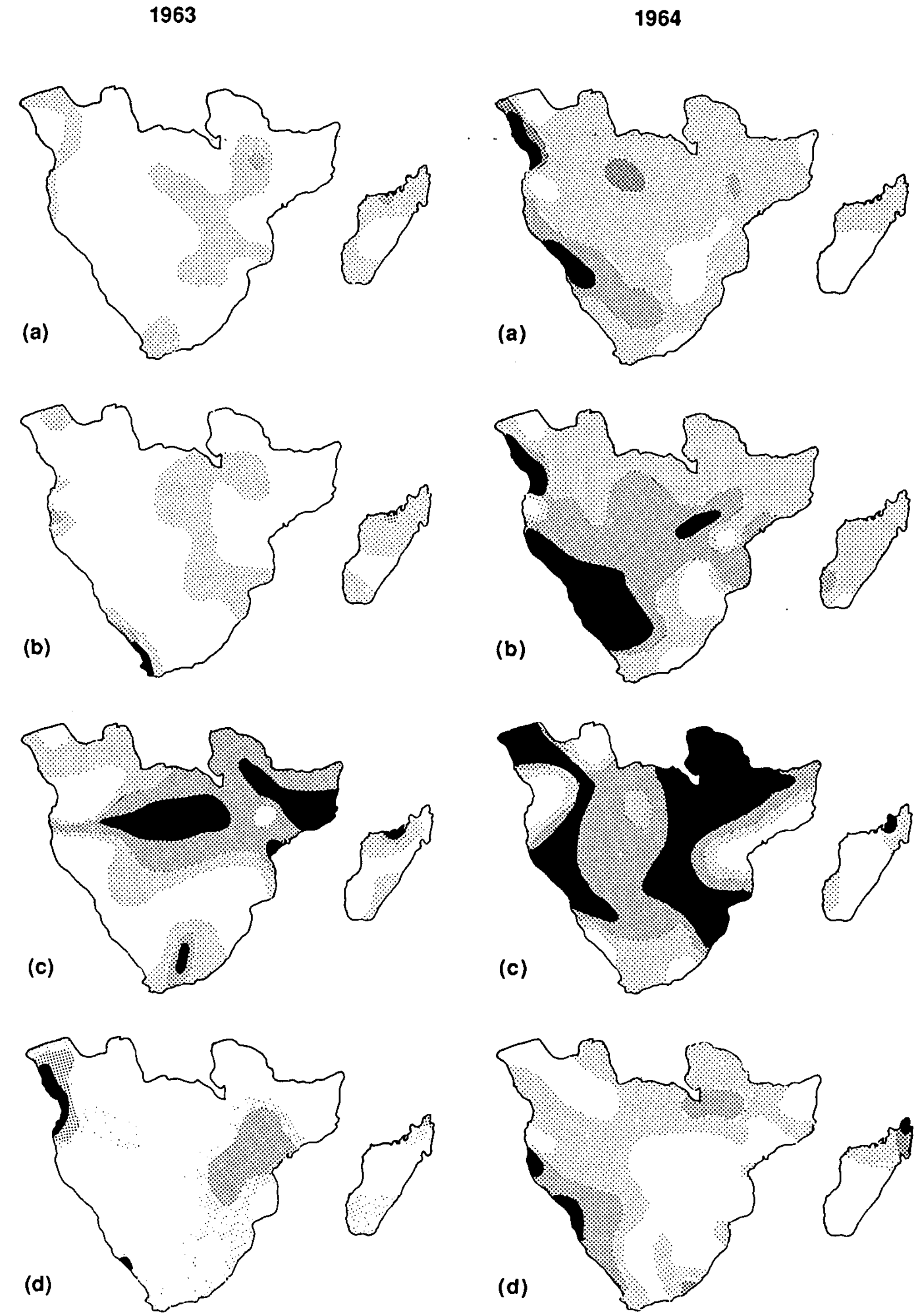


Fig. 2 Rainfall anomaly distribution over southern Africa for the years 1963 and 1964 – (a) whole years; (b) January to April inclusive; (c) May to September inclusive; (d) October to December inclusive. Open areas represent regions with above normal rainfall; light stippling, 0 to 25% below normal; heavy stippling, 25 to 50% below normal; black, more than 50% below normal.

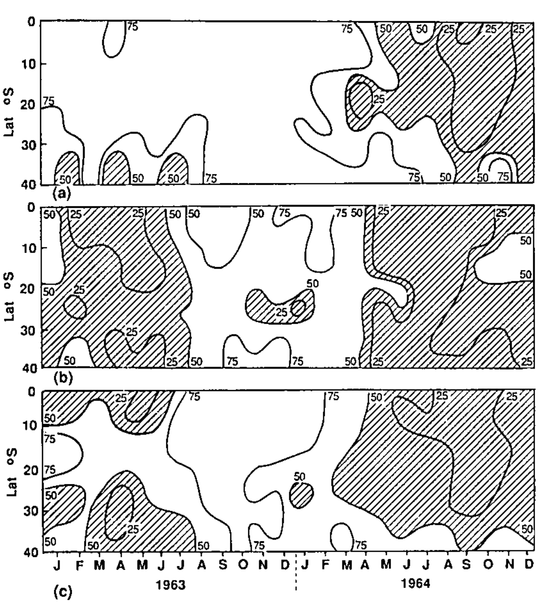


However, a clearly identifiable change exists between the relatively 'wet' year of 1963 and the subsequent 'dry' of 1964. The seasonal evolution of the rainfall anomaly and difference between the total annual distributions of the two years is shown in Fig. 2. In general, in the long-term mean, most of this region experiences a single summer maximum of precipitation although a single winter maximum occurs in the extreme southwest and a double maximum over the coast and nearby highlands of the extreme southeast (Griffiths 1972). For simplicity, only three seasons are shown in Fig. 2, two covering the summer wet-season and one, the less important dry winter period over most of the region. In the six-type classification of southern African rainfall anomalies (Nicholson 1986), the variation in the annual precipitation pattern from 1963 to 1964 is that from a Type 4 (widespread positive rainfall anomaly) in 1963 to a Type 1 (widespread rainfall deficiency) in 1964.

The variation of SST for the corresponding period has been examined for a 'western', an 'eastern' and a total (western + eastern) sector of the waters surrounding southern Africa extending from the equator to 40°S (see Fig. 1(a)). As with the Australian study the percentage of individual monthly mean degree-square SST observations which are warmer than the corresponding long-term mean was determined and the sequence over the two-year period is shown in Fig. 3. The change to colder SST with the onset of the dry year is notable particularly in the western sector between 10°S and 30°S where the percentage of available monthly mean degree-square observations of SST which were above normal decreased from 86 in 1963 to 40 in 1964. The sequence of Fig. 3 bears a general similarity to the similarly plotted data for 1950 and 1951 which represent the most marked transition from a wet to a dry year over continental Australia during the period of data (see Streten 1983 – Fig. 5), the contrast in both cases being most marked off the western coasts of the continents. Shannon et al. (1986) quote SST 2° to 4°C above normal in the upper 50 m and up to 150 km off Namibia in 1963 with high rainfall and some flooding and point to other possibly similar situations in 1934 and 1984. The present observation describes the reversion from the 1963 conditions to the dry 1964 with associated (but not necessarily causal) cooling of the SST.

The extreme variations in the rather crude broadscale rainfall index of Fig. 1(b) are not large for the twenty-year observation period but it had been intended to carry out a more complete analysis of the SST associated with the wet and dry years as had been done with the Australian data. Unfortunately, the SST data set used in the study is no longer accessible to the author and this analysis is not able to be carried out as originally intended. However, longer and apparently higher quality SST data sets which would be able to cover other possible extreme transitions are now becoming available. It is not appropriate here to review or quote the proliferating literature on possible ENSO teleconnections to African droughts but the results outlined above (which are, of course, limited to the extreme wet-dry transition in the observation period) suggest that more detailed examination of regional SST-broadscale southern African rainfall associations is warranted.

Fig. 3 Monthly and latitudinal distribution of SST anomaly for (a) western, (b) eastern, and (c) western plus eastern regions of Fig. 1(a) for the years 1963/64. The diagram indicates the percentage of available degree-square mean monthly SST observations which are above normal; time space zone values of less than 50% are shaded.



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