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6. REGIONAL CLIMATES—K. A. Shein,[82] Ed.

a. Overview—K. A. Shein[82]

While the anomalous global warmth of 2005 is generally reflected in regional temperatures, various regions of the planet respond differently to climate forcings at many scales, both spatial and temporal. An analysis of globally averaged climate may mask a number of important climatic conditions that have impacted some areas more than others. This section chronicles regional climatic conditions relative to their historical context, and highlights notable atmospheric events of 2005. In fact, most regions experienced some form of record-breaking weather or climate conditions in 2005.

This section is distributed by continent or major land region, and each regional subsection is further divided into logical climatic divisions, either geographic or political. The use of national names in no way implies political preference or precedence. Also, it should be noted that while the large-scale temperature and precipitation anomaly maps (i.e., Figs. 6.1, 6.7, 6.16, 6.17, 6.24, 6.29, and 6.39) all use a 1971–2000 base period for temperature and a 1979–2000 base period for precipitation, discussions of anomalies in individual regions may refer to alternate base periods.

b. Africa

1) Eastern Africa—C. Oludhe,[61] P. Ambenje,[2] and L. Ogallo[60]

The rainy seasons in the Greater Horn of Africa (GHA) are influenced by the intra-annual north–south migration of the ITCZ. In the GHA region, rainfall exhibits strong variability both in space and time. Much of the variability is strongly accounted for by the existence of complex topographic features, including the East African lakes, and is also partly influenced by the movement of the ITCZ. The subregion can, however, be divided into three sectors (Southern, Equatorial, and Northern) based on rainfall onsets and withdrawals. The Southern sector (central and southern Tanzania) experiences a unimodal precipitation regime, with rain occurring between December and April. The Equatorial sector (northern Tanzania, Kenya, southern and extreme eastern Ethiopia, southern Sudan, and the southern half of Somalia) generally exhibits a bimodal rainfall regime, with the "Long Rains" season from March to May and the "Short Rains" extending from October to December. However, both the western and coastal areas also receive substantial rainfall during July and August. In the Northern sector (central and northern Ethiopia, Eritrea, Djibouti, and the northern half of Sudan), the major rainy season is between June and September, but a few areas receive a secondary peak from March to May.

The climate over the GHA is largely regulated by sea surface temperatures in the Indian and Atlantic

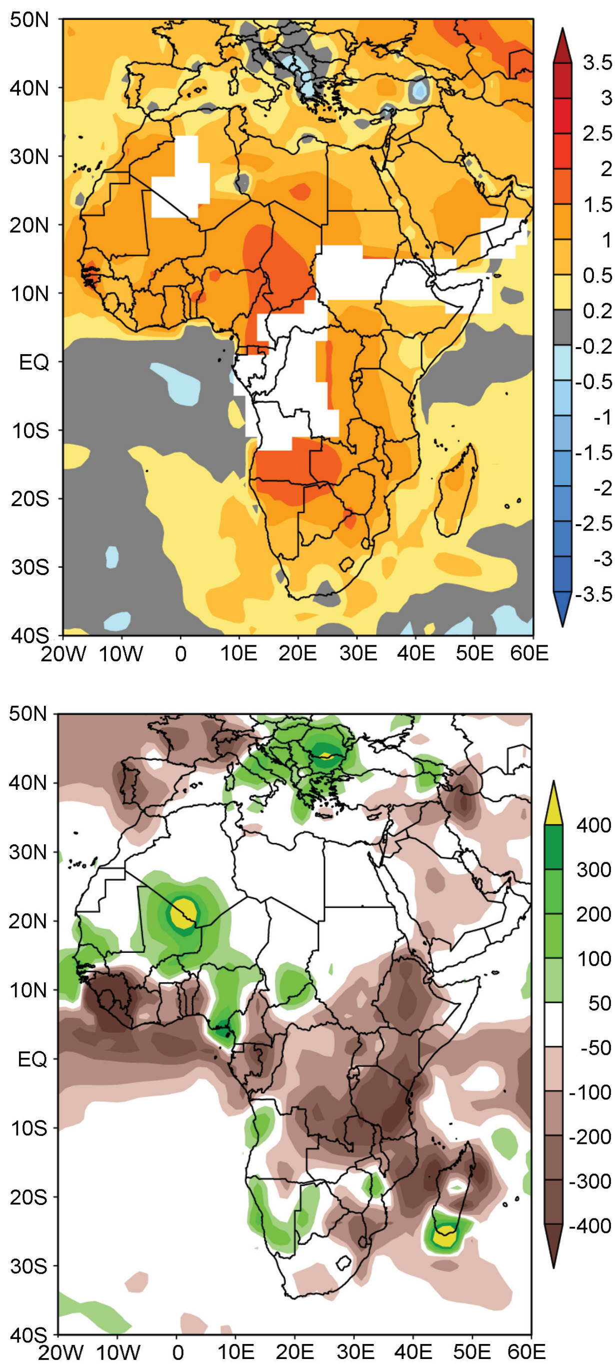

Fig. 6.1. African 2005 annual (top) temperature anomalies (°C; 1971–2000 base), and (bottom) precipitation anomalies (mm; 1979–2000 base) from the CAMS–OPI dataset (Janowiak and Xie 1999). [Source: NOAA/NCDC]

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Oceans, general atmospheric circulation and large-scale anomalies (e.g., ENSO, Indian Ocean dipole), Indian Ocean tropical cyclone activity, and the variability of the monsoon.

(i) Climate patterns in the GHA in 2005

Parts of the GHA were under persistent drought throughout the year with most stations recording rainfall much below their long-term mean (Fig. 6.1). In some of the arid and semiarid lands (ASALs), no significant rainfall was recorded for the year. Erratic rainfall and poor temporal distribution was common during the rainy seasons, even in areas that recorded normal to above-normal precipitation.

Most socioeconomic and subsistence activities in the GHA depend directly or indirectly on rainfall. Below-average rainfall during the year had far-reaching socioeconomic impacts, including the loss of life, livestock, and property.

The Southern sector experienced abundant rainfall between December 2004 and February 2005, providing relief, especially in areas such as central and southern Tanzania that had experienced extremely dry conditions during the 2003/04 rainfall season.

From March to May 2005 (Long Rains), most locations over the Equatorial sector received near-normal to below-normal rainfall amounts. There was a general late onset and early withdrawal as well as poor temporal and spatial distribution of the seasonal rainfall in most areas of the sector, especially the ASALs.

The month-by-month evolution of the Drought Severity Index for the Long Rains season indicates that although near-normal to wet conditions were observed at some locations during March and May, long dry spells were predominant, especially during the peak rainfall month of April, which was relatively dry at many locations within the Equatorial sector. Occasional short-lived heavy rainfall events, some exceeding 50 mm in 24 h, significantly contributed to seasonal rainfall totals in some areas. Unfortunately, these events generated flash flooding in some parts of the GHA, displacing thousands of people.

Western and coastal areas of the Equatorial sector recorded significant rainfall from June to August, although totals were slightly below the seasonal average in some areas (Fig. 6.2).

From October to December (Short Rains), most parts of the Equatorial sector received between 25% and 75% of long-term seasonal mean precipitation (Fig. 6.2). Like the Long Rains, the Short Rains were also characterized by poor temporal distribution, and were devoid of the heavy rainfall events common during tropical rainy seasons. The rains ceased in the second half of November instead of the usual mid-December. Performance was extremely poor in the ASALs, enhancing the cumulative rainfall deficiencies these areas had been experiencing for several consecutive seasons. As a result, an estimated five million people in Kenya and Tanzania were affected by famine.

The Northern sector had one major rainfall peak concentrated in June–September, with few areas receiving the usual secondary rainfall peak between March and May. Near- to above-normal rainfall was observed in parts of western and northern areas of the subregion during June–August 2005 (Fig. 6.2). Most locations recorded June–September rainfall totals of 75%–125% of the long-term average. Much of the eastern and central parts of the Northern sector experienced dry conditions, with most locations recording rainfall below 75% of the long-term average.

II) NORTHERN AFRICA—M. A. Bell[6] and K. Kabidi[36]

(i) Temperature

For 2005, mean temperature anomalies were generally between 0.25° and 1.5°C above normal throughout most of North Africa (Fig. 6.1). The year started with below-normal monthly mean tempera-

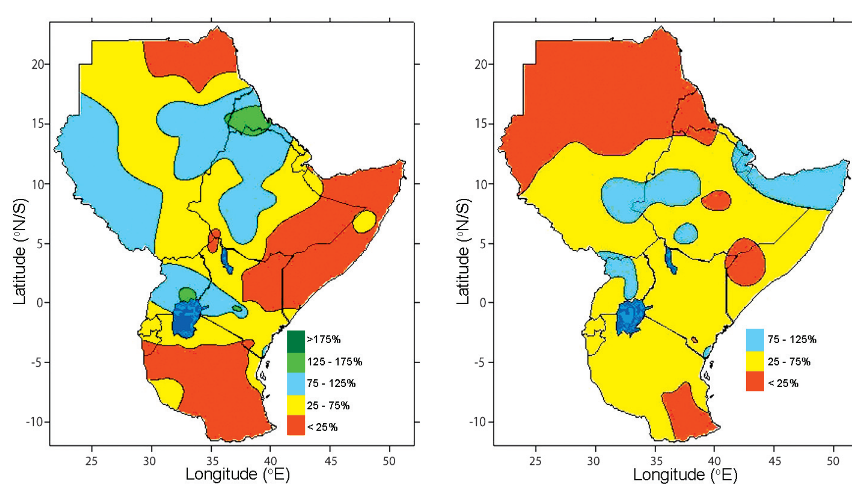

FIG 6.2. East African rainfall anomaly percentages for (left) June to August and (right) October to December 2005. [Source: Kenya Meteorological Service]

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tures in January, and particularly in February. Chefchaouen, Morocco, recorded 18 below-freezing days in January. Subfreezing temperatures were recorded in many other areas and broke numerous records. A low of −14°C was recorded in a mountainous area of Morocco. By April, positive temperature anomalies had begun to dominate, and a heat wave in mid-July resulted in at least 13 deaths in Algeria due to sunstroke, according to the British Broadcasting Corporation (BBC). In Algeria, the heat wave pushed July temperatures as high as 50°C.

(ii) Precipitation

The Mediterranean coast of North Africa receives the majority of its rainfall during October–April, largely from midlatitude cyclones and associated cold fronts. In the Atlas Mountains of northern Morocco, Algeria, and Tunisia, cold-frontal passages can bring subfreezing temperatures and heavy rain or snow, occasionally causing floods and landslides.

Accumulated precipitation anomalies for the October 2004–April 2005 rainy season indicate below-normal precipitation totals in most of Morocco (particularly in the north), northwestern Algeria, the southern half of Tunisia, and much of northern Libya, and above-normal precipitation in northeastern Algeria and northern Tunisia (Fig. 6.3).

The precipitation deficits in Morocco developed in November 2004, in concert with the genesis of the severe drought that would plague the Iberian Peninsula and other sections of southwestern Europe for much of the year. Although rain in mid- to late-February provided some relief, dry conditions persisted throughout most of the remainder of the 2004/05 boreal winter rainy season in Morocco. October–December 2005 began the winter rainy season with near-normal precipitation throughout North Africa.

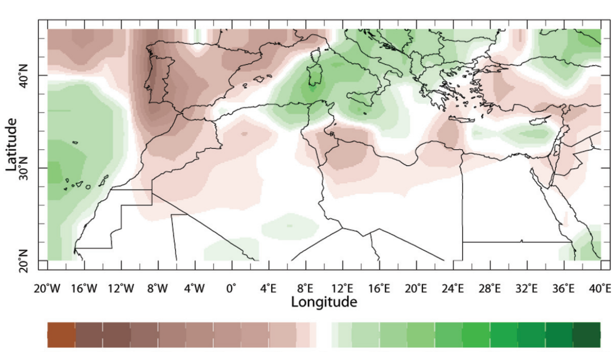

Fig. 6.3. October 2004–April 2005 precipitation anomalies (mm; 1979–2000 monthly means base) for northern Africa from CAMS–OPI.

As discussed in the CPC/Famine Early Warning System Network (FEWS NET) Africa Weekly Weather Hazards Assessments in 2005, although the cooler-than-normal temperatures early in the year may have temporarily reduced moisture demand and partially mitigated precipitation deficits in the major wheat-growing areas of North Africa, the persistence of below-normal rainfall and the development of positive temperature anomalies had a detrimental effect on the region's winter wheat crop, with grain production (including wheat) in 2005 was well below the previous year's record levels in Morocco, Algeria, and Tunisia, and also below the average of the past 5 yr in Morocco and Algeria [Source: U.S. Department of Agriculture (USDA) and United Nations (UN) Food and Agriculture Organization (FAO).]

(iii) Notable events

A winter storm in late January 2005 produced the heaviest snowfall seen in Algiers in "more than 50 years," according to the BBC, and was responsible for at least 10 deaths, primarily due to traffic accidents.

During February, a synoptic low pressure system brought heavy rainfall to the region, with a record of 193 mm falling in less than 24 h at Tetuan, Morocco. This system also brought high wind speeds exceeding 31 m s^{-1} in some places, and waves up to 10 m were recorded along the northwestern Atlantic coast (Fig. 6.4).

The most unusual climatic event recorded during 2005 was the landfall of Tropical Storm Delta. On 29 November, Delta passed to the north of the Canary Islands, where widespread damage and seven fatalities were reported. Soon after, Delta crossed over the southern coast of Morocco in the area of Tantan and Layoune Ports, where it quickly dissipated, but not before delivering much-needed rain to the area.

iii) Southern Africa—W. M. Thiaw,[85] T. Gill,[27] and W. A. Landman[43]

(i) Temperature

Annual mean temperatures across southern Africa for 2005 were generally 0.5°–1.5°C above the 1971–2000 mean (Fig. 6.1). Most of Madagascar was 0.5°–1.0°C above normal. Temperatures were up to 2°C above normal in an area including northern Namibia, southern Angola, northwestern Botswana, and western Zambia. In South Africa, June–August mean temperatures were 2°–3°C above normal over the northeastern parts of the country, 1°–2°C above normal over central regions, and near normal in southern and western sections.

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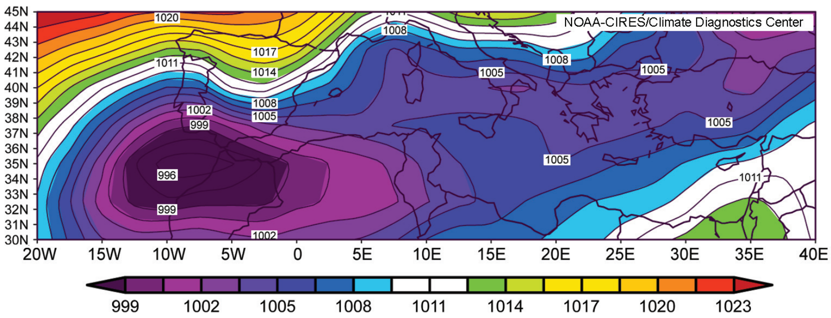

Fig. 6.4. Mean sea level pressure (hPa) over North Africa on 28 February. [Source: NOAA/Cooperative Institute for Research in Environmental Science (CIRES)/Climate Diagnostics Center (CDC)]

(ii) Precipitation

The rainy season in southern Africa extends from October to April, with the greatest amounts typically observed between December and March. In general, ENSO conditions play an important role in the variability of southern Africa rainfall, which tends to be drier than average during El Niño and wetter than average during La Niña.

Overall, the 2004/05 southern Africa rainy season was characterized by near-average rainfall (Fig. 6.1), although delayed onset of the rains in October 2004 and inconsistent rainfall led to deficits in January and February. Rainfall anomalies were quite variable in the wet zone (east of 25°E; Fig. 6.5 boxed region). In this area, 200–400 mm of rain fell during the period of November 2004–April 2005, ranking in the 10th–30th percentile across northeastern Botswana, the eastern half of Zimbabwe, and northeastern South Africa. Rainfall was also below normal in pockets along the east coast of Madagascar. In contrast, central Mozambique and southern Madagascar received from 700 to over 900 mm of rainfall, which ranked in the 70th–90th percentile. Average conditions prevailed in most of interior South Africa, eastern Zimbabwe, and southern Mozambique. Climatologically dry areas of the region registered near- to above-normal rainfall, with amounts in the 70th–90th percentile across southern Namibia.

The low-level atmospheric circulation for the 2004/05 rainy season featured near normal easterly winds (~4 m s^{-1}) along the equatorward flank of the Mascarene high. A significant reduction in low-level easterlies associated with the presence of an anomalous anticyclonic flow in the southwestern Indian Ocean contributed to rainfall deficits in November 2004 and February 2005. In addition, an elongated ridge extending from high latitudes into the continent contributed to strong subsidence in southern Africa.

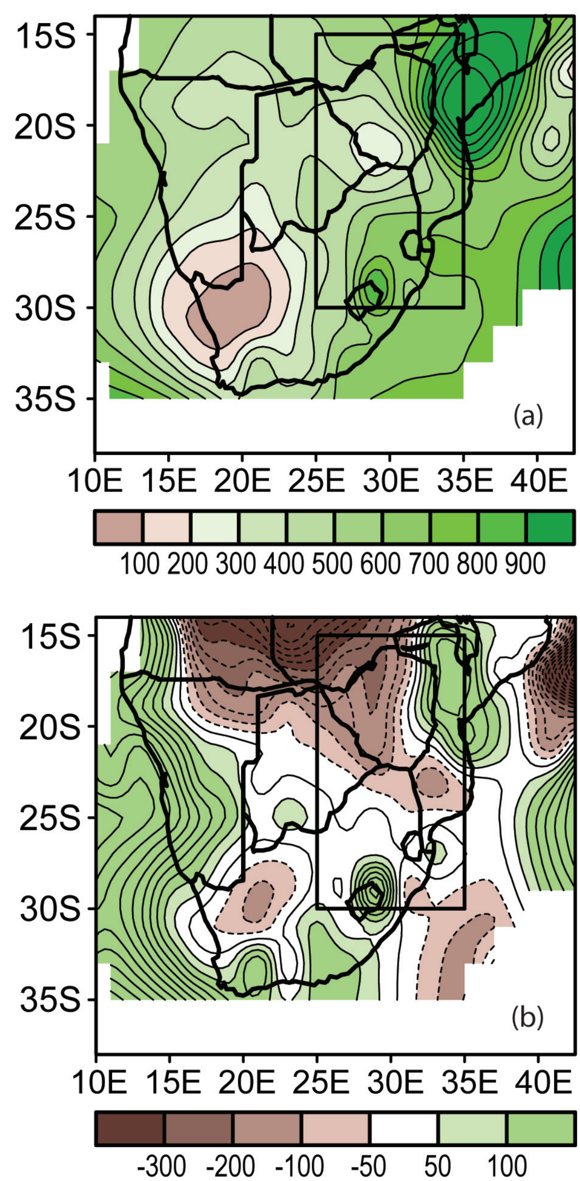

Fig. 6.5. November 2004–April 2005 (a) total rain and (b) precipitation anomaly (mm; 1971–2000 base) for southern Africa. Boxed region is considered the "wet zone."

IV) Western Africa—W. M. Thiaw[85] and M. A. Bell[6]

(i) West African Monsoon

West African rainfall can be divided into two quasi-homogeneous regions: the Sahel and the Gulf of Guinea. Rainfall in both areas is controlled by the annual progression of the ITCZ over the region. The African Sahel, defined here as the region between 12°–20°N, 18°W–20°E (Fig. 6.6, boxed region), receives

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approximately 90% of its mean annual rainfall during June–September. The rainfall is monsoonal and its penetration into the region is closely related to the position of the mid- and upper-level jets, and to the ITCZ, which starts its northward progression in March and reaches its northernmost position in August. Seasonal precipitation exhibits a strong meridional gradient, with average totals exceeding 600 mm in the south, and 100–300 mm in the north. These larger-scale circulation features are fairly sensitive to changes in the global monsoon circulation on both interannual and interdecadal time scales.

Further south, along the central Gulf of Guinea coast, the rainy season is bimodal and runs from about April to October, typically with a "little dry season" in July–August. This configuration produces an extremely marked north-to-south gradient in annual precipitation totals across the region.

(ii) Precipitation

The 2005 rainy season featured above-normal rainfall across most of the Sahel (Fig. 6.6). Rainfall totals exceeded 100 mm above average across most of the central and western areas of the Sahel. Overall, the 2005 rainy season was the second wettest since 1994.

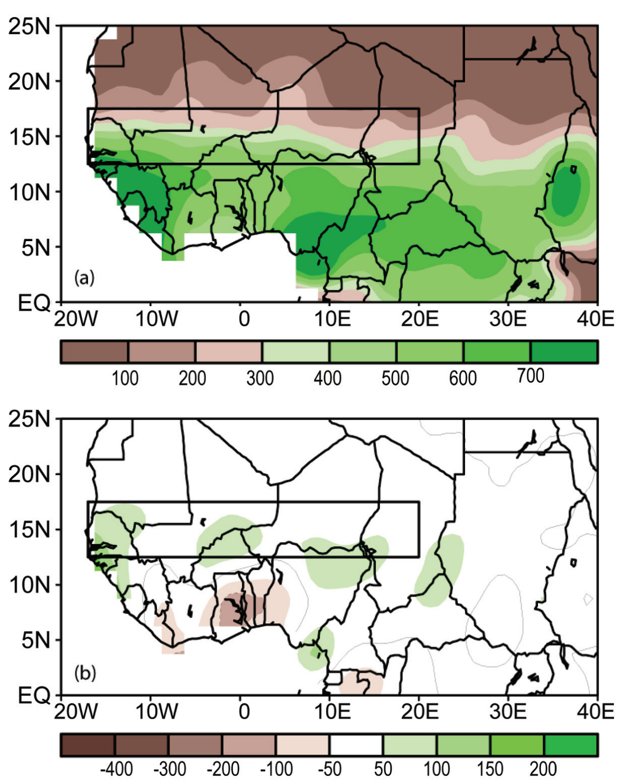

Fig. 6.6. June–September 2005 (a) total rainfall and (b) anomalies (mm; 1971–2000 base) for western Africa. Boxed region is the Sahel.

In particular, most of Senegal and southern areas of Mauritania, northern Burkina Faso, eastern Mali, southern and western Niger, and southeastern Nigeria received above-normal rainfall throughout most of the rainy season, with the exception of July precipitation in southeastern Nigeria. Rainfall anomalies were extremely strong over western Senegal, which received around 700 mm of rainfall between July and September (Fig. 6.6). That is about 300 mm above the long-term mean, making 2005 the rainiest season in this area since 1970. Seasonal totals along most of the Gulf of Guinea coast, from Côte d'Ivoire to western Nigeria were below normal, particularly in central Benin and Côte d'Ivoire. Rainfall deficits ranged between 50 and 200 mm below the climatological mean in the central areas of Ghana, Togo, and Benin.

Heavy rainfall in June, near the start of the rainy season in Guinea and Guinea-Bissau, reportedly sparked a severe cholera epidemic that would eventually spread to at least nine countries in West Africa over the course of the last half of the year, according to the World Health Organization (WHO). Initially, cases were largely confined to the capital city of Bissau, but it spread quickly. Heavy rainfall in Dakar, Senegal, from mid-August through early September not only flooded areas of the city's outer suburbs and forced the evacuation of approximately 60,000 people, but it also triggered a sharp increase in the number of local cholera cases. According to WHO statistics available in late September 2005, at least 43,638 cases of the disease and 759 deaths had been reported throughout West Africa. The end of the rainy season and a lack of new reported cases by the end of December allowed the Ministry of Health in Guinea-Bissau to declare an end to the epidemic in that country, according to the UN Integrated Regional Information Networks (IRIN).

c. North America

1) Canada—C. Kocot,[39] D. Phillips,[67] and R. Whitewood[92]

The climate of Canada in 2005 was characterized by warmer and wetter conditions than normal (relative to the 1951–80 base period). Although Canada was spared much of the extreme weather that impacted other regions of Earth, it was not totally immune. Anomalous winter warmth adversely impacted snowpack in British Columbia (BC). Several tornadoes and heavy flooding in three provinces contributed to 2005 being the costliest year to date, weatherwise, for insurers.

(i) Temperature

Above-normal temperatures were observed throughout the country, with most areas at least 1°C