ROYAL METEOROLOGICAL SOCIETY: AUSTRALIAN BRANCH MEETING

24 May 1977

Large-scale Tropical Atlantic Surface Circulation Patterns associated with Sub-Saharan Drought

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Dr Lamb, Department of Geography, University of Adelaide, began by mentioning that though the sub-Saharan drought over the last decade has drawn widespread attention on account of the human misery caused by food shortages, the area has in fact been subject to earlier climate variations. During the present century there was a succession of particularly wet years 1950-1958, and a number of particularly dry years including 1913 (which was at least as dry as the driest recent year, 1972), 1921, 1926,1941,1942, and 1949.

The sub-Sahara is a strip between latitudes 11°N and 20°N, with the Sahara desert proper lying immediately to the north and the Gulf of Guinea coast some 500 km to the south. The rainy season is July-September.

There have been suggestions (R. Bryson, H. Lamb, D. Winstanley) that rainfall deficiencies in the sub-Sahara are a consequence of systems at middle latitudes expanding to the south and 'squeezing the monsoon out'. But, on the contrary, it has been found (M. Miles, R. Newell, and others) that data for the subtropical and northern Atlantic show little evidence to support this hypothesis.

The speaker described his own investigation, in which he studied, in relation to sub-Sahara drought years, the patterns of surface atmospheric quantities and sea temperature over the Atlantic Ocean between 30°S and 30°N. For this he used data for 1° lat. and 1° long. squares and for every individual month over the period 1911 to 1972, numbering 35 million sets of data. By reference to sub-Sahara rainfall data available for 1941 to 1974, the Atlantic data were considered in three classes: (i) values for the only dry year (1968) for which the data are sufficiently complete to examine separately, (ii) averages over the other five driest years, and (iii) as a reference, averages over the 60-year period 1911 to 1970.

The 60-year average patterns over the Atlantic show the inter-tropical characteristics (MSL pressure trough, maximum variability of wind direction, 'kinematic axis' where the meridional wind component changes sign, maximum convergence, maximum sea and air temperatures, and maximum precipitation) near the latitude of the Guinea coast (2°N) in the northern winter, and at about 12°N in the northern summer (rainy season). There is always onshore average surface flow along the Guinea coast, and in the northern summer this extends up the western coast of the African bulge to about 12°N. This flow brings in the moisture that feeds the rain systems in the sub-Sahara, though it is to be noted that the individual subsynoptic systems themselves are in the form of bands moving with the upper flow in the reverse direction, east to west.

In summer (July-September), the meridional mean profiles of MSL pressure, divergence of the wind field, precipitation, and cloud amount, show a southward shift of about 2° (200 to 300 km) in 1968 and in the dry years composite data, as compared with the 60-year average profiles. Further, a similar southward shift is already apparent in the preceding season (April-June), and in some cases as early as January-March. Again, the position of the kinematic axis across the Atlantic, and the patterns of wind speed and sea-surface temperature departures from their 60-year means, also indicate such a shift (though not as distinctly for the preceding season in the case of the dry composite data).

The speaker pointed out that while the anomalies concerned are not large - only about ½ to 1 standard deviation from the 60-year means - their consistency suggests their reality. The tendency of the southward shift to appear some 3 to 6 months ahead encourages the hope that some measure of prediction of dry seasons may be possible.

Finally, he outlined a possible approach, used previously by Namias, for calculating the sea-surface temperature anomalies by considering the advection effect of the Ekman currents driven by the wind systems; and showed that this leads to tolerable agreement with the observed patterns to the west of the African bulge.

During discussion, Dr Lamb mentioned that the sub-Saharan drought has still persisted through 1975 and 1976. Regarding the inflow that brings moisture to the region from the southwest sector, he said that this extends through the lowest 100 to 150 mb, and that unfortunately, in the absence of adequate upper air data, information about the vertical structure of the monsoon is lacking.

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