

## Regional changes in temperature and precipitation extremes

Table 21.7: An assessment of observed and projected future changes in temperature and precipitation extremes over 26 sub-continental regions as defined in the SREX report (IPCC 2012; see also Figure 21.4 and Table SM21.2). Confidence levels are indicated by colour coding of the symbols. Likelihood terms are given only for high confidence statements and are specified in the text. Observed trends in temperature and precipitation extremes, including dryness, are generally calculated from 1950, using the period 1961–1990 as a baseline (see Box 3.1 chapter 3 of IPCC (2012a)). The future changes are derived from global and regional climate model projections of the climate of 2071–2100 compared with 1961–1990 or 2080–2100 compared with 1980–2000. Table entries are summaries of information in Tables 3.2 and 3.3 of IPCC (2012a) supplemented with or superseded by material from Chapters 2 (section 2.6 and Table 2.13) and 14 (section 14.4) of the IPCC AR5 WG1 report and Table 25-1 of the IPCC WG2 report.

The source(s) of information for each entry are indicated by the superscripts a (Table 3.2 of IPCC, 2012a), b (Table 3.3 of IPCC, 2012a), c (Chapter 2 (section 2.6 and Table 2.13) IPCC AR5 WG1 report), d (Chapter 14 (section 14.4) of the IPCC AR5 WG1 report) and e (Table 25-1 of the IPCC WG2 report).

Region/ region code	Trends in daytime temperature extremes (frequency of hot and cool days)		Trends in nighttime temperature extremes (frequency of warm and cold nights)		Trends in heat waves/warm spells		Trends in heavy precipitation (rain, snow)		Trends in dryness and drought	
	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected
West North America WNA, 3	Very likely large increases in hot days (large decreases in cool days) <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Very likely large decreases in cold nights (large increases in warm nights) <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase in warm spell duration <sup>a</sup>	Likely more frequent, longer and/or more intense heat waves and warm spells <sup>b</sup>	Spatially varying trends. General increase, decrease in some areas <sup>a</sup>	Increase in 20-year return value of annual maximum daily precipitation and other metrics over northern part of the region (Canada) <sup>b</sup>  Less confidence in Southern part of the region, due to inconsistent signal in these other metrics <sup>b</sup>	No or overall slight decrease in dryness <sup>a</sup>	Inconsistent signal <sup>b</sup>
Central North America CNA, 4	Spatially varying trends: small increases in hot days in the north, decreases in the south <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Spatially varying trends: Small increase in cold nights (and decreases in warm nights) in south and vice versa in the north <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Spatially varying trends <sup>a</sup>	Likely more frequent, longer and/or more intense heat waves and warm spells <sup>b</sup>	Very likely increase since 1950 <sup>a</sup>	Increase in 20-year return value of annual maximum daily precipitation <sup>b</sup>  Inconsistent signal in other heavy precipitation days metrics <sup>b</sup>	Likely decrease <sup>a, c</sup>	Increase in consecutive dry days and soil moisture in southern part of Central North America <sup>b</sup>  Inconsistent signal in the rest of the region <sup>b</sup>
East North America ENA, 5	Spatially varying trends. Overall increases in hot days (decreases in cool days), opposite or insignificant signal in a few areas <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Weak and spatially varying trends <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Spatially varying trends, many areas with increase in duration, some areas with decrease <sup>a</sup>	Likely more frequent, longer and/or more intense heat waves and warm spells <sup>b</sup>	Very likely increase since 1950 <sup>a</sup>	Increase in 20-year return value of annual maximum daily precipitation. Additional metrics support an increase in heavy precipitation over northern part of the region <sup>b</sup>  No signal or inconsistent signal in these other metrics in the southern part of the region <sup>b</sup>	Slight decrease in dryness since 1950 <sup>a</sup>	Inconsistent signal in consecutive dry days, some consistent decrease in soil moisture <sup>b</sup>
Alaska/Northwest Canada ALA, 1	Very likely large increases in warm days (decreases in cold days) <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Very likely large decreases in cold nights, increases in warm nights <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely more frequent, and/or longer heat waves and warm spells <sup>b</sup>	Slight tendency for increase <sup>a</sup>  No significant trend in southern Alaska <sup>a</sup>	Likely increase in heavy precipitation <sup>b</sup>	Inconsistent trends <sup>a</sup>  Increases in dryness in part of the region <sup>a</sup>	Inconsistent signal <sup>b</sup>

Region/ region code	Trends in daytime temperature extremes (frequency of hot and cool days)		Trends in nighttime temperature extremes (frequency of warm and cold nights)		Trends in heat waves/warm spells		Trends in heavy precipitation (rain, snow)		Trends in dryness and drought	
	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected
East Canada, Greenland, Iceland CGI, 2	Likely increases in hot days (decreases in cool days) in some areas, decrease in hot days (increase in cool days) in others <sup>a</sup>	Very likely increase in warm days (decrease in cold days) <sup>b</sup>	Small increases in unusually cold nights and decreases in warm nights in northeastern Canada <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Some areas with warm spell duration increase, some with decrease <sup>a</sup>	Likely more frequent, and/or longer heat waves and warm spells <sup>b</sup>	Increase in a few areas <sup>a</sup>	Likely increase in heavy precipitation <sup>b</sup>	Insufficient evidence <sup>a</sup>	Inconsistent signal <sup>b</sup>
Northern Europe NEU, 11	Increase in hot days (decrease in cool days), but generally not significant at the local scale <sup>a</sup>	Very likely increase in hot days (decrease in cool days) [but smaller trends than in central and southern Europe] <sup>b</sup>	Increase in warm nights (decrease in cold nights) over the whole region, but generally not significant at the local scale <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase in heat waves. Consistent tendency for increase in heat wave duration and intensity, but no significant trend <sup>a</sup>	Likely more frequent, longer and/or more intense heat waves/ warm spells, but summer increases smaller than in southern Europe <sup>b</sup> Little change over Scandinavia <sup>b</sup>	Increase in winter in some areas, but often insignificant or inconsistent trends at subregional scale, particularly in summer <sup>a</sup>	Likely increase in 20-year return value of annual maximum daily precipitation. Very likely increases in heavy precipitation intensity and frequency in winter in the north <sup>b</sup>	Spatially varying trends. Overall only slight or no increase in dryness, slight decrease in dryness in part of the region <sup>a</sup>	No major changes in dryness <sup>b</sup>
Central Europe CEU, 12	Likely overall increase in hot days (decrease in cool days) since 1950 in most regions. Very likely increase in hot days (likely decrease in cool days) in west Central Europe <sup>a</sup> Lower confidence in trends in east Central Europe (due to lack of literature, partial lack of access to observations, overall weaker signals, and change point in trends) <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely overall increase in warm nights (decrease in cold nights) at the yearly timescale. Some regional and seasonal variations in significance and in a few cases sign of trends. Very likely increase in warm nights (decrease in cold nights) in west Central Europe <sup>a</sup> Lower confidence in trends in east Central Europe (due to lack of literature, partial lack of access to observations, overall weaker signals, and change point in trends) <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase in heat waves. Consistent increase in heat wave duration and intensity, but no significant trend. Significant increase in maximum heatwave duration in west Central Europe in summer <sup>a</sup>	Likely more frequent, longer and/or more intense heat waves/ warm spells <sup>b</sup> Insignificant or inconsistent trends elsewhere, in particular in summer <sup>a</sup>	Increase in part of the region, in particular central Western Europe and European Russia, especially in winter <sup>a</sup> Less confidence in summer, due to inconsistent evidence <sup>b</sup>	Likely increase in 20-year return value of annual maximum daily precipitation. Additional metrics support an increase in heavy precipitation in large part of the region over winter <sup>b</sup>	Spatially varying trends. Increase in dryness in part of the region but some regional variation in dryness trends and dependence of trends on studies considered (index, time period) <sup>a</sup>	Increase in dryness in central Europe and increase in short-term droughts <sup>b</sup>
Southern Europe and Mediterranean MED, 13	Likely increase in hot days (decrease in cool days) in most of the region. Some regional and temporal variations in the significance of the trends. Likely strongest and most significant trends in Iberian peninsula and southern France <sup>a</sup> Smaller or less significant trends in southeastern Europe and Italy due to change point in trends, strongest increase in hot days since 1976 <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely increase in warm nights (decrease in cold nights) in most of the region. Some regional variations in the significance of the trends. Very likely overall increase in warm nights (decrease in cold nights) in S.W. Europe/W. Mediterranean <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Likely increase in most regions <sup>a</sup>	Likely more frequent, longer and/or more intense heat waves and warm spells (likely largest increases in SW, S and E of the region) <sup>b</sup>	Inconsistent trends across the region and across studies <sup>a</sup>	Inconsistent changes and/or regional variations <sup>b</sup>	Overall increase in dryness, likely increase in the Mediterranean <sup>a,c</sup>	Increase in dryness. Consistent increase in area of drought <sup>b,d</sup>

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	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected
West Africa WAF, 15	Significant increase in temperature of hottest day and coolest day in some parts <sup>a</sup> Insufficient evidence in other parts <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Increasing frequency of warm nights. Decrease in cold nights in western central Africa, Nigeria, and Gambia <sup>a</sup> Insufficient evidence on trends in cold nights in other parts <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Insufficient evidence for most of the region <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Rainfall intensity increased <sup>a</sup>	Slight or no change in heavy precipitation indicators in most areas <sup>b</sup> Low model agreement in northern areas <sup>b</sup>	Likely increase but 1970s Sahel drought dominates the trend; greater inter-annual variation in recent years <sup>a,c</sup>	Inconsistent signal <sup>b</sup>
East Africa EAF, 16	Lack of evidence due to lack of literature and spatially non-uniform trends <sup>a</sup> Increases in hot days in Southern tip (decrease in cool days) <sup>b</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Spatially varying trends in most areas <sup>a</sup> Increases in warm nights in Southern tip (decrease in cold nights) <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup> Increase in warm spell duration in Southern tip of the region <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely increase in heavy precipitation <sup>b</sup>	Spatially varying trends in dryness <sup>a</sup>	Decreasing dryness in large areas <sup>b</sup>
Southern Africa SAF, 17	Likely increase in hot days (decrease in cool days) <sup>a,c</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely increase in warm nights (decrease in cold nights) <sup>a,c</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase in warm spell duration <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Increases in more regions than decreases but spatially varying trends <sup>a</sup>	Lack of agreement in signal for region as a whole <sup>b</sup> Some evidence of increase in heavy precipitation in southeast regions <sup>b</sup>	General increase in dryness <sup>a</sup> Consistent increase in area of drought <sup>b</sup>	Increase in dryness, except eastern part <sup>b,d</sup> Consistent increase in area of drought <sup>b</sup>
Sahara SAH, 14	Lack of literature <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Increase in warm nights <sup>a</sup> Lack of literature on trends in cold nights <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Insufficient evidence <sup>a</sup>	Low agreement <sup>b</sup>	Limited data, spatial variation of the trends <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
Central America and Mexico CAM, 6	Increases in the number of hot days, decreases in the number of cool days <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Increases in number of warm nights (decrease in number of cold nights) <sup>a</sup>	Likely increase in warm nights (likely decrease in cold nights) <sup>b</sup>	Spatially varying trends (increases in some areas, decreases in others) <sup>a</sup>	Likely more frequent, longer and/or more intense heat waves/warm spells in most of the region <sup>b</sup>	Spatially varying trends. Increase in many areas, decrease in a few others <sup>a</sup>	Inconsistent trends <sup>b</sup>	Varying and inconsistent trends <sup>a</sup>	Increase in dryness in Central America and Mexico, with less confidence in trend in extreme South of region <sup>b</sup>
Amazon AMZ, 7	Insufficient evidence to identify trends <sup>a</sup>	Hot days likely to increase (cool days likely to decrease) <sup>b</sup>	Insufficient evidence to identify trends <sup>a</sup>	Very likely increase in warm nights (likely decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely more frequent and longer heat waves and warm spells <sup>b</sup>	Increases in many areas, decreases in a few <sup>a</sup>	Tendency for increases in heavy precipitation events in some metrics <sup>b</sup>	Decrease in dryness for much of the region. Some opposite trends and inconsistencies <sup>a</sup>	Inconsistent signals <sup>b</sup>
Northeastern Brazil NEB, 8	Increases in the number of hot days <sup>a</sup>	Hot days likely to increase (cool days likely to decrease) <sup>b</sup>	Increases in the number of warm nights <sup>a</sup>	Likely increase in warm nights (likely decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely more frequent and longer heat waves and warm spells in some studies <sup>b</sup>	Increases in many areas, decreases in a few <sup>a</sup>	Slight or no change <sup>b</sup>	Varying and inconsistent trends <sup>a</sup>	Increase in dryness <sup>b</sup>
Southeastern South America SSA, 10	Spatially varying trends (increases in some areas decreases in others) <sup>a</sup>	Hot days likely to increase (cool days likely decrease) <sup>b</sup>	Increases in number of warm nights (decreases in number of cold nights) <sup>a</sup>	Very likely increase in warm nights (likely decrease in cold nights) <sup>b</sup>	Spatially varying trends (increases in some areas, decreases in others) <sup>a</sup>	Tendency for more frequent and longer heat waves and warm spells <sup>b</sup>	Increases in northern areas <sup>a</sup> Insufficient evidence in southern areas <sup>a</sup>	Increases in northern areas <sup>b</sup> Insufficient evidence in southern areas <sup>b</sup>	Varying and inconsistent trends <sup>a</sup>	Inconsistent signals <sup>b</sup>
West Coast South America WSA, 9	Spatially varying trends (increases in some areas decreases in others) <sup>a</sup>	Hot days likely to increase (cool days likely decrease) <sup>b</sup>	Increases in number of warm nights (decreases in number of cold nights) <sup>a</sup>	Likely increase in warm nights (likely decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely more frequent and longer heat waves and warm spells <sup>b</sup>	Increases in many areas, decrease in a few areas <sup>a</sup>	Increases in tropics <sup>b</sup> Low confidence in extratropics <sup>b</sup>	Varying and inconsistent trends <sup>a</sup>	Decrease in consecutive dry days in the tropics, and increase in the extratropics <sup>b</sup>
										Increase in consecutive dry days and soil moisture in southwest South America <sup>b</sup>

Region/ region code	Trends in daytime temperature extremes (frequency of hot and cool days)		Trends in nighttime temperature extremes (frequency of warm and cold nights)		Trends in heat waves/warm spells		Trends in heavy precipitation (rain, snow)		Trends in dryness and drought	
	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected	Observed	Projected
North Asia NAS, 18	Likely increase in hot days (decrease cool days) <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely increase in warm nights (decrease cold nights) <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Spatially varying trends <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Increase in some regions, but spatial variation <sup>a</sup>	Likely increase in heavy precipitation for most regions <sup>b</sup>	Spatially varying trends <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
Central Asia CAS, 20	Likely increase in hot days (decrease cool days) <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely increase in warm nights (decrease cold nights) <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase in warm spell duration in a few areas <sup>a</sup> Insufficient evidence in others <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Spatially varying trends <sup>a</sup>	Inconsistent signal in models <sup>b</sup>	Spatially varying trends <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
East Asia EAS, 22	Likely increase in hot days (decrease cool days) <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Increase in warm nights (decrease cold nights) <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase heat wave in China <sup>a</sup> Increase in warm spell duration in northern China, decrease in southern China <sup>b</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Spatially varying trends <sup>a</sup>	Increase in heavy precipitation across the region <sup>b</sup>	Tendency for increased dryness <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
Southeast Asia SEA, 24	Increase in hot days (decrease cool days) for northern areas <sup>a</sup> Insufficient evidence for Malay Archipelago <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Increase in warm nights (decrease cold nights) for northern areas <sup>a</sup> Insufficient evidence for Malay Archipelago <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells over continental areas <sup>b</sup> Low confidence in changes for some areas <sup>b</sup>	Spatially varying trends, partial lack of evidence <sup>a</sup>	Increases in most metrics over most (especially non-continental) regions. One metric shows inconsistent signals of change <sup>b</sup>	Spatially varying trends <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
South Asia SAS, 23	Increase in hot days (decrease cool days) <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Increase in warm nights (decrease in cold nights) <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Insufficient evidence <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Mixed signal in India <sup>a</sup>	More frequent and intense heavy precipitation days over parts of S. Asia. Either no change or some consistent increases in other metrics <sup>b</sup>	Inconsistent signal for different studies and indices <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
West Asia WAS, 19	Very likely increase in hot days (decrease in cool days <i>more likely than not</i> ) <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely increase in warm nights (decrease in cold nights) <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase in warm spell duration <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Decrease in heavy precipitation events <sup>a</sup>	Inconsistent signal of change <sup>b</sup>	Lack of studies, mixed results <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
Tibetan Plateau TIB, 21	Likely increase in hot days (decrease cool days) <sup>a</sup>	Likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely increase in warm nights (decrease cold nights) <sup>a</sup>	Likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Spatially varying trends <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Insufficient evidence <sup>a</sup>	Increase in heavy precipitation <sup>b</sup>	Insufficient evidence. Tendency to decreased dryness <sup>a</sup>	Inconsistent signal of change <sup>b</sup>
North Australia NAU, 25	Likely increase in hot days (decrease in cool days). Weaker trends in northwest <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Likely increase in warm nights (decrease in cold nights) <sup>a</sup>	Very likely increase in warm nights (decrease of cold nights) <sup>b</sup>	Insufficient literature <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Spatially varying trends, which mostly reflect changes in mean rainfall <sup>a</sup>	Increase in most regions in the intensity of extreme (i.e. current 20 year return period) heavy rainfall events <sup>a</sup>	No significant change in drought occurrence over Australia (defined using rainfall anomalies) <sup>a</sup>	Inconsistent signal <sup>b</sup>
South Australia/ New Zealand SAU, 26	Very likely increase in hot days (decrease in cool days) <sup>a</sup>	Very likely increase in hot days (decrease in cool days) <sup>b</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>a</sup>	Very likely increase in warm nights (decrease in cold nights) <sup>b</sup>	Increase in warm spells across southern Australia <sup>a</sup>	Likely more frequent and/or longer heat waves and warm spells <sup>b</sup>	Spatially varying trends in S Australia, which mostly reflect changes in mean rainfall <sup>a</sup> Spatially varying trends in NZ, which mostly reflect changes in mean rainfall <sup>b</sup>	Increase in most regions in the intensity of extreme (i.e. current 20 year return period) heavy rainfall events <sup>a</sup>	No significant change in drought occurrence over Australia (defined using rainfall anomalies) <sup>a</sup>	Increase in drought frequency in southern Australia, and in many regions of New Zealand <sup>b</sup>
									No trend in drought occurrence over New Zealand (defined using a soil water balance model) since 1972 <sup>a</sup>	