Supplementary Information

Evaluating Regionally Diverse Pathways to Unprecedented Heat Extremes Across Africa in NeuralGCM.

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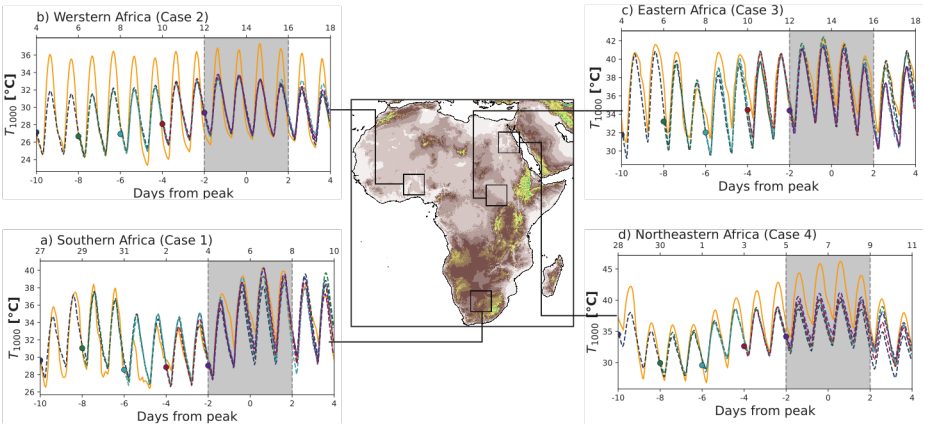

Fig. S1 | NeuralGCM accurately reproduces the temporal evolution of near-surface air temperature relative to ERA5. Time series of the near-surface air temperature averaged over the four study regions shown in panel **e** for (**a**) Southern Africa (Case 1), (**b**) Western Africa (Case 2), (**c**) Eastern Africa (Case 3), and (**d**) Northeastern Africa (Case 4). The solid orange line represents the ERA5 reanalysis, while dashed colored lines denote NeuralGCM forecasts initialized at successive lead times. Grey shading marks the period surrounding the peak heat event. The lower x-axis shows forecast lead time (days relative to the event peak), whereas the upper x-axis indicates the corresponding day of the month for each case (January–February for Case 1, February for Case 2, March for Case 3, and May–June for Case 4). Across all cases, NeuralGCM closely reproduces the observed evolution of near-surface air temperature, including the timing and magnitude of the temperature peak, demonstrating skillful forecasts several days in advance.

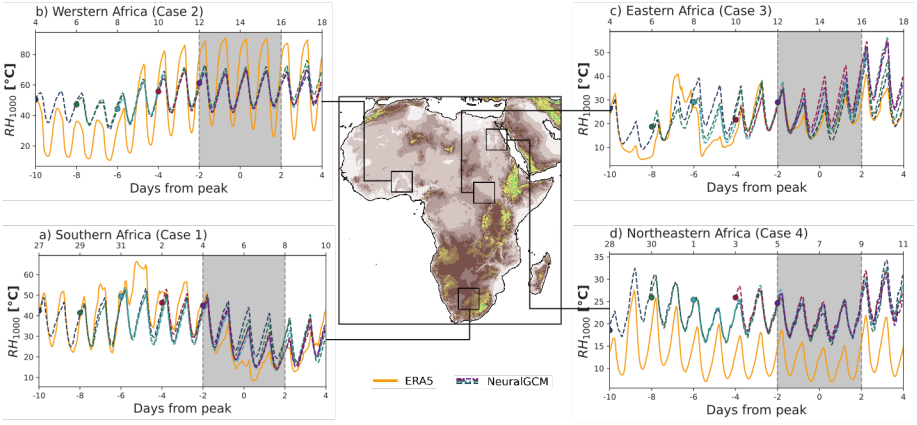

Fig. S2 | NeuralGCM accurately reproduces the temporal evolution of near-surface relative humidity relative to ERA5. Time series of the near-surface relative humidity averaged over the four study regions shown in panel **e** for (**a**) Southern Africa (Case 1), (**b**) Western Africa (Case 2), (**c**) Eastern Africa (Case 3), and (**d**) Northeastern Africa (Case 4). The solid orange line represents the ERA5 reanalysis, while dashed colored lines denote NeuralGCM forecasts initialized at successive lead times. Grey shading marks the period surrounding the peak heat event. The lower x-axis shows forecast lead time (days relative to the event peak), whereas the upper x-axis indicates the corresponding **da**y of the month for each case (January–February for Case 1, February for Case 2, March for Case 3, and **Ma**y–June for Case 4). Across all cases, NeuralGCM closely reproduces the observed evolution of near**-surface re**lative humidi**t**y, **includi**ng the timing and magnitude of the humidity anomalies during the event, **demonstr**ating skillful forecasts **s**everal days in advance.