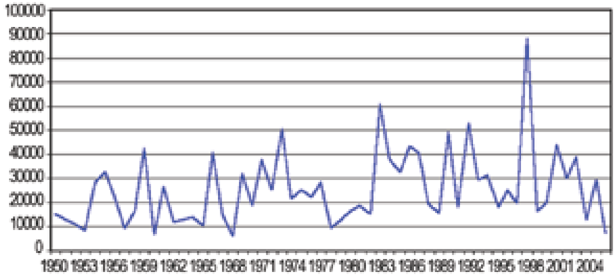

Fig. 6.23. Seasonal January–June discharge (m^3 s^{-1}) of the Uruguay River at Salto Grande during 1950–2006.

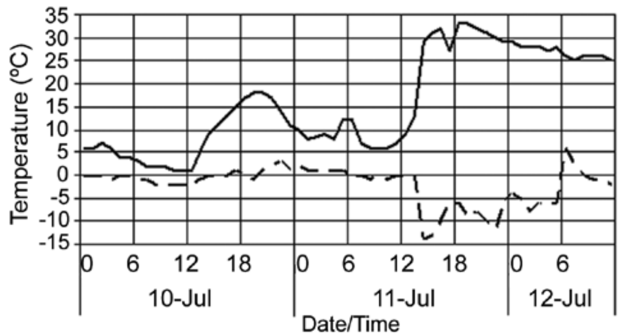

Fig. 6.24. Hourly evolution of surface temperature (°C) and dewpoint temperature (°C) in San Juan, Argentina.

Negro Rivers reached their lowest values since 1968, producing shortages in hydroelectric power in the whole country.

The SPI, as defined by McKee et al. (1993, 1995), quantifies the drought in southern Brazil. The SPI accounts for the various time scales at play during drought and subsequent rains. For the last four years, the SPI values were lower than the moderate (–1.0) to very dry (–1.5) threshold. The drought situation affecting southern Brazil is not just the consequence of the rainfall deficit in 2006, but is due to a rainfall deficit that has accumulated during the last three years.

The causes of this extended drought have been linked to variability in the regional circulation. Cold fronts represent the main rainfall-producing mechanisms in southern Brazil. An assessment of the number of cold fronts during January 2003–June 2006 affecting the region shows that this number was below normal. This behavior is consistent with an increase in the frequency of blocking systems in southern South America and a reduction in wavenumber in the higher latitudes of the Southern Hemisphere.

(ii) The Zonda event in Argentina—F. Norte, G. Ulke, *S. Simonelli, and M. Viale*

The Zonda is a strong, warm, and very dry wind associated with adiabatic compression upon descending the eastern slopes of the Andes, preferentially in winter and spring. It is the Argentine version of katabatic winds, which are also called mistral, chinook, Santa Ana, and foehn winds in different parts of the world. Although this phenomenon occurs across the entire length of the extratropical Andes, it is most frequently detected near the cities of Mendoza (33°S) and San Juan (31.5°S), which are the most populated cities in western Argentina (1.5 million inhabitants).

Four categories define the strength of the Zonda. The top two categories, "severe" (Z3) and "extremely severe" (Z4), respectively, account for less than 8% of Zonda events (Norte 1988). The event of 11 July reached categories Z3 and Z4 in the surrounding area of Mendoza and San Juan, where wind speeds reached over 120 km h^{-1} during a 2–3-hour period without interruption.

The synoptic surface and upper-air conditions were the typical ones associated with a severe Zonda wind occurrence: 1) a surface cold front approaching the central coast of Chile driven by a 500-hPa-level trough, 2) a deep low pressure surface system approximately over 55°S and 65°W, and 3) a strong upper-level jet stream. The main feature of the event is the sharp polar air advection from the south and an intense meridional 500–1000-hPa thickness gradient. The occurrence of the Zonda episode was characterized by a marked increase in temperature and a decrease in humidity. Thus, in Mendoza, the temperature reached 28.2°C while the dewpoint dropped to –6°C. At San Juan, the air temperature rose to 33.0°C, and the dewpoint fell to –15.0°C (Fig. 6.24). The Zonda caused severe impacts in the region, including fires, power outages, fallen trees, and destroyed buildings.

f. Asia

1) West and central Asia—O. Bulygina, N. N. Korshunova, and V. N. Razuvaev

The year 2006 in Russia showed near-normal rainfall (Fig. 6.25), while much of the country was quite warm (Fig. 6.26). The anomaly of the mean annual air temperature averaged over the Russian territory was 0.5°C. In early 2006, most of the Russian territory experienced severe frosts. Record-breaking low mean monthly temperatures were recorded in western Siberia. In both the Yamalo-Nenets Autonomous Area and the Khanty-Mansisk Autonomous

Area, the minimum air temperature dropped as low as −58°C. Six meteorological stations in the Tomsk region recorded temperatures that were 0.1°–0.4°C below the absolute minimum. Daily anomalies exceeded −25°C.

In the Kemerovo region, thermometers dropped to −53°C. In the second and third 10-day periods, record-breaking anomalies were recorded in the Tomsk and Kemerovo regions and in the Krasnoyarsk Territory. This winter, the Siberian anticyclone moved far to the west of its usual position over Yakutia. The anticyclone center was over the southern part of the Krasnoyarsk Territory. Therefore, severe frosts persisted there for a long time. At the station of Bor, frosts below −30°C lasted 22 days—a new record. The same pattern was observed in the northern part of the Tomsk region at Aleksandrovskoe, where severe frosts persisted for 24 days, with frosts below −30°C persisting for 23 days.

Record-breaking low minimum air temperatures were recorded in the second 10-day period of January in the eastern parts of the central Chernozem region. By 24 January, severe frosts reached southern regions; in Krasnodar and Adygeia, the recorded air temperatures were −34° and −29°C, respectively. Even on the Black Sea coast, in the vicinity of Anapa-Novorossisk, the air temperature dropped as low as −25°C. The Astrakhan region (Verkhny Baskunchak) experienced the record-breaking low minimum air temperature of −33.3°C. The lowest minimum air temperatures for the whole period of record were observed in Krasnodar (−30.6°C) and Stavropol (−24.3°C). On 30 January, temperatures in Krasnoyarsk dropped to −41.3°C, dropping below the previous daily record of −40°C. In some of the settlements in the Krasnoyarsk Territory, the air temperature dropped as low as −50°C. The lowest temperature in Russia was registered on 30 January in the Evenki Autonomous Area (−58.5°C in the Kerbo Settlement). For comparison, in Oimyakon, the town in Yakutia that is the "cold pole" in the Northern Hemisphere, thermometer readings did not drop below −45.4°C.

In most of European Russia, it was also cold in February. Severe frosts persisted in the southern part of the Evenki Autonomous Area and in the central Krasnoyarsk Territory (1°–2°C below normal). In western Siberia, particularly in the north, February was warm. In the north of the Yamalo-Nenets Autonomous Area, mean monthly temperature anomalies were 6°–8°C. In northeastern Siberia, mean monthly air temperature in February was 3°–5°C above normal. February was also warmer than normal in the Tyva Republic. Maximum positive anomalies (more than 4°C) were recorded in the northwest of the Yakutia-Sakha Republic and in the east of the Chukotka Autonomous Area. In Chukotka, warm weather was accompanied by a large amount of precipitation, frequent snow storms with wind speeds attaining 23–28 and 35–40 m s^{-1} on the coast, and poor visibility. Above-average precipitation was also recorded in the eastern Amur Region, central Khabarovsk Territory, and Maritime Territory, and on the western coast of Kamchatka.

In March, a substantial part of European Russia experienced cold weather: the entire Northwestern Federal District and nearly all of the Central Federal District, except for the Voronezh, Belgorod, and Kursk regions. At the cold center, the anomalies were −6°C. In Ural, warmer weather was accompanied by

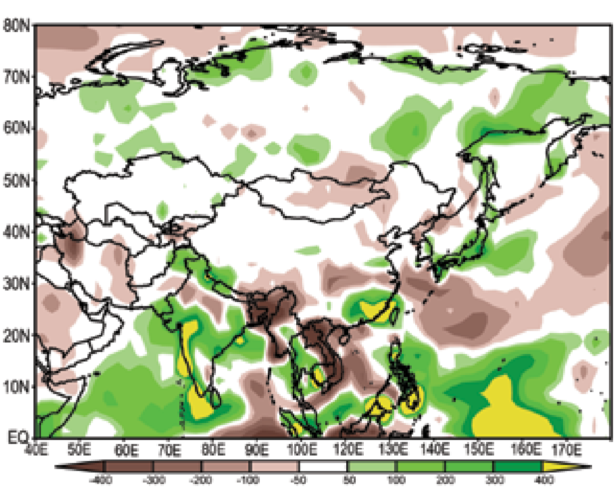

Fig. 6.25. Asian 2006 annual precipitation anomalies (mm, 1979–2000 base) from CAMS-OPI.

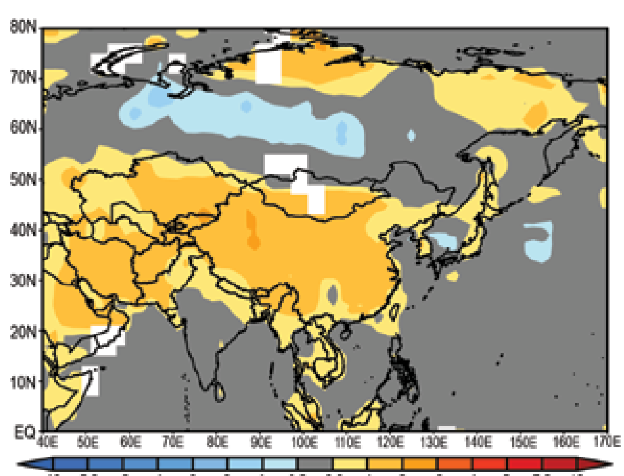

Fig. 6.26. Asian 2006 annual temperature anomalies (°C, 1971–2000 base) from CAMS-OPI.

substantial precipitation (200%–300% of monthly norms). A monthly precipitation norm was also considerably exceeded in the Volga-Vyatka and central Chernozem regions (250%–300%). Very large amounts of precipitation (250%–330% of monthly norms) were recorded in the southern Far East. Particularly intensive precipitation was recorded in Sakhalin and the Maritime Territory in the third 10-day period.

In April, positive temperature anomalies were recorded in most of European Russia. East of Ural, the air temperature was below normal, with temperature anomalies –6° to –8°C in the Yamalo-Nenets Autonomous Area and in the vicinity of the Ob Bay. In southwestern Siberia, cool weather was accompanied by high precipitation (170%–230% of the monthly norm), which, combined with intensive snow melting, caused torrential spring floods in the Kemerovo region and Altai Territory. Particularly serious hydrological conditions were noted on the Biya River near Biysk: about 500 houses were impounded in the town and people had to be evacuated.

Summer began with hot weather. In nearly the entire Russian territory, mean monthly air temperatures in June were above normal. Although temperature anomalies were no higher than 5°C, positive anomalies over most of the Russian territory resulted in 2006 having the warmest June on record (1936–2006). In July, the mean monthly temperature in the west of European Russia was 0.5°–1.0°C above normal. In the northwestern region, from 8 to 12 July, mean daily air temperatures attained 24°–27°C (anomalies of 7°–10°C).

A significant precipitation deficit in the north of the north Caucasus region caused soil drought in most of the Rostov region and the steppe zone of the Kabardino-Balkaria Republic, and allowed soil drought to persist in the southern and Volga areas of the Volgograd region. Soil drought was also recorded in individual regions of the republics of Mordovia, Chuvashia, and Udmurtia. The southern Khabarovsk Territory received more than two monthly precipitation norms, which caused high rainfall floods on the territory's rivers that had not been recorded since 1961.

In August, very hot weather set in the southern Federal District. Mean monthly air temperature anomalies were 5°–6°C. In the first half of the month, air temperatures rose as high as 37°–43°C. On 10 August, air drought started in the steppe regions of north Osetia; the dry period lasted 25–35 days, during which the maximum air temperature exceeded 30°C. Air drought was aggravated by soil drought. On 23–24 August, rains in the north and southeast of the Rostov region stopped soil drought. August in central European Russia proved to be very rainy. The Kaluga, Tula, Oryol, and Ryazan regions received more than two monthly precipitation norms. In Kaluga, August of 2006 was the most humid in the past century.

In the Far East, warm weather prevailed in August. Mean monthly air temperature anomalies in the southern Khabarovsk Territory and in Sakhalin exceeded 3°C. The southeast of the Yakutia-Sakha Republic and the north of the Magadan region and the Khabarovsk Territory experienced very warm weather. However, frequent rains were observed in these regions; some places received more than three monthly precipitation norms. Okhotsk, for example, received 72 mm of precipitation in 12 hours on 15–16 August. September, like in the previous year, proved to be warm in most of the country, though mean monthly air temperature anomalies were lower than those in September 2005.

In the first 10-day period of October, cold weather occurred abruptly in the north of the Irkutsk Region, causing frost conditions. Strong winds and snow caused damage of power transmission lines and power supply failures. For all of October, the northeast of the Far East region experienced a strong heat center, where mean monthly temperature anomalies exceeded 6°C. In November, Russia experienced two large heat foci, divided by a sufficiently intensive cold zone. On the Arctic coast and on the islands, as well as in most of the Far East, November was very warm. The center of this focus was over continental zones of the Magadan region and the Chukotka Autonomous Area. At the center, mean monthly air temperature anomalies were 13°–15°C. In the east and south of Yakutia, the Amur region, the northern Khabarovsk Territory, the north of the Chita region, and the southwest of the Magadan region, warm weather was accompanied by a large amount of precipitation. This is not typical for this season, when the Siberian anticyclone is normally prevailing in these regions. As a result, monthly precipitation norms were exceeded by up to 100%–300% in many places. This November in Magadan, for example, following two very low-snow months of November, 161 mm of precipitation (358% of the monthly normal) was recorded, which is only 5 mm lower than the 1995 absolute maximum.

The end of the year proved to be abnormally warm over most of the Russian territory (Fig. 6.27). The mean monthly air temperature averaged over the territories of the quasi-homogeneous regions (region

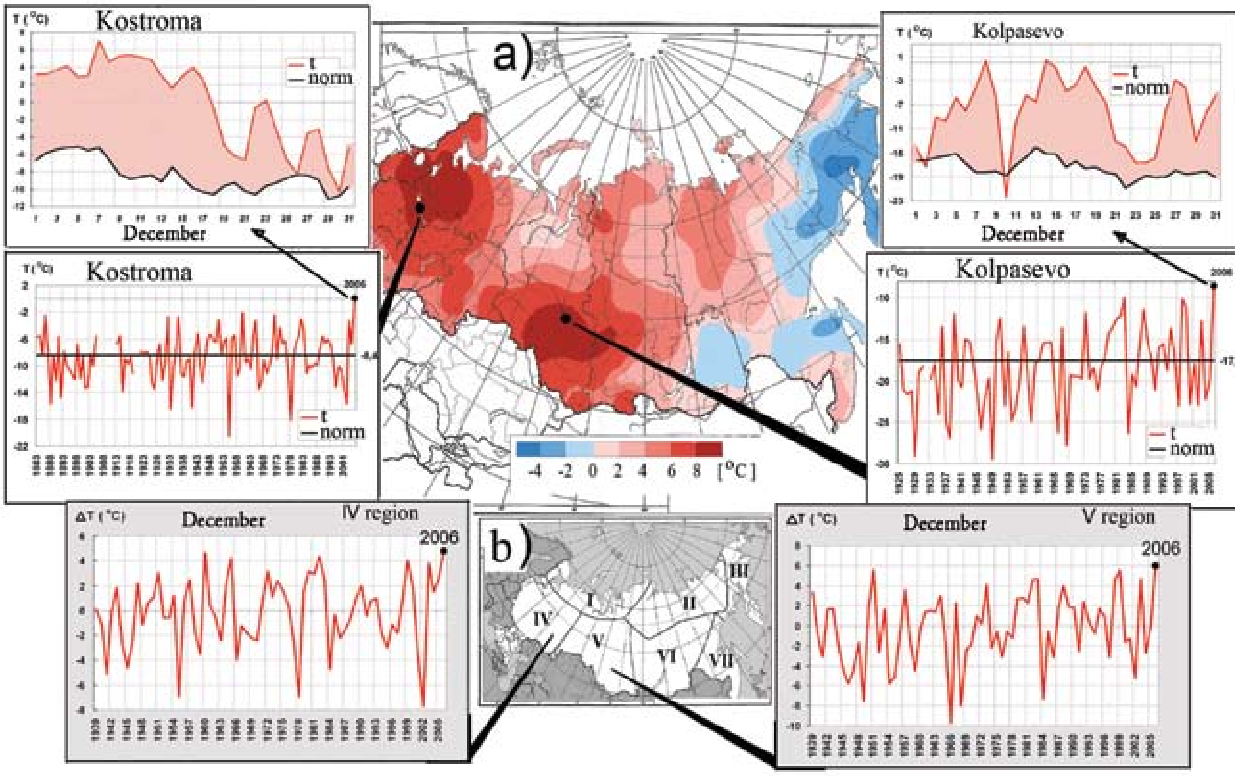

Fig. 6.27. Russian air temperature anomalies (°C) in December 2006. The middle side panels (a) show December mean monthly air temperature series at meteorological stations Kostroma (1883–2006) and Kolpasevo (1925–2006). The upper side panels depict daily air temperature values during December 2006 for these two stations. The lower panels (b) show the December mean monthly air temperatures averaged over quasi-homogeneous regions IV and V.

IV in the center and the south of European Russia and region V in the center and the south of western Siberia) was the warmest on record (Fig. 6.27b). Meteorological stations at the places of positive anomalies registered record-breaking mean monthly air temperatures (Fig. 6.27a). In Moscow, for more than 100 years of observations, the mean December air temperature did not reach such values as in 2006. It was 1.2°C. Mean daily air temperatures were above normal during the whole month, except for 26 December. Daily air temperatures that are maximal for the whole period of record were exceeded 11 times. On 15 December, the maximum air temperature reached 9°C.

2) China—Ling Wang and D. Ye

(i) Temperature

The annual mean temperature of China in 2006 was 9.9°C, which was 1.1°C above the climatology (1971–2000 mean value). The year 2006 was the warmest year since 1951 (see Fig. 6.28). The seasonal mean temperature was also above the climatology in all four seasons, and reached the hottest peak since 1951 in both summer and autumn.

Above-normal temperatures were observed almost throughout the whole country. In the northwest, southwest, western parts of north China, Huanghuai region, the middle and lower reaches of the Yangtze River, and western parts of inner Mongolia, the temperature anomalies were 1°–2°C above normal (see Fig. 6.29). In the winter of 2005/06 (December–February), warmer-than-normal temperatures were observed in most areas of the Tibetan Plateau, where the temperature was 2°–5°C above normal. In summer (June–August), a record-breaking heat wave affected Chongqing and eastern parts of Sichuan. In Chongqing, from mid-July to late August, the number of "broil days" in which the daily maximum temperature was greater than 38°C was 21. This was significantly above the normal of 3.2 days, and reached the maximum in records. In autumn (September–November), above-normal temperatures were observed in most regions of China.

(ii) Precipitation and droughts

In association with the higher temperature,

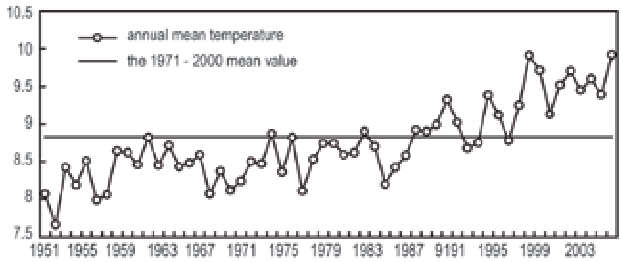

Fig. 6.28. Time series of annual average air temperature (°C) in China, 1951–2006.

China experienced a deficient rainfall year. Below-normal precipitation was observed in most areas of the Yangtze River valley, north China, and western parts of northeast and eastern parts of Inner Mongolia. Rainfall was 10%–50% less than normal in these regions. From June to the first half of November, the Yangtze River valley endured dry conditions, and the average precipitation was the second lowest since 1951, making the river drop to record low levels.

A severe drought occurred in Sichuan Province and Chongqing City during the summer. From June to August, the precipitation over these regions was about 67% of normal, and was the lowest since 1951. Meanwhile, due in part to the heat wave, Chongqing and Sichuan endured the worst drought since 1951: about 3.38 million ha of crops were damaged. Total losses were estimated at 19.3 billion RMB.

Eastern parts of China experienced warmer and drier conditions during autumn. The precipitation was 50%–80% less than normal in north China, Huanghuai region, and western parts of south China during September to the first half of November. In addition, higher temperatures were observed almost throughout the country. This condition enhanced the soil water evaporation and caused a large-scale drought over eastern China. More than 6.4 million ha of crops were affected, particularly in Shandong and Guangxi Provinces.

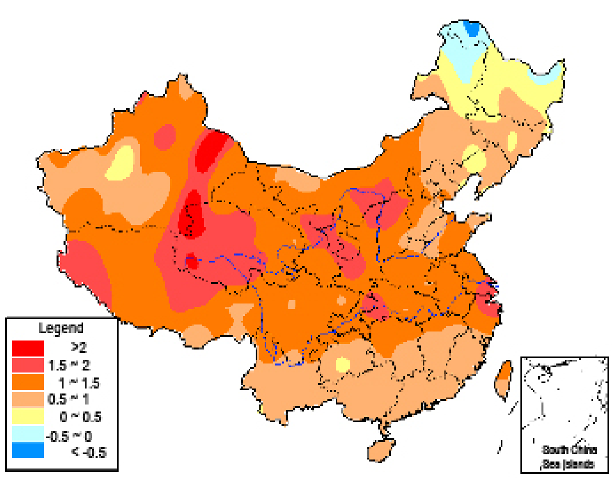

Fig. 6.29. Annual air temperature anomalies (°C) over China in 2006.

(iii) Floods and heavy rainstorms

Heavy rainstorms during 2–10 June affected southern China, where the accumulated precipitation was about 100–300 mm. It reached 500 mm on Shanwei, on the eastern coast of Guangdong Province. During 12–13 June, extremely heavy rain occurred in Wangmo County in the southern part of Guizhou Province. The 4-hour accumulated precipitation reached 196 mm, causing severe mountain torrents and mudslides, leading to 30 deaths. During 5–13 October, heavy rain continued to control the south-central parts of Yunnan Province, and brought 100–300 mm of precipitation, which is 100%–200% more than the October normals.

(iv) Tropical cyclones

In 2006, there were 24 tropical cyclones with at least tropical storm intensity in the western North Pacific, this was below the 1971–2000 average of 27. Six of them made landfall in China (the average of seven). The first landfalling typhoon, Chanchu, was earlier than normal by 40 days. It is the earliest typhoon to directly strike Guangdong since 1949. From July to August, five tropical cyclones made landfall in China one after another, with strong intensity, causing devastation. In autumn, no tropical cyclones made landfall, which is also a rare occurrence. There were 1522 deaths caused by tropical cyclones in China during 2006 (the most deaths in 10 years). Associated with the southwesterly monsoon, Tropical Storm Bilis killed 843 people. Supertyphoon Saomai was the most powerful typhoon to strike China since 1949; it directly struck Zhejiang Province with a maximum wind near the center of 60 m s^{-1} and a minimum pressure of 920 hPa, resulting in 483 fatalities.

(v) Dust storms

In spring of 2006, 18 dust weather events occurred, including 5 strong dust storms. The number of dust events reached the maximum since 2000. The strongest dust storm occurred on 9–11 April, affecting 13 provinces in northern China; Tulufan Basin in Xinjiang Province witnessed the most intense dust storm in the past 22 years. Another dust storm happened on 16–18 April, which affected about 1.2 million km^2, with large impacts in Beijing.

3) Southeast Asia—W. Li and Y. Zhu

(i) East Asian monsoon

The East Asian summer monsoon onset commenced over the SCS in the fourth pentad of May, which is near normal, and the flow remained southwesterly over regions from South China to the Jiangnan area before the third pentad of June. During the fourth pentad of June, with the subtropical high skipping northward, southwesterly flow advanced to the Huanghuai area. Meanwhile, the 340-K isoline of potential pseudoequivalent temperature moved northward and remained north of 35°N from July to the first decad of August. During the fourth pentad of August, the 340-K isoline retreated southward quickly to 30°N, and to 20°N during the first decad of September. During the second pentad of October, the 340-K isoline withdrew from the SCS, which indicated that the warm and humid air had withdrawn from the SCS. Meanwhile, at the 850-hPa level, wind flow over the SCS changed 180° to become northeasterly. This indicated that the SCS summer monsoon came to an end during the second pentad of October 2006, which was later than normal.

The SCS summer monsoon index was −0.79 in 2006, which was weaker than average. Pentad intensities of the SCS summer monsoon were weaker than normal during most of the time (Fig. 6.30). During the summer of 2006, rainfall totals were more than normal in South China, Huanghuai area, and mid-northern northeast China, while they were less than normal in the mid–lower reaches of the Yangtze River.

(ii) Temperature

Generally, monthly mean surface air temperatures were slightly above normal (1971–2000 mean) in most regions of Southeast Asia during December 2005–November 2006. Seasonal mean surface air temperatures were above normal in most of Southeast Asia during winter (December 2005–February 2006) and autumn (September–November), with departures exceeding 1°C in the northern Indo-China peninsula during boreal winter and in the eastern Indo-China peninsula during boreal autumn. Generally, temperatures were near normal across Southeast Asia throughout the remainder of the year.

(iii) Precipitation

Generally, precipitation was above normal across the western Indo-China peninsula and below normal in the eastern Indo-China peninsula from December 2005 to November 2006. During winter, rainfall totals were 50%–100% above average in the western Indo-China peninsula. Meanwhile, heavy amounts of rain associated with the northeast monsoon contributed to significant flooding across the central Philippines and parts of the Malay peninsula. In spring, precipitation was ~50%–100% above average in the northwestern Indo-China peninsula. June–August precipitation was close to normal, though heavy rainfall associated with the monsoon affected Vietnam, Cambodia, and the Philippines. During autumn, rainfall totals were 30% to 50% below average in the eastern Indo-China peninsula, and near normal elsewhere.

(iv) Notable events

In the Philippines, heavy rainfall induced deadly landslides in southeastern Philippines during the second decad of February 2006; there were at least 139 confirmed fatalities. Typhoon Chanchu crossed the Philippines during 11–13 May and produced torrential rain, causing 41 deaths and leaving thousands homeless. Typhoon Xangsane crossed the Philippines during 27–28 September and was blamed for 110 deaths. Typhoon Durian struck the northern Philippines on 30 November, with at least 406 fatalities. Across eastern Indonesia, landslides and floods caused by torrential rain on 21 February killed at least 33 people in the city of Manado. Monsoon-related rainfall produced flooding in east Java during mid-April, and was blamed for at least 23 deaths. Floods and landslides ravaged eastern Indonesia on 19–20 June, causing about 200 fatalities. In Malaysia during the mid-December 2005, flooding killed at least 9 people, and over 17,000 people were driven into relief shelters.

During the third decad of May, heavy rainfall brought devastating flooding and mudslides to parts of northern Thailand. More than 100 people may have died in flash floods. In Thailand during early October, heavy rainfall in the wake of the remnants of Typhoon Xangsane was responsible for 32 deaths across the country, and affected 1.8 million people.

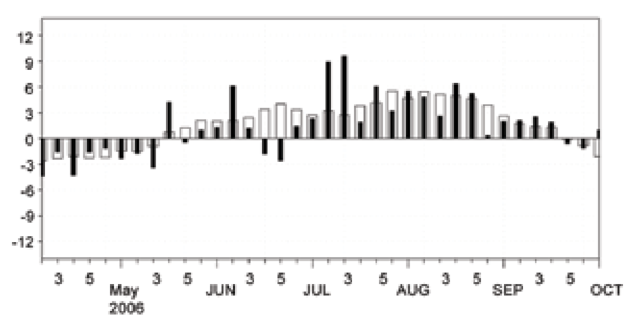

Fig. 6.30. Variation of the zonal wind index over the South China Sea (m s^{-1}).

Monsoon-related flooding in central and northern regions of Vietnam was blamed for 42 deaths during August. Typhoon Xangsane made a final landfall in central Vietnam in October; there were 68 deaths and nearly 320,000 homes were destroyed or submerged.

4) South Asia—M. Rajeevan and Jayashree Revadekar

The year 2006 was marked by extreme weather across South Asia, both in terms of precipitation and temperature. In January, many parts of South Asia experienced severe cold wave conditions with minimum temperatures dipping below normal by more than 4°C. Minimum temperatures hovered around the freezing point at some stations like Amritsar (–2°C on 7 January), Srinagar (–7°C on 11 January), and Ganganagar (–1°C on 8 January). Frost was observed in New Delhi for the first time in 70 years as cold air sweeping in from the Himalayas produced a low temperature of 0.2°C on 8 January. Over north India, more than 150 deaths were attributed to cold weather conditions. In neighboring Bangladesh, unusually cold weather also claimed some lives during the same period. However, in February, many parts of South Asia experienced unusually warm temperatures, which severely affected the winter crops over this region. During the month, mean temperatures were 5°–6°C warmer than normal over northern parts of India and adjoining Pakistan and Afghanistan. More than 30 stations reported the highest maximum temperatures ever recorded for the month of February, even some 100-year records. At Allahabad, the monthly mean maximum temperature in February was 36.3°C, breaking the previous record set in 1896.

Before the southwest monsoon sets in, heat waves are common in May and June over northern parts of India and Pakistan. During the second week of May, severe heat wave conditions prevailed over northwestern parts of India, with daily maximum temperatures above normal by 6°C, claiming more than 50 lives. At some stations, temperatures reached 45°C. Over India, mean temperatures were consistently above normal during all the months, except in June. The year 2006 was the warmest year on record since 1901, with the annual mean temperature above normal (1961–90) by 0.59°C. In January, snowstorms and flooding affected major parts of Afghanistan, claiming many lives. Badakhstan was among the worst hit provinces when snowstorms moved over this region. During April, flooding due to snowmelt and seasonal rainfall affected numerous provinces of Afghanistan-like Faryab and Baghlan. On the other hand, drought conditions and severe water stress prevailed over some parts of Pakistan, especially in Balochistan, due to inadequate rainfall during the winter and spring seasons.

(i) South Asian summer monsoon (June–September)

The summer monsoon season (June–September) is the main rainy season over a major portion of South Asia, contributing 60%–90% of annual rainfall. The onset phase of the 2006 monsoon season was characterized by an early monsoon onset over the south peninsula (26 May). However, after the first active spell associated with monsoon onset, there was a prolonged hiatus of about 16 days, due to southward intrusion of stronger midlatitude westerlies and enhanced convection over the equatorial Indian Ocean. During this period, the advance of the monsoon over northern and northwestern parts of India was delayed. The monsoon revived during the last week of June and it finally covered northwestern parts of India and Pakistan during the last week of July, about 10 days later than its normal date.

Breaking the declining trends observed over the past few years, a revived occurrence of low pressure systems typical of the summer monsoon was observed this year. As many as 16 low pressure systems formed over the Indian region, 12 over the Bay of Bengal, 1 over the Arabian Sea, and 3 over land. Of these 16 low pressure systems, 8 (the highest since 1997) intensified into monsoon depressions and 1 into a cyclonic storm (Mukda). In August, four monsoon depressions formed over the Bay of Bengal, which is a record since 1891. The monsoon depressions formed over the Bay of Bengal moved more in a west-to-northwesterly direction, very much south of the normal track position, thus giving copious amounts of rainfall over central India. The remnants of these systems then moved over extreme northwest India and adjoining Pakistan.

The all-India summer monsoon seasonal rainfall was near normal (100% of its long period average). However, rainfall was not well distributed over space and time. After the first spell of active rainfall activity associated with the onset phase, the monsoon was more or less subdued over the country until the third week of July. As of 26 July, cumulative all-India seasonal rainfall departure was only 87% of its long period average. However, the monsoon revived rapidly during the last week of July and remained active over India and Pakistan almost until the end of September. In August, all-India rainfall was 6% above its long period average and in September, it was 2%.

During this season, out of 36 meteorological subdivisions of India, 6 received excess rainfall, 21 received normal rainfall, and the remaining 9 received deficient rainfall. About 60% of the 533 meteorological districts received excess/normal rainfall and the remaining 40% received deficient or scanty rainfall. About 25% of the districts experienced moderate drought and 30 districts (6%) experienced severe drought conditions on a seasonal scale. During the second half, the seasonal trough (monsoon trough) was confined mainly south of its normal position and all the low pressure systems moved across central India along the monsoon trough. Due to this, central India received excess rainfall by 16%, while seasonal rainfall over northeastern parts of India and adjoining Bangladesh was below normal by more than 15%. However, northwest and southern parts of India received normal rainfall during the season (Fig. 6.31). Over Nepal, rainfall activity was below normal by more than 20% in July and August. Rainfall activity picked up only in September, during which the monthly rainfall was above normal.

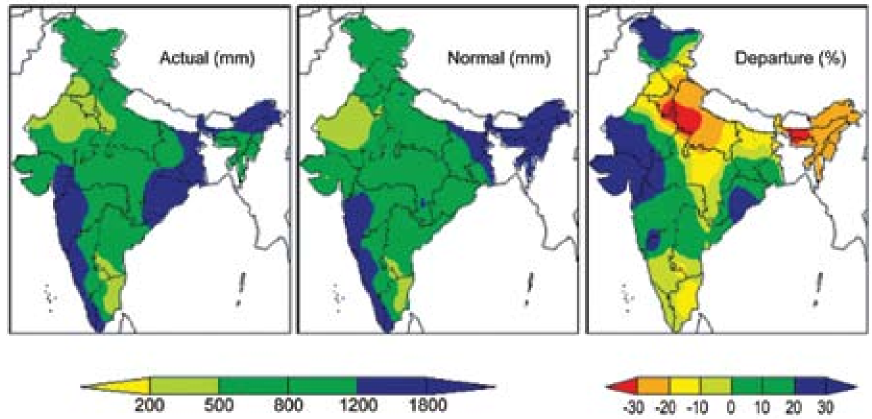

Fig. 6.31. Seasonal rainfall patterns during the 2006 summer monsoon season. [Source: http://soman.tropmet.res.in/mol.]

Pakistan experienced moderately above normal rainfall (27.2%) during the monsoon season (July–September). The province of Punjab received normal rainfall (1.5%) and the provinces of NWFP and Balochistan experienced slightly above normal rainfall (22.0% and 12.4%, respectively). The province of Sindh had received largely above normal rainfall (116.6%). Another interesting aspect of this season was the occurrence of extreme rainfall events. In many places, many heavy rainfall events occurred, causing localized but severe flooding. The unprecedented heavy rains and destructive flooding across much of South Asia, including Afghanistan, Pakistan, India, and Nepal, affected more than 5 million people and resulted in more than 1000 deaths. During the third week of August, unusually heavy rainfall in the Thar Desert over northwest India caused devastating floods. During the period 16–25 August, 549 mm of rainfall was recorded over this region, which destroyed thousands of hectares of standing crops.

(ii) Northeast monsoon

The northeast monsoon (October–December) contributes 30%–50% of annual rainfall over southeastern parts of India and Sri Lanka. During the 2006 northeast monsoon season, heavy rainfall continued unabated over these regions especially during October and December. In India, the states of Tamil Nadu and Andhra Pradesh were the worst affected. However, the season known for tropical cyclone activity, witnessed only one tropical cyclone (Ogni), which affected parts of Tamil Nadu and Andhra Pradesh. Most of the rainfall activity during the season was associated with the movement of easterly waves. The associated floods in southeast India and Sri Lanka affected more than 1 million people with at least 100 fatalities and had a considerable socioeconomic impact. Over these regions, the northeast monsoon seasonal rainfall was above normal by more than 15%.

5) Southwest Asia—F. Rahimzadeh and M. Khoshkam

Anomalously warm and cold seasonal temperature was observed across the region this year. Temperature patterns varied in time and space. Warmer-than-average temperatures occurred in winter and spring (about 1°–2°C above average). Cooler-than-average and wetter-than-average conditions occurred in the western half of Iran during autumn.

(i) Winter

Temporal and spatial temperature variability was intense in winter (2005/06). Iran experienced anomalously warm temperatures in February. On average, winter temperatures were 2°C above that of the long-term. Parts of central and northeastern Iran were 2°–3°C cooler than normal. The areas with precipitation amounts near normal or above were the west, southwest, northwest, and Alborz Mountains, while the rest of the area had precipitation amounts of 75% of normal or less. The range of winter precipitation was 1250 mm. The largest amount of precipitation was observed near the Zagros Mountains (Koohrang 1250 mm) in western Iran, and the lowest (5.9 mm) in southeastern Iran. Winter precipitation was 28% less than 2005, and 6% less than the long-term average. Much of the precipitation falls as snow, especially in December and January. Heavy rainfall brought flooding to parts of the southern provinces during February 2006, creating serious transportation problems for the mountain and cold provinces.

(ii) Spring

Spring temperatures were mostly 0°–2°C above normal over most parts of Iran. A few exceptions were Fars, Kerman, Yazd, and the south, which was 2°C cooler, as well as a few places that were up to 4°–6°C warmer than the long-term spring averages. The seasonal mean temperatures ranged from 10°C in the northwest to 35°C in the southeast. Precipitation totals across the southeast of the country were only 0%–25% of the long-term mean, whereas wetter-than-average conditions prevailed over the central region, which received 100%–260% of its long-term average precipitation. The northwest region received 50%–100% of normal rainfall. In general, precipitation increased with respect to 2005, but was 14% lower than the long-term mean in spring.

(iii) Summer

Summer was cooler than average over one-fourth of Iran (in the central and eastern provinces) while above-average temperatures were observed in the rest of the country, with averaged departures 2°C above normal. Many parts including central, eastern, and some parts of the southwest received no measurable rainfall. Averaged precipitation was below normal in the summer of 2006, 5% lower than 2005, and 24% lower than the long-term mean. Areas with precipitation amounts of 75% normal to near normal were parts in south, southeast, northeast, and northwest. Dust and sandstorms occurred in the Sistan and Balochestan provinces in southeastern Iran, western Afghanistan, and Pakistan.

(iv) Autumn

In autumn, cooler-than-average conditions persisted across southern and central Iran; warmer-than-average conditions were limited to parts in the eastern provinces. Cold temperatures affected many areas during autumn, with many locations breaking their all-time record minimum temperatures for the season. Averaged across the nation as a whole, it was one of coldest autumns in decades. A severe cold wave, which arrived during early December, brought some of the coldest temperatures to the region in decades. Parts

COUNTRY SPOTLIGHT: TURKEY—S. Sensoy

The annual surface temperature anomaly averaged over Turkey in 2006 was 0.9°C above the 1971–2000 average (Fig. 6.32). Only one station (Solhan) in the eastern part of Turkey had annual temperatures below average (−0.59°C). Generally, western parts of the country had annual temperatures near average while eastern parts were above the mean. Positive temperature anomalies have been reported since 1994 (except 1997). The number of summer days ($T_{max} \geq 25°C$) have been increasing all over Turkey while ice days and frost days have decreased. Temperatures in January, November, and December were below average. Between February and October, temperatures were near and above average. Significant positive temperature anomalies ($p \leq 0.05$) occurred during the summer season (JJA).

Due to Turkey's topography, rain clouds seldom penetrate the country's interior. Rain clouds drop most of their water on the slopes opposite the sea. For this reason, the central Anatolia does not have very much precipitation. While Rize receives 2200 mm of precipitation annually, Konya receives only 320 mm. Average annual total precipitation for Turkey is 632 mm according to the 1971–2000 base periods (Sensoy 2004). The average total precipitation in 2006 was 606 mm, slightly below average. Western parts of Turkey and the Çukurova Plateau had been suffering prolonged drought conditions. Approximately 150 stations received less precipitation than average in the winter, spring, and summer seasons. Despite these dry conditions, flood events occurred in some places. Ten people died in Diyarbakir in October from flooding.

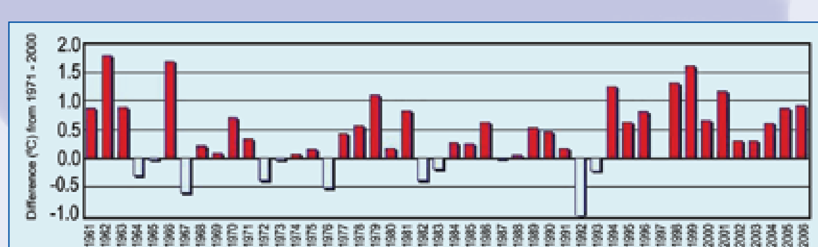

Fig. 6.32. Time series of Turkish annual average air temperature anomalies (°C; 1971–2000 base) from 1961–2006.

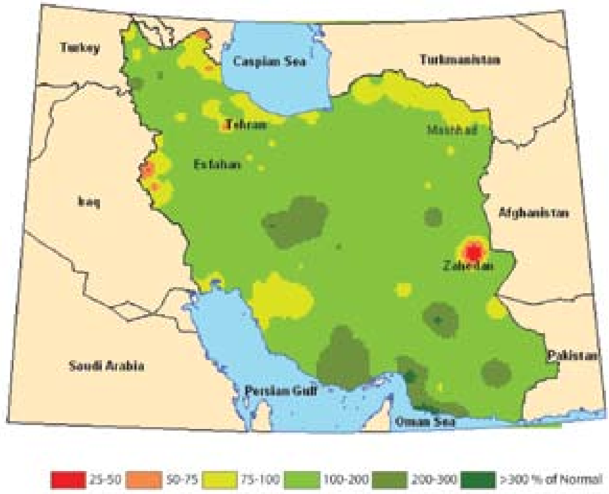

Fig. 6.33. Autumn precipitation anomalies (%) over Iran. [Source: I.R. of the Iran Meteorological Organization.]

of Iran were up to 8°C cooler than normal during December. Snow and cold weather penetrated northern Iran, with heavy rainfall in eastern and southern Iran. For the country, the average of precipitation in autumn was 83 mm. The largest anomalies were recorded in Hormozgan Province, with 2.2 times the normal precipitation (Fig. 6.33). From a seasonal perspective, precipitation totals were normal to above normal in much of Iran during autumn 2006.

(v) Significant weather events

Significant weather events included drought, heat and cold waves, flooding, and dust and sandstorms. Floods occurred in northern Iraq in February and November, in Turkey in July, in Pakistan from late July through mid-August, in Afghanistan in August and November, and in Iran's Ardebil Province in May. Heavy rain triggered mudslides in Tajikistan in May and in northern Pakistan on 3 July. In addition, significant drought continued throughout some parts of the region. For example, significant drought across Afghanistan occurred in July as rainfall had been lacking since April 2006. Dust storms blew and spread out over a wide area, covering some parts of Afghanistan, southeastern Iran, and western Pakistan during summer and autumn. Other extreme events, such as a severe winter storm accompanied by heavy snowfall in some provinces of Afghanistan, and near Dushanbe in Tajikestan, caused economic losses.

g. Europe and the Middle East

1) Overview—A. Obregón, P. Bissolli, and J. J. Kennedy

CAMS-OPI precipitation and air temperature anomalies over Europe are shown in Figs. 6.34 and 6.35, respectively. Europe experienced above-normal temperature anomalies across nearly the entire continent in 2006.[6] For the 35°–75°N and 10°W–30°E region the annual average land surface temperature was 1.15° ±0.08°C above the 1961–90 average (based on CRU TEM3; Brohan et al. 2006). The annual average near-surface temperature, incorporating land and sea surface temperatures, was 0.93 ±0.05°C above the 1961–90 mean (Fig. 6.36). The highest positive annual anomalies of more than +4°C were found in

[6] Contributing countries (national meteorological and hydrological services) to this section are Armenia, Austria, Bulgaria, Cyprus, Denmark, Finland, France, Germany, Iceland, Italy, Kazakhstan, Lithuania, Norway, Portugal, Romania, Russia, Spain, Sweden, and the United Kingdom.

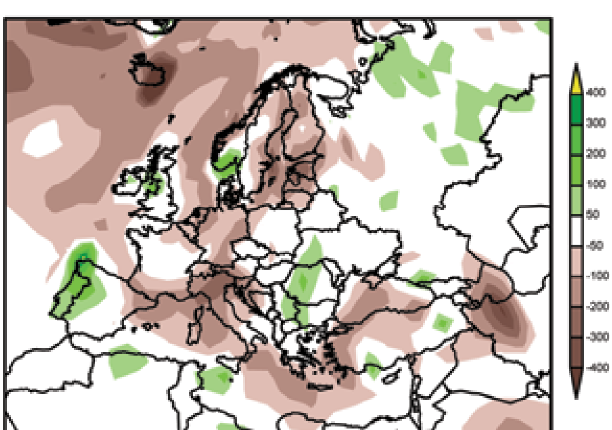

Fig. 6.34. European 2006 annual precipitation anomalies (mm, 1979–2000 base) from CAMS-OPI.

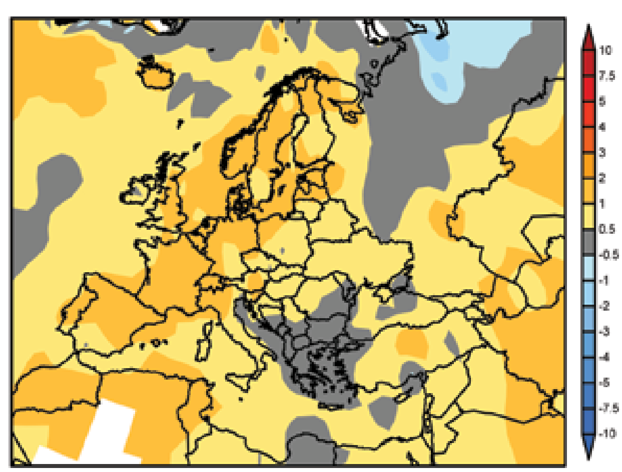

Fig. 6.35. European 2006 annual temperature anomalies (°C, 1971–2000 base) from CAMS-OPI.