

Supplement of the manuscript:

Holtanová et al.: Quantifying changes in seasonal temperature variations using a functional data analysis approach

List of the figures in the Supplement:

page 2 **Figure S01:** The distances between the smoothed annual cycle curves in the two historical periods 1981-2010 and 1951-1980.

page 19 **Figure S02:** The distances between the smoothed annual cycle curves in the future and reference periods 2071-2100 and 1961-1990.

page 36 **Figure S03:** The smoothed annual cycle curves in the two historical periods 1981-2010 and 1951-1980.

page 53 **Figure S04:** The smoothed annual cycle curves in the future and reference periods of 2071-2100 and 1961-1990.

page 70 **Figure S05:** The distances between the first derivatives of the smoothed annual cycle curves in the two historical periods 1981-2010 and 1951-1980.

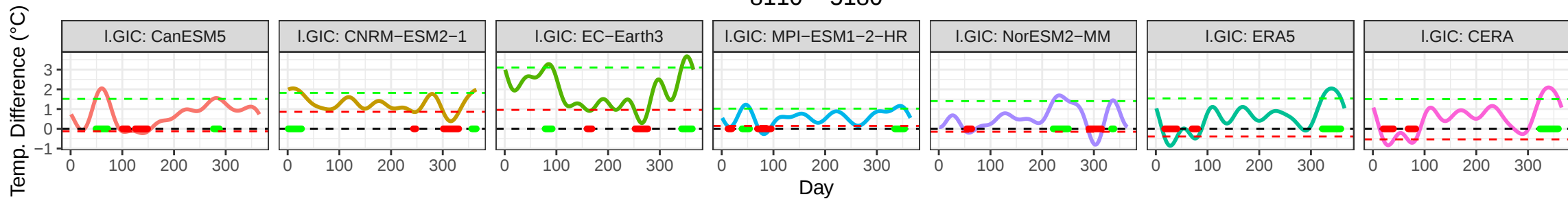
page 87 **Figure S06:** The distances between the first derivatives of the smoothed annual cycle curves in the future and reference periods 2071-2100 and 1961-1990.

page 104 **Figure S07:** The smoothed annual cycle curves in the two historical periods 1981-2010 and 1951-1980.

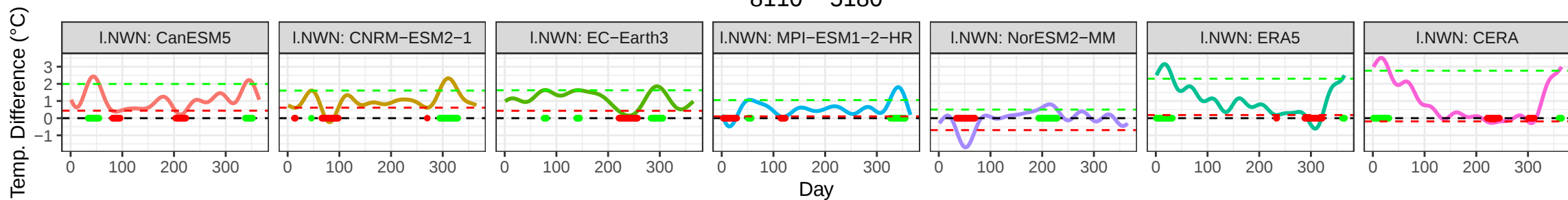
page 121 **Figure S08:** The smoothed annual cycle curves in the future and reference periods of 2071-2100 and 1961-1990.

Figure S01: The distances between the smoothed annual cycle curves in the two historical periods 1981-2010 and 1951-1980. Plots for five selected CMIP6 ESMs and two reanalyses are shown in different columns, plots for different geographical regions are depicted in different rows of the figure. The red dashed line represents the 10th percentile, and the green dashed line represents the 90th percentile. For all values below/above the 10th/90th percentile-threshold, the time periods of the year when these values occur are shown in red/green. The results shown in this figure are summarized in Fig. 3 in the manuscript.

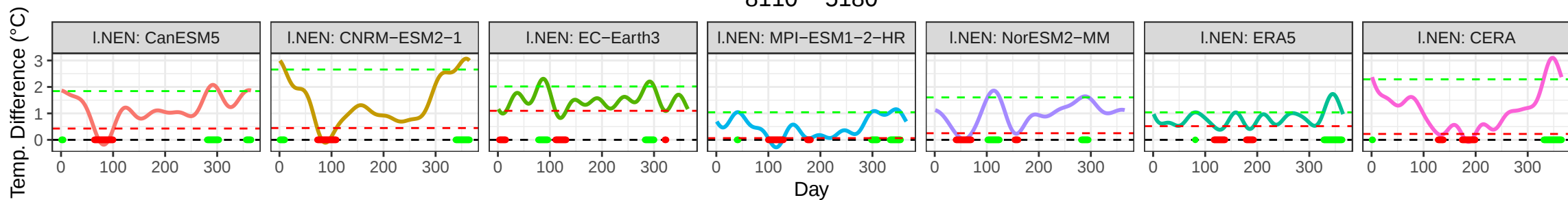
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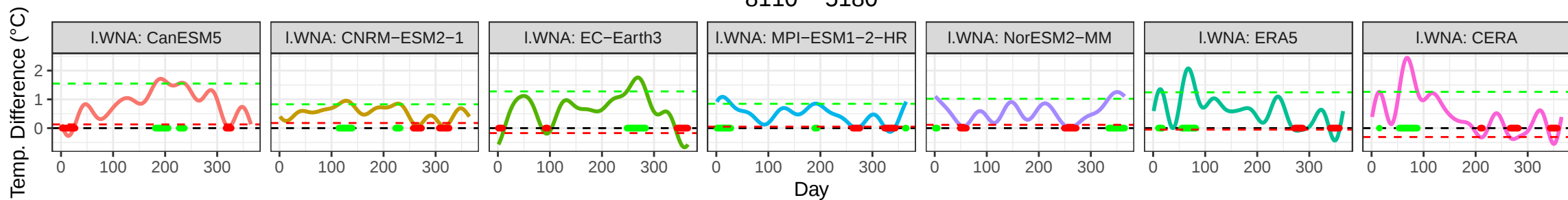
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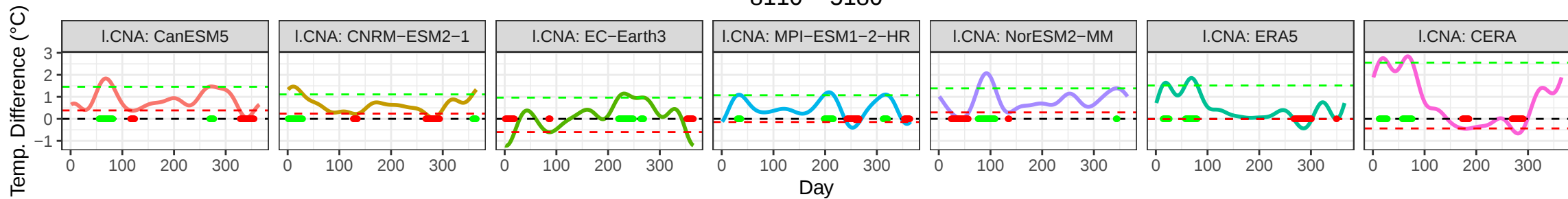
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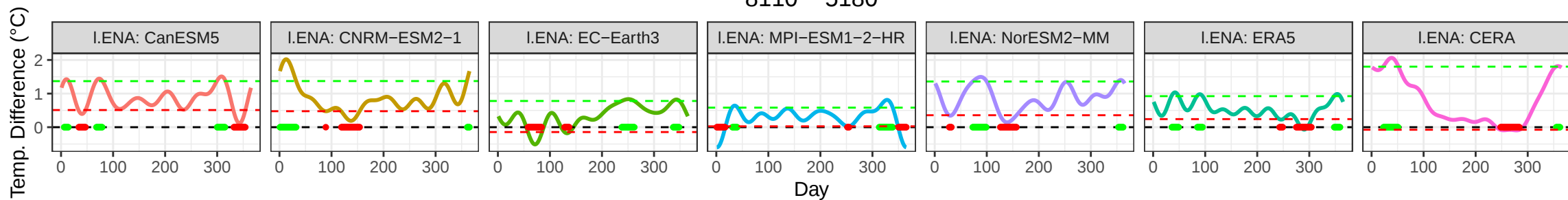
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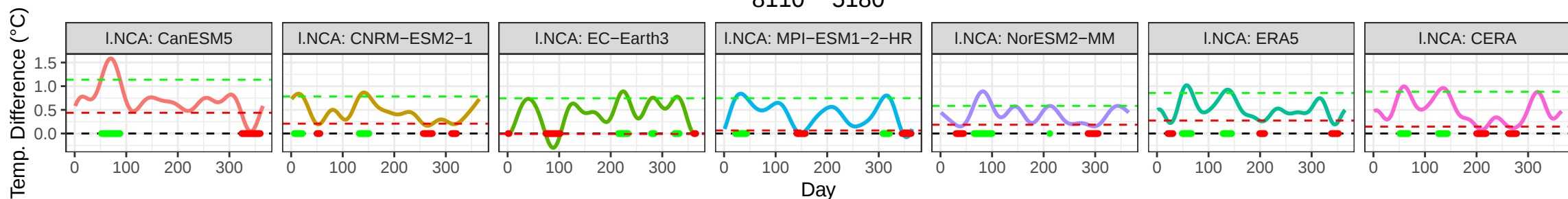
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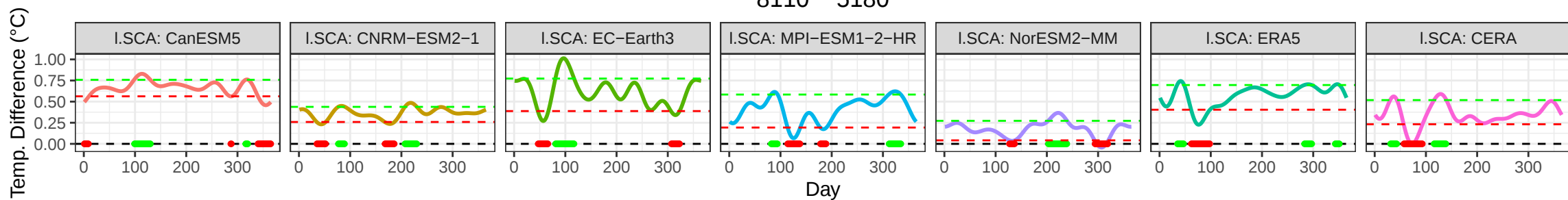
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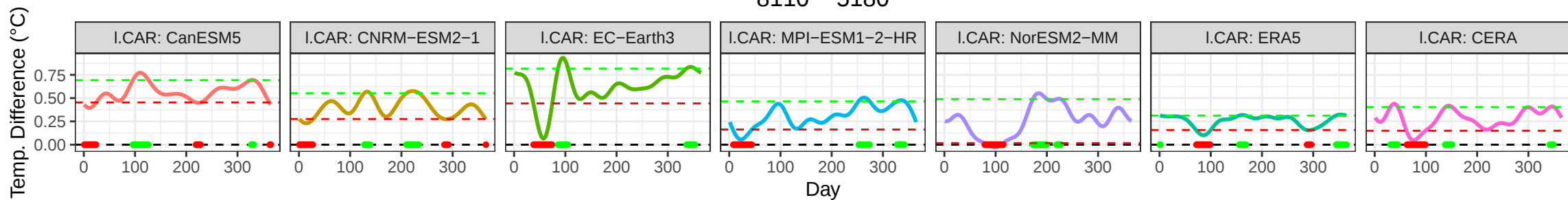
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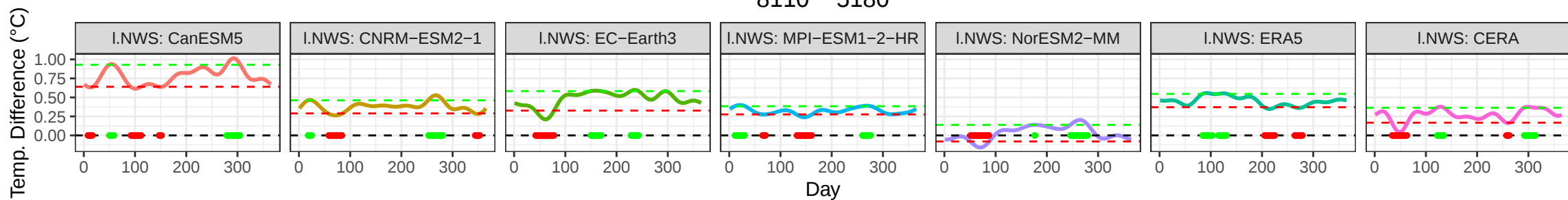
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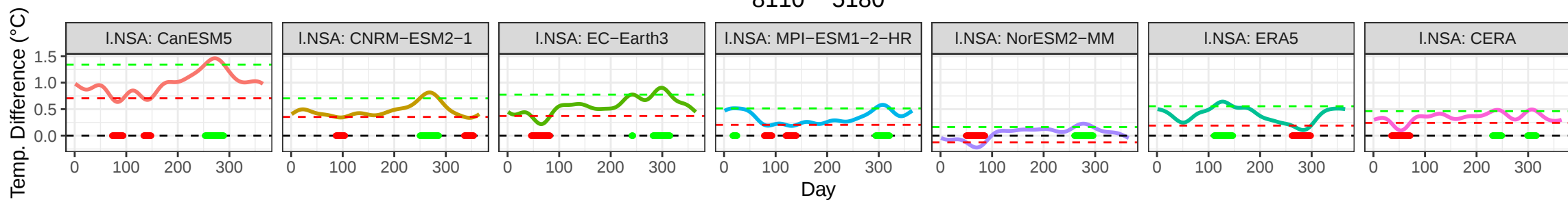
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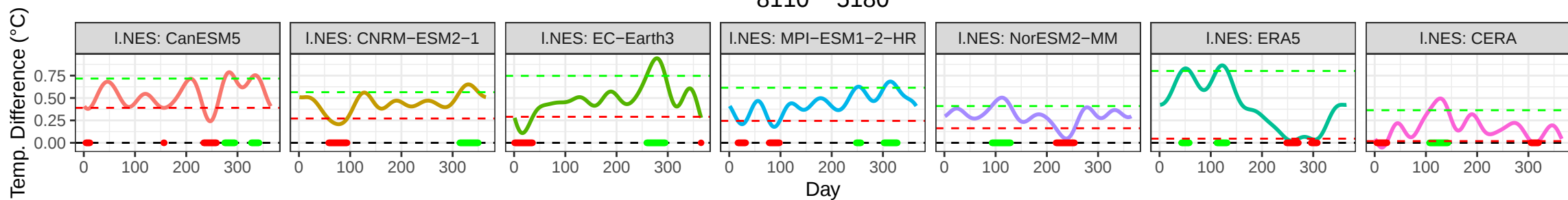
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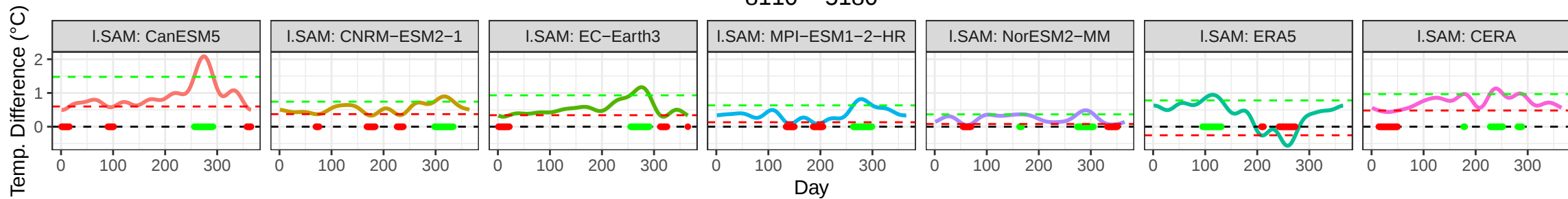
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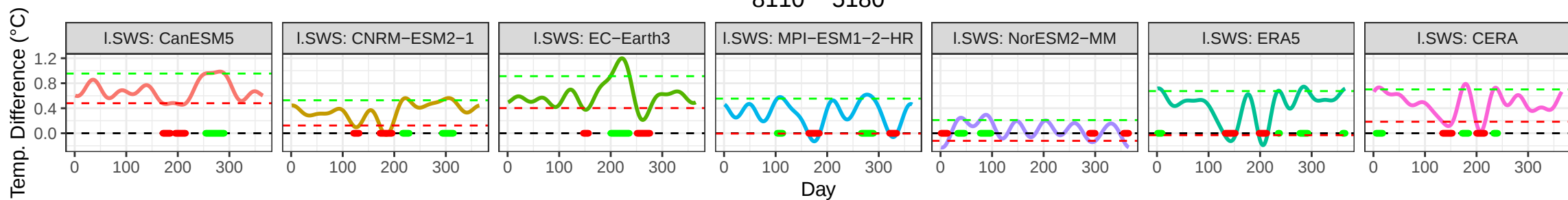
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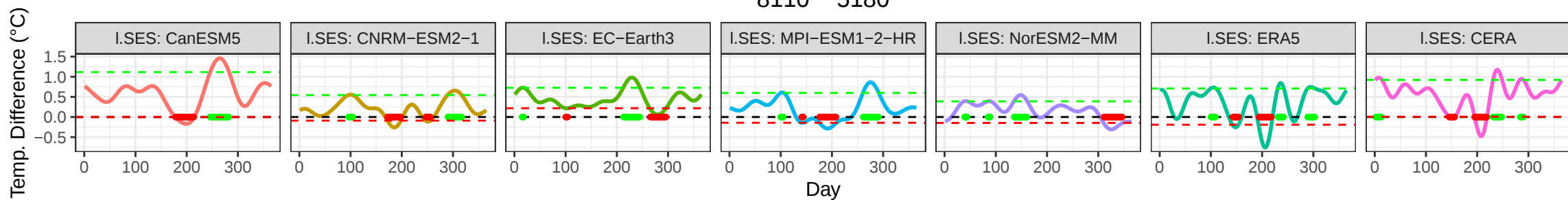
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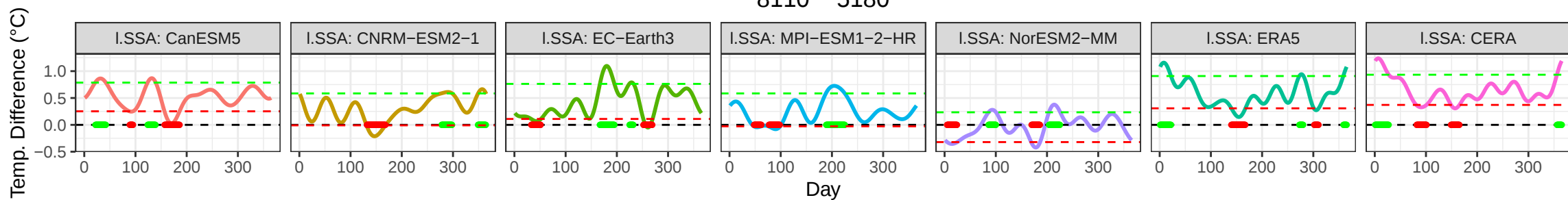
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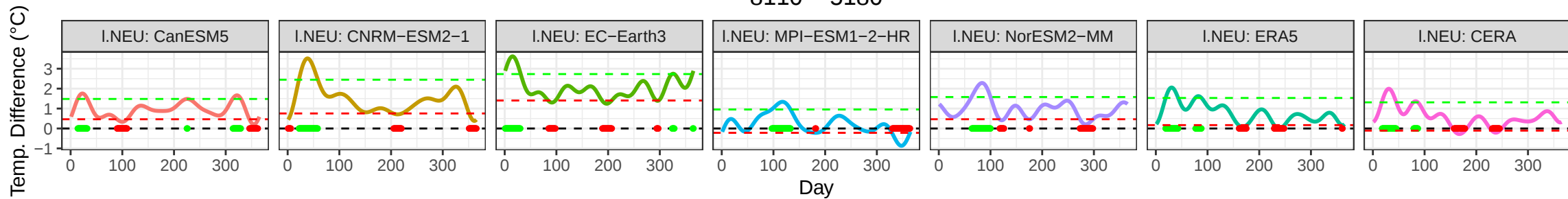
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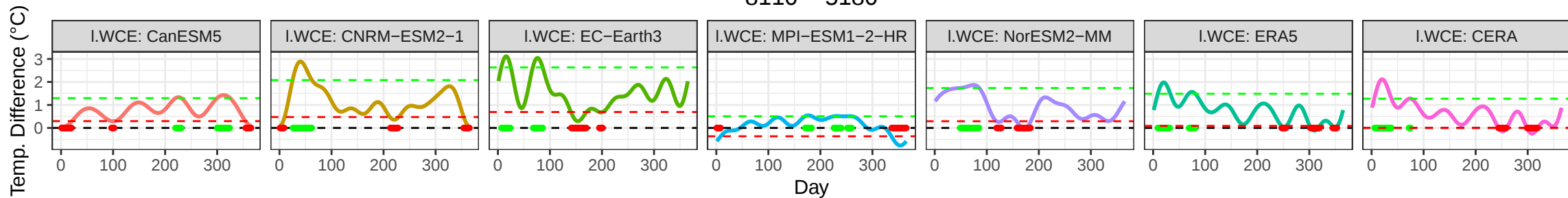
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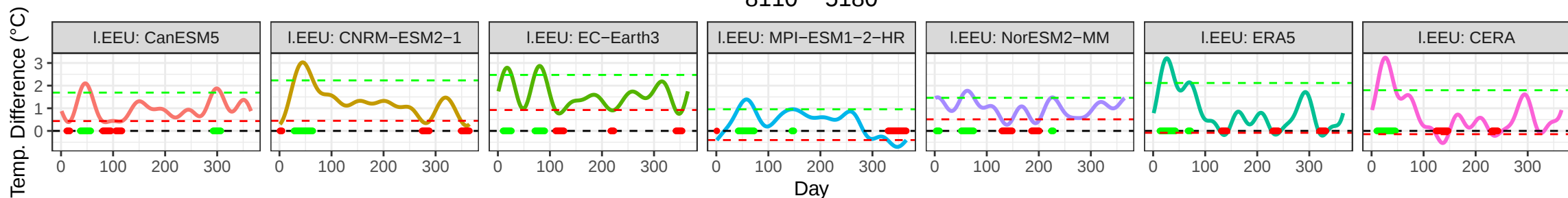
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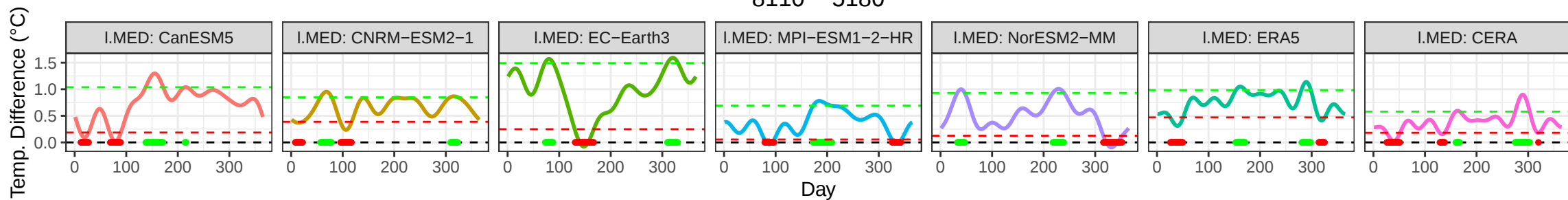
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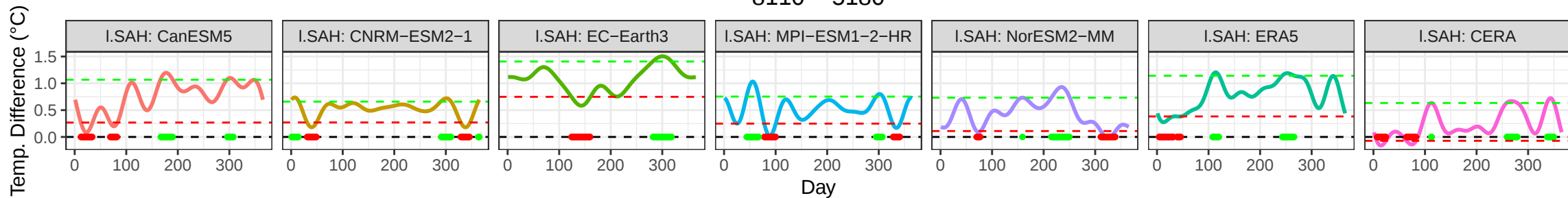
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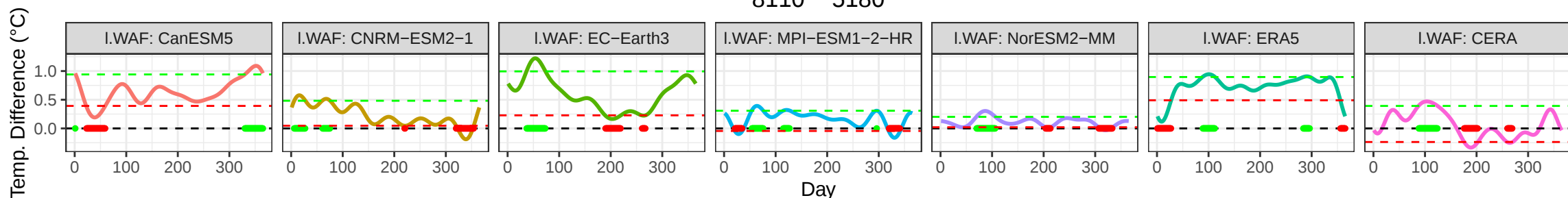
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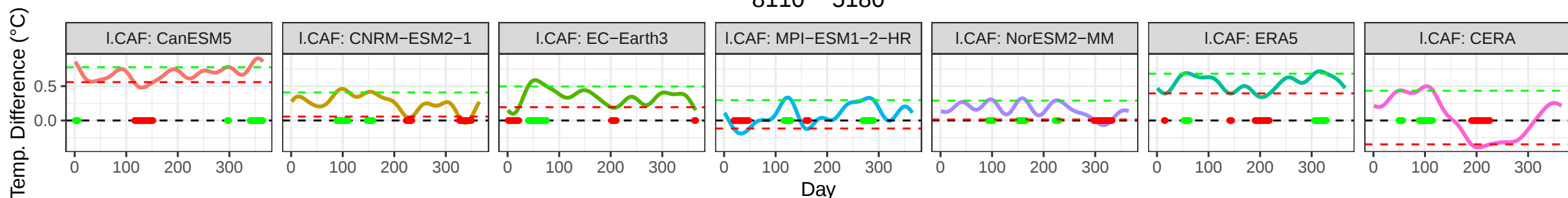
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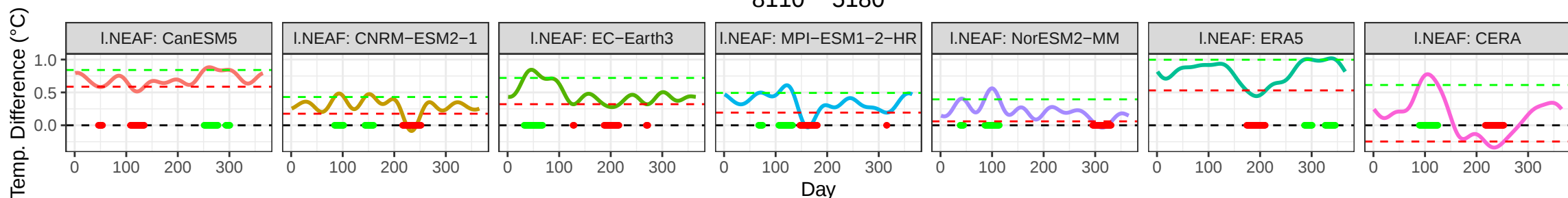
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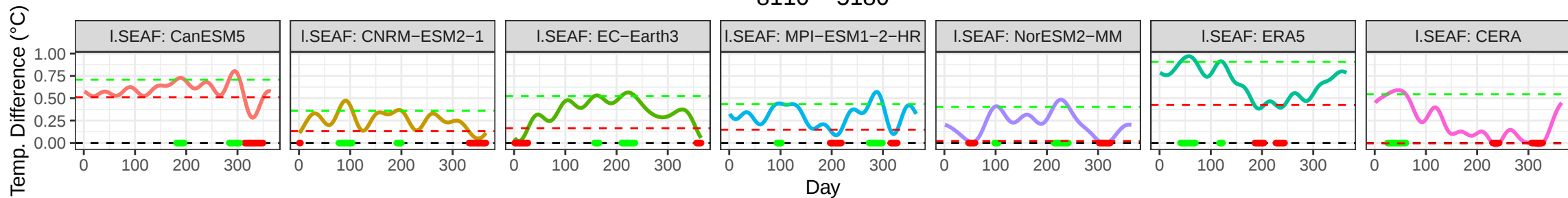
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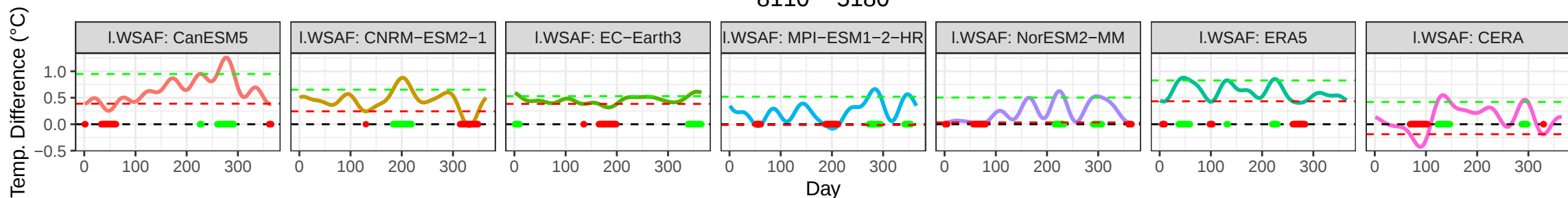
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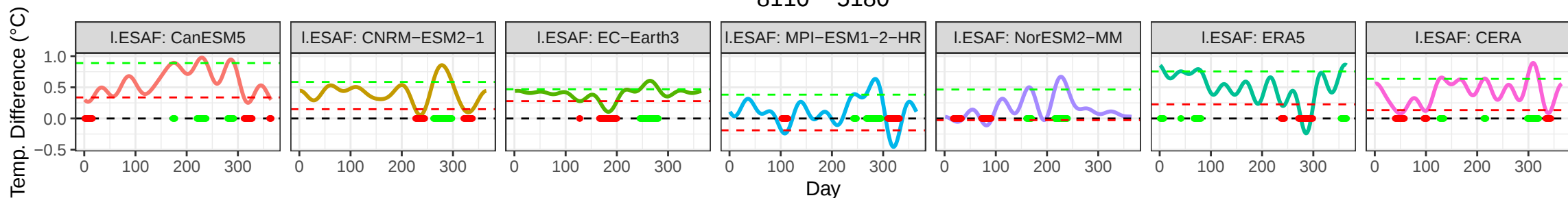
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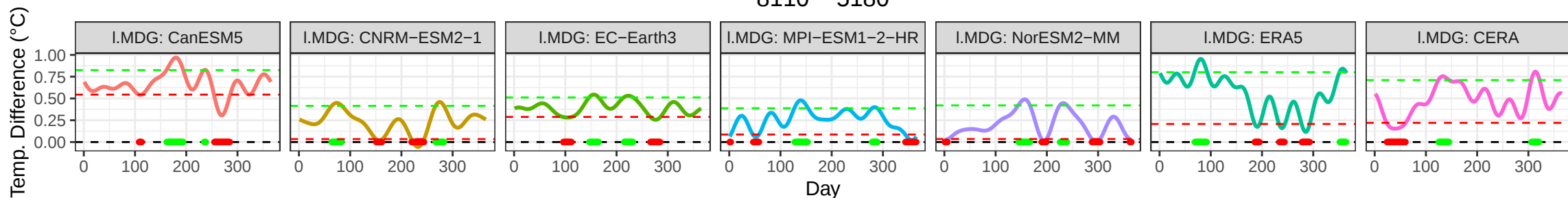
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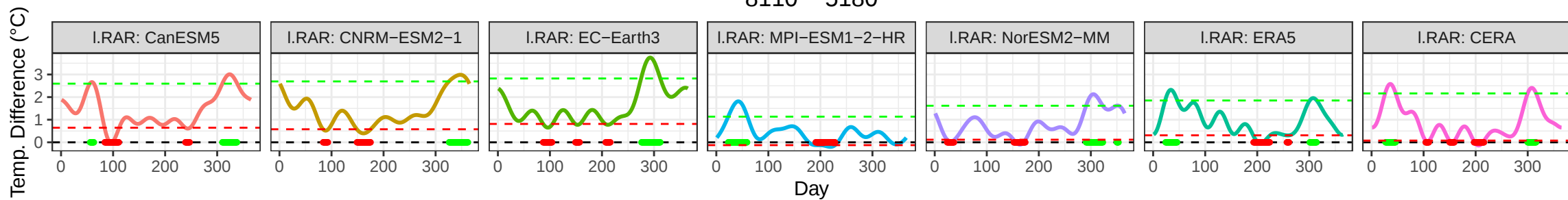
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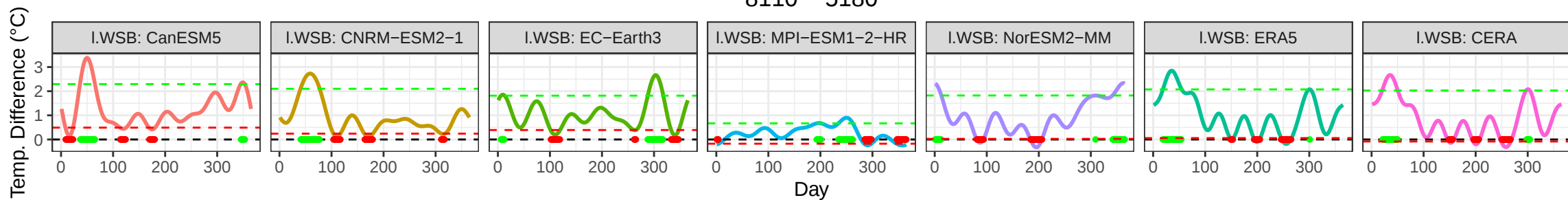
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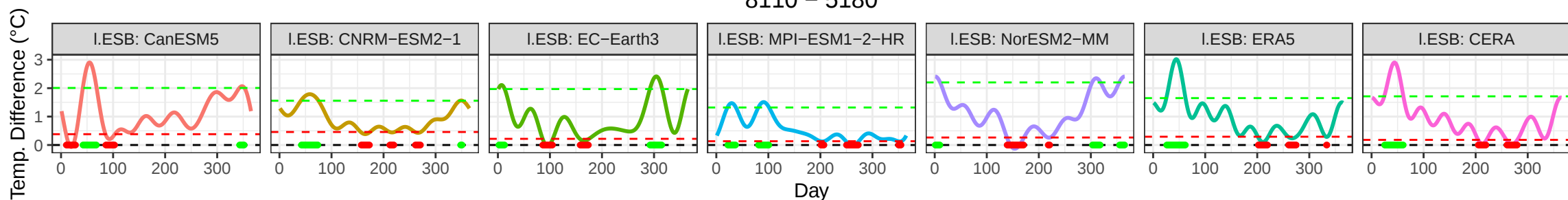
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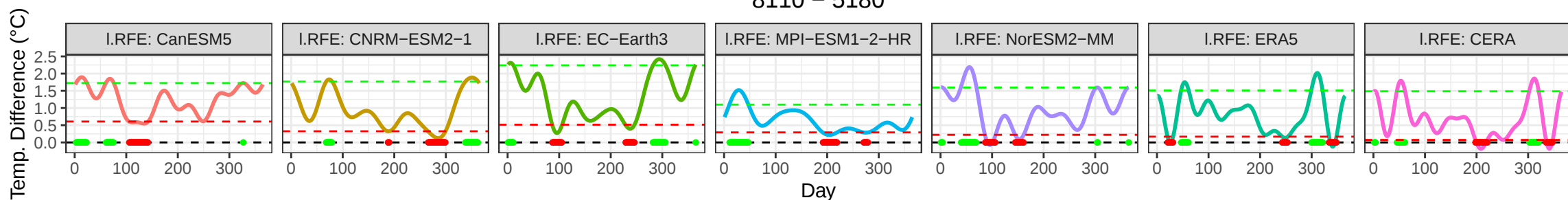
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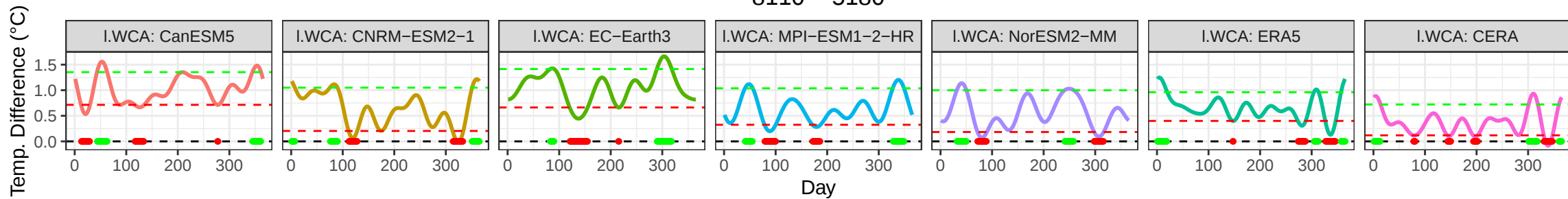
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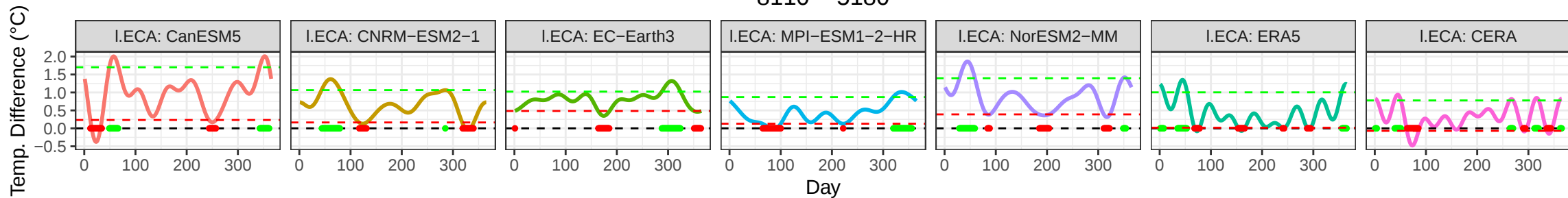
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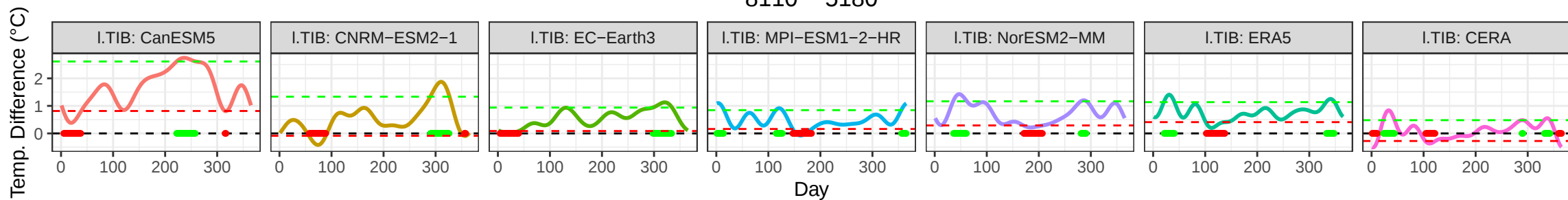
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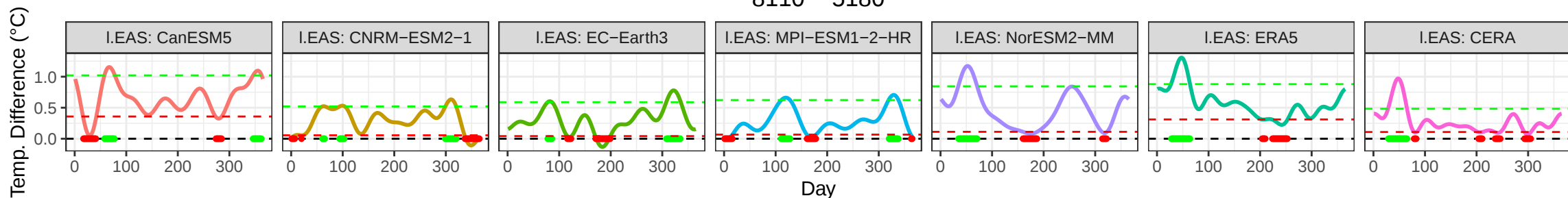
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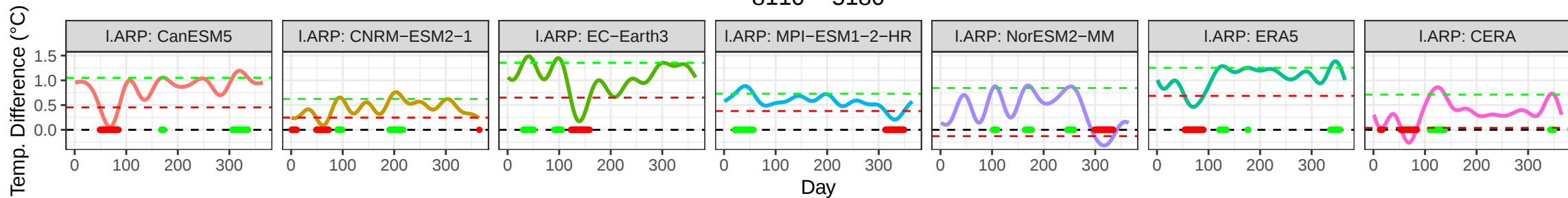
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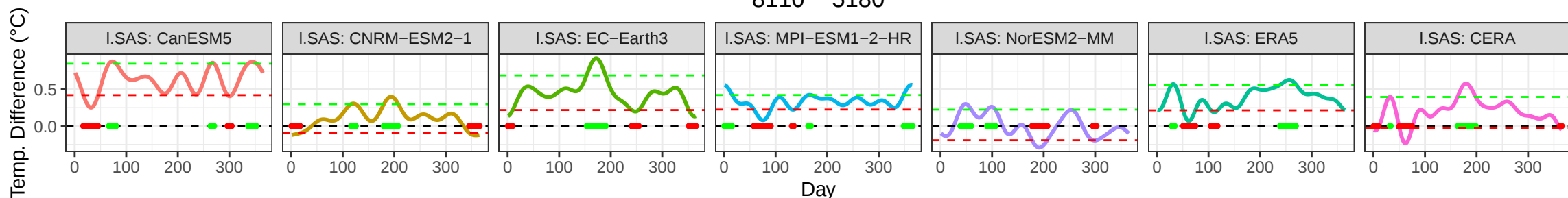
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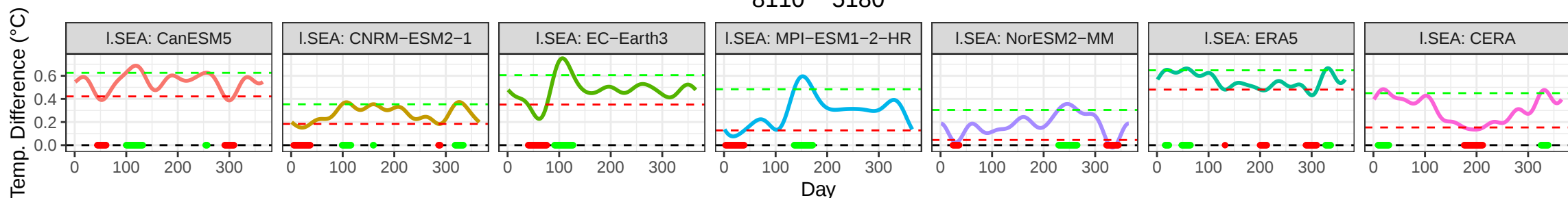
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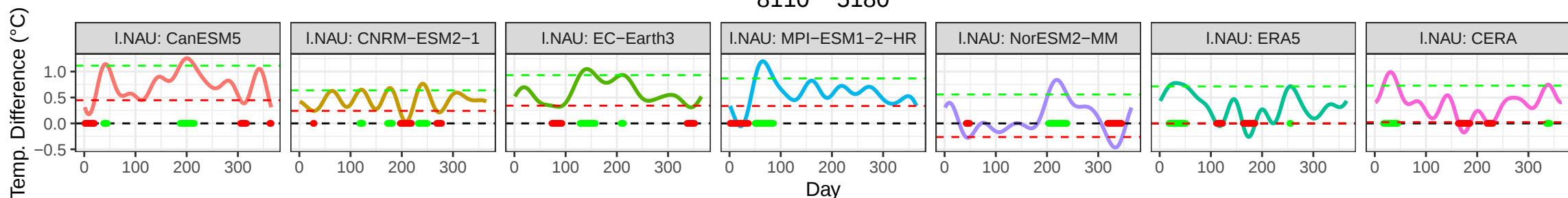
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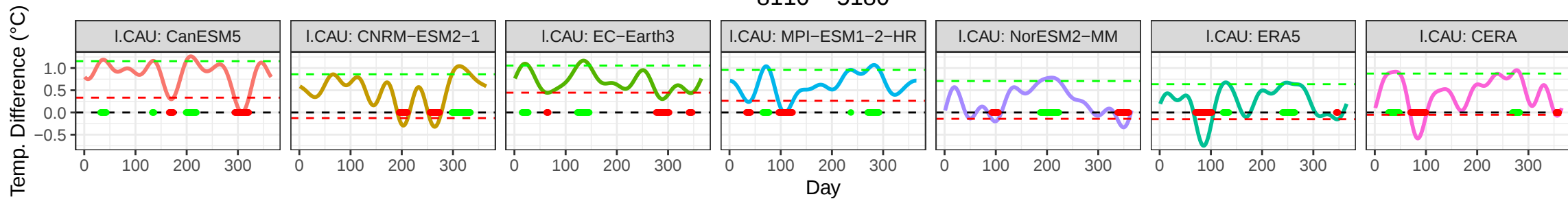
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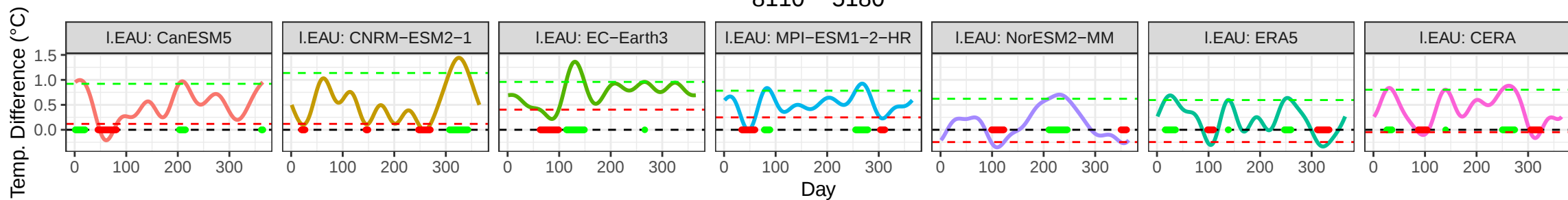
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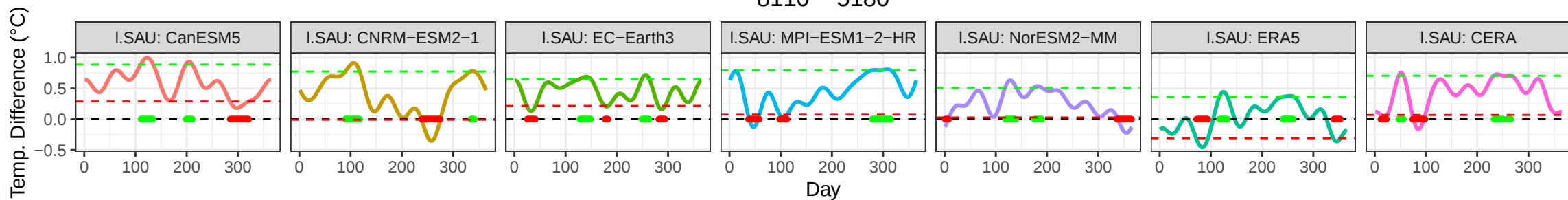
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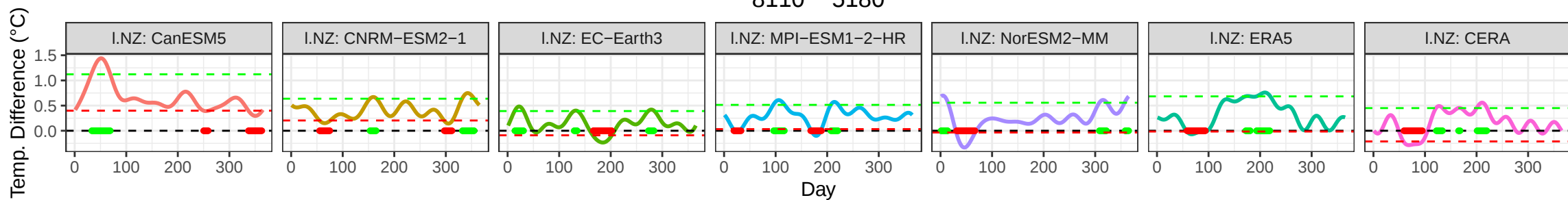
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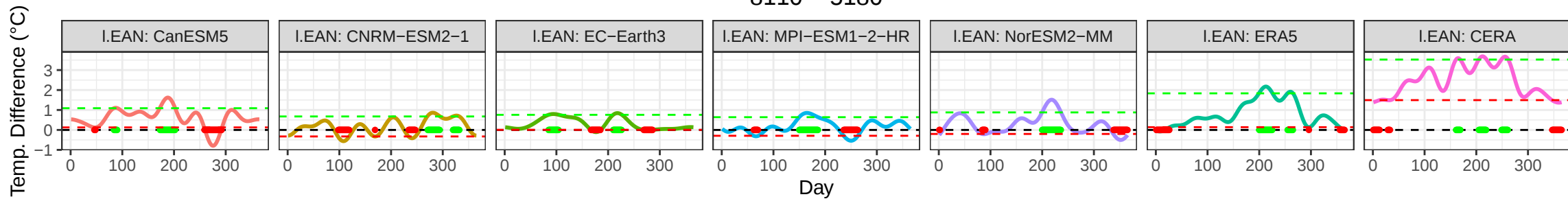
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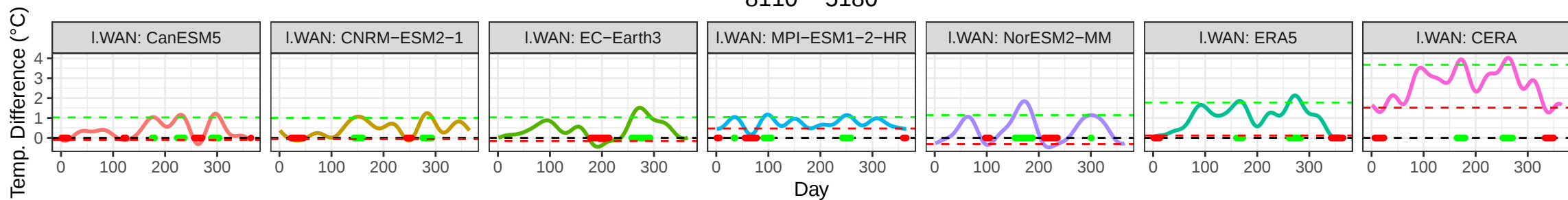
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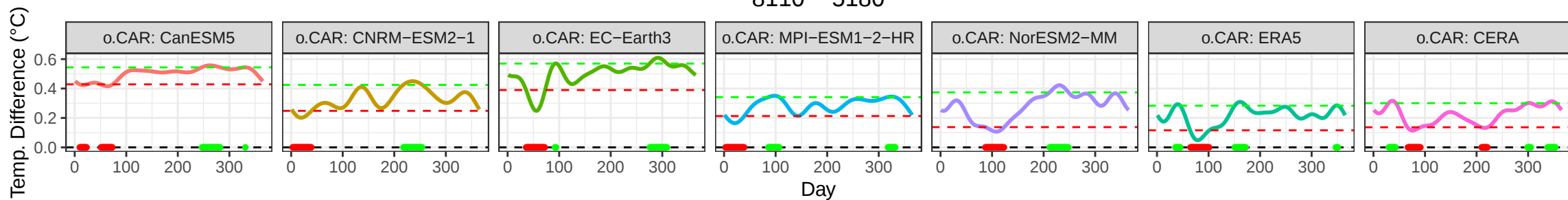
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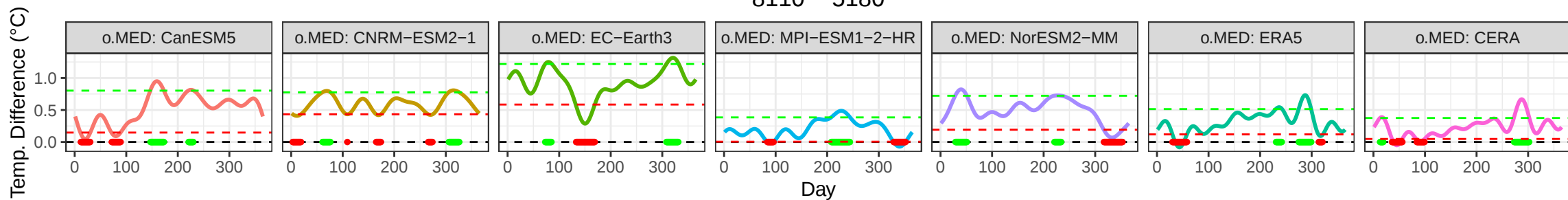
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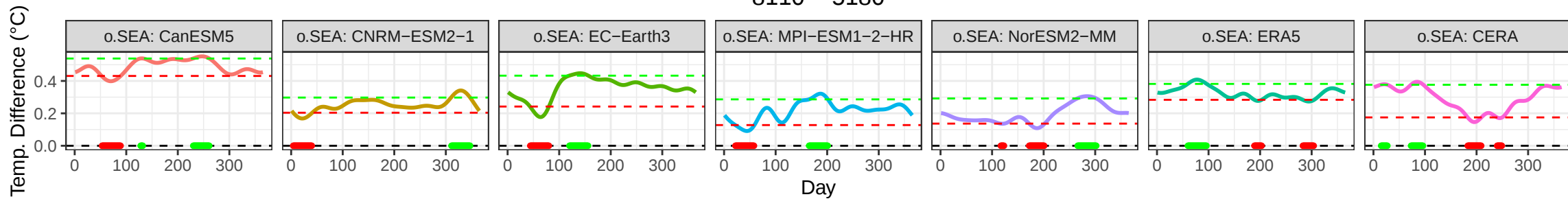
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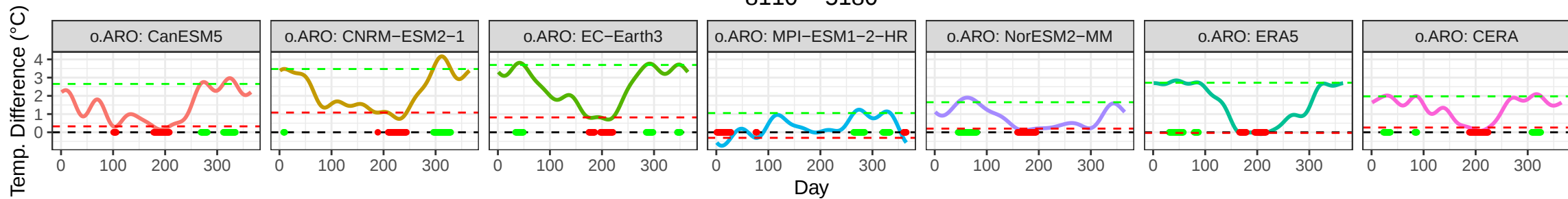
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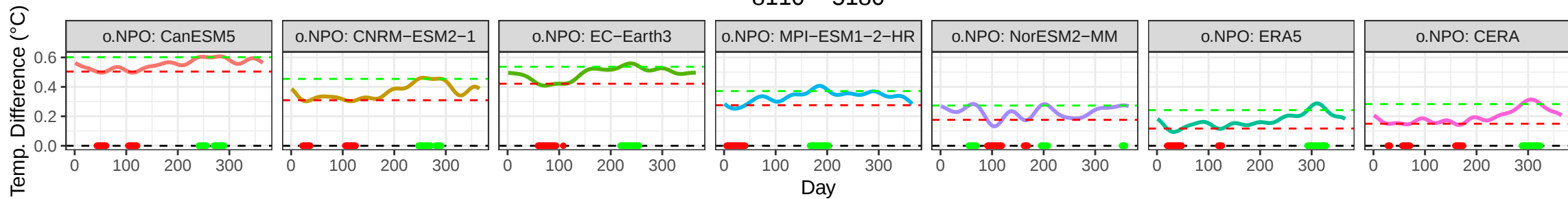
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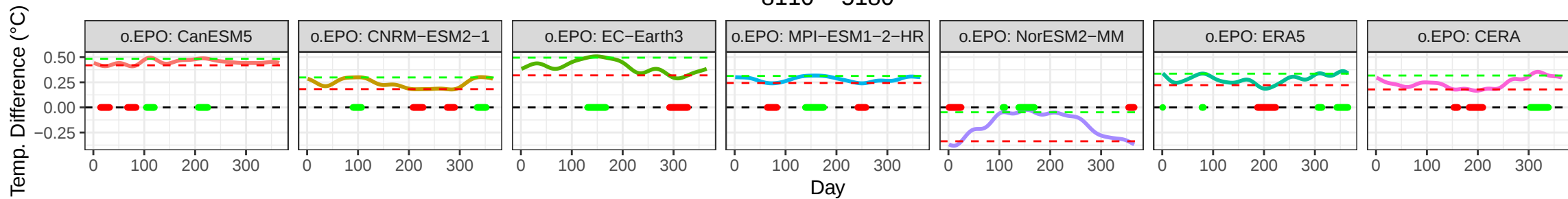
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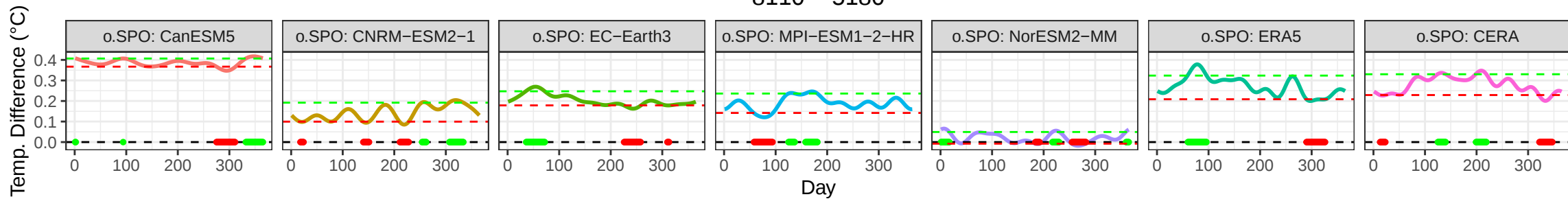
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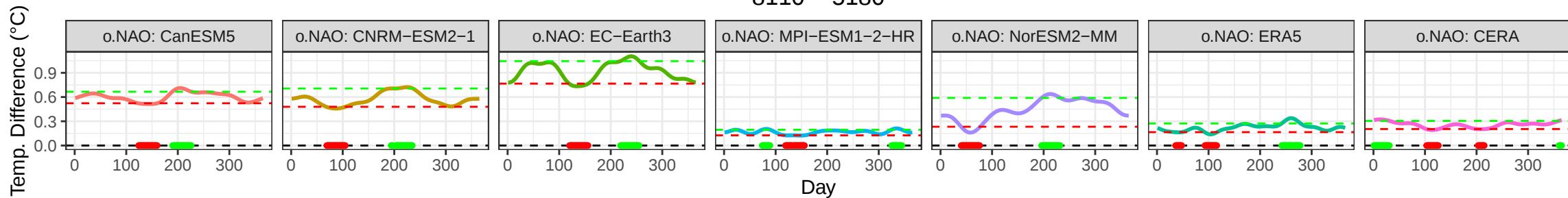
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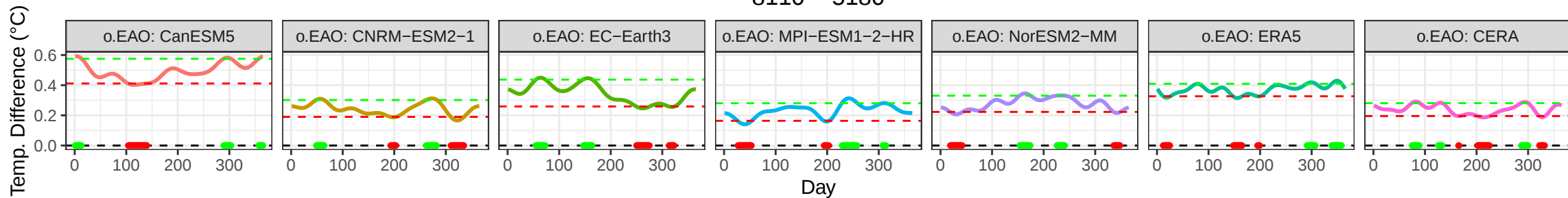
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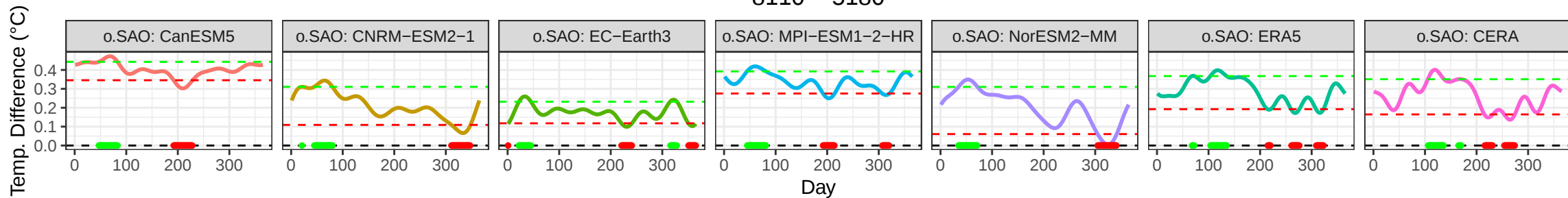
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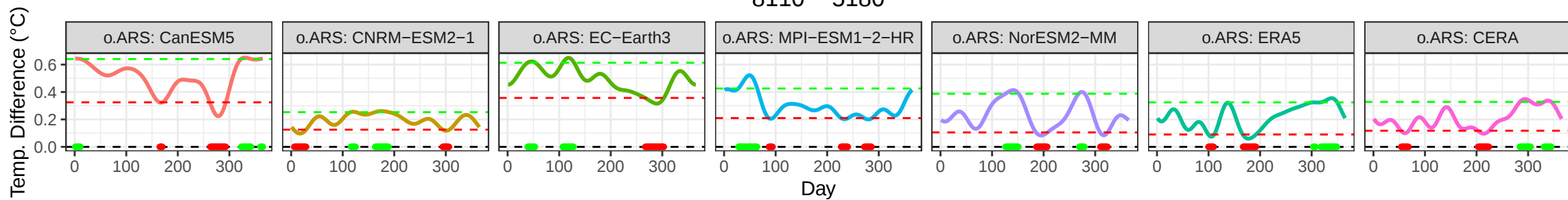
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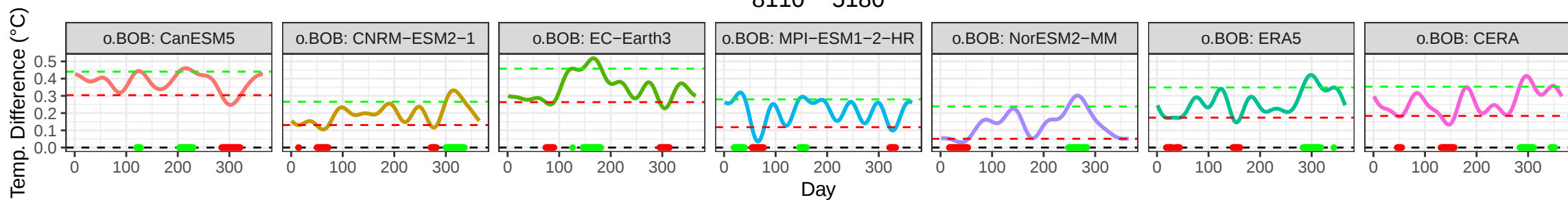
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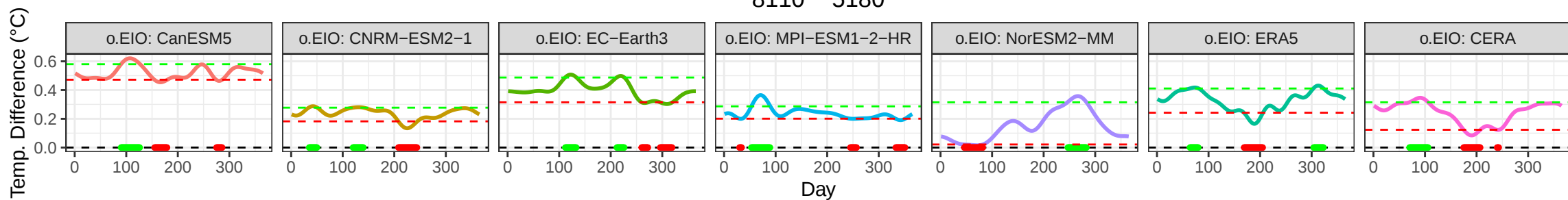
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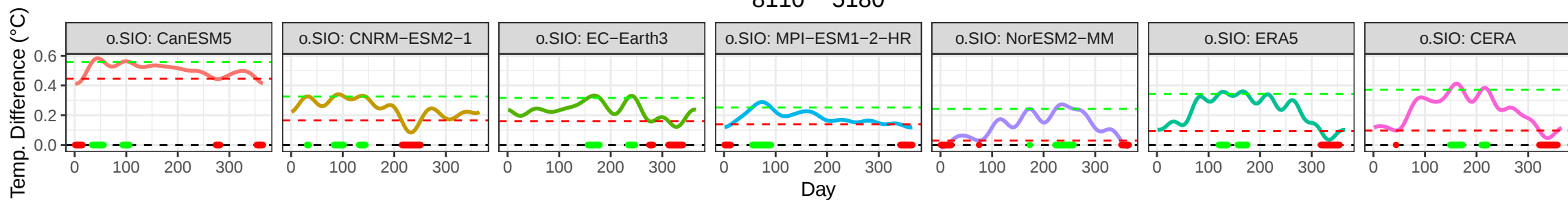
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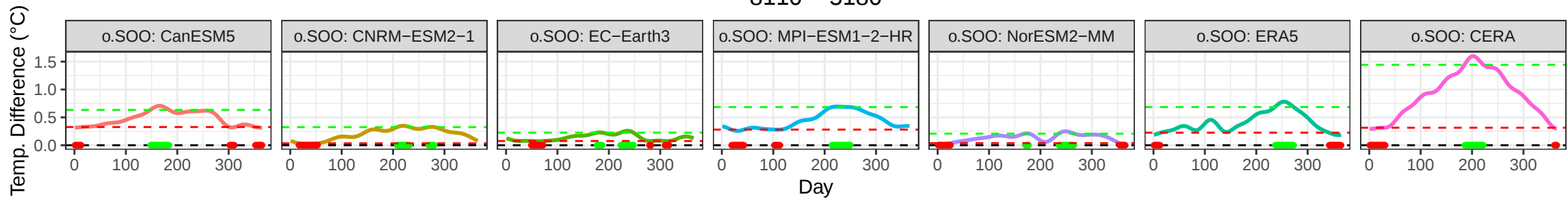
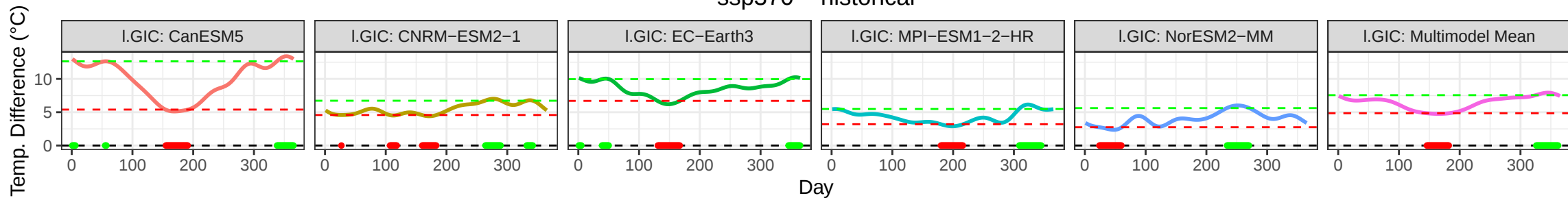
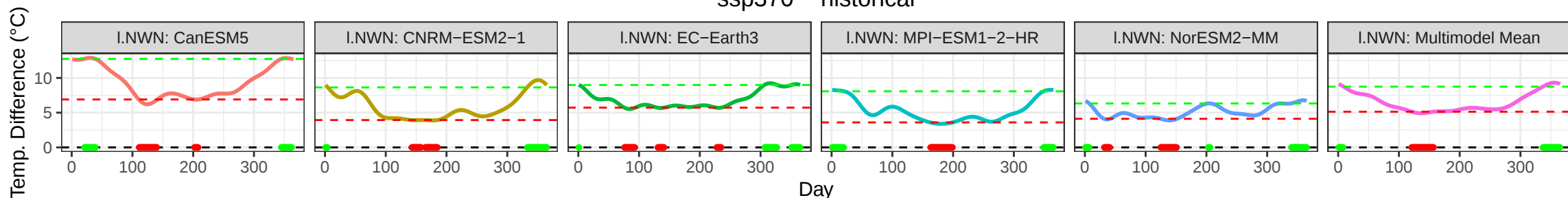


Figure S02: The distances between the smoothed annual cycle curves in the future and reference periods 2071-2100 and 1961-1990. Plots for five selected CMIP6 ESMs and their multi-model mean are shown in different columns, plots for different geographical regions are depicted in different rows of the figure. The red dashed line represents the 10th percentile, and the green dashed line represents the 90th percentile. For all values below/above the 10th/90th percentile-threshold, the time periods of the year when these values occur are shown in red/green. The results shown in this figure are summarized in Fig. 4 in the manuscript.

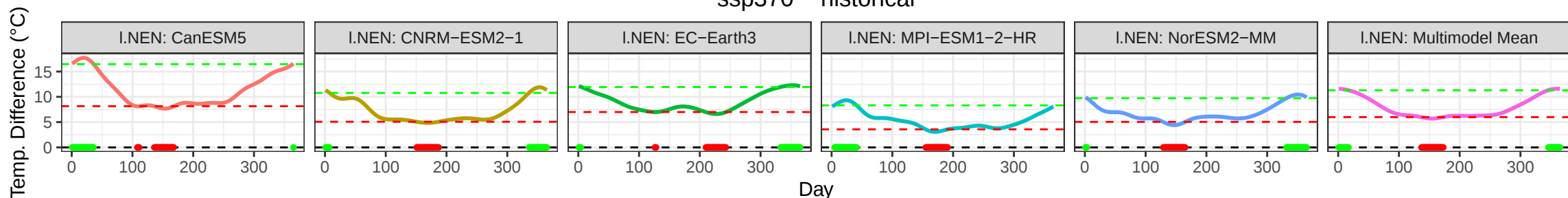
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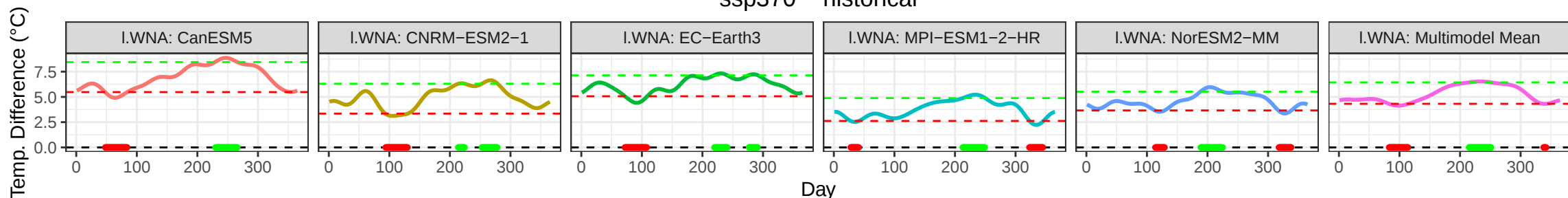
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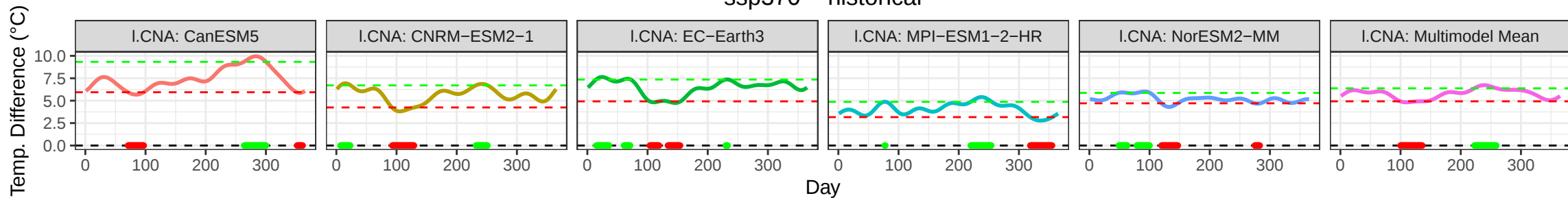
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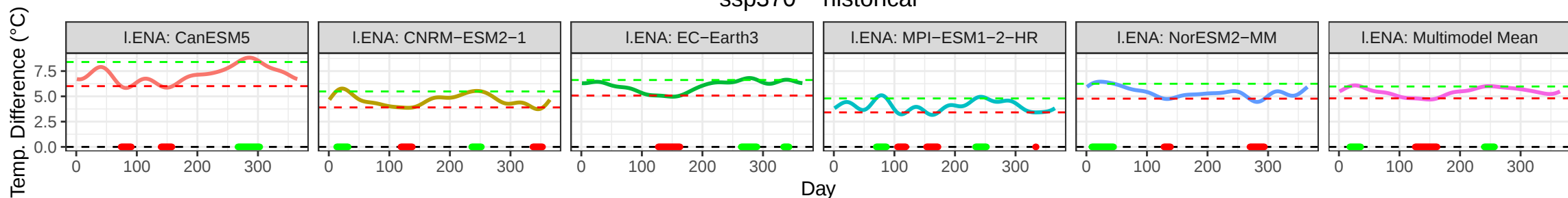
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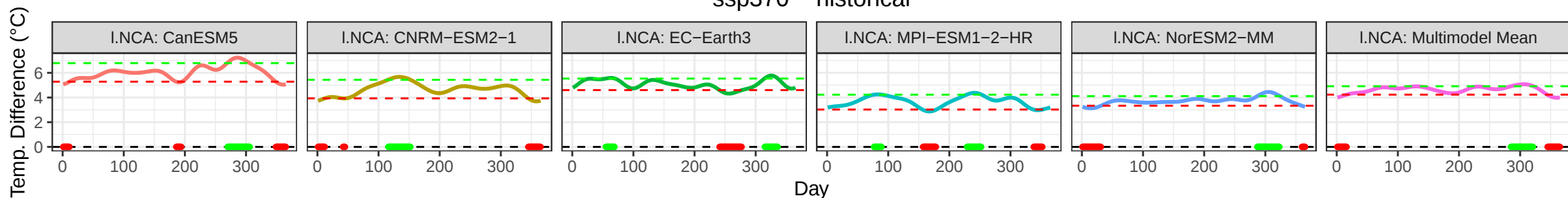
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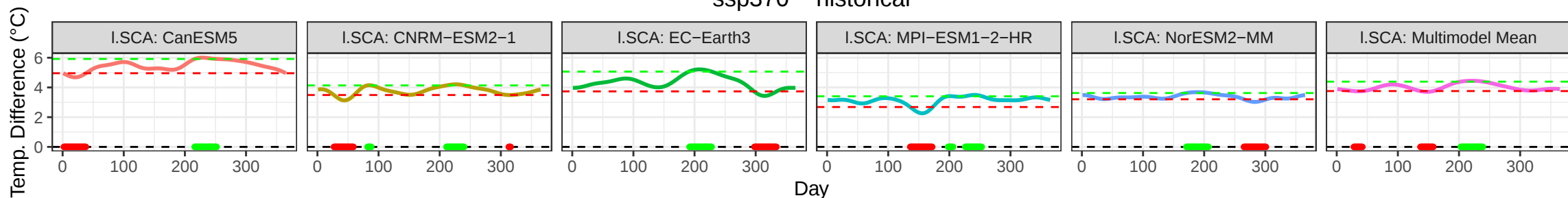
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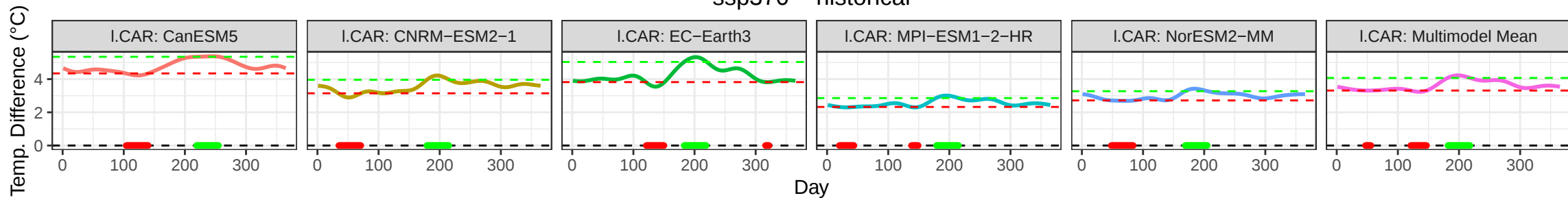
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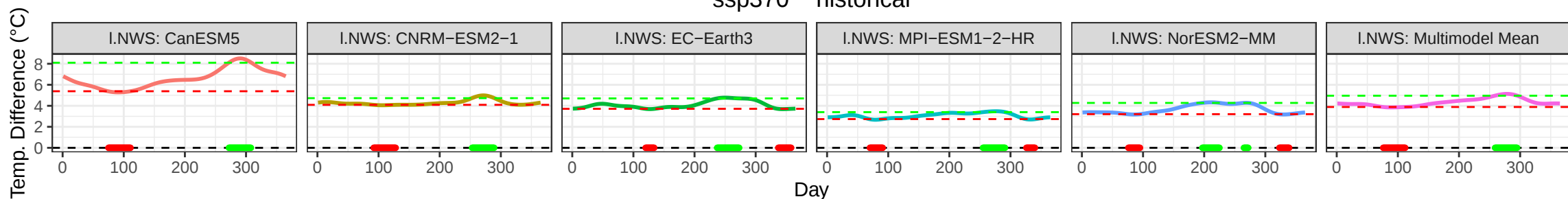
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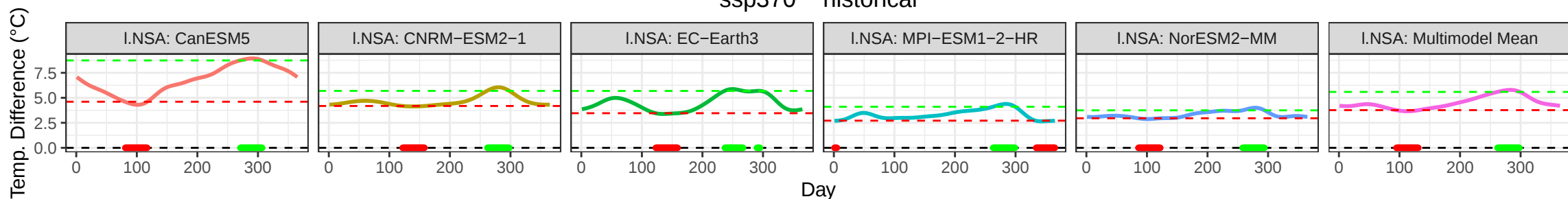
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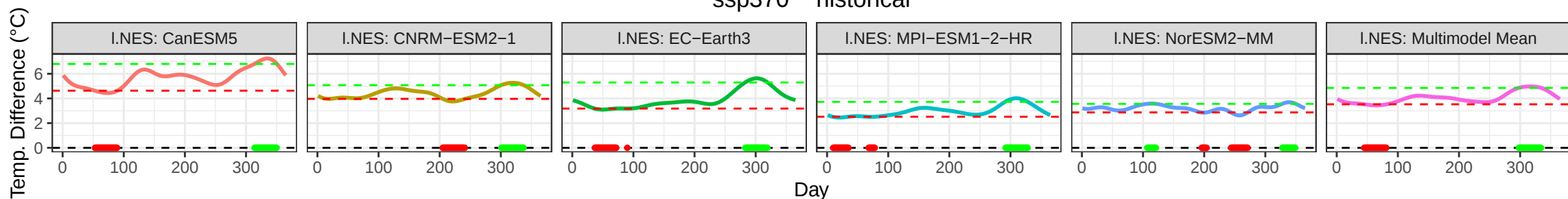
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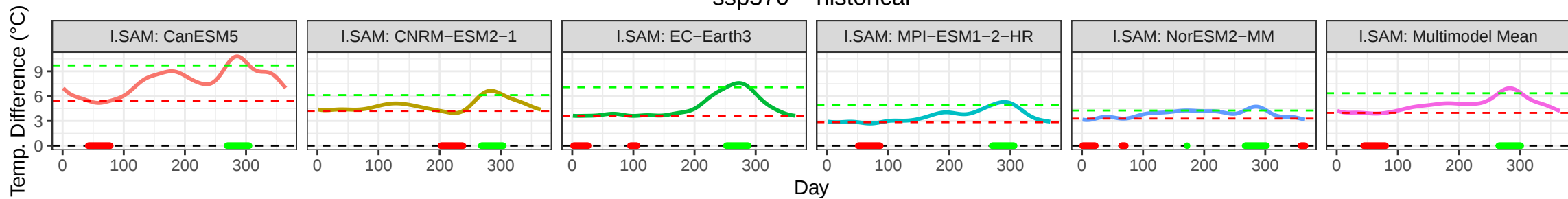
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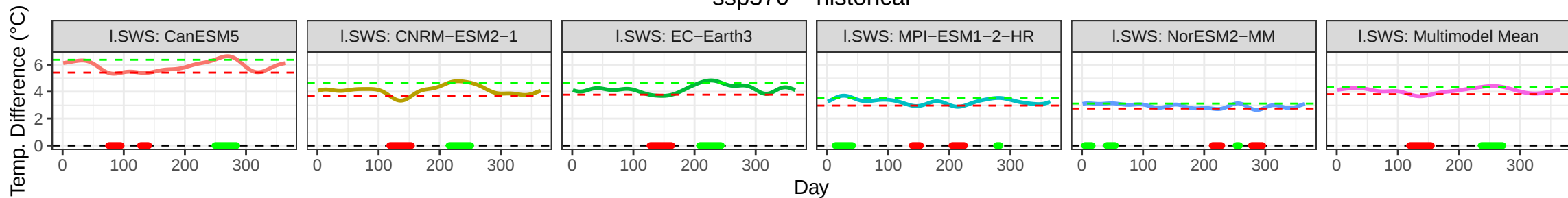
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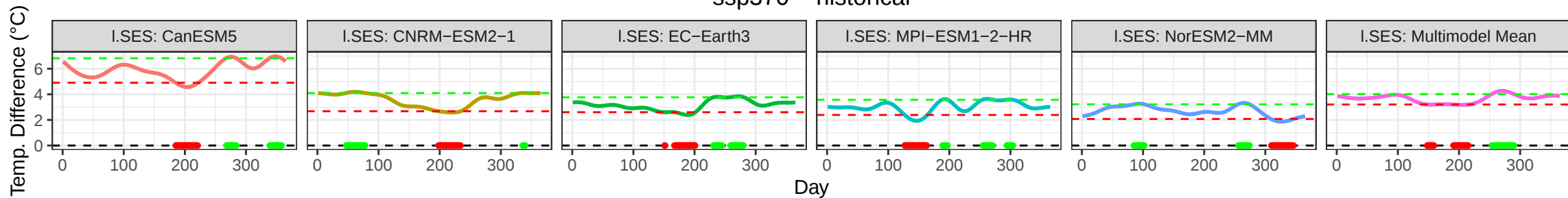
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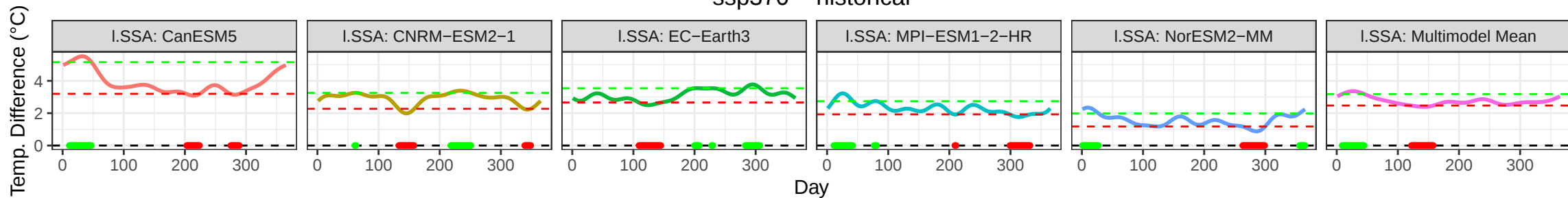
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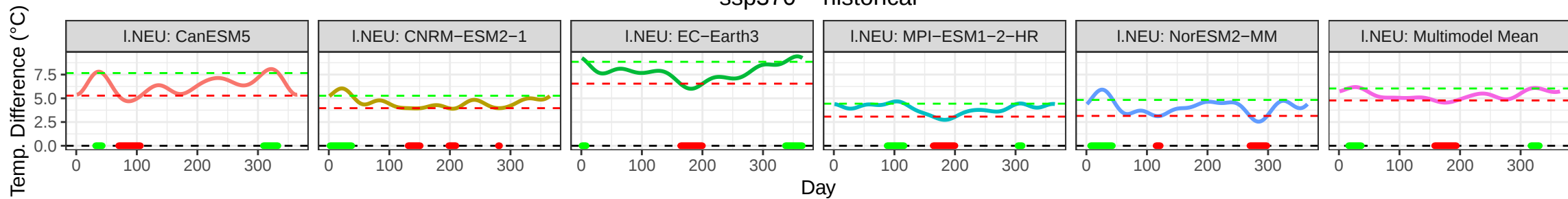
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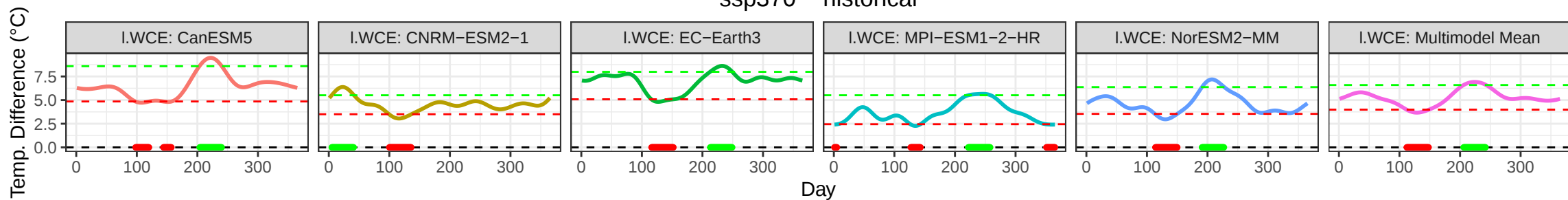
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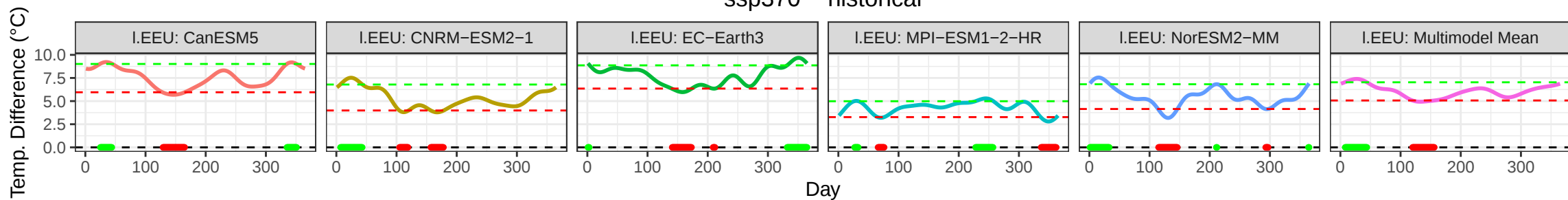
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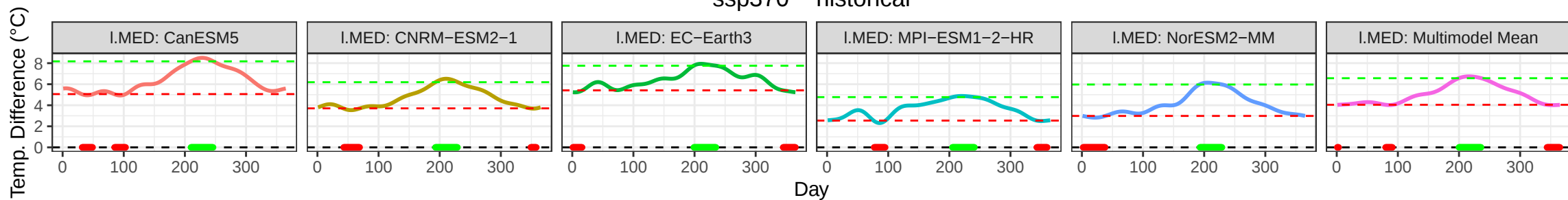
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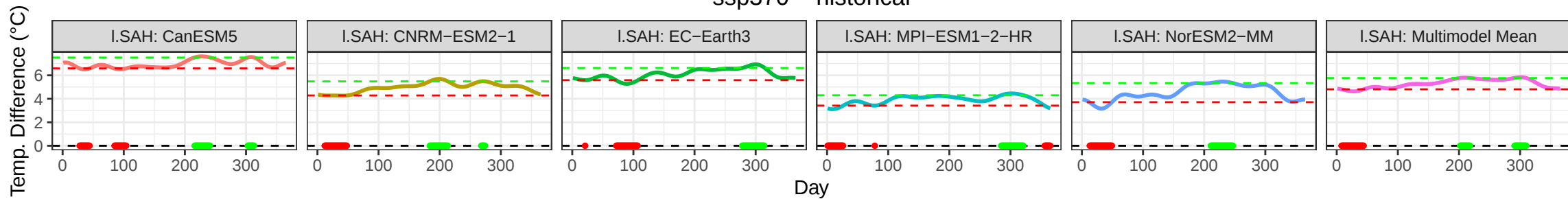
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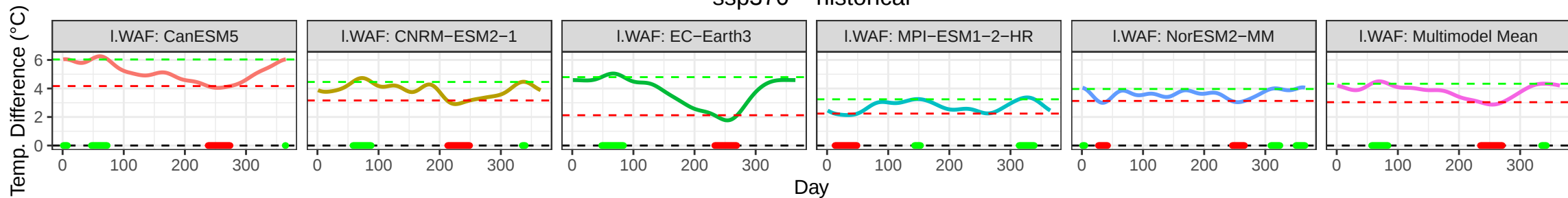
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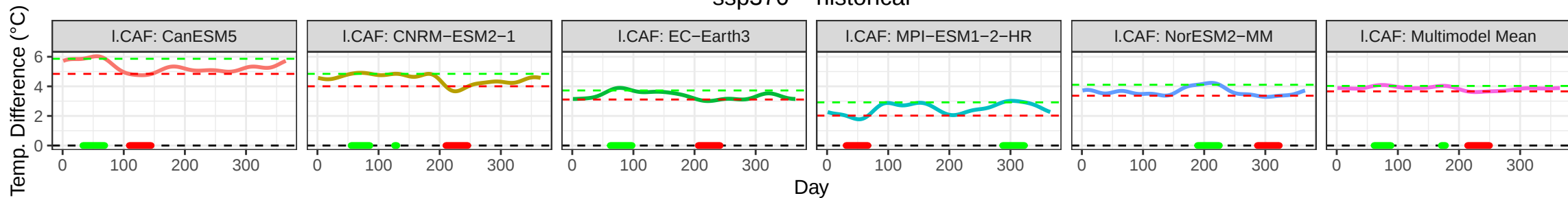
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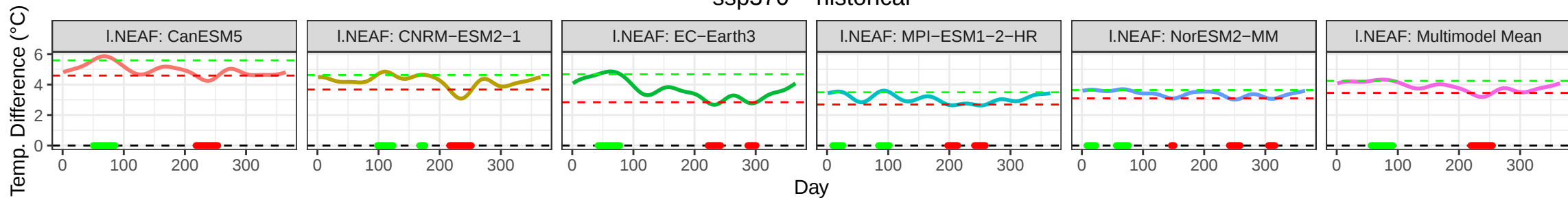
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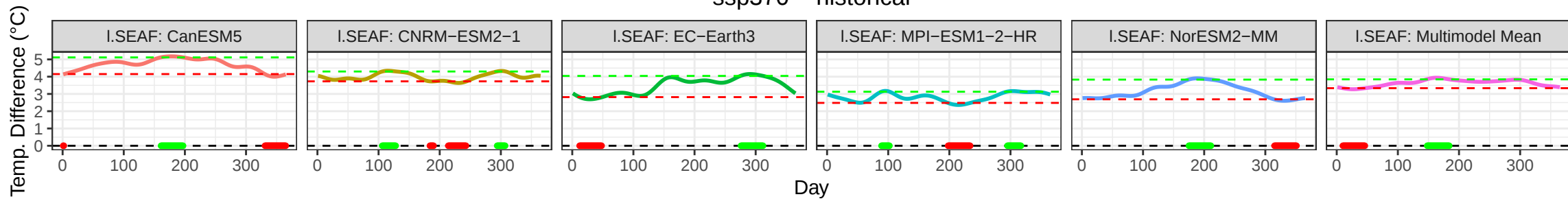
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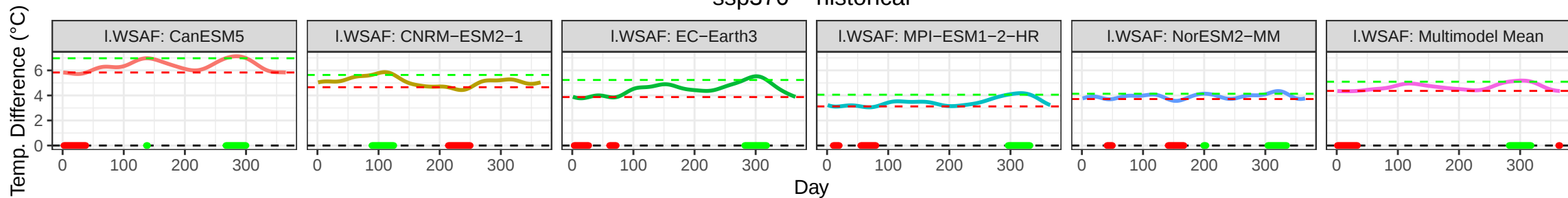
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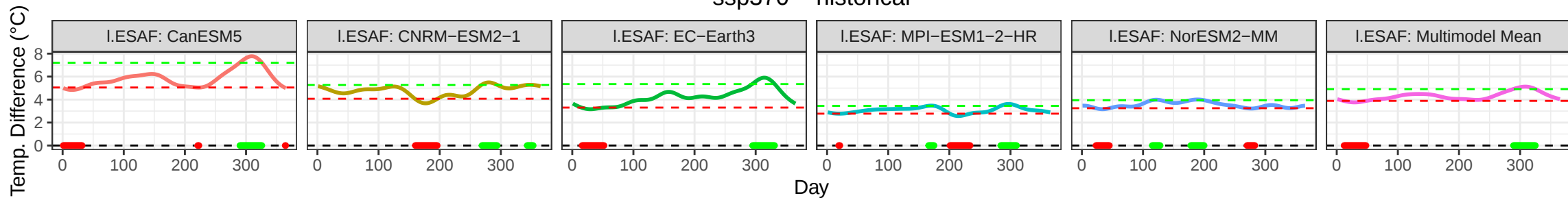
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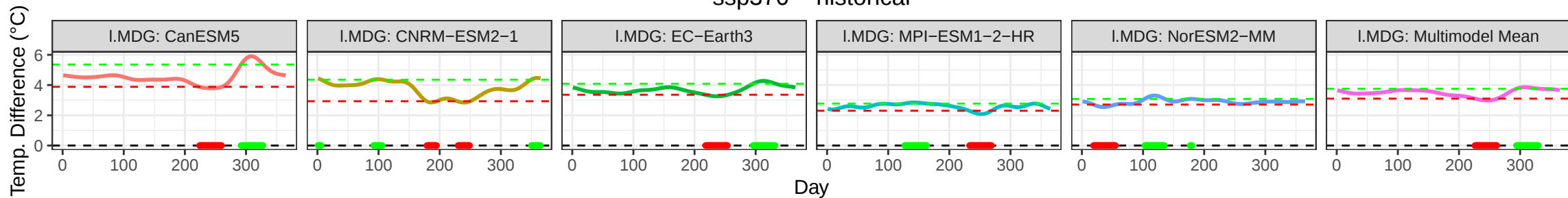
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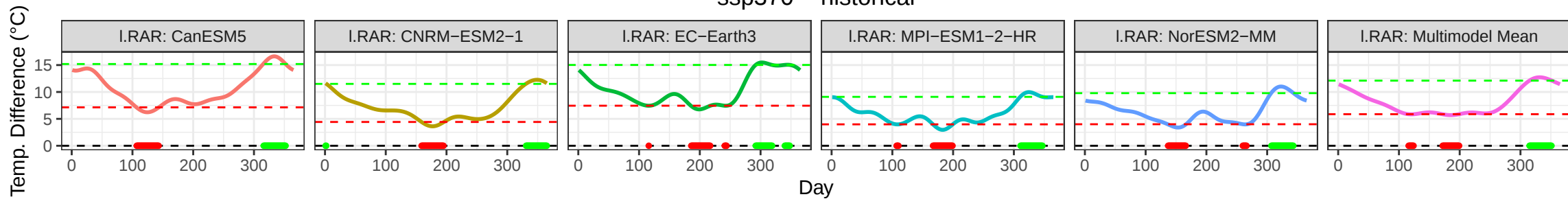
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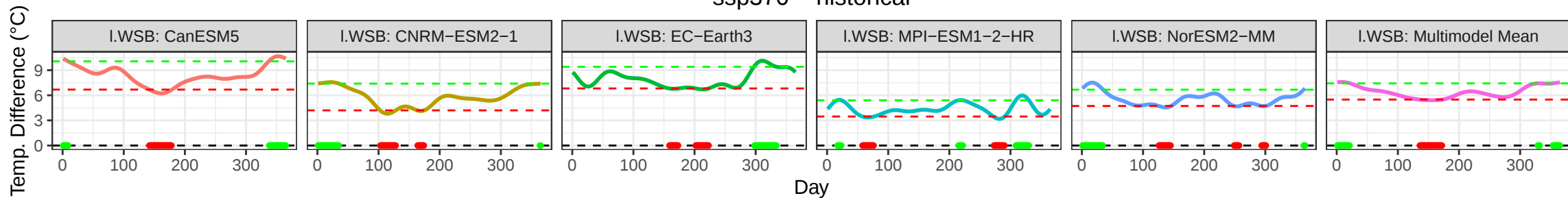
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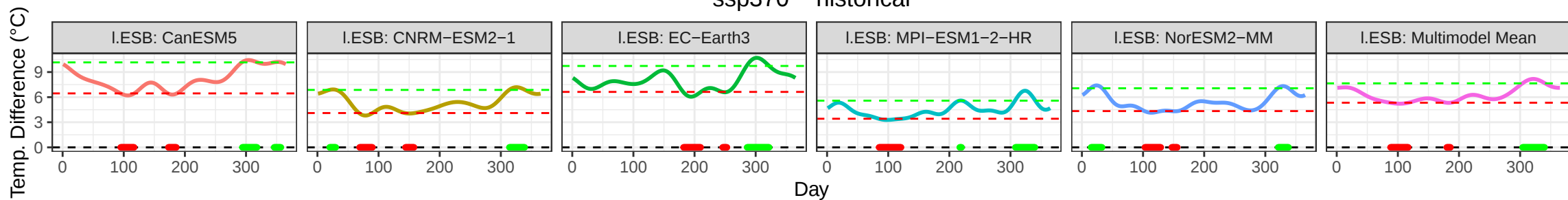
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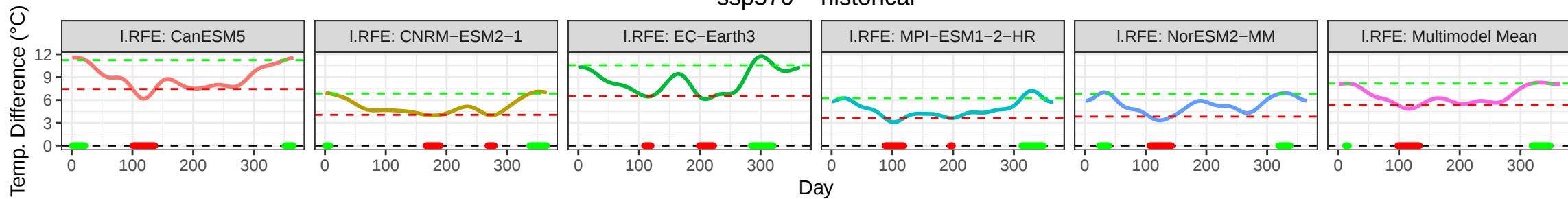
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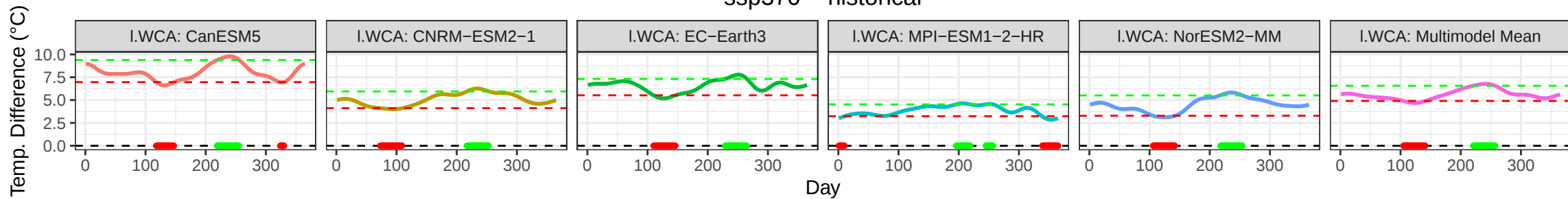
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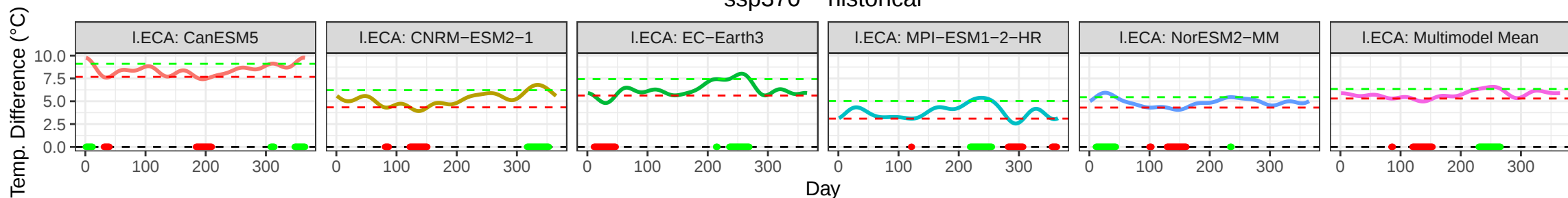
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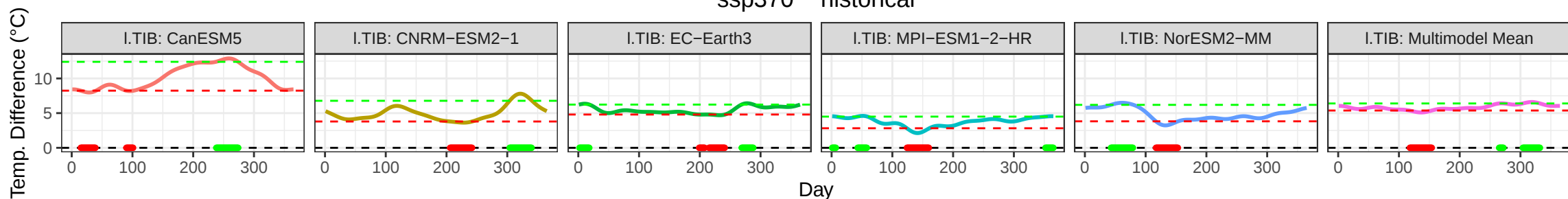
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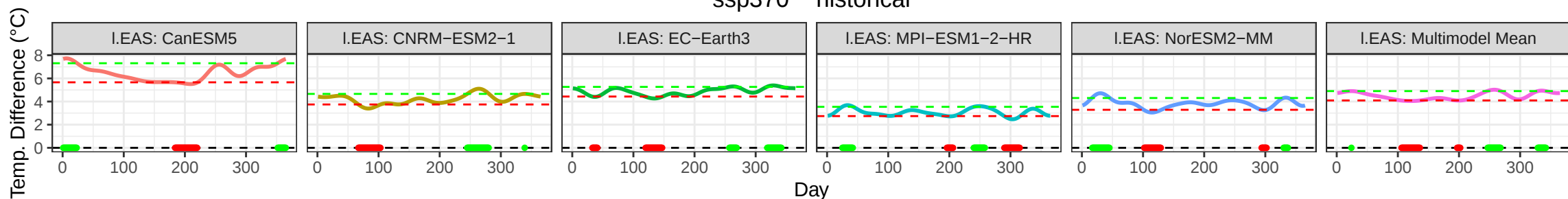
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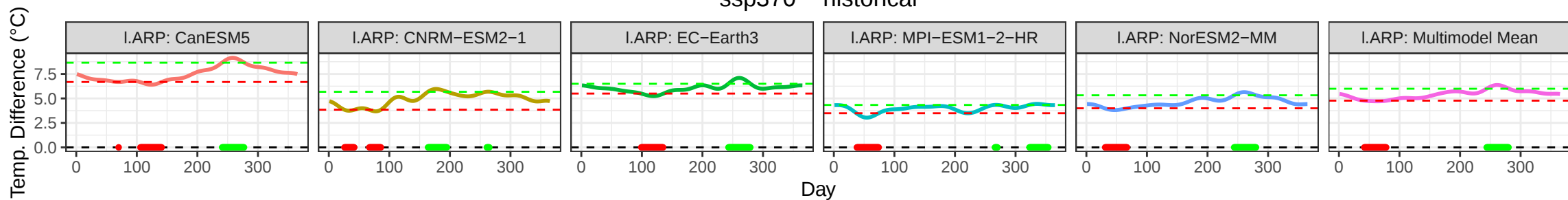
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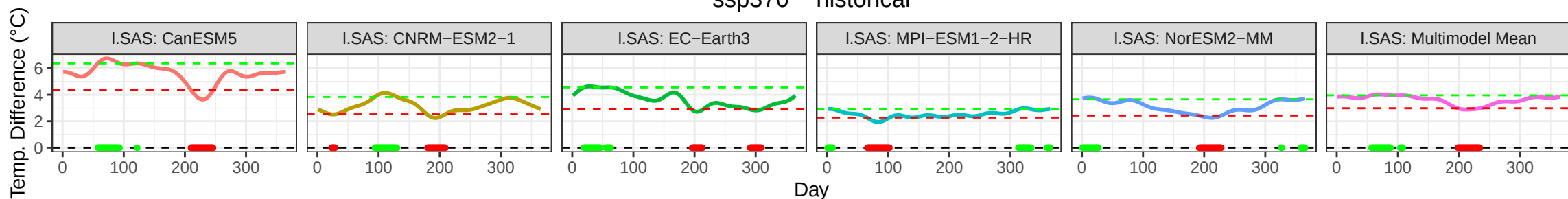
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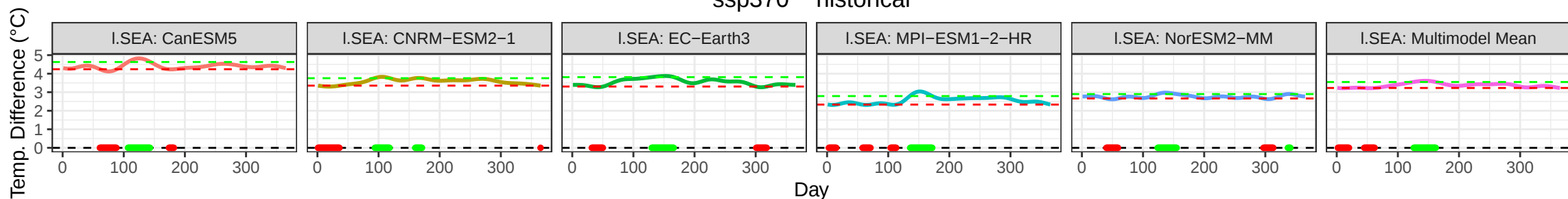
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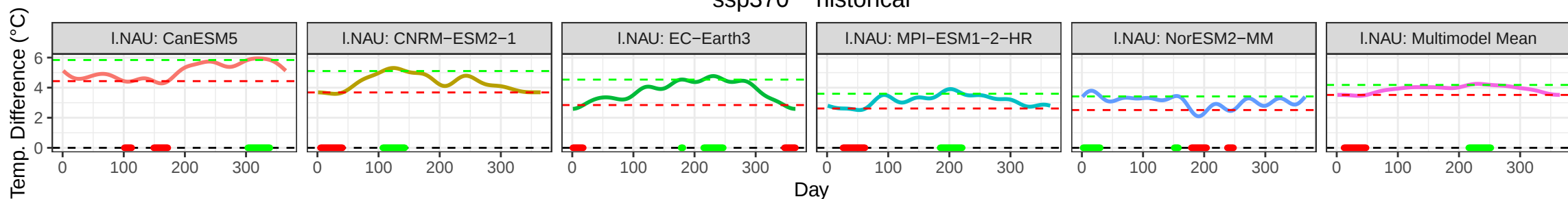
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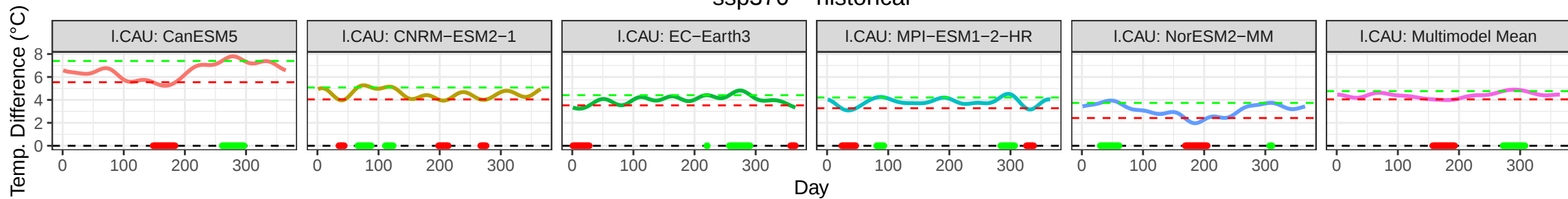
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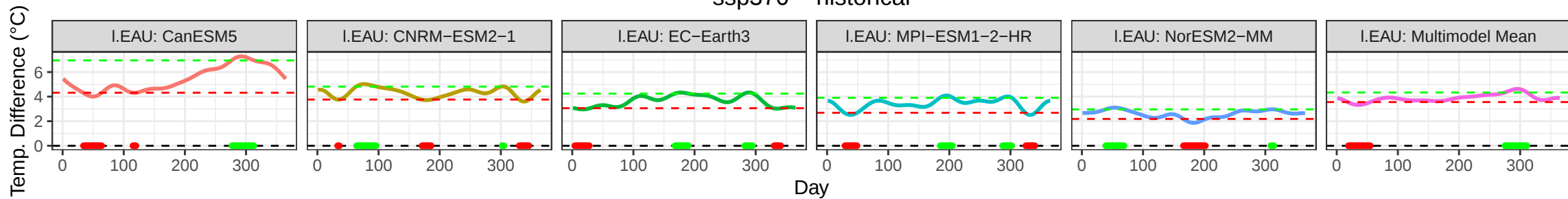
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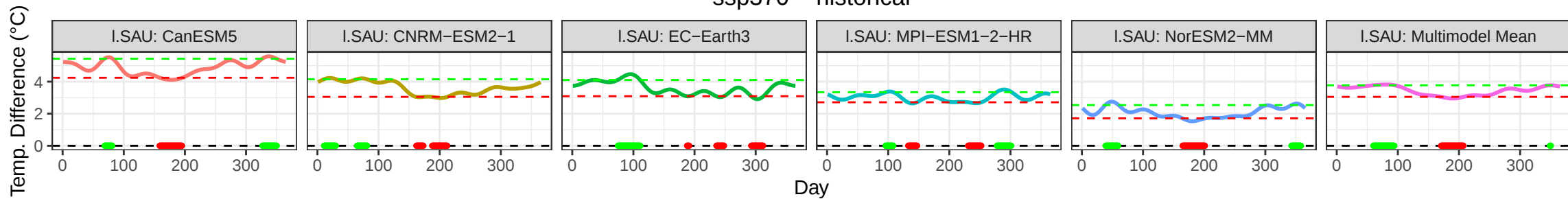
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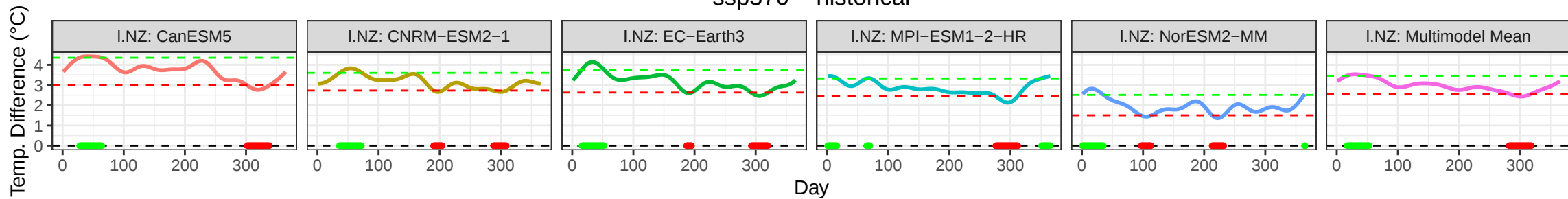
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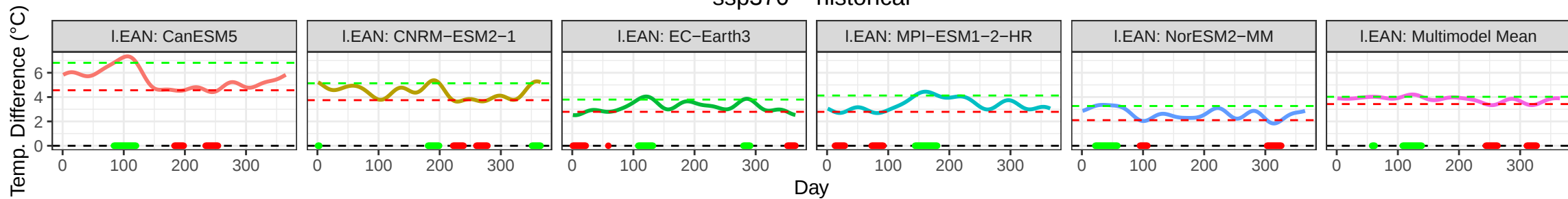
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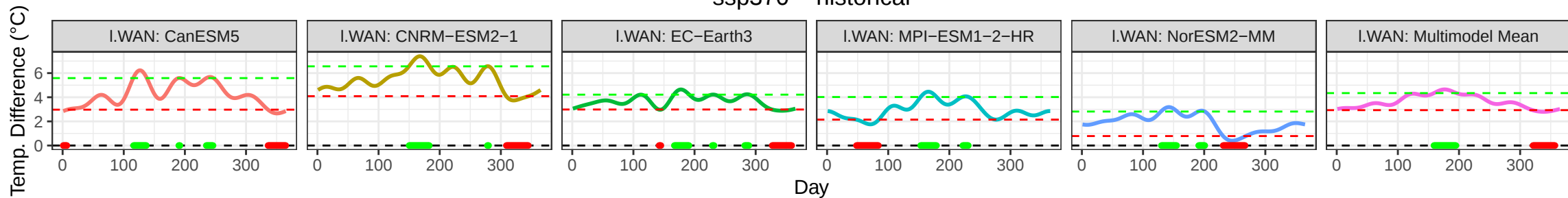
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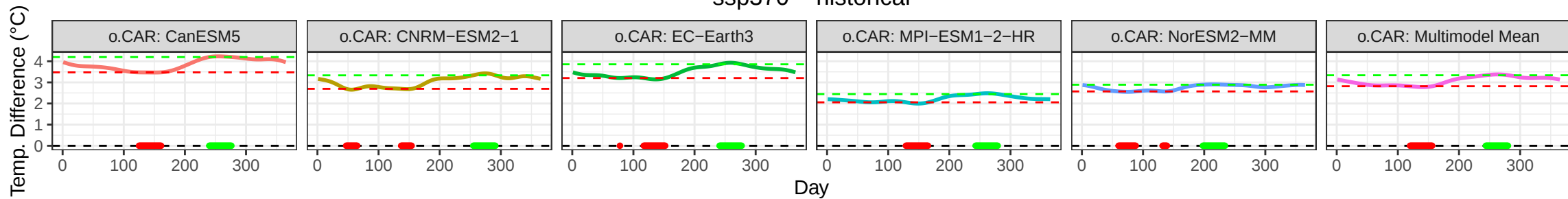
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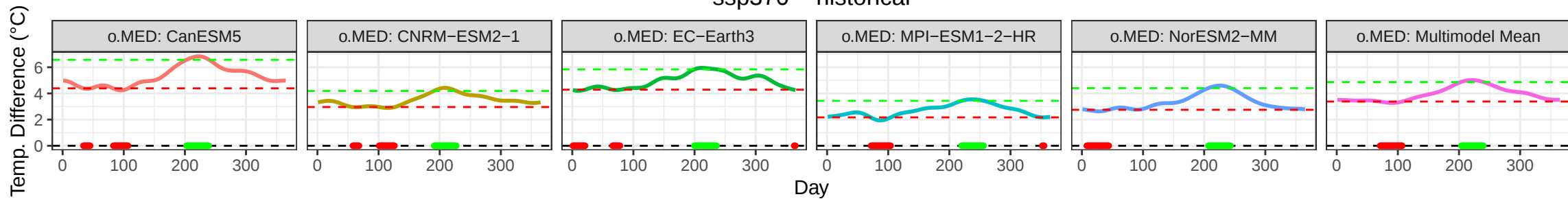
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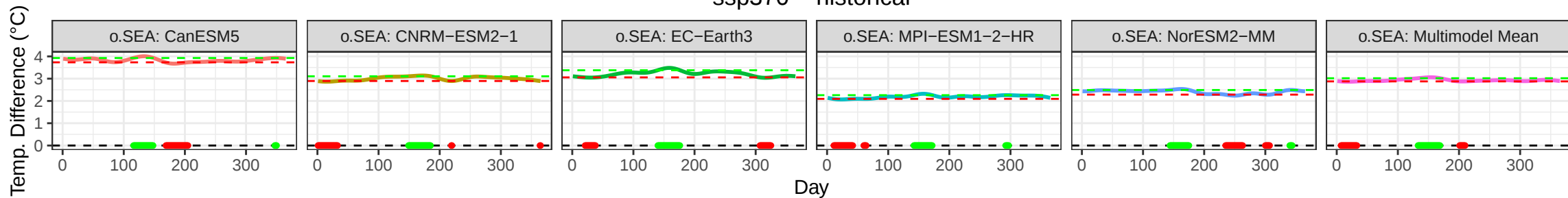
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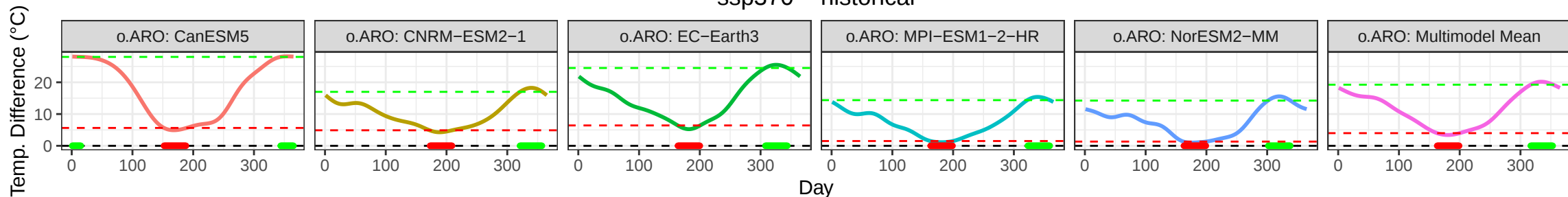
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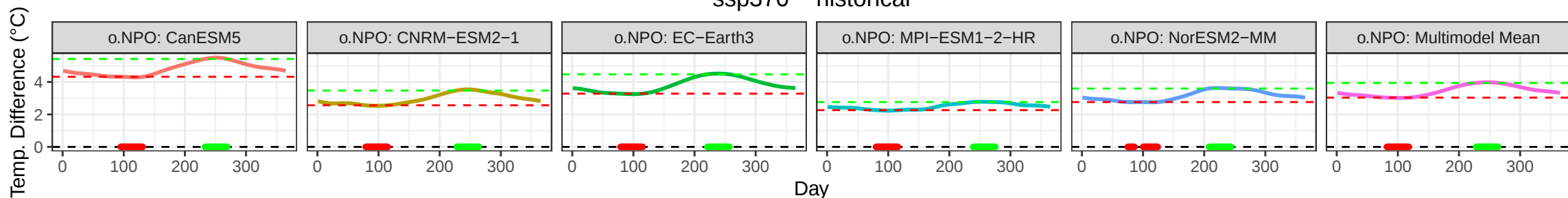
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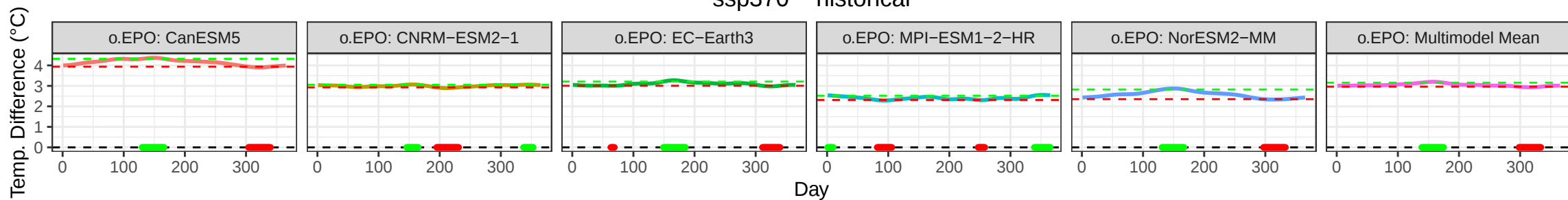
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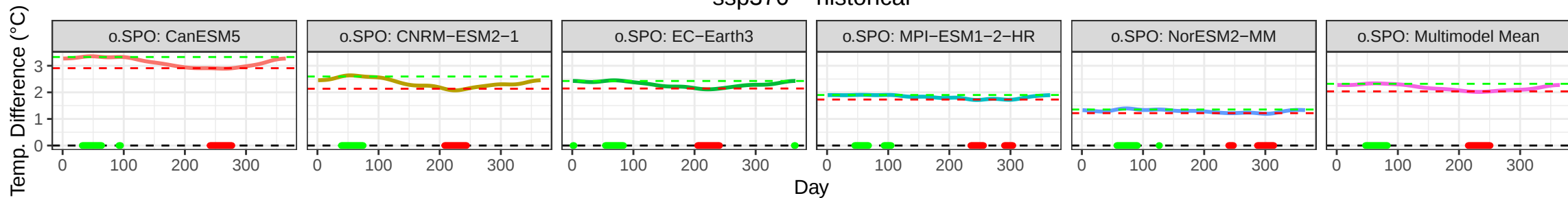
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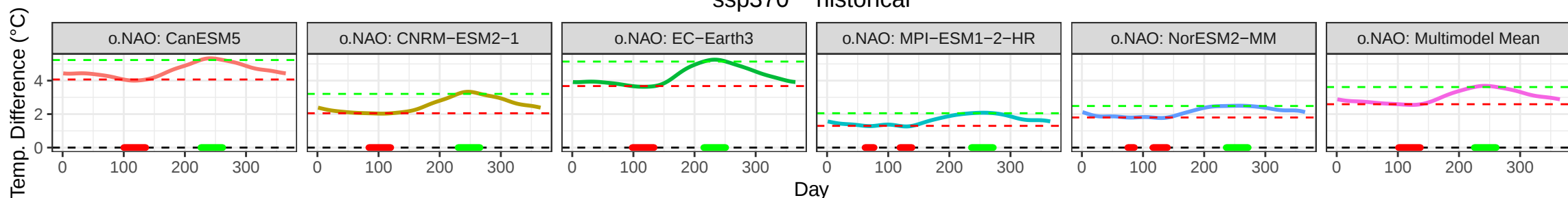
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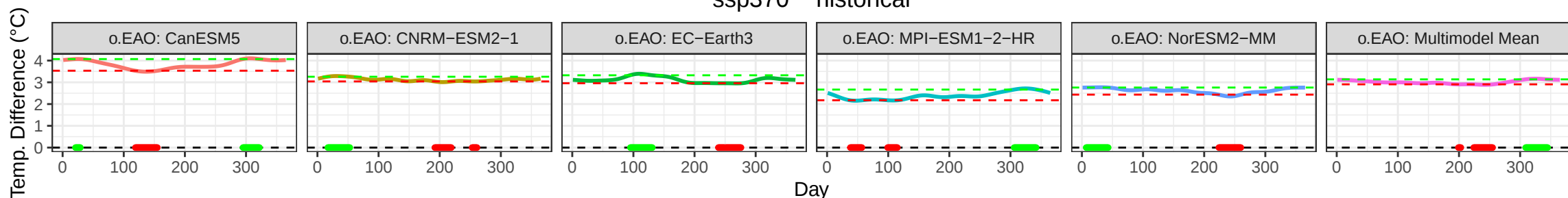
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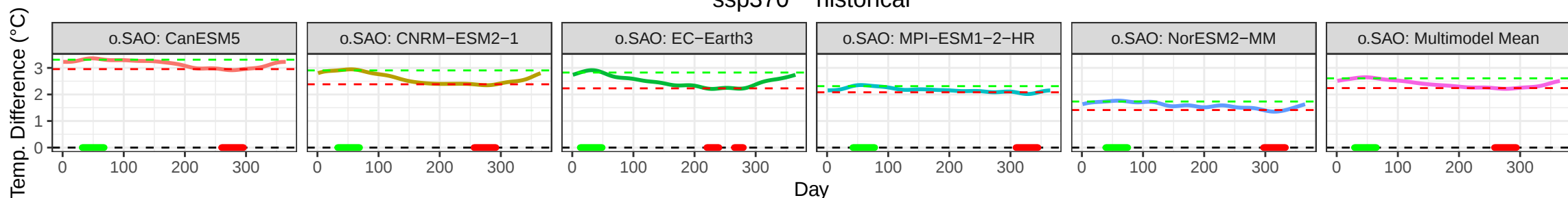
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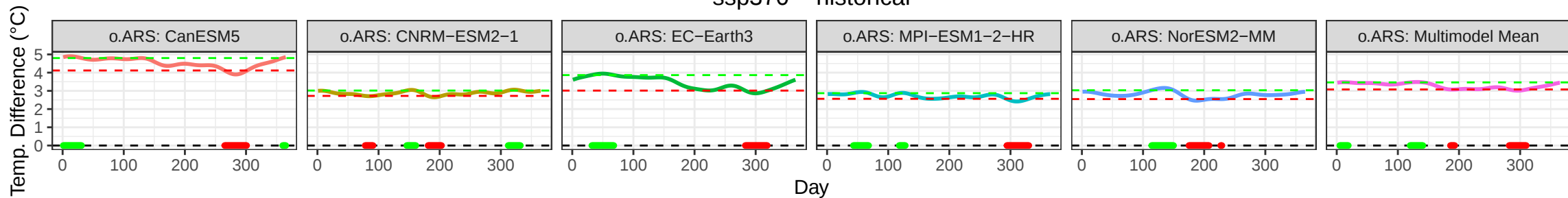
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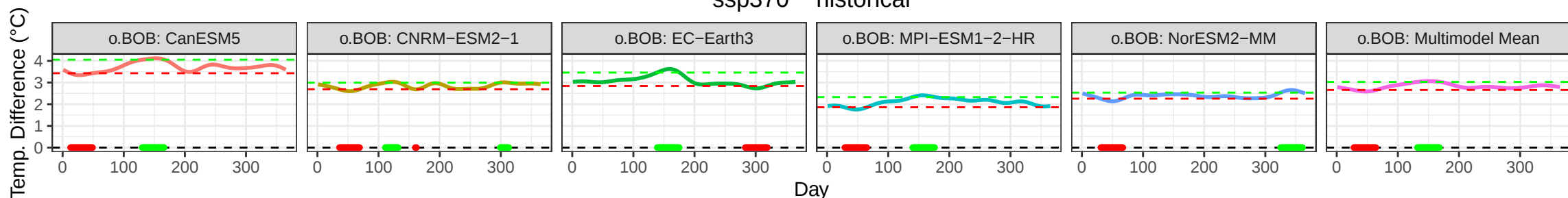
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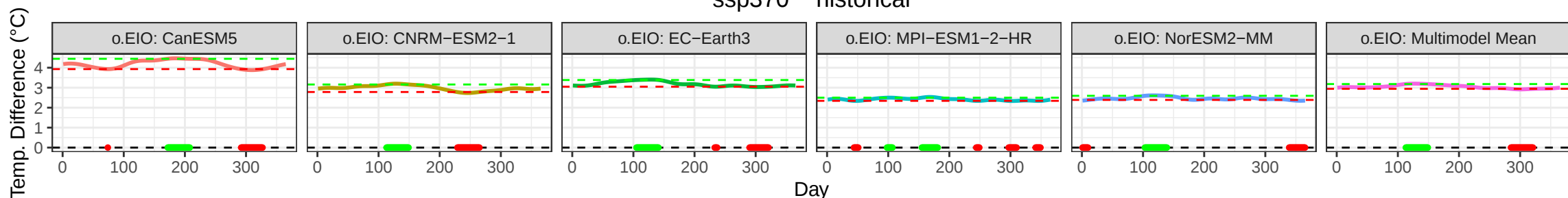
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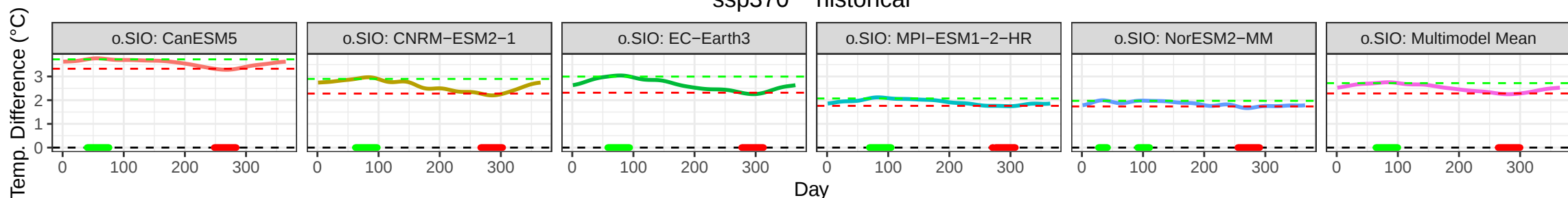
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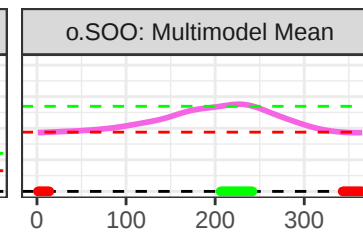
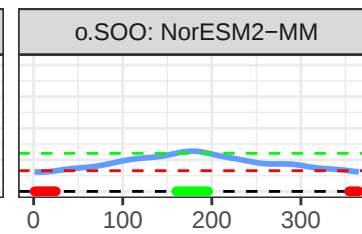
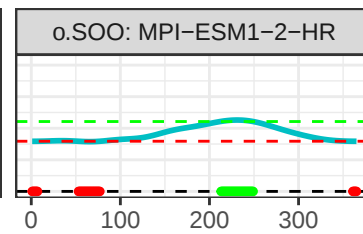
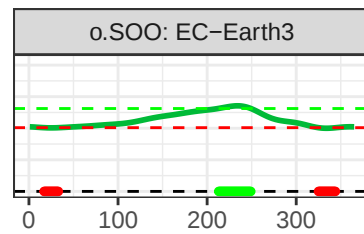
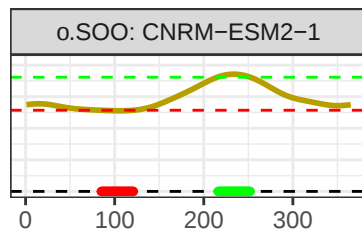
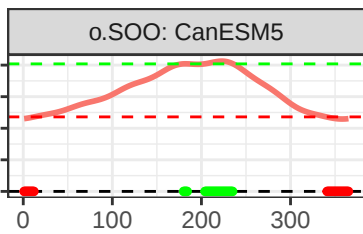


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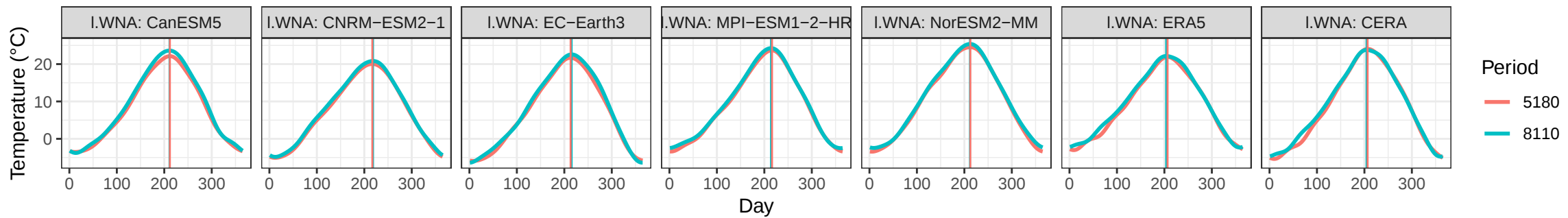
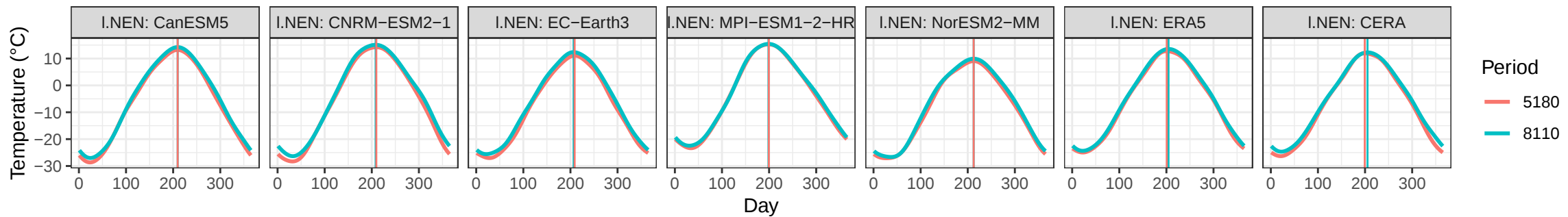
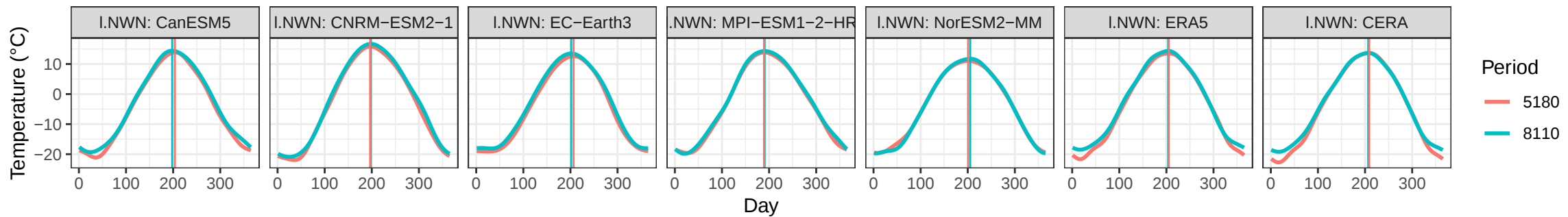
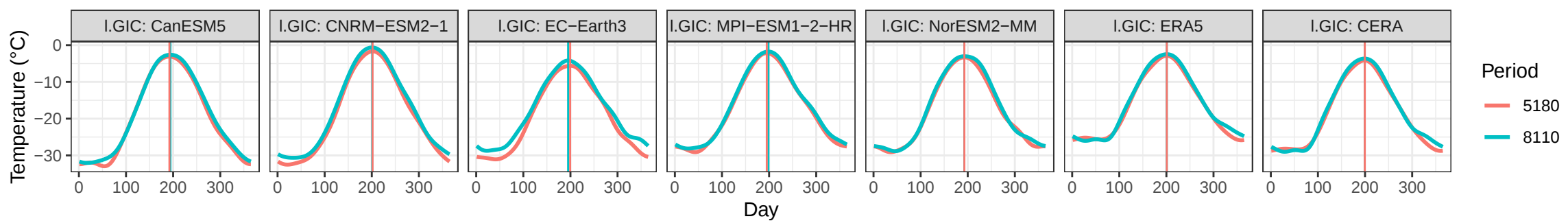
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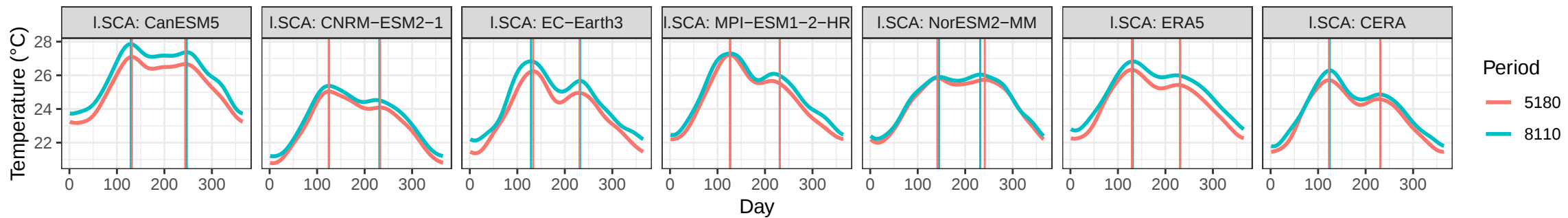
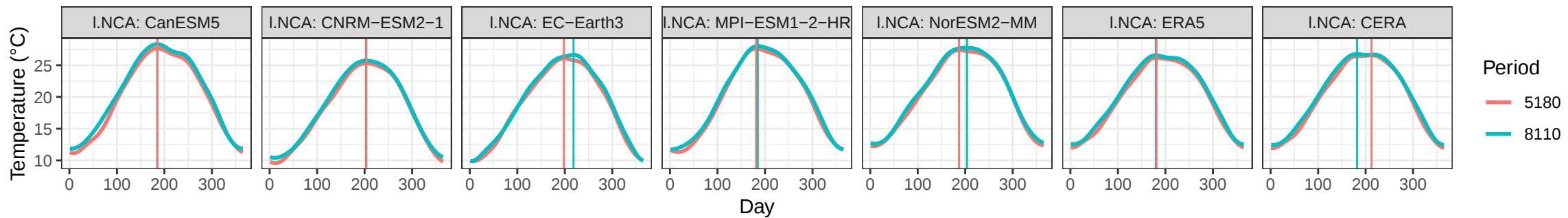
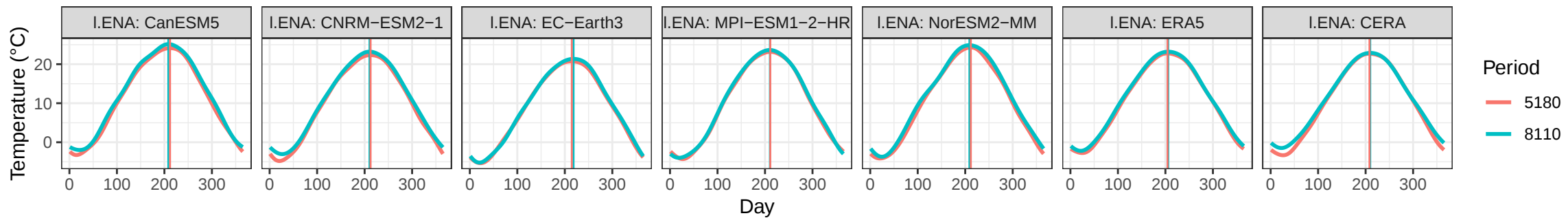
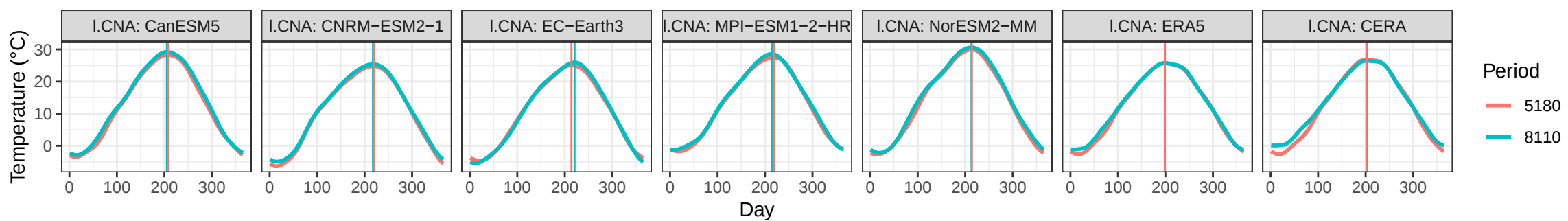
Temp. Difference (°C)

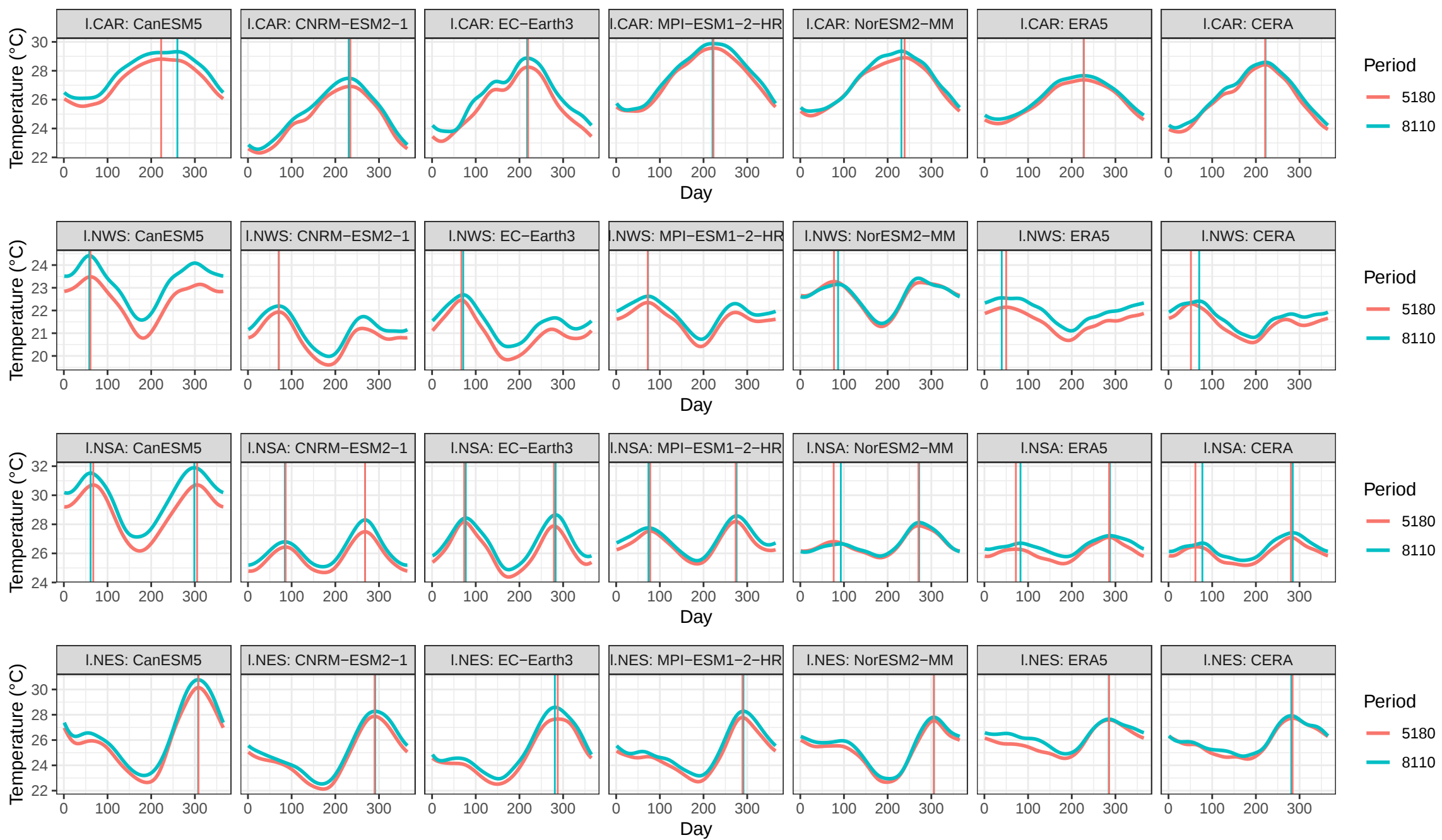


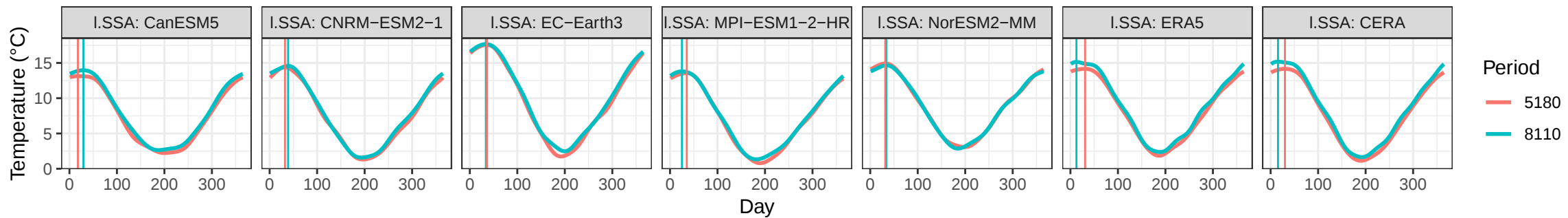
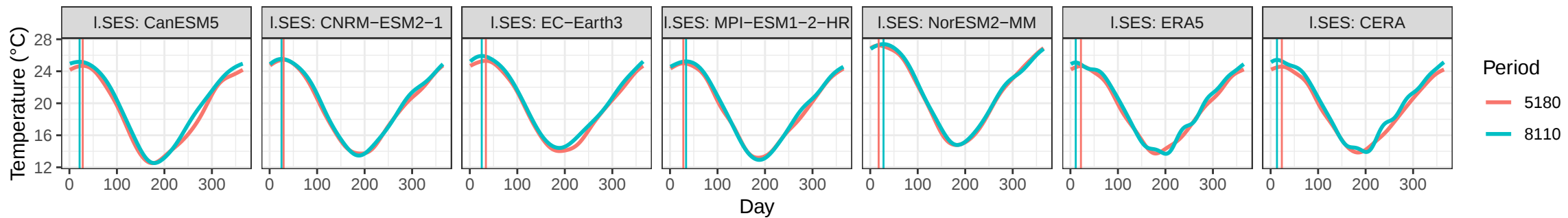
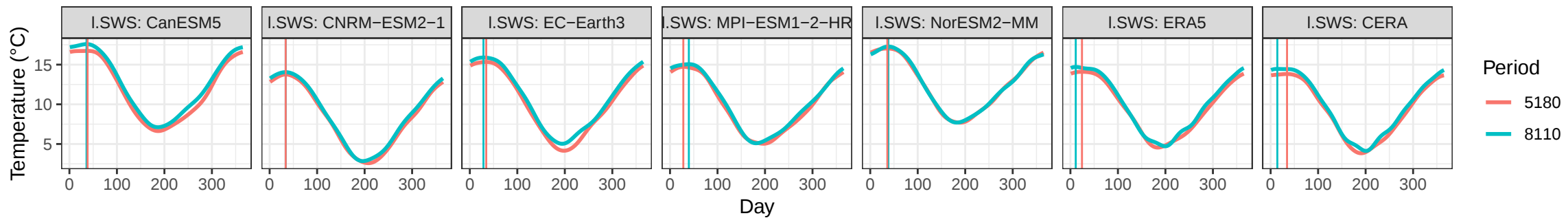
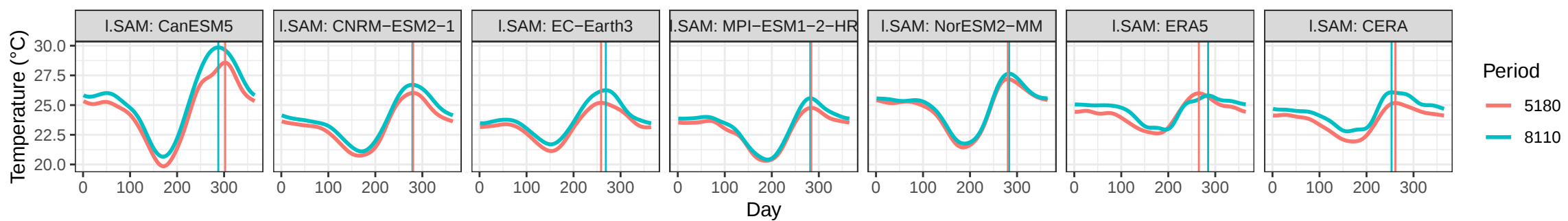
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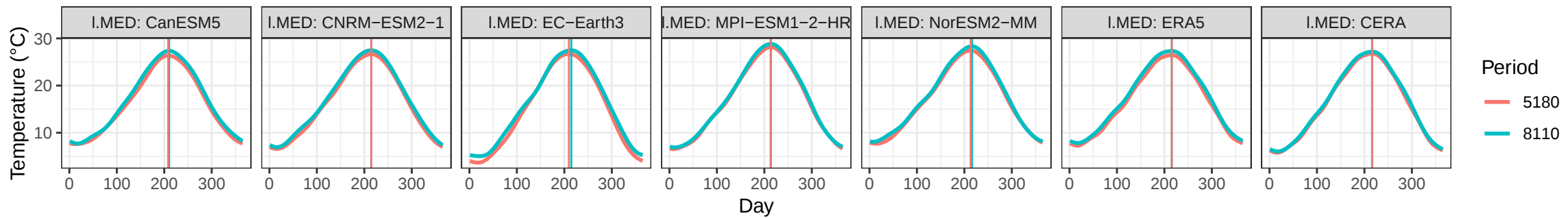
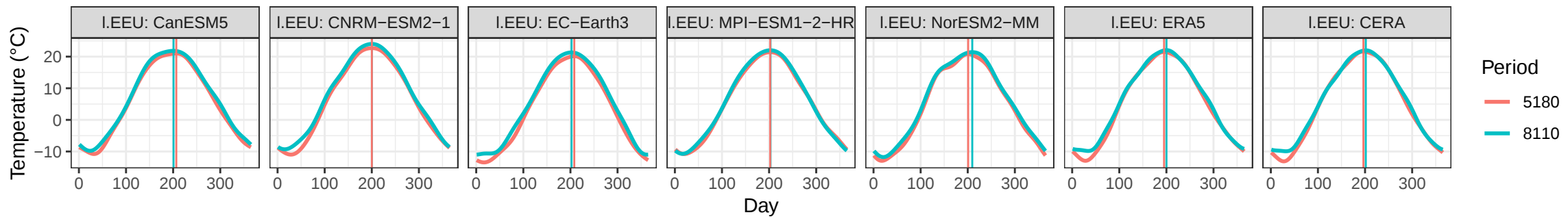
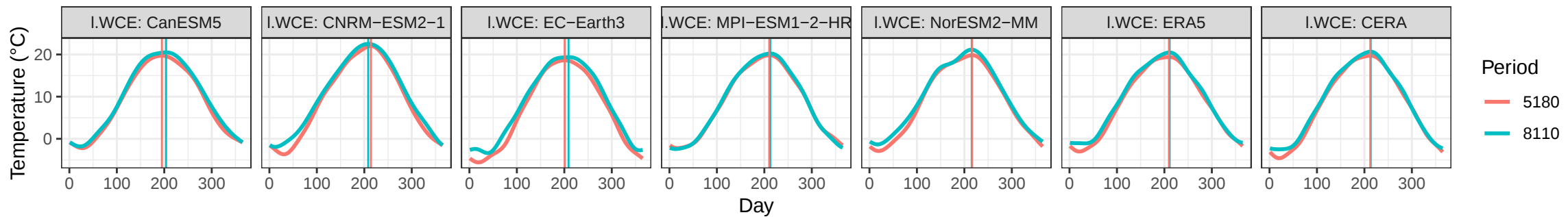
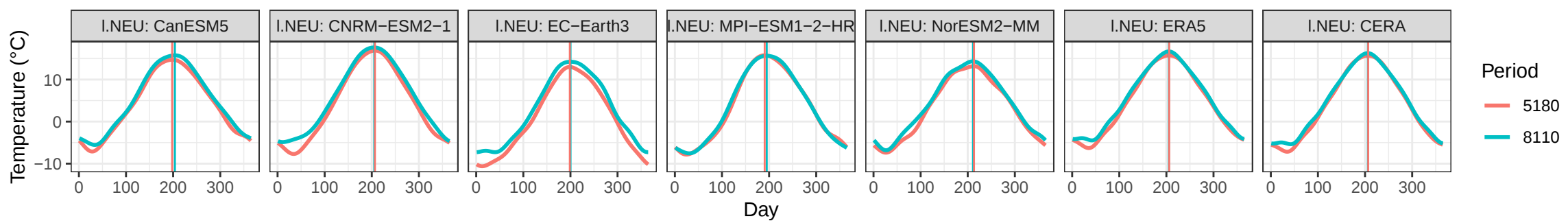
Figure S03: The smoothed annual cycle curves in the two historical periods 1981-2010 (8110, blue curve) and 1951-1980 (5180, red curve). Plots for five selected CMIP6 ESMs and their multi-model mean are shown in different columns, plot for different geographical regions are depicted in different rows of the figure. Positions of the annual cycle maxima in the two periods are denoted by the vertical lines. The results shown in this figure are summarized in Fig. 5 in the manuscript.

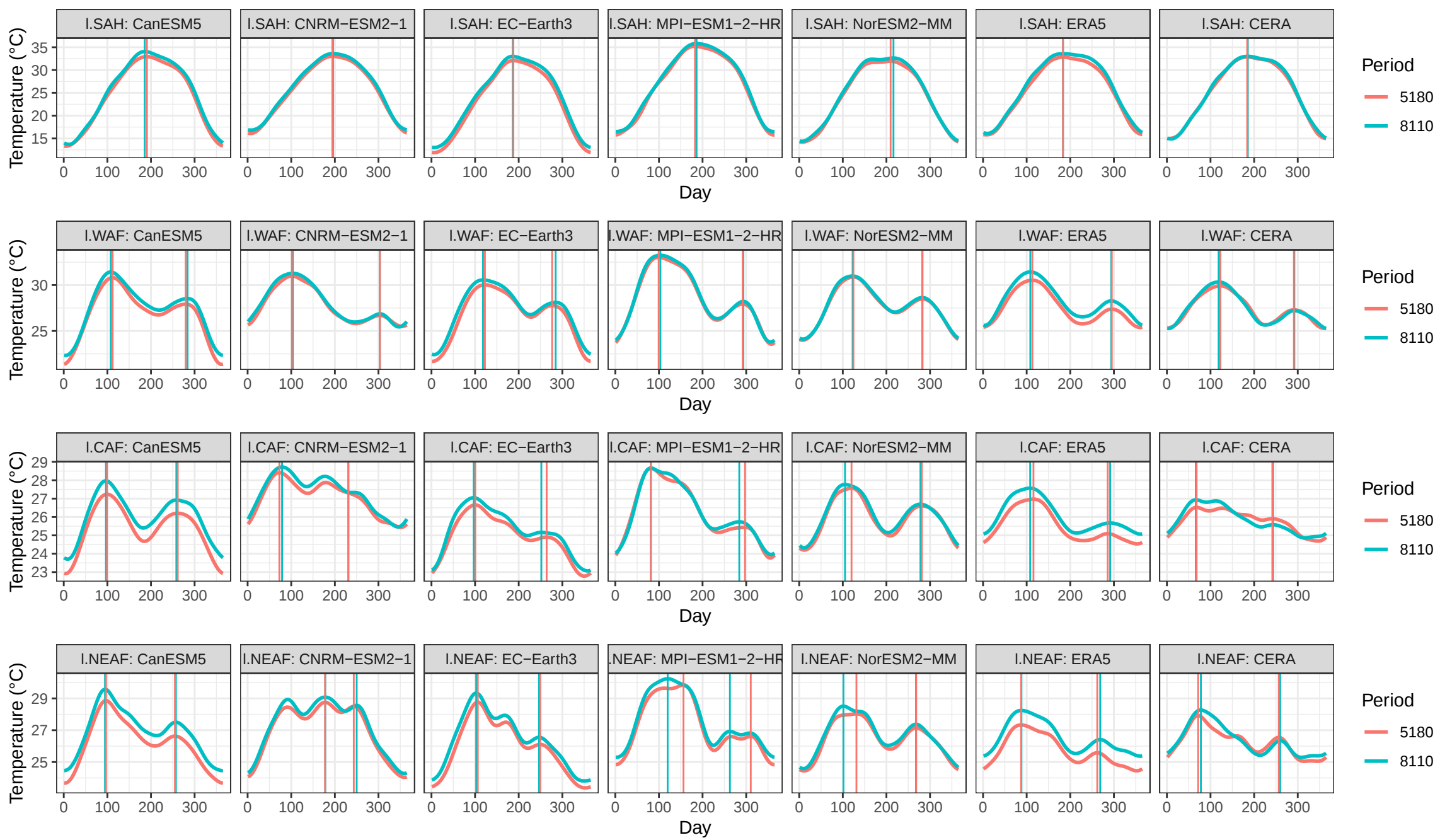


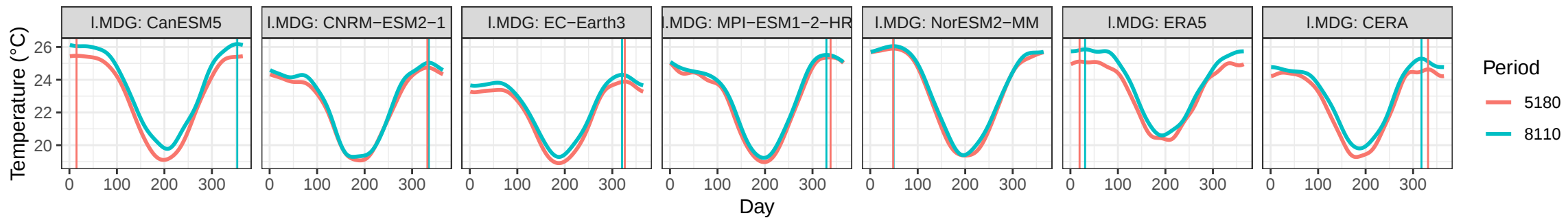
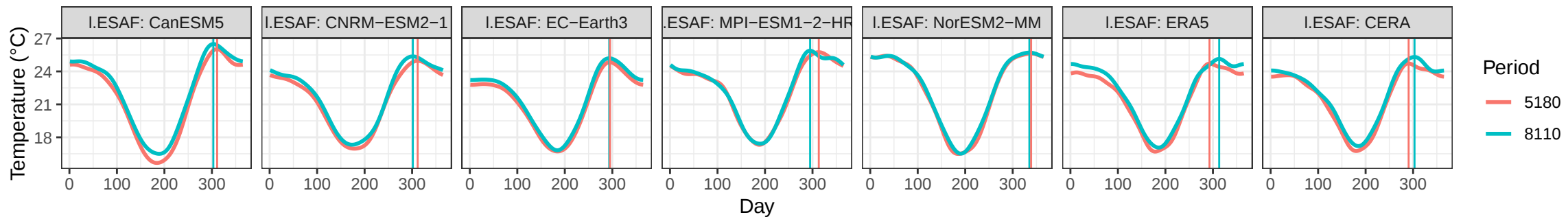
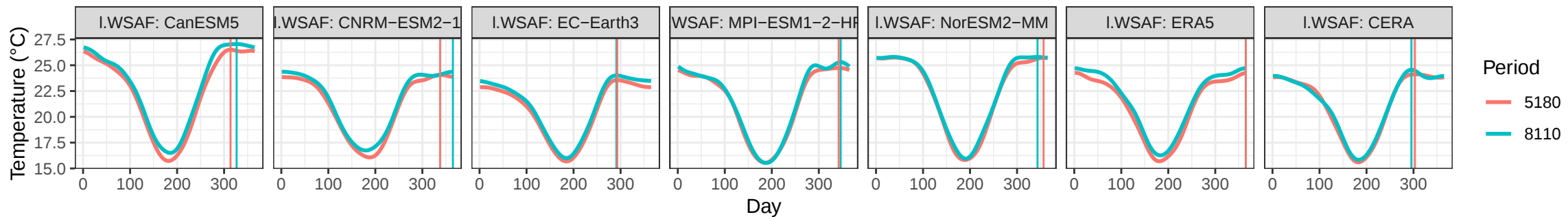
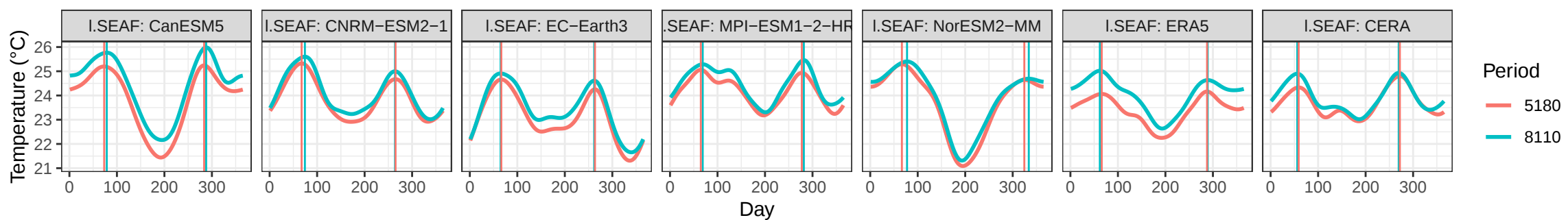


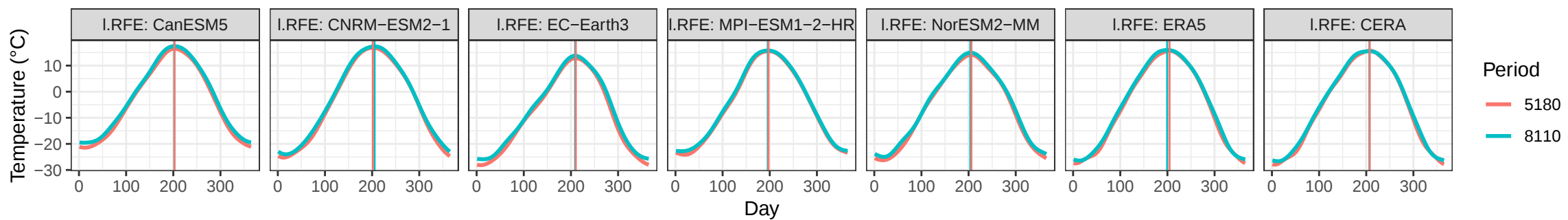
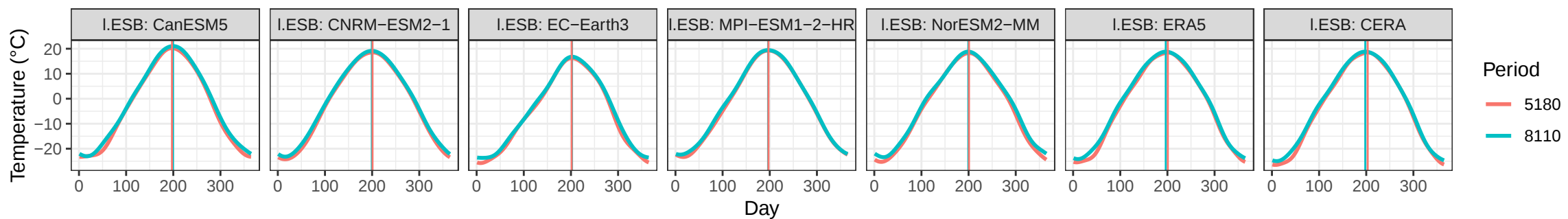
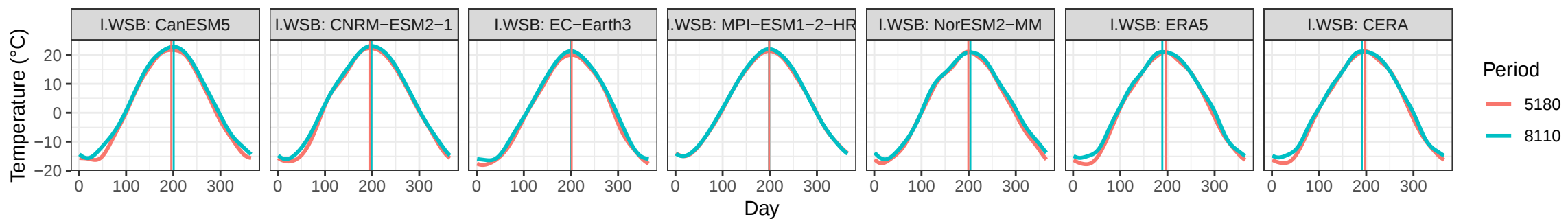
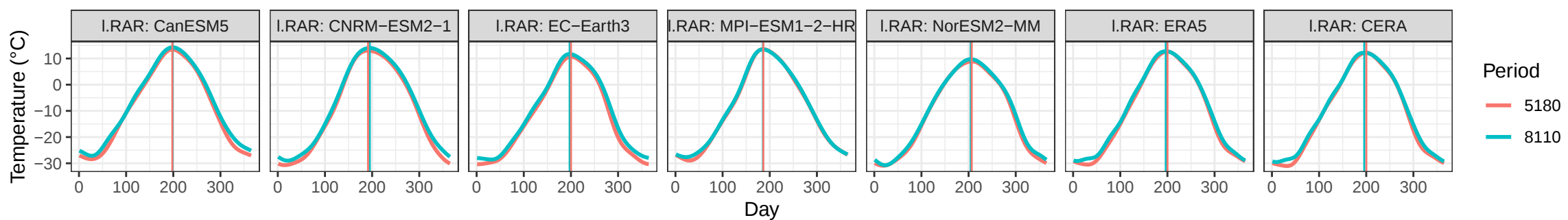


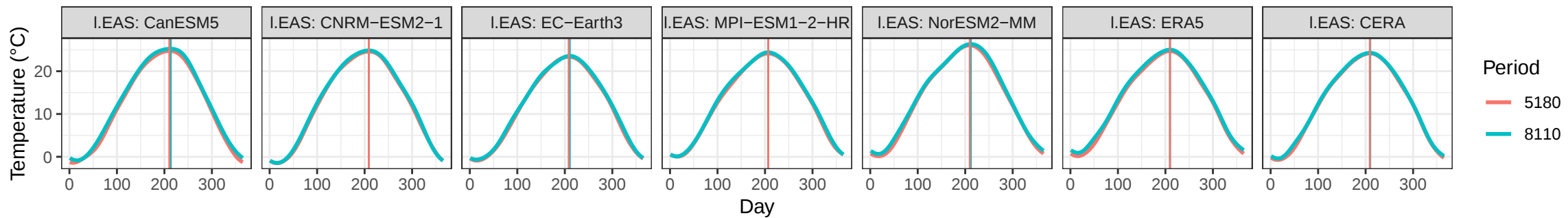
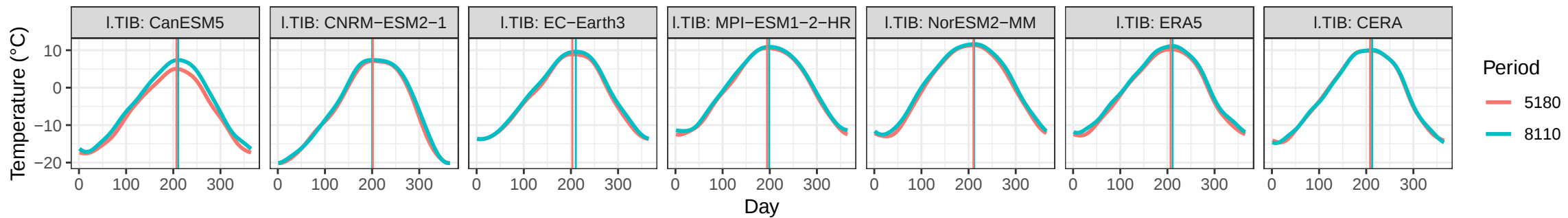
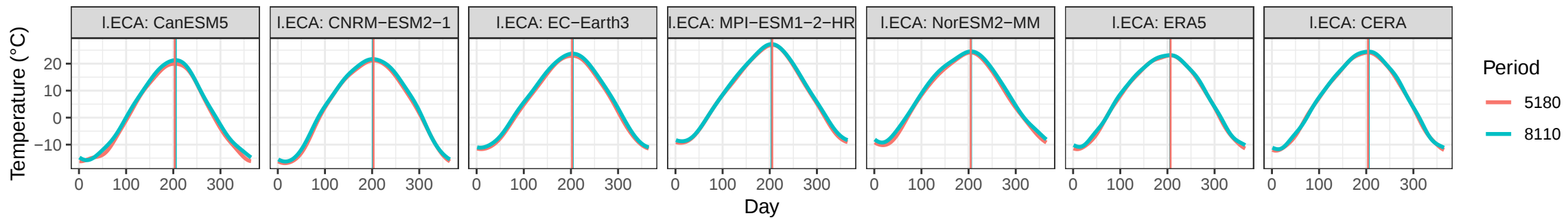
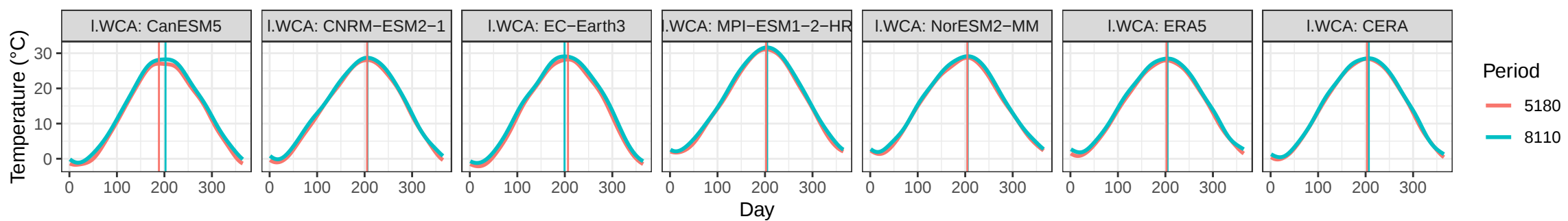


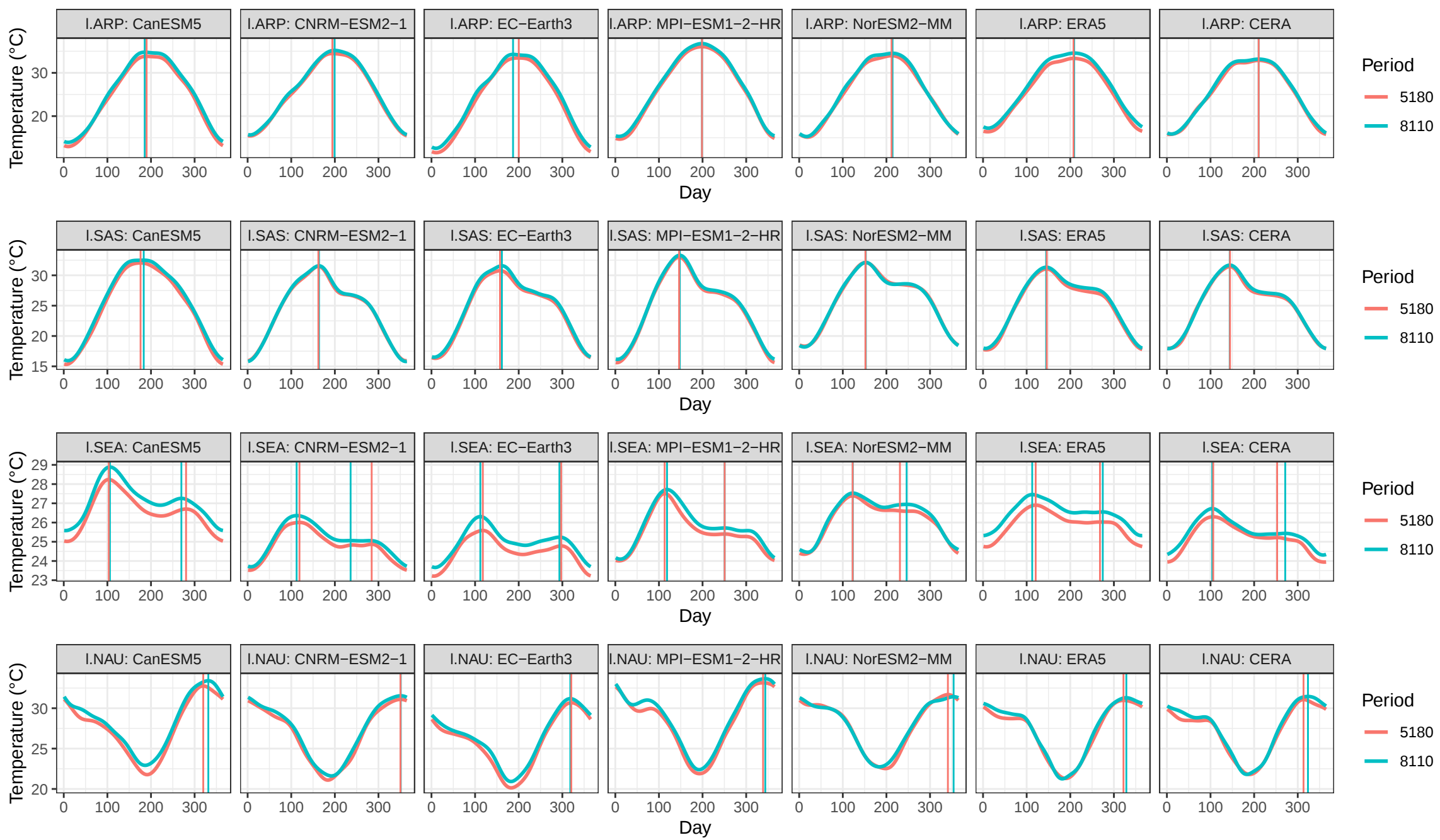


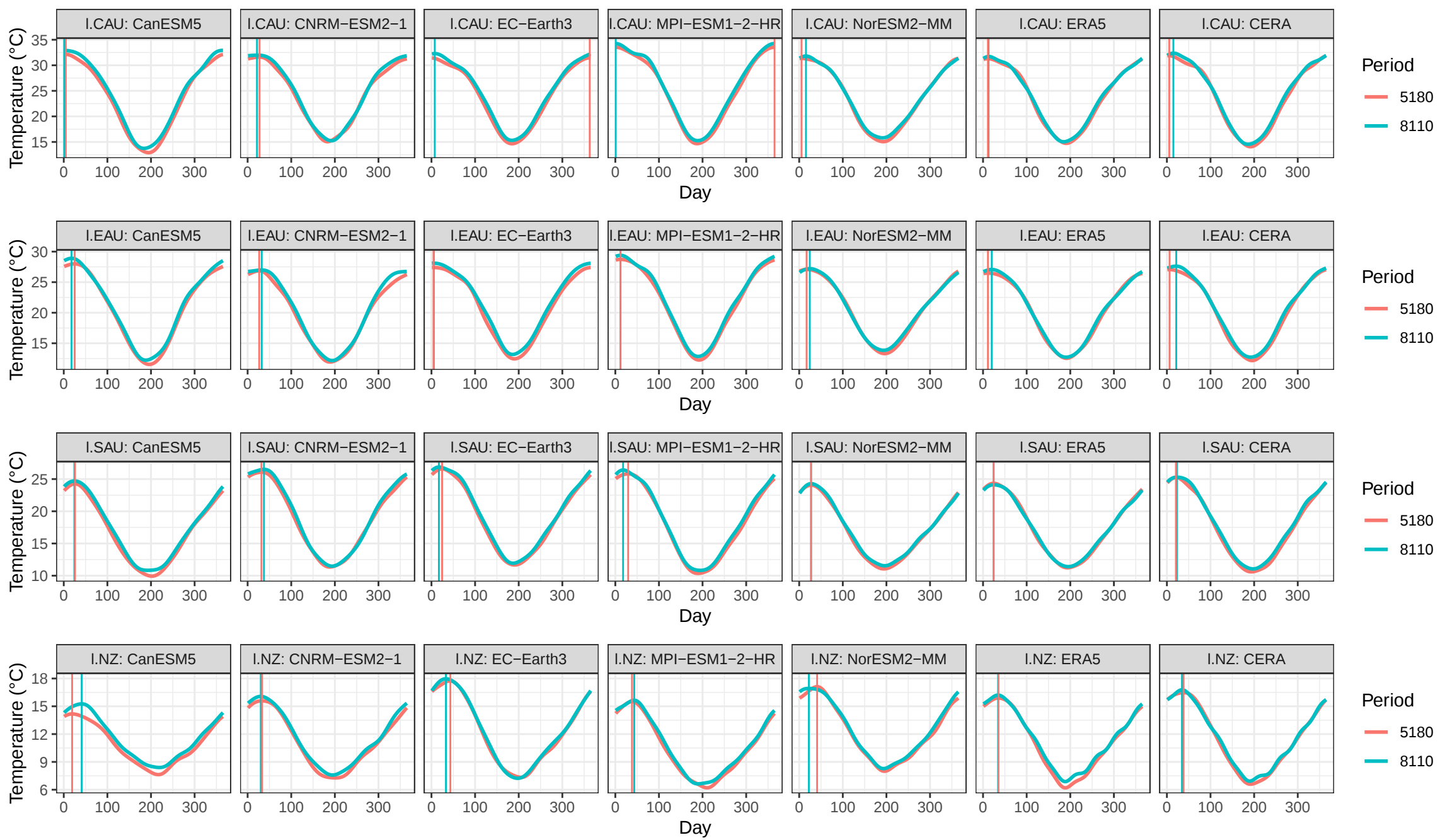


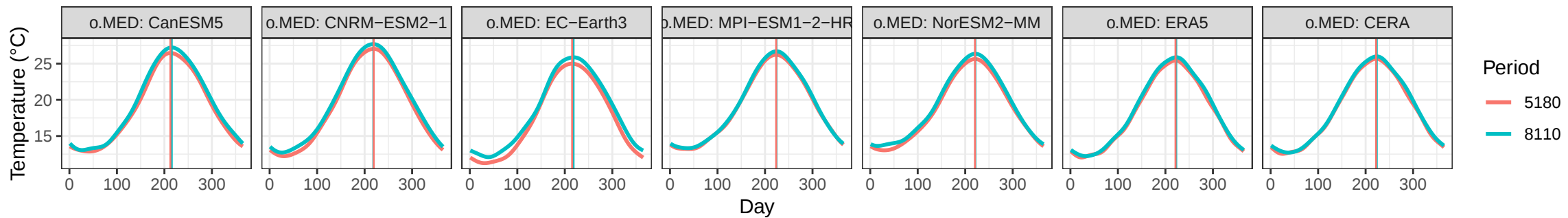
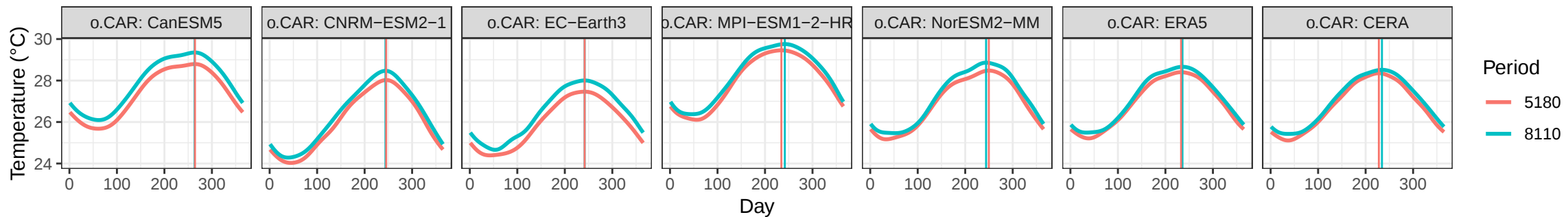
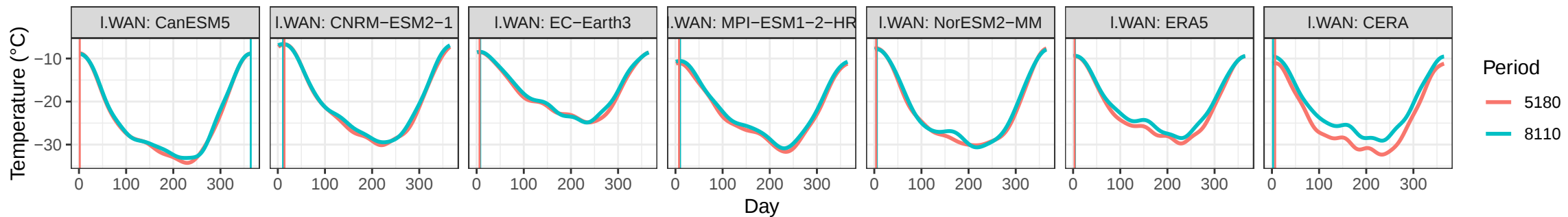
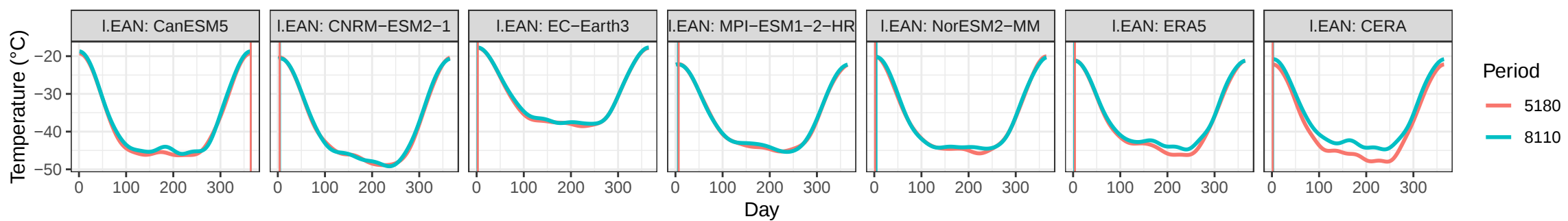


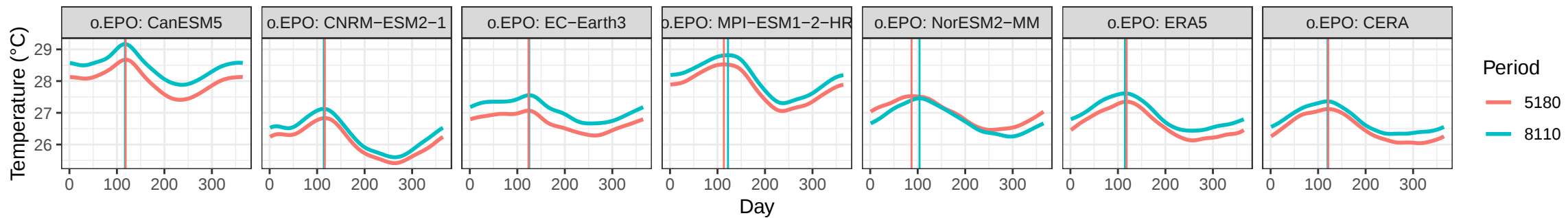
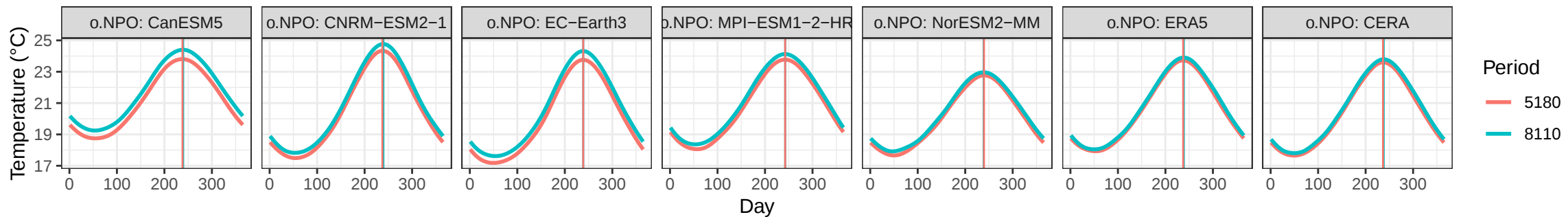
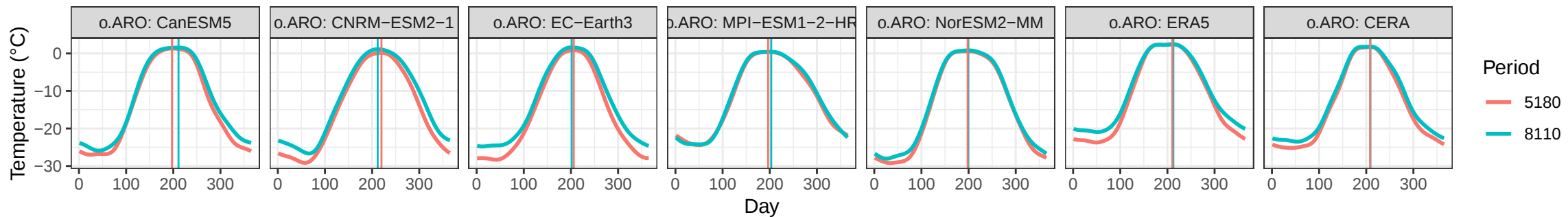
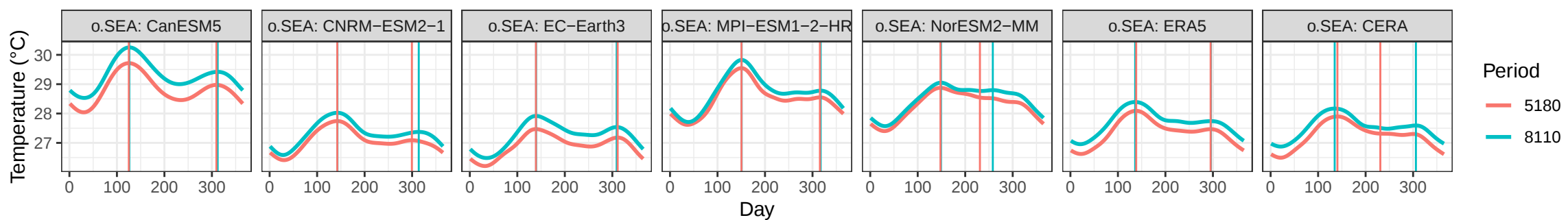


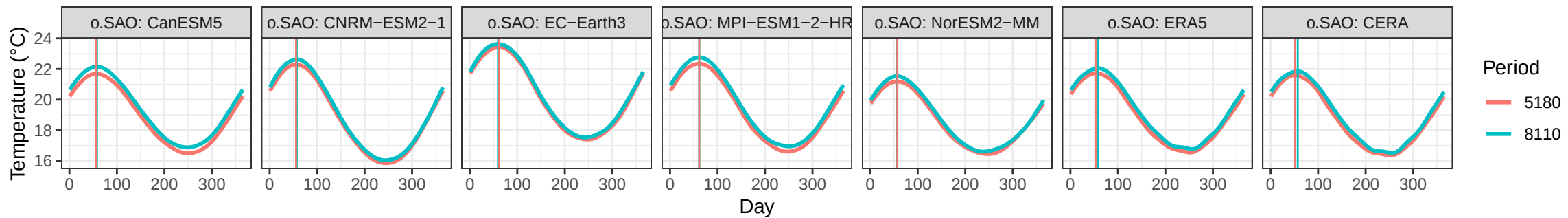
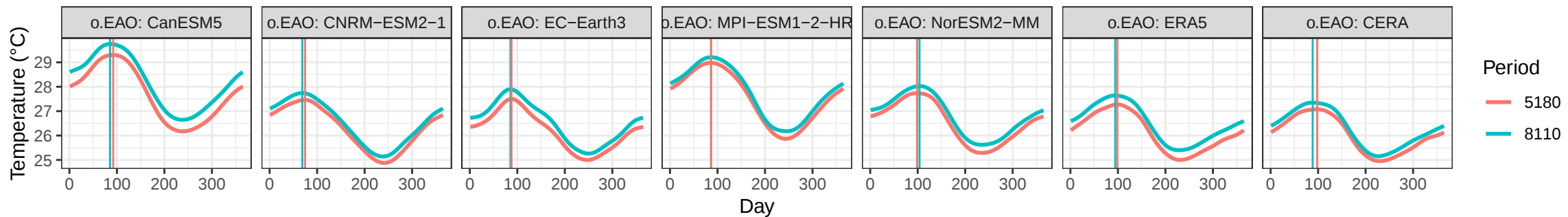
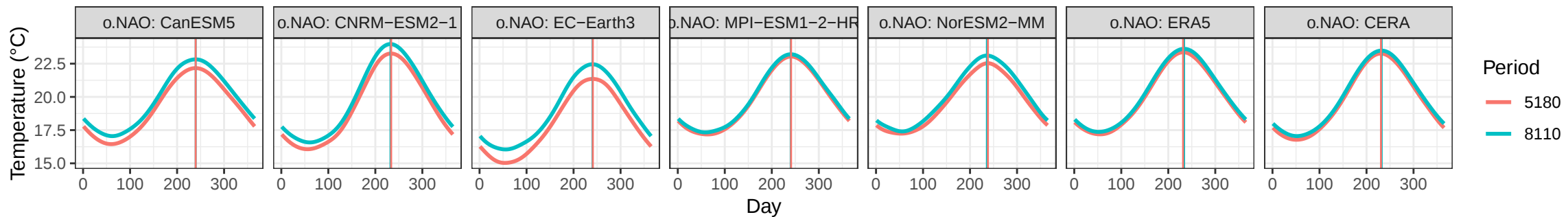
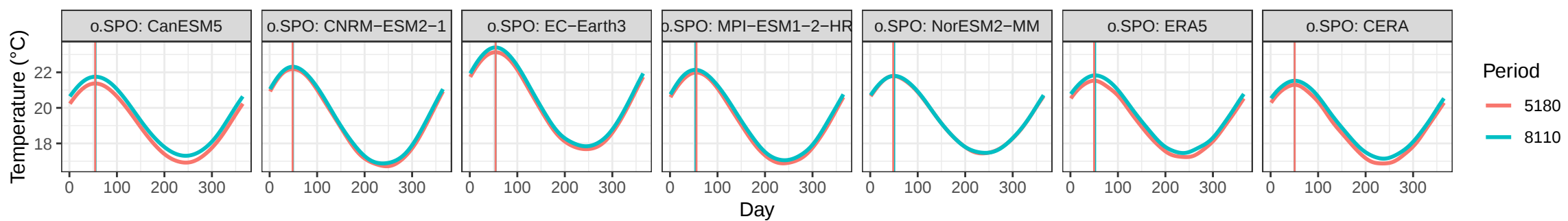


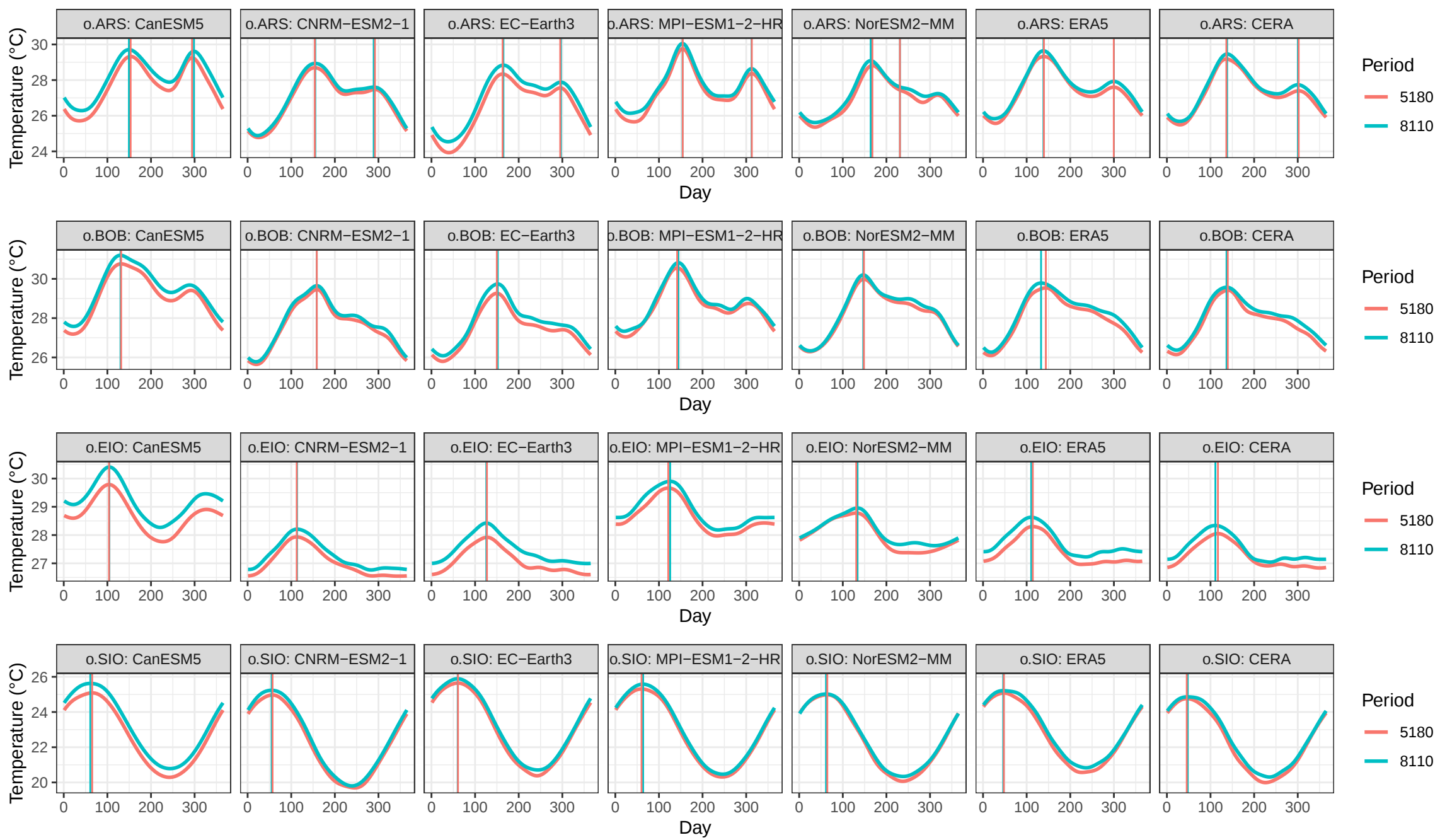












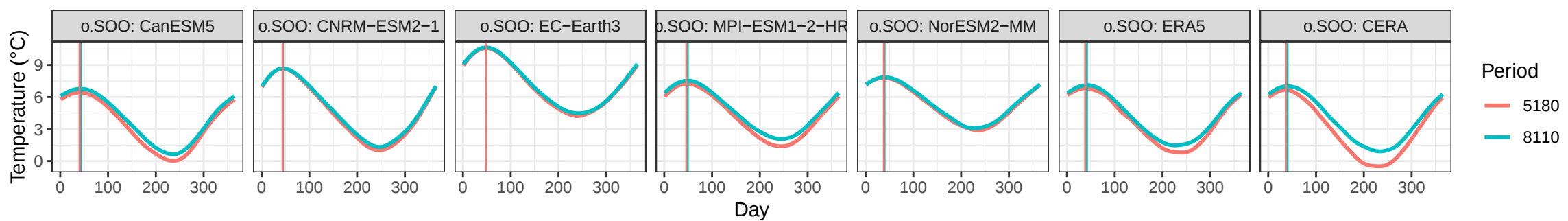
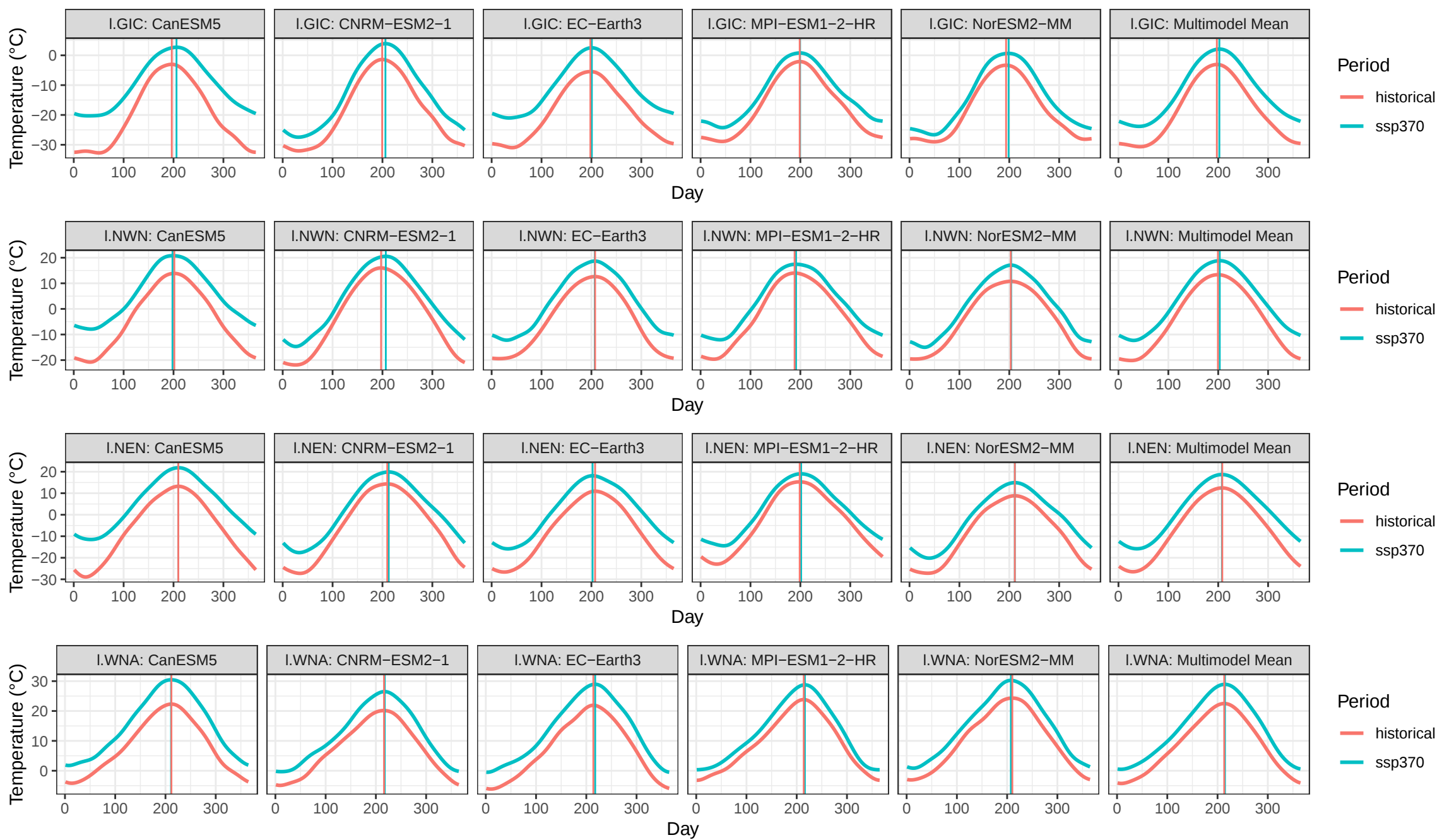
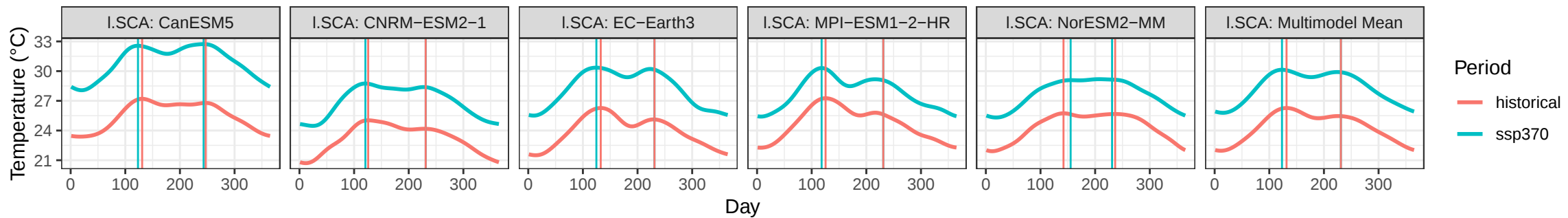
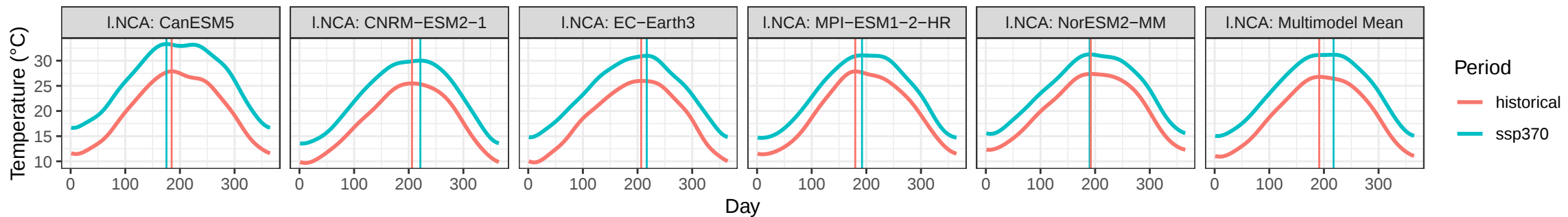
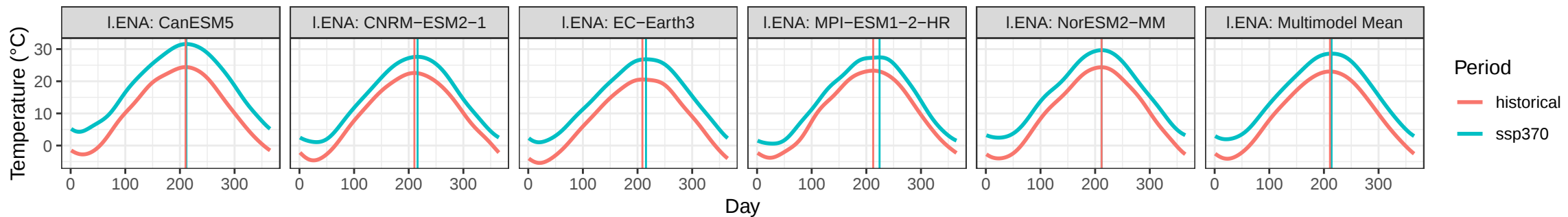
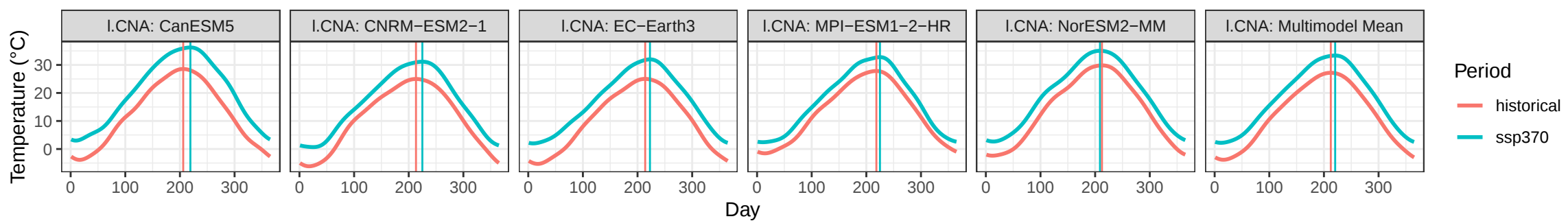
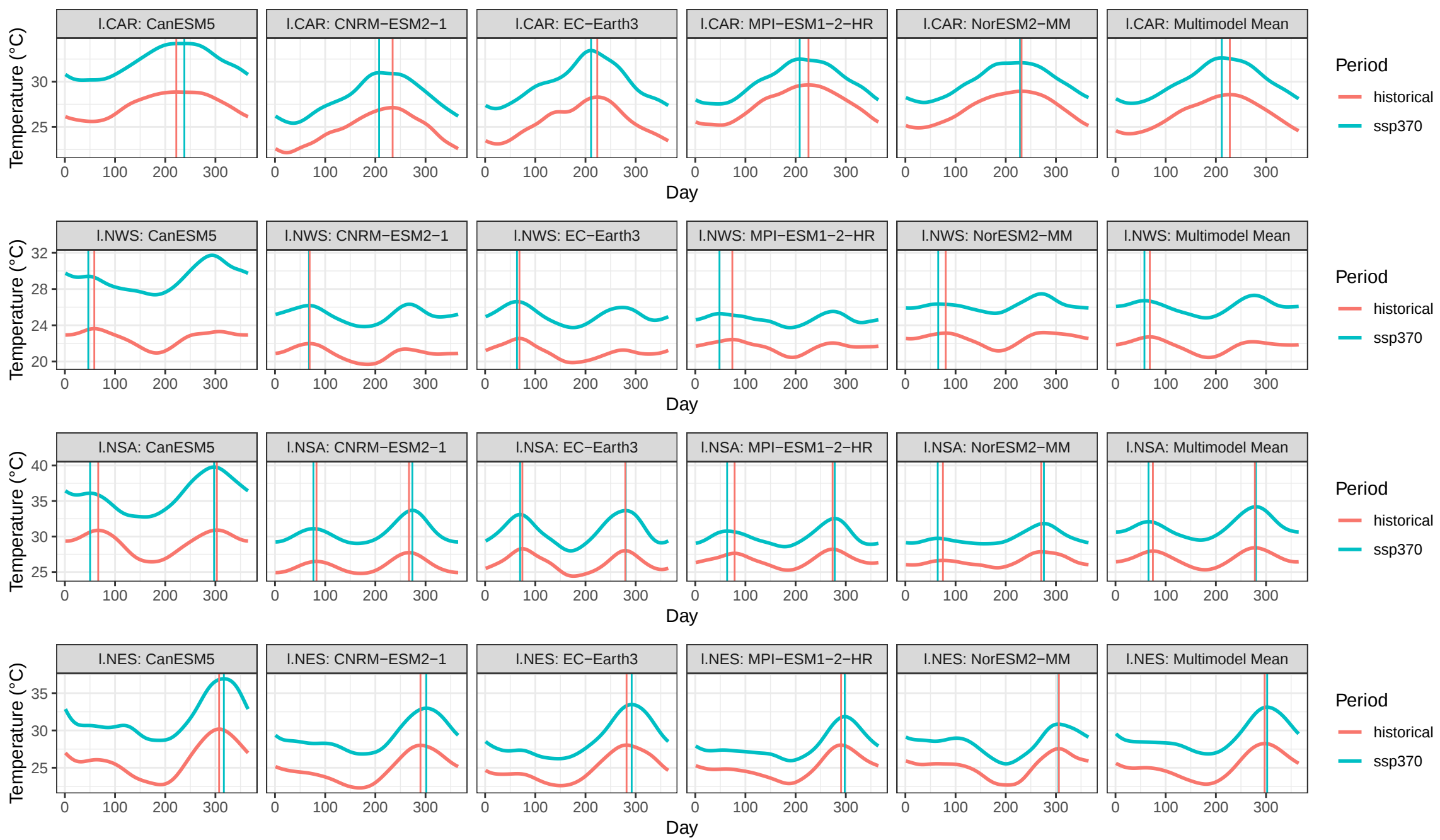
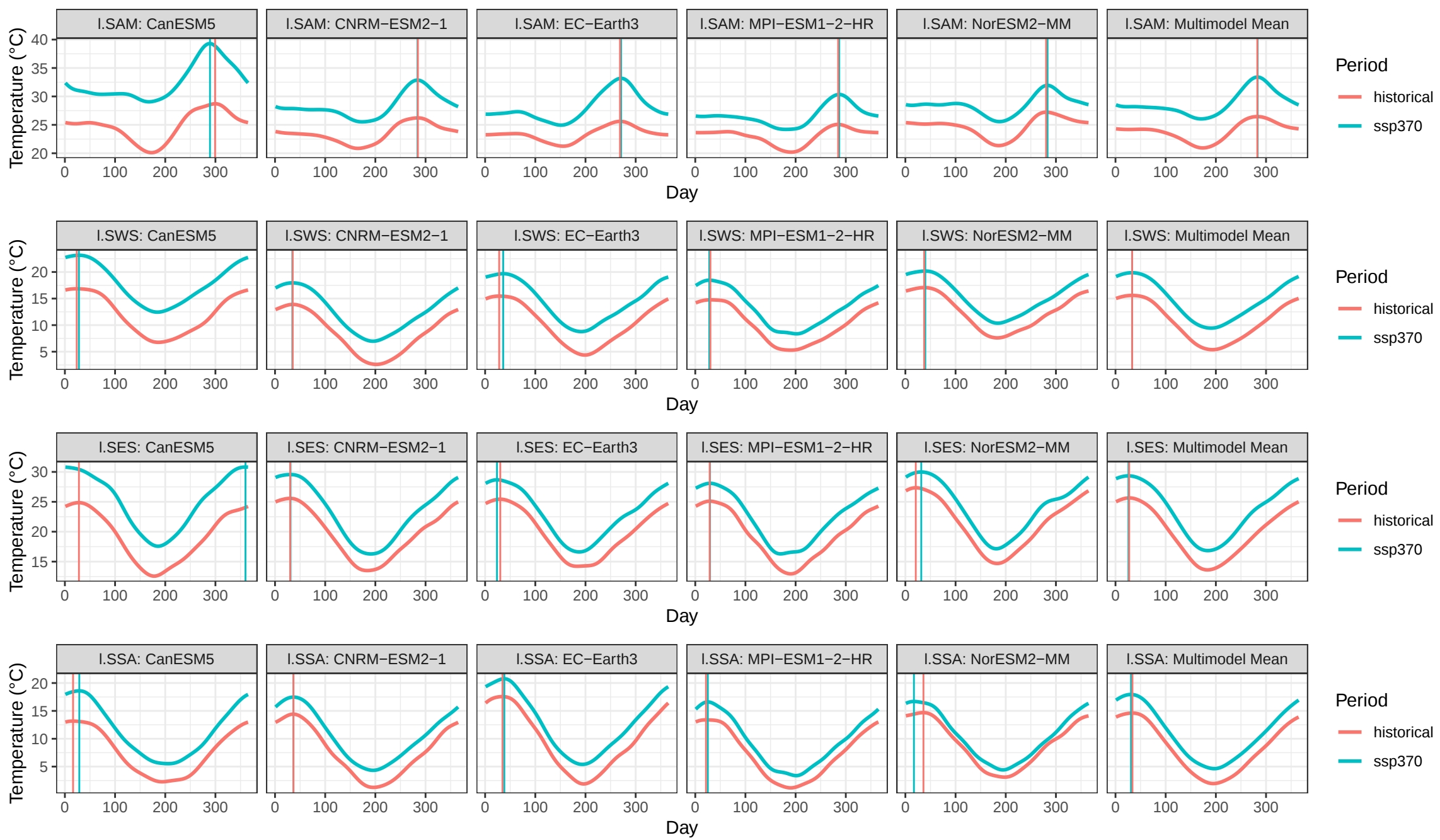


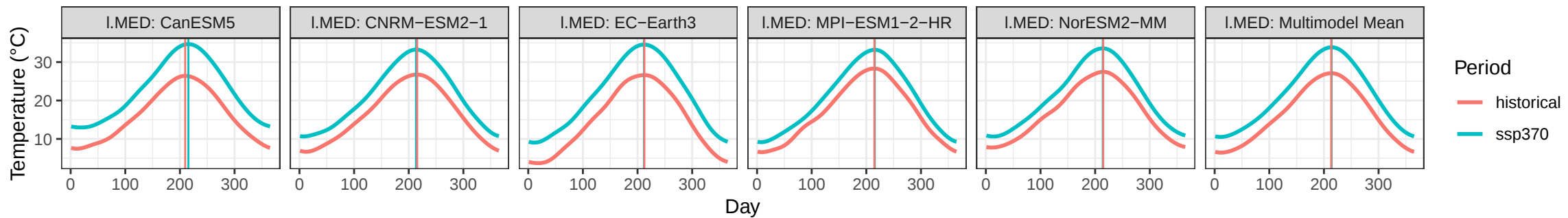
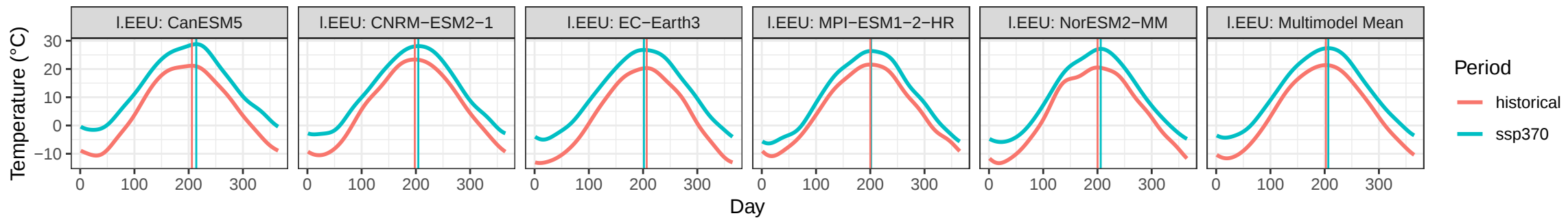
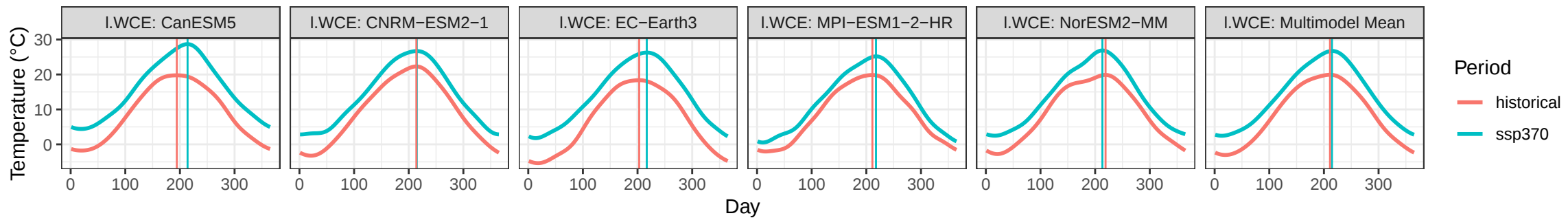
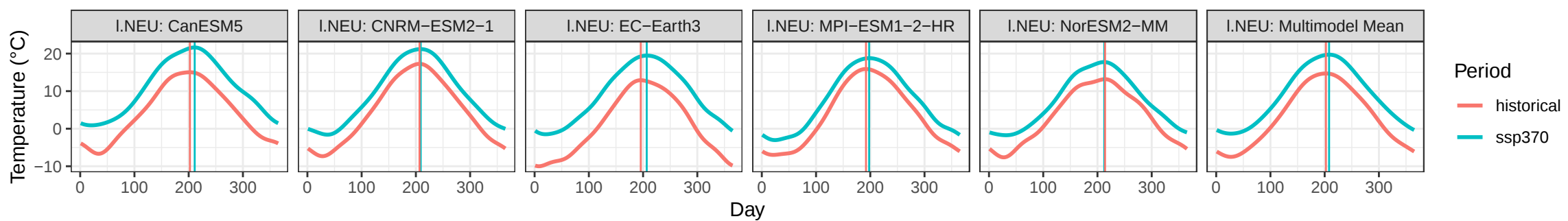
Figure S04: The smoothed annual cycle curves in the future and reference periods of 2071-2100 (ssp370, blue curve) and 1961-1990 (historical, red curve). Plots for five selected CMIP6 ESMs and their multi-model mean are shown in different columns, plots for different geographical regions are depicted in different rows of the figure. Positions of the annual cycle maxima in the two periods are denoted by the vertical lines. The results shown in this figure are summarized in Fig. 6 in the manuscript.

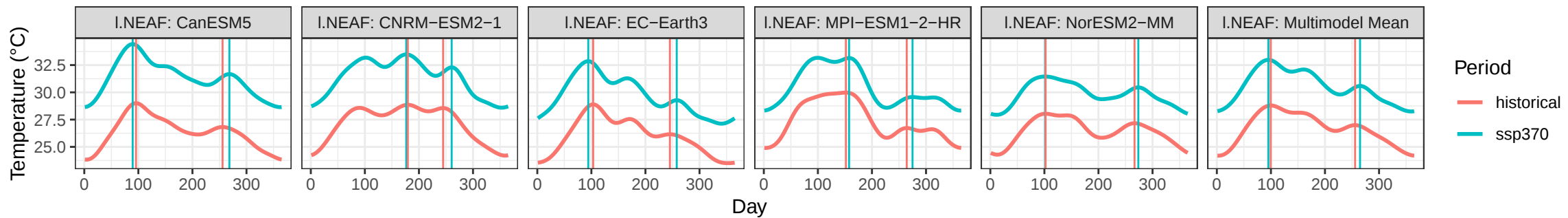
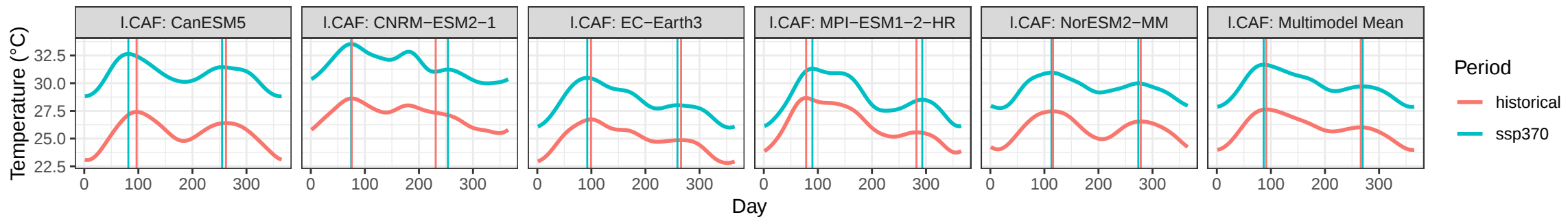
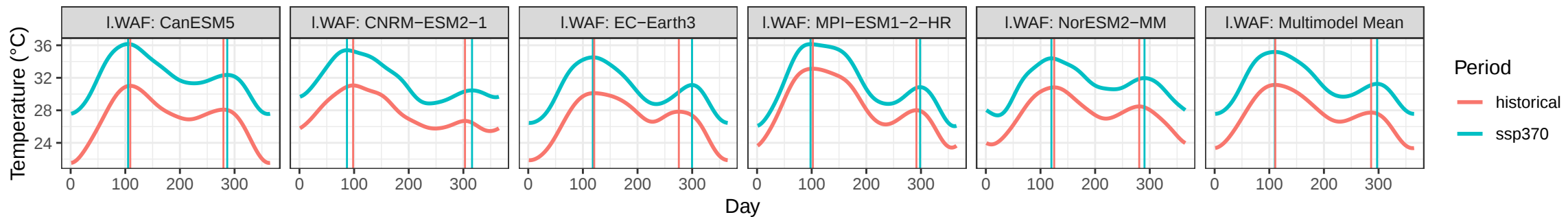
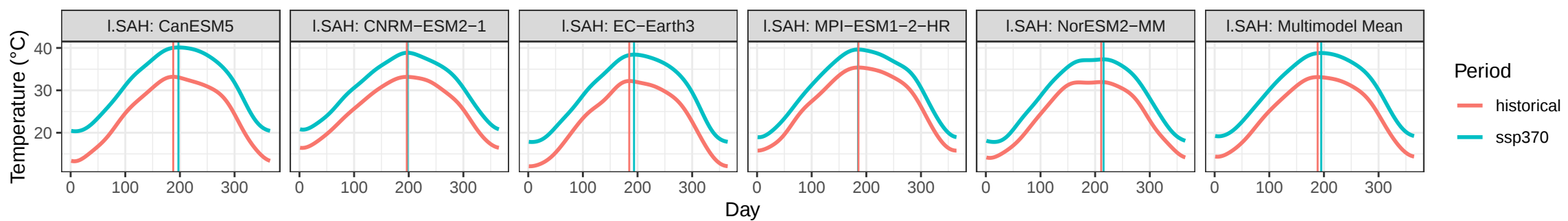


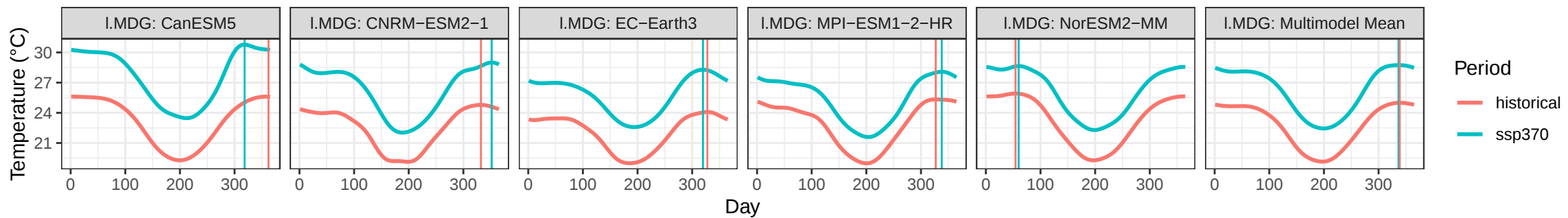
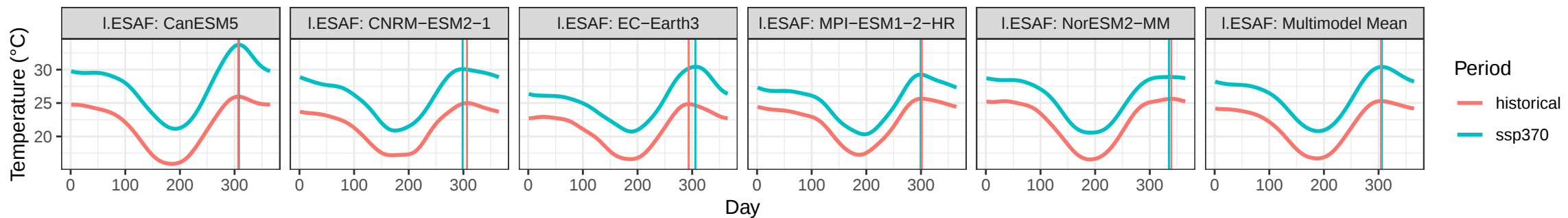
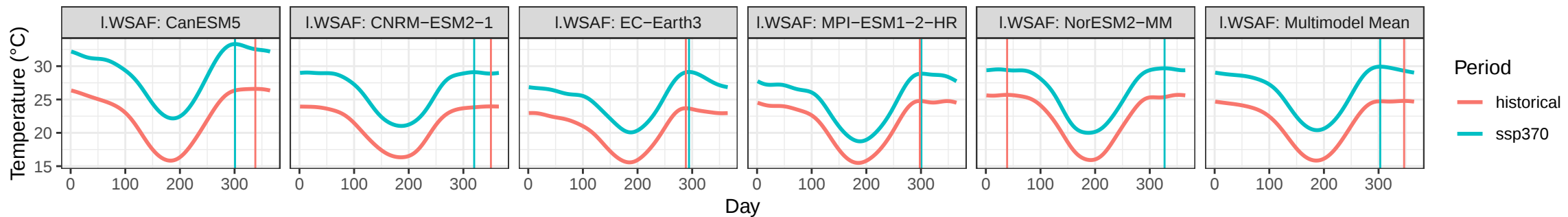
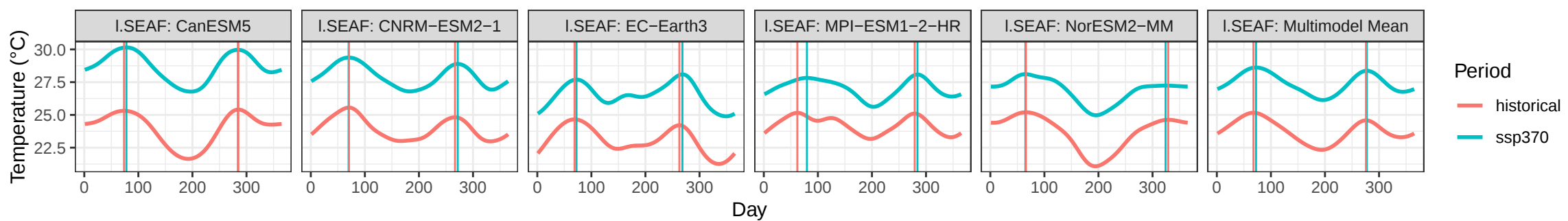


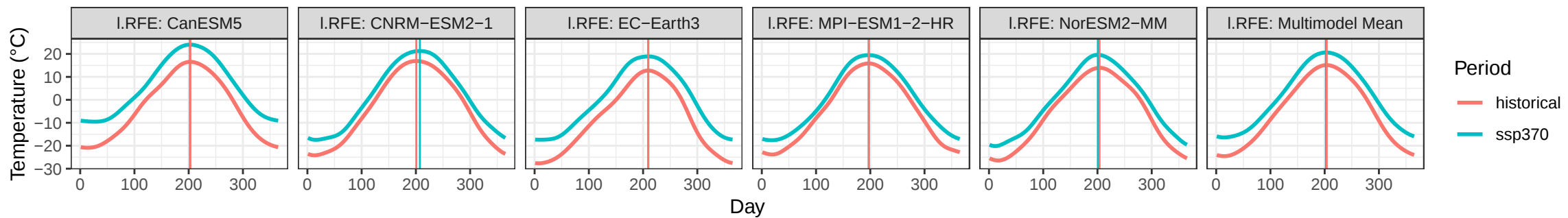
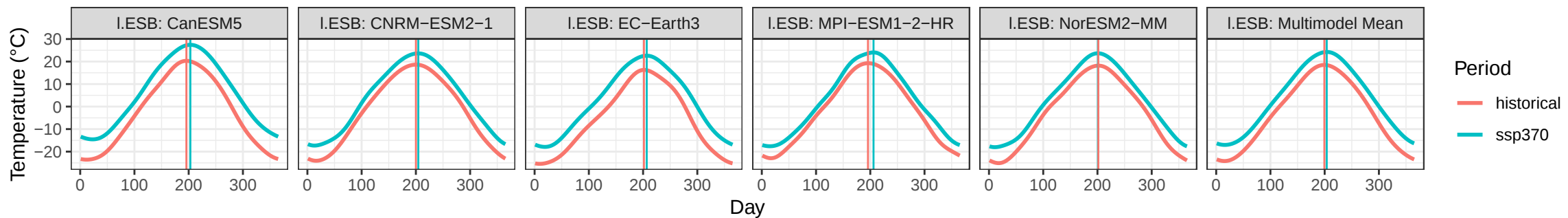
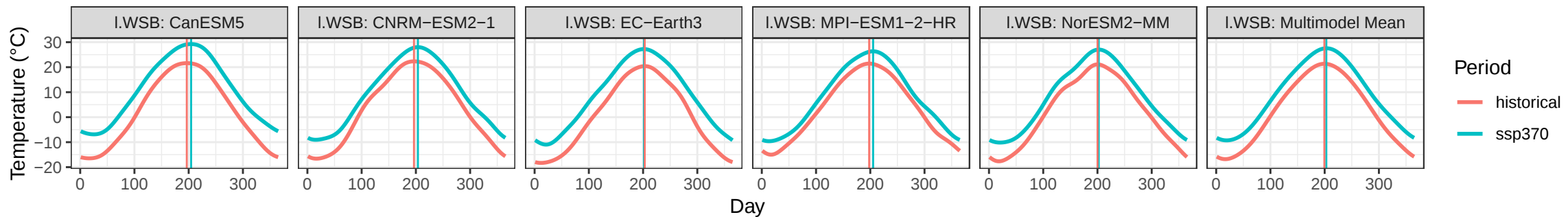
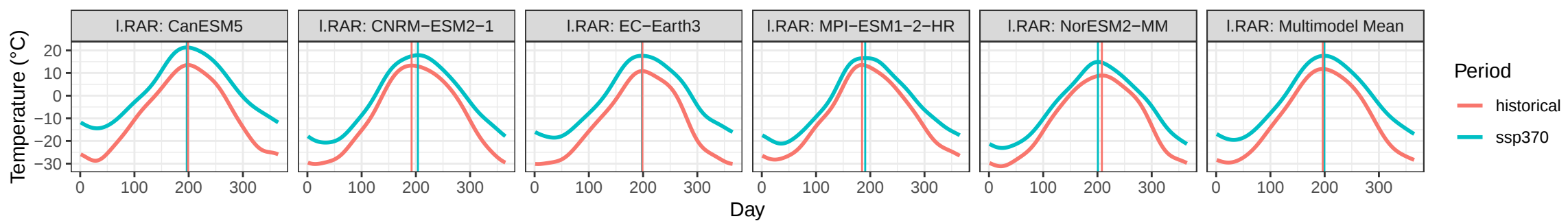


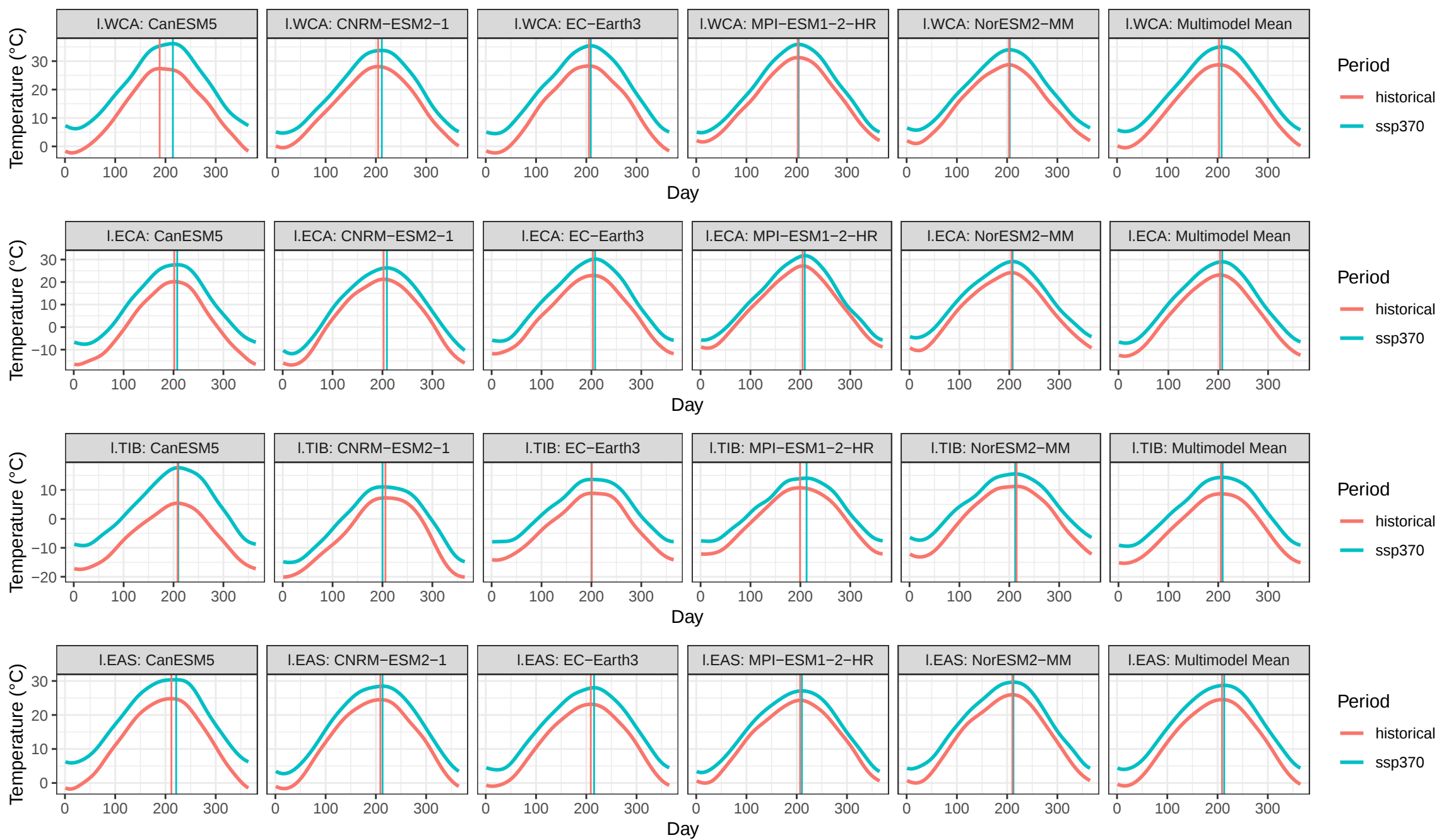


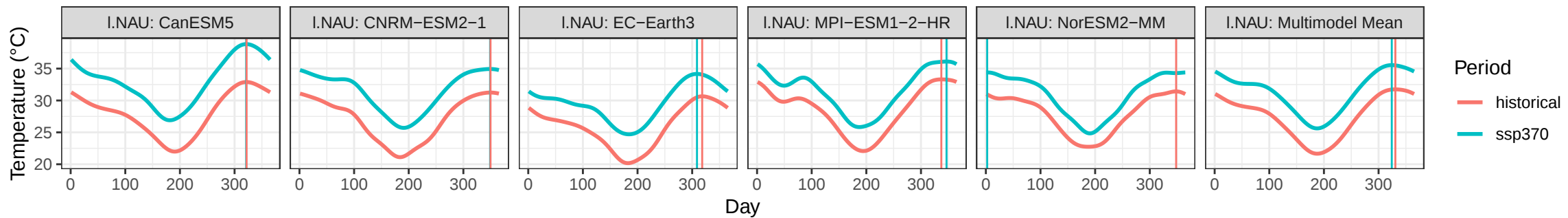
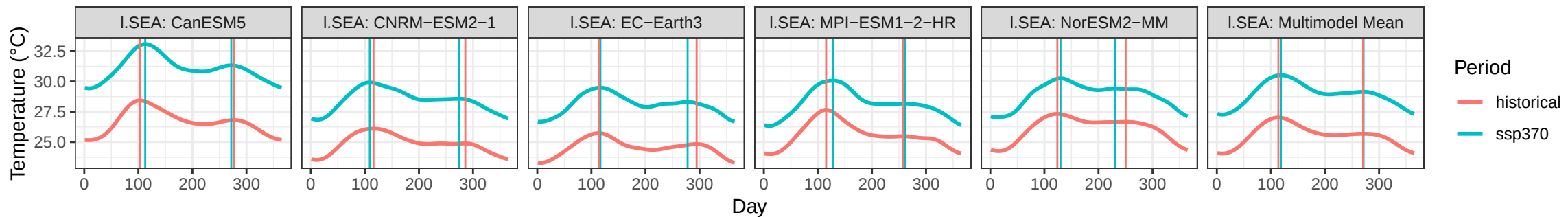
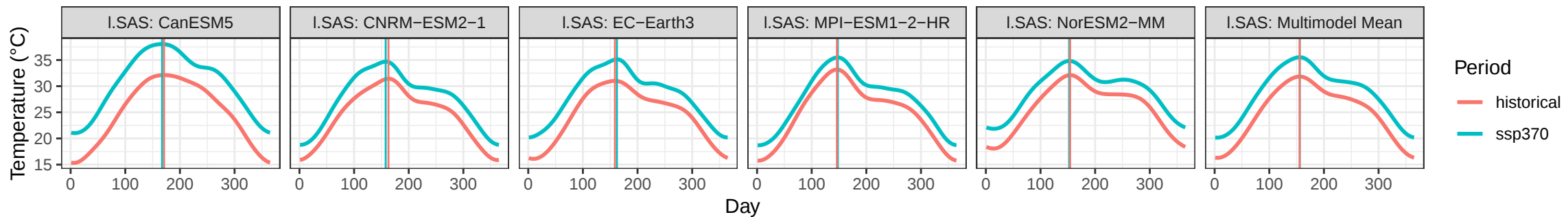
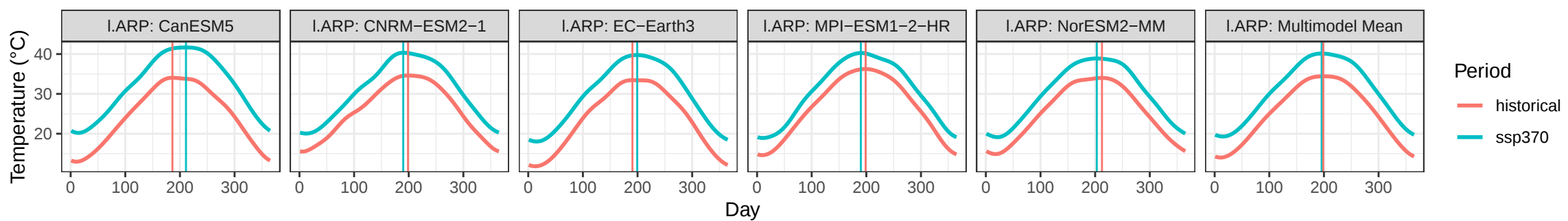


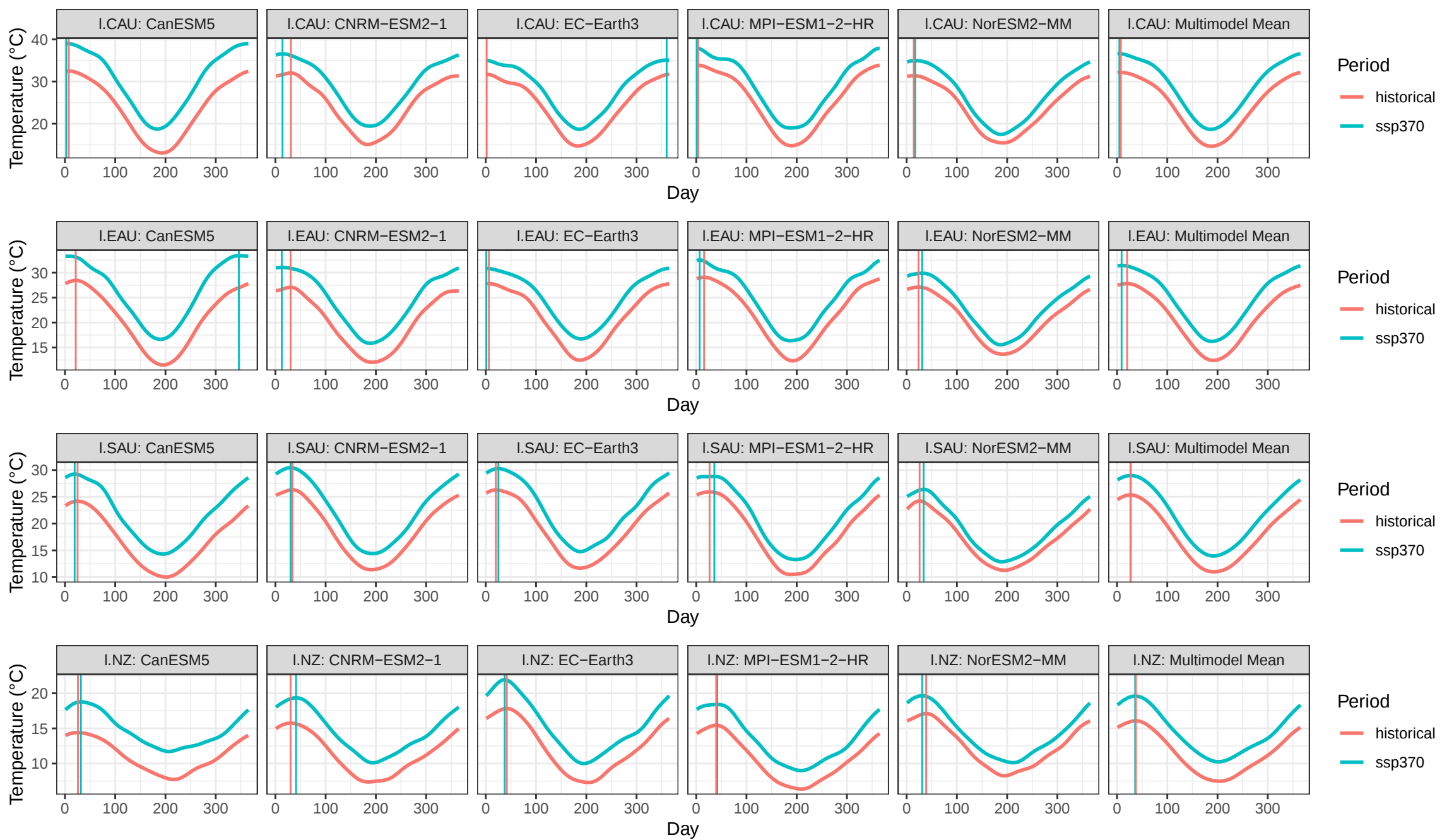


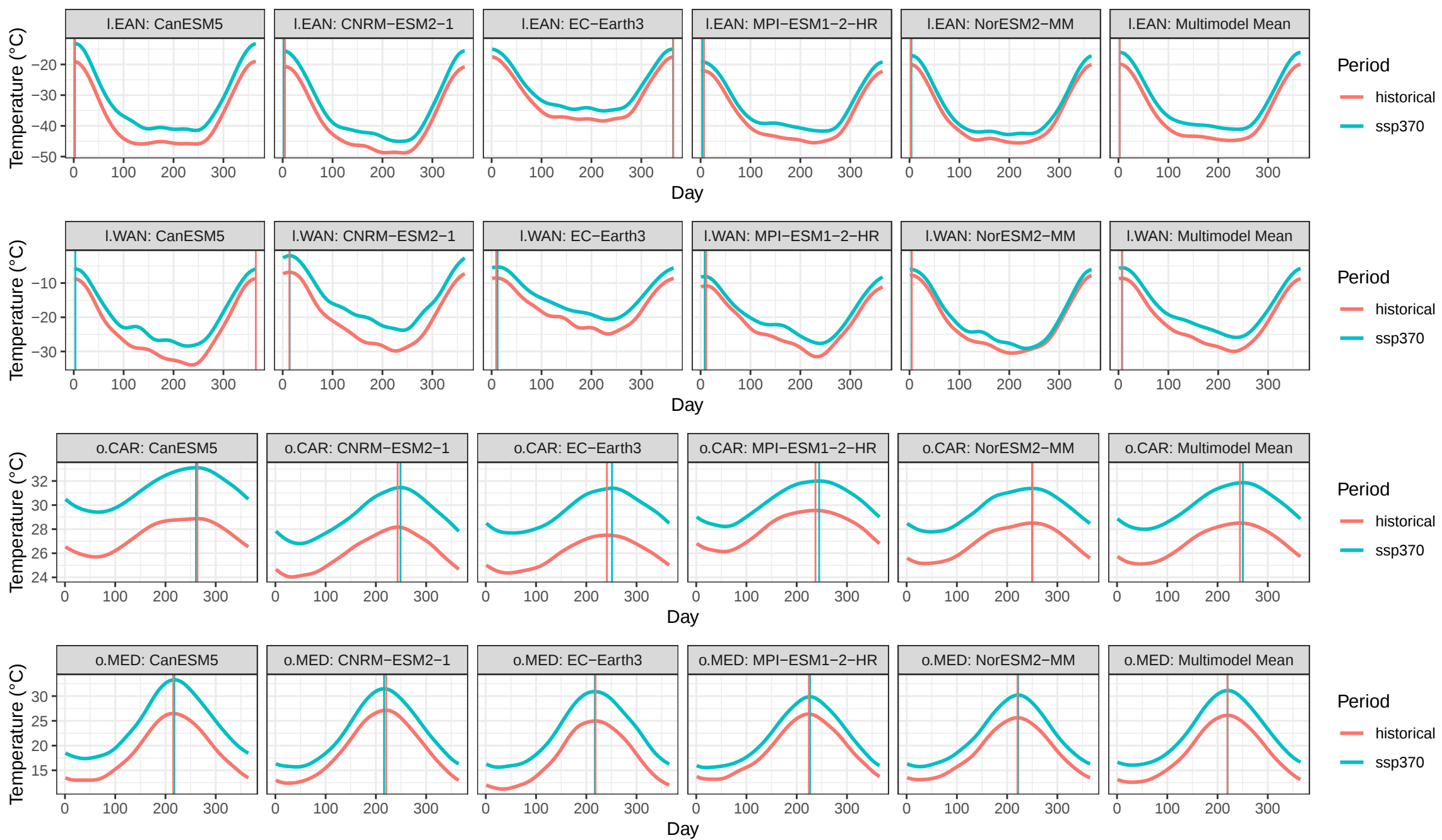


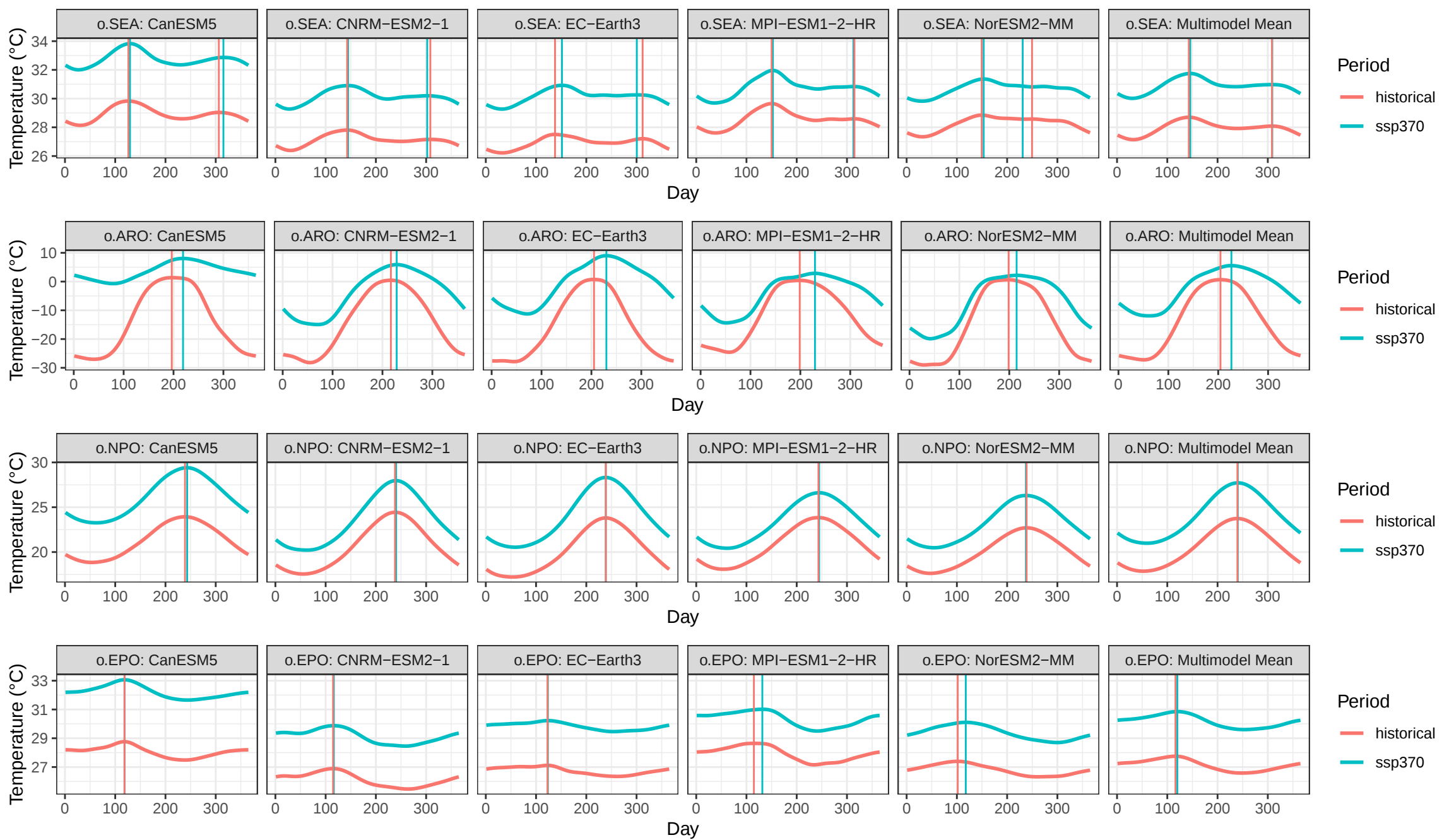


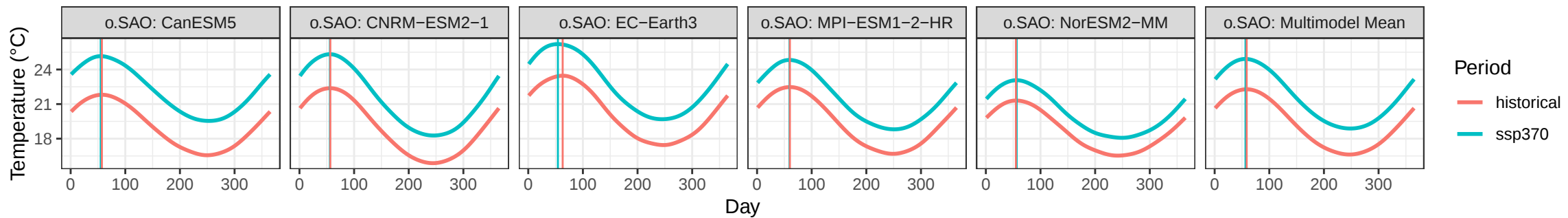
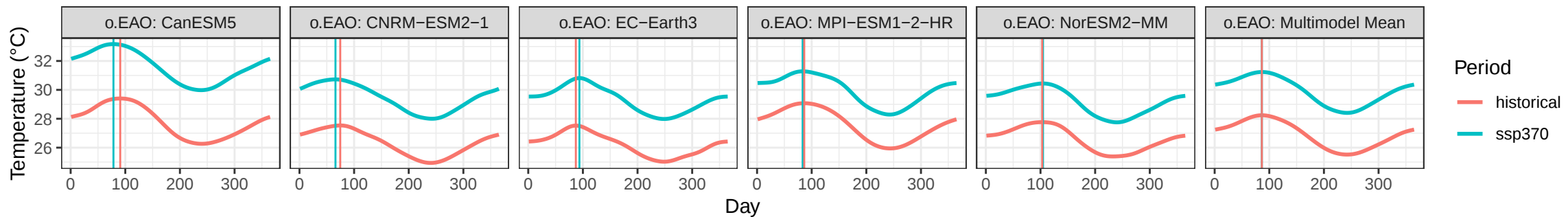
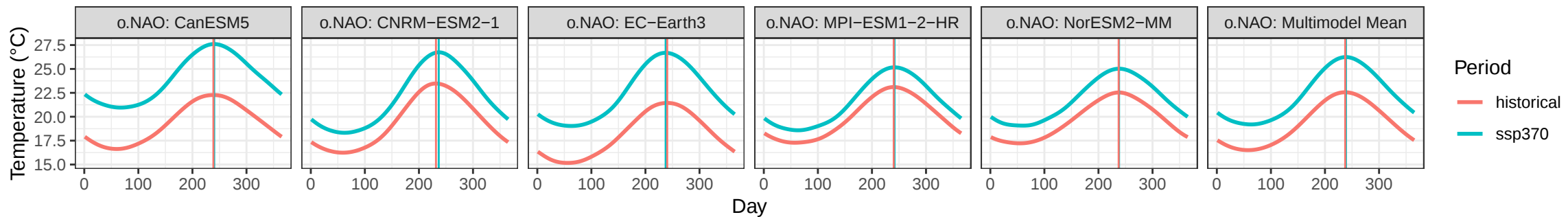
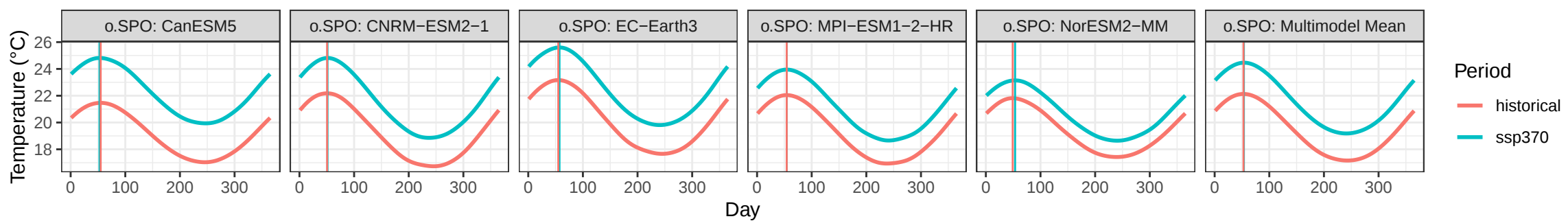


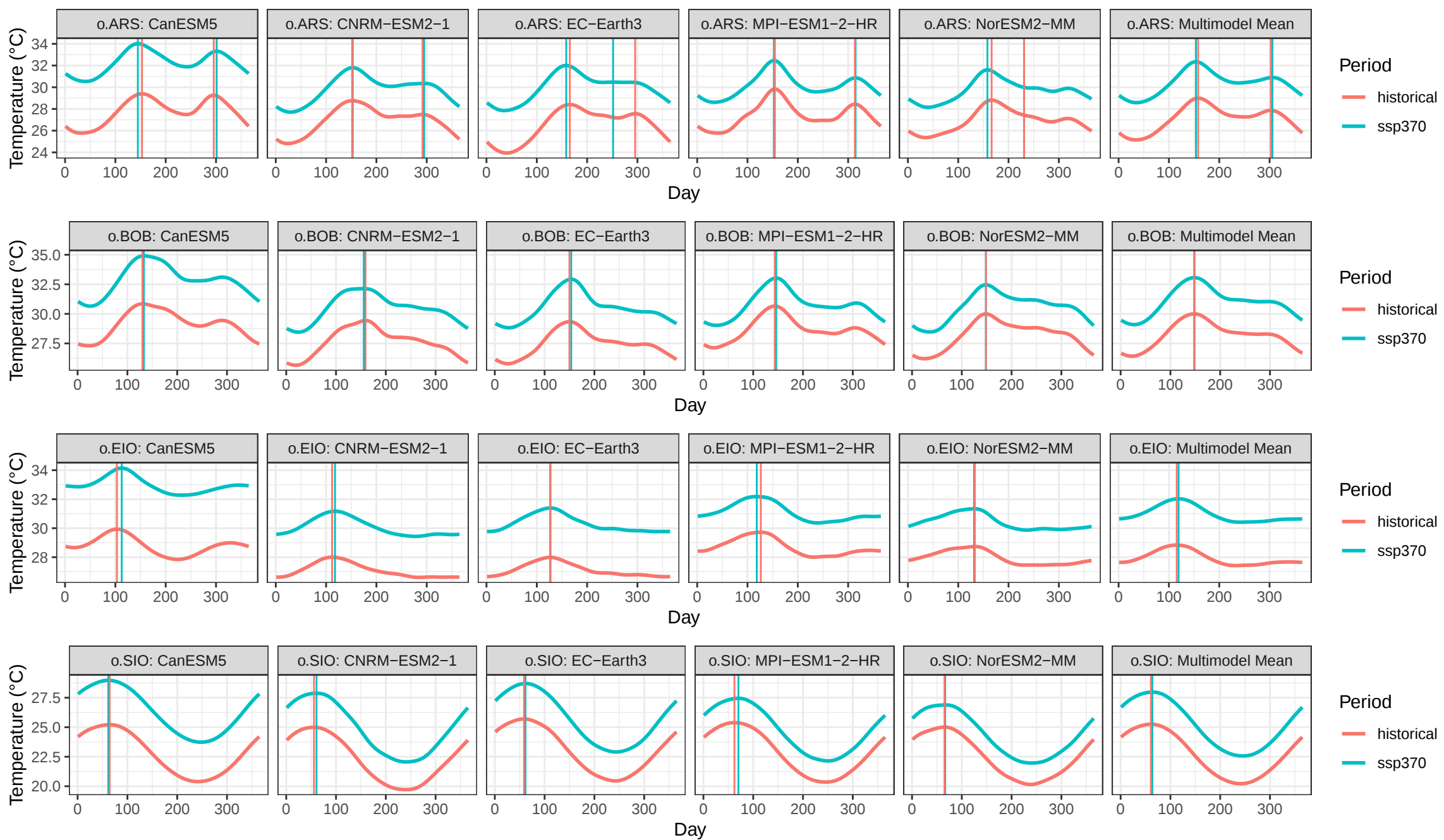












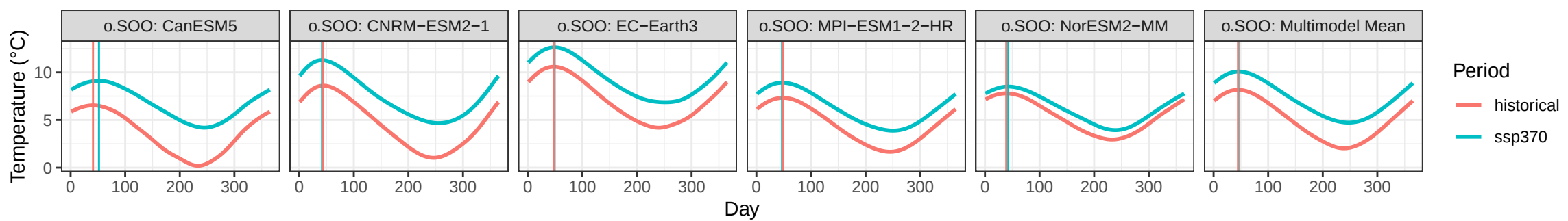
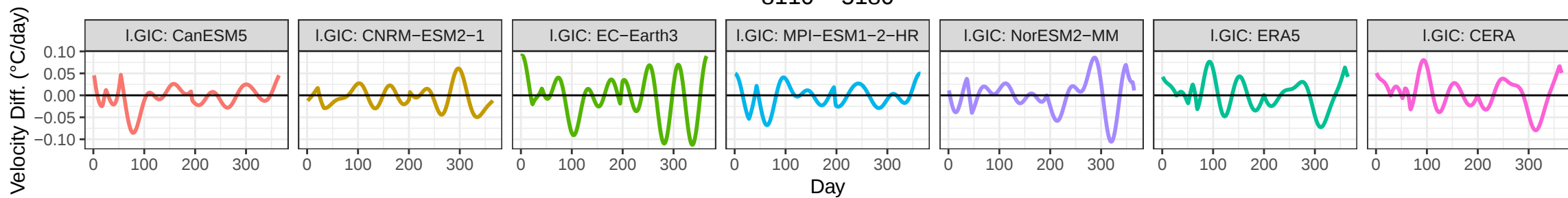
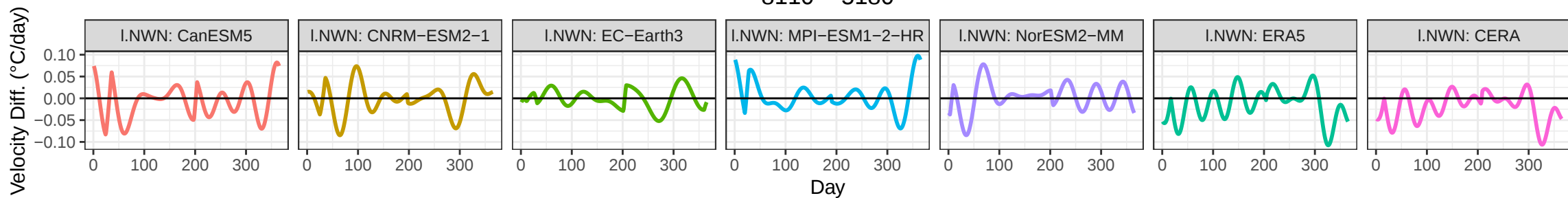


Figure S05: The distances between the first derivatives of the smoothed annual cycle curves in the two historical periods 1981-2010 and 1951-1980. Plots for five selected CMIP6 ESMs and two reanalyses are shown in different columns, plots for different geographical regions are depicted in different rows of the figure. The results shown in this figure are summarized in Fig. 7 in the manuscript.

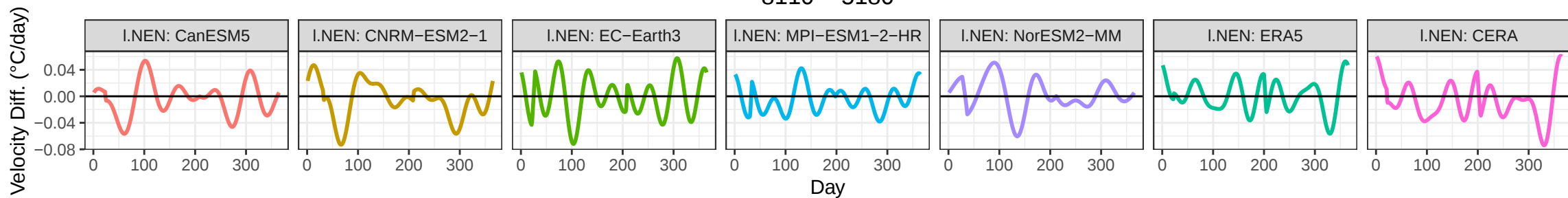
8110 – 5180



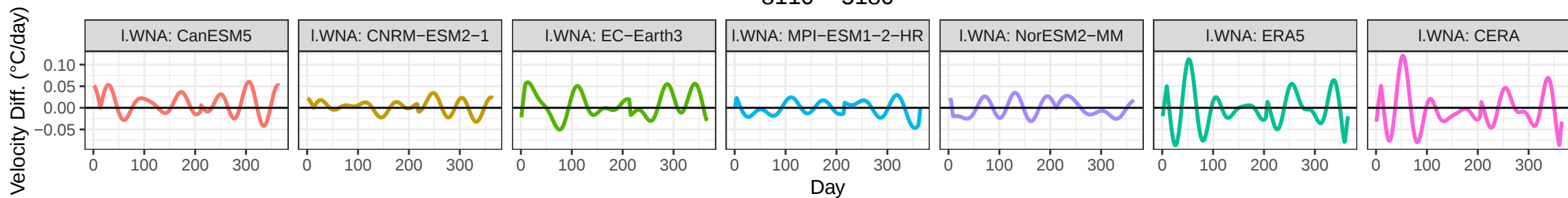
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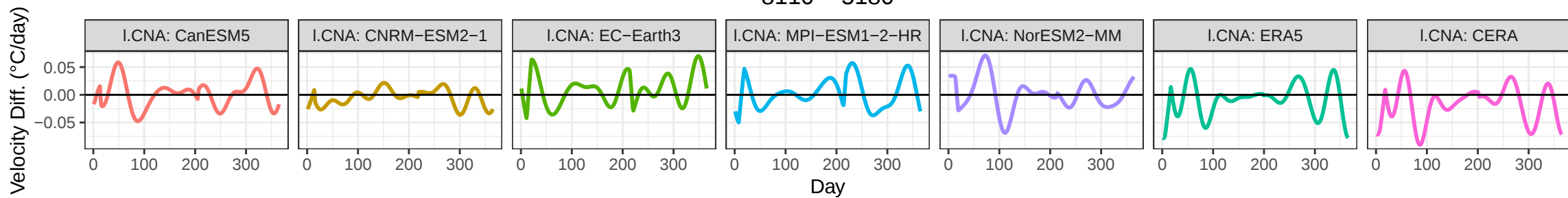
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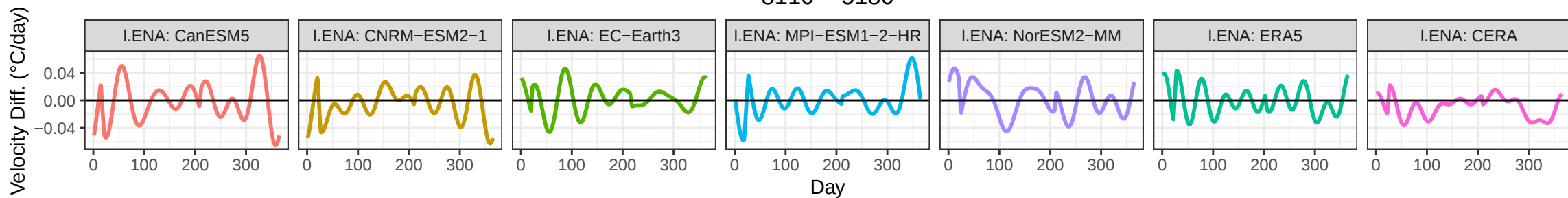
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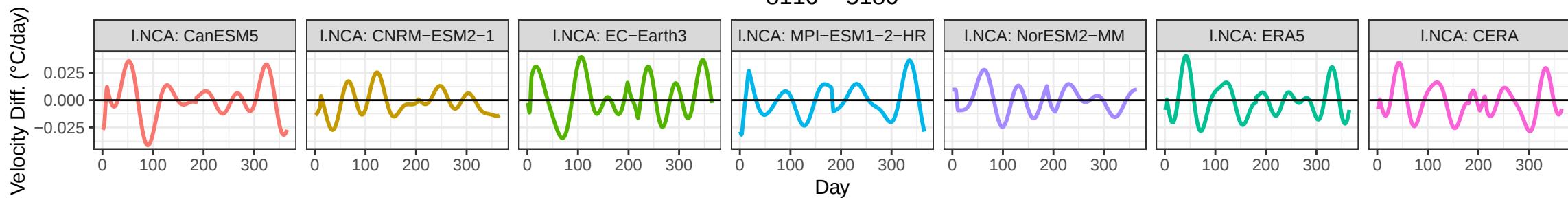
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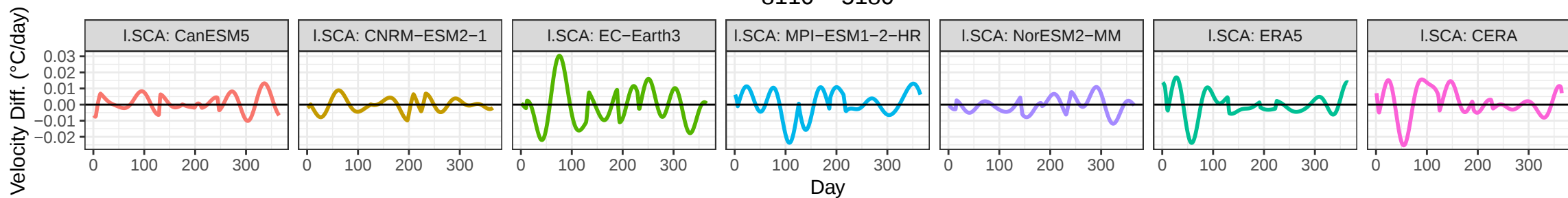
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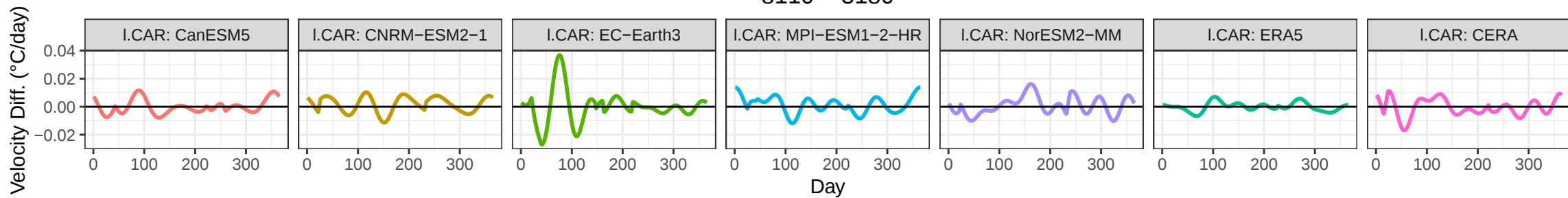
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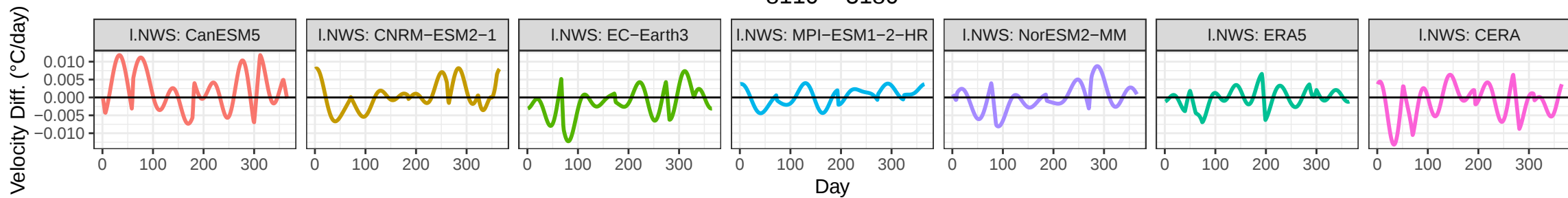
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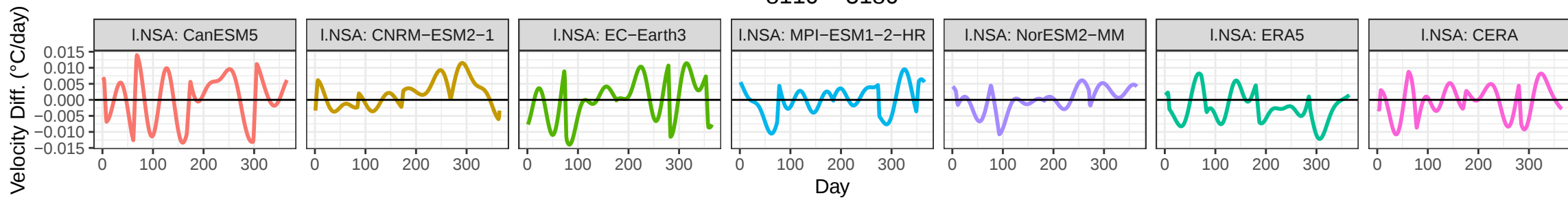
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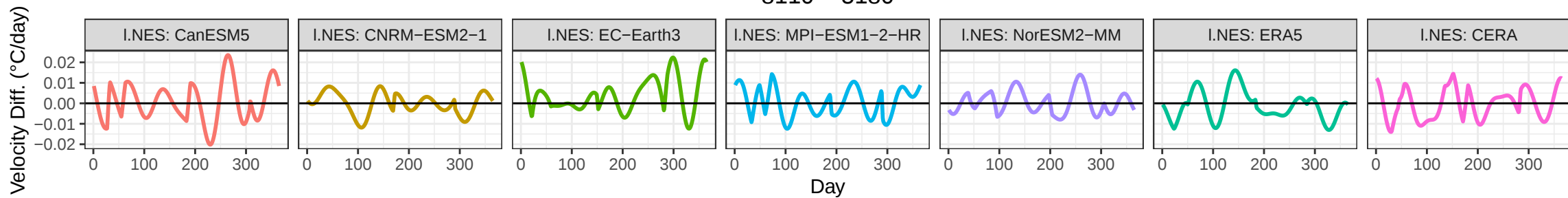
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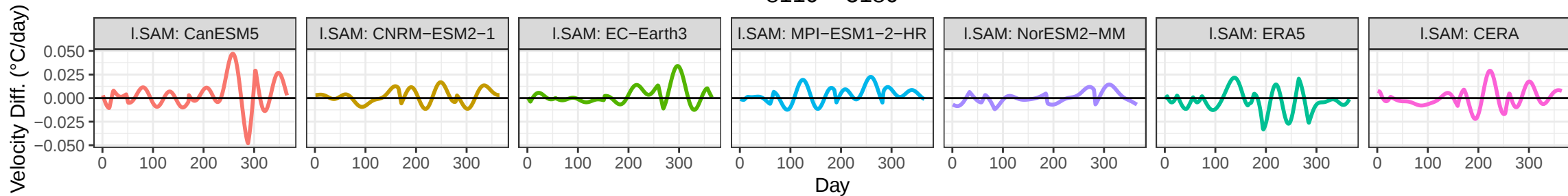
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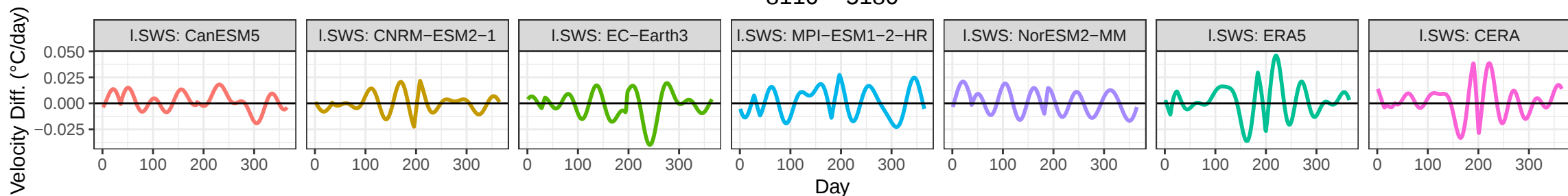
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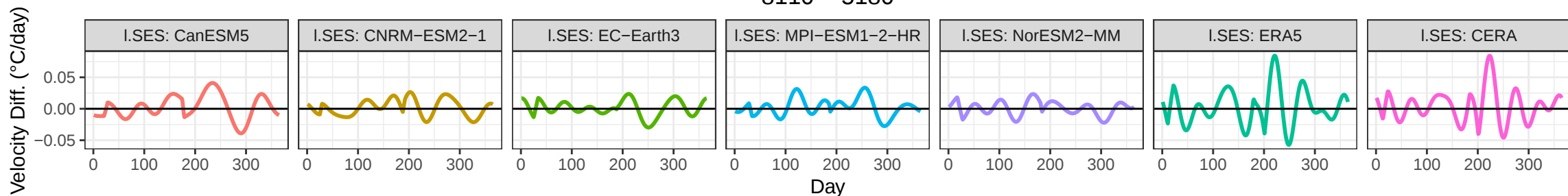
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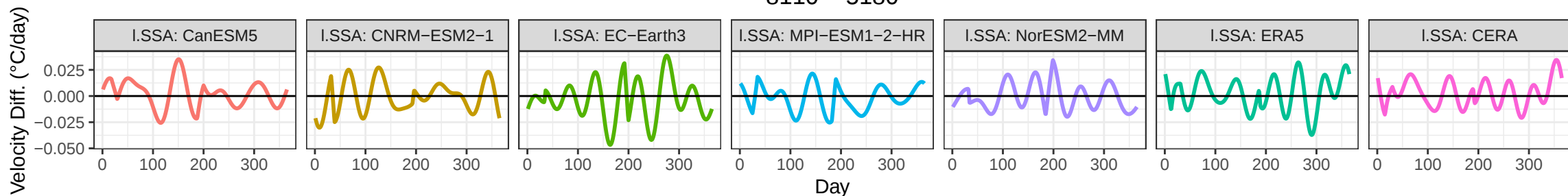
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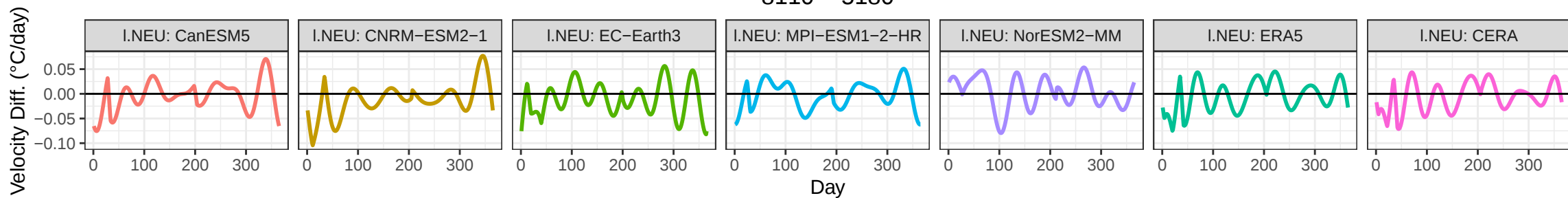
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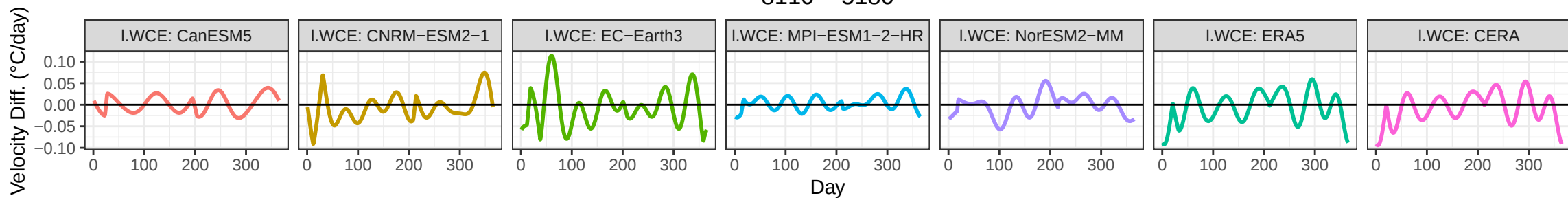
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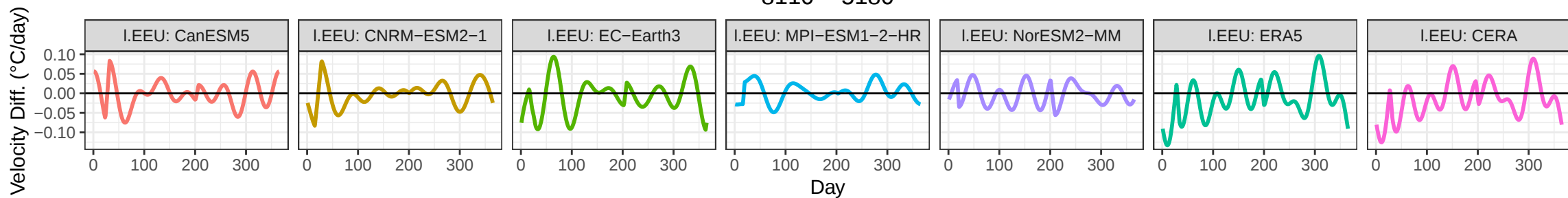
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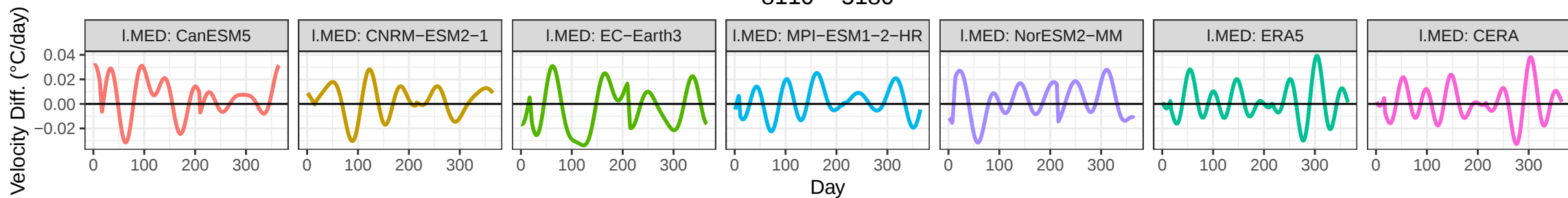
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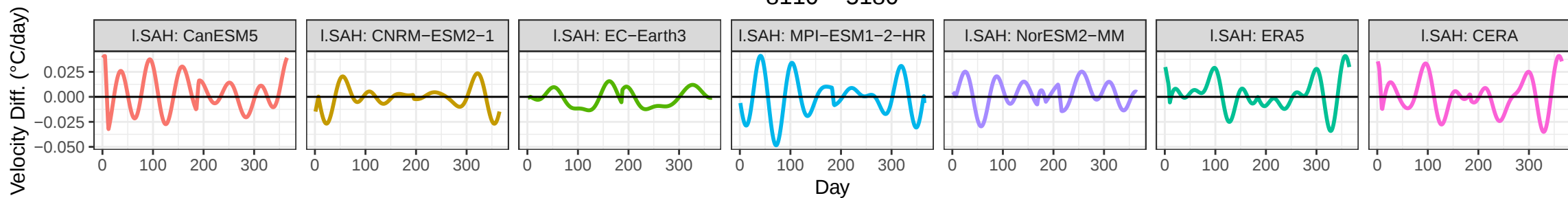
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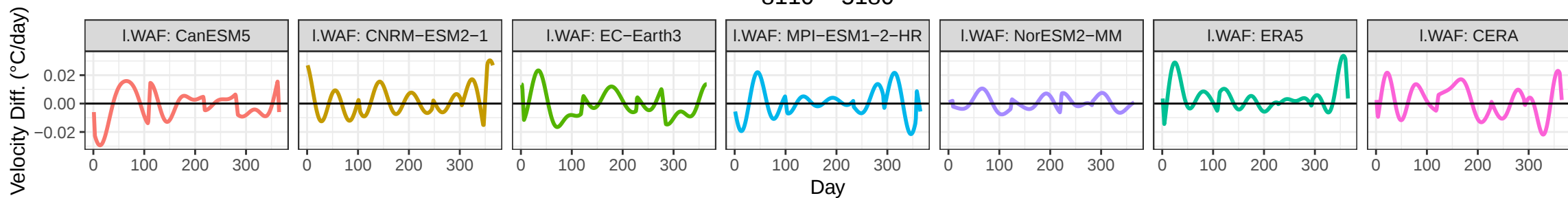
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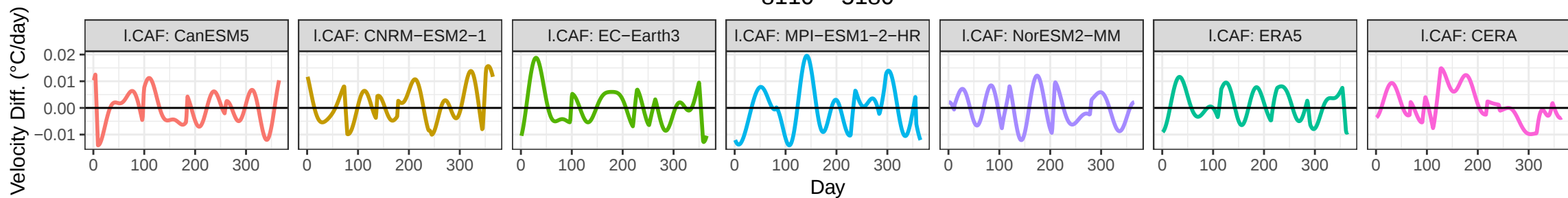
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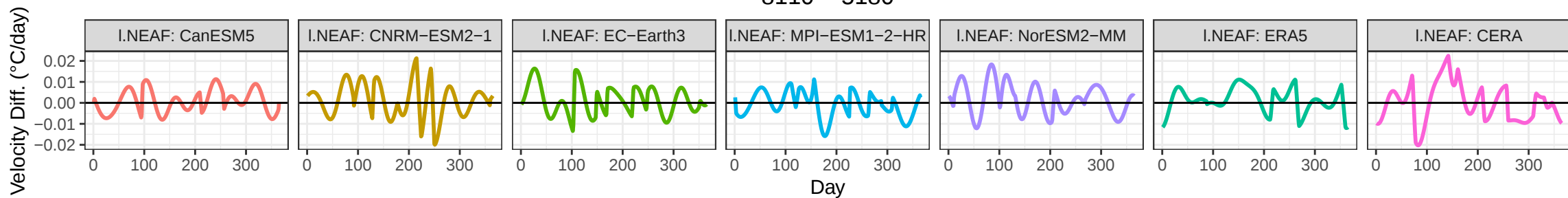
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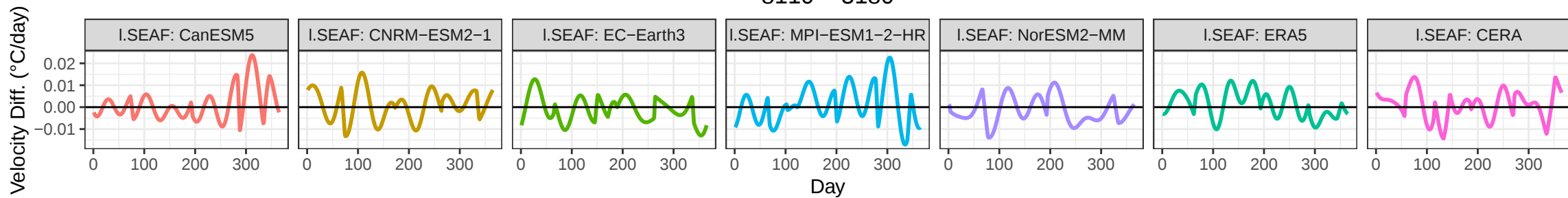
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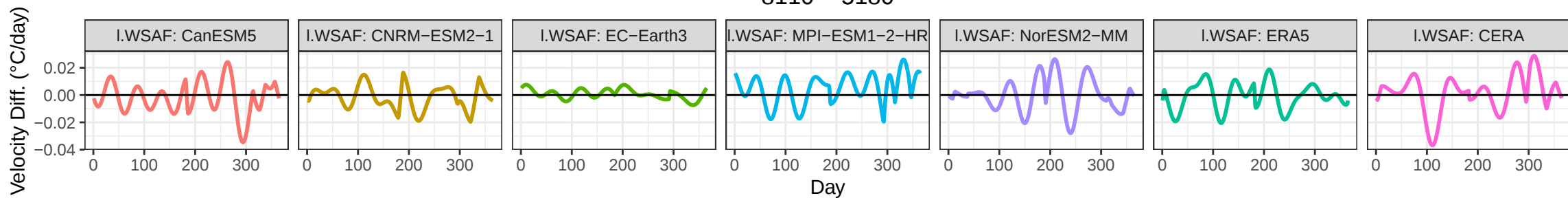
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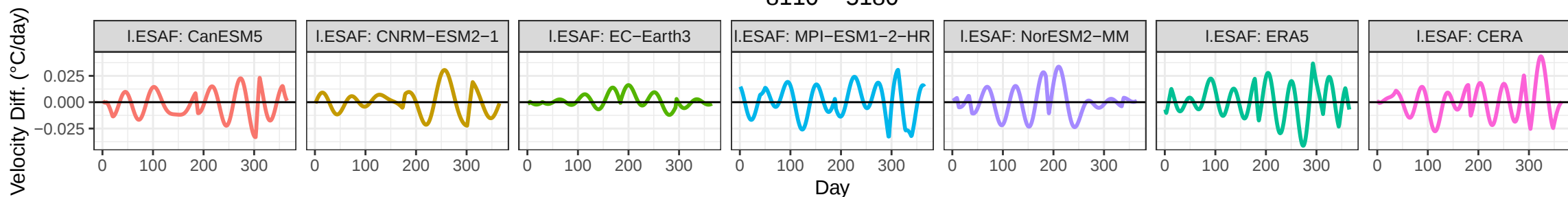
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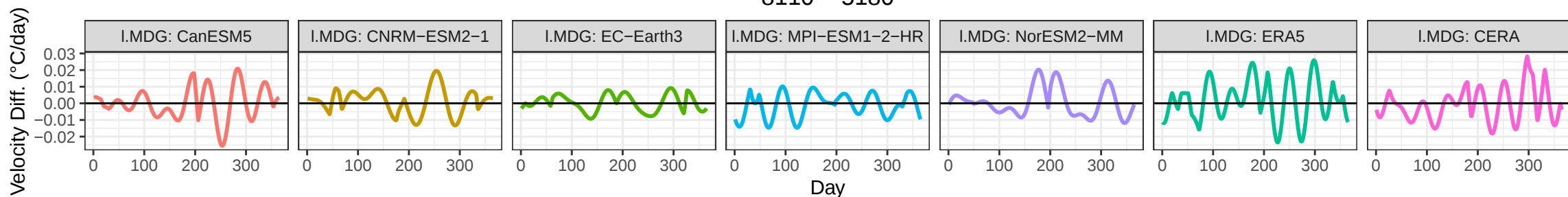
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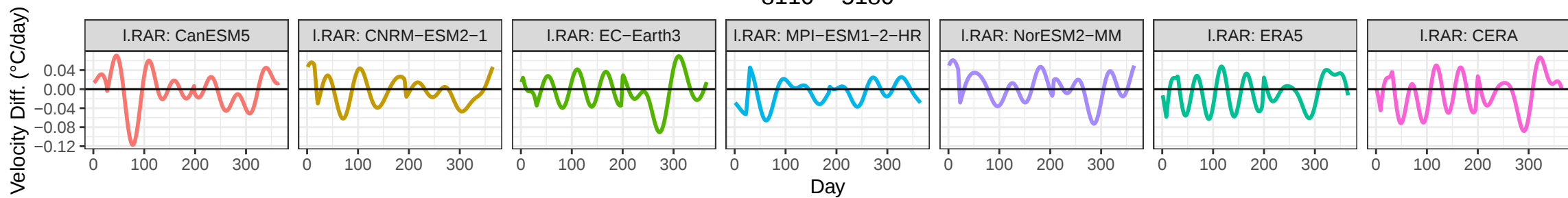
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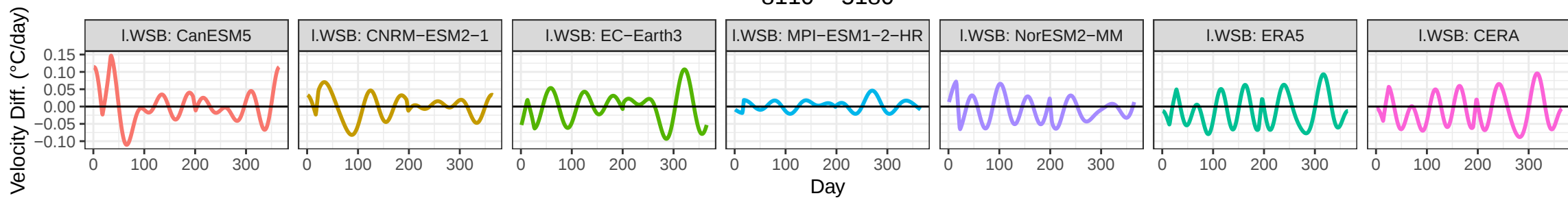
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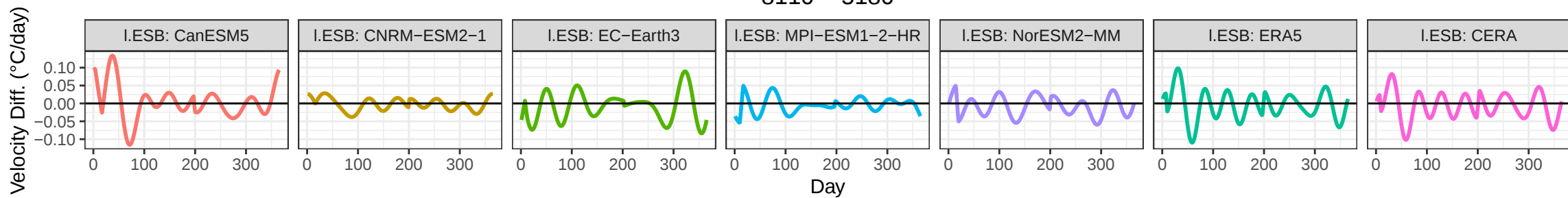
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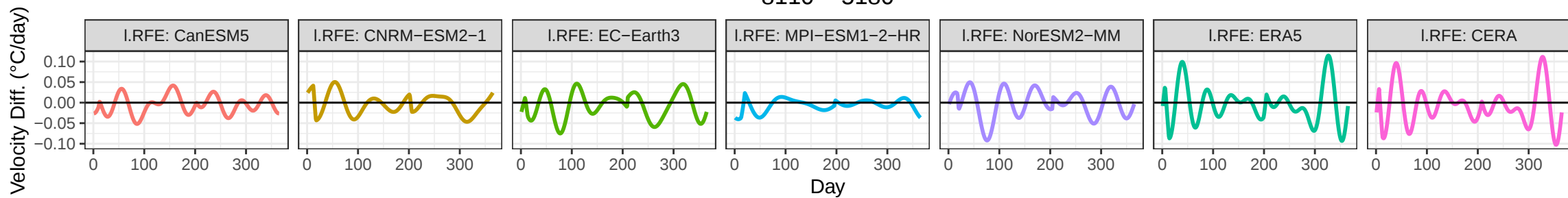
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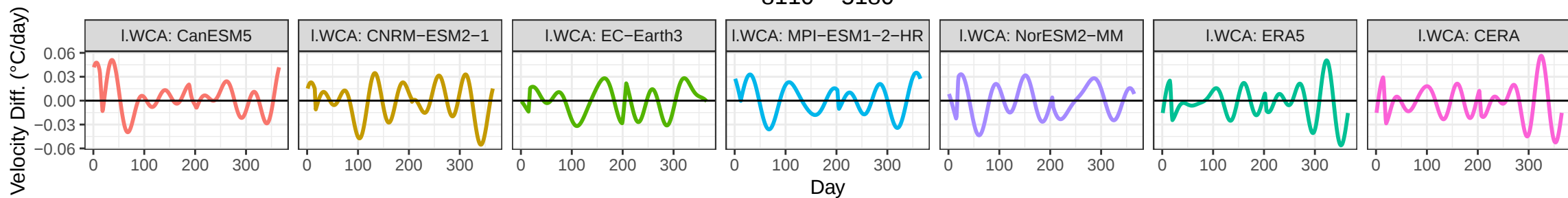
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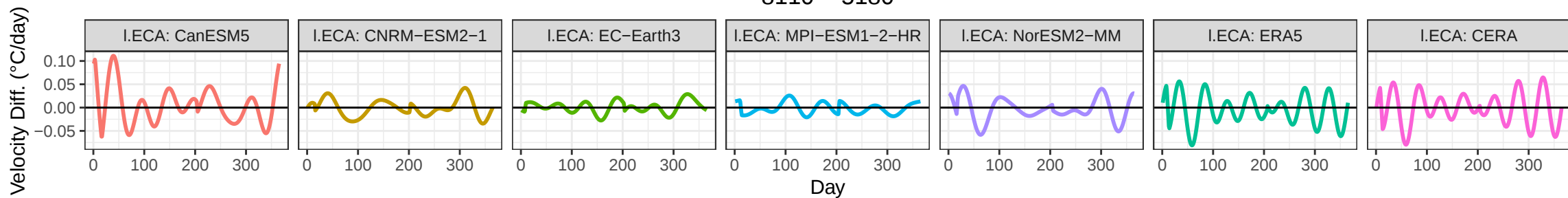
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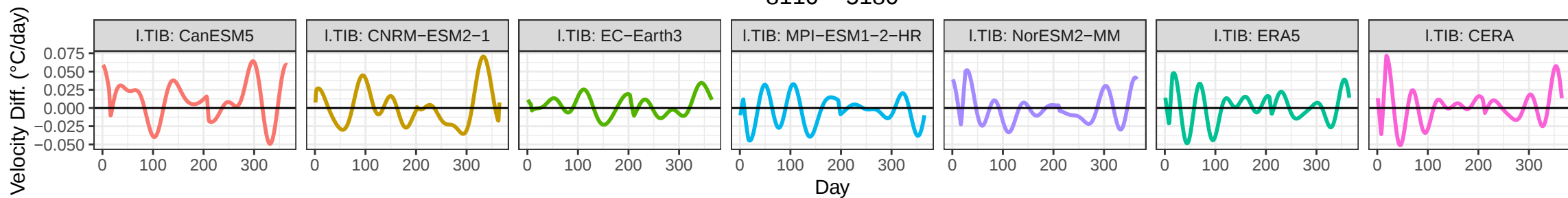
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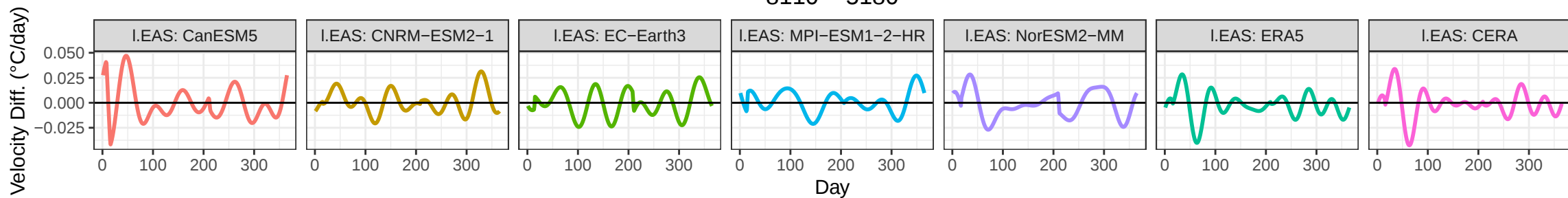
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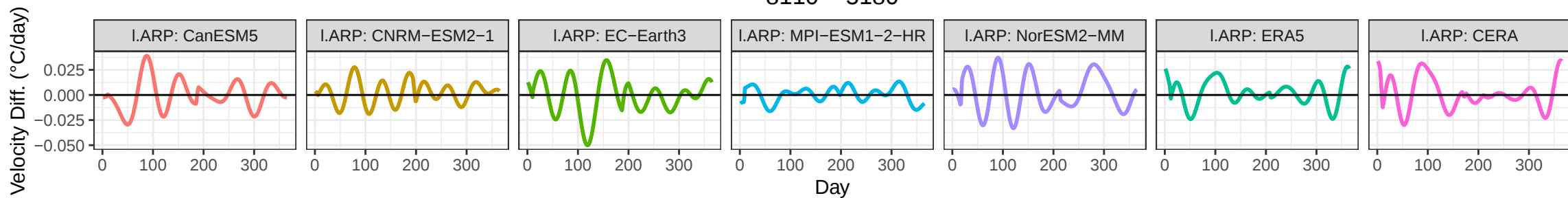
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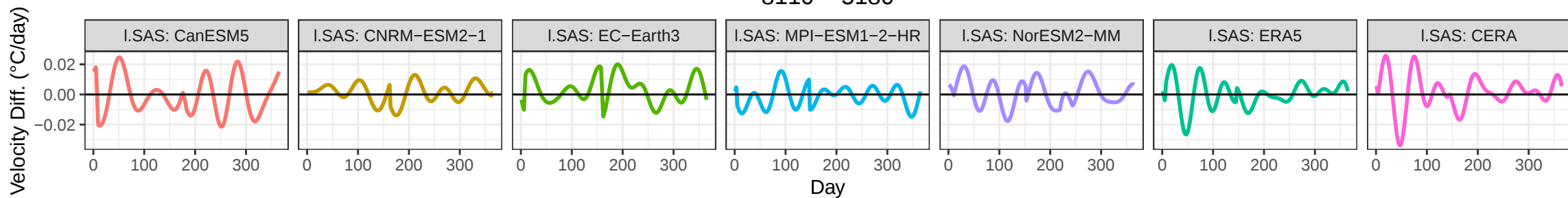
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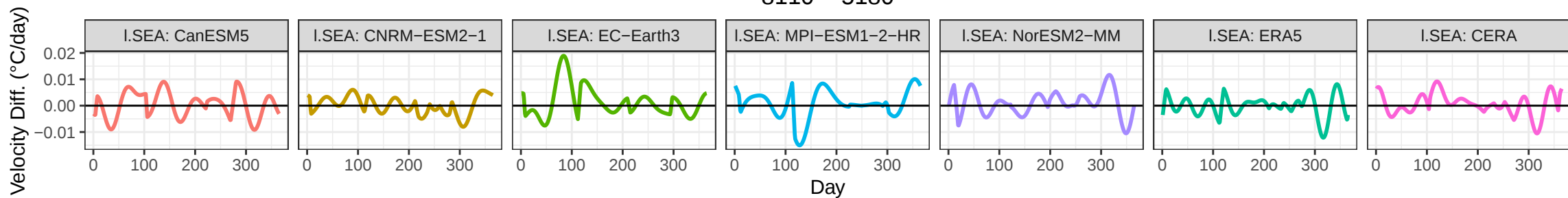
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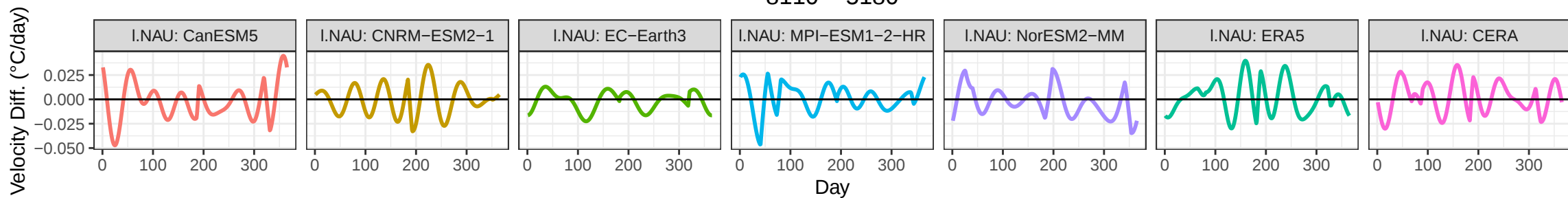
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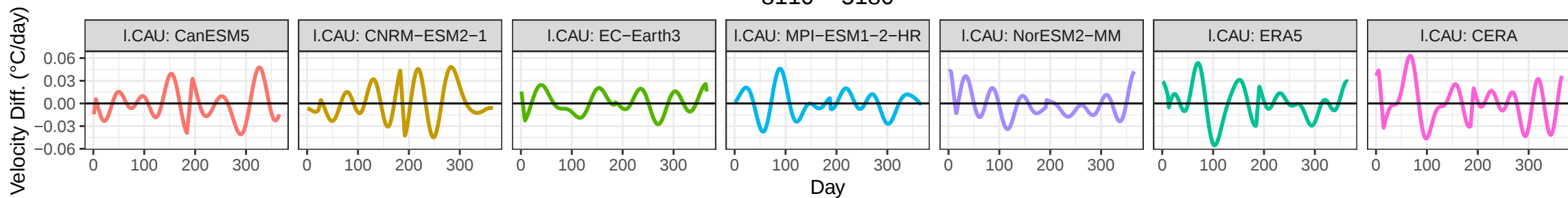
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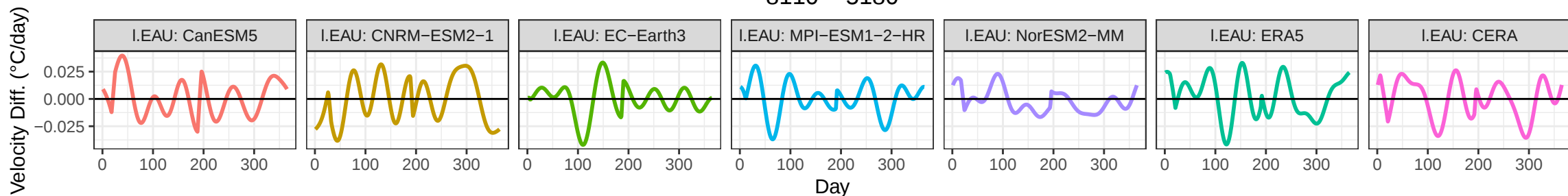
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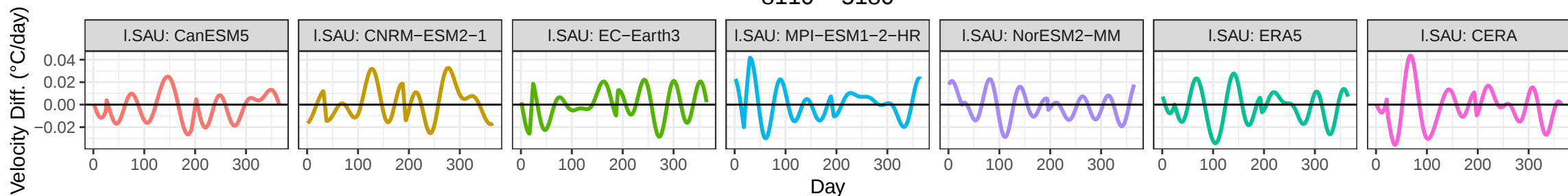
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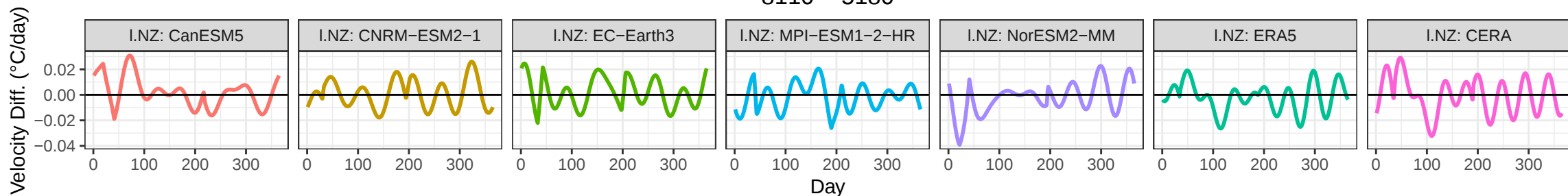
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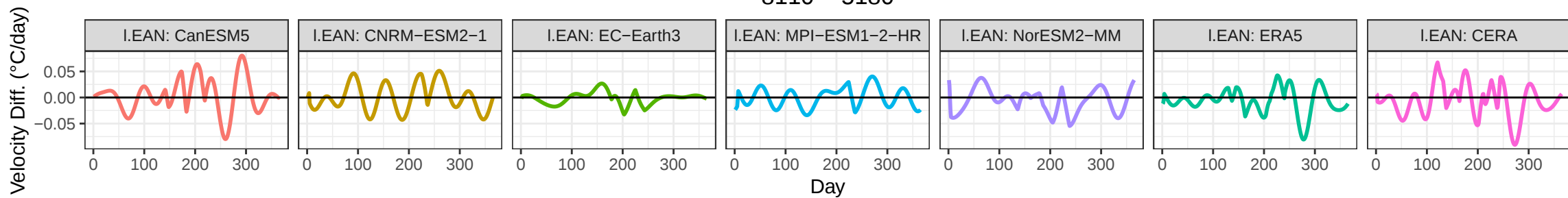
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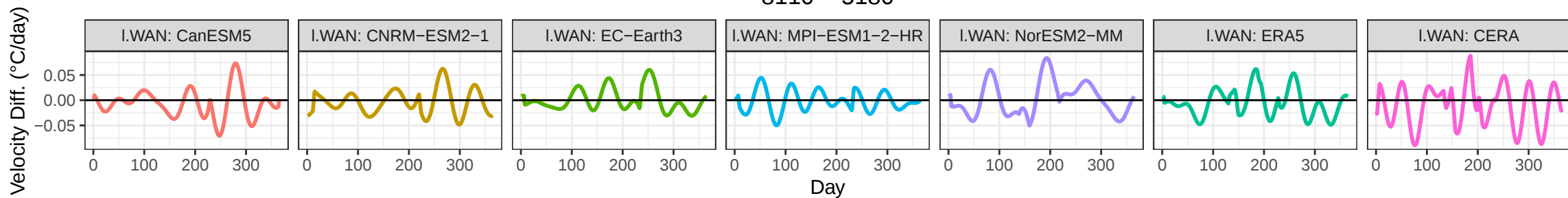
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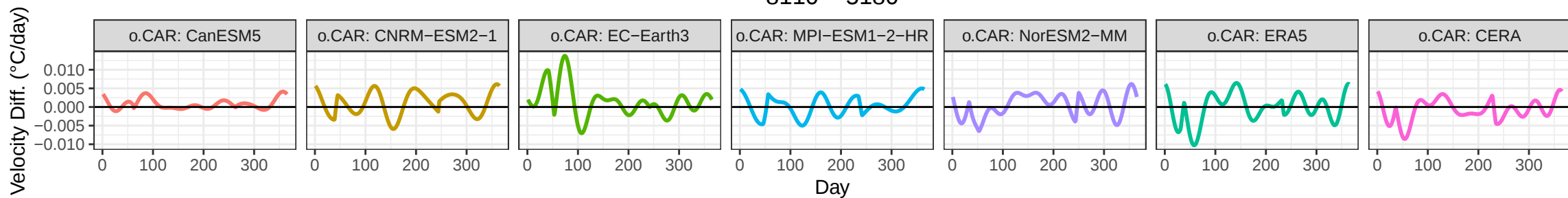
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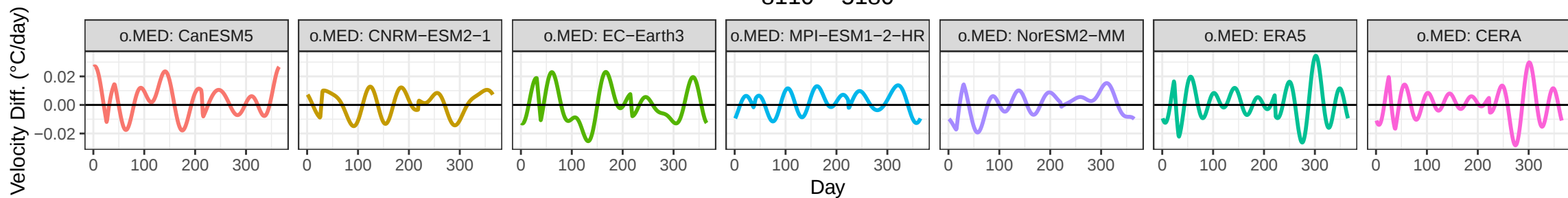
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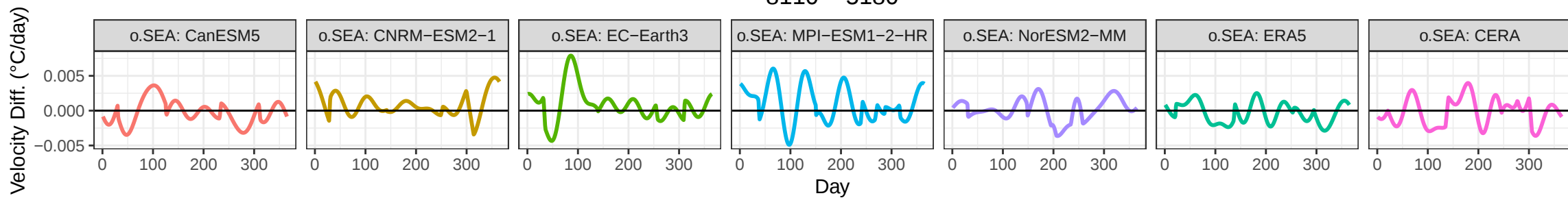
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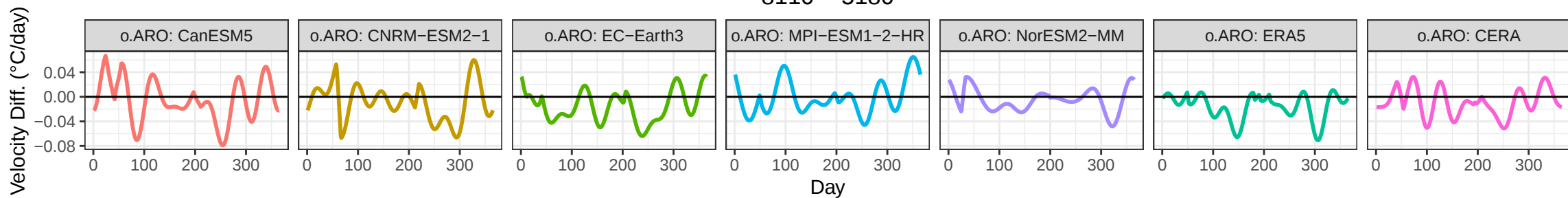
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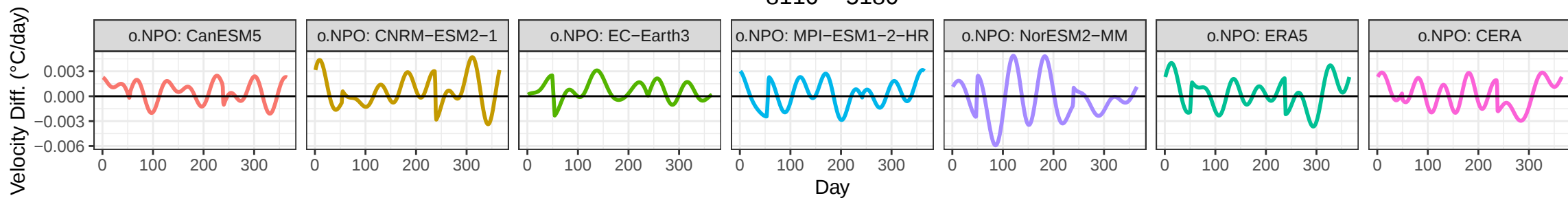
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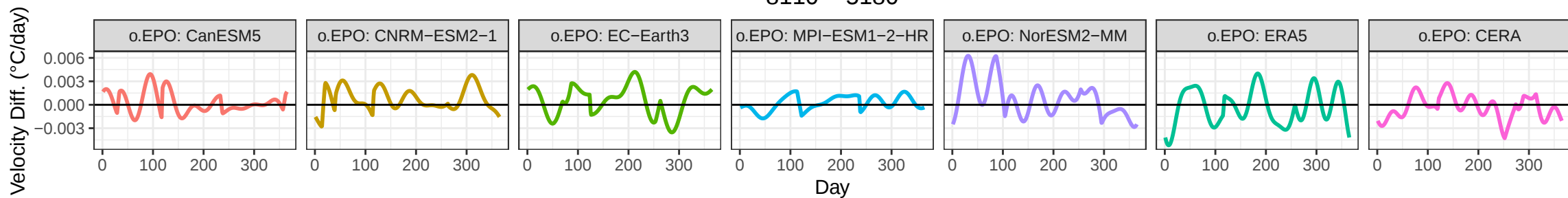
8110 – 5180



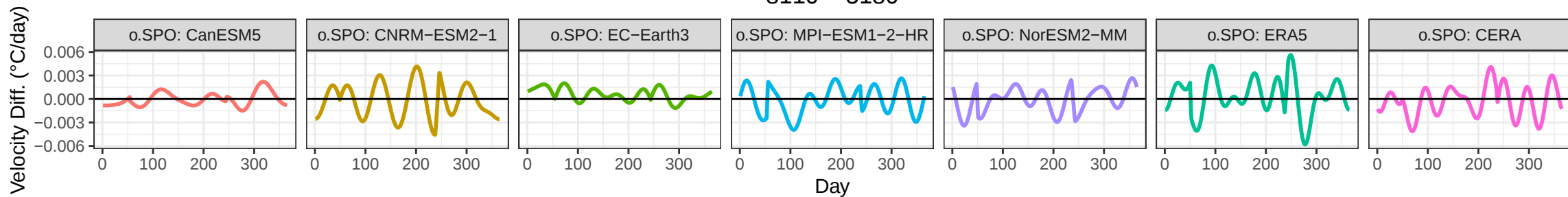
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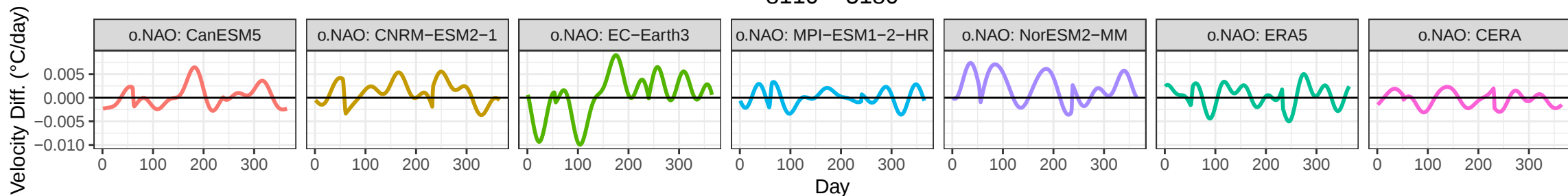
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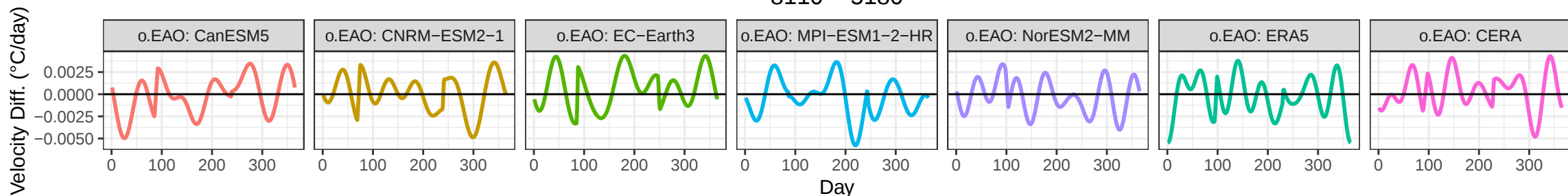
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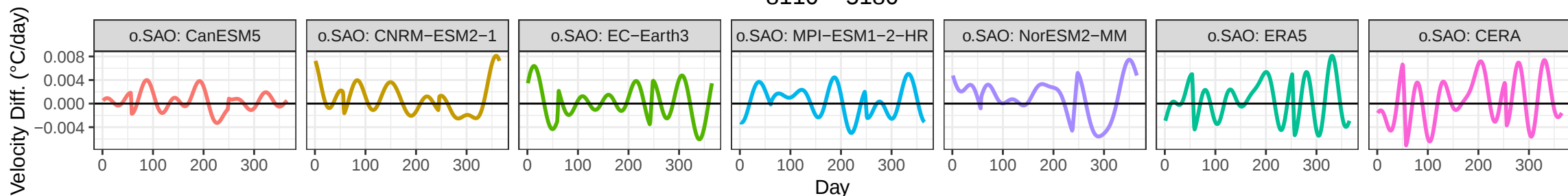
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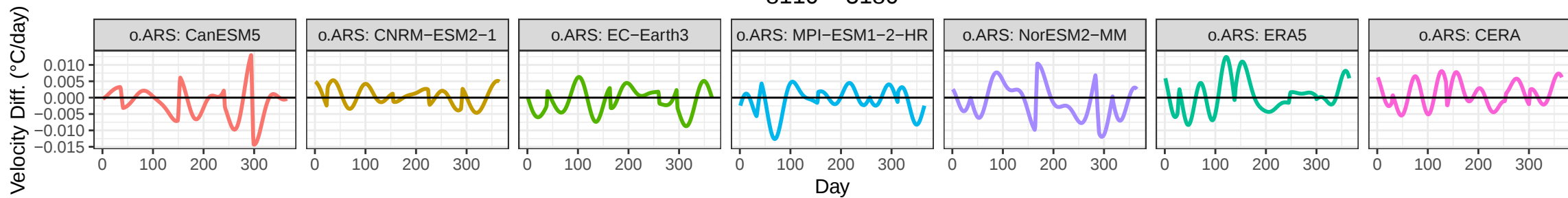
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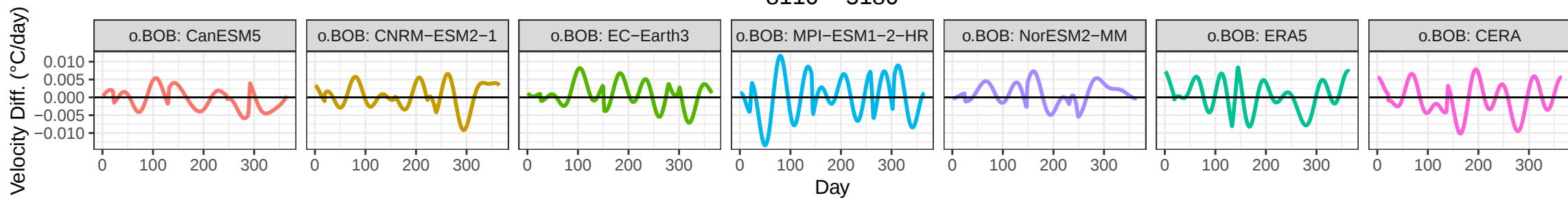
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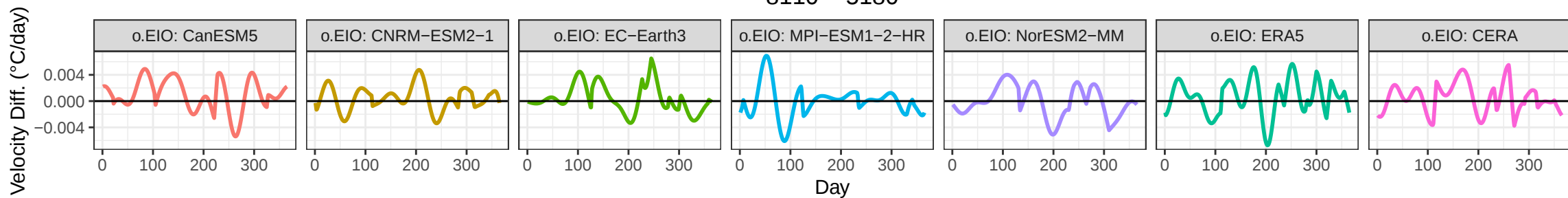
8110 – 5180



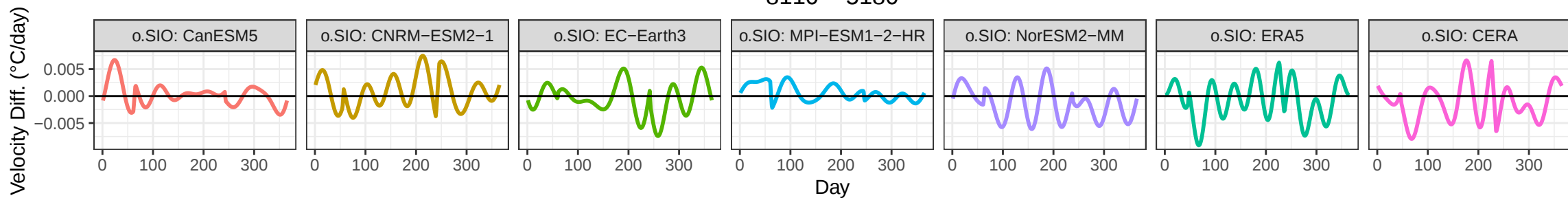
8110 – 5180



8110 – 5180



8110 – 5180



8110 – 5180

Velocity Diff. (°C/day)

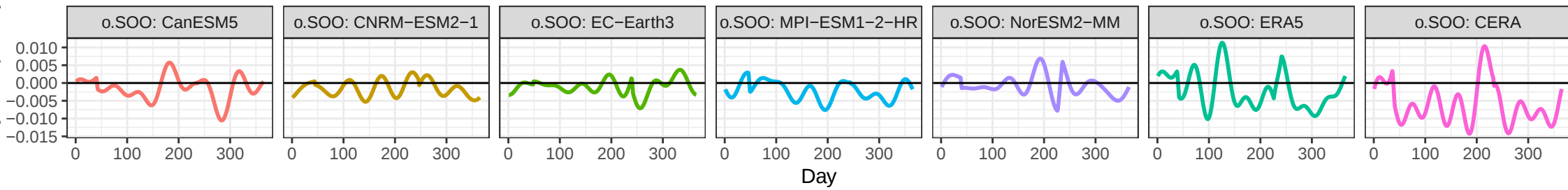
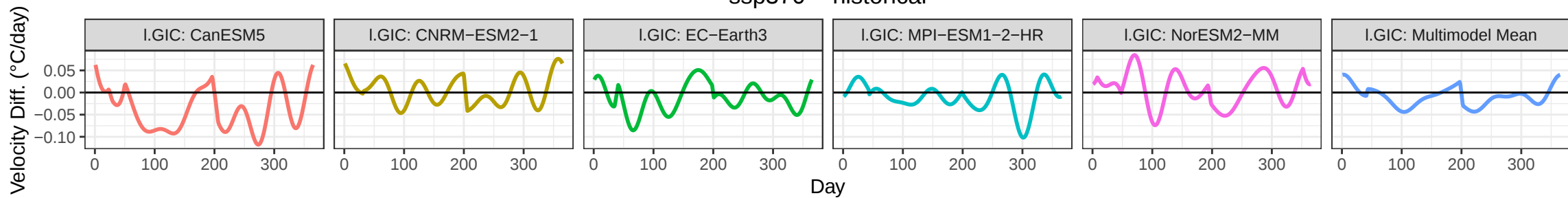
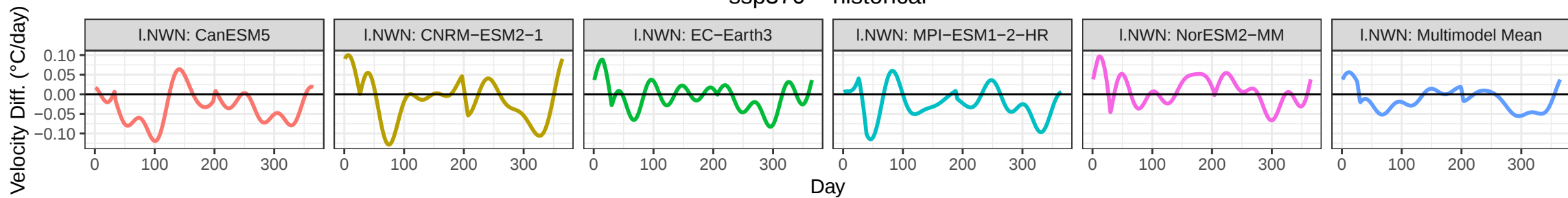


Figure S06: The distances between the first derivatives of the smoothed annual cycle curves in the future and reference periods 2071-2100 and 1961-1990. Plots for five selected CMIP6 ESMs and their multi-model mean are shown in different columns, plots for different geographical regions are depicted in different rows of the figure. The results shown in this figure are summarized in Fig. 8 in the manuscript.

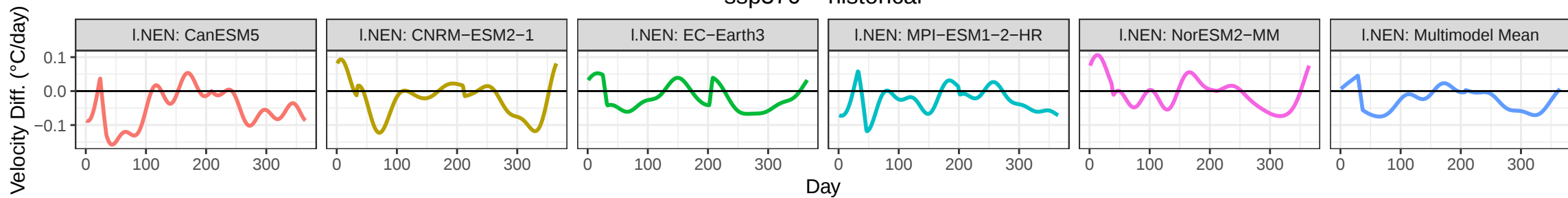
ssp370 – historical



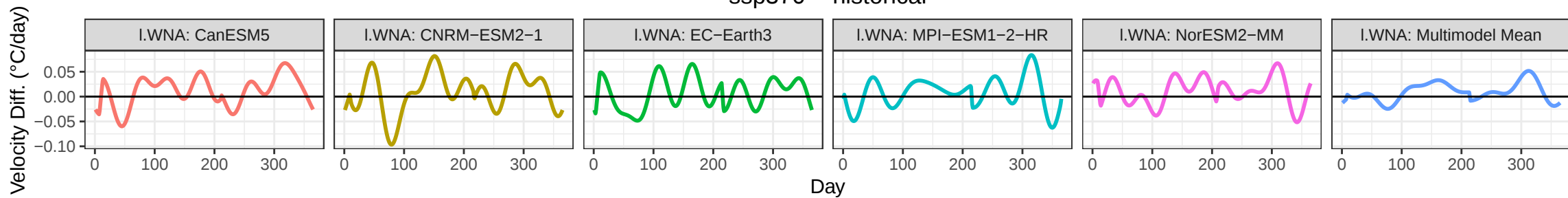
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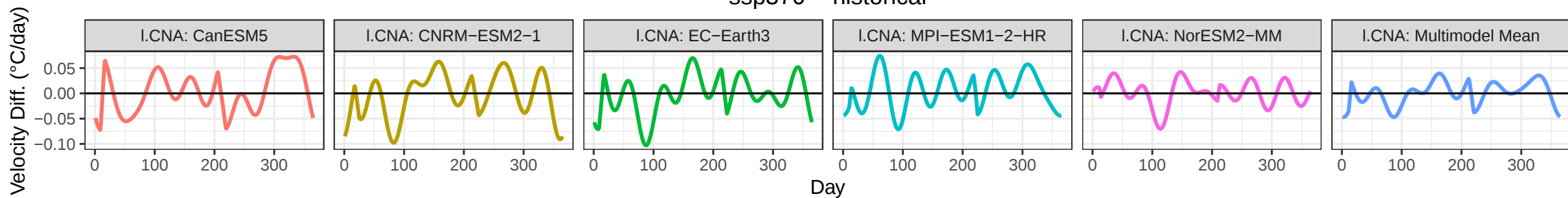
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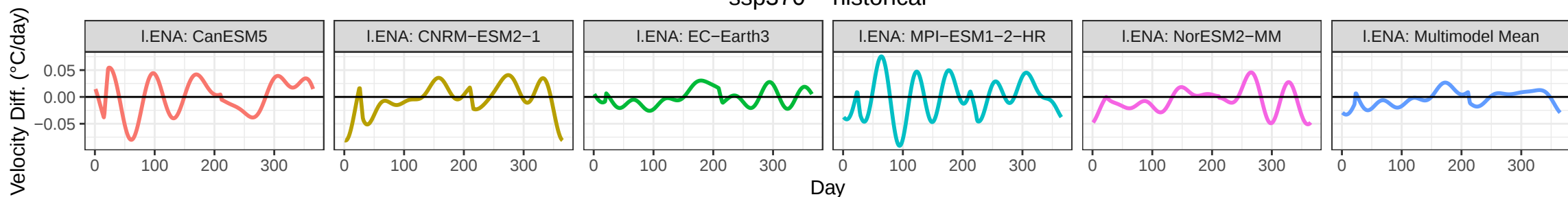
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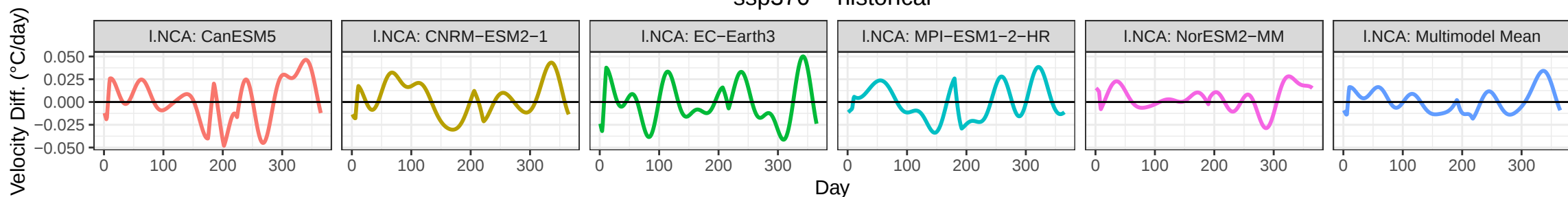
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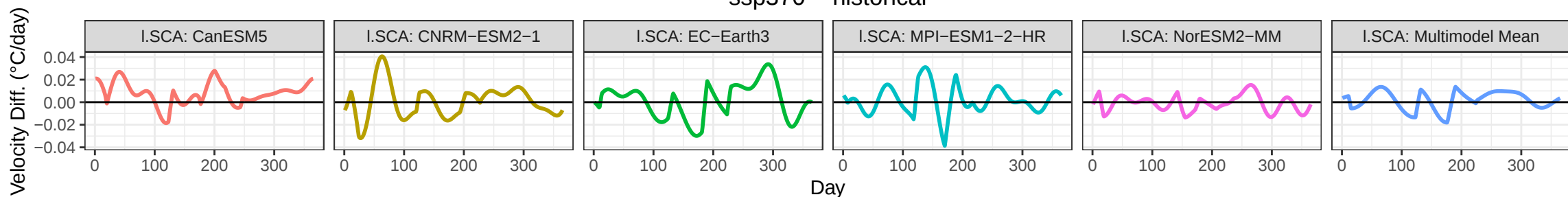
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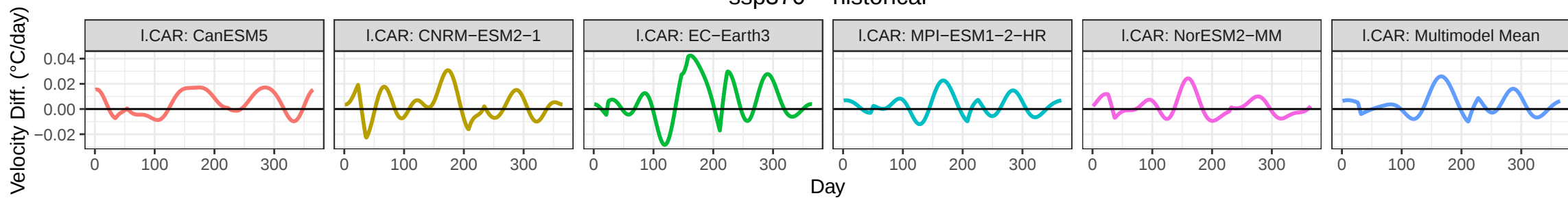
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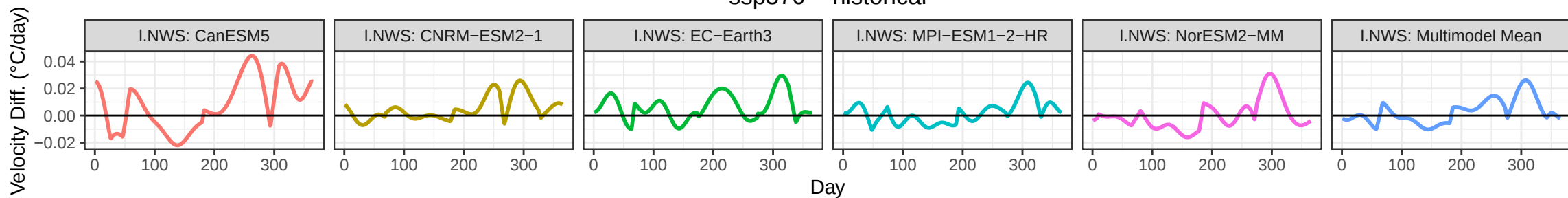
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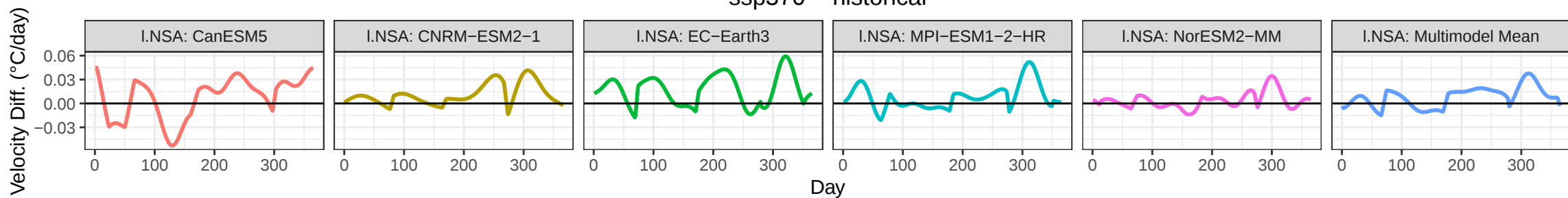
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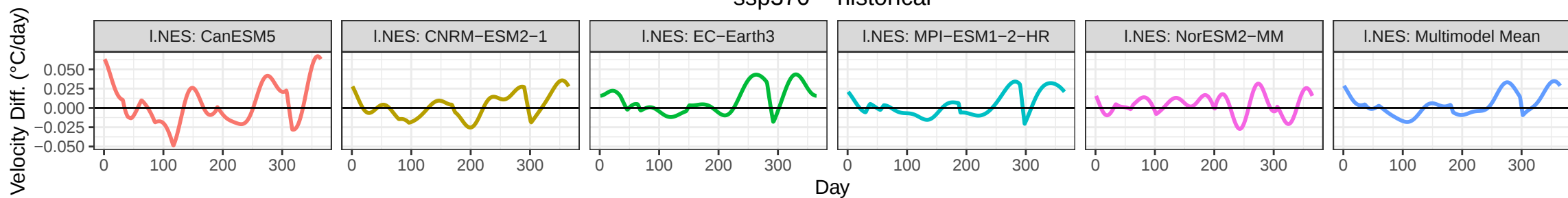
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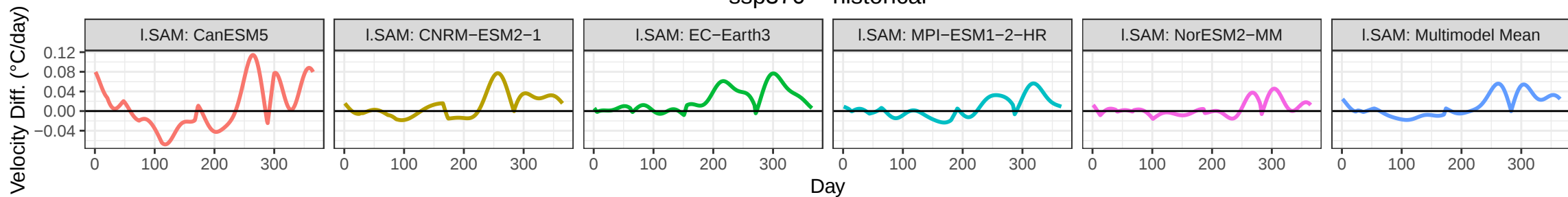
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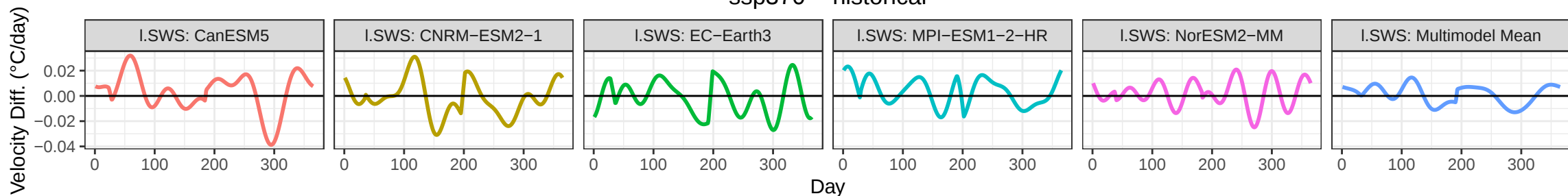
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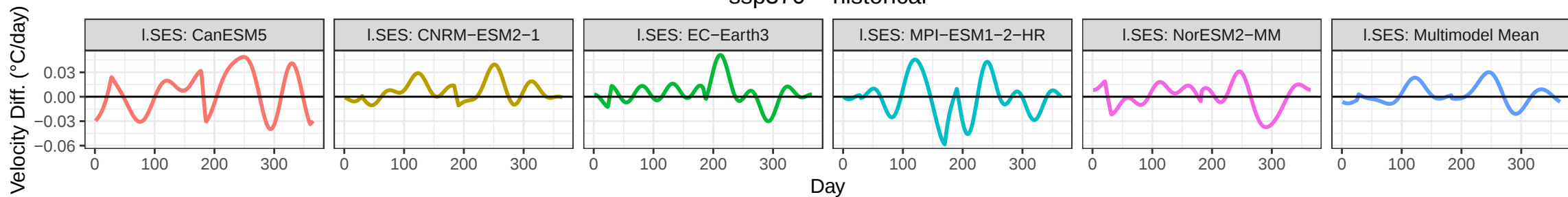
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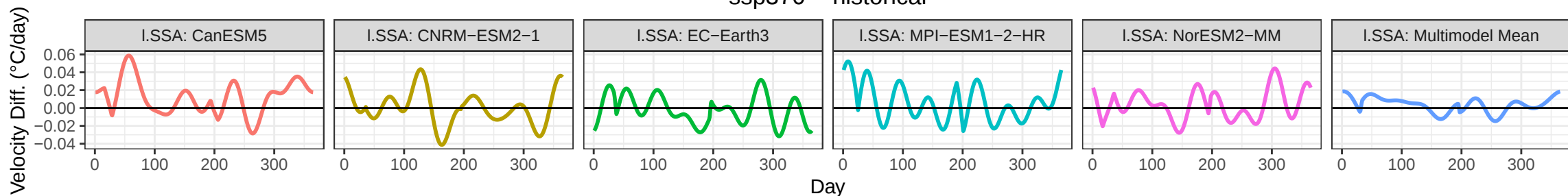
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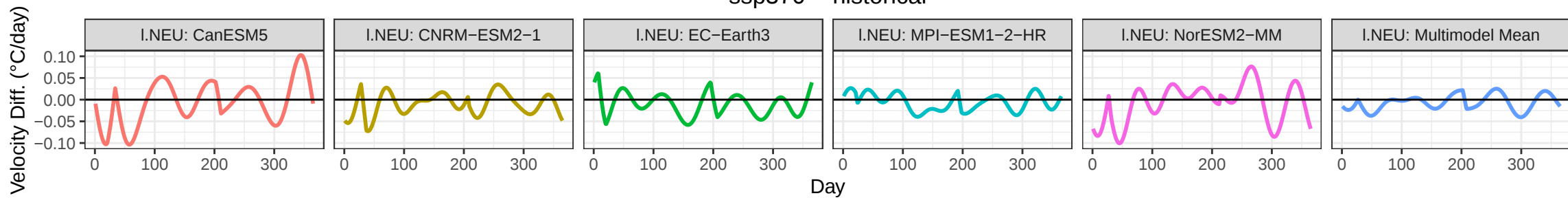
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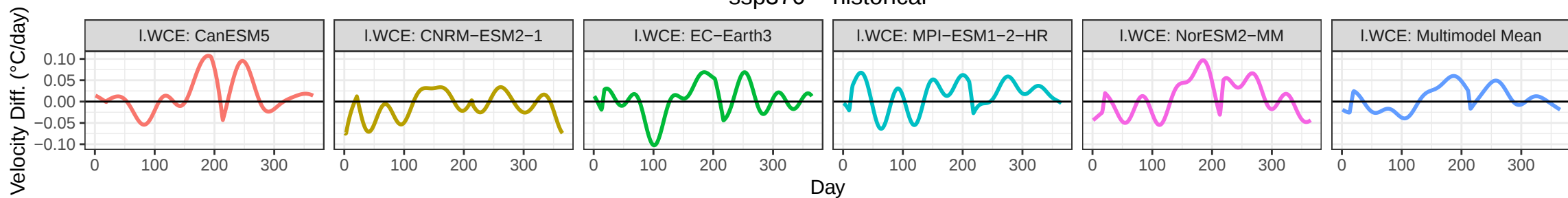
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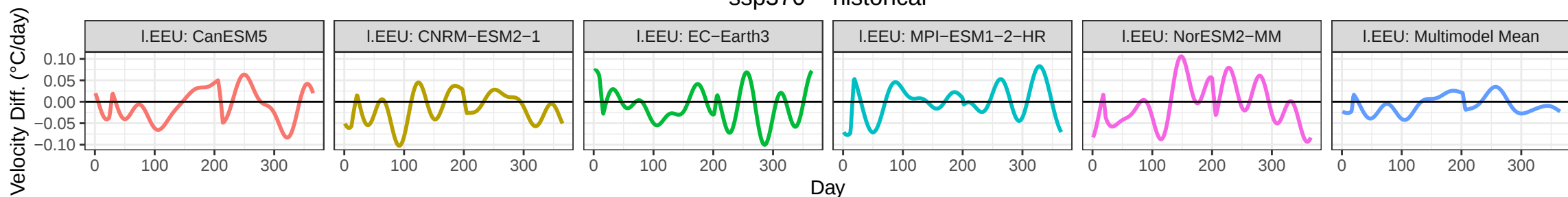
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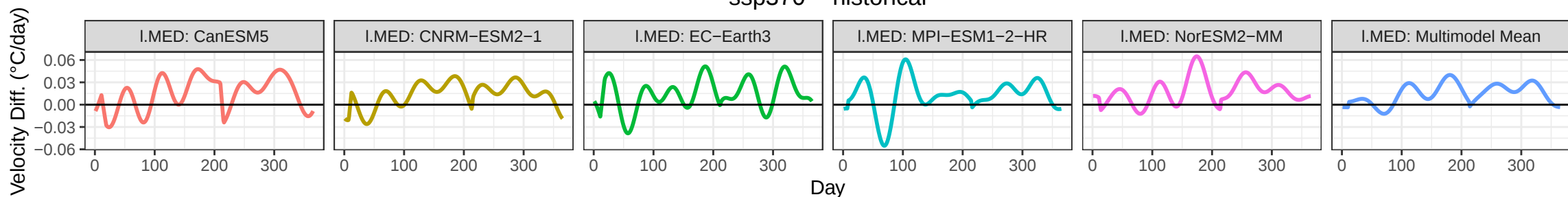
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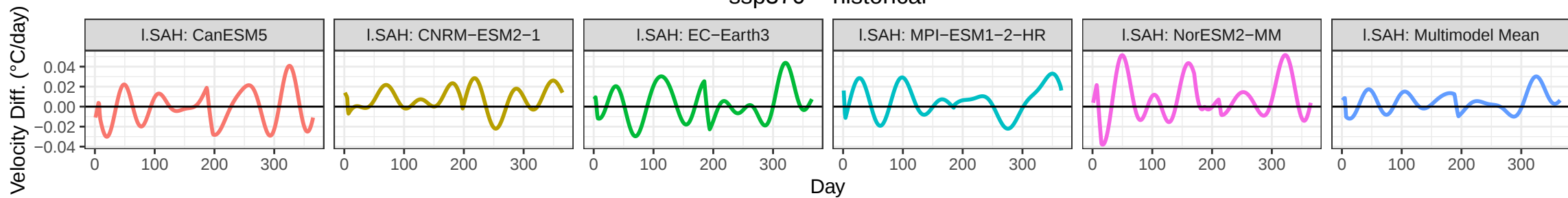
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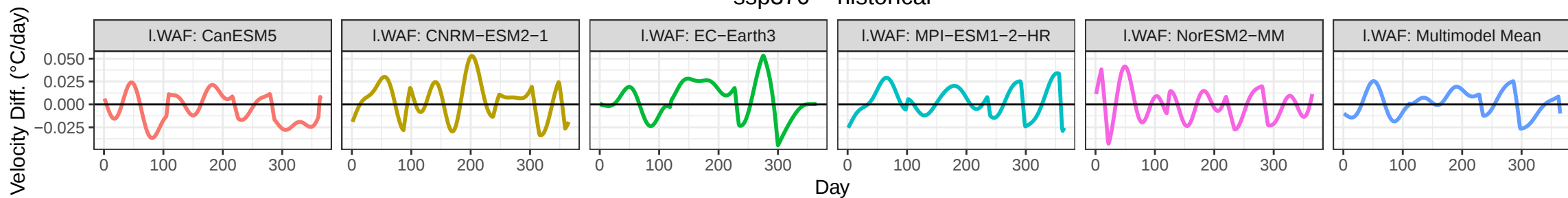
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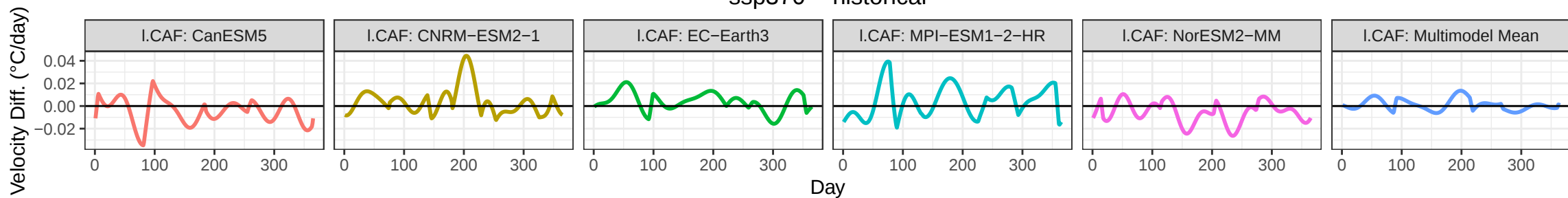
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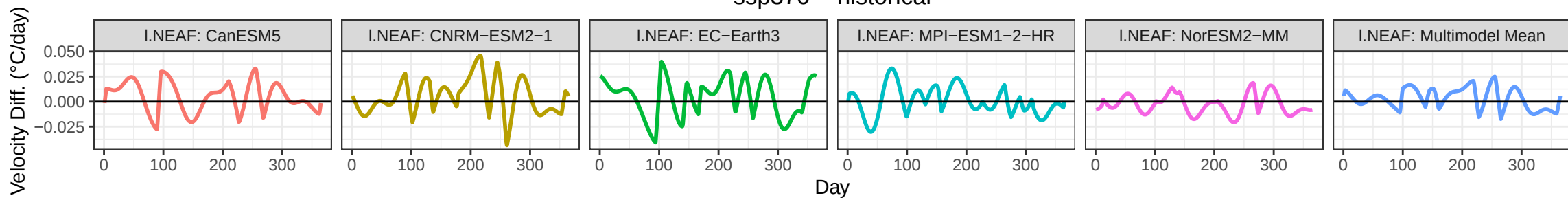
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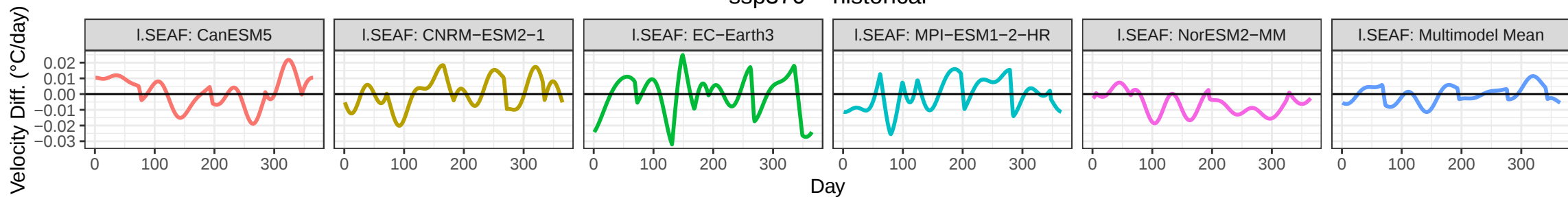
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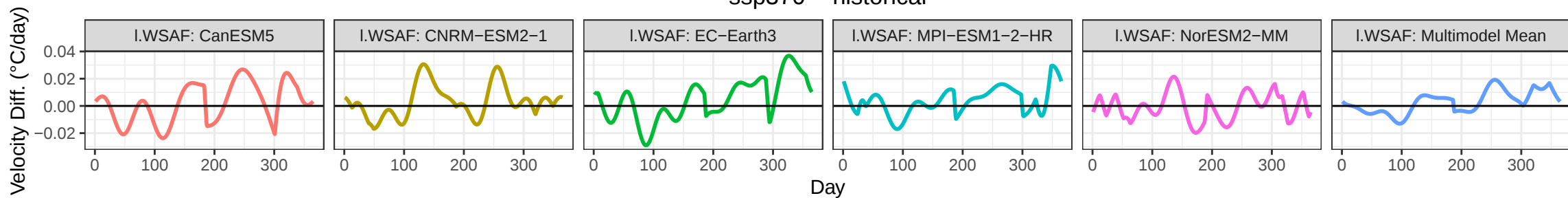
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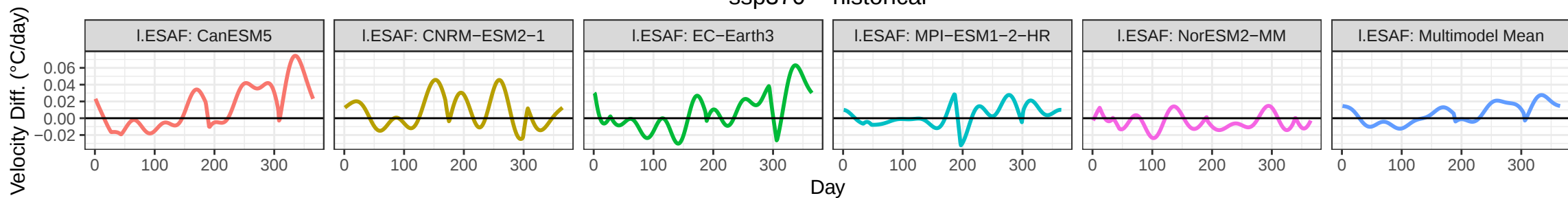
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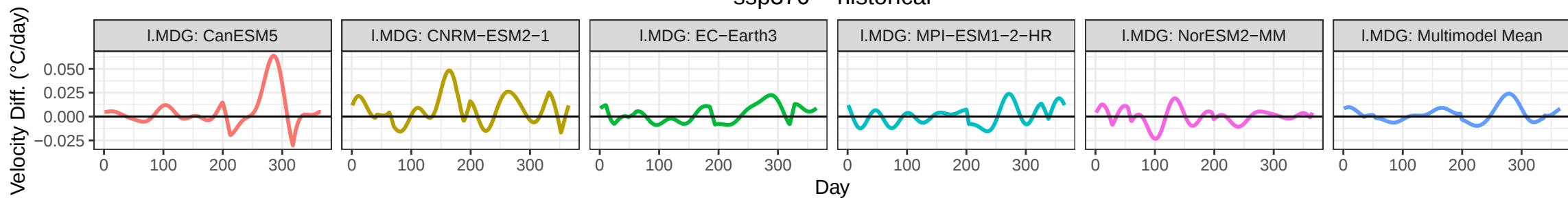
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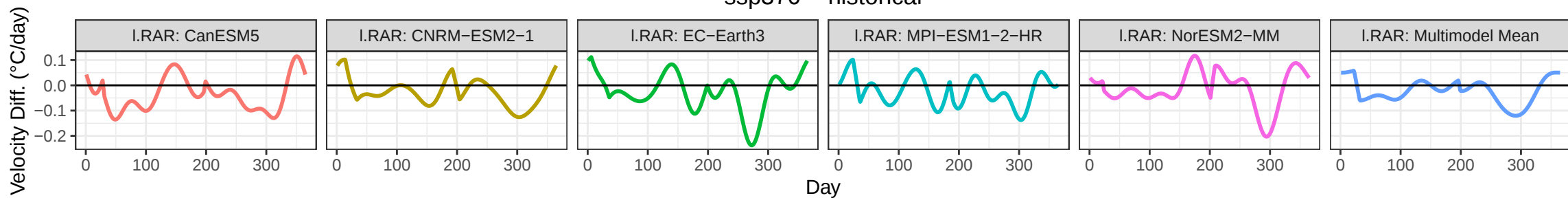
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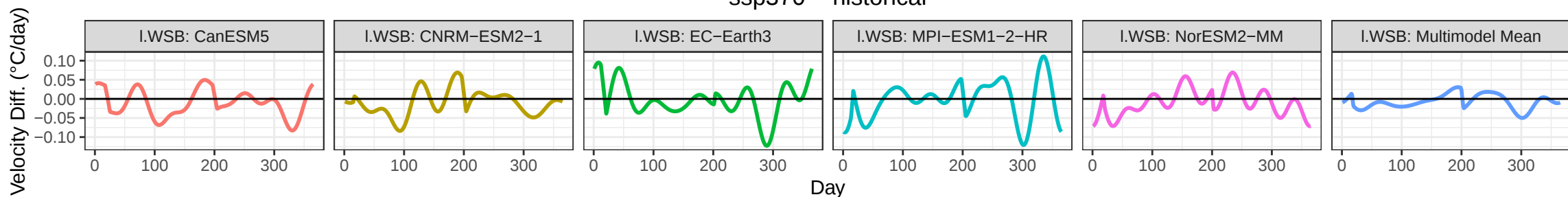
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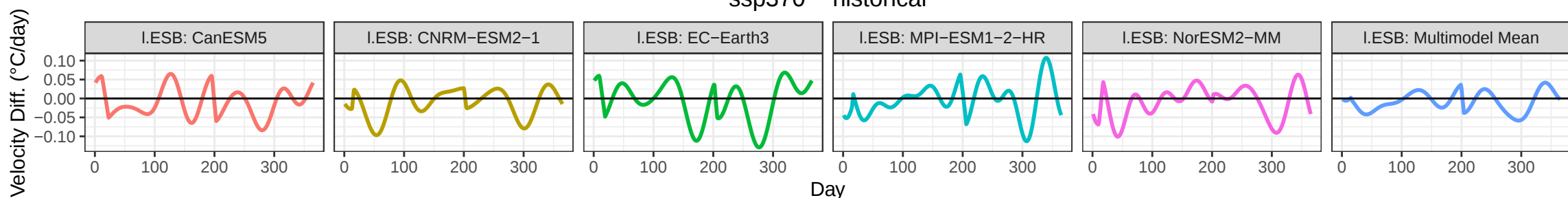
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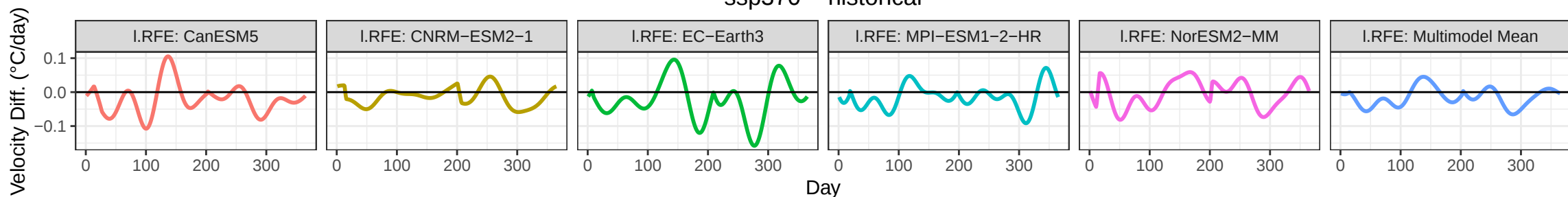
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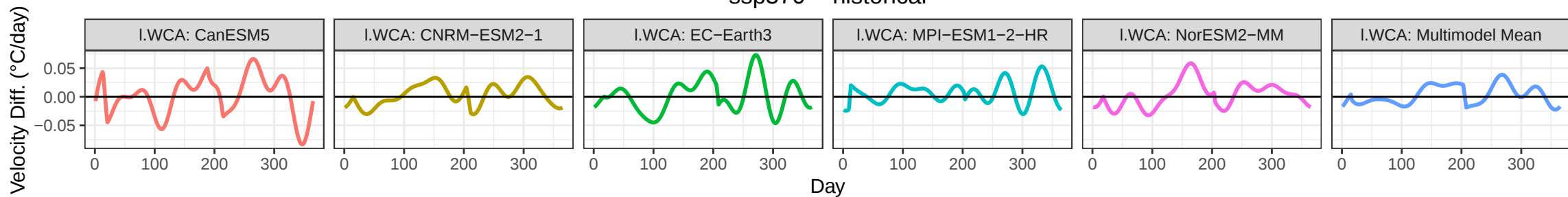
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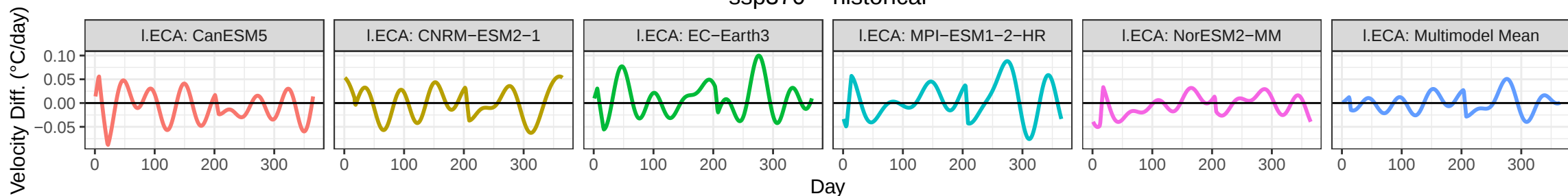
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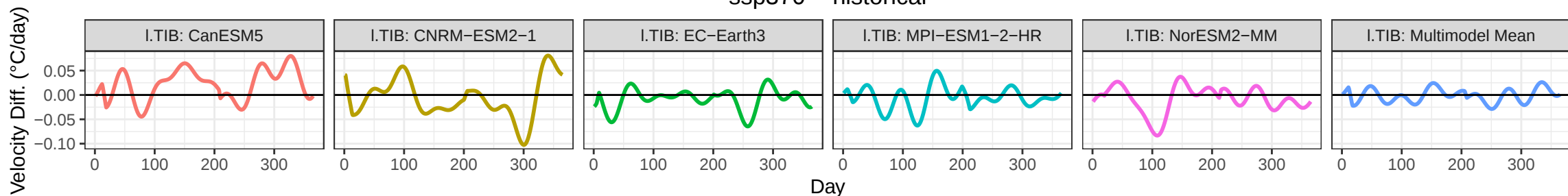
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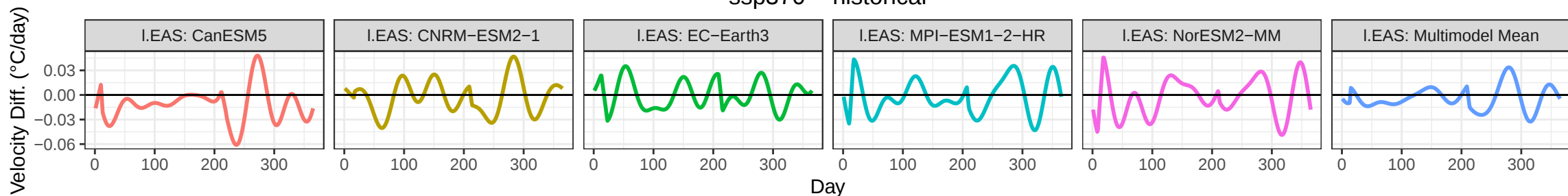
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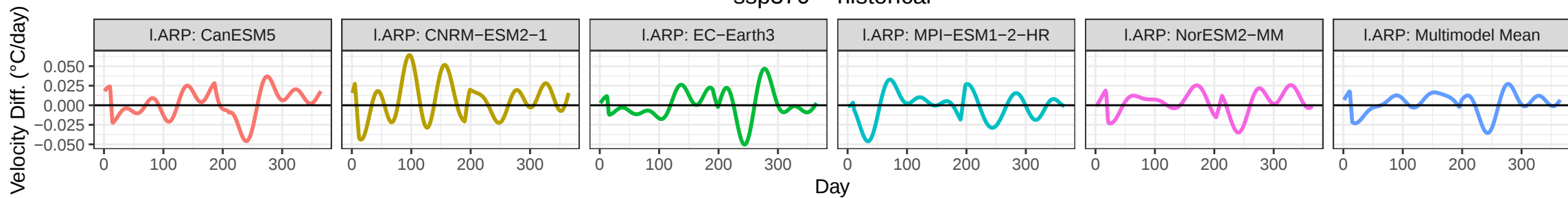
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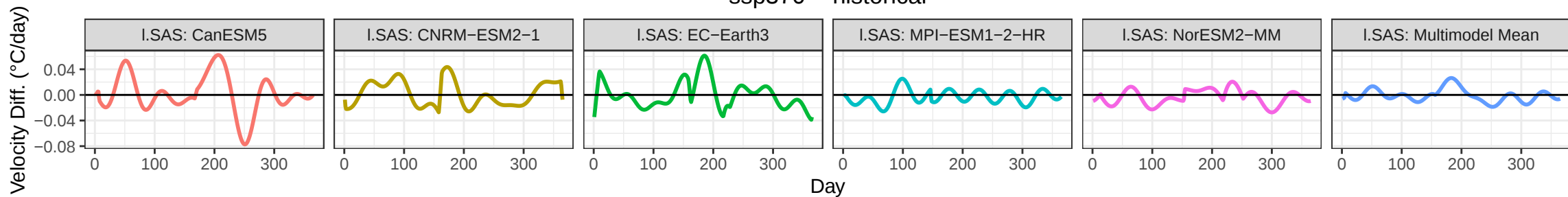
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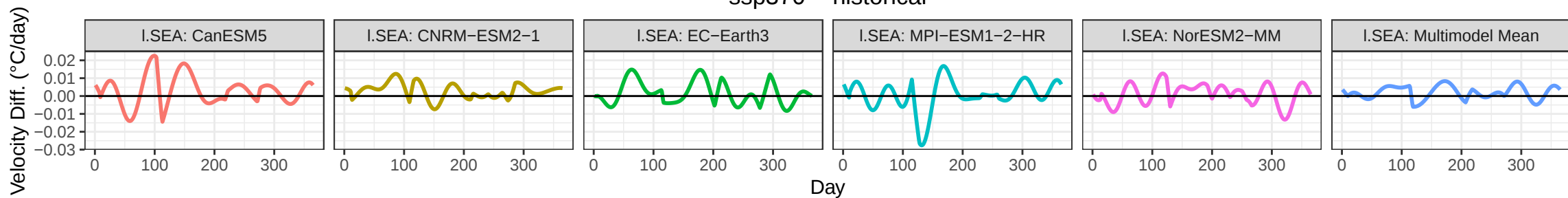
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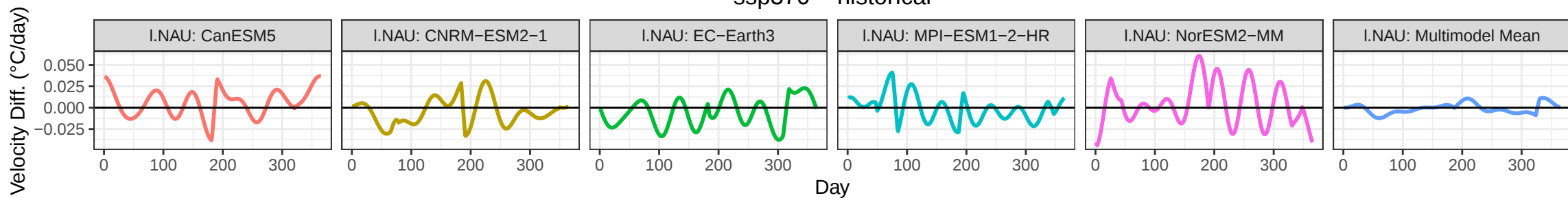
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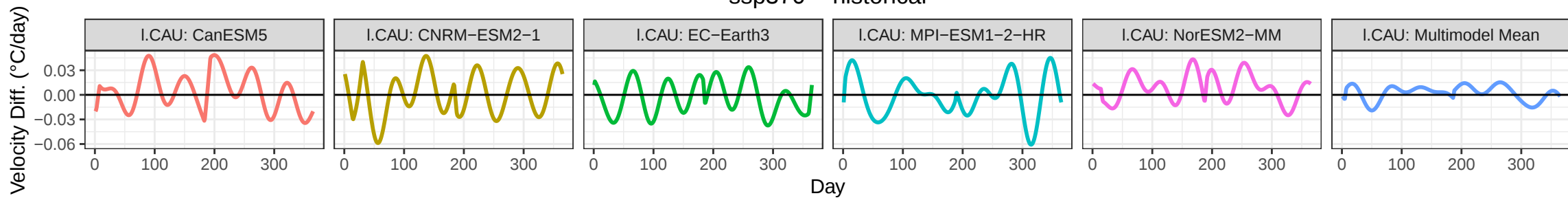
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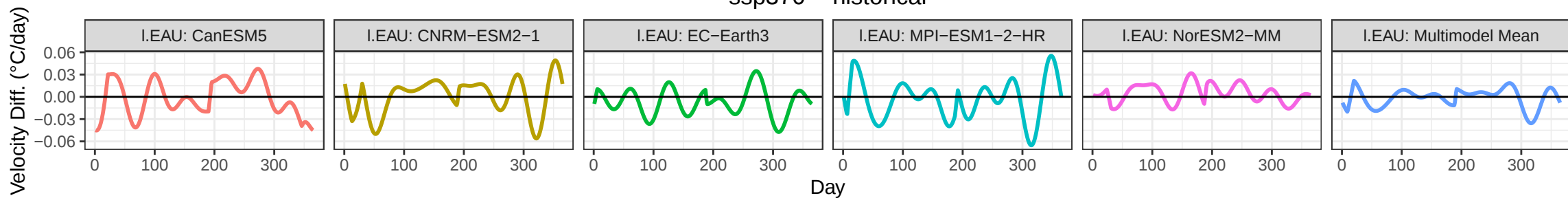
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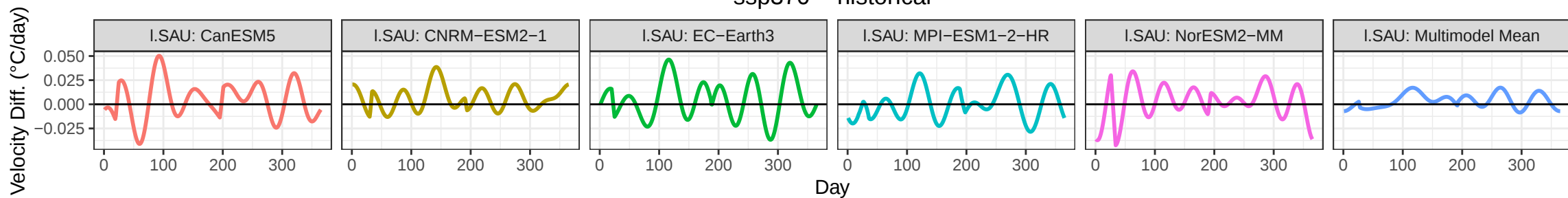
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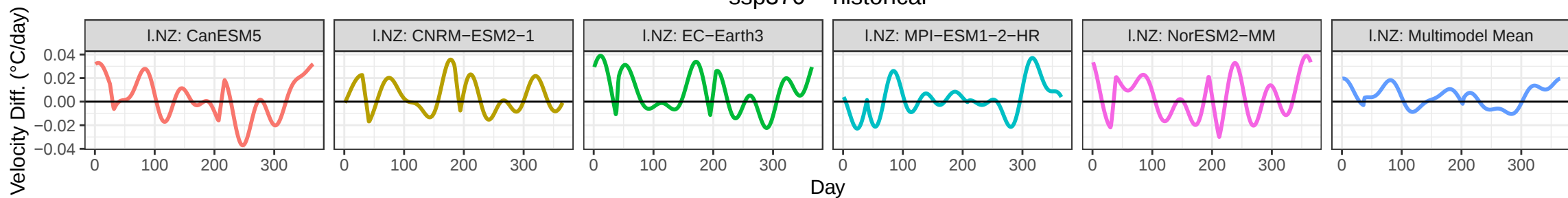
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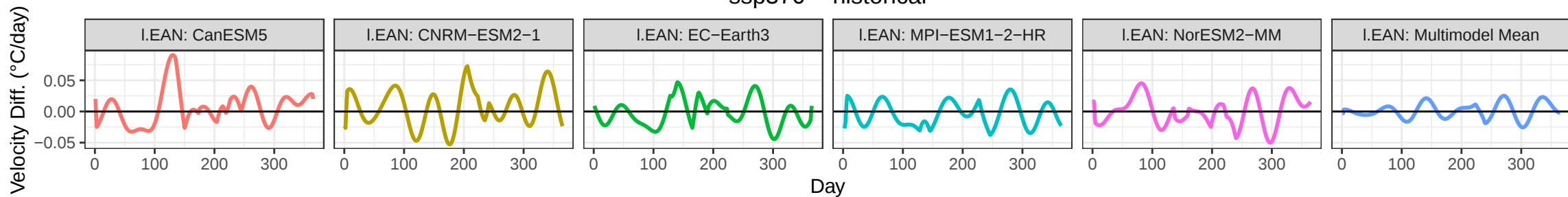
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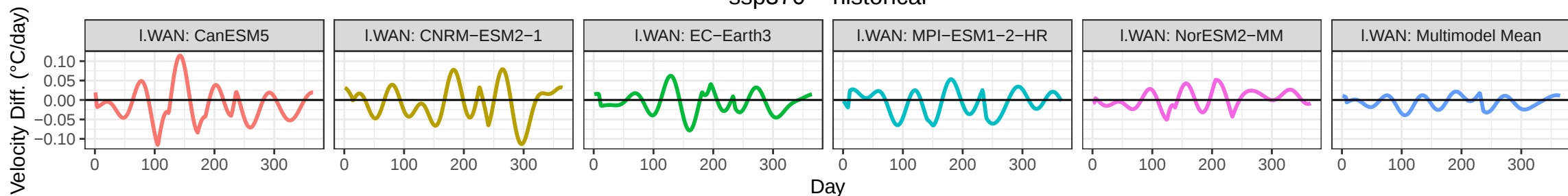
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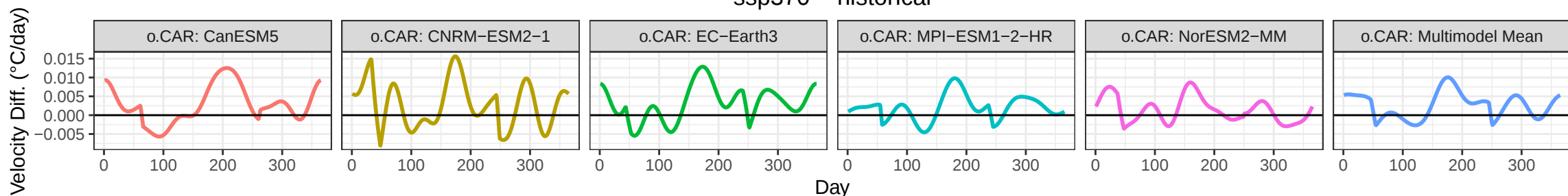
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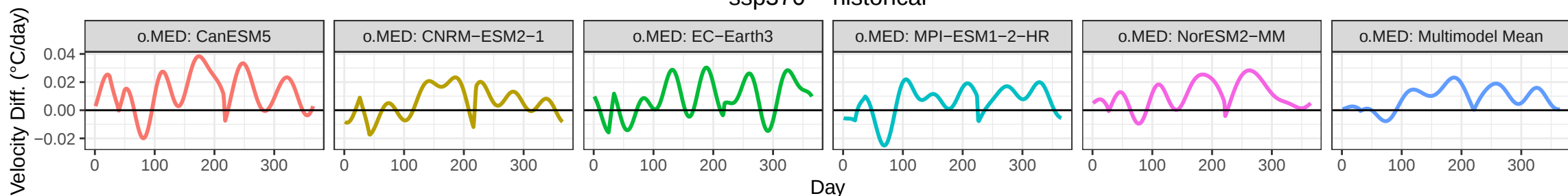
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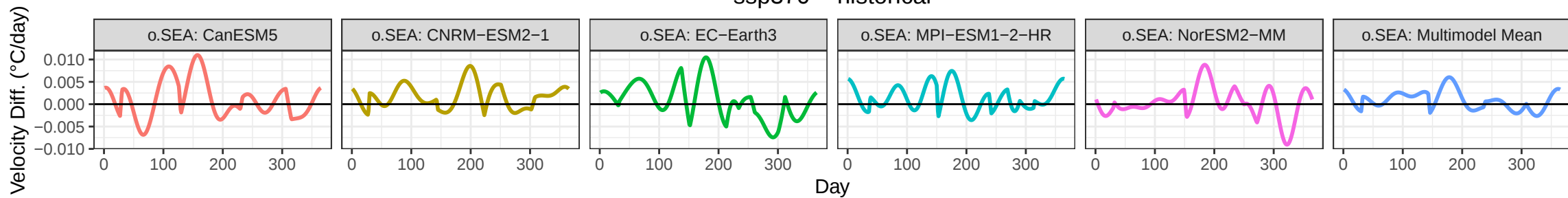
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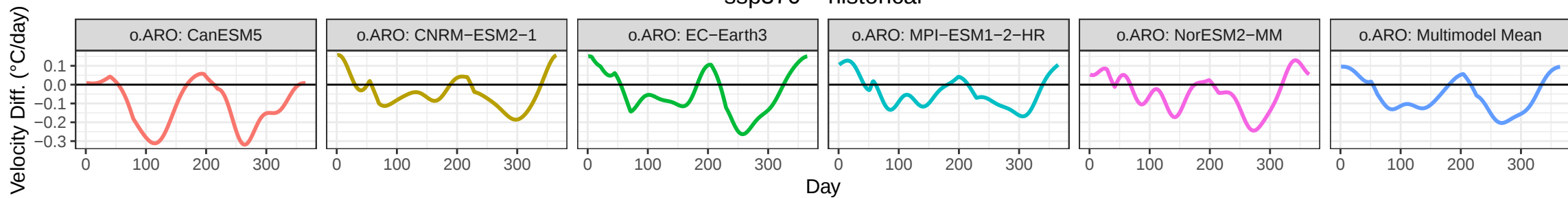
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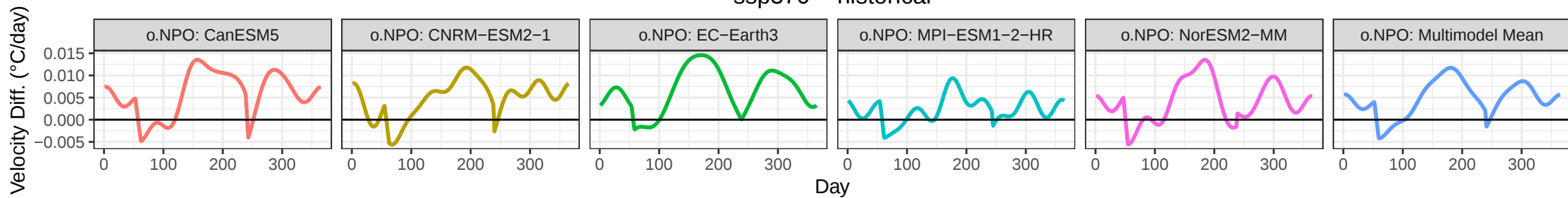
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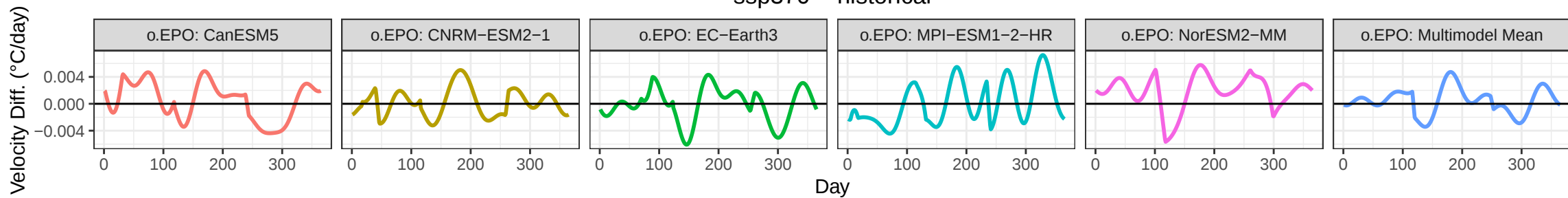
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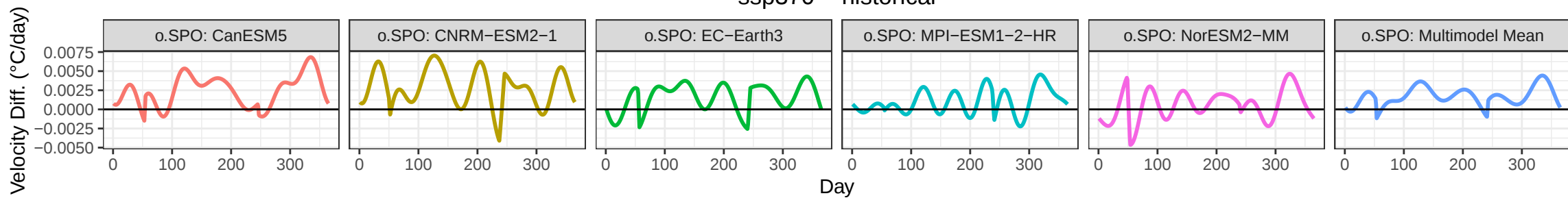
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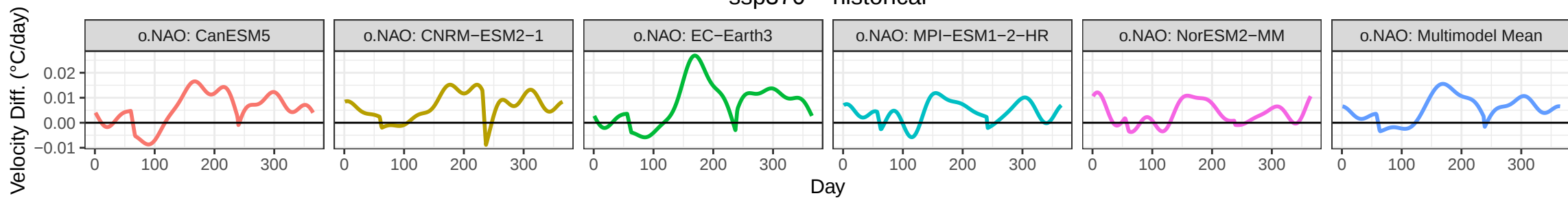
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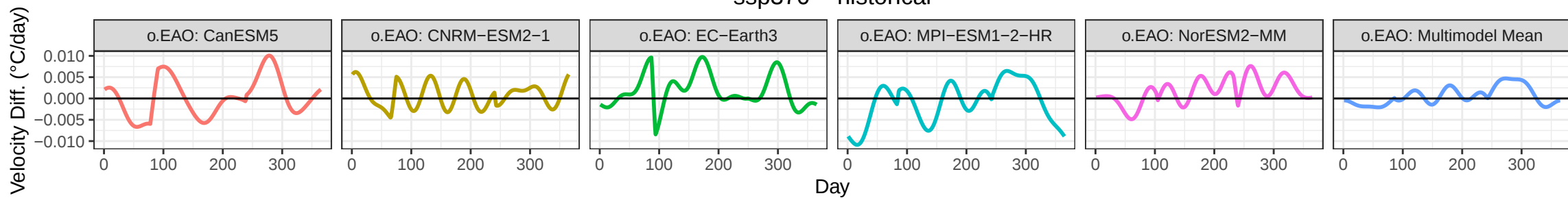
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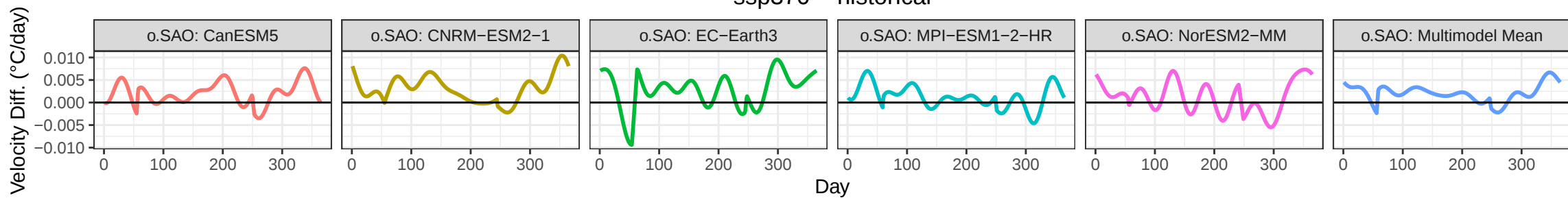
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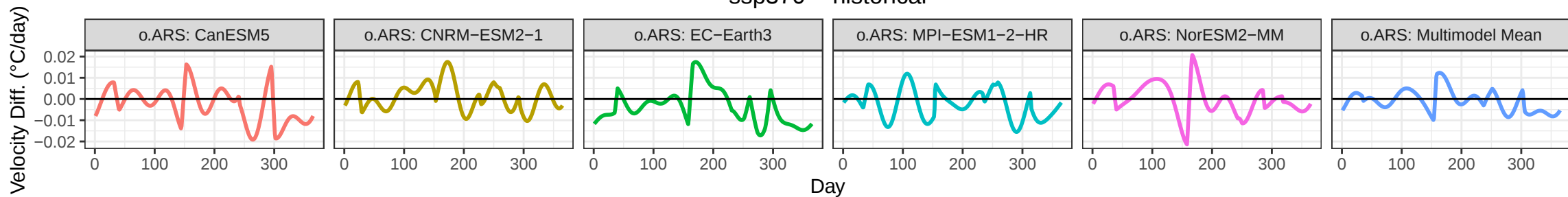
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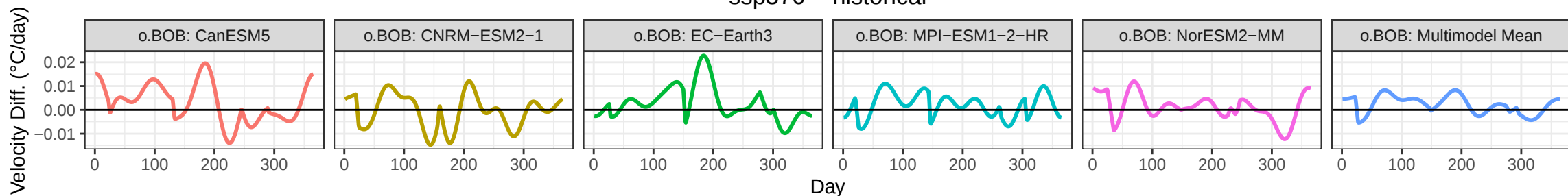
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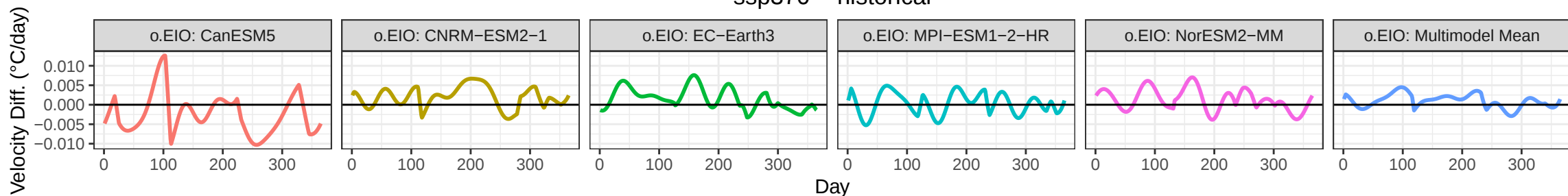
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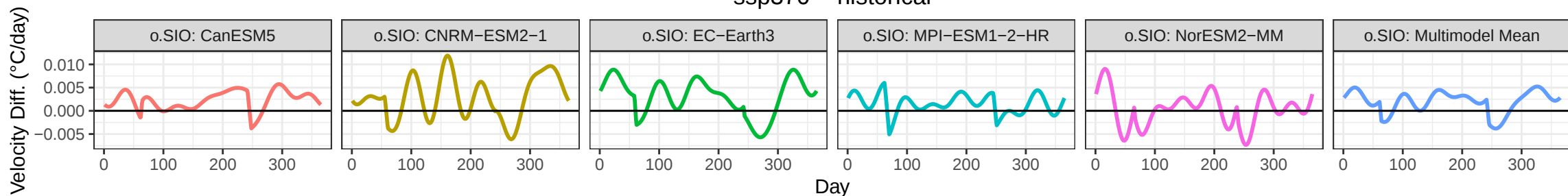
ssp370 – historical



ssp370 – historical



ssp370 – historical



ssp370 – historical

Velocity Diff. (°C/day)

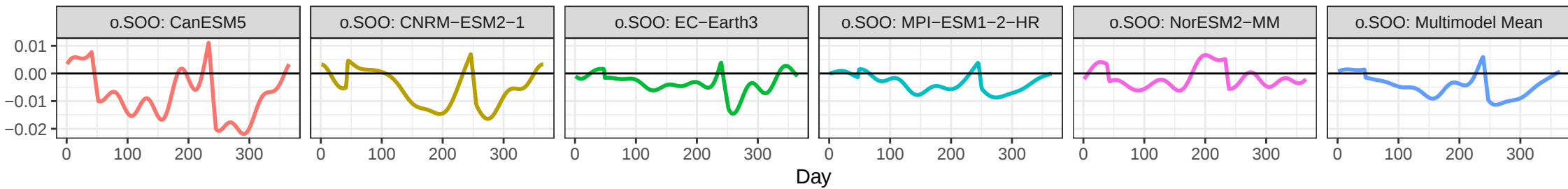
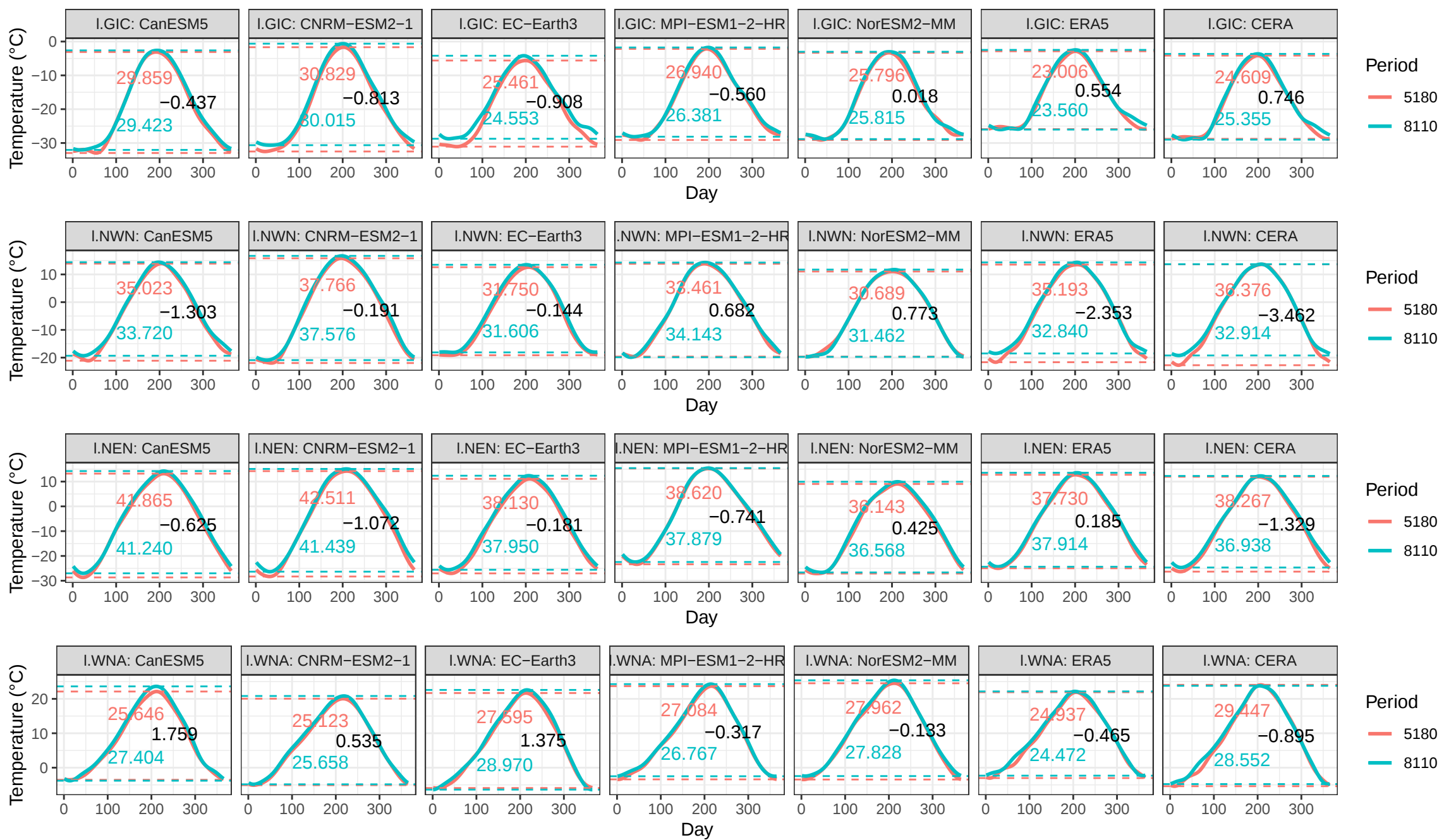
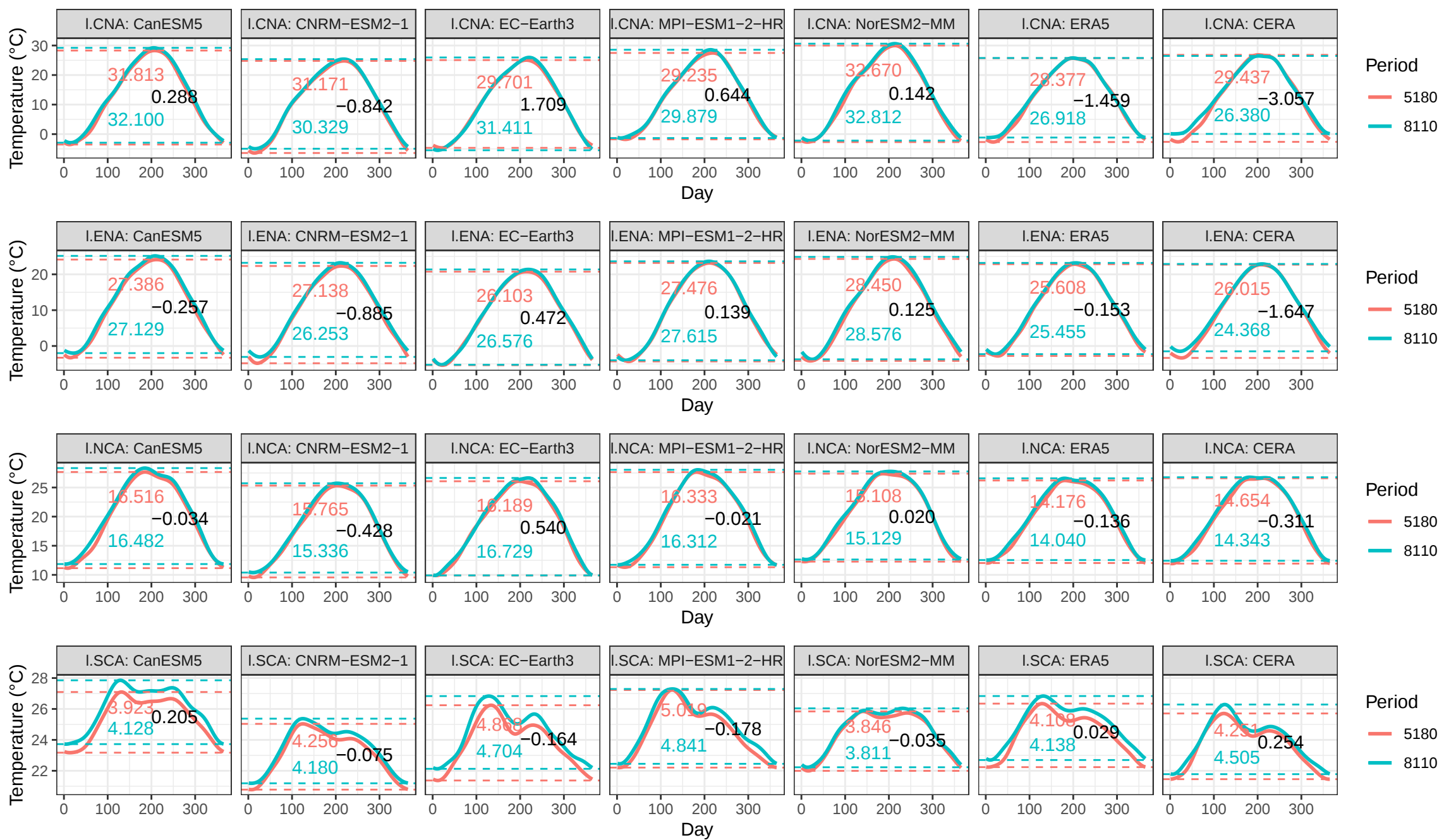
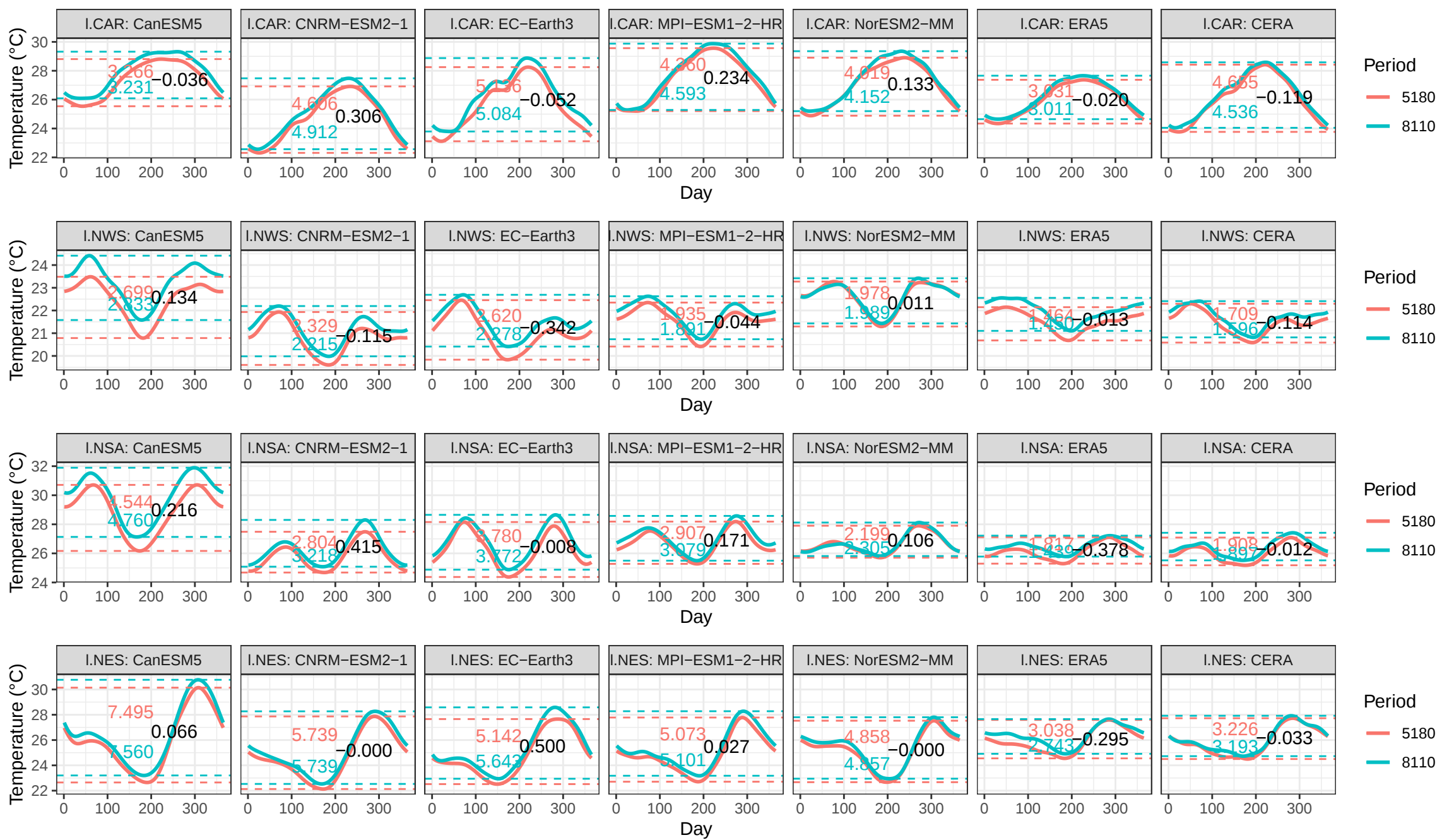
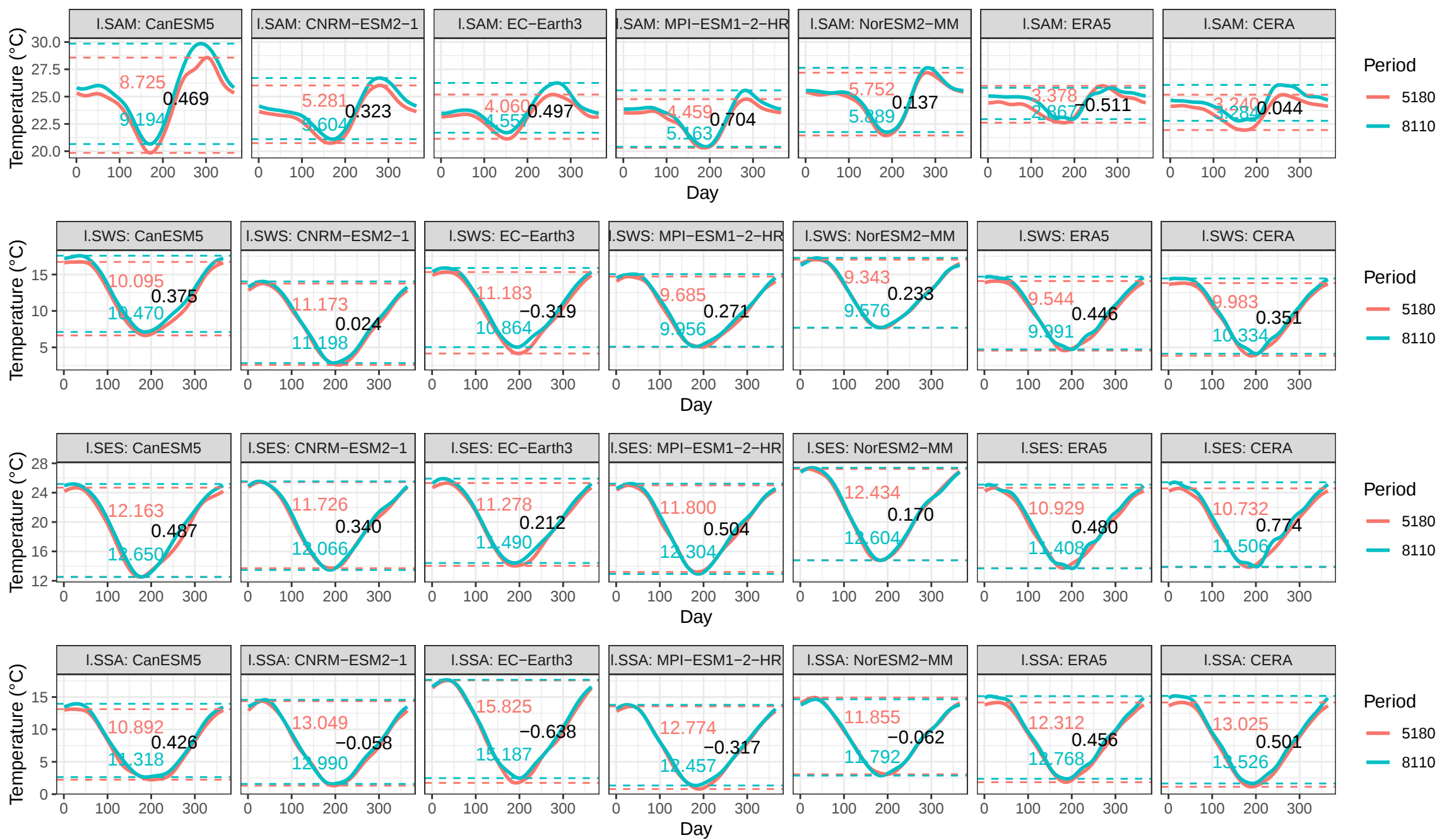


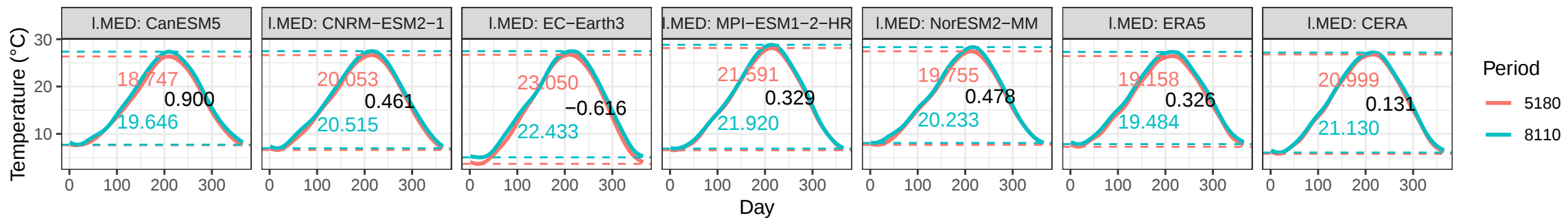
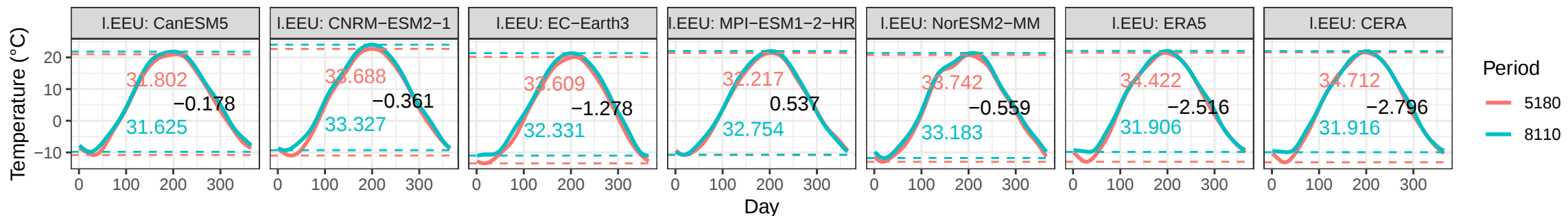
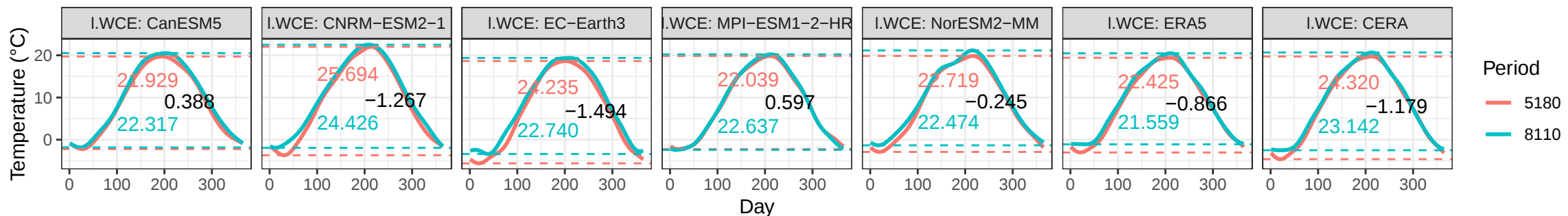
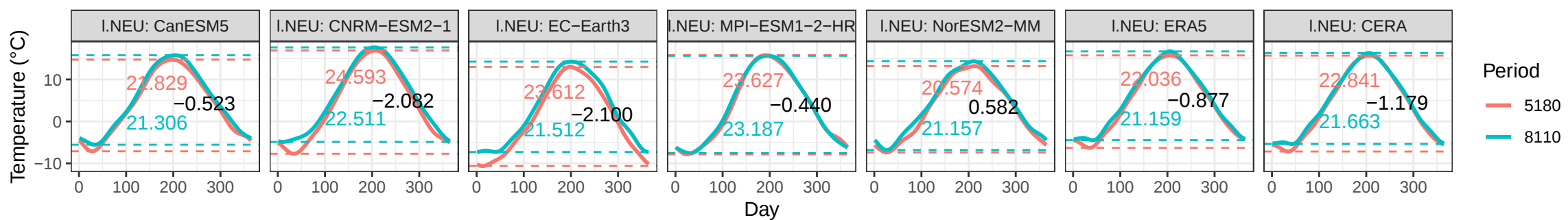
Figure S07: The smoothed annual cycle curves in the two historical periods 1981-2010 (8110, blue curve) and 1951-1980 (5180, red curve). Plots for five selected CMIP6 ESMs and their multi-model mean are shown in different columns, plots for different geographical regions are depicted in different rows of the figure. The horizontal dashed lines denote annual minimum and maximum temperatures in the two periods. The blue and red numbers describe the amplitudes of the annual cycle in the two periods. The black number in each plot says the differences between the amplitudes in the two periods. The results shown in this figure are summarized in Fig. 9 in the manuscript.

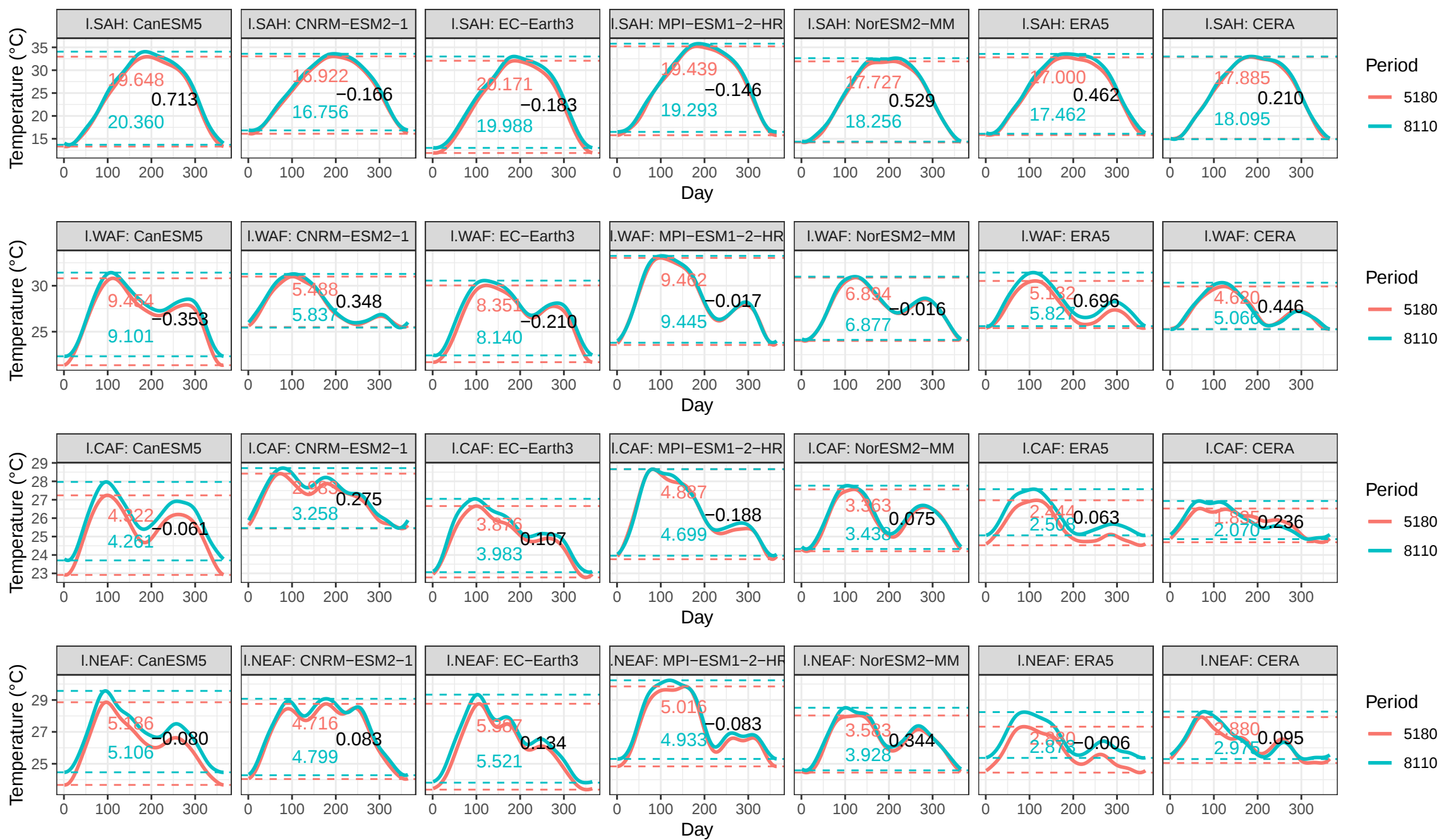


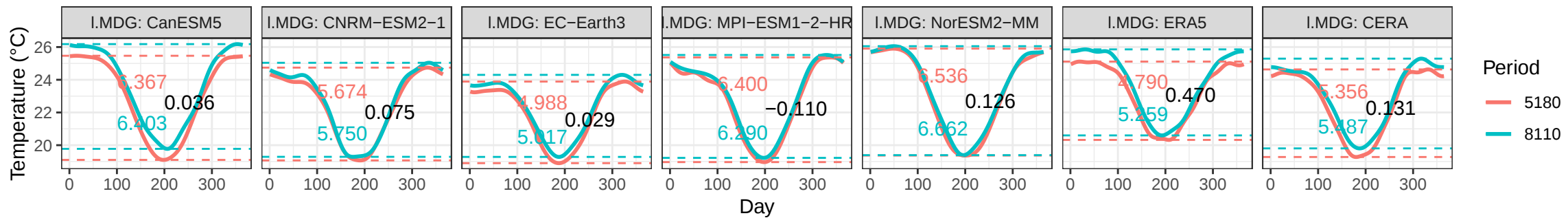
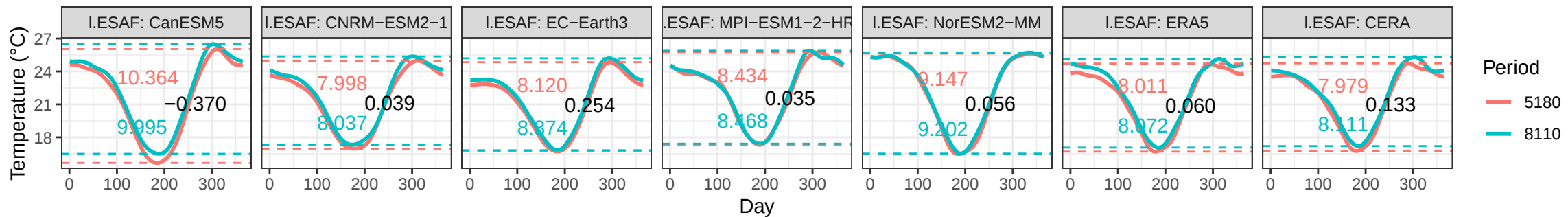
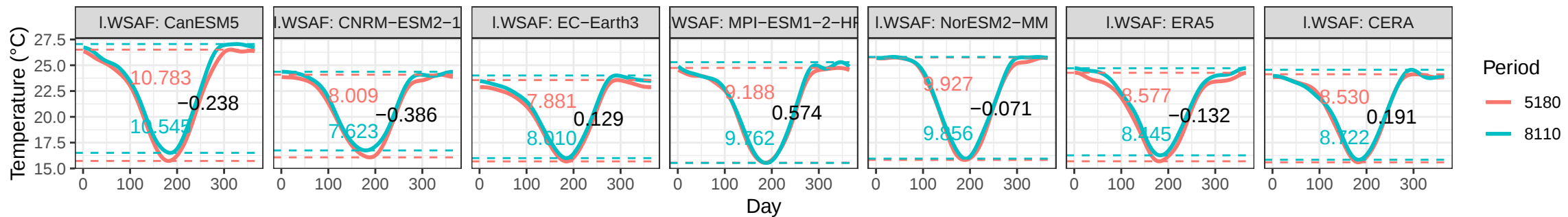
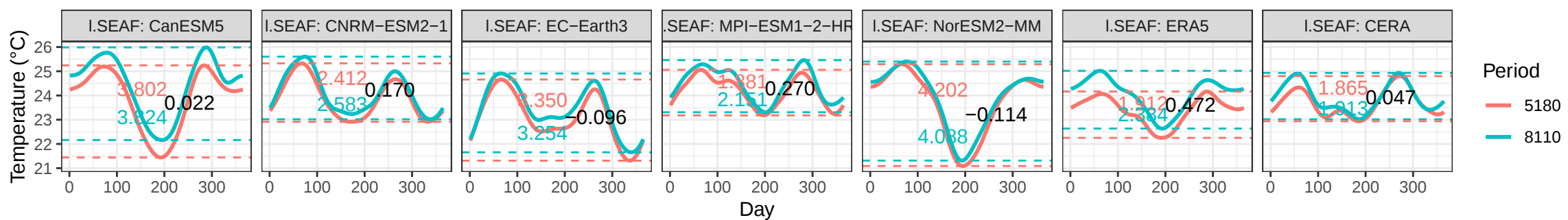


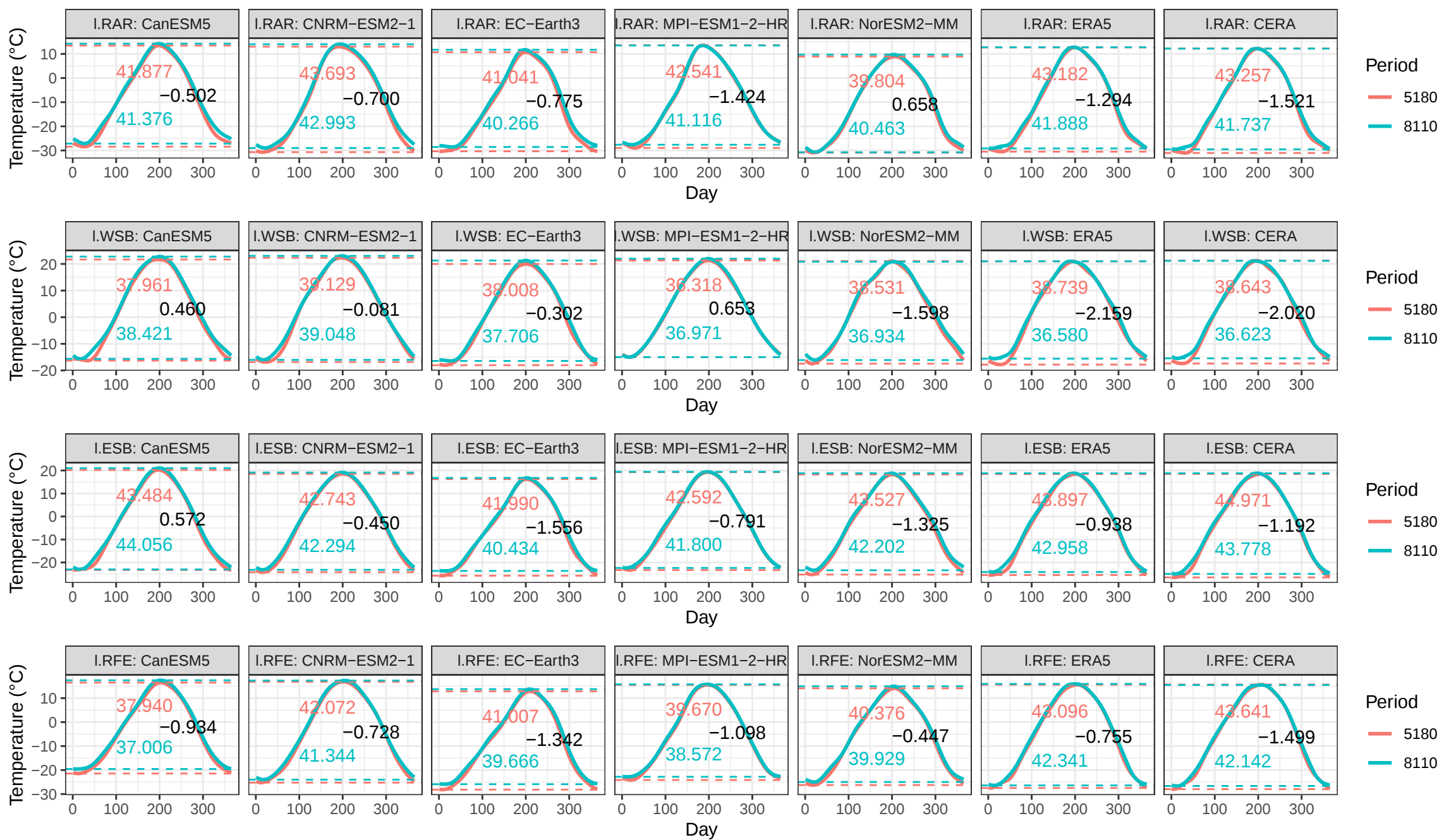


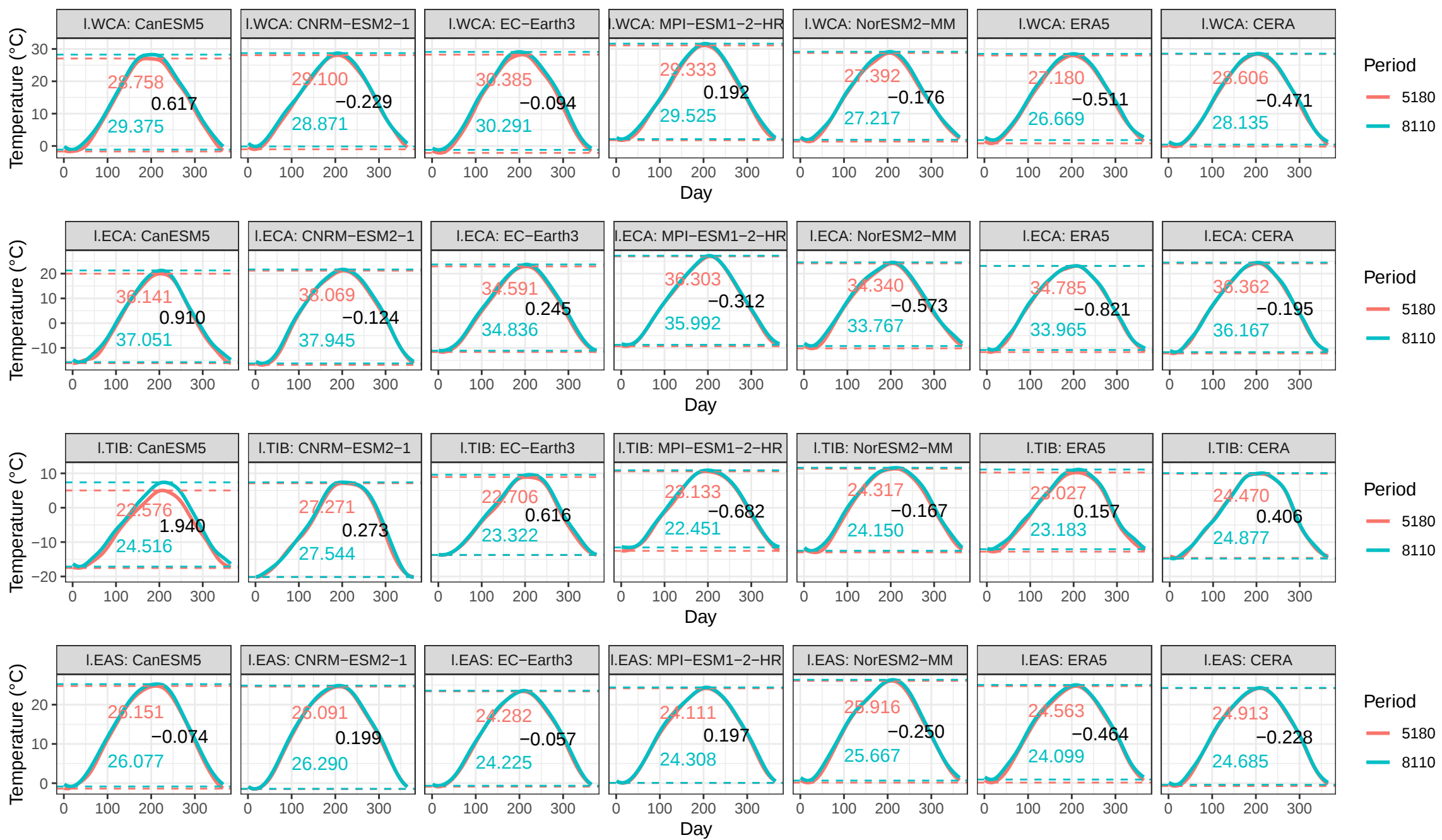


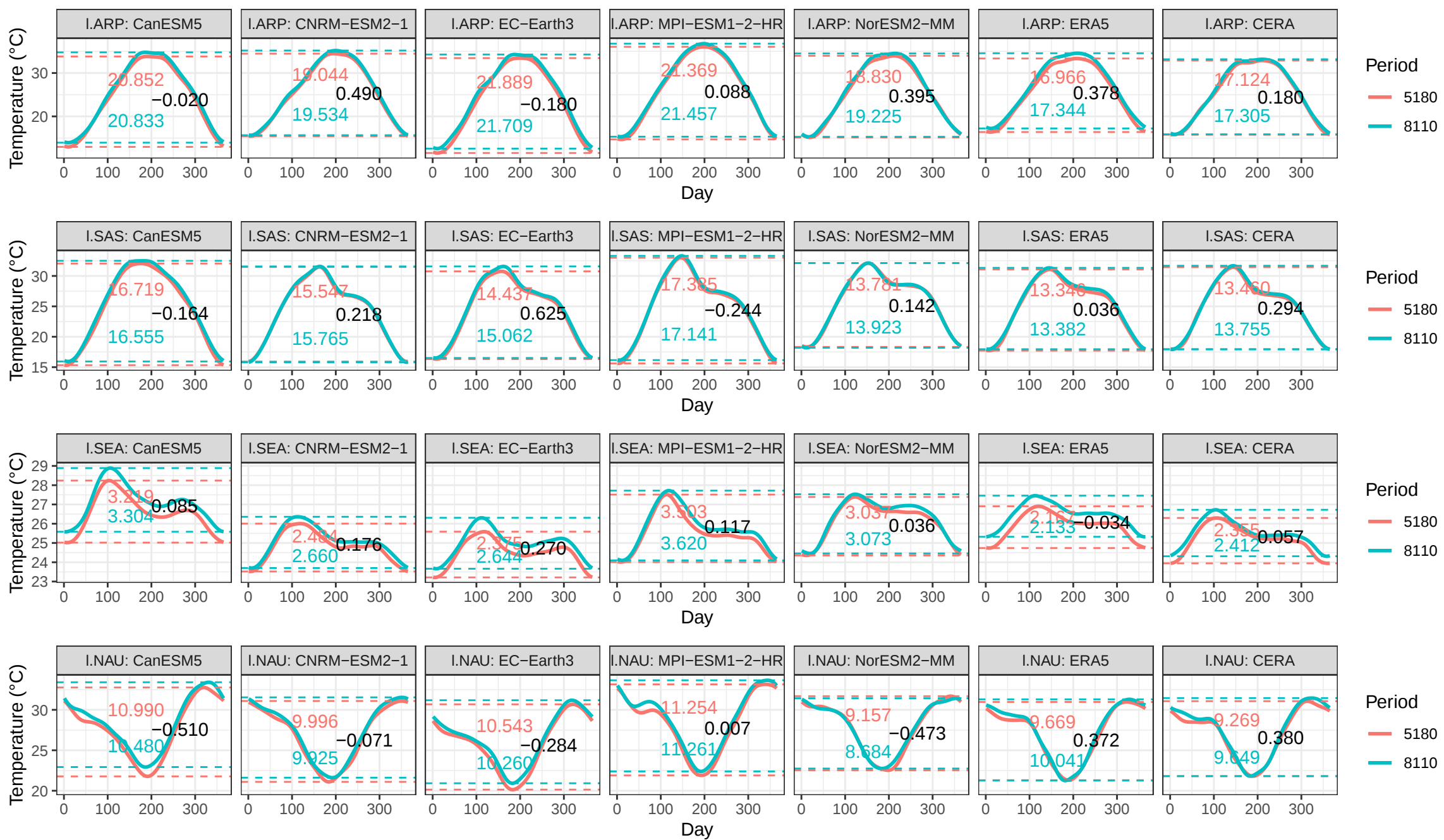


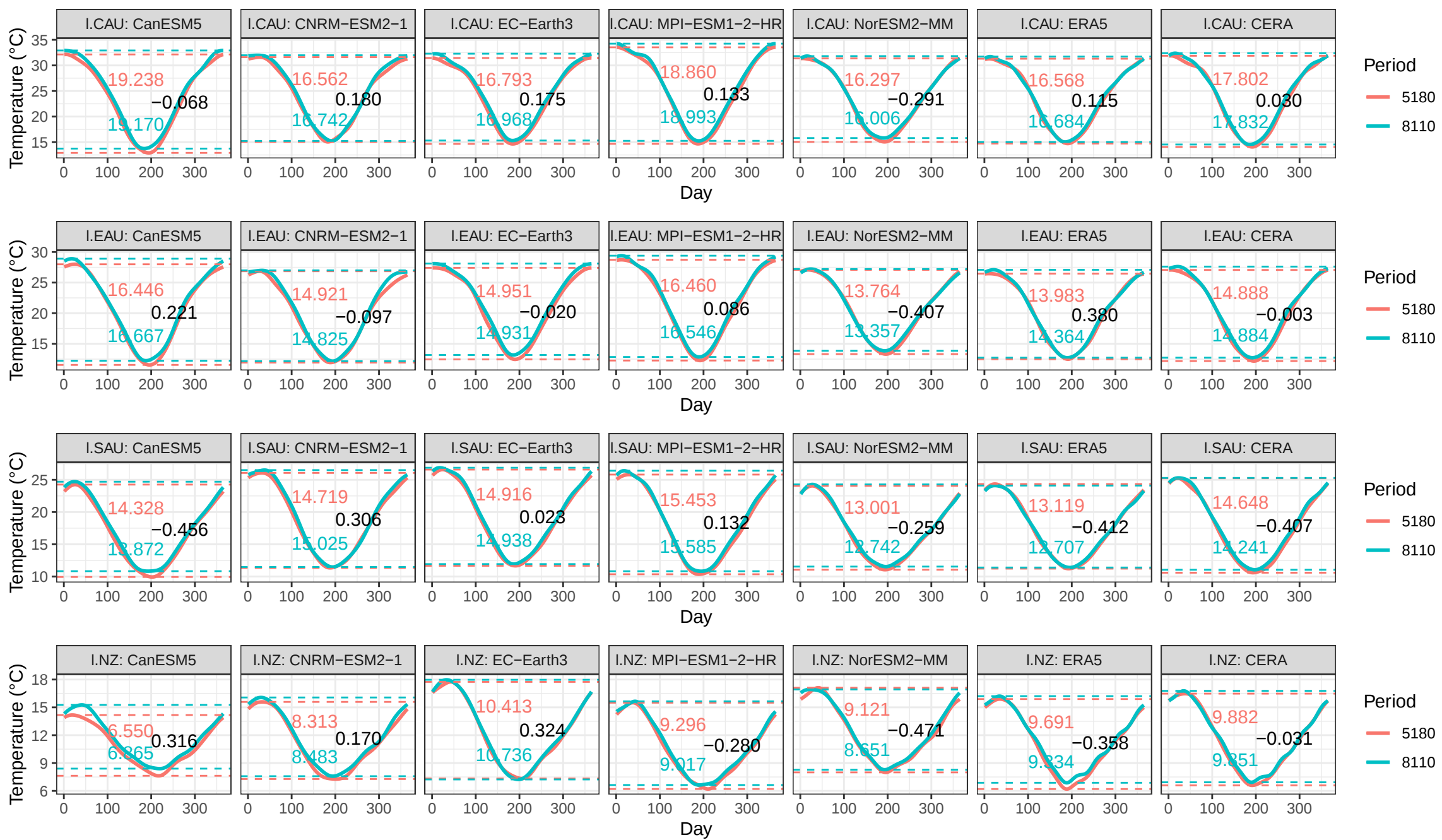


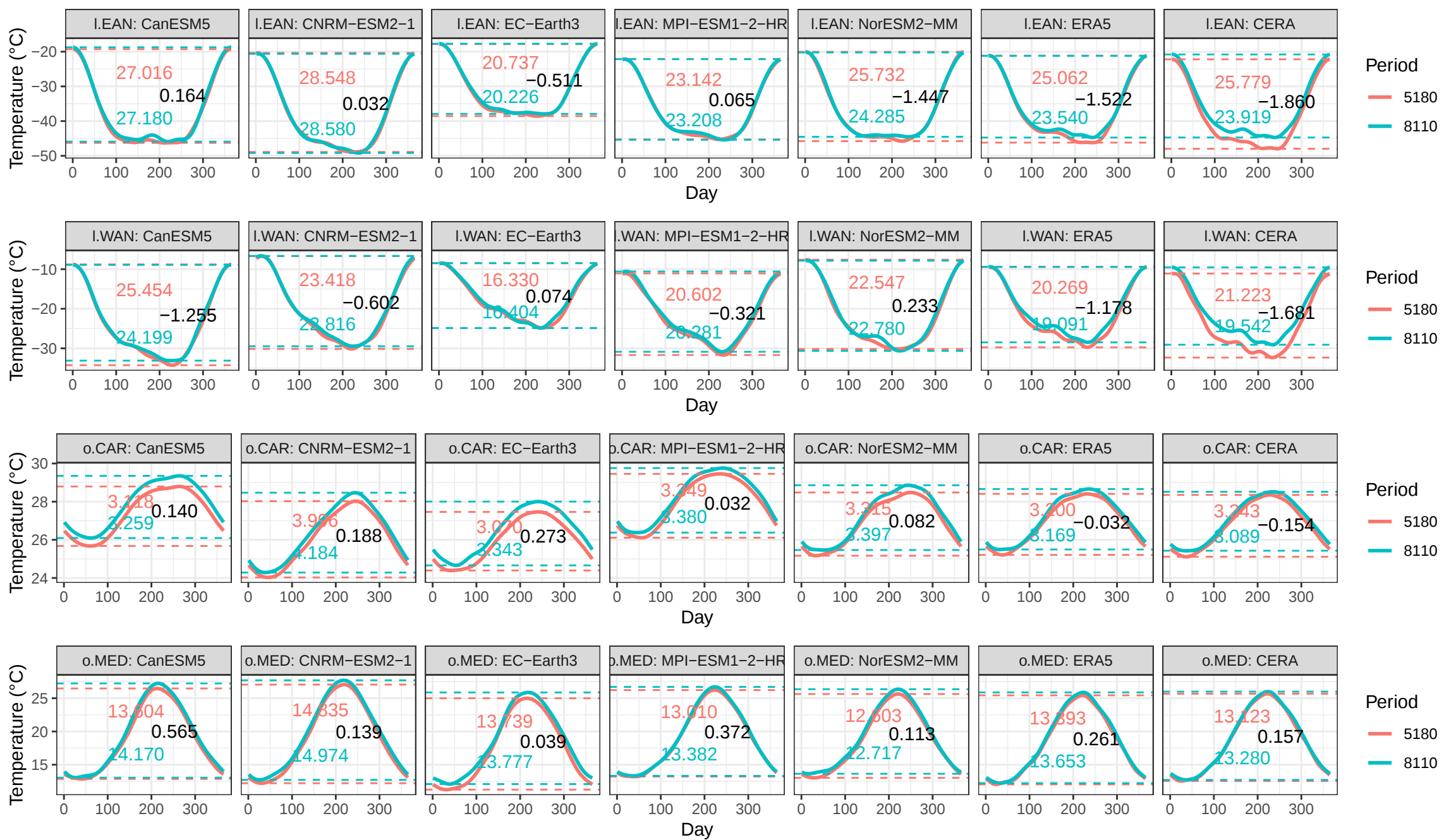


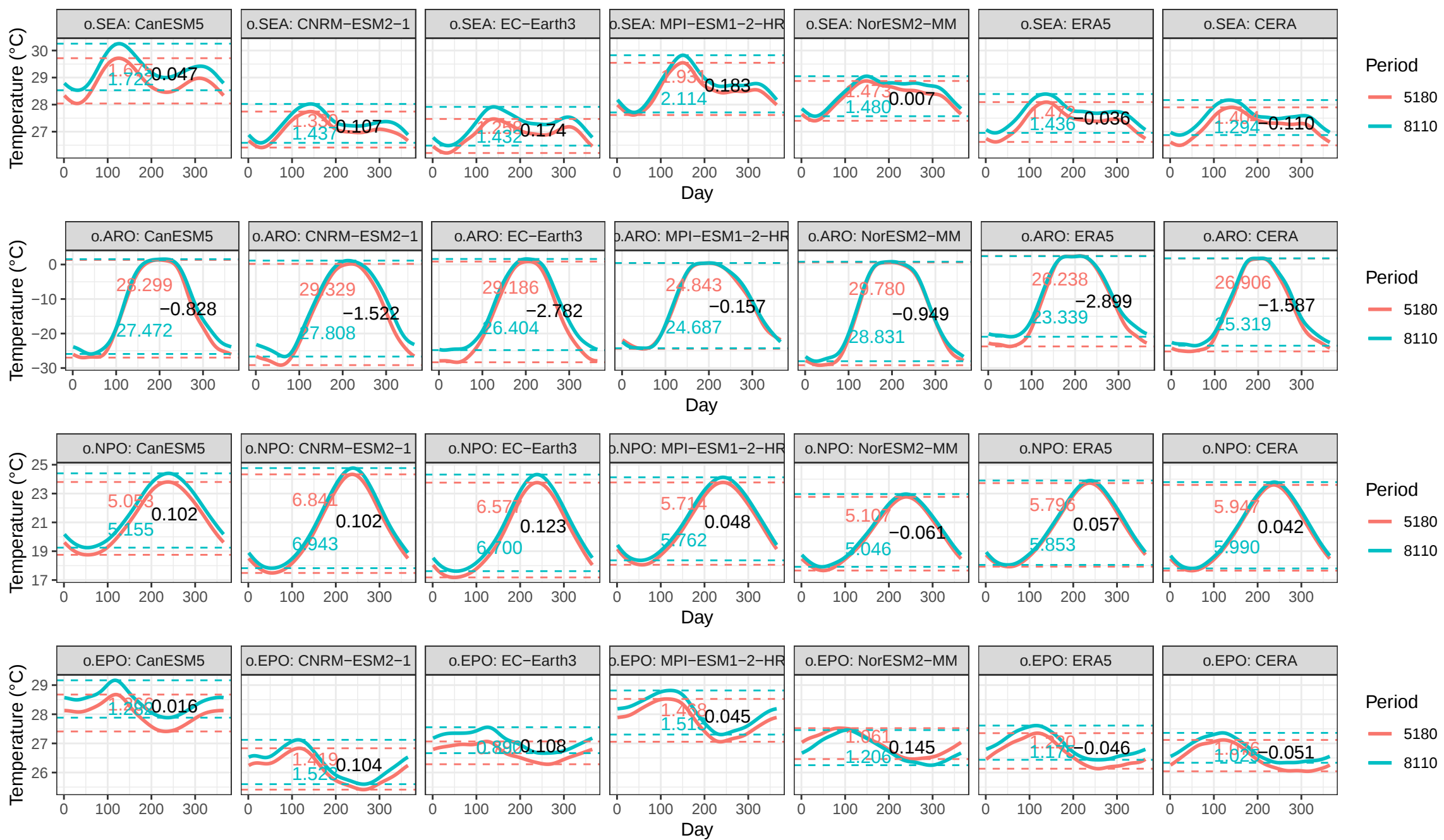


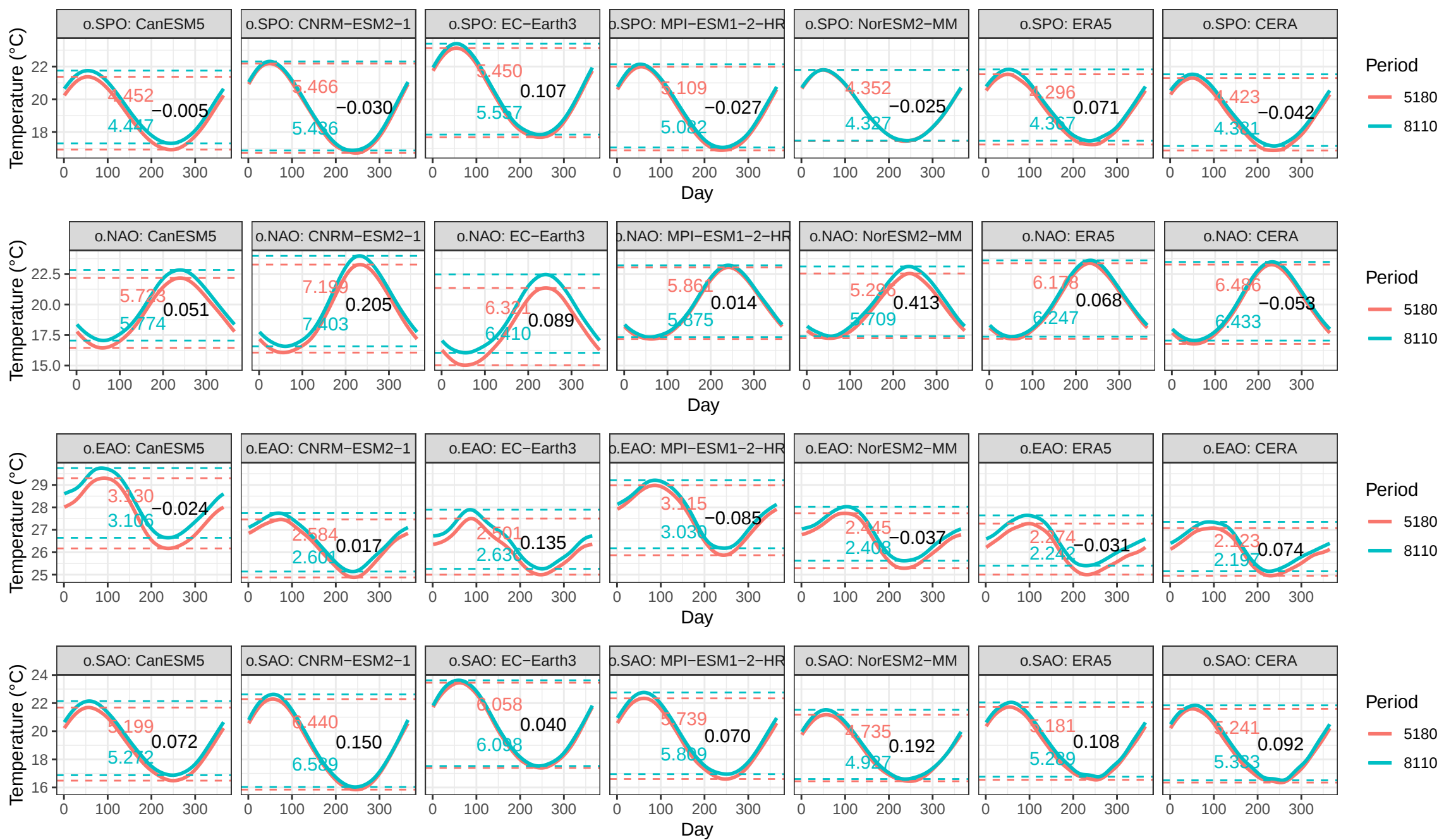


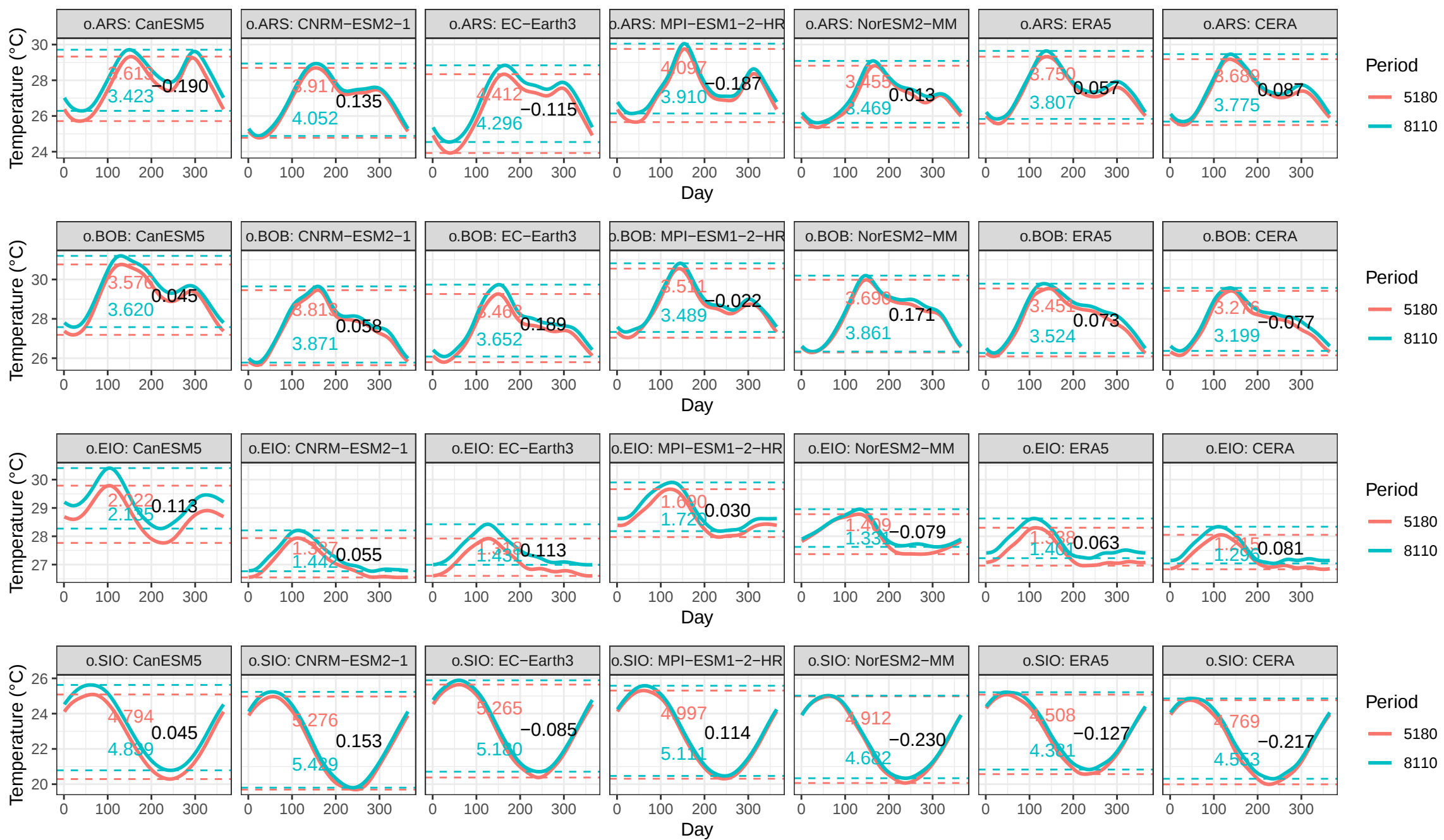












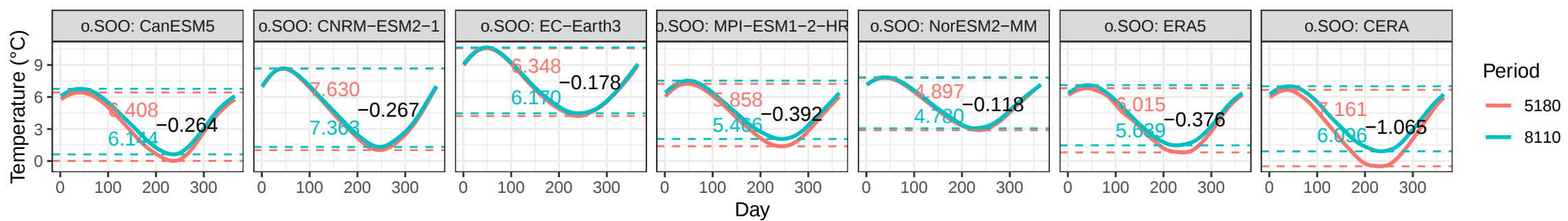


Figure S08: The smoothed annual cycle curves in the future and reference periods of 2071-2100 (ssp370, blue curve) and 1961-1990 (historical, red curve). Plots for five selected CMIP6 ESMs and their multi-model mean are shown in different columns, plots for different geographical regions are depicted in different rows of the figure. The horizontal dashed lines denote annual minimum and maximum temperatures in the two periods. The blue and red numbers describe the amplitudes of the annual cycle in the two periods. The black number in each plot says the differences between the amplitudes in the two periods. The results shown in this figure are summarized in Fig. 10 in the manuscript.

