

**National Roadmap for Adaptation 2100**  
Portuguese Territorial Climate Change Vulnerability Assessment for XXI Century

## REPORT

### WP2 – CLIMATE PROJECTIONS, EXTREMES, AND INDICES

#### Mainland Portugal

Final Version – Supplementary Material



## National Roadmap for Adaptation 2100

### Portuguese Territorial Climate Change Vulnerability Assessment for XXI Century

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Title: RNA2100 – Climate Projections, Extremes, and Indices – Mainland Portugal Supplementary Material

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February 2024

This report is a product of the National Roadmap for Adaptation 2100 project.

Through the Agreement on the European Economic Area (EEA), Iceland, Liechtenstein and Norway are partners in the internal market with the Member States of the European Union.

In order to promote a continuous and balanced strengthening of economic and trade relations, the parties to the EEA Agreement have established a and trade relations, the parties to the EEA Agreement established a multi-annual Financial Mechanism, known as the EEA. known as EEA Grants.

The EEA Grants aim to reduce social and economic disparities in Europe and to strengthen bilateral relations between these three countries and the beneficiary countries.

For the 2014-2021 period, a total contribution of 2.8 billion euros has been agreed for 15 beneficiary countries. for 15 beneficiary countries. Portugal will receive 102.7 million euros.

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# 1. Annual and Seasonal Mean Changes

## Temperature

### Mean Temperature

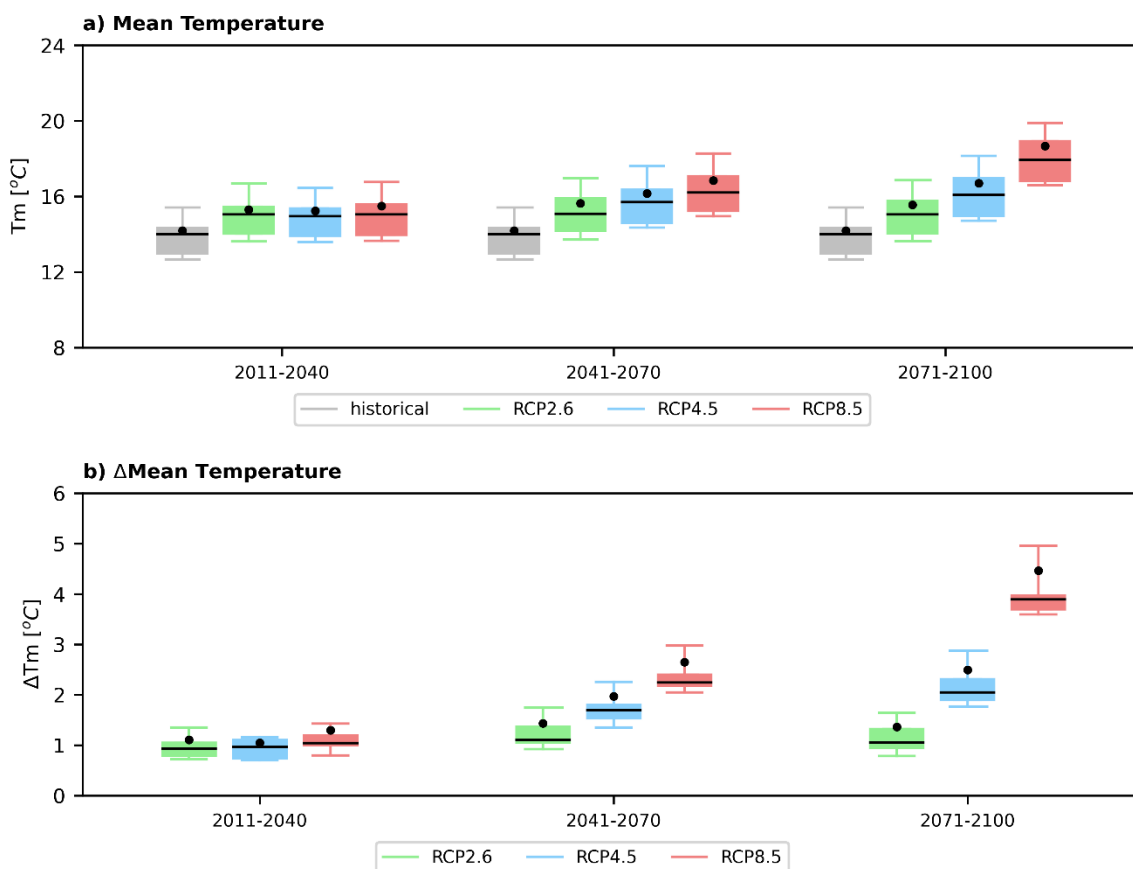


Figure A 1 (a) Climatology of daily mean temperature averaged over the full year for the NUTS I region. Three future periods are shown: 2011-2040, 2041-2070, and 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean. (b) Future projected changes in daily mean temperature averaged over the full year for the NUTS I region. The 1971-2000 period as reference. The black point represents the multi-model ensemble mean. The 1971-2000 period as reference.

Table A 1 Multi-model ensemble projected changes in daily mean temperature (°C) averaged over the full year for the NUTS I region.

NUTS I	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Portugal	1.11	1.05	1.29	1.44	1.97	2.64	1.36	2.50	4.46

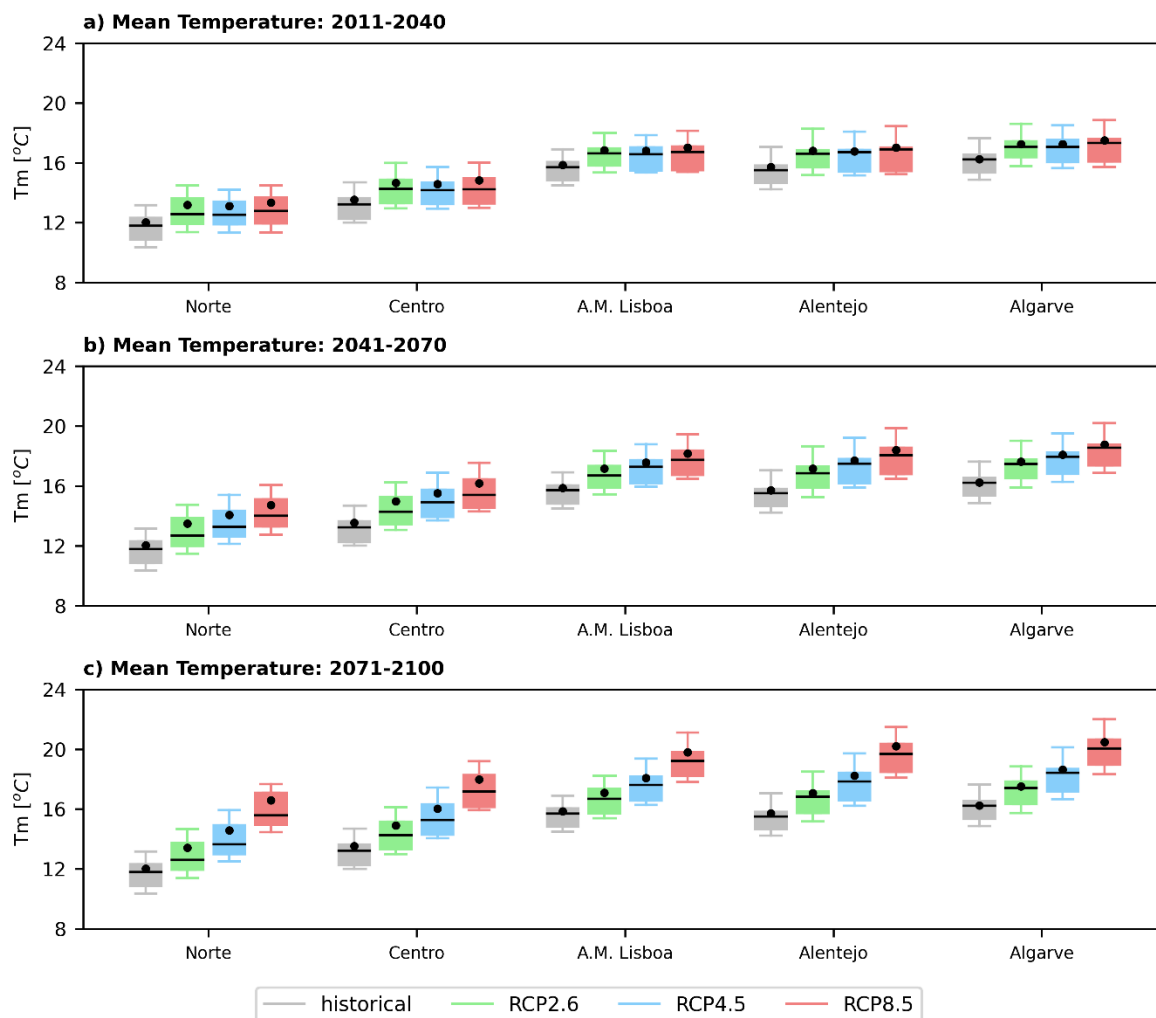


Figure A 2 Climatology of daily mean temperature averaged over the full year for the NUTS II region. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean. The 1971-2000 period as reference.

Table A 2 Multi-model ensemble projected changes in daily mean temperature (°C) averaged over the full year for the NUTS II regions.

NUTS II	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Norte	1.15	1.08	1.31	1.45	2.03	2.69	1.39	2.54	4.56
Centro	1.12	1.05	1.29	1.43	1.97	2.63	1.36	2.49	4.45
AM Lisboa	0.98	0.94	1.16	1.30	1.71	2.31	1.24	2.22	3.93
Alentejo	1.10	1.05	1.31	1.45	1.98	2.68	1.37	2.52	4.50
Algarve	1.00	1.01	1.25	1.39	1.85	2.52	1.27	2.39	4.24

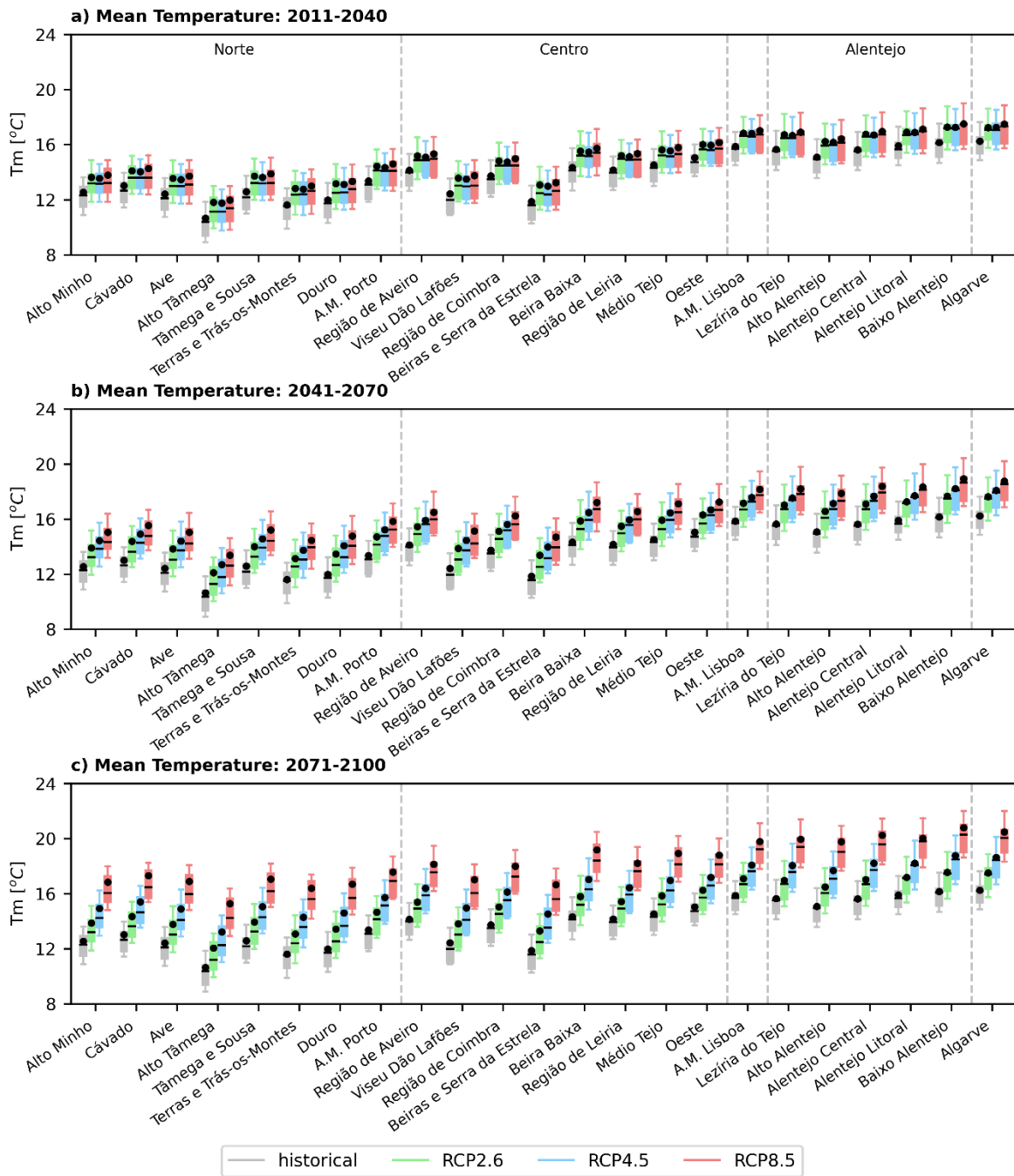


Figure A 3 Climatology of daily mean temperature averaged over the full year for the NUTS III region. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean. The 1971-2000 period as reference.

**Table A 3 Multi-model ensemble projected changes in daily mean temperature (°C) averaged over the full year for the NUTS III regions.**

NUTS III	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Alto Minho	1.08	0.99	1.23	1.36	1.89	2.51	1.31	2.38	4.28
Cávado	1.09	1.00	1.24	1.38	1.90	2.52	1.32	2.40	4.29
Ave	1.12	1.04	1.29	1.42	1.98	2.63	1.35	2.48	4.47
Alto Tâmega	1.17	1.11	1.34	1.47	2.06	2.74	1.40	2.58	4.63
Tâmega e Sousa	1.13	1.04	1.30	1.43	1.98	2.63	1.36	2.48	4.47
Terras de Trás-os-Montes	1.21	1.14	1.37	1.52	2.13	2.84	1.47	2.67	4.78
Douro	1.19	1.13	1.35	1.50	2.09	2.79	1.44	2.62	4.70
AM Porto	1.07	0.98	1.23	1.36	1.86	2.47	1.29	2.35	4.20
R. de Aveiro	1.03	0.94	1.18	1.32	1.76	2.35	1.25	2.26	4.00
Viseu	1.15	1.06	1.32	1.45	2.04	2.71	1.38	2.54	4.58
Dão Lafões	1.08	1.00	1.24	1.38	1.88	2.51	1.31	2.38	4.25
R. de Coimbra	1.21	1.13	1.37	1.52	2.13	2.84	1.44	2.67	4.79
Beiras e S. da Estrela	1.20	1.13	1.40	1.54	2.15	2.89	1.46	2.70	4.85
Beira Baixa	1.03	0.96	1.19	1.33	1.78	2.38	1.26	2.28	4.05
R. de Leiria	1.10	1.03	1.27	1.40	1.94	2.61	1.33	2.44	4.40
Médio Tejo	0.96	0.91	1.11	1.26	1.63	2.19	1.20	2.14	3.75
Oeste	0.98	0.94	1.16	1.30	1.71	2.31	1.24	2.22	3.93
AM Lisboa	1.06	1.01	1.25	1.38	1.89	2.54	1.31	2.39	4.30
Lezíria do Tejo	1.15	1.08	1.34	1.48	2.06	2.79	1.41	2.60	4.68
Alto Alentejo	1.13	1.07	1.33	1.48	2.04	2.77	1.40	2.58	4.63
Alentejo Central	1.00	0.97	1.21	1.35	1.80	2.43	1.28	2.31	4.12
Alentejo Litoral	1.12	1.09	1.35	1.50	2.05	2.77	1.40	2.61	4.63
Baixo Alentejo	1.00	1.01	1.25	1.39	1.85	2.52	1.27	2.39	4.24
Algarve	1.00	1.01	1.25	1.39	1.85	2.52	1.27	2.39	4.24

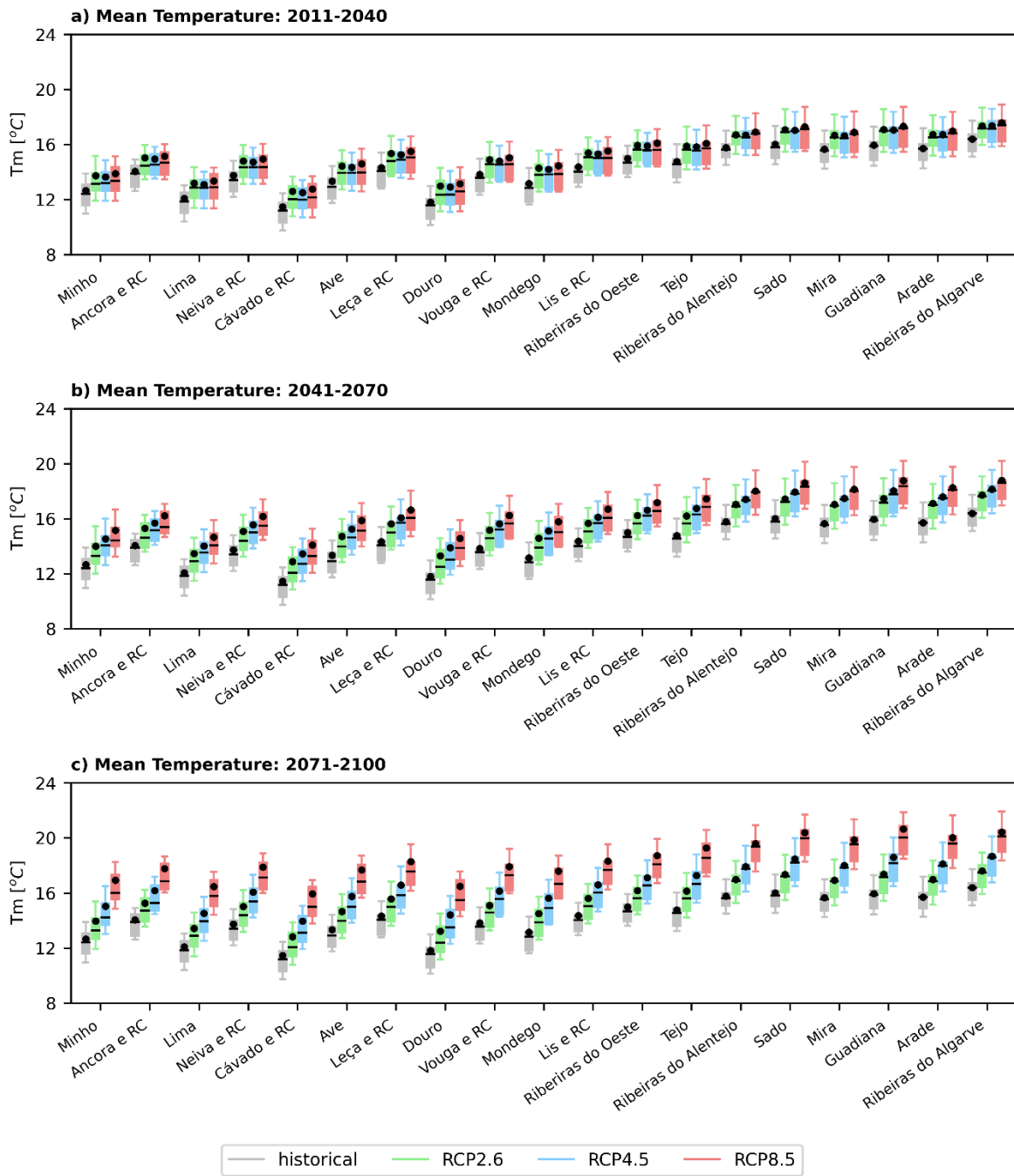


Figure A 4 Climatology of daily mean temperature averaged over the full year for the basins. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean. The 1971-2000 period as reference.

**Table A 4 Multi-model ensemble projected changes in daily mean temperature (°C) averaged over the full year for the basins.**

Basins	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Minho	1.08	0.99	1.22	1.35	1.88	2.50	1.31	2.37	4.27
Ancora e RC	0.98	0.90	1.10	1.25	1.64	2.17	1.22	2.13	3.71
Lima	1.11	1.02	1.26	1.39	1.94	2.57	1.34	2.44	4.39
Neiva e RC	1.06	0.97	1.20	1.34	1.83	2.42	1.29	2.32	4.14
Cávado e RC	1.13	1.05	1.30	1.43	1.99	2.63	1.36	2.50	4.47
Ave	1.10	1.01	1.26	1.39	1.92	2.55	1.33	2.42	4.34
Leça e RC	1.03	0.93	1.16	1.31	1.74	2.32	1.25	2.24	3.95
Douro	1.18	1.11	1.34	1.49	2.08	2.77	1.43	2.61	4.68
Vouga e RC	1.05	0.96	1.20	1.34	1.80	2.41	1.27	2.30	4.09
Mondego	1.12	1.04	1.28	1.42	1.96	2.62	1.35	2.47	4.43
Lis e RC	1.01	0.94	1.16	1.31	1.73	2.32	1.24	2.23	3.95
Ribeiras do Oeste	0.96	0.91	1.11	1.26	1.63	2.19	1.20	2.14	3.74
Tejo	1.12	1.06	1.31	1.44	1.99	2.68	1.37	2.51	4.51
Ribeiras do Alentejo	0.93	0.90	1.13	1.26	1.64	2.23	1.20	2.15	3.81
Sado	1.07	1.03	1.28	1.42	1.93	2.60	1.34	2.45	4.38
Mira	1.01	0.98	1.24	1.38	1.84	2.49	1.28	2.36	4.20
Guadiana	1.14	1.10	1.37	1.51	2.08	2.82	1.41	2.64	4.70
Arade	1.01	1.02	1.27	1.41	1.88	2.56	1.28	2.42	4.31
Ribeiras do Algarve	0.95	0.97	1.20	1.33	1.75	2.39	1.22	2.28	4.04



## Maximum Temperature

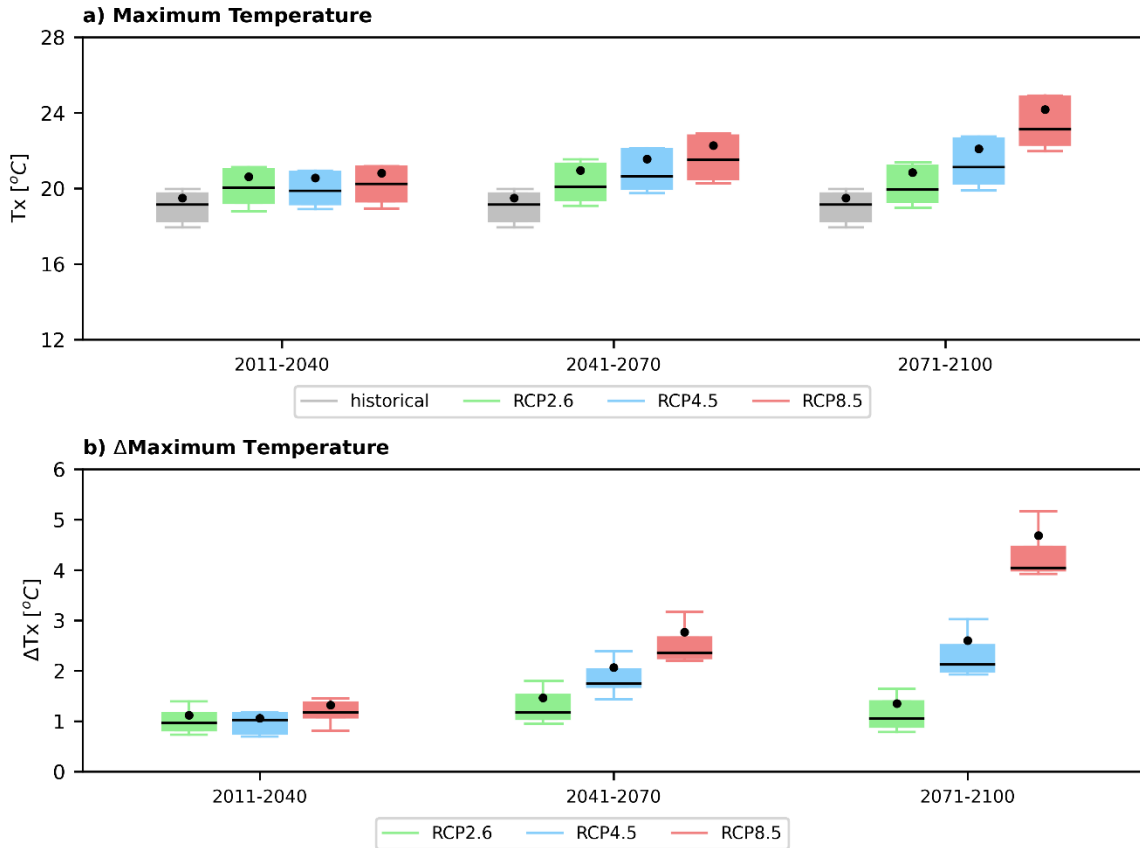


Figure A 5 (a) Climatology of daily maximum temperature averaged over the full year for the NUTS I region. Three future periods are shown: 2011-2040, 2041-2070, and 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean. (b) Future projected changes in daily maximum temperature averaged over the full year for the NUTS I region. The 1971-2000 period as reference.

Table A 5 Multi-model ensemble projected changes in daily maximum temperature ( $^{\circ}$ C) averaged over the full year for the NUTS I region.

NUTS I	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Portugal	1.12	1.06	1.32	1.47	2.07	2.77	1.35	2.60	4.68

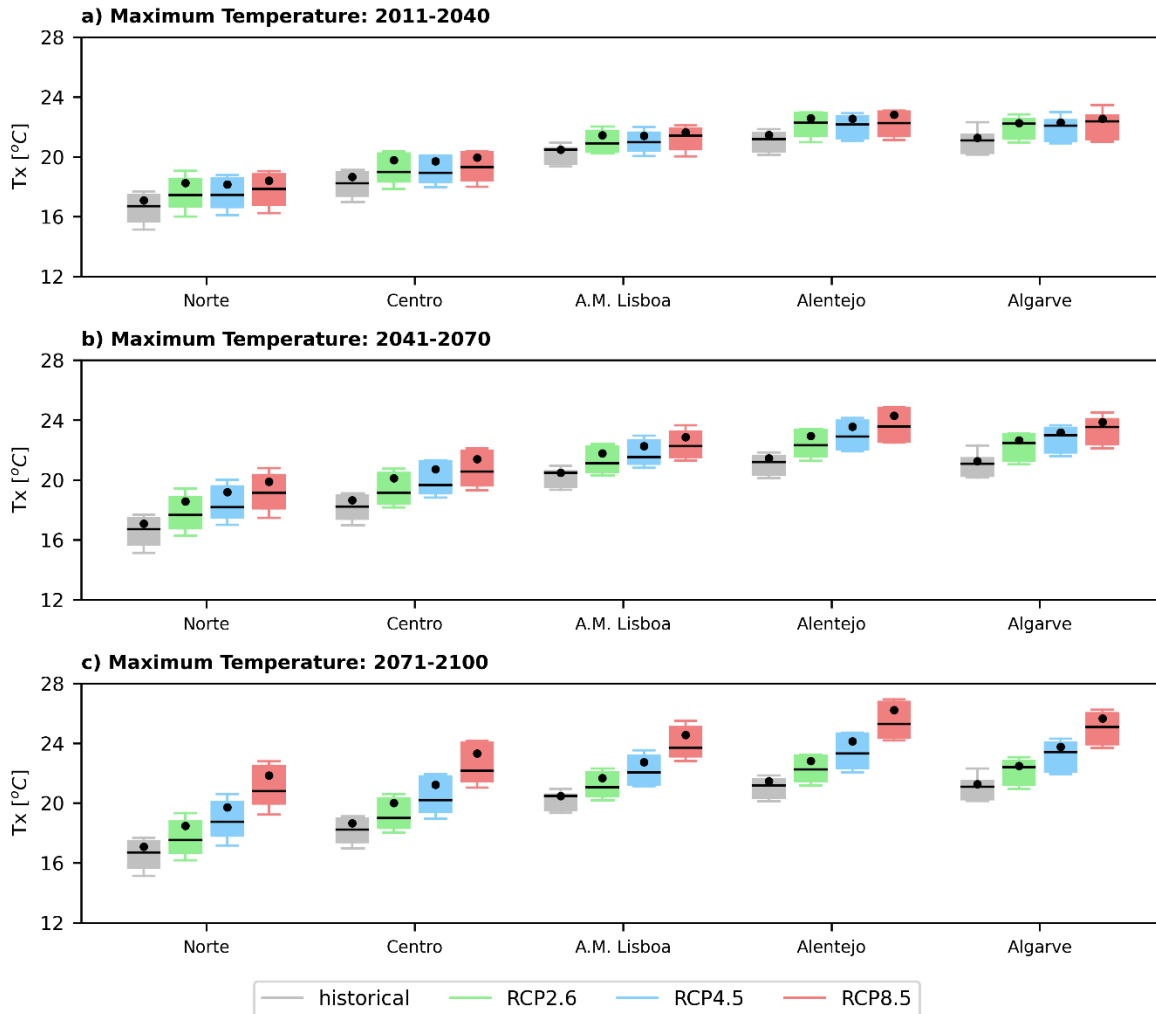


Figure A 6 Climatology of daily maximum temperature averaged over the full year for the NUTS II region. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean.

Table A 6 Multi-model ensemble projected changes in daily maximum temperature (°C) averaged over the full year for the NUTS II region.

NUTS II	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Norte	1.16	1.07	1.33	1.49	2.11	2.81	1.40	2.63	4.76
Centro	1.13	1.05	1.31	1.45	2.06	2.74	1.35	2.57	4.66
AM Lisboa	0.96	0.93	1.16	1.30	1.78	2.38	1.20	2.26	4.08
Alentejo	1.12	1.09	1.35	1.49	2.10	2.84	1.36	2.67	4.77
Algarve	1.00	1.04	1.28	1.40	1.91	2.62	1.22	2.50	4.40

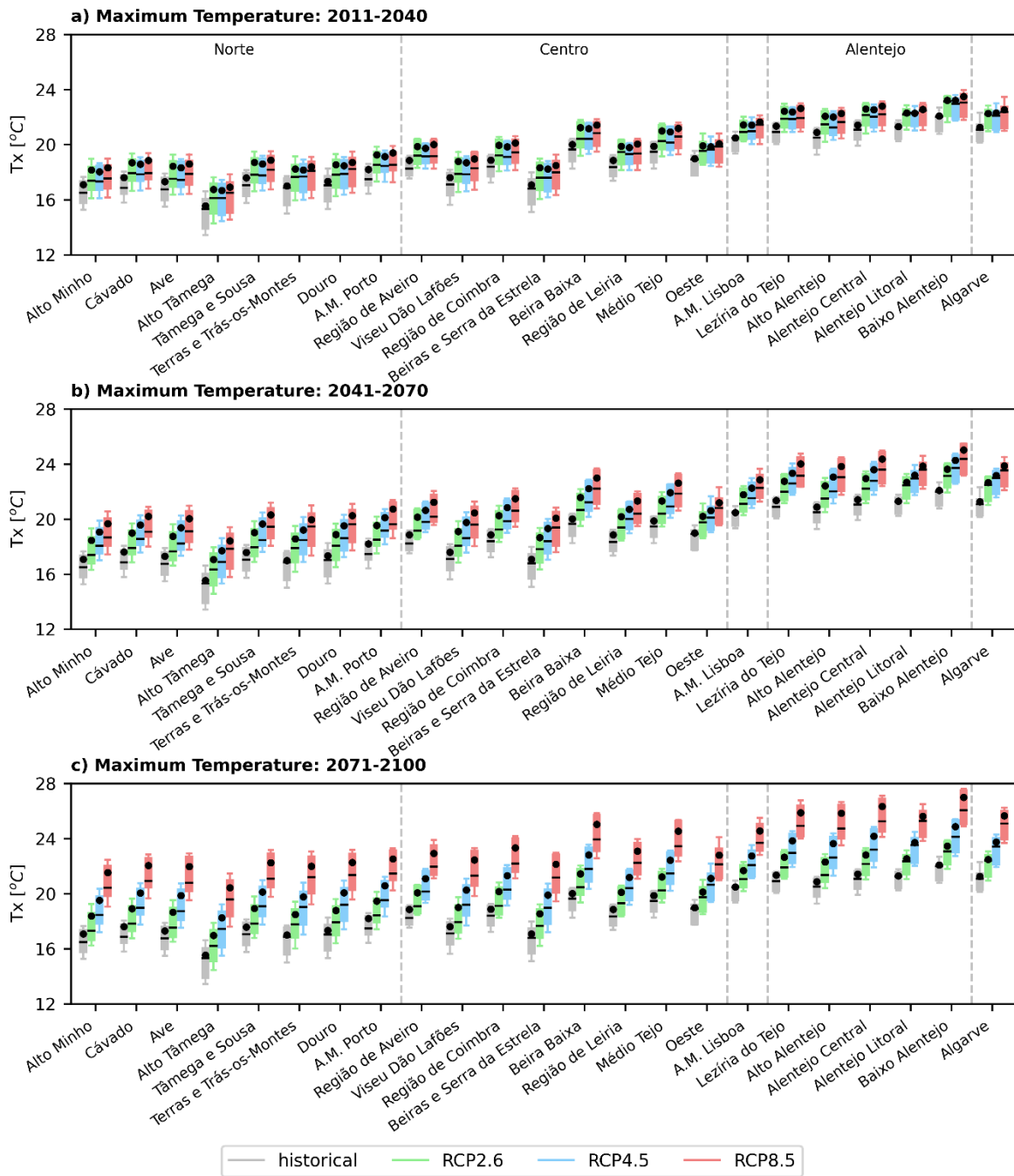


Figure A 7 Climatology of daily maximum temperature averaged over the full year for the NUTS III region. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean.

**Table A 7 Multi-model ensemble projected changes in daily maximum temperature (°C) averaged over the full year for the NUTS III region.**

NUTS III	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Alto Minho	1.08	0.95	1.23	1.38	1.97	2.59	1.30	2.44	4.46
Cávado	1.08	0.96	1.23	1.38	1.97	2.58	1.31	2.44	4.44
Ave	1.13	1.01	1.30	1.44	2.07	2.73	1.36	2.55	4.67
Alto Tâmega	1.20	1.12	1.36	1.53	2.17	2.88	1.42	2.71	4.89
Tâmega e Sousa	1.13	1.01	1.30	1.44	2.07	2.73	1.36	2.54	4.66
Terras de Trás-os-Montes	1.23	1.15	1.39	1.58	2.21	2.97	1.49	2.77	4.99
Douro	1.21	1.13	1.36	1.54	2.18	2.91	1.45	2.73	4.92
AM Porto	1.06	0.94	1.21	1.35	1.91	2.53	1.27	2.38	4.33
R. de Aveiro	1.00	0.89	1.15	1.29	1.79	2.37	1.21	2.24	4.08
Viseu	1.18	1.08	1.36	1.50	2.15	2.86	1.40	2.66	4.85
Dão Lafões	1.08	0.98	1.25	1.39	1.97	2.61	1.30	2.45	4.46
R. de Coimbra	1.25	1.16	1.41	1.58	2.25	3.00	1.46	2.82	5.07
Beiras e S. da Estrela	1.22	1.15	1.41	1.56	2.22	2.98	1.44	2.80	5.02
Beira Baixa	1.02	0.93	1.19	1.33	1.86	2.47	1.24	2.32	4.23
R. de Leiria	1.12	1.05	1.31	1.44	2.06	2.75	1.34	2.56	4.66
Médio Tejo	0.93	0.86	1.09	1.23	1.65	2.21	1.14	2.12	3.81
Oeste	0.95	0.93	1.16	1.30	1.78	2.38	1.20	2.26	4.08
AM Lisboa	1.07	1.03	1.28	1.41	1.99	2.67	1.30	2.49	4.53
Lezíria do Tejo	1.19	1.13	1.39	1.54	2.18	2.96	1.42	2.77	4.96
Alto Alentejo	1.17	1.12	1.38	1.53	2.18	2.94	1.41	2.75	4.92
Alentejo Central	1.00	0.98	1.25	1.37	1.89	2.54	1.24	2.41	4.32
Alentejo Litoral	1.14	1.13	1.40	1.54	2.18	2.94	1.38	2.78	4.91
Baixo Alentejo	1.00	1.04	1.28	1.40	1.91	2.62	1.22	2.50	4.40
Algarve									

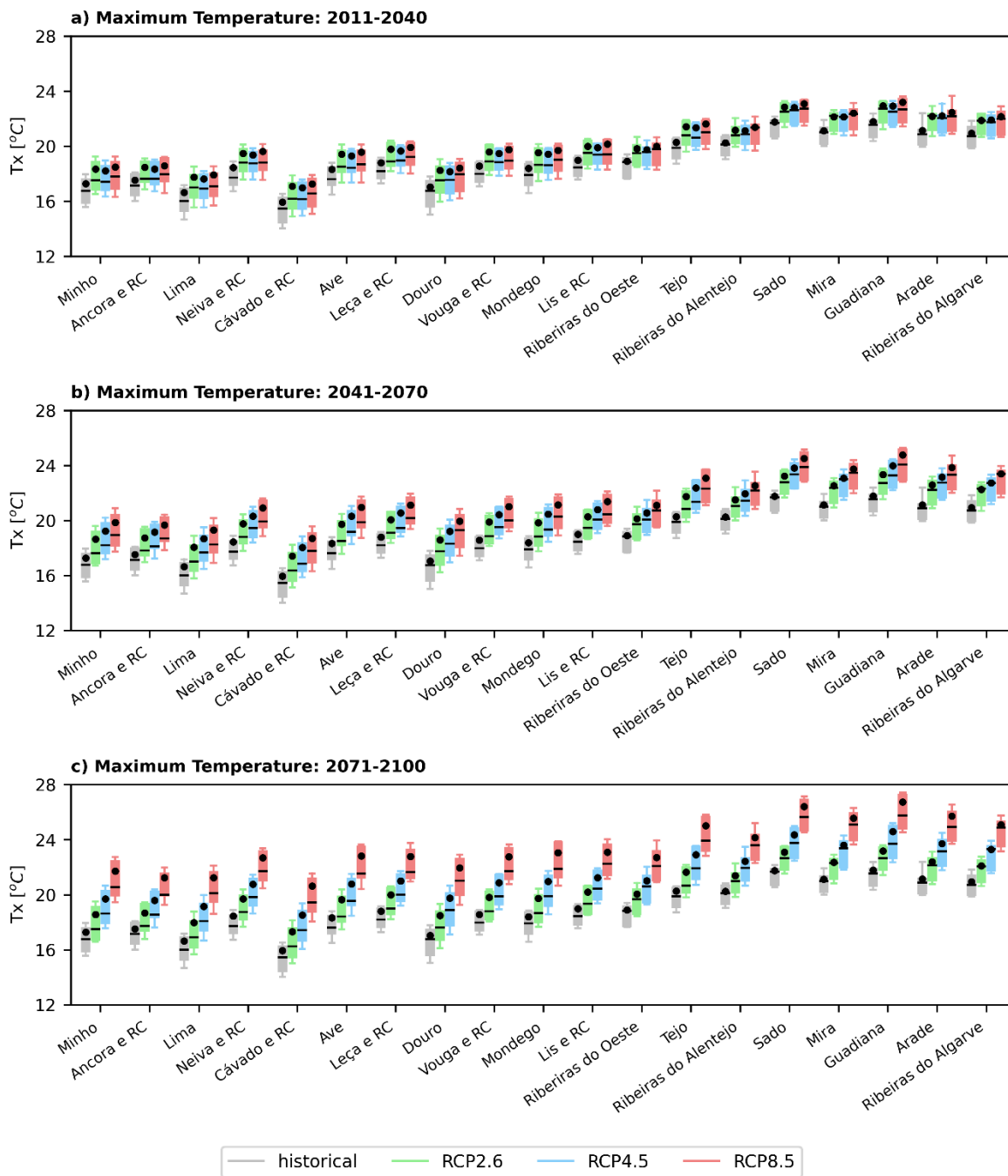


Figure A 8 Climatology of daily maximum temperature averaged over the full year for the basins. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean.

**Table A 8 Multi-model ensemble projected changes in daily maximum temperature (°C) averaged over the full year for the basins.**

Basins	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Minho	1.07	0.94	1.22	1.36	1.96	2.58	1.30	2.42	4.44
Ancora e RC	0.94	0.82	1.05	1.21	1.63	2.15	1.16	2.08	3.71
Lima	1.11	0.98	1.27	1.41	2.04	2.67	1.34	2.51	4.60
Neiva e RC	1.03	0.91	1.17	1.32	1.87	2.47	1.25	2.33	4.24
Cávado e RC	1.15	1.03	1.31	1.46	2.08	2.74	1.37	2.58	4.69
Ave	1.09	0.97	1.25	1.39	1.99	2.62	1.31	2.46	4.49
Leça e RC	0.99	0.86	1.12	1.27	1.75	2.33	1.20	2.21	3.99
Douro	1.20	1.11	1.36	1.54	2.17	2.90	1.44	2.71	4.90
Vouga e RC	1.03	0.92	1.18	1.32	1.85	2.45	1.24	2.31	4.20
Mondego	1.13	1.03	1.31	1.45	2.07	2.74	1.35	2.56	4.67
Lis e RC	1.00	0.91	1.16	1.30	1.80	2.39	1.21	2.26	4.11
Ribeiras do Oeste	0.93	0.86	1.09	1.23	1.65	2.21	1.14	2.12	3.81
Tejo	1.14	1.08	1.34	1.48	2.09	2.81	1.37	2.63	4.75
Ribeiras do Alentejo	0.91	0.87	1.14	1.25	1.69	2.28	1.15	2.18	3.90
Sado	1.08	1.06	1.33	1.46	2.05	2.76	1.33	2.59	4.64
Mira	1.01	1.00	1.28	1.40	1.95	2.62	1.24	2.49	4.44
Guadiana	1.16	1.14	1.41	1.55	2.20	2.98	1.40	2.81	4.96
Arade	1.03	1.06	1.32	1.44	2.00	2.70	1.26	2.58	4.57
Ribeiras do Algarve	0.94	0.98	1.21	1.32	1.79	2.45	1.16	2.35	4.14

## Minimum Temperature

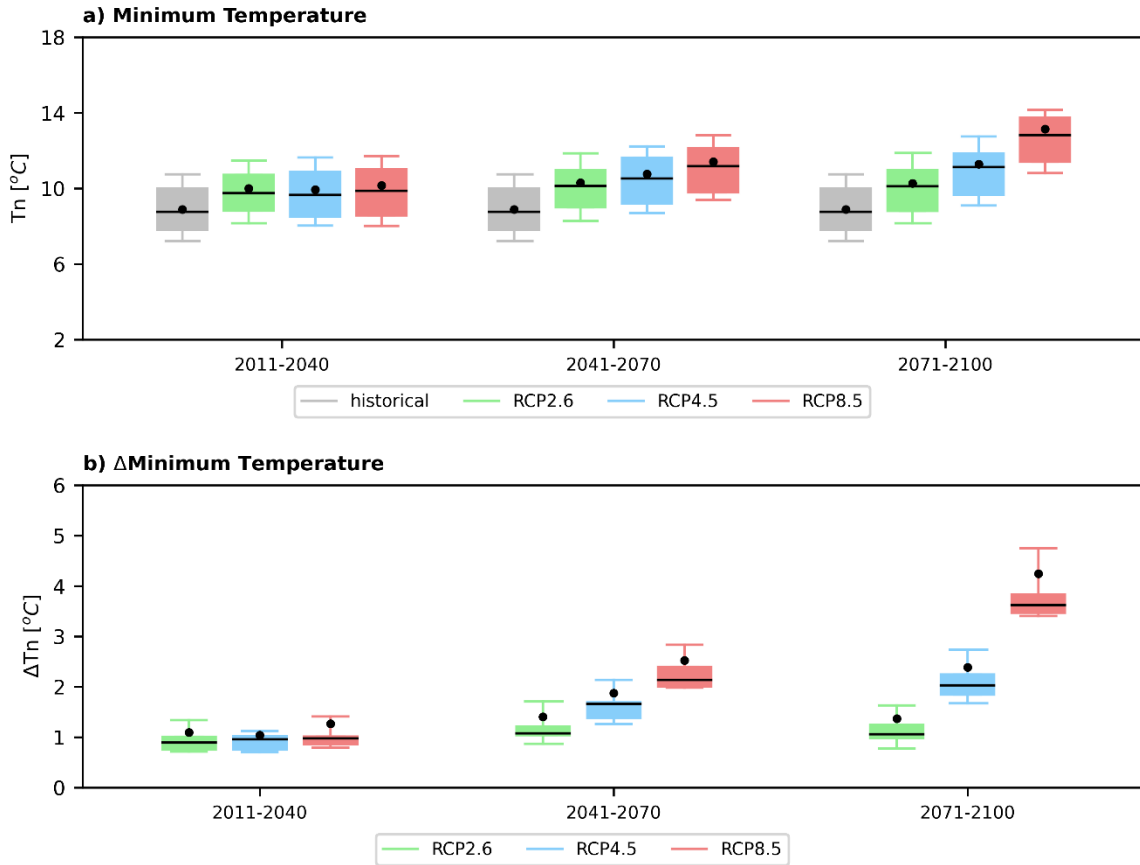


Figure A 9 (a) Climatology of daily minimum temperature averaged over the full year for the NUTS I region. Three future periods are shown: 2011-2040, 2041-2070, and 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean. (b) Future projected changes in daily minimum temperature averaged over the full year for the NUTS I. The 1971-2000 period as reference.

Table A 9 Multi-model ensemble projected changes in daily minimum temperature (°C) averaged over the full year for the NUTS I region.

NUTS I	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Portugal	1.10	1.04	1.27	1.41	1.87	2.52	1.37	2.39	4.24

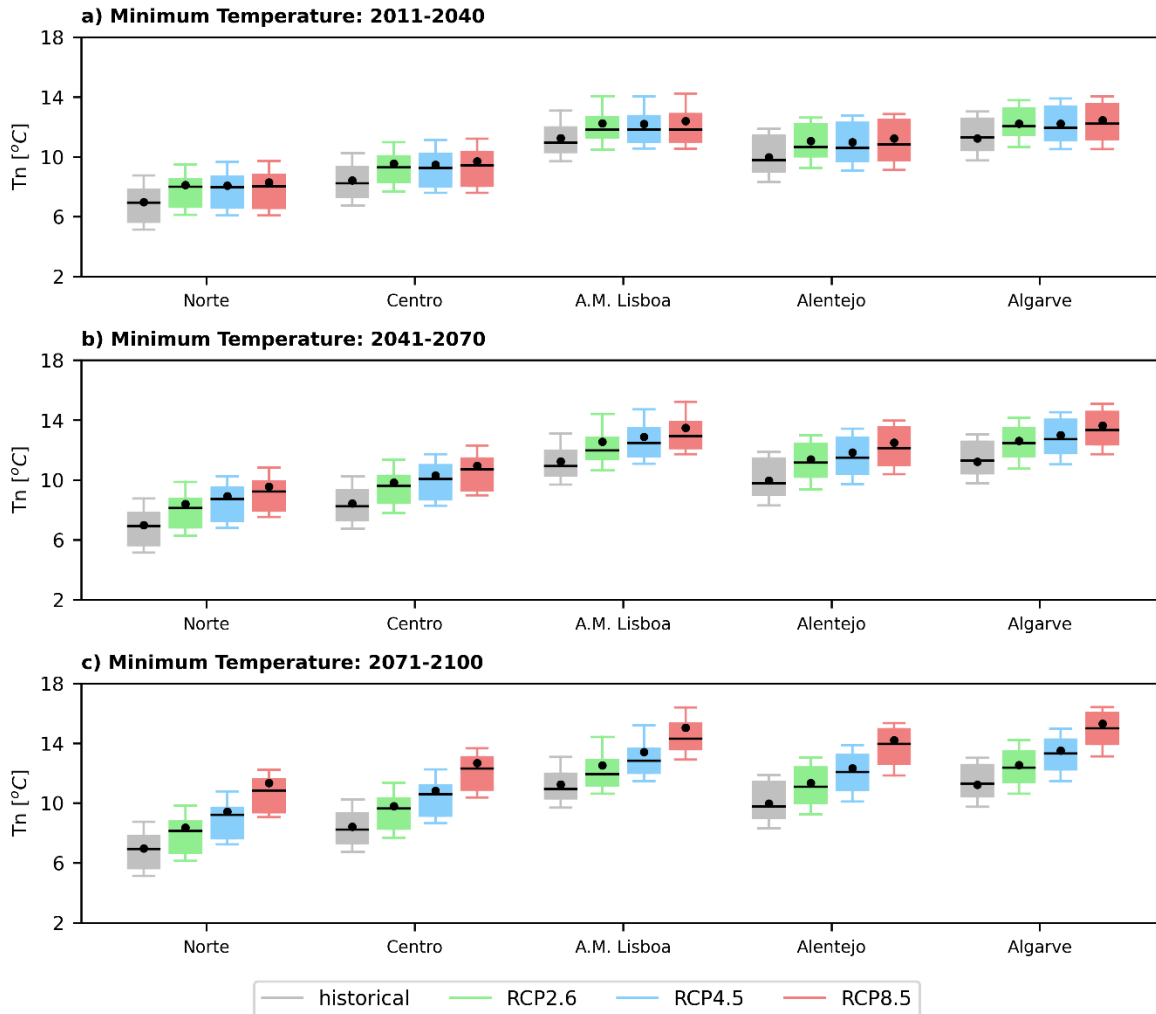


Figure A 10 Climatology of daily minimum temperature averaged over the full year for the NUTS II region. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean.

Table A 10 Multi-model ensemble projected changes in daily minimum temperature (°C) averaged over the full year for the NUTS II regions.

NUTS II	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Norte	1.15	1.09	1.30	1.42	1.94	2.58	1.39	2.46	4.36
Centro	1.11	1.04	1.27	1.41	1.88	2.52	1.36	2.40	4.25
AM Lisboa	0.99	0.96	1.15	1.31	1.65	2.24	1.28	2.18	3.79
Alentejo	1.08	1.02	1.26	1.41	1.86	2.53	1.38	2.37	4.24
Algarve	1.00	0.99	1.23	1.38	1.78	2.42	1.32	2.28	4.08



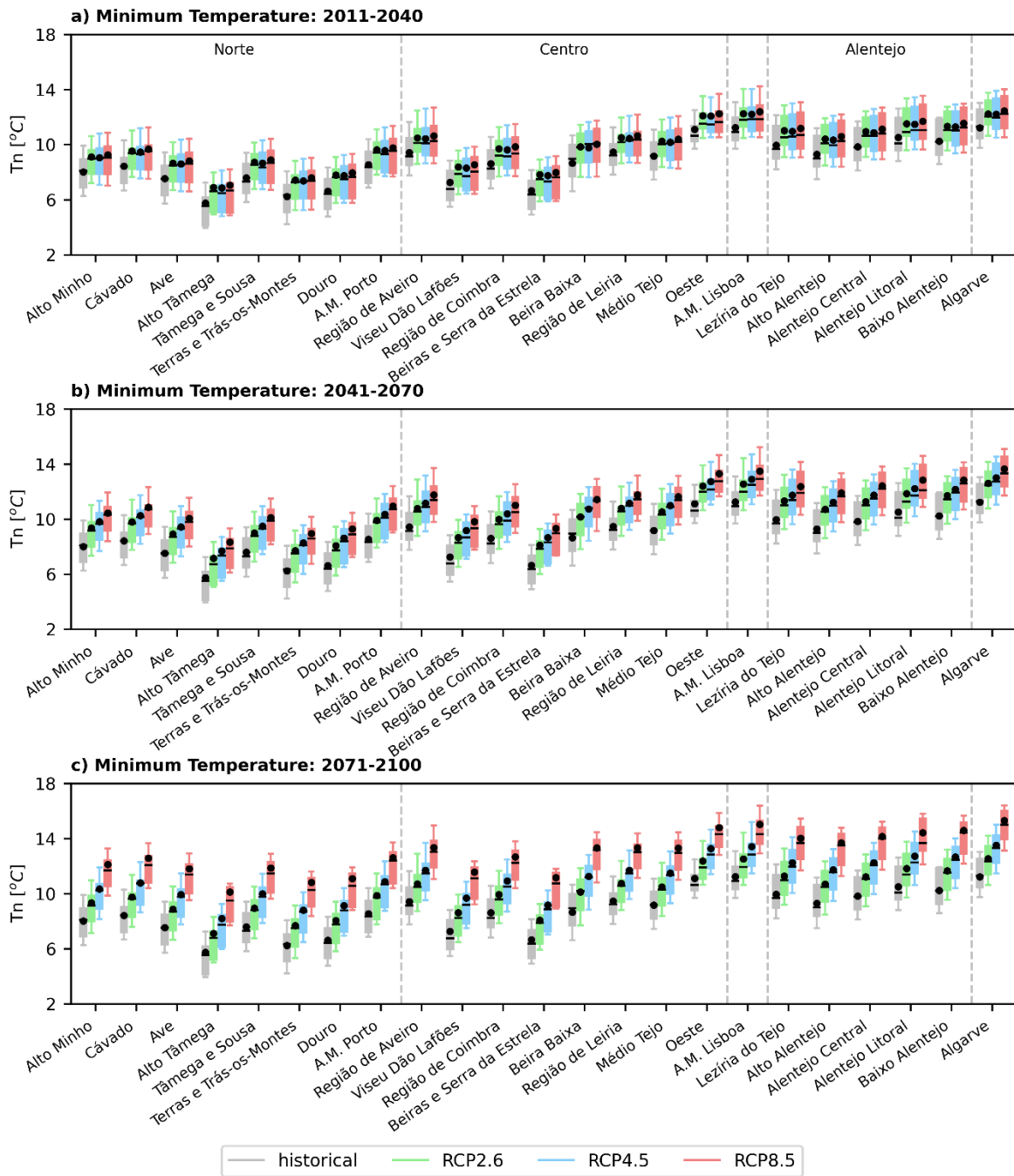


Figure A 11 Climatology of daily minimum temperature averaged over the full year for the NUTS III region. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey).

**Table A 11 Multi-model ensemble projected changes in daily minimum temperature (°C) averaged over the full year for the NUTS III regions.**

NUTS III	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Alto Minho	1.09	1.04	1.24	1.35	1.81	2.43	1.32	2.33	4.11
Cávado	1.11	1.04	1.25	1.37	1.84	2.45	1.34	2.36	4.15
Ave	1.12	1.06	1.29	1.39	1.90	2.52	1.35	2.41	4.28
Alto Tâmega	1.14	1.10	1.31	1.40	1.95	2.59	1.37	2.46	4.37
Tâmega e Sousa	1.13	1.07	1.29	1.41	1.90	2.53	1.36	2.41	4.27
Terras de Trás-os-Montes	1.19	1.13	1.35	1.47	2.04	2.71	1.45	2.57	4.58
Douro	1.18	1.12	1.33	1.46	2.00	2.66	1.43	2.52	4.48
AM Porto	1.09	1.02	1.24	1.37	1.80	2.41	1.32	2.33	4.07
R. de Aveiro	1.07	1.00	1.21	1.35	1.73	2.33	1.29	2.28	3.93
Viseu	1.12	1.05	1.29	1.40	1.92	2.56	1.36	2.42	4.32
Dão Lafões	1.12	1.05	1.29	1.40	1.92	2.56	1.36	2.42	4.32
R. de Coimbra	1.09	1.02	1.23	1.37	1.78	2.41	1.32	2.32	4.05
Beiras e S. da Estrela	1.17	1.09	1.33	1.47	2.01	2.68	1.42	2.52	4.51
Beira Baixa	1.19	1.12	1.38	1.52	2.08	2.79	1.48	2.61	4.69
R. de Leiria	1.04	0.98	1.18	1.33	1.70	2.30	1.29	2.24	3.88
Médio Tejo	1.07	1.00	1.23	1.36	1.82	2.46	1.32	2.33	4.14
Oeste	0.99	0.96	1.13	1.29	1.62	2.18	1.26	2.16	3.69
AM Lisboa	1.00	0.96	1.15	1.31	1.65	2.24	1.28	2.18	3.79
Lezíria do Tejo	1.06	0.99	1.22	1.36	1.78	2.41	1.32	2.29	4.07
Alto Alentejo	1.12	1.04	1.30	1.43	1.93	2.62	1.40	2.44	4.40
Alentejo Central	1.10	1.03	1.29	1.42	1.91	2.59	1.39	2.41	4.33
Alentejo Litoral	1.00	0.97	1.18	1.34	1.70	2.32	1.31	2.21	3.92
Baixo Alentejo	1.09	1.04	1.30	1.46	1.92	2.60	1.42	2.43	4.35
Algarve	1.00	0.99	1.23	1.38	1.78	2.42	1.32	2.28	4.08

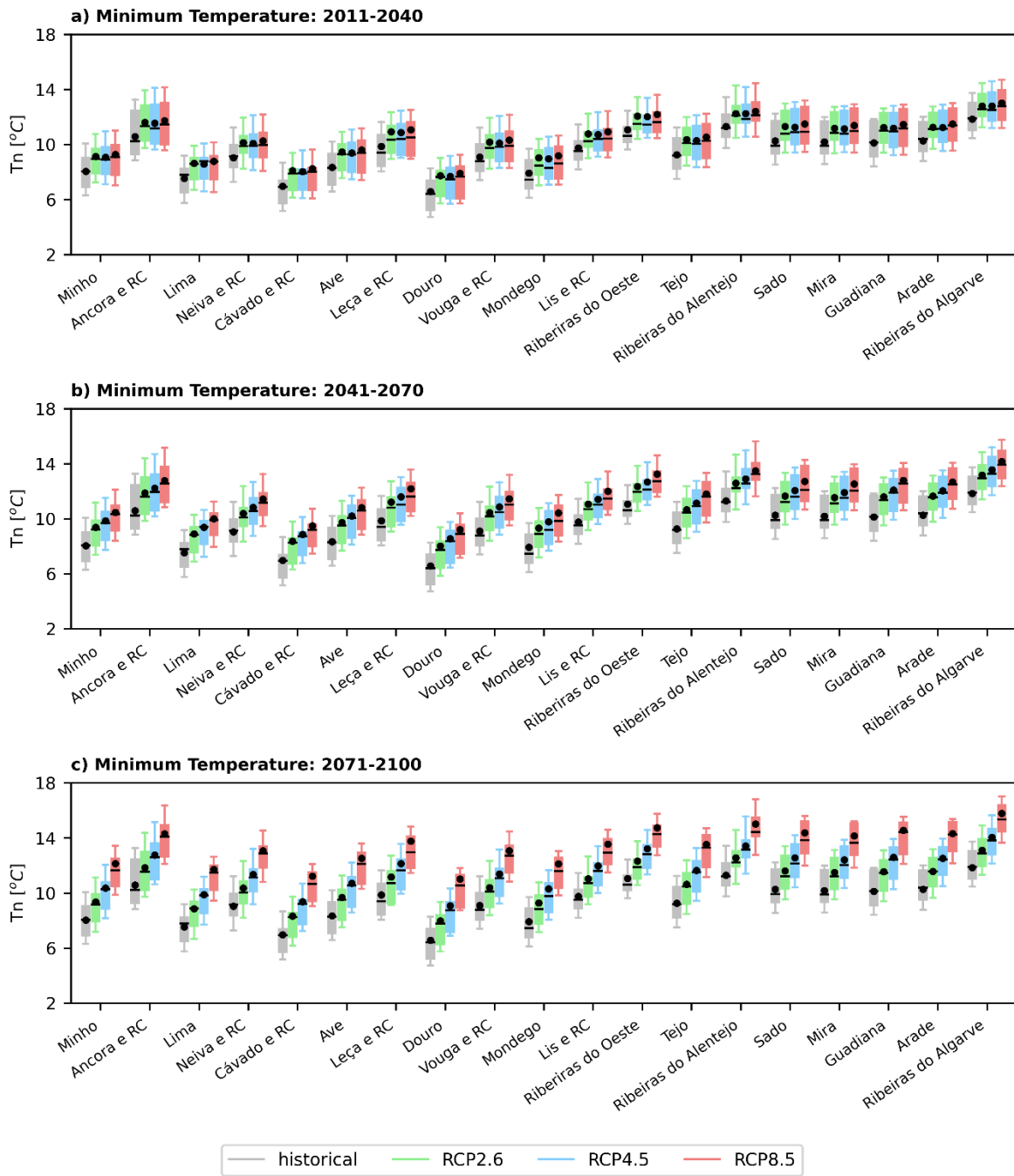


Figure A 12 Climatology of daily minimum temperature averaged over the full year for the basins. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey).

**Table A 12 Multi-model ensemble projected changes in daily minimum temperature (°C) averaged over the full year for the basins.**

Basins	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Minho	1.09	1.04	1.23	1.34	1.81	2.42	1.32	2.32	4.10
Ancora e RC	1.02	0.97	1.15	1.29	1.64	2.19	1.27	2.18	3.72
Lima	1.10	1.05	1.26	1.36	1.84	2.47	1.34	2.36	4.18
Neiva e RC	1.09	1.03	1.23	1.35	1.78	2.38	1.32	2.31	4.04
Cávado e RC	1.12	1.06	1.28	1.39	1.89	2.52	1.35	2.41	4.26
Ave	1.11	1.05	1.26	1.38	1.85	2.47	1.34	2.38	4.18
Leça e RC	1.06	1.01	1.20	1.34	1.74	2.32	1.30	2.28	3.92
Douro	1.16	1.11	1.32	1.45	1.98	2.64	1.41	2.50	4.45
Vouga e RC	1.07	1.01	1.22	1.35	1.76	2.36	1.30	2.30	3.98
Mondego	1.11	1.04	1.26	1.39	1.85	2.49	1.35	2.37	4.19
Lis e RC	1.03	0.97	1.16	1.31	1.66	2.25	1.28	2.21	3.80
Ribeiras do Oeste	0.99	0.96	1.13	1.29	1.62	2.18	1.26	2.15	3.68
Tejo	1.10	1.03	1.27	1.41	1.88	2.54	1.37	2.39	4.28
Ribeiras do Alentejo	0.94	0.94	1.11	1.28	1.59	2.19	1.26	2.13	3.72
Sado	1.05	1.00	1.23	1.38	1.80	2.44	1.35	2.30	4.11
Mira	1.00	0.96	1.19	1.36	1.72	2.35	1.32	2.23	3.97
Guadiana	1.11	1.06	1.32	1.47	1.96	2.65	1.43	2.47	4.43
Arade	1.00	0.97	1.22	1.38	1.77	2.41	1.31	2.26	4.06
Ribeiras do Algarve	0.96	0.96	1.18	1.34	1.71	2.33	1.28	2.22	3.94

# Precipitation

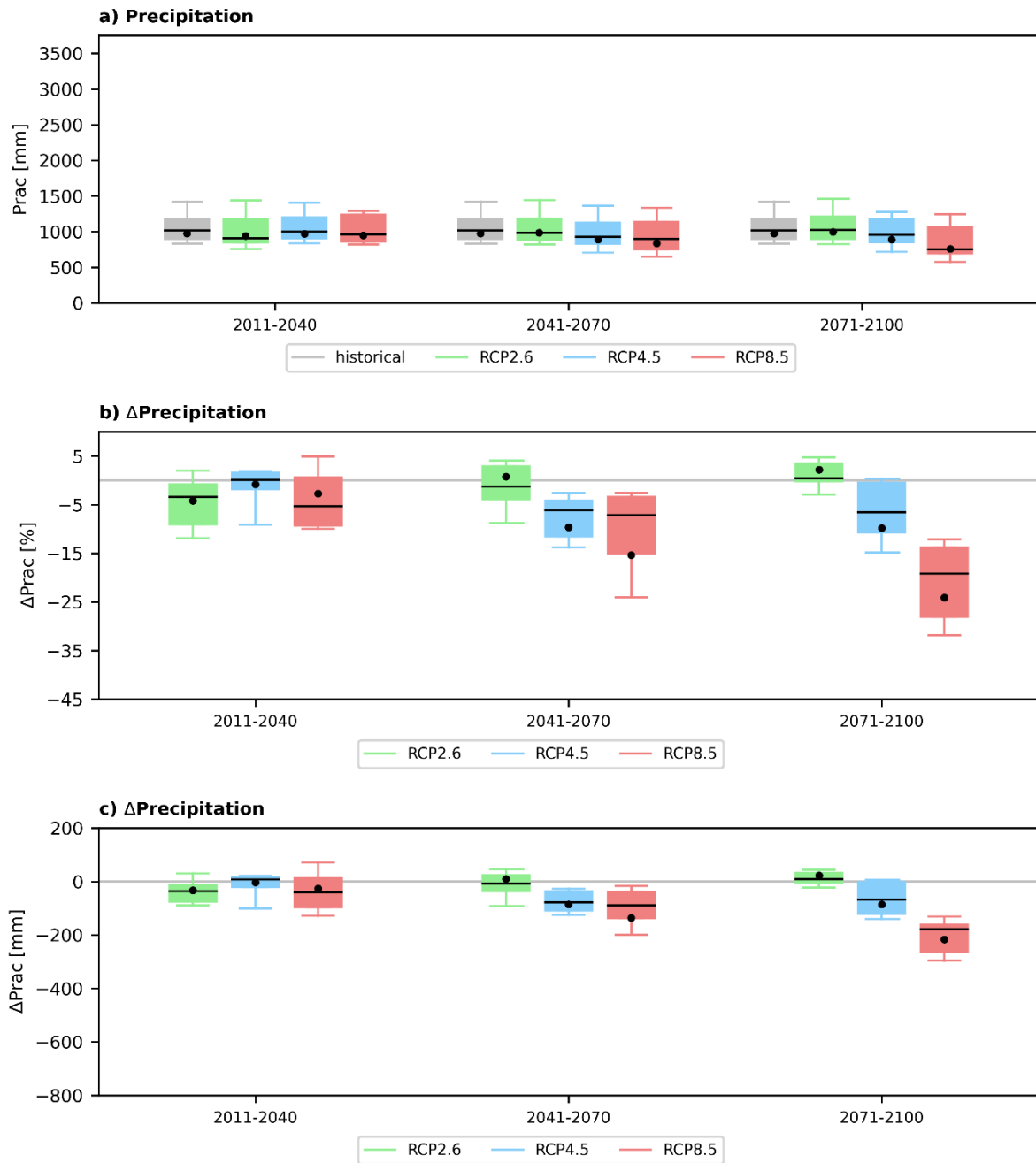


Figure A 13 (a) Climatology of yearly accumulated precipitation for the NUTS I region. Three future periods are shown: 2011-2040, 2041-2070, and 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean. Future projected changes in yearly accumulated precipitation (b) in percentage and (c) in mm, for the different NUTS I region. The 1971-2000 period as reference.

**Table A 13 Multi-model ensemble projected relative changes in yearly accumulated precipitation (%) averaged over the full year for the NUTS I region.**

NUTS I	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Portugal	-4.18	-0.79	-2.74	0.80	-9.62	-15.38	2.22	-9.82	-24.09

**Table A 14 Multi-model ensemble projected absolute changes in yearly accumulated precipitation (mm) averaged over the full year for the NUTS I region.**

NUTS I	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Portugal	-32.96	-3.80	-25.91	9.26	-85.56	-136.67	22.13	-85.55	-217.05

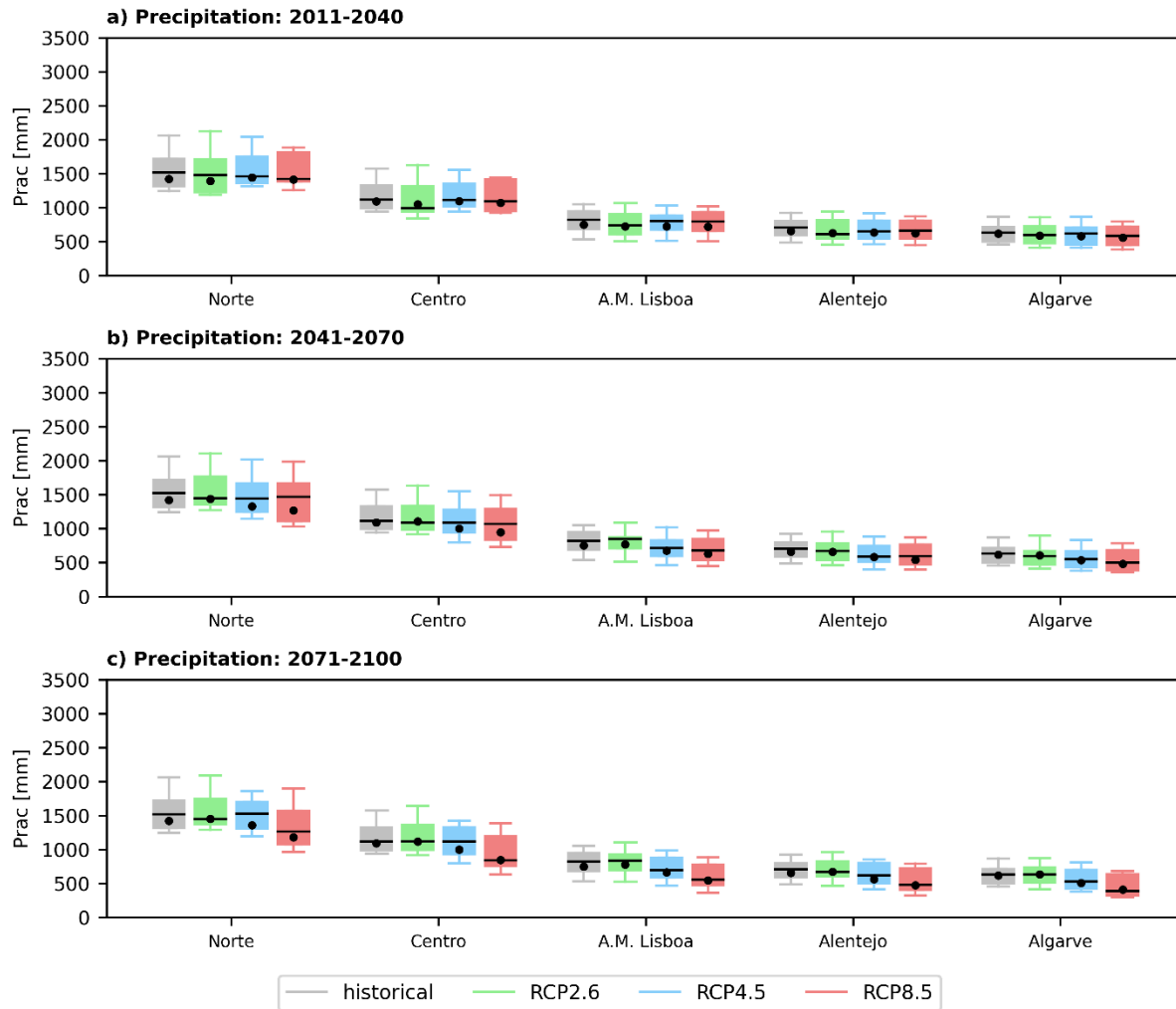


Figure A 14 Climatology of yearly accumulated precipitation for the NUTS II regions. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean.

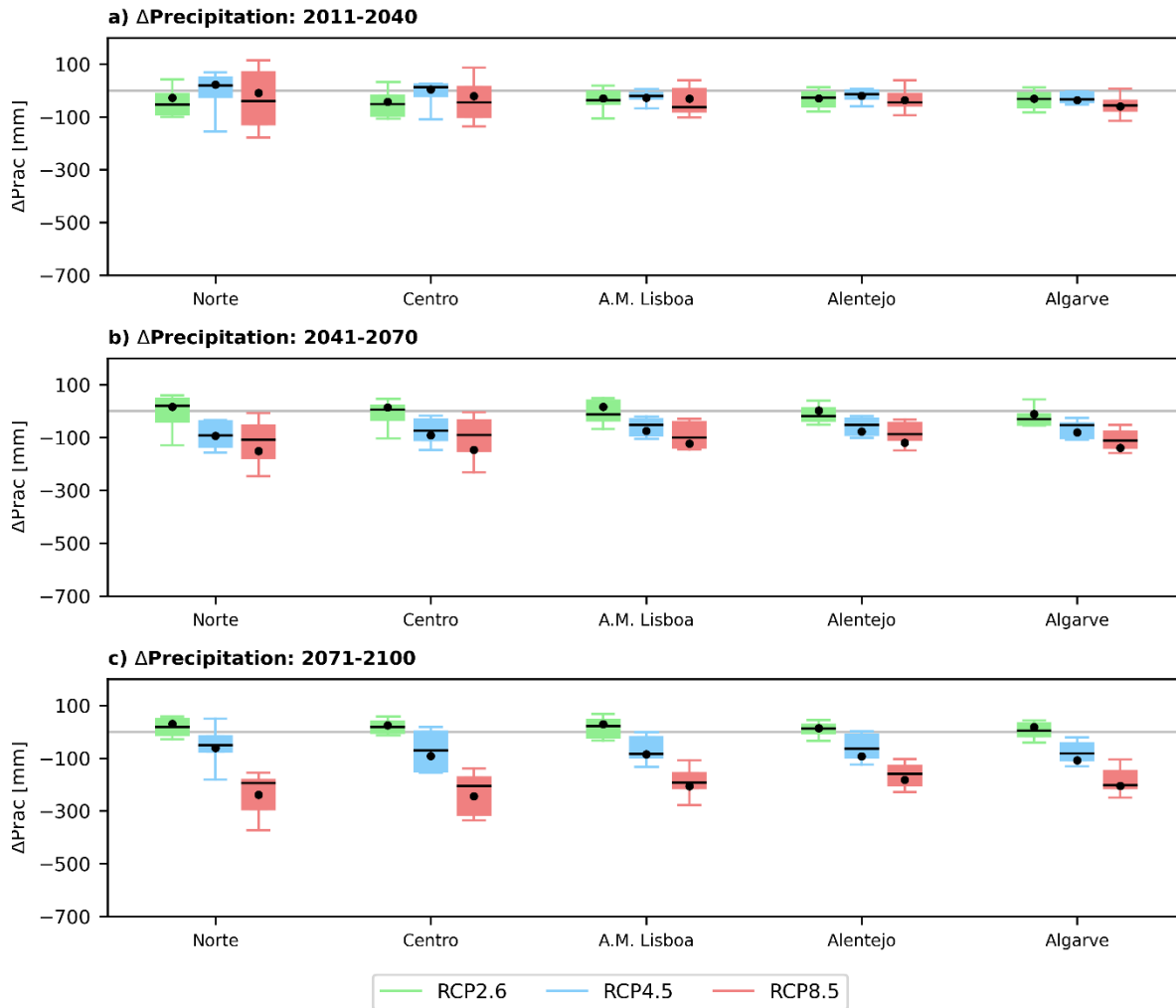


Figure A 15 Future projected changes in yearly accumulated precipitation for the different NUTS II regions. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red). The black point represents the multi-model ensemble mean. The 1971-2000 period as reference.



**Table A 15 Multi-model ensemble projected relative changes in yearly accumulated precipitation (%) averaged over the full year for the NUTS II regions.**

NUTS II	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Norte	-2.20	2.49	0.98	2.02	-6.17	-10.47	2.81	-3.33	-16.31
Centro	-4.43	0.78	-1.13	1.57	-8.34	-13.70	2.38	-8.04	-22.75
AM Lisboa	-4.28	-3.41	-3.51	2.16	-10.25	-16.84	3.67	-11.15	-28.06
Alentejo	-5.12	-3.23	-5.42	-0.26	-12.37	-18.76	1.49	-14.31	-28.55
Algarve	-5.22	-6.09	-9.63	-2.64	-13.48	-22.88	2.55	-17.55	-33.40

**Table A 16 Multi-model ensemble projected absolute changes in yearly accumulated precipitation (mm) averaged over the full year for the NUTS II regions.**

NUTS II	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Norte	-27.71	22.23	-8.44	16.59	-93.83	-151.44	30.25	-61.45	-238.18
Centro	-42.28	3.64	-21.06	14.03	-91.60	-146.53	25.16	-91.28	-243.60
AM Lisboa	-29.13	-27.11	-30.49	16.64	-75.03	-122.77	29.49	-84.99	-206.05
Alentejo	-29.08	-19.97	-35.76	2.72	-76.58	-119.07	13.85	-92.98	-182.50
Algarve	-30.53	-36.58	-59.96	-10.76	-80.67	-138.95	18.48	-107.95	-205.28

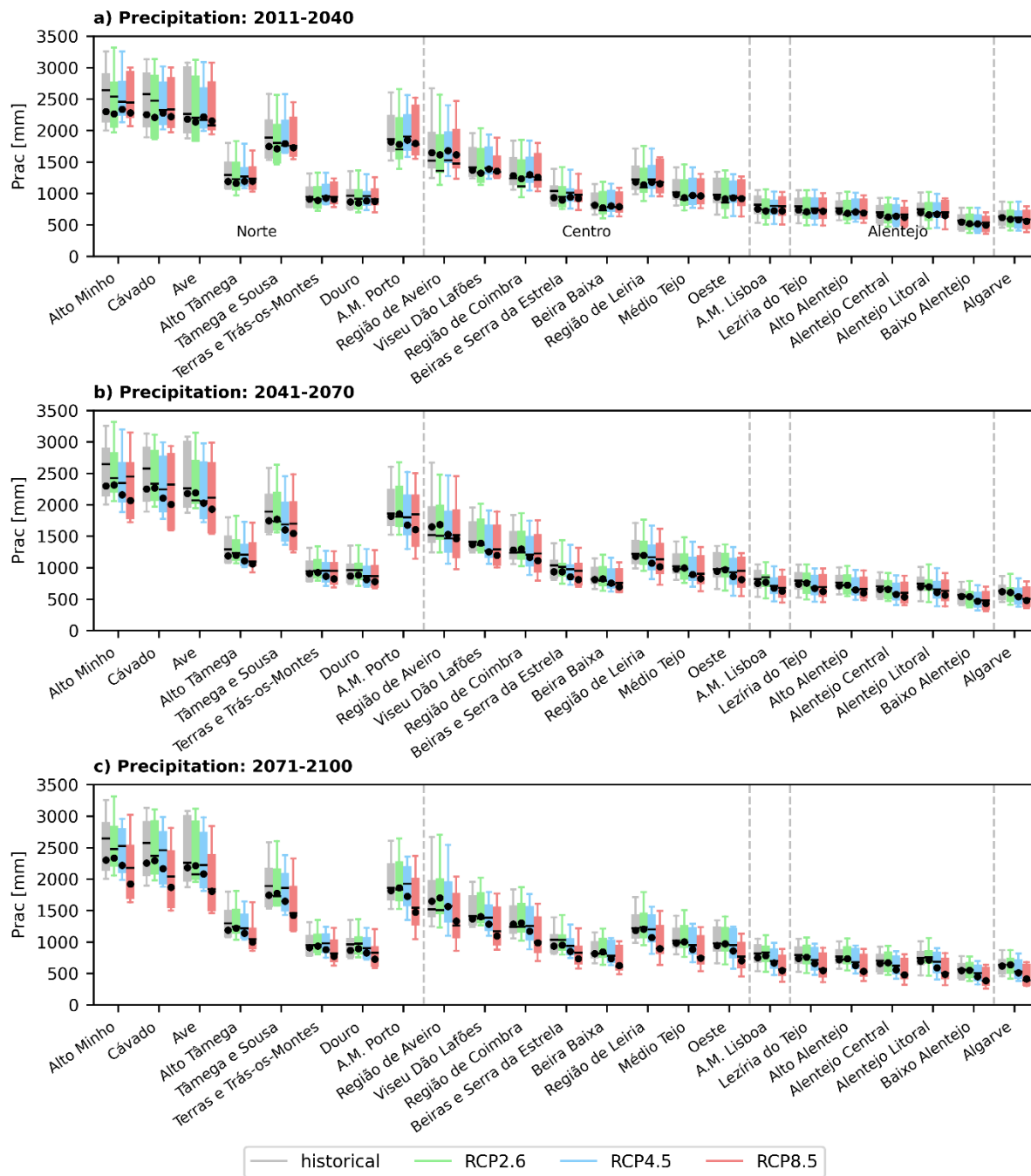


Figure A 16 Climatology of yearly accumulated precipitation for the NUTS III regions. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean.

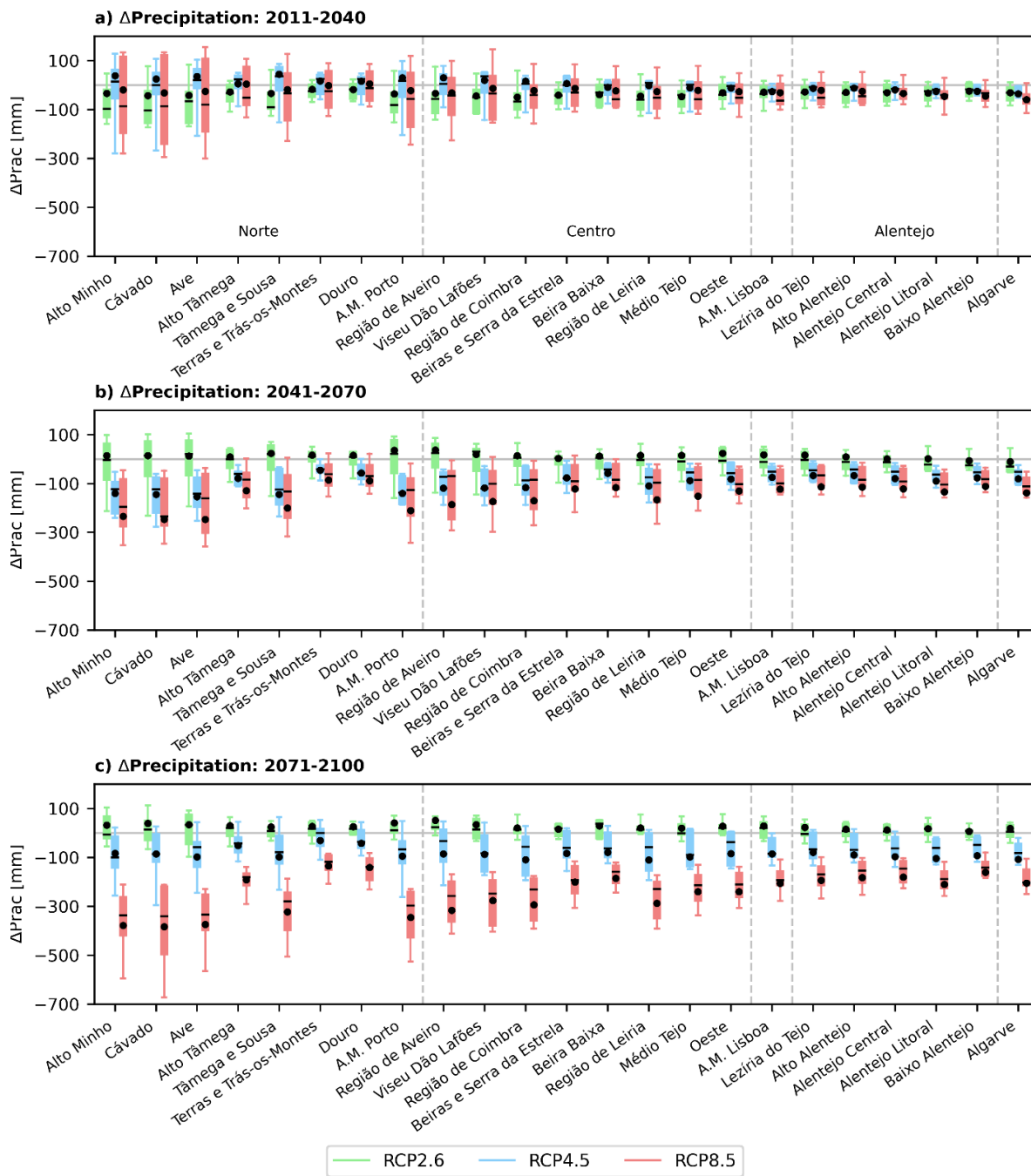


Figure A 17 Future projected changes in yearly accumulated precipitation for the different NUTS III regions. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red). The black point represents the multi-model ensemble mean. The 1971-2000 period as reference.

**Table A 17 Multi-model ensemble projected relative changes in yearly accumulated precipitation (%) averaged over the full year for the NUTS III regions.**

NUTS III	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Alto Minho	-1.70	2.69	0.51	1.13	-5.99	-10.33	1.61	-2.45	-16.58
Cávado	-2.23	2.20	0.41	1.45	-6.27	-11.20	2.22	-2.35	-17.04
Ave	-2.46	2.41	0.21	1.05	-7.27	-12.01	1.71	-3.56	-17.74
Alto Tâmega	-2.16	0.87	1.44	1.46	-5.89	-10.16	3.49	-3.35	-14.92
Tâmega e Sousa	-2.40	3.47	0.10	1.87	-8.48	-11.89	1.51	-4.85	-19.03
Terras de Trás-os-Montes	-2.17	2.77	1.19	2.62	-4.80	-9.58	3.42	-2.60	-14.86
Douro	-2.17	2.86	1.95	2.60	-5.92	-9.70	3.60	-3.84	-15.64
AM Porto	-2.58	2.65	0.05	2.49	-7.98	-12.03	2.33	-4.31	-19.47
R. de Aveiro	-3.08	2.76	-0.38	2.71	-7.76	-12.05	3.08	-4.43	-20.25
Viseu	-3.63	2.40	-0.05	1.90	-8.59	-12.92	2.77	-5.67	-20.23
Dão Lafões	-4.54	1.77	-1.03	1.27	-9.35	-13.73	1.41	-7.98	-23.52
R. de Coimbra	-4.20	1.95	-0.10	1.08	-7.33	-12.22	2.38	-7.68	-20.42
Beiras e S. da Estrela	-4.20	1.95	-0.10	1.08	-7.33	-12.22	2.38	-7.68	-20.42
Beira Baixa	-5.21	-1.05	-2.39	1.57	-7.14	-14.61	3.53	-9.60	-23.23
R. de Leiria	-4.48	0.16	-1.69	1.32	-9.62	-14.44	1.44	-9.00	-25.05
Médio Tejo	-5.35	-1.02	-1.68	1.50	-9.13	-15.88	1.80	-9.60	-24.98
Oeste	-4.00	-1.15	-2.28	2.42	-9.32	-14.24	2.61	-8.94	-26.50
AM Lisboa	-4.28	-3.41	-3.51	2.16	-10.25	-16.84	3.67	-11.15	-28.06
Lezíria do Tejo	-4.31	-1.88	-2.60	1.97	-9.40	-15.79	2.75	-10.44	-26.81
Alto Alentejo	-4.89	-1.66	-3.30	0.99	-9.86	-16.61	1.79	-12.46	-26.20
Alentejo Central	-5.40	-2.97	-5.09	-0.45	-12.72	-19.09	1.33	-14.79	-28.08
Alentejo Litoral	-5.69	-3.84	-6.24	-0.64	-13.92	-20.10	1.71	-15.26	-31.15
Baixo Alentejo	-5.14	-4.97	-8.31	-2.04	-14.58	-20.86	0.56	-16.81	-29.95
Algarve	-5.22	-6.09	-9.63	-2.64	-13.48	-22.88	2.55	-17.55	-33.40

**Table A 18 Multi-model ensemble projected absolute changes in yearly accumulated precipitation (mm) averaged over the full year for the NUTS III regions.**

NUTS III	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Alto Minho	-34.14	38.22	-19.31	13.96	-140.83	-234.50	32.66	-83.63	-377.95
Cávado	-43.67	25.10	-31.79	13.77	-144.34	-247.40	39.52	-85.81	-383.32
Ave	-42.48	35.26	-25.67	11.86	-153.81	-247.42	33.82	-97.38	-374.35
Alto Tâmega	-27.82	4.84	3.73	8.70	-78.92	-129.26	30.29	-51.76	-191.29
Tâmega e Sousa	-34.15	43.97	-18.79	22.98	-144.32	-200.25	24.58	-98.16	-323.06
Terras de Trás-os-Montes	-17.77	15.95	-1.74	16.45	-45.42	-85.62	26.55	-30.92	-135.05
Douro	-18.99	15.09	5.54	15.38	-57.49	-88.79	26.24	-42.48	-141.52
AM Porto	-36.39	30.16	-22.99	35.87	-141.12	-210.67	41.79	-94.18	-345.53
R. de Aveiro	-34.24	29.35	-31.62	37.00	-118.94	-185.65	51.85	-85.48	-315.96
Viseu	-44.92	19.42	-13.62	18.69	-117.91	-173.41	34.68	-87.16	-275.70
Dão Lafões	-49.22	15.11	-23.25	14.36	-116.74	-170.90	20.93	-108.96	-293.33
R. de Coimbra	-41.19	6.06	-13.26	2.22	-76.45	-121.86	16.07	-83.42	-201.19
Beiras e S. da Estrela	-38.75	-9.79	-23.50	11.80	-57.74	-116.93	28.59	-79.11	-184.94
Beira Baixa	-45.51	-2.42	-26.83	14.97	-109.51	-166.51	20.88	-110.17	-287.70
R. de Leiria	-47.17	-11.60	-21.76	14.70	-88.37	-151.97	19.92	-97.74	-239.89
Médio Tejo	-31.42	-12.22	-27.37	22.94	-81.94	-129.98	28.50	-84.84	-240.16
Oeste	-29.13	-27.11	-30.49	16.64	-75.03	-122.77	29.49	-84.99	-206.05
AM Lisboa	-27.72	-13.64	-21.55	16.05	-67.63	-114.01	22.42	-79.59	-193.29
Lezíria do Tejo	-30.12	-12.03	-25.71	8.68	-67.94	-115.33	16.02	-89.13	-182.54
Alto Alentejo	-30.93	-19.19	-33.98	0.58	-80.13	-122.58	12.30	-97.12	-180.23
Alentejo Central	-33.27	-26.32	-46.24	1.25	-89.69	-134.16	17.29	-104.11	-209.72
Alentejo Litoral	-24.71	-25.90	-45.75	-6.32	-76.30	-111.70	6.52	-92.37	-160.44
Baixo Alentejo	-30.53	-36.58	-59.96	-10.76	-80.67	-138.95	18.48	-107.95	-205.28
Algarve									

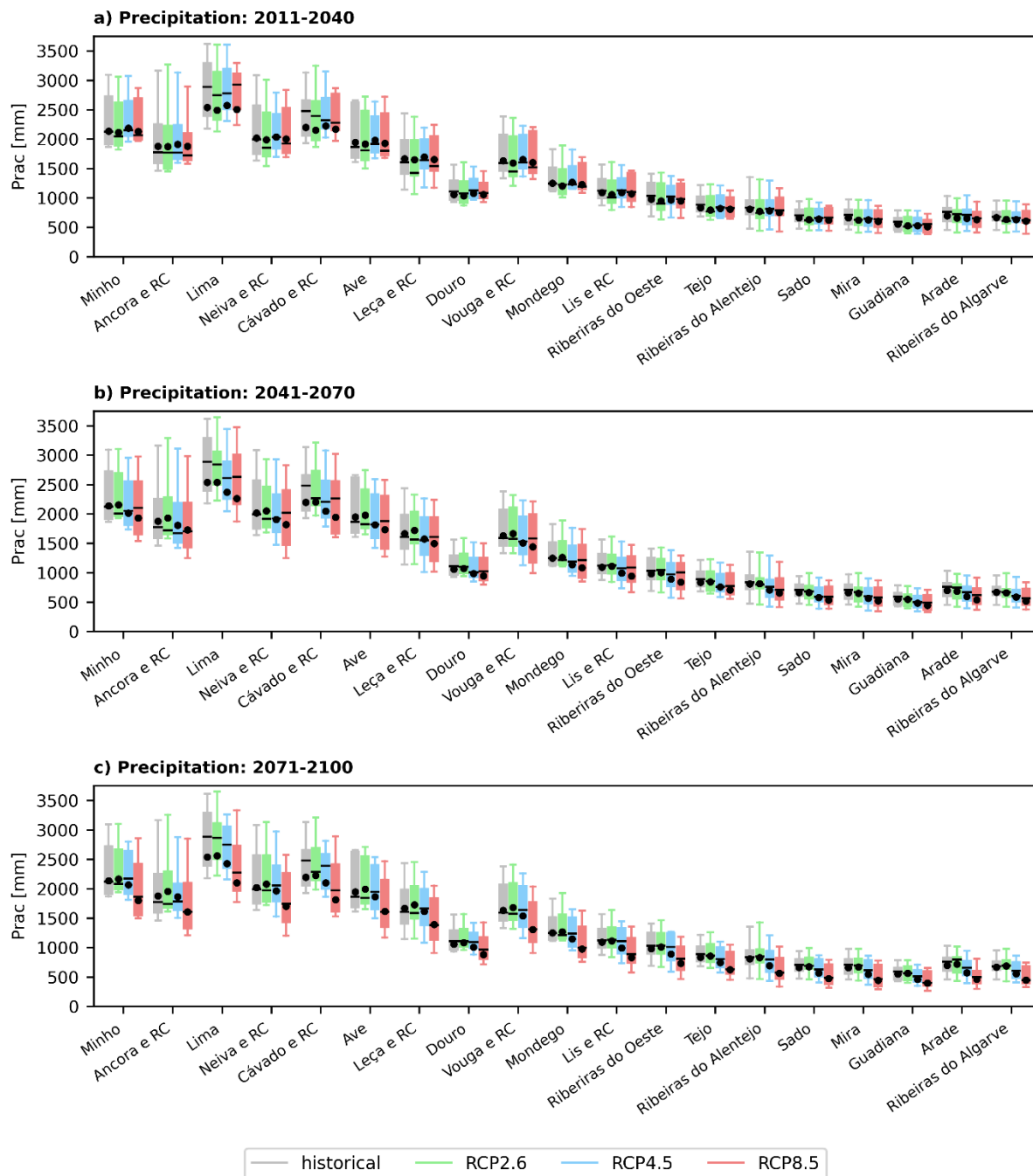


Figure A 18 Climatology of yearly accumulated precipitation for the different basins. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red), with historical period (grey). The black point represents the multi-model ensemble mean.

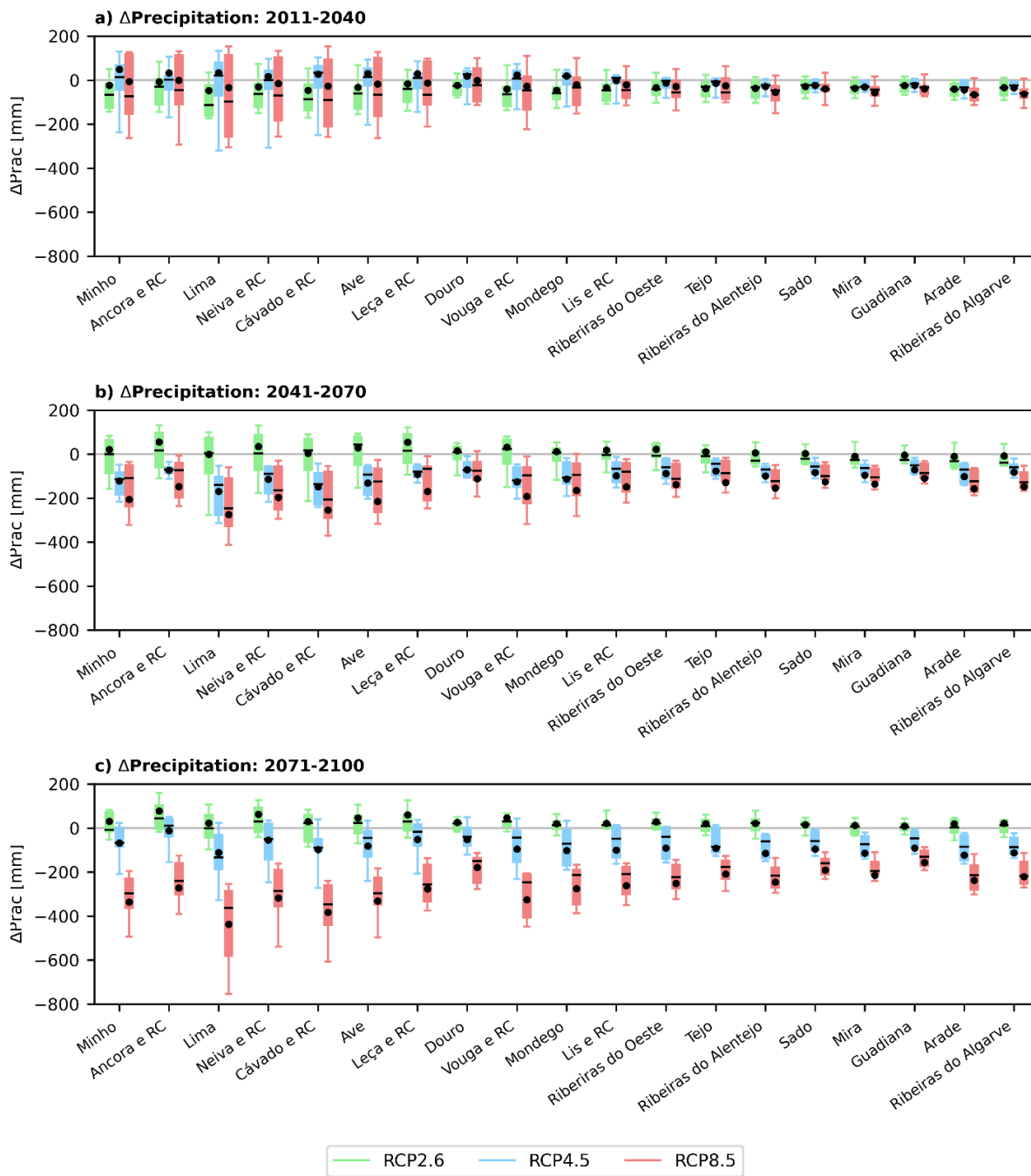


Figure A 19 Future projected changes in yearly accumulated precipitation for the basins. Three future periods are shown: a) 2011-2040, b) 2041-2070, and c) 2071-2100, under all emission scenarios – RCP2.6 (green), RCP4.5 (blue) and RCP8.5 (red). The black point represents the multi-model ensemble mean. The 1971-2000 period as reference.

**Table A 19 Multi-model ensemble projected relative changes in yearly accumulated precipitation (%) averaged over the full year for the basins.**

Basins	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Minho	-1.39	3.20	0.89	1.21	-5.69	-9.84	1.41	-2.17	-16.06
Ancora e RC	-0.85	2.90	1.79	3.34	-4.19	-8.16	4.28	0.61	-14.94
Lima	-2.04	2.35	-0.03	0.58	-6.50	-11.04	1.15	-3.25	-17.28
Neiva e RC	-1.96	2.05	0.91	2.18	-5.76	-10.23	3.22	-1.38	-16.17
Cávado e RC	-2.37	1.94	0.17	0.81	-6.68	-11.83	1.76	-3.47	-17.44
Ave	-2.31	2.40	0.57	1.99	-7.07	-11.71	2.42	-3.17	-17.63
Leça e RC	-1.90	2.77	0.98	3.55	-6.21	-10.94	3.49	-2.02	-17.34
Douro	-2.39	2.60	1.19	2.20	-6.11	-10.30	3.11	-4.02	-16.47
Vouga e RC	-3.28	2.34	-0.39	2.49	-8.05	-12.34	2.95	-5.12	-20.79
Mondego	-4.19	2.40	-0.68	1.34	-9.07	-13.42	1.67	-7.34	-22.26
Lis e RC	-3.92	0.14	-1.42	1.64	-9.39	-14.04	1.53	-8.86	-24.69
Ribeiras do Oeste	-4.08	-1.19	-2.38	2.28	-9.61	-14.63	2.55	-9.14	-26.64
Tejo	-5.04	-1.62	-2.74	1.24	-9.30	-15.90	2.37	-10.85	-25.73
Ribeiras do Alentejo	-5.67	-3.54	-6.40	-0.18	-13.62	-20.16	1.66	-14.86	-31.77
Sado	-5.22	-3.71	-5.75	-0.34	-13.52	-19.65	1.54	-14.55	-29.73
Mira	-6.36	-4.91	-8.40	-2.41	-15.32	-21.25	1.24	-17.33	-33.23
Guadiana	-4.98	-4.36	-7.33	-1.56	-13.35	-20.29	1.13	-16.33	-28.74
Arade	-6.16	-6.26	-9.26	-1.94	-14.79	-22.51	2.23	-17.40	-34.11
Ribeiras do Algarve	-5.62	-5.47	-9.31	-2.27	-13.18	-22.95	2.86	-17.29	-33.76



**Table A 20 Multi-model ensemble projected absolute changes in yearly accumulated precipitation (mm) averaged over the full year for the basins.**

Basins	2011-2040			2041-2070			2071-2100		
	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5	RCP2.6	RCP4.5	RCP8.5
Minho	-23.80	48.31	-5.91	20.57	-122.05	-206.44	30.68	-67.91	-336.15
Ancora e RC	-6.90	32.15	-0.49	55.34	-72.90	-147.95	77.76	-11.85	-271.75
Lima	-47.32	33.85	-33.93	-0.79	-169.39	-275.27	23.21	-111.12	-436.30
Neiva e RC	-30.37	17.19	-15.95	34.40	-113.91	-197.05	62.44	-54.01	-317.93
Cávado e RC	-46.52	26.74	-27.07	3.76	-149.29	-253.79	29.29	-97.55	-382.65
Ave	-32.85	30.80	-17.75	29.00	-131.79	-214.82	46.24	-81.03	-330.95
Leça e RC	-16.25	29.66	-13.48	53.89	-93.17	-168.95	60.83	-51.68	-275.93
Douro	-23.62	18.07	-2.04	15.59	-70.75	-112.26	26.47	-51.22	-179.29
Vouga e RC	-40.52	23.02	-28.57	31.55	-126.34	-192.33	46.96	-95.10	-325.97
Mondego	-46.10	18.69	-20.90	11.80	-113.54	-165.21	20.02	-101.87	-275.48
Lis e RC	-35.20	-1.82	-20.89	18.11	-97.93	-149.07	21.51	-99.62	-261.13
Ribeiras do Oeste	-33.44	-13.23	-29.52	22.09	-87.82	-138.34	28.65	-90.23	-250.82
Tejo	-38.40	-14.03	-25.58	10.17	-76.22	-129.50	20.83	-91.66	-209.21
Ribeiras do Alentejo	-37.61	-29.14	-55.92	5.78	-99.73	-153.93	21.79	-114.98	-245.61
Sado	-29.31	-23.61	-39.56	2.76	-83.70	-125.71	14.71	-95.37	-190.98
Mira	-37.07	-31.58	-56.64	-10.16	-95.64	-136.52	12.92	-113.84	-214.31
Guadiana	-24.79	-22.96	-39.96	-4.46	-70.98	-109.75	9.38	-90.32	-155.65
Arade	-40.53	-44.51	-65.38	-10.56	-102.32	-156.33	18.99	-123.37	-237.20
Ribeiras do Algarve	-33.52	-35.27	-63.47	-7.89	-82.24	-147.60	21.67	-112.85	-220.19

# Climate Extremes

## Precipitation Extremes

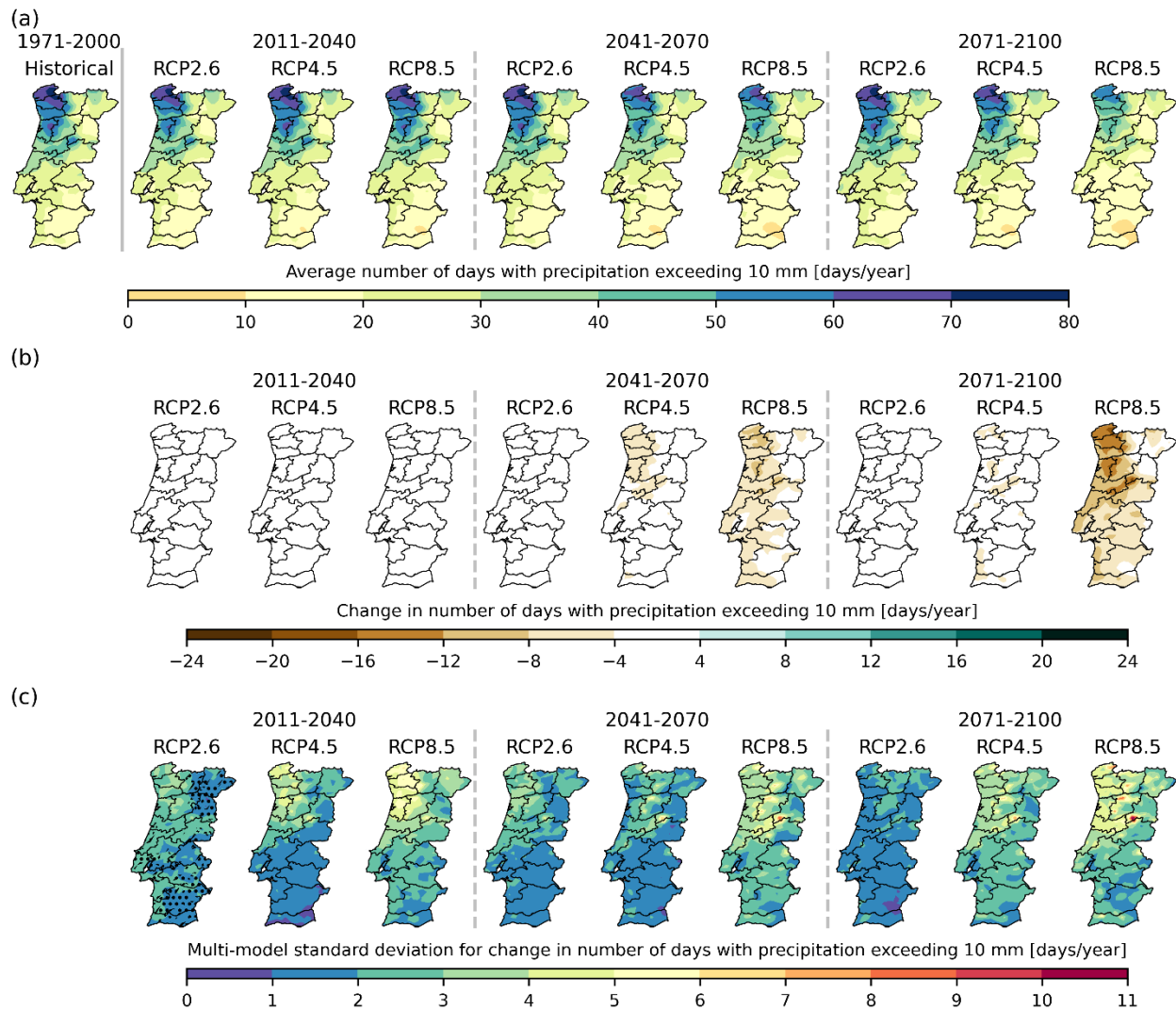


Figure A 20 (a) Annual average number of days with precipitation exceeding 10 mm for historical period (1971-2000) and for the future periods considering different GHG emission scenarios. (b) Future projected changes in average number of days with precipitation exceeding 10 mm over mainland Portugal, considering the 1971-2000 period as reference. (c) Multi-model spread in future projected changes in average number of days with precipitation exceeding 10 mm over mainland Portugal, considering the 1971-2000 period as reference. The spread is quantified by the standard deviation of the anomalies between different models. Grid-points where the change signal does not agree in at least 66% of the models is identified by dotted hatching.

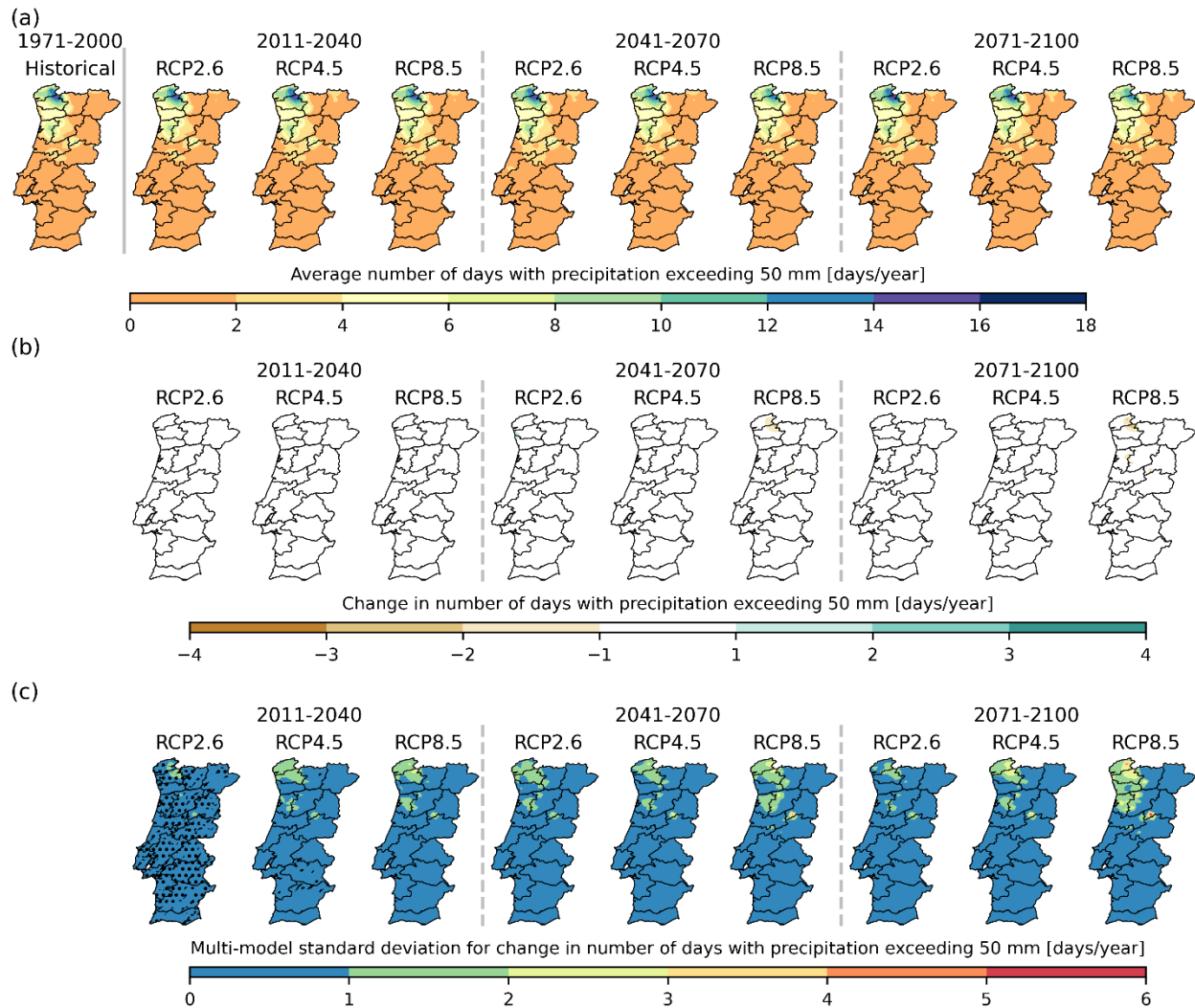


Figure A 21 (a) Annual average number of days with precipitation exceeding 50 mm for historical period (1971-2000) and for the future periods considering different GHG emission scenarios. (b) Future projected changes in average number of days with precipitation exceeding 50 mm over mainland Portugal, considering the 1971-2000 period as reference. (c) Multi-model spread in future projected changes in average number of days with precipitation exceeding 50 mm over mainland Portugal, considering the 1971-2000 period as reference. The spread is quantified by the standard deviation of the anomalies between different models. Grid-points where the change signal does not agree in at least 66% of the models is identified by dotted hatching.