UNDP Climate Change Country Profiles

Benin

C. McSweeney[1], M. New[1,2] and G. Lizcano[1]

1. School of Geography and Environment, University of Oxford.
2. Tyndall Centre for Climate Change Research

http://country-profiles.geog.ox.ac.uk

General Climate

Benin is located in West Africa on the Guinea Coast. At latitudes of 6-13˚N, the climate of Benin is tropical, and strongly influenced by the West African Monsoon.

The rainfall seasons of Benin are controlled by the movement of the tropical rain belt (also known as the Inter-Tropical Conversion Zone, ITCZ), which oscillates between the northern and southern tropics over the course of a year. The dominant wind direction in regions south of the ITCZ is south-westerly, blowing moist air from the Atlantic onto the continent, but north of the ITCZ the prevailing winds come from the north east, bringing hot and dusty air from the Sahara desert (known as the 'Harmattan'). As the ITCZ migrates between its north and south positions over the course of the year, the regions between these those northern and southernmost positions of the ITCZ experience a shift between the two opposing prevailing wind directions. This pattern is referred to as the West African Monsoon. In northern Benin, there is a single wet season occurring between May and November, when the ITCZ is in its northern position and the prevailing wind is south-westerly, and a dry season between December and March when the 'Harmattan' wind blows north-easterly. The northern and central regions receive 200-300mm per month in the peak months of the wet season (July to September). The southern regions of Benin have two wet seasons, one in March to July, and a shorter wet season in September to November, corresponding to the northern and southern passages of the ITCZ across the region.

The seasonal rainfall in this region varies considerably on inter-annual and inter-decadal timescales, due in part to variations in the movements and intensity of the ITCZ, and variations in timing and intensity of the West African Monsoon. The most well documented cause of these variations is the El Niño Southern Oscillation (ENSO). El Niño events are associated with drier conditions in West Africa.

Seasonal variations in temperature in Benin are greatest in the north, with highest temperatures in the hot, dry season (AMJ) at 27-32˚C, and lowest in JAS at 25-27˚C. Further south, temperatures reach up to 27-32˚C in the warmest season JFM, and 22-25˚C at their lowest in JAS.

Recent Climate Trends

Temperature

- Mean annual temperature has increased by 1.1˚C since 1960, an average rate of 0.24˚C per decade. The rate of increase has been most rapid in AMJ, a around 0.31˚C per decade.

- Daily temperature data indicate that the frequency of 'hot'[1] days has increased significantly in all seasons except DJF, and that the frequency of 'hot' nights has increased significantly in all seasons.
    - The average number of 'hot' days per year in Benin has increased by 39 (an additional 10.7% of days[2]) between 1960 and 2003. The rate of increase is seen most strongly in SON when the average number of hot SON days has increased by 9.6 days per month (an additional 31% of SON days) over this period.
    - The average number of 'hot' nights per year increased by 73 (an additional 20% of nights) between 1960 and 2003. The rate of increase is seen most strongly in SON when the average number of hot SON nights has increased by 8.7 days per month (an additional 28.1% of SON nights) over this period.

- The frequency of 'cold'[3] days and nights, annually, has decreased significantly since 1960.
    - The average number of 'cold 'days per year has decreased by 13 (3.6% of days) between 1960 and 2003. This rate of decrease is most rapid in summer (JJA) when the average number of cold summer days has decreased by 2.4 days per month (7.7% of summer days) over this period.
    - The average number of 'cold' nights per year has decreased by 34 (9.3% of days). This rate of decrease is most rapid in SON when the average number of cold SON nights has decreased by 3.4 nights per month (11.1% of SON nights) over this period.

Precipitation

- Annual rainfall in Benin is highly variable on inter-annual and inter-decadal timescales. This means that long term trends are difficult to identify. There is no indication of a long term trend in the annual rainfall record in Benin between 1960 and 2006, but the record is punctuated by wetter and drier periods; rainfall decreased between the early 60s and the 80s, but has since recovered since this particularly dry period.
- Rainfall in AMJ, however, has decreased more consistently throughout the period 1960 to 2006, at an average rate of 3.9mm per month (3.5%) per decade. These decreases are strongest in southern Benin.

[1] 'Hot' day or 'hot' night is defined by the temperature exceeded on 10% of days or nights in current climate of that region and season.

[2] The increase in frequency over the 43-year period between 1960 and 2003 is estimated based on the decadal trend quoted in the summary table.

[3] 'Cold' days or 'cold' nights are defined as the temperature below which 10% of days or nights are recorded in current climate of that region or season.

- The proportion of rainfall that falls in 'heavy'[4] events has decreased since 1960, but the decreases have occurred mainly in the last 5 years.

- Significant decreasing trends have been observed in 1-day rainfall maxima in all seasons and in 5-day rainfall maxima in JJA and SON only.

GCM Projections of Future Climate

Temperature

- The mean annual temperature is projected to increase by 1.0 to 3.0˚C by the 2060s, and 1.5 to 5.1˚C by the 2090s. The range of projections by the 2090s under any one emissions scenario is around 2.0-2.5˚C.
- The projected rate of warming is most rapid in the northern inland regions of Benin than the coastal regions.

- All projections indicate substantial increases in the frequency of days and nights that are considered 'hot' in current climate.
    - Annually, projections indicate that 'hot' days are projected to occur on 16-56% of days by the 2060s, and 23-87% of days by the 2090s. Days considered 'hot' by current climate standards for their season are may increase most rapidly in JAS, but the range between model projections is large, occurring on 33-99% of days of the season by the 2090s.
    - Nights that are considered 'hot' for the annual climate of 1970-99 are projected to occur on 28-72% of nights by the 2060s and 39-88% of nights by the 2090s. Nights that are considered hot for each season by 1970-99 standards are projected to increase most rapidly in JAS, occurring on 61-99% of nights in every season by the 2090s.
- Most projections indicate decreases in the frequency of days and nights that are considered 'cold' in current climate. 'Cold' days and nights occur on less than 3% of days by the 2090s.
- Although the projected mean temperature increases most rapidly in the interior regions of Benin than near the coast, the projected changes in the daily temperature extremes ('hot' and 'cold' days and nights) in Benin are largest in the coastal areas, and smaller inland.

Precipitation

- Projections of mean annual rainfall averaged over the country from different models in the ensemble project a wide range of changes in precipitation for Benin, covering a similar range of increases as decreases.
- Seasonally, the projections tend towards decreases in JFM and AMJ rainfall, and increases in JAS and OND rainfall.

[4] A 'Heavy' event is defined as a daily rainfall total which exceeds the threshold that is exceeded on 5% of rainy days in current the climate of that region and season.

- The proportion of total annual rainfall that falls in 'heavy' events tends towards increases in the ensemble projections. Seasonally, this varies between tendencies to decrease in JFM and to increases in JAS and OND, but the range of changes projected by the ensemble includes both increases and decreases in all seasons.
- 1- and 5-day rainfall maxima in projections tend towards increases, particularly in JAS. The range of changes in projections from the model ensemble covers both increases and decreases in all seasons.

Other Regional Climate Change Information

- Model simulations of precipitation changes for the Sahelian and Guinea coast regions of Africa are strongly divergent and most models fail to reproduce realistic inter-annual and inter-decadal rainfall variability in the Sahel in 20th century simulations. Our understanding of the processes causing tropical rainfall is insufficient to allow a prediction of the direction of change with any certainty. The IPCC identify this as an area requiring further research to understand the variety of model responses in this region (Christensen *et al*., 2007).
- Model simulations show wide disagreements in projected changes in the amplitude of future El Niño events. West African climate can be strongly influenced by ENSO, thus contributing to uncertainty in climate projections for this region.
- The coastal regions of Benin may be vulnerable to sea-level rise. Sea-level in this region is projected by climate models to rise by the following levels[5] by the 2090s, relative to 1980-1999 sea-level:
    - 0.13 to 0.43m under SRES B1
    - 0.16 to 0.53m under SRES A1B
    - 0.18 to 0.56m under SRES A2

- For further information on climate projections for Africa, see Christensen *et al.* (2007) IPCC Working Group I Report: '*The Physical Science Basis'*, Chapter 11 *(Regional Climate projections*): Section 11.2 *(Africa*).

[5] Taken from the IPCC Working group I (*The Physical Science Basis*): Chapter 10 (Global Climate Projections) (Meehl *et al*., 2007). Regional sea-level projections are estimated by applying regional adjustments (Fig 10.32, p813) to projected global mean sea-level rise from 14 AR4 models.

Data Summary

	Observed Mean 1970-99	Observed Trend 1960-2006		Projected changes by the 2030s			Projected changes by the 2060s			Projected changes by the 2090s		
				Min	Median	Max	Min	Median	Max	Min	Median	Max
Temperature												
	(˚C)	(change in ˚C per decade)		Change in ˚C			Change in ˚C			Change in ˚C		
			A2	0.9	**1.2**	1.6	1.7	**2.5**	3.0	2.9	**4.0**	5.1
Annual	26.8	0.24*	*A1B*	0.9	**1.3**	1.7	1.8	**2.5**	3.0	2.5	**3.2**	4.6
			B1	0.6	**1.0**	1.4	1.0	**1.7**	2.2	1.5	**2.1**	2.9
			A2	0.9	**1.3**	1.8	1.7	**2.4**	3.4	2.9	**4.3**	5.7
JFM	28	0.25*	*A1B*	0.9	**1.3**	1.9	1.8	**2.5**	3.1	2.6	**3.2**	4.9
			B1	0.6	**1.1**	1.5	1.0	**1.8**	2.2	1.4	**2.2**	3.3
			A2	0.9	**1.3**	1.6	1.5	**2.4**	3.0	2.8	**4.0**	5.4
AMJ	28.6	0.31*	*A1B*	1.0	**1.4**	2.0	1.9	**2.5**	3.1	2.5	**3.3**	4.7
			B1	0.3	**1.0**	1.7	1.1	**1.9**	2.3	1.5	**2.3**	2.9
			A2	0.8	**1.1**	1.5	1.8	**2.2**	2.8	2.9	**3.6**	4.9
JAS	25	0.20*	*A1B*	0.7	**1.2**	1.6	1.5	**2.3**	3.0	2.2	**2.9**	4.5
			B1	0.5	**1.0**	1.3	0.7	**1.5**	2.2	1.4	**1.9**	2.7
			A2	0.7	**1.3**	1.6	1.7	**2.6**	3.1	3.1	**4.1**	5.2
OND	25.9	0.22*	*A1B*	0.9	**1.2**	2.1	1.5	**2.6**	2.9	2.3	**3.2**	4.2
			B1	0.5	**1.0**	1.4	0.9	**1.7**	2.2	1.3	**2.1**	2.8
Precipitation												
	(mm per month)	(change in mm per decade)		Change in mm per month			Change in mm per month			Change in mm per month		
			A2	-13	**1**	5	-11	**4**	13	-25	**2**	13
Annual	88.1	-1.7	*A1B*	-8	**0**	8	-13	**1**	12	-24	**4**	17
			B1	-7	**1**	7	-8	**2**	9	-14	**0**	15
			A2	-5	**-1**	3	-4	**0**	11	-6	**-2**	24
JFM	15.9	-0.9	*A1B*	-5	**-1**	4	-4	**0**	9	-7	**-3**	13
			B1	-3	**0**	7	-4	**-1**	6	-7	**-1**	5
			A2	-24	**-4**	20	-24	**3**	36	-28	**-9**	27
AMJ	112.8	-3.9*	*A1B*	-26	**0**	14	-46	**-5**	34	-33	**-13**	41
			B1	-18	**0**	25	-18	**-5**	32	-26	**-10**	35
			A2	-19	**5**	33	-45	**13**	25	-76	**6**	42
JAS	190.8	-2.5	*A1B*	-12	**1**	24	-38	**7**	21	-72	**12**	36
			B1	-7	**4**	40	-24	**5**	18	-20	**5**	37
			A2	-11	**0**	10	-4	**5**	16	-7	**6**	21
OND	33.1	0.5	*A1B*	-7	**0**	12	-16	**0**	25	-8	**5**	17
			B1	-5	**0**	8	-6	**2**	15	-8	**4**	14
Precipitation (%)												
	(mm per month)	(change in % per decade)		% Change			% Change			% Change		
			A2	-9	**1**	5	-7	**3**	12	-17	**2**	12
Annual	88.1	-2.0	*A1B*	-7	**0**	6	-13	**0**	11	-17	**4**	16
			B1	-6	**2**	5	-7	**1**	8	-11	**0**	14
			A2	-12	**-6**	11	-18	**1**	24	-60	**-7**	50
JFM	15.9	-5.7	*A1B*	-36	**-6**	11	-28	**-4**	19	-54	**-12**	32
			B1	-18	**-4**	17	-42	**-5**	15	-50	**-7**	15
			A2	-12	**-1**	10	-12	**2**	18	-29	**-8**	13
AMJ	112.8	-3.5*	*A1B*	-14	**-1**	7	-25	**-5**	17	-23	**-6**	21
			B1	-10	**0**	13	-9	**-4**	16	-18	**-6**	18
			A2	-6	**3**	16	-16	**5**	13	-27	**2**	18
JAS	190.8	-1.3	*A1B*	-7	**0**	10	-13	**5**	14	-25	**6**	17
			B1	-5	**1**	14	-9	**3**	11	-10	**3**	18
			A2	-12	**0**	20	-8	**11**	26	-15	**11**	35
OND	33.1	1.6	*A1B*	-10	**0**	15	-18	**0**	31	-17	**7**	21
			B1	-11	**0**	11	-12	**2**	18	-13	**6**	18

	Observed Mean 1970-99	Observed Trend 1960-2006		Projected changes by the 2030s			Projected changes by the 2060s			Projected changes by the 2090s		
				Min	Median	Max	Min	Median	Max	Min	Median	Max
	% Frequency	Change in frequency per decade					Future % frequency			Future % frequency		
Frequency of Hot Days (TX90p)												
			A2	****	****	****	17	**31**	53	31	**43**	87
Annual	11.7	2.49*	*A1B*	****	****	****	23	**32**	56	33	**39**	84
			B1	****	****	****	16	**26**	42	23	**31**	59
			A2	****	****	****	21	**46**	68	30	**69**	88
JFM	10.4	(0.88)	*A1B*	****	****	****	33	**46**	66	46	**61**	86
(DJF)			*B1*	****	****	****	19	**39**	56	34	**48**	72
			A2	****	****	****	28	**38**	63	47	**58**	94
AMJ	12.1	(2.91*)	*A1B*	****	****	****	30	**38**	69	43	**50**	91
(MAM)			*B1*	****	****	****	20	**33**	52	28	**41**	70
			A2	****	****	****	37	**47**	85	57	**76**	99
JAS	11.7	(2.39*)	*A1B*	****	****	****	36	**51**	87	47	**66**	96
(JJA)			*B1*	****	****	****	22	**39**	75	33	**50**	87
			A2	****	****	****	23	**46**	78	47	**69**	93
OND	15.0	(7.21*)	*A1B*	****	****	****	34	**45**	80	43	**64**	90
(SON)			*B1*	****	****	****	20	**34**	67	34	**47**	83
Frequency of Hot Nights (TN90p)												
			A2	****	****	****	33	**56**	72	71	**78**	88
Annual	13.8	4.65*	*A1B*	****	****	****	32	**56**	71	59	**74**	84
			B1	****	****	****	28	**42**	62	39	**54**	72
			A2	****	****	****	25	**43**	63	38	**62**	75
JFM	12.7	(2.69*)	*A1B*	****	****	****	25	**41**	58	36	**53**	73
(DJF)			*B1*	****	****	****	21	**38**	51	26	**42**	61
			A2	****	****	****	43	**75**	90	68	**95**	98
AMJ	13.8	(5.03*)	*A1B*	****	****	****	42	**76**	90	62	**91**	97
(MAM)			*B1*	****	****	****	41	**63**	82	54	**74**	88
			A2	****	****	****	68	**81**	96	97	**98**	99
JAS	13.7	(4.75*)	*A1B*	****	****	****	70	**81**	98	89	**96**	99
(JJA)			*B1*	****	****	****	45	**67**	85	61	**82**	94
			A2	****	****	****	39	**52**	70	58	**73**	87
OND	15.6	(6.53*)	*A1B*	****	****	****	38	**55**	70	47	**67**	81
(SON)			*B1*	****	****	****	29	**42**	61	38	**54**	71
Frequency of Cold Days (TX10p)												
			A2	****	****	****	0	**2**	4	0	**0**	2
Annual	9.1	-0.84*	*A1B*	****	****	****	0	**1**	3	0	**0**	2
			B1	****	****	****	0	**3**	5	0	**2**	3
			A2	****	****	****	0	**1**	26	0	**0**	28
JFM	11.0	(0.68)	*A1B*	****	****	****	0	**1**	7	0	**0**	1
(DJF)			*B1*	****	****	****	0	**3**	16	0	**2**	3
			A2	****	****	****	0	**1**	3	0	**0**	0
AMJ	9.3	(-1.09*)	*A1B*	****	****	****	0	**1**	3	0	**0**	1
(MAM)			*B1*	****	****	****	0	**3**	4	0	**1**	3
			A2	****	****	****	0	**1**	5	0	**0**	0
JAS	7.9	(-1.78*)	*A1B*	****	****	****	0	**0**	2	0	**0**	1
(JJA)			*B1*	****	****	****	0	**2**	4	0	**1**	2
			A2	****	****	****	0	**2**	8	0	**0**	6
OND	8.7	(-1.11)	*A1B*	****	****	****	0	**1**	3	0	**0**	1
(SON)			*B1*	****	****	****	1	**2**	6	0	**2**	5
Frequency of Cold Nights (TN10p)												
			A2	****	****	****	0	**2**	3	0	**0**	1
Annual	7.7	-2.17*	*A1B*	****	****	****	0	**2**	3	0	**0**	1
			B1	****	****	****	2	**3**	6	1	**2**	3
			A2	****	****	****	0	**0**	2	0	**0**	1
JFM	9.6	(-1.19)	*A1B*	****	****	****	0	**0**	2	0	**0**	1
(DJF)			*B1*	****	****	****	0	**2**	6	0	**0**	2
			A2	****	****	****	0	**0**	1	0	**0**	0
AMJ	7.4	(-2.46*)	*A1B*	****	****	****	0	**0**	2	0	**0**	0
(MAM)			*B1*	****	****	****	0	**1**	2	0	**0**	2
			A2	****	****	****	0	**0**	0	0	**0**	0
JAS	7.5	(-2.07*)	*A1B*	****	****	****	0	**0**	0	0	**0**	0
(JJA)			*B1*	****	****	****	0	**0**	1	0	**0**	0
			A2	****	****	****	0	**1**	2	0	**0**	0
OND	6.9	(-2.57*)	*A1B*	****	****	****	0	**1**	2	0	**0**	0
(SON)			*B1*	****	****	****	0	**2**	3	0	**1**	3

	Observed Mean 1970-99	Observed Trend 1960-2006		Projected changes by the 2030s Min	Median	Max	Projected changes by the 2060s Min	Median	Max	Projected changes by the 2090s Min	Median	Max
% total rainfall falling in Heavy Events (R95pct)												
	%	*Change in % per decade*					*Change in %*			*Change in %*		
			A2	****	****	****	-4	**1**	10	-5	**1**	14
Annual	17.0	-1.58*	*A1B*	****	****	****	-4	**1**	9	-6	**4**	15
			B1	****	****	****	-4	**2**	5	-5	**1**	10
			A2	****	****	****	-14	**-5**	8	-26	**-3**	15
JFM	****	****	*A1B*	****	****	****	-13	**0**	4	-17	**-4**	11
(DJF)			*B1*	****	****	****	-23	**-2**	8	-12	**-1**	4
			A2	****	****	****	-4	**0**	13	-8	**2**	15
AMJ	****	****	*A1B*	****	****	****	-7	**0**	13	-7	**1**	21
(MAM)			*B1*	****	****	****	-4	**0**	7	-5	**0**	10
			A2	****	****	****	-3	**2**	12	-5	**3**	17
JAS	****	****	*A1B*	****	****	****	-4	**2**	13	-6	**5**	17
(JJA)			*B1*	****	****	****	-4	**2**	6	-4	**1**	14
			A2	****	****	****	-5	**3**	11	-7	**4**	12
OND	****	****	*A1B*	****	****	****	-8	**3**	9	-2	**3**	16
(SON)			*B1*	****	****	****	0	**2**	10	-12	**2**	13
Maximum 1-day rainfall (RX1day)												
	mm	*Change in mm per decade*					*Change in mm*			*Change in mm*		
			A2	****	****	****	-4	**1**	23	-1	**5**	39
Annual	71.7	-1.91	*A1B*	****	****	****	-3	**0**	18	-3	**4**	33
			B1	****	****	****	-2	**2**	11	-6	**0**	25
			A2	****	****	****	-1	**0**	1	-3	**0**	4
JFM	3.5	(-1.43*)	*A1B*	****	****	****	-1	**0**	1	-3	**0**	3
(DJF)			*B1*	****	****	****	-2	**0**	2	-3	**0**	1
			A2	****	****	****	-7	**0**	8	-12	**1**	10
AMJ	24.7	(-2.95*)	*A1B*	****	****	****	-3	**0**	8	-10	**0**	17
(MAM)			*B1*	****	****	****	-7	**0**	6	-9	**0**	9
			A2	****	****	****	-3	**1**	23	-4	**1**	37
JAS	43.0	(-1.91*)	*A1B*	****	****	****	-5	**1**	19	-6	**4**	33
(JJA)			*B1*	****	****	****	-4	**1**	12	-4	**0**	25
			A2	****	****	****	-1	**1**	7	-1	**1**	8
OND	21.0	(-2.05*)	*A1B*	****	****	****	-4	**0**	4	0	**1**	8
(SON)			*B1*	****	****	****	0	**0**	4	-4	**0**	4
Maximum 5-day Rainfall (RX5day)												
	mm	*Change in mm per decade*					*Change in mm*			*Change in mm*		
			A2	****	****	****	-6	**4**	27	-3	**2**	38
Annual	121.1	-2.8	*A1B*	****	****	****	-5	**1**	26	-7	**6**	38
			B1	****	****	****	-4	**3**	15	-11	**1**	28
			A2	****	****	****	-6	**0**	4	-8	**-1**	5
JFM	3.9	(-0.77)	*A1B*	****	****	****	-4	**0**	3	-10	**-2**	8
(DJF)			*B1*	****	****	****	-6	**-1**	3	-8	**-1**	4
			A2	****	****	****	-10	**0**	21	-17	**1**	14
AMJ	30.7	(-2.72)	*A1B*	****	****	****	-8	**-1**	20	-13	**0**	35
(MAM)			*B1*	****	****	****	-9	**0**	9	-15	**0**	24
			A2	****	****	****	-9	**4**	28	-25	**3**	37
JAS	67.1	(-5.41*)	*A1B*	****	****	****	-13	**2**	29	-23	**6**	30
(JJA)			*B1*	****	****	****	-10	**4**	19	-9	**2**	28
			A2	****	****	****	-3	**0**	15	-6	**3**	16
OND	37.2	(-4.83*)	*A1B*	****	****	****	-5	**2**	10	-5	**3**	16
(SON)			*B1*	****	****	****	-1	**2**	11	-10	**2**	14

* indicates trend is statistically significant at 95% confidence

**** indicates data are not available

Bracketed trend values for extremes indices indicate values for the closest seasons that data is available. See documentation.

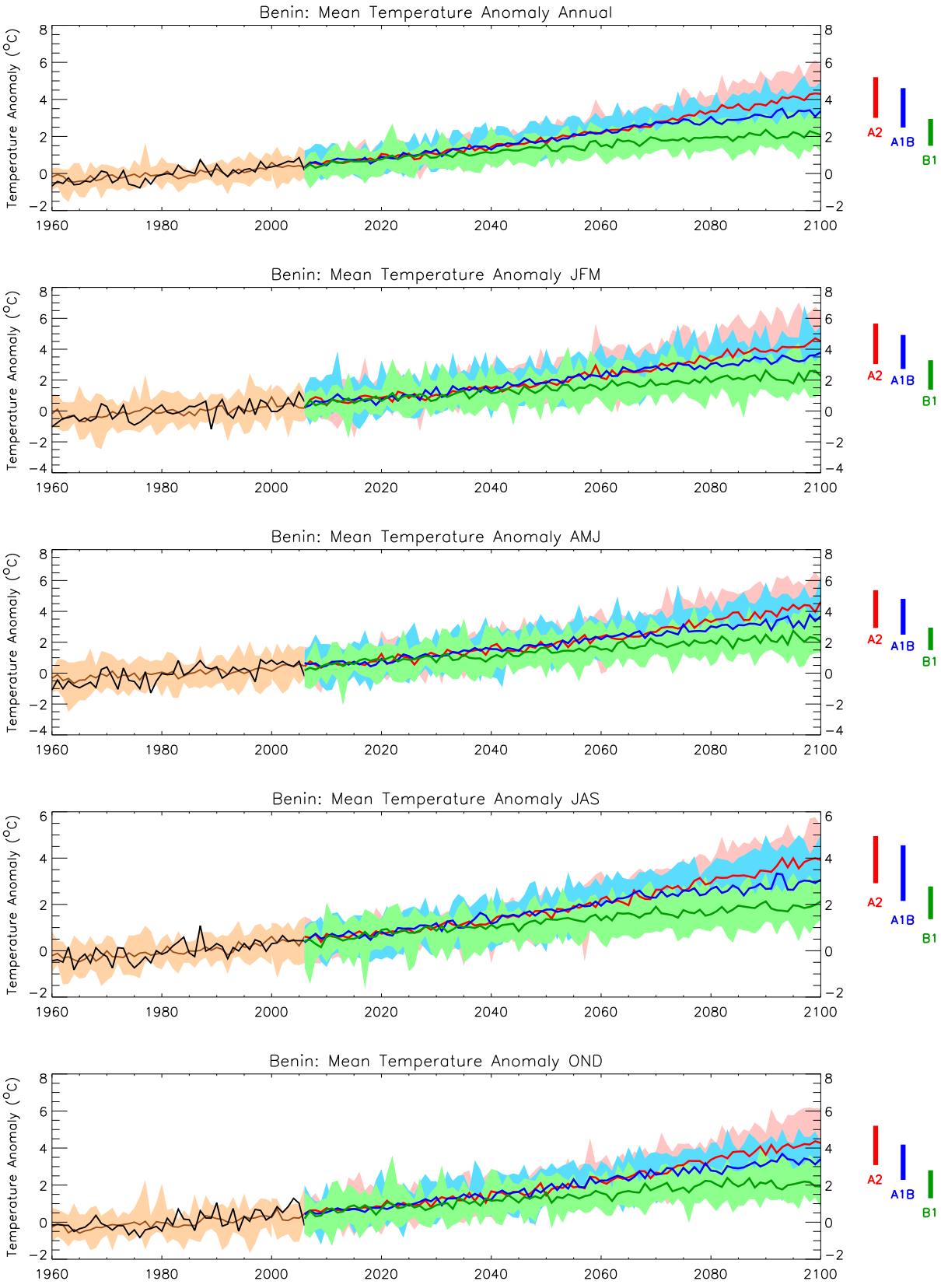

Figure 1: Trends in annual and seasonal mean temperature for the recent past and projected future. All values shown are anomalies, relative to the 1970-1999 mean climate. Black curves show the mean of observed data from 1960 to 2006, Brown curves show the median (solid line) and range (shading) of model simulations of recent climate across an ensemble of 15 models. Coloured lines from 2006 onwards show the median (solid line) and range (shading) of the ensemble projections of climate under three emissions scenarios. Coloured bars on the right-hand side of the projections summarise the range of mean 2090-2100 climates simulated by the 15 models for each emissions scenario.

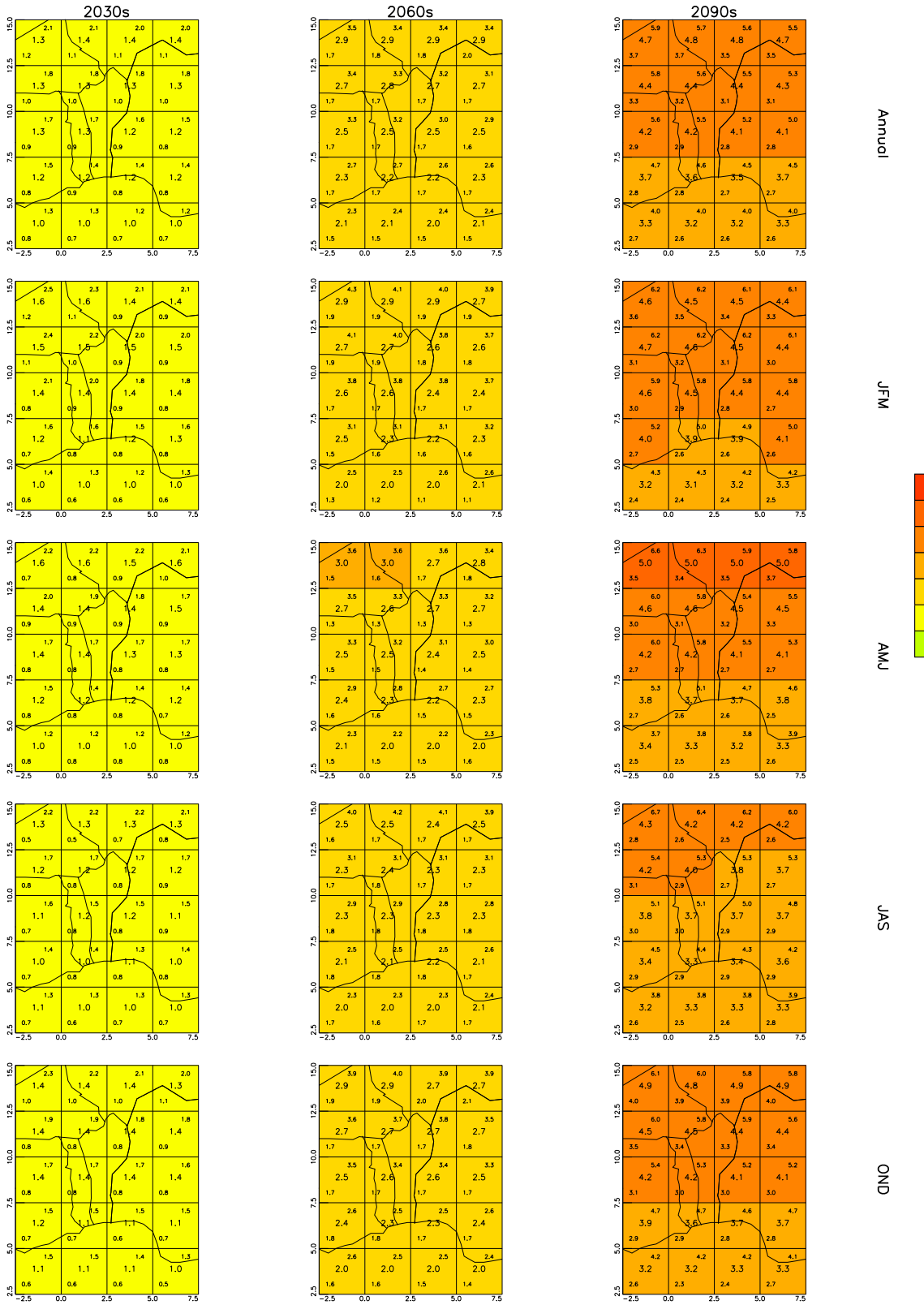

Figure 2: Spatial patterns of projected change in mean annual and seasonal temperature for 10-year periods in the future under the SRES A2 scenario. All values are anomalies relative to the mean climate of 1970-1999. In each grid box, the central value gives the ensemble median and the values in the upper and lower corners give the ensemble maximum and minimum.

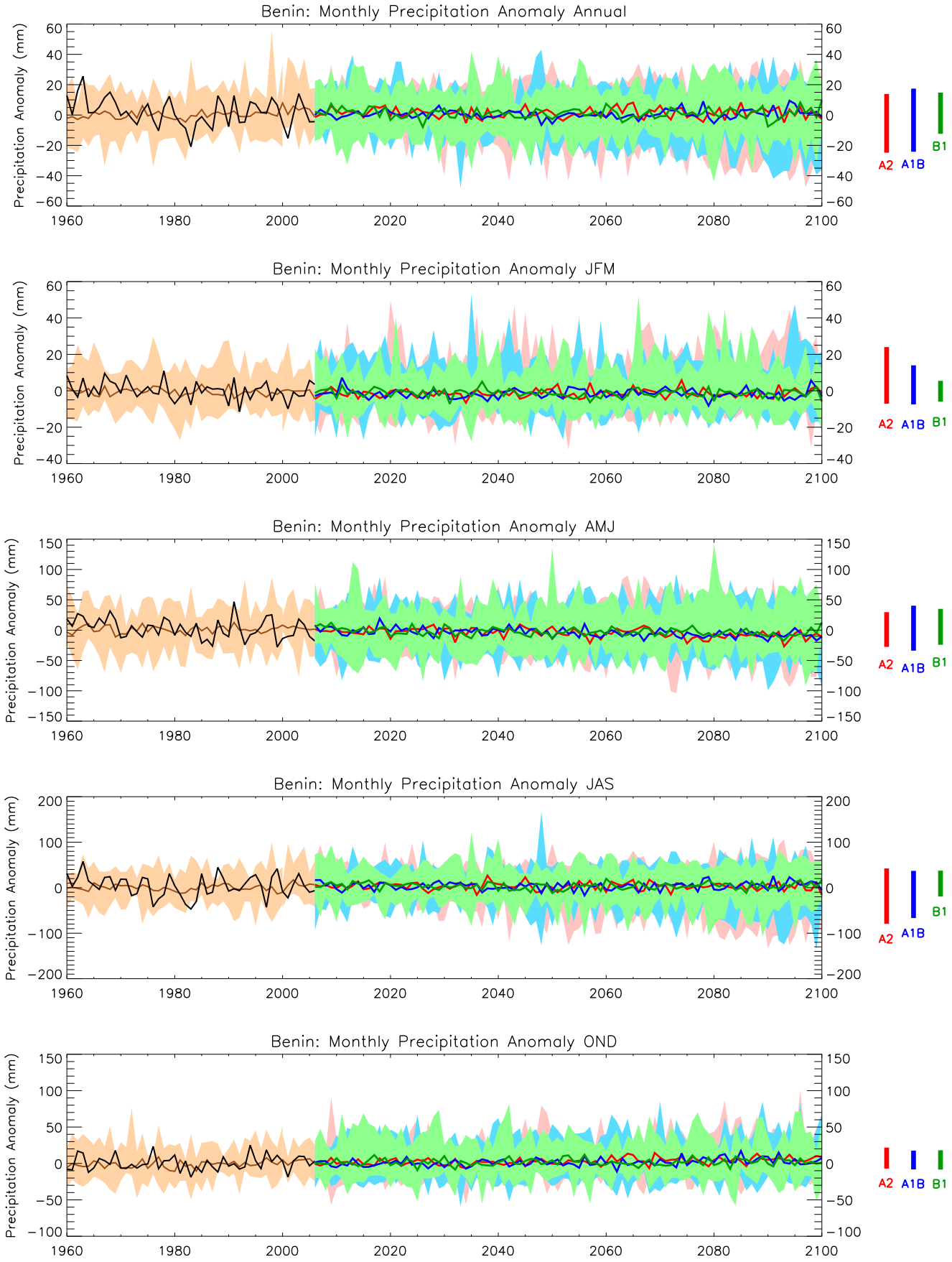

Figure 3: Trends in monthly precipitation for the recent past and projected future. All values shown are anomalies, relative to the 1970-1999 mean climate. See Figure 1 for details.

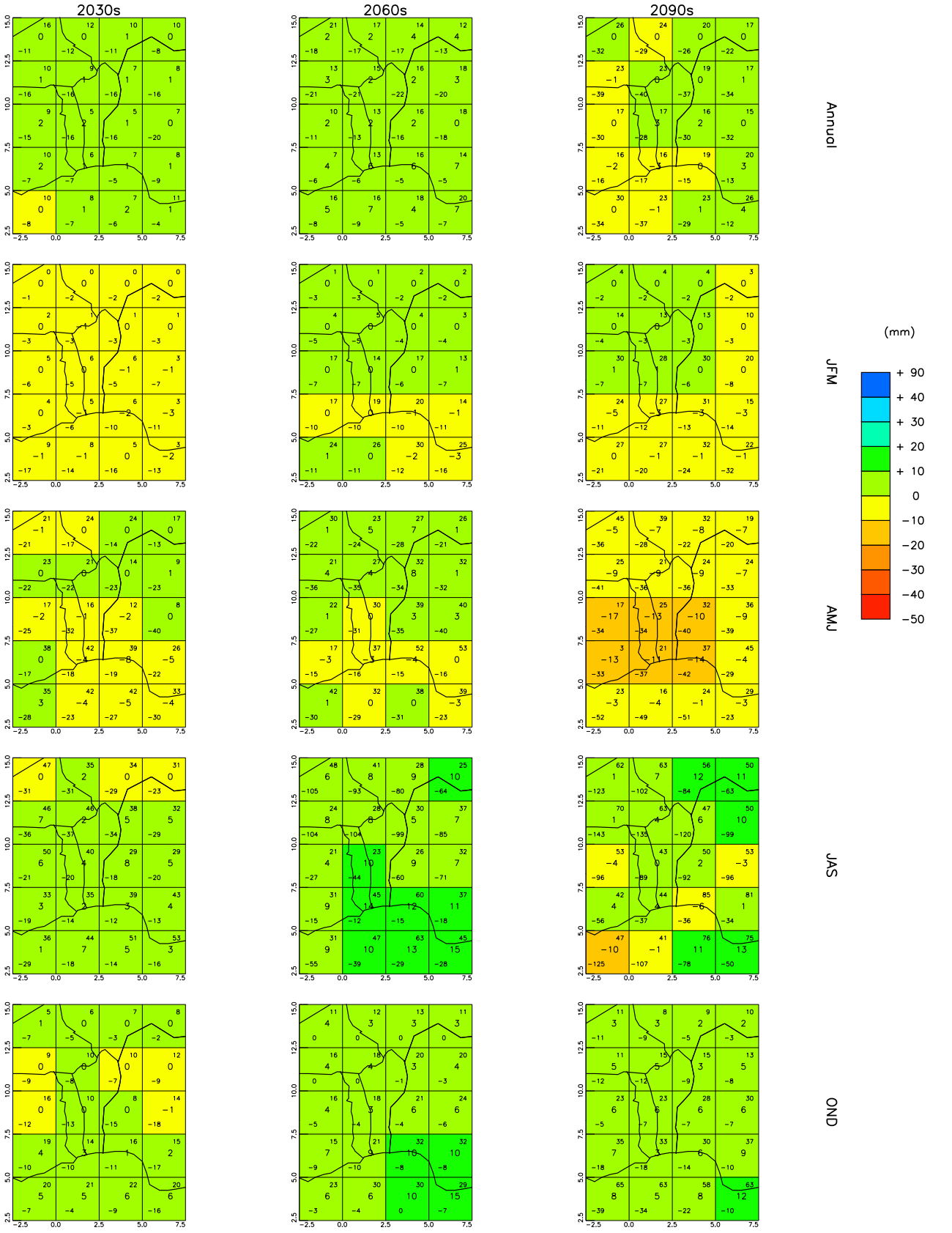

Figure 4: Spatial patterns of projected change in monthly precipitation for 10-year periods in the future under the SRES A2 scenario. All values are anomalies relative to the mean climate of 1970-1999.See Figure 2 for details.

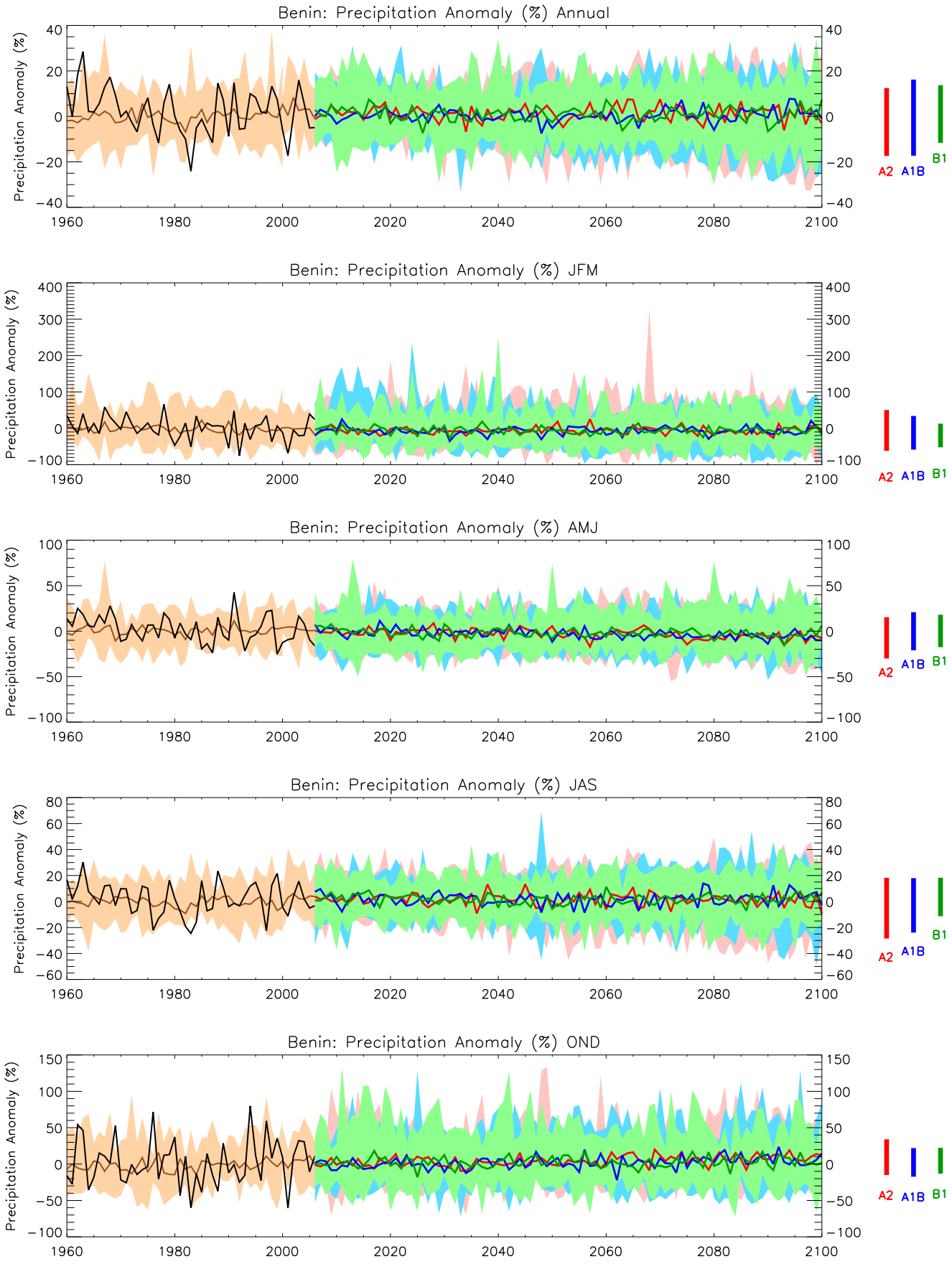

Figure 5: Trends in monthly precipitation for the recent past and projected future. All values shown are percentage anomalies, relative to the 1970-1999 mean climate. See Figure 1 for details.

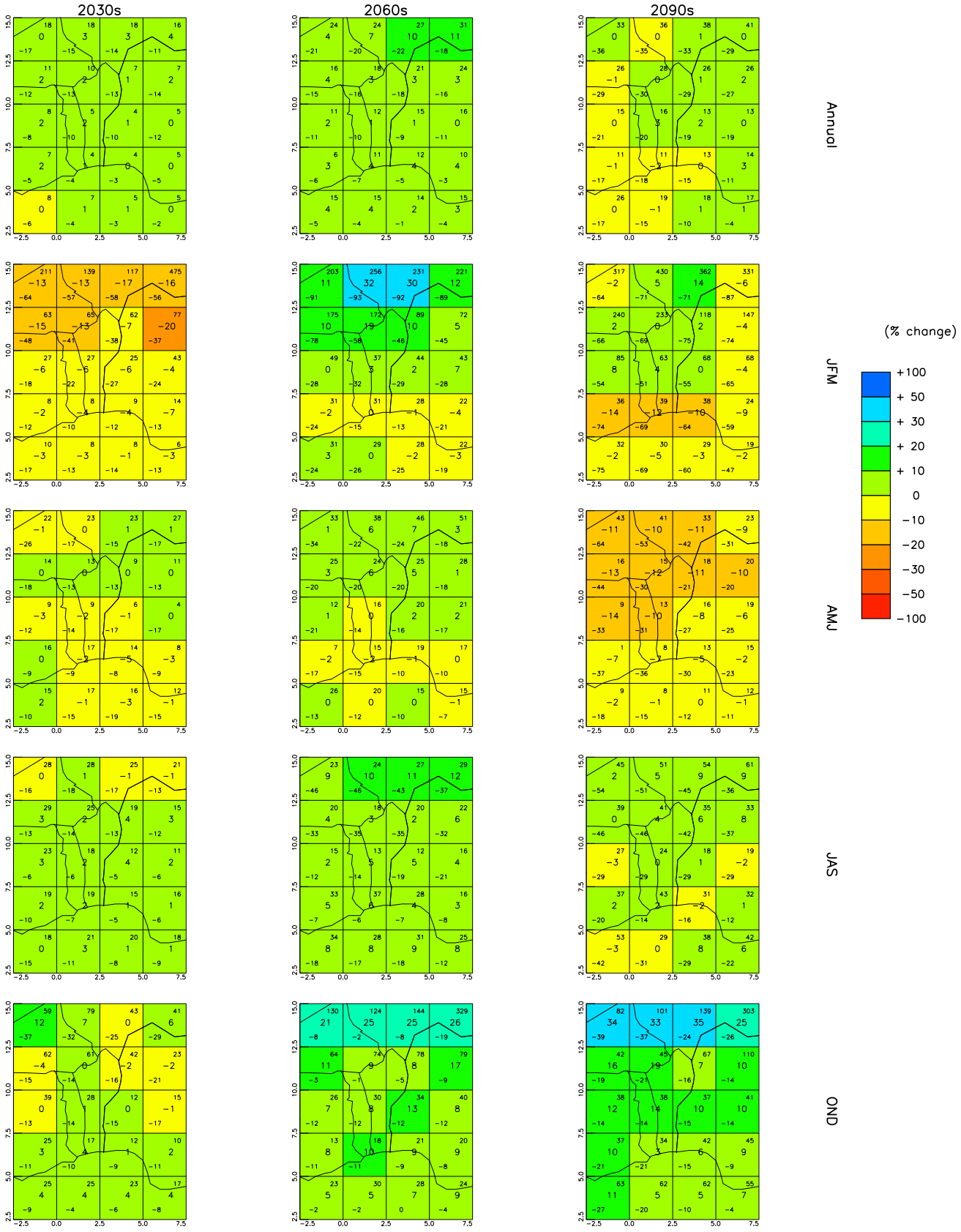

Figure 6: Spatial patterns of projected change in monthly precipitation for 10-year periods in the future under the SRES A2 scenario. All values are percentage anomalies relative to the mean climate of 1970-1999.See Figure 2 for details.

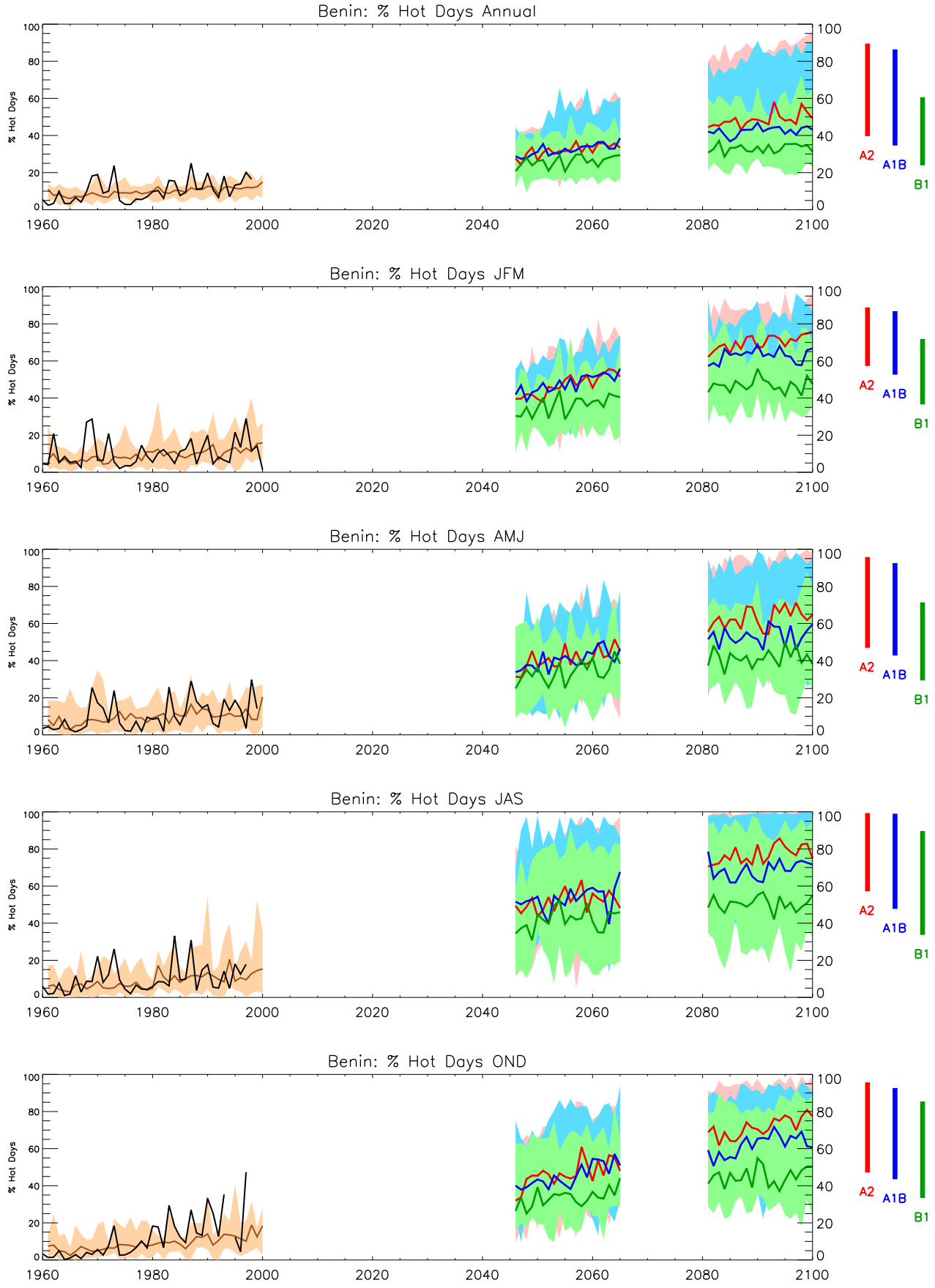

Figure 7: Trends in Hot-day frequency for the recent past and projected future. See Figure 1 for details.

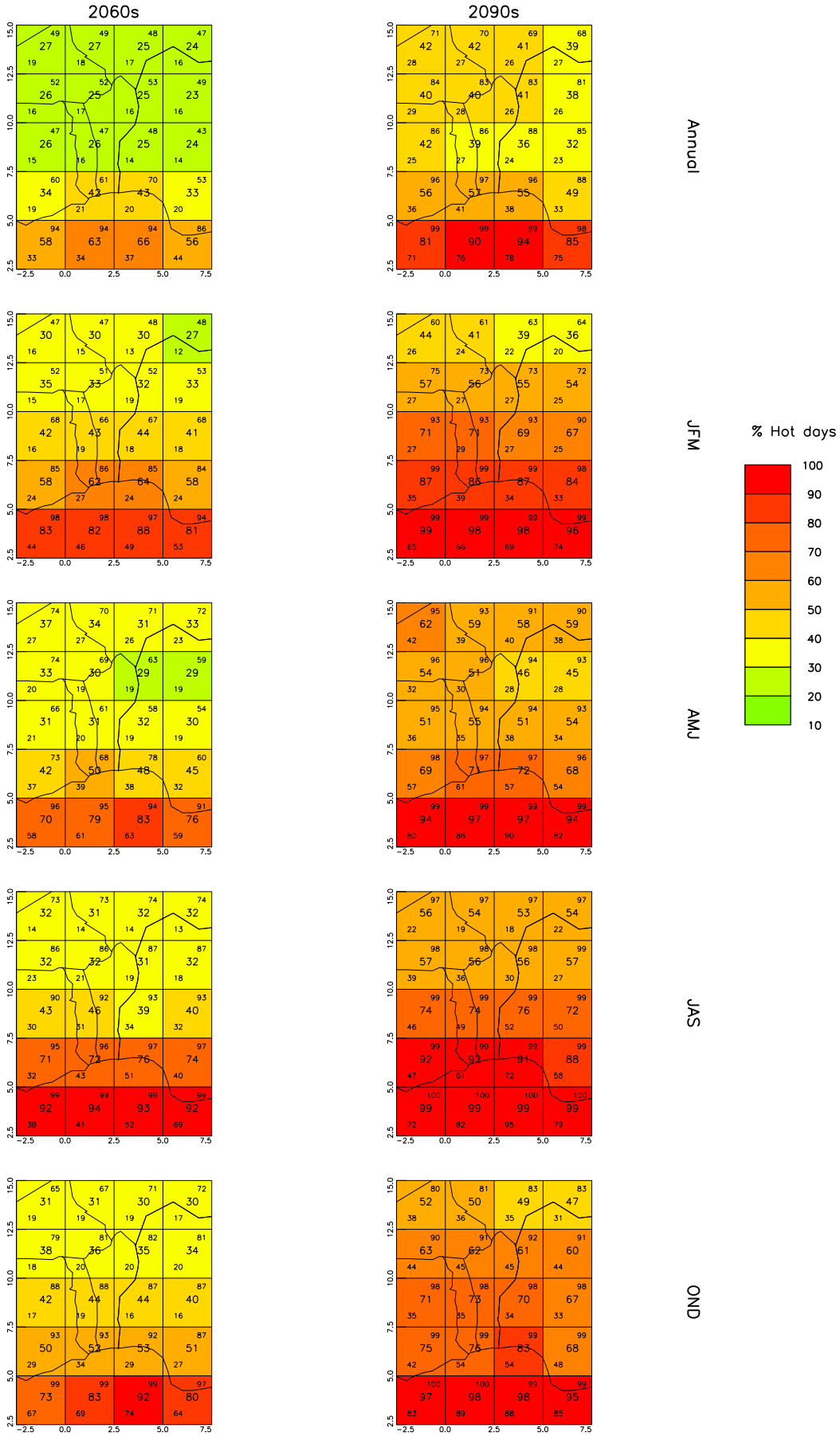

Figure 8: Spatial patterns of projected change in Hot-day frequency for 10-year periods in the future under the SRES A2 scenario. See Figure 2 for details.

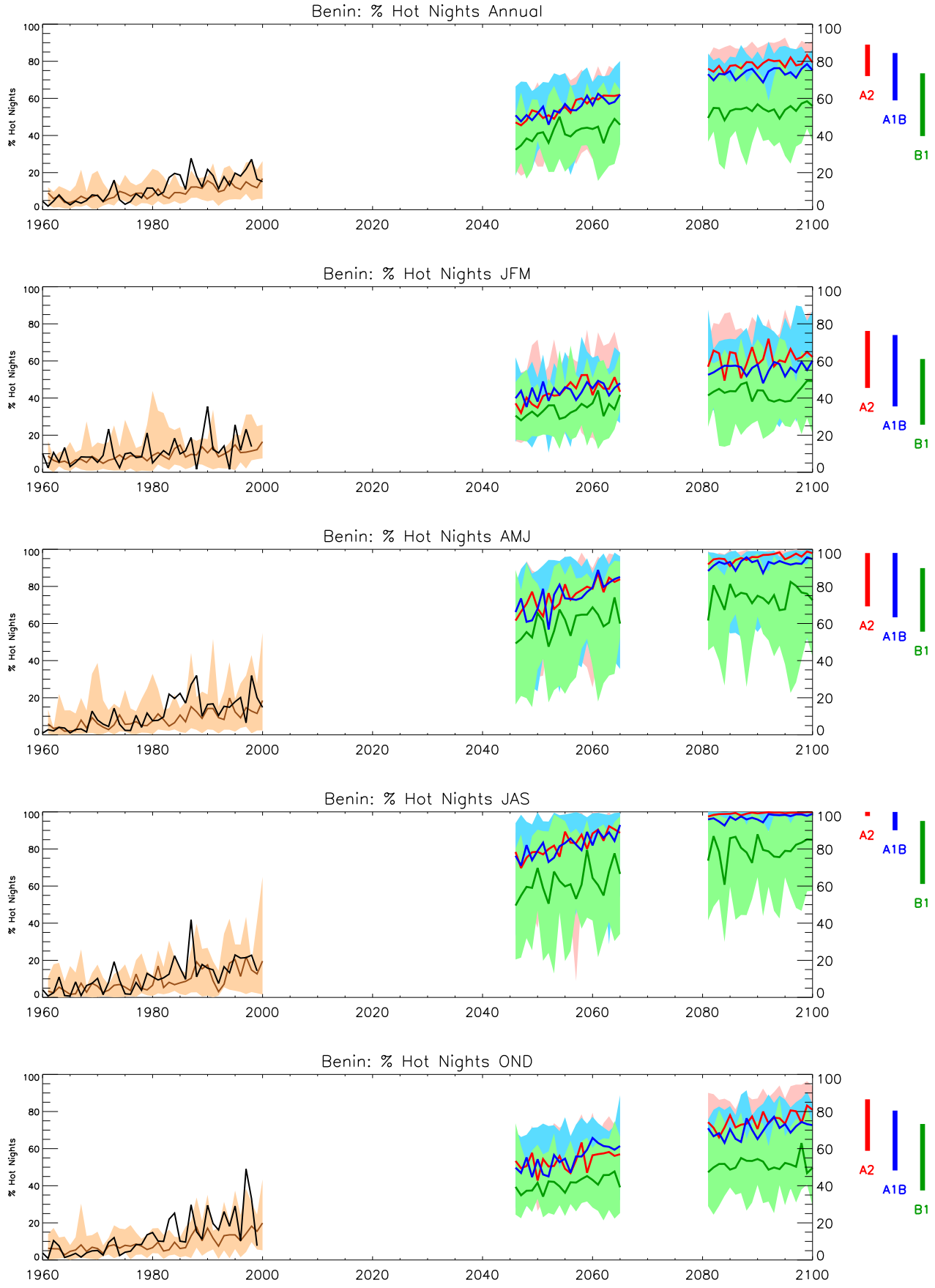

Figure 9: Trends in hot-night frequency for the recent past and projected future. See Figure 1 for details.

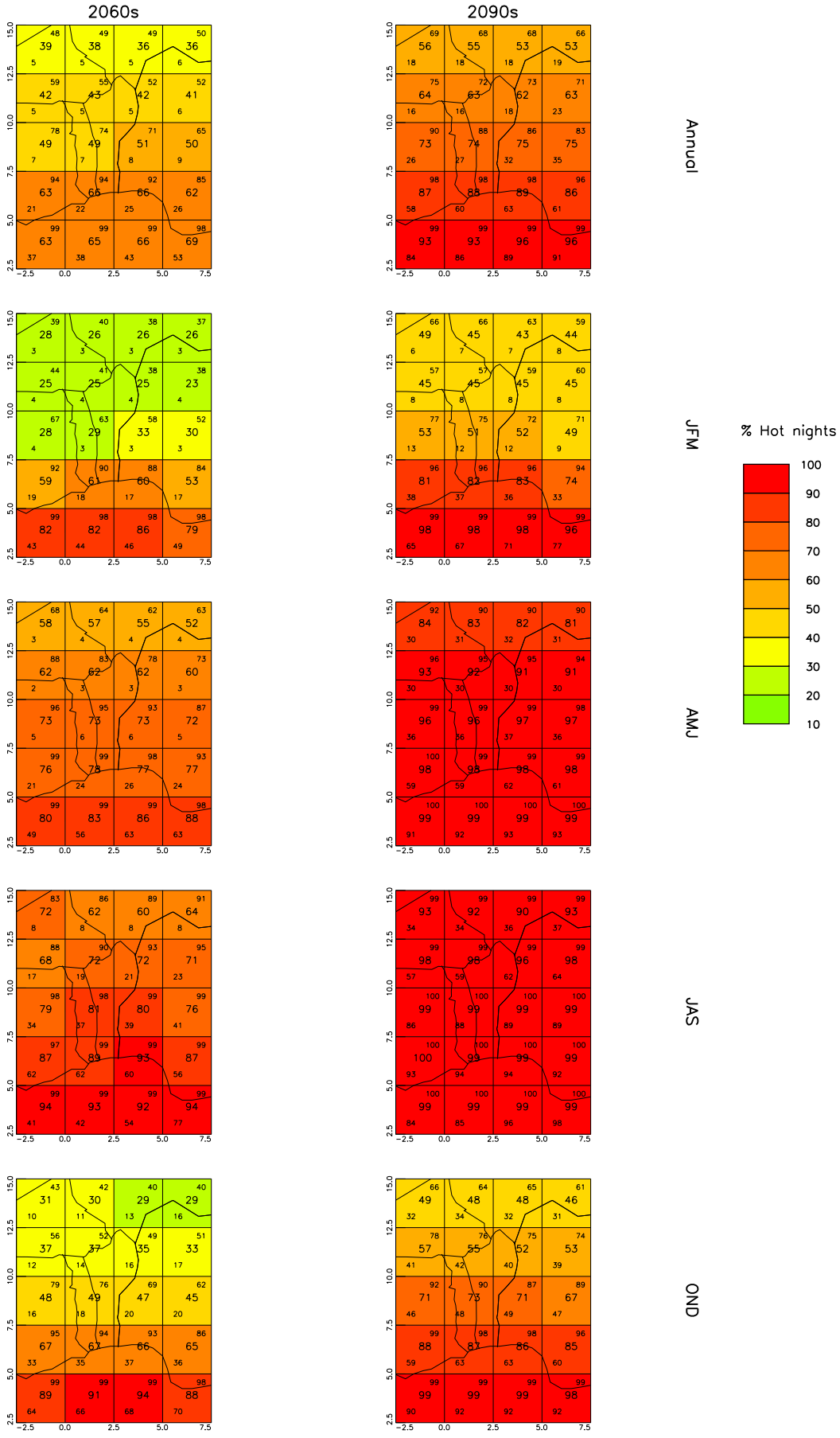

Figure 10: Spatial patterns of projected change in hot-night frequency for 10-year periods in the future under the SRES A2 scenario. See Figure 2 for details.

Figure 11: Trends in cold-day frequency for the recent past and projected future. See Figure 1 for details.

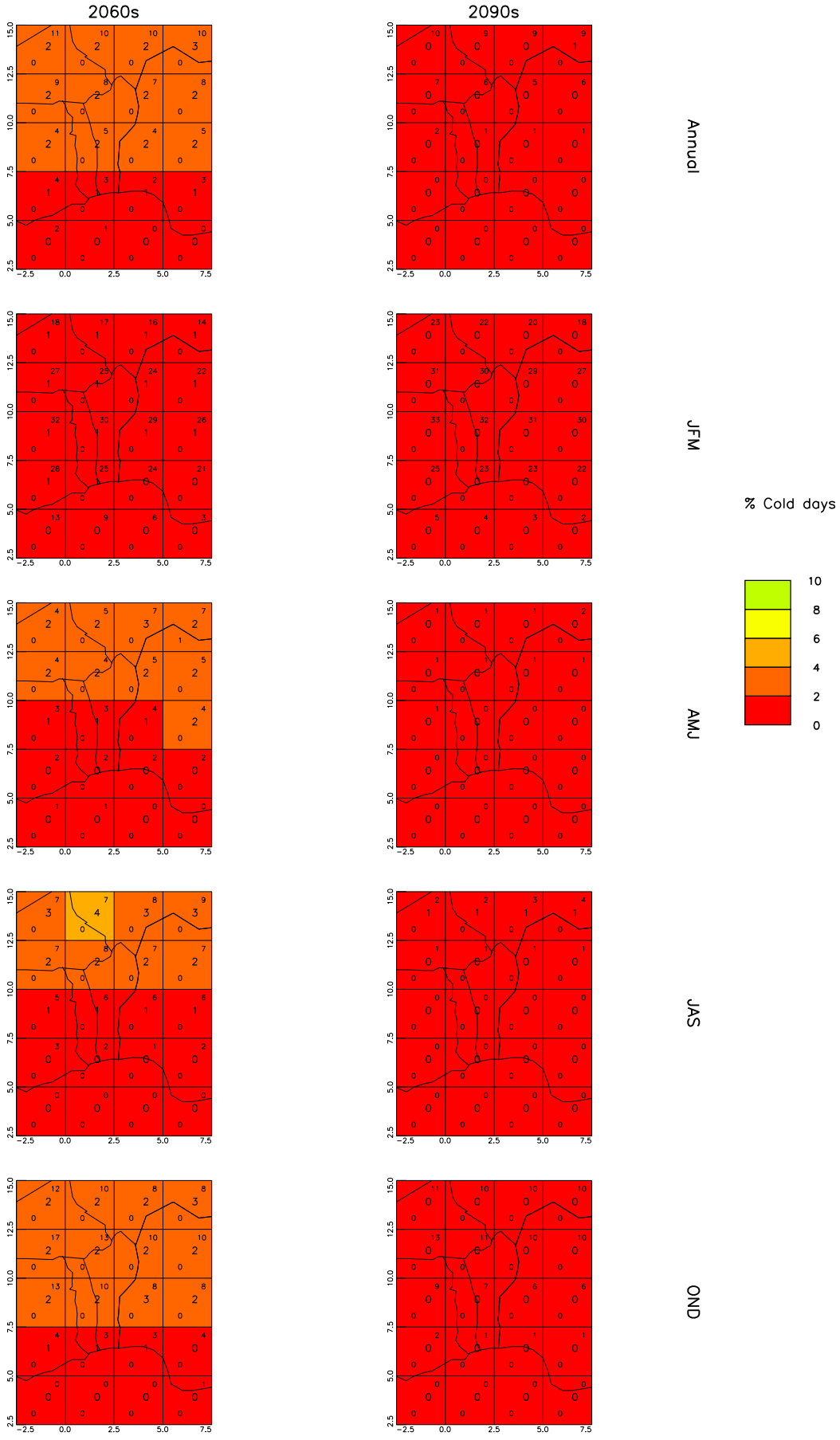

Figure 12: Spatial patterns of projected change in cold-day frequency for 10-year periods in the future under the SRES A2 scenario. See Figure 2 for details.

Figure 13: Trends in cold-night frequency for the recent past and projected future. See Figure 1 for details.

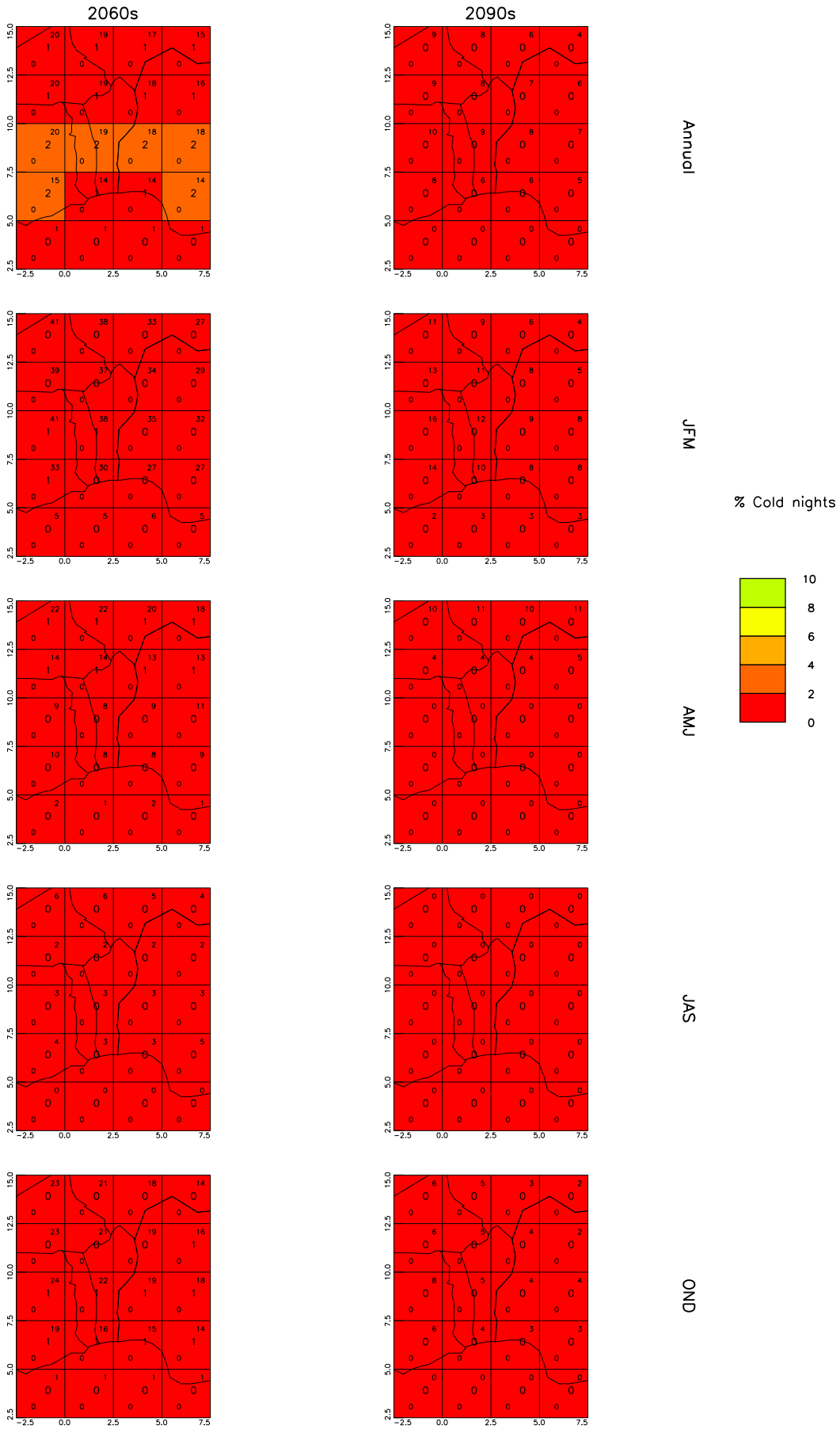

Figure 14: Spatial patterns of projected change in cold-night frequency for 10-year periods in the future under the SRES A2 scenario. See Figure 2 for details.

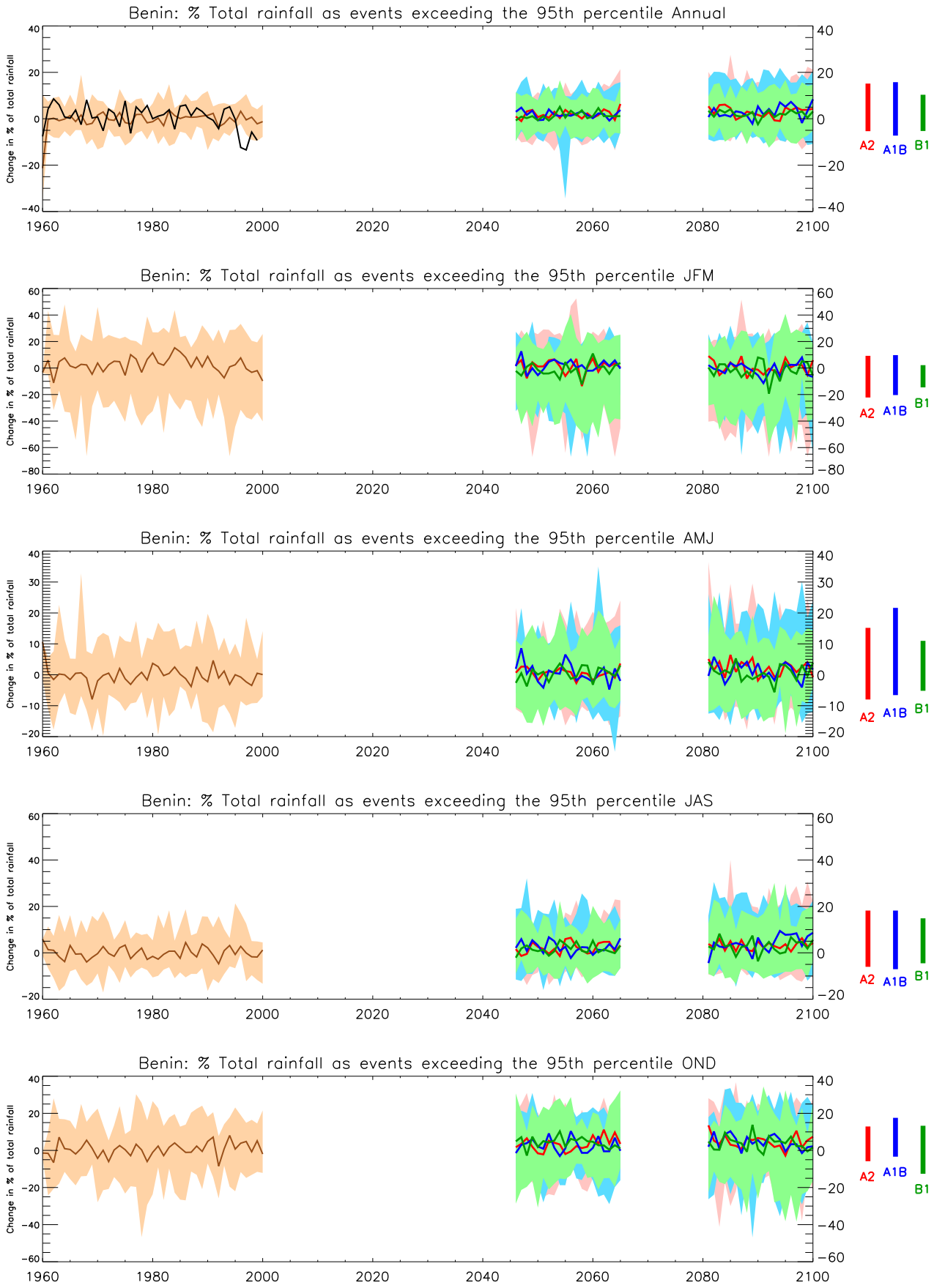

Figure 15: Trends in the proportion of precipitation falling in 'heavy' events for the recent past and projected future. All values shown are anomalies, relative to the 1970-1999 mean climate. See Figure 1 for details.

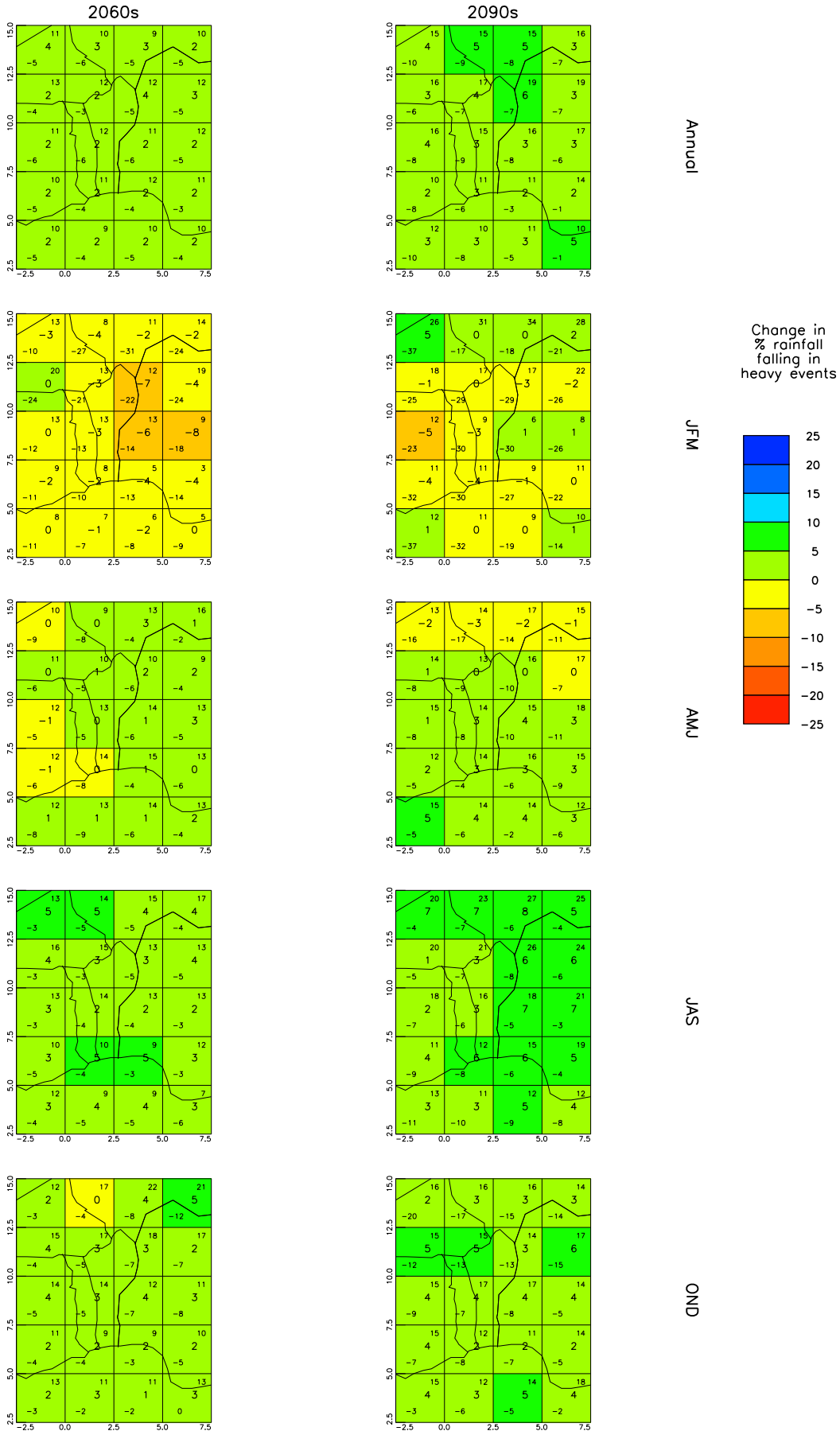

Figure 16: Spatial patterns of projected change in the proportion of precipitation falling in 'heavy' events for 10-year periods in the future under the SRES A2 scenario. All values are anomalies relative to the mean climate of 1970-1999. See Figure 2 for details.

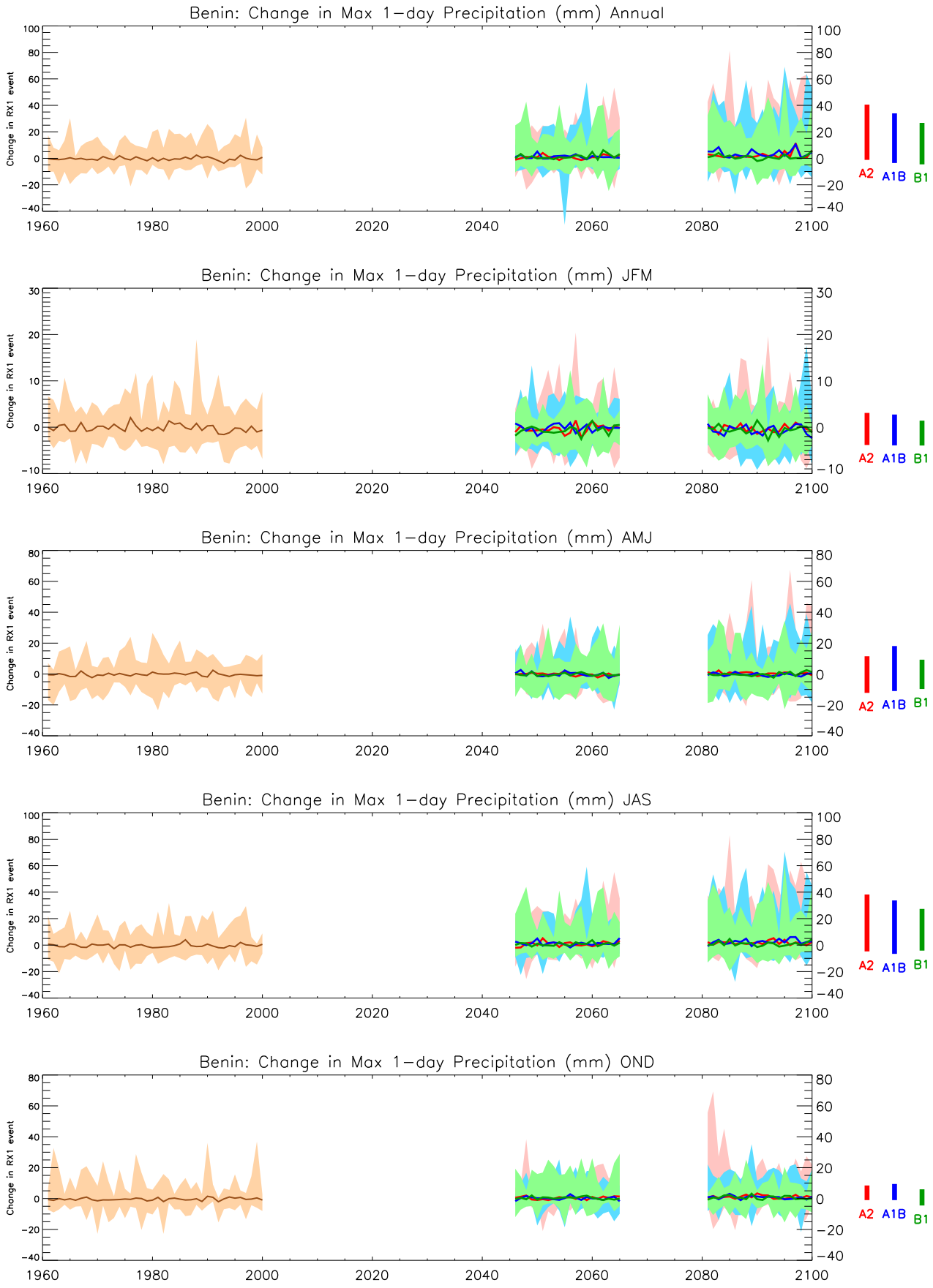

Figure 17: Trends in maximum 1-day rainfall for the recent past and projected future. All values shown are anomalies, relative to the 1970-1999 mean climate. See Figure 1 for details.

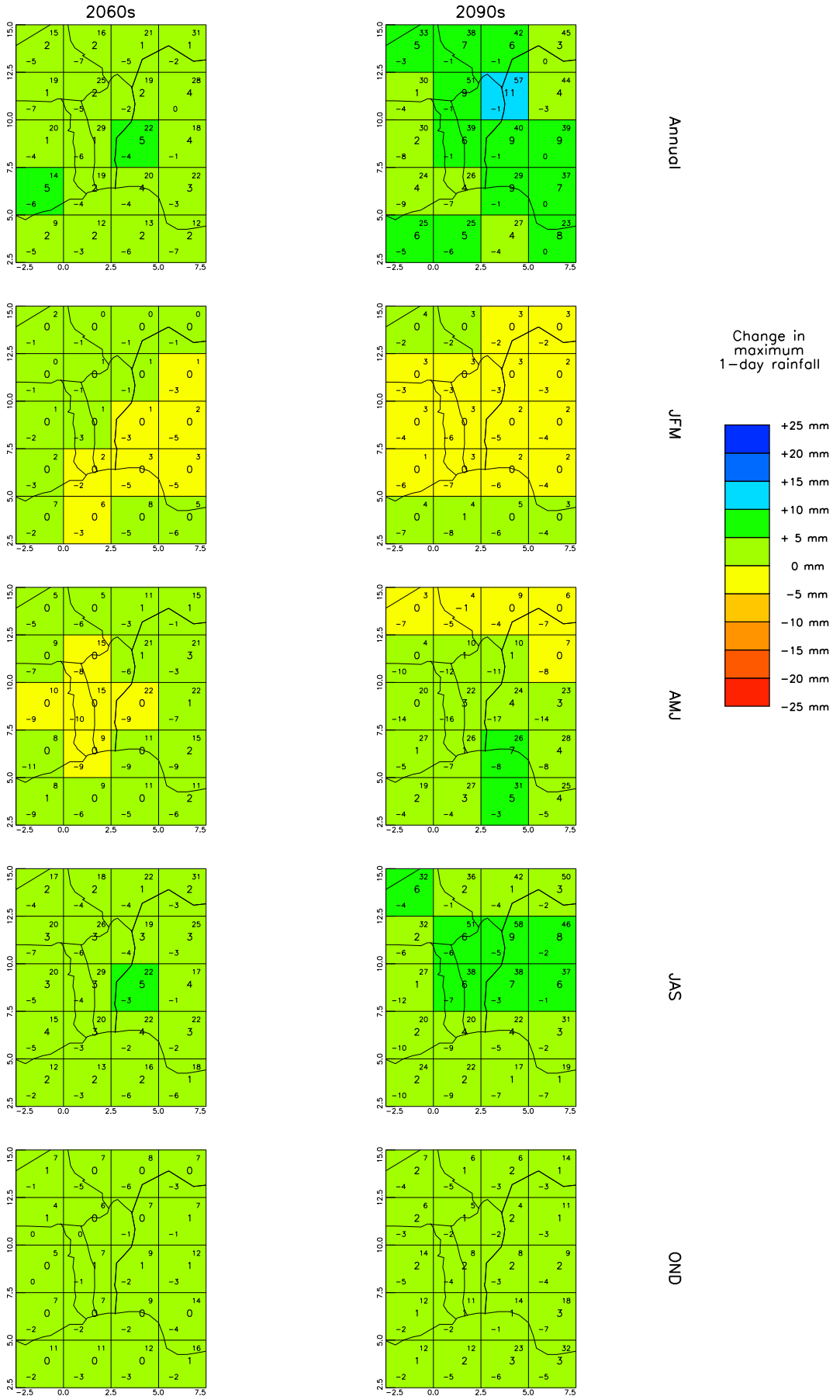

Figure 18: Spatial patterns of maximum 1-day rainfall for 10-year periods in the future under the SRES A2 scenario. All values are anomalies relative to the mean climate of 1970-1999. See Figure 2 for details.

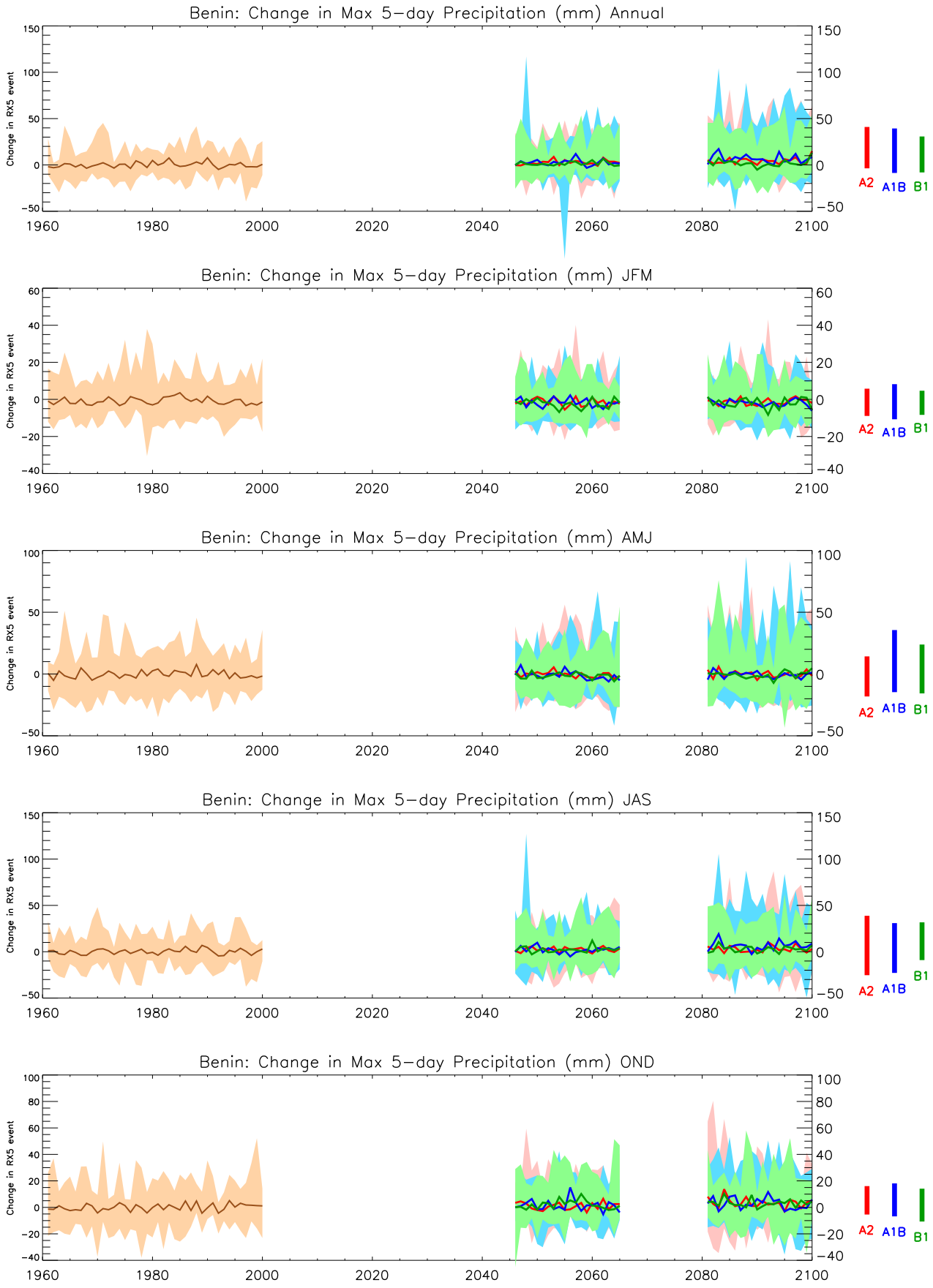

Figure 19: Trends in maximum 5-day rainfall for the recent past and projected future. All values shown are anomalies, relative to the 1970-1999 mean climate. See Figure 1 for details.

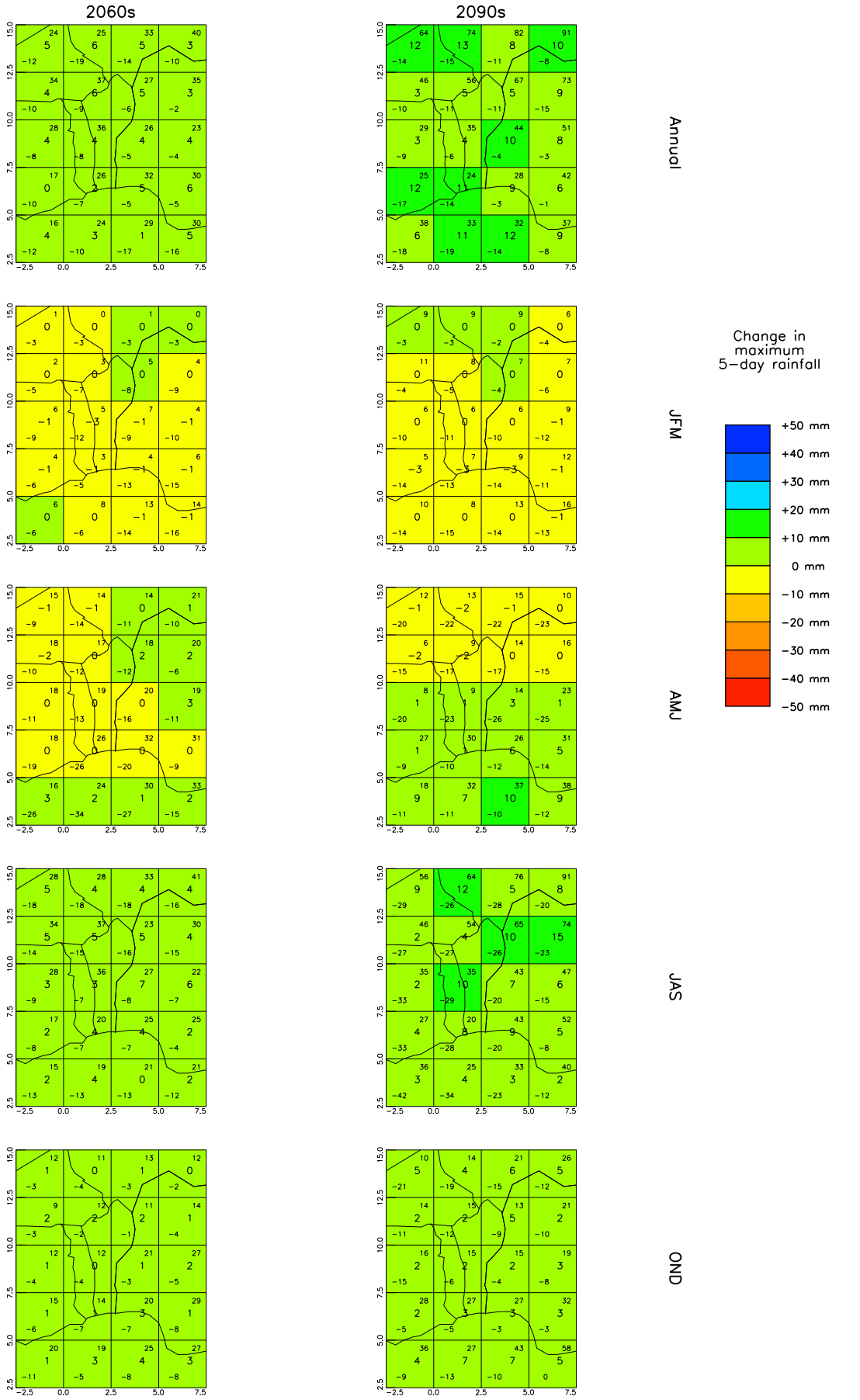

Figure 20: Spatial patterns of projected change in maximum 5-day rainfall for 10-year periods in the future under the SRES A2 scenario. All values are anomalies relative to the mean climate of 1970-1999. See Figure 2 for details.