and also (50% of normal) in central regions. Overall, spring precipitation in Iran was just 42% of the normal. Summer precipitation in Iran was 20% below normal, with especially dry conditions in the west half of the country. However, heavy rains in the east did result in flooding. Below-normal precipitation continued into the autumn across much of Iran. Autumn precipitation in Iran was 37% below the long-term mean, and some parts in the east received just 0%–25% of the normal seasonal precipitation due to the delayed onset of late-season precipitation.

g. *Europe*

1) Overview—J. J. Kennedy[38]

The annual surface temperature anomaly (Brohan et al. 2006) averaged over Europe in 2005 was 0.71 ±0.07°C above the 1961–90 average (Fig. 6.28). Only a small area extending north from Greece had annual temperatures below average (Fig. 6.29), and that was only by around 0.1°C. Annual average temperatures in the United Kingdom and northern Norway and Finland were above the 90th percentile of occurrence according to statistics based on the period 1961–90 (all European temperature and precipitation percentiles herein refer to this period).

Temperatures during the first three months of 2005 were significantly (meaning in the upper or lower decile of the distribution) below average in southern Europe, through Spain and the Mediterranean and into Italy. In the same period, above-average temperatures observed in the north and east exceeded the 90th percentile only over Scotland. Between April and June, temperatures were above average in all areas and significantly above normal over much of Europe west of 15°E and south of 55°N.

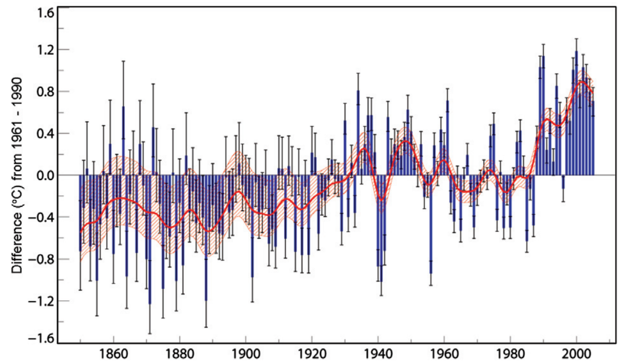

Fig. 6.28. European average temperature anomalies (°C; relative to 1961–90 mean) 1850–2005. Blue bars show the annual values with uncertainties represented by the black bars. The red curves show the annual anomalies and uncertainties after smoothing with a 21-term binomial filter. [Source: Brohan et al. 2006]

Temperatures in Spain and France exceeded the 98th percentile. From July to September temperatures once again were above average in most areas, although temperatures were close to average in southeastern Europe. Scandinavia and Eastern Europe were significantly above normal. Cooler conditions in southeastern and central Europe coincided with the largest regional rainfall totals for the season. October–December brought a north–south split, with much of the Mediterranean and southern Europe experiencing below-average temperatures, while in the north temperatures were generally above average with areas of the United Kingdom and Scandinavia significantly above average.

Total precipitation (Rudolf et al. 1994, 2005; Rudolf and Schneider 2005; Beck et al. 2005) between January and November 2005 (Fig. 6.29) was below

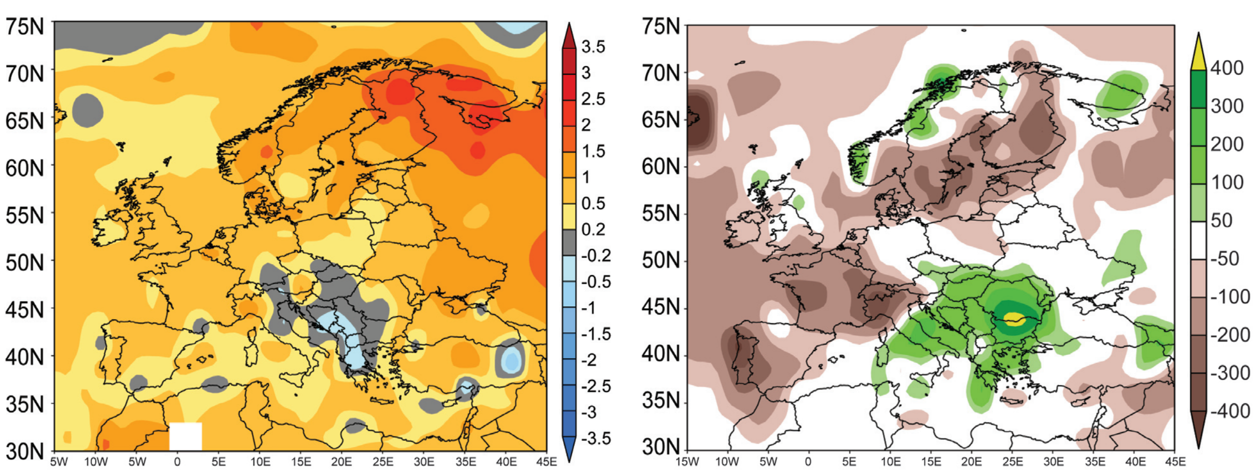

Fig. 6.29. European 2005 annual (left) temperature anomalies (°C; 1971–2000 base), and (right) precipitation anomalies (mm; 1979–2000 base) from CAMS–OPI.

average in southwestern Europe, with parts of France and the Iberian Peninsula receiving less than 40% of the 11-month 1961–90 average. Precipitation in southeastern Europe was above the 1961–90 average. Romania and Bulgaria received significant rainfall excesses during the year, with August totals in some areas approaching 500% of the monthly average.

ii) Central and Eastern Europe—J. J. Kennedy[38]

Annual average temperatures in the region ranged from near average in Hungary and neighboring countries to over 2°C above average in eastern Ukraine (Fig. 6.29). January–November rainfall was significantly above average in Romania (Fig. 6.29).

A warm January, with areas of eastern Ukraine more than 5°C above average, gave way to colder conditions in February and March. Precipitation was generally below average in the southwest, but further north and east exceeded the average, with the largest excesses occurring in January and February. March rainfall was below average in most areas.

April–June temperatures in parts of Austria and the Czech Republic were significantly above average, and in Switzerland some western areas experienced temperatures above the 98th percentile. Further east, however, temperatures were nearer the average. Rainfall anomalies were generally higher in the east than the west, with the highest anomalies in Romania and Moldova.

In June, temperatures were significantly above normal in Austria and Switzerland and, in the far west, were high enough to exceed the 98th percentile. At the same time, temperatures in Ukraine and Romania fell below average. With only eastern Ukraine experiencing below-average rainfall, April precipitation was above average in most areas and the excess rainfall led to flooding in Romania. May precipitation was close to average in many areas, but Romania again experienced above-average totals. Most areas were drier than usual in June, with only eastern Romania and Ukraine experiencing wetter-than-normal conditions.

Temperatures were above average between July and September everywhere. The largest anomalies were in the east where temperatures were significantly above average. Smaller positive temperature anomalies further to the west coincided with the largest rainfall anomalies. Some areas of southern Romania received more than three times the seasonal average, generating widespread flooding in July and August. July temperatures were above average in all areas, but above-average precipitation contributed to depressed temperature anomalies in central Europe. Only Ukraine, where precipitation levels were below normal, showed significant warmth. August brought above-average rainfall to all but the most easterly areas, and temperatures fell below average in the west. Ukraine showed the highest temperature anomalies, with temperatures significantly above normal in parts.

October and November were mainly drier than usual in western areas, with wetter-than-average conditions confined to eastern Romania and Ukraine. Cold anomalies spread from the southeast in October to cover the central and western states in November. In December, cold anomalies were confined to the westernmost regions, with some parts of Austria significantly below normal.

iii) Fennoscandinavia, Iceland, and Greenland—C. Achberger[1] and D. Chen[16]

Fennoscandinavia's (here Norway, Sweden, Finland, and Denmark) climate is to a large extent controlled by the atmospheric circulation over the European and North Atlantic region. Objective synoptic classification based on the Lamb scheme (Lamb 1950) has been extensively used in Sweden to quantify impacts of atmospheric circulation (e.g., Chen 2000). In 2005, occurrences of the four dominant weather types—anticyclonic (A), cyclonic (C), westerly (W), and southwesterly (SW)—were all above the 1961–90 mean. The generally warmer than normal conditions over Fennoscandinavia in 2005 correspond well to increased frequencies of W and SW types.

(i) Temperature

Annual mean temperatures for 2005 in the Nordic countries (including Greenland and Iceland) were around 0.5° to 4.5°C above the 1961–90 mean (Fig. 6.30), depending on geographical location. At Svalbard on Spitsbergen, annual mean temperatures reached –3.0°C, which is 3.6°C above normal, ranking 2005 as the warmest year since 1912. Danmarkshavn, in northeastern Greenland, reported an annual mean temperature of –9.5°C, placing 2005 as the warmest year since reliable measurements started in 1949. Parts of Finland were also unusually warm, at around 2.3°C above the long-term mean. Sweden, Denmark, and Norway, however, experienced more moderate temperature deviations, ranging between 1.1° and 1.7°C above normal, while the annual mean temperature for Iceland was about 1°C warmer than the 1961–90 mean. The warmer-than-normal temperatures were most profound at the highest latitudes.

Autumn (September–November) was extraordinarily warm at many Nordic locations, several of

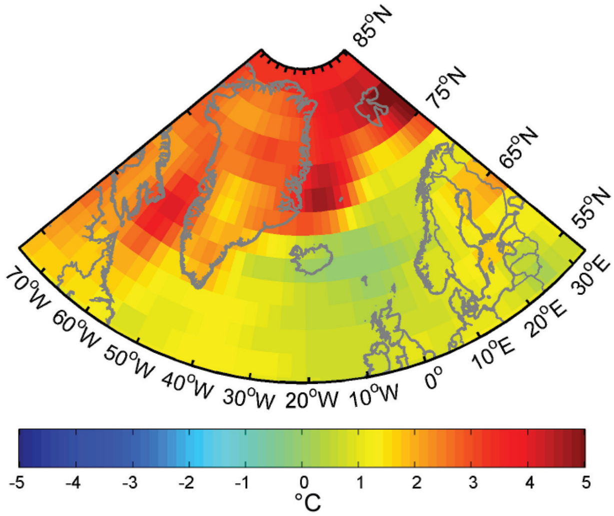

Fig. 6.30. Annual temperature anomalies (°C) across Fennoscandinavia, the North Atlantic, and Greenland in 2005 (1961–90 base). [Source: NCAR–NCEP Reanalysis]

which broke existing records. For example, on 11 October 2005 several Norwegian stations reported daytime temperatures well above 20°C. Of these, Molde Airport recorded the highest temperature (25.6°C), which is a new Norwegian record for October. Finland also experienced two unusually warm spells in autumn, making November 2005 the warmest November since 1900 in the central regions. For Denmark, 2005 was the fourth sunniest year on record and Reykjavik, Iceland, experienced 280 more sunshine hours compared to the 1961–90 mean. In all, 2005 is ranked as the fifth to eight warmest year since the second half of the eighteenth century, when regular measurements commenced in many Nordic countries.

(ii) Precipitation

Annual precipitation amounts across the region were both above and below the 1961–90 average (Fig. 6.31). Across much of Finland, northern regions of Norway and Sweden, the Färö Islands, and along the southern half of the Norwegian west coast, annual precipitation was above average (Fig. 6.31, right), where positive departures reached up to 40% of the long-term mean. Greenland also experienced remarkable precipitation deviations from the long-term mean (Fig. 6.31, left). However, while large regions of southernmost, western, and northern Greenland received from 50% to over 100% more precipitation than the 1961–90 mean, parts of eastern and southern Greenland were considerably drier than normal (Fig. 6.31, left).

Southern Sweden, Denmark, and Iceland received annual precipitation amounts either somewhat below or close to the long-term average. Many locations across Fennoscandinavia, though, reported record or near-record precipitation in 2005: Nuuk, Greenland, received 1219 mm, ranking 2005 as the wettest year there since 1958. For Norway, 2005 was among the second to third wettest year since measurements began. Parts of Finland experienced a very wet May, with precipitation 200%–300% above normal. Severe flooding occurred along several rivers in northern Finland as a result of snowmelt. Also, Sweden experienced heavy rainfall in July and August.

(iii) Notable events

For much of the region, 2005 started with an extremely severe storm. On 8–9 January an intense low pressure system formed west of the British Isles and intensified on its way toward Fennoscandinavia. Mean sea level pressure dropped as low as 960 hPa when the system, named Gudrun, reached Sweden, causing major damage. Mean wind speeds and maximum gusts reached 33 and 42 m s^{-1}, respectively. In addition to widespread power failure and infrastructure damage, Gudrun was responsible for several fatalities, and became the worst tree-felling storm in Sweden since 1930, when statistics on storm-related forest damage started. In addition, record sea levels and coastal flooding occurred along parts of

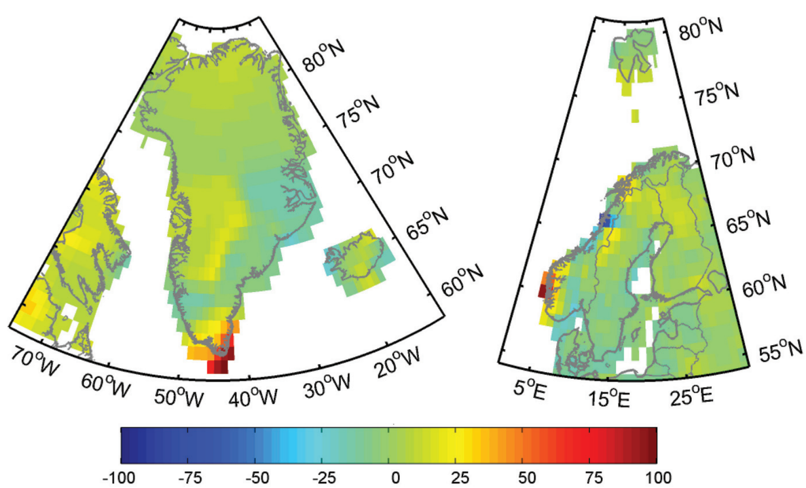

Fig. 6.31. Annual precipitation departures from normal (mm yr^{-1}) across (left) Greenland and (right) Fennoscandinavia (1961–90 base). [Source: Global Precipitation Climatology Center (GPCC)]

the Swedish, Norwegian, and Finnish west coasts. Swedish insurance companies rank Gudrun as the costliest natural event in their history.

Remnants of Hurricane Katrina reached Greenland as an extratropical low pressure system in early September. The low brought several thunderstorms and frequent lightning to southwest Greenland.

On 14 November, an exceptionally strong low pressure system named Loke reached Norway and brought over 200 mm of precipitation over 24 h to several locations. In addition to one fatality, the storm generated landslides across Norway, closing many roads and the train line between Oslo and Bergen. Loke produced the country's second highest daily precipitation amount (223 mm) on record, measured near Bergen.

iv) Central northern Europe—J. J. Kennedy[38]

Annually averaged temperatures in 2005 were above average throughout the region (Fig. 6.29). Precipitation totals for January–November were near average in the west and east, but somewhat drier than average in Poland (Fig. 6.29).

January temperatures and precipitation were above average everywhere, with the largest temperature anomalies (more than 5.3°C) in the east. February temperatures fell to below average everywhere except the far northeast. These northeastern areas were also drier than normal, but most areas experienced above-average rainfall in February. March temperatures were more than 3°C below average in Estonia and Latvia, and only western Germany experienced warmer-than-average temperatures. Rainfall totals in March were anomalously large in Belarus, Lithuania, and eastern Poland, but were lower than average in other areas.

April–June temperatures in some areas of Poland and Germany were significantly above average. Temperatures were above average everywhere in April, with significant warmth (> 2°C) in parts of Germany and Poland. May anomalies were generally lower than those in April, with below-average temperatures in the east. After a dry April, May rainfall was above average. Precipitation was particularly heavy in the east with many areas receiving more than twice the usual monthly amount. One area in Belarus received nearly three times its average monthly total. In June, temperature anomalies fell again in the east, with temperatures dropping below average everywhere east of central Poland. Temperature anomalies in southwestern Germany, however, rose above 2.8°C (98th percentile).

July–September was another warm period. Temperature anomalies were highest in the east, exceeding the 90th percentile in large parts of Poland, Belarus, and Estonia. Precipitation was below average except in Germany. July saw above-average temperatures in all areas, although significant positive anomalies were found in only a few areas of Poland, Belarus and Lithuania. Above average rainfall in Germany and Poland may have acted to reduce temperature anomalies in those regions. Below-average August temperatures occurred in Germany and much of Poland, and wetter-than-average conditions existed in the east. September was drier and warmer than average in most areas, with Belarus, northern Germany, and western Poland experiencing significant warmth. Only central parts of Germany received above-average rainfall.

Temperatures between October and December were above average and precipitation totals were below average in all regions. October temperature anomalies were highest in Germany, where temperatures were significantly above normal over much of the country, and even rose above the 98th percentile in the west (+2.5°C anomaly). Some areas of Poland received less than 20% of the average October precipitation. In November southern Germany and Poland had below-average temperatures, but anomalies increased to the north. November was another dry month, and no area experienced above-average rainfall. In December, temperatures were above average in most areas, although southern Germany had temperatures that were more than 1.6°C below the average.

v) Northwestern Europe—J. J. Kennedy[38]

Annually averaged temperatures in northwestern Europe in 2005 were above average in all areas. The United Kingdom and Netherlands experienced significantly above-normal temperatures, and anomalies in Scotland exceeded the 98th percentile for the year. France and the south of the United Kingdom were drier than average between January and November 2005 and some areas of France received less than 60% of the average rainfall.

January saw significantly above-average temperatures in the United Kingdom. Most areas were dry, but the north of the United Kingdom received above-average rainfall, which led to flooding in a number of areas. Temperatures fell below average in most areas in February. In the south of France both temperatures and rainfall were significantly below average, with some areas receiving less than 20% of normal precipitation. Drier-than-average conditions continued in March across France and the United Kingdom. March temperatures were above average in most areas, and significantly so in Scotland and Ireland.

April–June average temperatures were significantly above normal everywhere except Scotland and Ireland. Temperatures in France exceeded the 98th percentile. April was warmer than average in all regions, but significant warmth was confined to the Low Countries, southeast England, and western Scotland. Precipitation was above average in most areas. Temperatures in May were below average only in Ireland and Scotland, while the south of France experienced significantly high temperatures. Rainfall was below average in England, Wales, and France, but above average in Scotland and Ireland. Significantly high June temperatures covered all areas except central England, where subzero temperatures were experienced near the start of the month and the central England minimum temperature index (Parker and Horton 2005) dropped below the 5th percentile of occurrence (3.6°C on 7 June). Contrastingly, temperatures in the southeast of France exceeded the 98th percentile. Precipitation totals were below average over continental regions.

July was warmer than average in all areas, with the highest anomalies over continental areas. Rainfall deficits were observed in the south of France and Scotland, but other areas experienced above-average rainfall. August was warmer and drier than usual in the west, but cooler and wetter than normal in the east. Anomalies increased in September with above-average temperatures in all areas. Southern France had the lowest temperature anomalies and highest rainfall anomalies, but other areas were predominantly dry.

In October temperatures in central areas exceeded the 98th percentile. On 12 October the highest ever October minimum central England temperature (15.2°C) was recorded. October precipitation was above average in the United Kingdom and northwest France, but below average in other areas. November temperatures in France and England were below average, and it was drier than average over most of the region. Temperatures in December were below average in France, particularly in the south of the country, where it was significantly below normal (< –2°C anomaly).

vi) Iberia—R. Trigo,[86] R. Garcia-Herrera,[24] and D. Paredes[64]

(i) Temperature

The average 850-hPa temperature across Iberia in 2005 was 0.3°C above normal (1961–90 base period mean). However, this relatively moderate annual anomaly conceals considerably larger cold and warm temperature anomalies observed in winter (-1.6°C) and summer (+1.7°C).

Wintertime upper-level 500-hPa geopotential height anomaly fields confirm the overall structure observed at surface, with intense positive anomalies centered between the Azores and Iceland (Fig. 6.32, left). As a consequence of this strong northwest–southeast geopotential height gradient, Western Europe was under the influence of strong cold air advection from higher latitudes. Several consecutive cold wave outbreaks were observed between the end of January and early March affecting all of Iberia as well as France and central Europe (Garcia-Herrera et al. 2006, manuscript submitted to *J. Hydrometeor.*). Daily maximum and minimum temperatures for Lisbon, Portugal, reveal that these cold waves reached the western coast of Iberia, producing a number of days with temperatures in the coldest decile (lowest 10%) of daily long-term records (Fig. 6.33). Interestingly, soon after the last cold wave, a circulation shift to North African air penetration resulted in late-March/early April daily temperatures within the highest decile (hottest 10%) of long-term temperature records for those days (Fig. 6.33).

Spring and summer months were characterized by warmer-than-normal temperature values, particularly between late May and August, with most of Iberia impacted by two intense heat waves in June and August (Fig. 6.33). Positive SLP anomalies over Europe, due to the extended Azores anticyclone, contributed to the anomalous warmth in these months. The summer 500-hPa geopotential height anomaly field was dominated by a positive anomaly maximum centered between Iberia and the United Kingdom (Fig. 6.32, right). This large-scale feature not only impeded the natural eastward progression of low pressure systems that frequently cross northern Europe in the summer, but contributed to the advec-

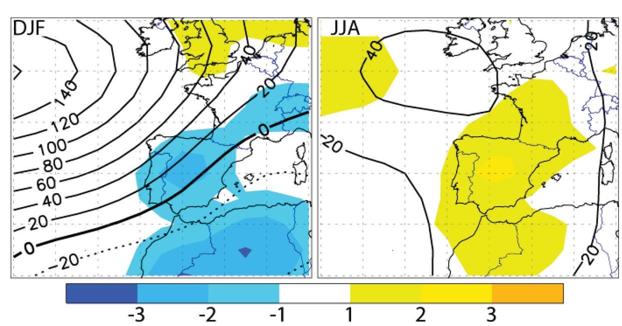

Fig. 6.32. (left) Winter (DJF) and (right) summer (JJA) anomalies of 500-hPa geopotential height (contours; gpm) and corresponding 850-hPa temperature anomaly field (color; °C) over southwest Europe and North Africa. [Source: NCAR NCEP reanalyses; 1961–90 base]

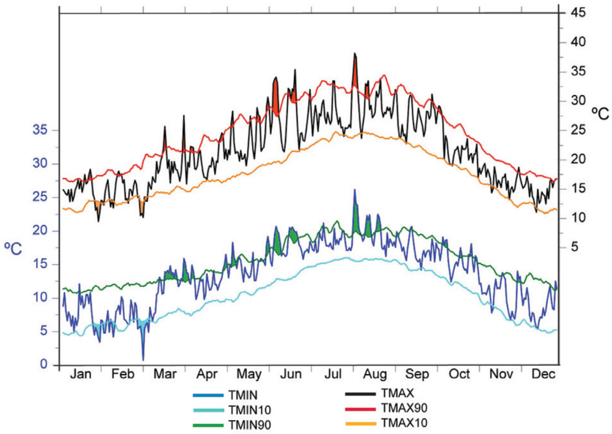

Fig. 6.33. Daily Tmax (black) and Tmin (dark blue) temperature (°C) in Lisbon during 2005. Red (green) and orange (light blue) lines correspond to the 90th and 10th percentiles, respectively, of the Tmax (Tmin) for each day of the year (10-day moving window), and were computed using the period 1941–2000.

tion of warm air masses in the south as well as enhanced adiabatic heating through subsidence (Trigo et al. 2004). Furthermore, extended periods of clear skies associated with anticyclonic conditions contributed to increased solar radiative heating over the region.

(ii) Precipitation

The Iberian Peninsula experienced drier-than-normal conditions during 2005 relative to the 1961–90 base period mean (Fig. 6.29). The hydrological year of 2004/05 (October 2004–September 2005) was among the driest since regular precipitation records started in both Portugal and Spain (see sidebar). In fact, based on the monthly Global Precipitation Climatology Center (GPCC)-gridded dataset (Rudolf and Schneider 2005), drought conditions prevailed in 2005 over a large area of Western Europe, including the southern United Kingdom, France, and Northern Italy (Fig. 6.29). During winter and spring, usually the wettest seasons, dry conditions prevailed over much of Iberia, with precipitation less than 50% (and in places < 25%) of 1961–90 mean values. Winter months were characterized by the presence of intense anticyclonic circulation, located northward of its usual latitude (Azores). Drought conditions continued through the spring months, although with less intensity than in winter. However, unlike winter, several storm tracks progressed from the Atlantic toward Iberia and France, but were stopped from penetrating the European continent by the development of extensive blocking events.

The summer season of 2005 was also characterized by reduced precipitation over Western Europe and northern Africa, with the maximum amplitude over Iberia. Precipitation totals rebounded across the northeastern sector of the Iberian Peninsula during autumn 2005, but normal precipitation fell in the remaining areas, particularly in the southern sector.

Major climatic anomalies are often driven by enhanced values of large-scale atmospheric circulation indices [e.g., ENSO, PNA, NAO, east Atlantic (EA)]. Interestingly, this record-breaking drought is only partially associated with extreme values of teleconnection indices, particularly those that are known to have a significant impact upon winter Iberian precipitation (NAO and EA). Moderately positive (negative) values of NAO (EA) recorded between November and February are clearly associated with the scarce precipitation observed over Iberia. However, the similarly dry conditions observed in March are more difficult to associate with the intense negative NAO (–1.8) and moderately positive EA (+1.1) indices. Instead, an extremely intense blocking event positioned over unusually southern latitudes contributed to the widespread March precipitation anomaly over Europe.

vii) Mediterranean and southern Europe—J. J. Kennedy[38]

Temperatures in the Mediterranean were above average in most areas in 2005. Greece was one of the few countries that experienced below-average temperatures for the year as a whole. Precipitation was generally below average in the west, but above average further east.

January–March temperatures were below average in all regions and significantly below average in Italy. In the western Mediterranean, temperatures fell below the 2nd percentile of occurrence. The north of Italy and the western Mediterranean were drier than average, while southern Italy and Greece were wetter. January temperatures were above average only in Greece, and in the western Mediterranean temperatures were below the 2nd percentile. Cold conditions continued into February and the whole of the Mediterranean area west of 25°E experienced significant cold. The south and west were the coolest areas, with temperature anomalies of –3.7°C in the Balearic Islands falling below the 2nd percentile. January was drier than average in the west, but above-average January precipitation in Greece and Italy spread westward in February, when only northern Italy experienced below-average rainfall. March was much drier, with most areas experiencing below-average rainfall.

In April–June, average temperatures were significantly above normal in all areas except Greece. West of Sardinia, temperatures exceeded the 98th percentile. Precipitation was below average in most regions, with the exception of southern Italy and Sicily. April temperatures were near average in most regions. May was warmer with large areas in the west showing significant warmth. Heating continued through June, with significantly above-normal temperatures in all areas except Greece. Parts of northern Italy exceeded the 98th percentile. Anomalous rainfall occurred in southern Italy and Sicily, where totals were above average in all three months.

Significant heat continued into July over large areas of the region. Above-normal precipitation fell over Greece, with eastern areas receiving more than twice the monthly average. Temperature anomalies were somewhat lower in August, dropping below average in northeastern areas, but high temperatures in the western Mediterranean brought large numbers of jellyfish to Spanish beaches. Most areas saw above-average rainfall, and northern Greece again received significant excesses of precipitation. Temperature anomalies in the west fell in September, and most areas experienced above-average rainfall.

Average October–December temperatures were below average in most areas. October temperatures were below average in the east, and above average in the west. In November, cold anomalies spread over much of the Mediterranean and by December temperatures had dropped significantly below normal in central areas. In December, Greece was the only country in the region to experience above-average temperatures. October was mainly a dry month, with northern Italy the only place to receive above-average precipitation. November in contrast was wetter than average in most areas.

VIII) Southeastern Europe—J. J. Kennedy[38]

Temperatures in southeastern Europe in 2005 were within 0.2°C of the 1961–90 average. Eastern areas, particularly Bulgaria, received significantly

THE EXTREME IBERIAN DROUGHT OF 2004/05—R. Trigo,[86] R. Garcia-Herrera,[24] and D. Paredes[64]

The year 2005 was characterized by one of the worst droughts ever recorded in the Iberian Peninsula, particularly in its southern half. The hydrological year that spans between October 2004 and September 2005 was the driest on record for several locations throughout Iberia, namely in the capital cities of Lisbon, Portugal, and Madrid, Spain, where reliable precipitation records have been kept since 1865 and 1859, respectively (Fig. 6.34). In particular, in Lisbon the 2004/05 event surpassed the previous record drought of the 1944/45 hydrological year (Fig. 6.35).

The precipitation regime over Iberia is characterized by strong seasonal behavior, with a unimodal rainy season concentrated between October and March and relatively arid conditions at other times. Therefore, all major droughts in this region are characterized by lack of rainfall during several months of the winter half of the year (Trigo et al. 2004). Using data from the GPCC (Rudolf and Schneider 2005) the spatially averaged precipitation over Iberia, between October 2004 and September 2005, was roughly 45% less than the 1961–90 climatological average (Garcia-Herrera et al. 2006, manuscript submitted to *J. Hydrometeor.*). However, regionally, the drought was most intense in the southern and southwestern sectors of the Iberian Peninsula, where rainfall was as little as 40% of normal during that period (Fig. 6.34)

The 2004/05 drought had major socioeconomic impacts in both Iberian countries, particularly for hydroelectricity and cereals production, which decreased to 40% and 60%, respectively, of their long-term average values. Agricultural losses due to scarce water resources and diminished pasture land during this season have been estimated to be on the order of $2 billion USD.

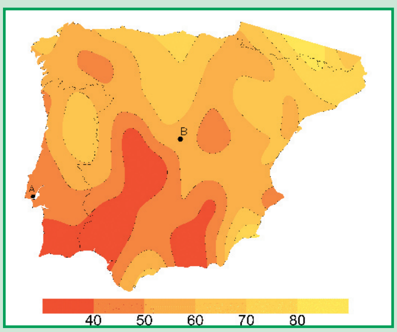

Fig. 6.34. Percentage of normal (1961–90 base) precipitation accumulated between October 2004 and September 2005. [Source: GPCC] Lisbon (A) and Madrid (B) are shown.

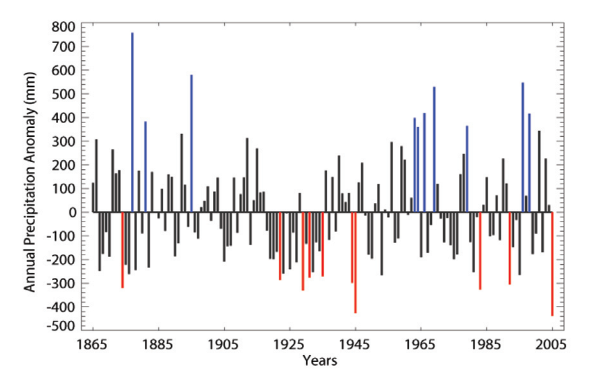

Fig. 6.35. Annual precipitation anomaly (mm) for Lisbon from 1865 to 2005 (1865–2005 mean). Anomalies correspond to the hydrological year that spans between October of year *n*-1 and September of year *n*.

above-average precipitation totals for the year, causing flooding in many areas.

The January–March period was colder than average in all but eastern Bulgaria. January was generally warmer than average, but February saw significant cold in most areas, with temperatures in Serbia more than 3°C below average. Temperatures in March were also below average, but not significantly so. The greatest precipitation anomalies occurred in Bulgaria in all three months, which led to flooding there in February.

April saw the end of the anomalously cold weather, with above-average temperatures in all areas. May and June temperatures were above average in most areas, significantly warmer than normal in Croatia and Bosnia-Herzegovina, but below average for June in Bulgaria. Rainfall totals in April and June were close to average in most parts, but in Bulgaria significant May rainfall once again brought flooding.

Although July temperature anomalies in southeastern Europe were positive, they were lower than in most areas of Europe. Even so, temperatures along the Adriatic coast were significantly above normal. Temperatures in August were below average except in eastern Bulgaria, which experienced significant warmth. September was warmer than average. July, August, and September rainfall totals were far above average, with Bulgaria receiving more than twice the seasonal average, and large areas recording more than three times the average. In August, 500% above-normal monthly rainfall in Bulgaria produced flooding that continued into September and left more than 30 dead.

Excessive rains continued in the east into October, but November totals were close to average in all areas. October and November temperatures were below average in the south and east, but December saw the colder weather shifting to the west. Temperatures in the north were above average in October, but fell below average for the last two months of the year.

h. Oceania

1) Australia—A. B. Watkins[90]

Despite the notable absence of an active basin-wide El Niño event, 2005 was the hottest year on meteorological record for Australia.[2] Neutral to slightly warm conditions in the equatorial Indian and Pacific Oceans at the start of 2005 persisted until June, returning to near normal in the latter half of the year. Correspondingly, pressure over Australia was higher than normal during the first half of the year, and from normal to below normal during the remainder of 2005. The anomalously high pressure over the country during early 2005 greatly reduced rainfall over the interior and inhibited the northward penetration of frontal systems from the Southern Ocean. High pressure also contributed to a sporadic Australian monsoon, which failed to extend far inland, resulting in anomalously warm and dry conditions in the north.

(i) Temperature

Due in part to the inconsistent Australian monsoon, the tropical wet season (October 2004–April 2005) was relatively warm. Northern Australia experienced a +1.5°C maximum temperature (Tmax) anomaly (0.6°C above the previous wet season record). Additionally, April, ordinarily the start of the main winter cropping season, was climatologically one of the most remarkable months on record for Australia. Australia-wide, April mean Tmax was 3.11°C above normal (Fig. 6.36). Not only was this 0.7°C above the previous April record, but it was the largest anomaly recorded for any month since Australia-wide temperature records began in 1950, which is substantially higher than the previous record (+2.68°C) set in October 1988. Combined with record high minimum temperatures (Tmin), the April mean temperature anomaly of +2.58°C was 0.85°C above the previous April record set in 2002 and 0.26°C above the previous record for any month (June 1996). Notably, the April mean temperature was the highest on record over 66% of the continent, with 86% of the continent experiencing mean temperatures for the month in the highest 10% the of recorded totals.

June–December Tmax and Tmin remained above average across virtually the entire country (+0.75° and +0.94°C anomalies, respectively). When combined with the hot start to the year, temperatures for 2005 were exceptional. The Australia-wide Tmax anomaly for 2005 was +1.21°C, equal to the record set in 2002, while the Australia-wide Tmin anomaly

[2] For Australia-wide, as well as large-scale regional averages, high-quality monthly temperature data is available from 1950, with high-quality annual temperature data starting 1910. For rainfall, high-quality area-averaged data commences in 1900. All records and percentile values are calculated with respect to these years. Anomalies are calculated with respect to the 1961 to 1990 average, in accordance with World Meteorological Organization guidelines (WMO Publication No. 100: www.wmo.ch/web/wcp/ccl/ GuideHome/html/wmo100.html).