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# 2006 WAS THE 6TH WARMEST YEAR ON RECORD

## TOP WEATHER RECORDS FOR 2006

- Globally, sixth warmest year since climate data started to be collected on a global scale in 1861. The ten warmest years have occurred in the past twelve years.

- Second warmest summer in the U.S. and Canada. Warmest summer in Northeast Australia.

- Warmest year in the UK (since 1659) and the Netherlands (since 1706). Warmest autumn in Denmark, Norway, Netherlands, Switzerland, Germany and the UK.

- Worst wild fire season in the United States. More than 9.5 million acres (38 thousand square kilometers) have been burned.

- Arctic sea ice extent for the month of September second lowest on record.

- Possibly the worst flooding in the Great Horn of Africa region for 50 years. Heavy rainfall exceeding 300-600 percent average amount fell after a long period of drought.

- Most powerful typhoon ever to land in China. With maximum wind speeds of 60-80 m/s (134-180 mph), the intensity of super typhoon Saomai was higher than that of hurricane Katrina at landfall.

## THE TREND CONTINUES – GREENHOUSE GAS CONCENTRATIONS HIGHEST IN 650,000 YEARS

The year 2006 continued the recent trend of ever hotter years, and was itself the sixth warmest year on record (WMO, 2006a). The ten warmest years on earth since climate data started to be collected on a global scale in 1861, have occurred since 1995. Since the start of the 20th century, the global average surface temperature has risen approximately 0.7°C (1.25°F). However, warming has accelerated dramatically since 1976, and is now at a rate that is approximately three times higher than that of the century-scale trend (NOAA, 2006a).

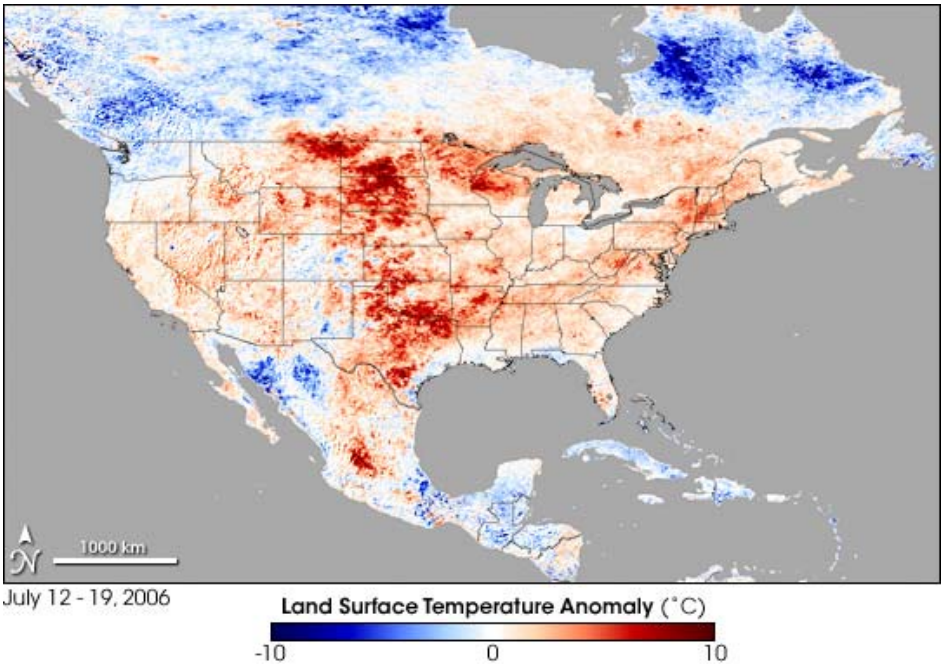
Through burning of fossil fuels and other activities, humans have pumped large amounts of the greenhouse gas, carbon dioxide, into the atmosphere, trapping heat at the Earth's surface, causing widespread warming worldwide and profoundly changing the Earth's climate. Atmospheric concentrations of carbon dioxide, are now 35% higher than at pre-industrial times (WMO, 2006b); deep ice cores in Antarctica show that the atmosphere now holds more carbon dioxide than at any other time in the past 650,000 years (Siegenthaler et al., 2005). The link between elevated concentrations of carbon dioxide and global warming is indisputable. Record and extreme weather events and publication of compelling scientific research in 2006 reinforce that global warming is real and that urgent action is needed to avoid extremely dangerous climate change.

## SYDNEY, NEW YORK, LONDON – SCORCHED BY HOTTEST SUMMERS

Summer 2005/2006 was the hottest summer on record in the northeastern Australian states of Queensland and New South Wales. Sydney, the Australian capital, sweltered under 44°C (111°F) on New Year's Day (Australian Bureau of Meteorology, 2006a,b,c). At some locations in the southern Great Barrier Reef, up to 50 percent of coral bleached under the heat (NASA, 2006a). Warm waters force corals to cast out the tiny algae that help them thrive and give them their color. Without these algae, the corals turn white and could eventually die, if the condition persists for too long.

The heat was not isolated in Australia, however. Later in the year, a record heat wave spread through North America and Europe. The United States and Canada experienced their second warmest summer on record (NOAA, 2006a; Environment Canada, 2006), while the UK, Belgium, Ireland and the Netherlands saw their warmest July on record. Recent scientific research has confirmed that the warming of North America and Europe in recent decades are at least partly due to the increase in carbon dioxide in the atmosphere caused by human

activities (Karoly and Stott, 2006; Karoly et al, 2003). Research also shows that if such human-caused global warming continues, heat waves like the ones experienced in 2006 are likely to occur more often (Santos and Real, 2006; Stott et al., 2004).




*Land surface temperatures above or below the six-year average in the United States for the period 12-19 July, 2006. Deep red across the Midwest indicates that land surface temperatures were as much as 10°C (18°F) warmer than the six-year average. Courtesy of NASA Earth Observatory (2006b).*

In the United States, 2006 was the third warmest year since records began in 1895 (NOAA, 2006b). July temperatures broke more than 2,300 daily temperature records (NOAA, 2006a,c). Air temperatures soared past 38°C (100°F). There were more than 150 heat-related deaths, many of them in the state of California. The mayor of New York declared a state of emergency in the city due to the heat (NYC, 2006). The scorching temperatures, combined with a shortage of rainfall, led to moderate-to-extreme drought conditions in more than half of the country in July, creating one of the biggest droughts in the last 50 years (NOAA, 2006c). Hot and dry conditions sent wildfires raging across the country. Over 9.5 million acres (38 thousand square kilometers) have been burned, making 2006 a record year for the number of acres burned for an entire year (NIFC, 2006). Over the past three decades, wildfire frequency and duration in the western United States have already increased several-fold, as a result of earlier snowmelt, higher spring and summer temperatures (Westerling et al., 2006). According to the California Climate Change Center, if global warming continues, the probabilities of large fires in the state could increase by over one-

third by mid-century, resulting in a similar increase in related damage costs (Westerling and Bryant, 2006).

Across the Atlantic, a summer heat wave was followed by a record-breaking warm autumn. July 2006 was the warmest month in Germany since records began in 1901. The central half of the country, including the cities of Berlin, Freiburg and Heidelberg, recorded temperatures that were 5-6°C (9-11°F) above average (DWD, 2006a). This summer became the hottest summer in the UK since records began in 1659 (UK Met Office, 2006a). The heat compounded below-average rainfall in south east and central England in the two previous winters. By the end of the summer, these regions were experiencing the driest 23-month period between November and September[1] in 70 years (UK Met Office, 2006b). Later in the year, the countries of Denmark, Norway, Netherlands, Switzerland, Germany and the UK all experienced the warmest autumn since their weather records began (EUMETSTAT, 2006; DWD, 2006b; Météo Suisse, 2006). The Netherlands and the UK, which have some of the longest weather records in the world - stretching back over 300 years – saw 2006 as the warmest year on their records.

The hot and dry conditions affected cereal crops, such as wheat, maize and barley, in large parts of Europe. The weather conditions reduced the photosynthetic activity of the plants and shortened the plants' life cycles. The largest losses in crop yields were recorded in France, Germany, the Baltic countries and Poland. In Germany and Estonia, yields of wheat crops were 10 and 37 percent below average respectively (European Commission, 2006).

## ARCTIC SEA ICE, GREENLAND ICE SHEET SHRINK RAPIDLY

## ANTARCTIC ICE SHELF COLLAPSE LINKED TO GREENHOUSE WARMING

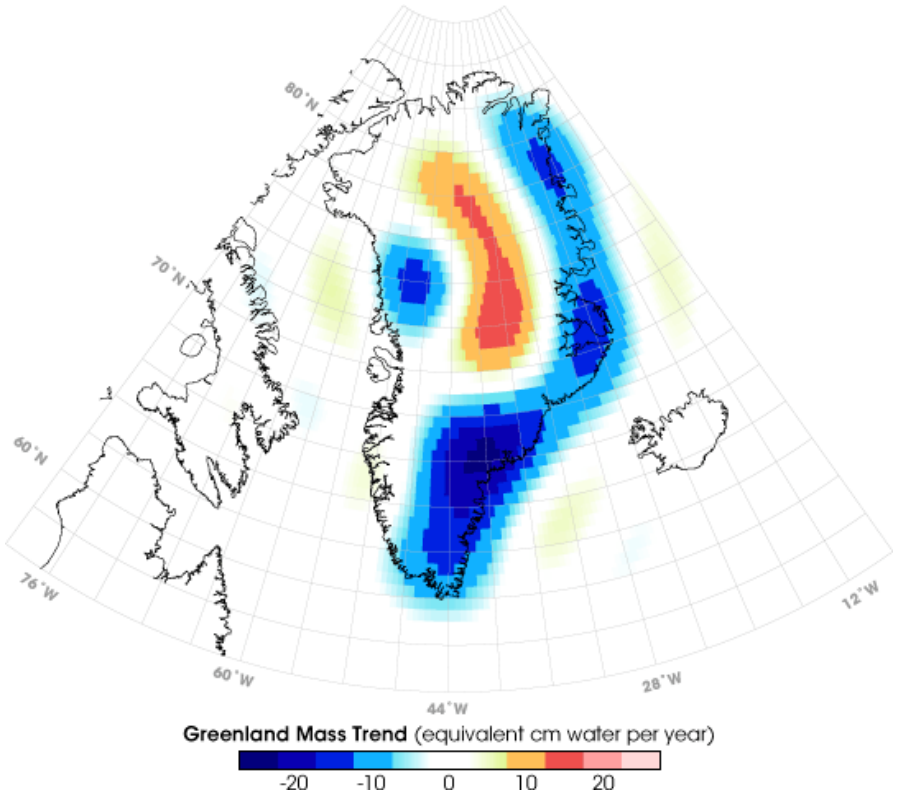
Arctic sea ice continued its sharp decline in 2006. The average sea ice extent (or area covered) for the entire month of September was the second lowest on record - the lowest was recorded in 2005. High temperatures limited ice growth in the winter and accelerated ice melt in the summer. According to the U.S. National Snow and Ice Data Center, Arctic sea ice extent is shrinking at a rate of approximately 60,421 square kilometers (23,328 square miles) - one-fifth the size of Germany - per year (NSIDC, 2006). Latest research shows that the Arctic Ocean could have no ice in September by the year 2040 (Holland et al., 2006).

[1] Comparison is made between equivalent fixed periods, i.e., periods that span 23 months from November of Year 1 to September of Year 3. The last driest equivalent fixed period was November 1932 to September 1934.

Polar bears depend on sea ice for survival as sea ice serves as the platform on which they travel and hunt. Sea ice is now forming three weeks later in autumn in Hudson Bay. The shorter ice season and the reduced amount of ice are already taking a toll on polar bear populations in parts of Canada. Bear numbers have declined by one-fifth in western Hudson Bay, and the average weight of female bears – a key to reproductive success - has also reduced by about 65 kg (143 pounds). Scientists expect that if the average weight of female bears continues to decline at a similar rate, most will stop producing cubs within the next 20 to 30 years as the climate continues to warm (Stirling and Parkinson, 2006).

*Polar bear (Ursus maritimus), in blue ice. Bukta Tikay, Franz Josef Land, Svalbard, Spitsbergen, Norway. Arctic archipelago © WWF-Canon / Wim VAN PASSEL*

Still in the Arctic, scientists from NASA have now confirmed that the Greenland ice sheet is losing more ice than it is gaining (Luthcke et al., 2006). Greenland's massive ice sheet has lost nearly 100 gigatons of ice annually recently and does not seem to show any signs of slowing down. Between 2002 and 2004, glaciers in southern Greenland have accelerated their flow into the surrounding seas by 250 percent. Earlier studies show that glaciers in the north may also be starting to accelerate, increasing the rate at which they lose ice to the sea (Velicogna and Wahr, 2006).



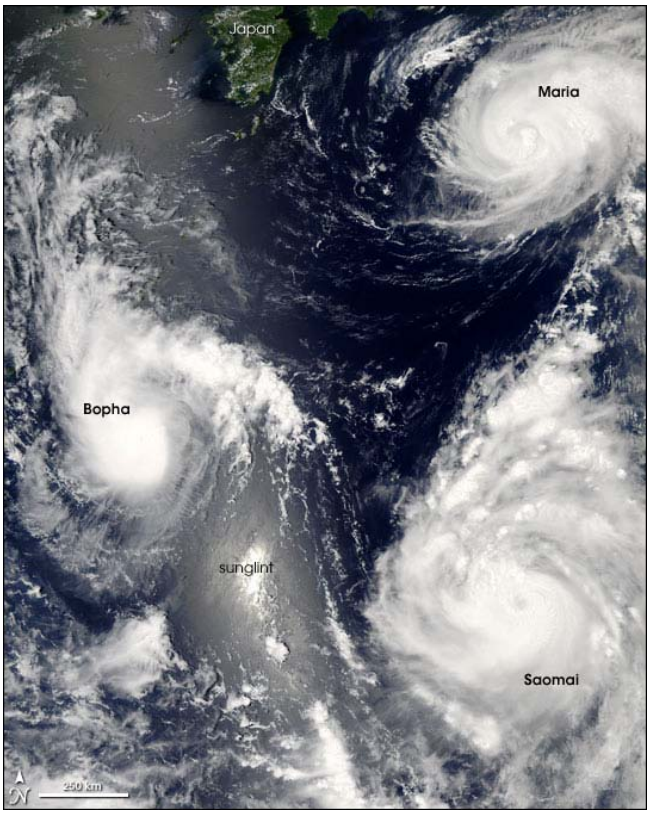

*Blue areas show net ice loss. Orange areas show net ice gain. Courtesy of NASA Earth Observatory (2006d).*

At the other end of the world, the Antarctic Peninsula saw the collapse of the Larsen B Ice Shelf in 2002. A chunk of ice 3250 square kilometers (1,250 square miles, and about the size the state of Rhode Island in the United States) in area and 220 m (720 feet) thick broke off from the Antarctic ice sheet, and opened the gate for nearby glaciers to flow towards the ocean at up to eight times their original speed. After several years of research, scientists from the British Antarctic Survey have now confirmed that human-caused global warming coupled with the effects of the ozone hole were responsible for creating the weather conditions that led to the ice shelf's disintegration (Marshall et al., 2006).

Melting glaciers and ice sheets contribute to global sea level rise. According to the latest estimates, they are responsible for 20-30% of the current sea level rise (Kaser et al., 2006). In the European Alps, glaciers have already lost two-thirds of their total volume since 1850. Scientists estimate that a 3°C (5.4°F) warming of summer air temperature would reduce the currently existing Alpine glacier cover by another 80%. In the event of a 5°C (9°F) temperature increase, the Alps would become almost completely ice-free (Zemp et al., 2006).

# SUPER TYPHOON, STRONGER THAN KATRINA, LANDS IN CHINA

In August, southeastern China was hit by super typhoon Saomai, which slammed into Zhejiang province with maximum wind speeds of 60-80 m/s (134-180 mph), going down into the record books as the most powerful typhoon ever to land over China. At landfall, the intensity of typhoon Saomai was higher than that of hurricane Katrina that landed in New Orleans in the southeastern United States in 2005. Saomai resulted in the evacuation of 1.5 million people and at least 441 fatalities (Duan, 2006). Earlier in the year, another typhoon, Bilis, set the record as the longest-living typhoon ever to be sustained over the country. After landfall, Bilis remained active for five days – five times longer than the lifetime of the majority of typhoons - inundating areas in the western part of South China with 300-500 mm (12-20 inches) of rain, causing devastating mudslides and millions of yuan of damage (Duan, 2006). The active typhoon season in 2006 was not an isolated event – scientists from the China Meteorological Administration and the UK Meteorological Office have found that typhoons have intensified over eastern and southeastern parts of China over the past half century (Zou et al., 2006).




*Three different typhoons were spinning over the western Pacific Ocean on August 7, 2006. Typhoon Saomai was the strongest of the three. Courtesy of NASA Earth Observatory (2006c)*

Record cyclones were not limited to the Northern Hemisphere in 2006. The most powerful cyclone ever observed in the Australian basin landed in northern Australia in April, 2006 (Saunders and Lea, 2006). Severe tropical cyclone Monica was a small cyclone in size but was very intense. Maximum wind gusts were estimated to reach 360 km/h (224 mph) (Australian Bureau of Meteorology, 2006d). Fortunately its landfall as a Category 5 storm occurred in a sparsely populated area to the east of Darwin, resulting in minor damage to human infrastructure.

As well as Monica, two other very severe tropical cyclones struck Australia in 2006. With estimated maximum wind gusts of 300 km/h (186 mph), cyclone Glenda probably ranks among one of the strongest cyclones ever observed in the Australian basin (Australian Bureau of Meteorology, 2006e). Slightly less intense, cyclone Larry crossed near a populated section of the east coast of Queensland in March. With estimated maximum wind gusts of 290 km/h (180 mph), Larry destroyed 90% of the region's banana crop, resulting in losses of 295 million Australian dollars (approximately 175 million Euros) (Australian Banana Growers Council, 2006) and damaged up to 80% buildings in some areas. Electricity transmission, and road and rail access were severely disrupted, and food drops were necessary for some communities in the northwest part of the state (Australian Bureau of Meteorology, 2006f; Saunders and Lea, 2006).

After a record-breaking season in 2005, North Atlantic hurricane activity returned to average levels in 2006. Scientists now confirm that the exceptionally active hurricane season in 2005 was fueled by record high sea surface temperatures in the North Atlantic Ocean, which were partly caused by human-caused global warming (Trenberth and Shea, 2006; Santer et al., 2006). Many studies have suggested that continued global warming is likely to affect the frequency and characteristics of severe storms worldwide. Some have already documented the strengthening and increasing destructiveness of typhoons in the western North Pacific, subtropical East Asia and southern and eastern China in the past 30-50 years (Zou et al., 2006; Emanuel, 2005; Wu et al., 2005). In the North Atlantic, the intensity and longevity of hurricanes have increased significantly over the past 20 years (Klotzbach, 2006). A number of independent studies, examining data from the past 40 years or longer, support the argument that higher sea surface temperatures are fueling stronger and more large Atlantic hurricanes (Mann and Emmanuel, 2006; Sriver and Huber, 2006; Elsner, 2006; Hoyos et al., 2006), while the same relationship was not found in analyses focusing on shorter time periods or at a finer spatial resolution (Michaels et al, 2006; Klotzbach, 2006).

## RECORD RAINFALLS, RIVER LEVELS IN INDIA AND EASTERN EUROPE

The effects of human-caused global warming are not limited to just heat waves and droughts. Because the earth's climate is profoundly altered, global warming

also brings along more variable extreme precipitation (rain or snow) events, which have the potential to unleash devastating floods.

***South Asia***

The twentieth century was the wettest period in northern Pakistan over the past millennium, likely as a result of human-caused global warming (Treydte et al., 2006). The trend of heavy rainfall continued into 2006 where the monsoon season brought record rainfall in some locations in Pakistan and neighbouring India, and caused widespread flooding, property damage and fatalities. In northern Pakistan, where communities were still recovering from the devastating earthquake of October 2005, landslides and flash floods damaged houses, roads and other infrastructure. Heavy rains damaged crops across the country (IFRC, 2006a). In the city of Bhopal in central India, rainfall broke a 33-year record, with a 32 cm (12.6 inches) of rain falling in one day. Over 4,000 houses were damaged. Electricity and water supply were interrupted, and rail, road and air traffic were disrupted for two days (UNICEF, 2006a). Home to the Thar or Great Indian Desert, the northwestern Indian state of Rajasthan is normally prone to droughts. However, unusually heavy rains in August triggered the worst floods in 200 years (IFRC, 2006b). An estimated 28 million cubic meters (or 1,000 million cubic feet of water, equivalent to the volume of 11,200 Olympic-sized swimming pools) stagnated in Malwa village, and 47,000 cattle have been killed during the floods (UNDP, 2006).

***Southeast Europe***

In Central and southeast Europe, extraordinarily fast progressing snowmelt and heavy rainfall pushed the Danube river to its highest levels for over a century. Floods began in Hungary in April, where, in the capital city Budapest, the Danube rose above its record levels which were last reached during the major floods of 2002. Further down the river in Serbia, floods submerged 3,000 houses and left 11,000 people displaced or homeless. Five percent of the country's arable land was submerged, and local authorities estimated farm damage at 35.7 million Euros. At the lower reaches of the Danube, water volume reached double its average value for the time of the year. In Romania, 15,000 persons were evacuated, and over 500 km (310 miles) of roads and more than 200 bridges were damaged. A situation of disaster was declared in seven regions along the Danube in Bulgaria, and a tent camp for 3,000 to 4,500 was set up in the Vidin region to prepare for evacuation of endangered communities (Stability Pact for South East Europe, 2006; IFRC, 2006c; WWF, 2006).

***Africa***

The Great Horn of Africa region, encompassing the countries of Somalia, Kenya and Ethiopia, has experienced severe drought since late 2005. Heavy rains arrived in October 2006. Most regions of Somalia received more than 300 percent normal rainfall, with some stations recording rainfall 400-600 percent higher than average (FAO, 2006). The dry ground was unable to soak up the large amounts of rainfall, and led to severe flooding, and widespread property

damage and crop losses (UN, 2006). In Kenya, it is estimated that 3 million people are at risk of cholera and malnutrition as a result of the breakdown of sanitation and water supply and crop destruction (UNICEF, 2006b). This year's floods are said to be the worst in 50 years in the region (WMO, 2006a).

Such events are exactly in line with what scientists have projected would be the consequences of global warming in the region. Research shows that East Africa is likely to experience warmer temperatures and a 5-20% increased rainfall from December-February and 5-10% decreased rainfall from June-August by 2050 (Hulme et al., 2001; IPCC, 2001). These changes are likely to occur in sporadic and unpredictable events, accompanied by more frequent and severe droughts during the dry season and a few but very large rainstorms during the wet season.

## GERMANY'S 2006 WILD WEATHER: A SYMPTOM OF CLIMATE CHANGE

Human-caused global warming is profoundly changing the Earth's climate. Warmer and drier conditions are more common. The climate also becomes more variable, bringing more extreme events with greater intensity. The wild weather in Germany in 2006 is a distinct symptom of this change.

Germany began the year with a cold, snowy winter. In January, arctic winds blew from Siberia and plunged Bavaria into a deep freeze. Temperatures of -20°C to -36°C (-4°F to -33°F) were measured across Bayerischer Wald, Vorpommern and Berchtesgadener Alpen. Berlin recorded its coldest day since 1978. Thick sheets of ice stretched over 80 km (50 miles) over the Rhine-Main-Danube canal. The canal had to be closed to shipping.

Heavy snowfall made several visits to southern Germany during the winter of 2006. February saw the heaviest snowfall in the region in a decade. Thousands of firefighters, army personnel and volunteers worked frantically to remove snow from roofs, which have, in some cases, accumulated up to 2.5 m (eight feet) in depth. Bavaria and Baden-Württemberg were hit again by heavy snowfall in March. Road and air traffic came to a standstill. Volunteers distributed blankets and hot tea to motorists who were trapped in 300 km (186 miles) of traffic jam. Over 600 flights had to be canceled from the airports of Frankfurt Main and Munich (DWD, 2006c).

When the year's exceptionally large amount of snow started to melt, many rivers in southern and eastern Germany overflowed, resulting in one of the largest spring floods during the past 50 years. In April, the Elbe River in parts of northern Germany rose to a record level, even higher than during record flood 2002, the old town of Hitzacker in Lower Saxony was completely flooded. A bigger flood was only prevented by exceptionally emptying Czech reservoirs along the Moldava River before the arrival of the flood waters.

After a period of exceptional wetness, the month of July arrived as a month of extreme heat and drought, at the time of the World Cup final. July 2006 was the hottest month ever in Germany since records began over a century ago. In Berlin, where the World Cup final was held, temperatures reached 39°C (102°F). Scientific research has shown that, if human-caused global warming continues, heat waves such as these are likely to occur more often (Santos and Real, 2006; Stott et al., 2004).

Also, during the month of July, over 90% of the country received below-average rainfall. Areas of eastern Germany and the Bavarian forest received less than one-fifth of the normal average rainfall for the month. Water levels dropped in lakes and rivers. Navigation on the Elbe River was disrupted after water levels dropped below navigable levels. Four months after flooding its banks, water in the river was just 90 centimeters (three feet) deep in some parts. Low river levels and high water temperatures forced power plants to slow down their production in order to avoid overheating nearby rivers with hot water draining from their cooling systems. The exceptionally hot and dry conditions also severely affected cereal harvests, lowering yields of wheat crops by 10% (European Commission, 2006). Such dry conditions are likely to become more common in the future: scientists from the University of Kassel have shown that, as global warming continues, droughts could become ten times as frequent as today in eastern parts of the country (Lehner et al., 2006).

The warmest July on record was followed by the warmest autumn, also since records began in 1901. The mean temperature during this autumn was 3-4°C (5-7°F) above average. The city of Kalkar on the Lower Rhine has the distinction of recording the highest temperature this autumn on the 12th September with 31.4°C (88.5°F) (DWD, 2006c). Global warming leads to warmer mean temperatures but it also means that extreme temperatures become more likely (IPCC, 2001). As a result, unusually warm weather is likely to become more common in the future.

Earlier in the year, German and Swiss scientists published their research findings which show that global warming is likely to lead to stronger storms in large parts of Europe (Leckebusch et al., 2006). Not long after, northern Germany was hit by hurricane-force winds which caused widespread damage to property and infrastructure. Storm Britta sustained winds of up to 156 km/h (97 mph), causing waves of up to 17 m (55 feet) high north of Borkum (DWD, 2006c). One ship sank, parts of the port of Hamburg had to be closed because the streets were underwater and the Elbe River stood 5 m (16 feet) above its normal level.

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