HEAT ANALYSIS

Kerala, India

April 2024

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Woodwell Climate Research Center

GeoHazards International

GeoHazards Society India

In 2023, Kerala experienced its deadliest heatwave during one of the warmest years in the past century. This analysis and the associated data (already shared with Kerala State Disaster Management Authority (KSDMA)) aim to inform the ongoing revision of the state's Heat Action Plan, to better understand and prepare for future heat extremes. In partnership with KSDMA, GeoHazards International (GHI), and GeoHazards Society (GHS), we conducted an analysis combining daily station temperature data with downscaled model output to examine increasing heat trends in Kerala, India.

Historically, temperatures are warmest in inland, lowland regions, and the coolest temperatures occur at high elevations. March is often the hottest month of the year for many locations throughout Kerala, and the modeled historical maximum near-surface air temperature ($T_{as,max}$) is shown in Figure 1.

Figures 2, a–i show the seasonal cycle of the monthly averaged daily $T_{as,max}$ from observations[1] and modeled projections adjusted to observations using the *delta method*[2] under a range of scenarios and time periods. Observations from 1990 to 2020 are shown by the solid black line. The yellow lines represent the 2030 (2020–2040) time period, and the red lines represent the mid-century (2050, 2040–2060) time period. Similarly, the dashed lines show the SSP2-4.5 scenario (representing a middle-of-the road pathway), and the solid lines show the SSP5-8.5 scenario (representing a fossil fuel-dependent pathway). It should be noted that the model output underestimated historical temperature observations (Appendix, Figures A10–A18), and therefore our analysis focuses primarily on the change between historical and future time periods (Figures 2 and 3), rather than on the absolute values themselves (Figure 1).

Throughout the state, temperatures are highest in the spring, peaking in March or April. Temperatures drop during the summer monsoon season, from June through August. **By mid-century, all stations can expect an annual average increase of at least ~1°C above recently observed (1990–2020) temperatures, reaching up to ~1.4°C under the SSP5-8.5 scenario.**

[1] Daily observational station data was provided by KSDMA.

[2] CHELSA-downscaled monthly climatology data and the *delta method* are described in the Appendix.

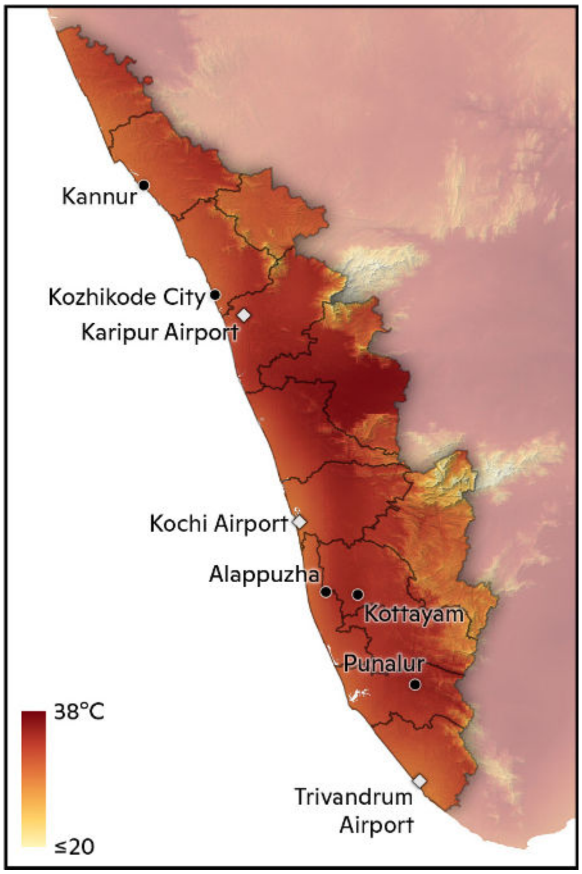


Figure 1. The historical (1990–2020) March average $T_{as,max}$ from CHELSA-downscaled model output.

Figure 2a. Kannur Temperature (°C)

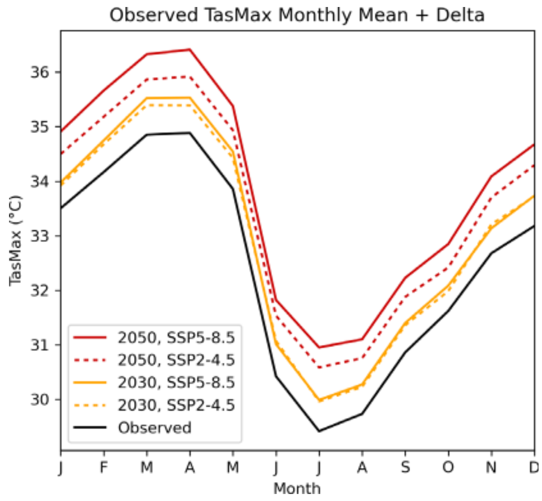


Figure 2b. Kozhikode City Temperature (°C)

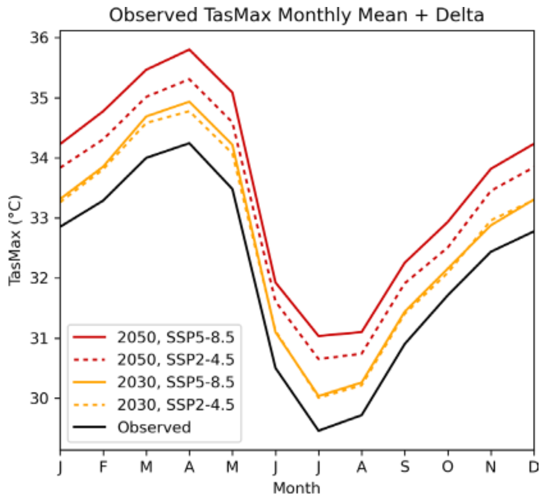


Figure 2c. Karipur Airport Temperature (°C)

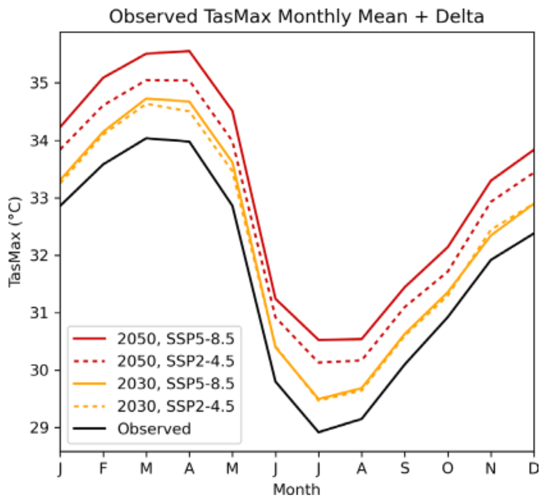


Figure 2d. Kochi Airport Temperature (°C)

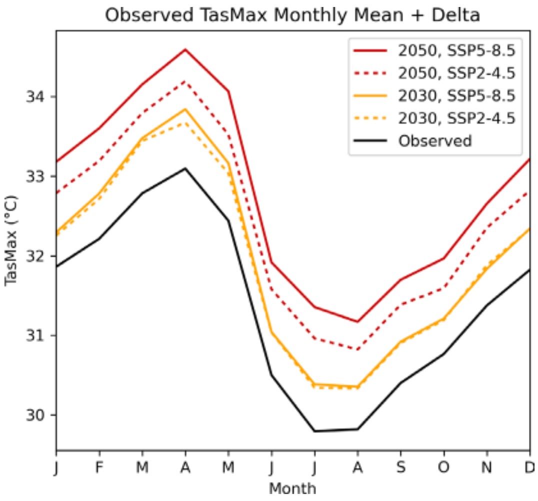


Figure 2e. Alappuzha Temperature (°C)

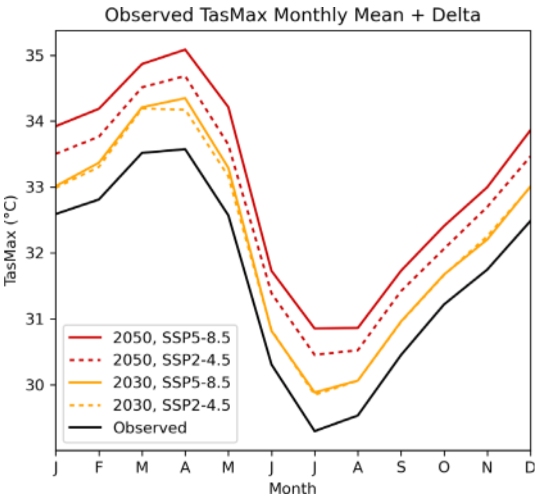


Figure 2f. Kottayam Temperature (°C)

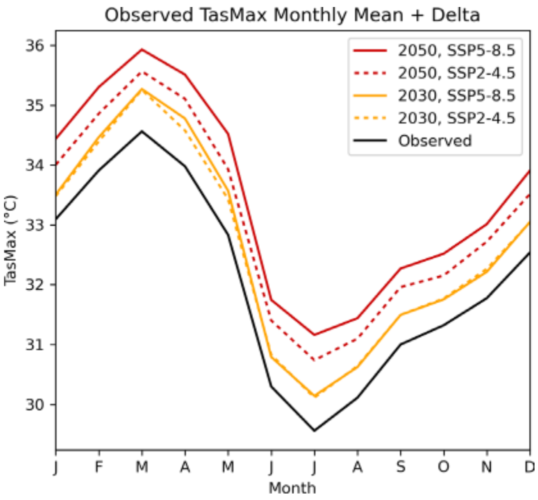


Figure 2g. Punalur Temperature (°C)

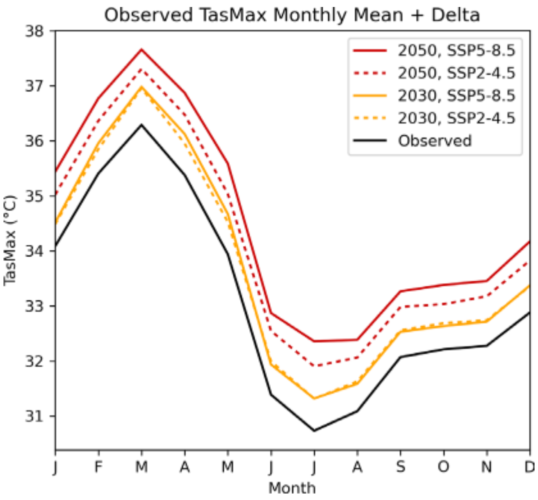


Figure 2h. Trivandrum Airport Temperature (°C)

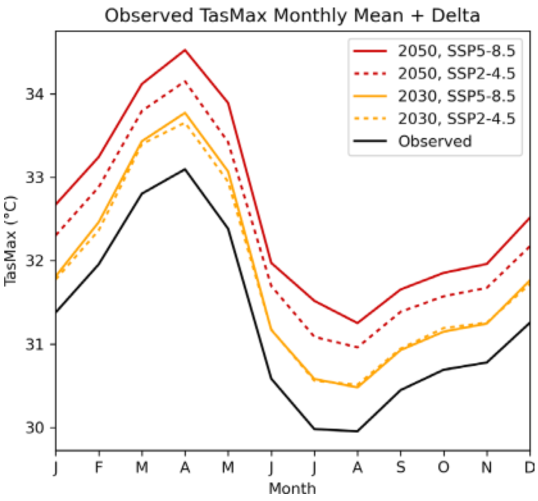
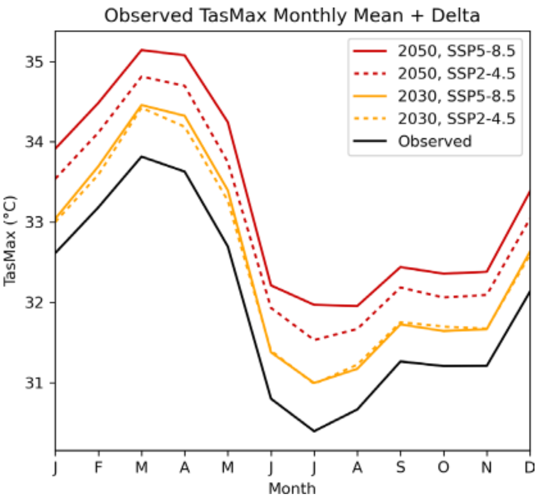


Figure 2i. Trivandrum City Temperature (°C)



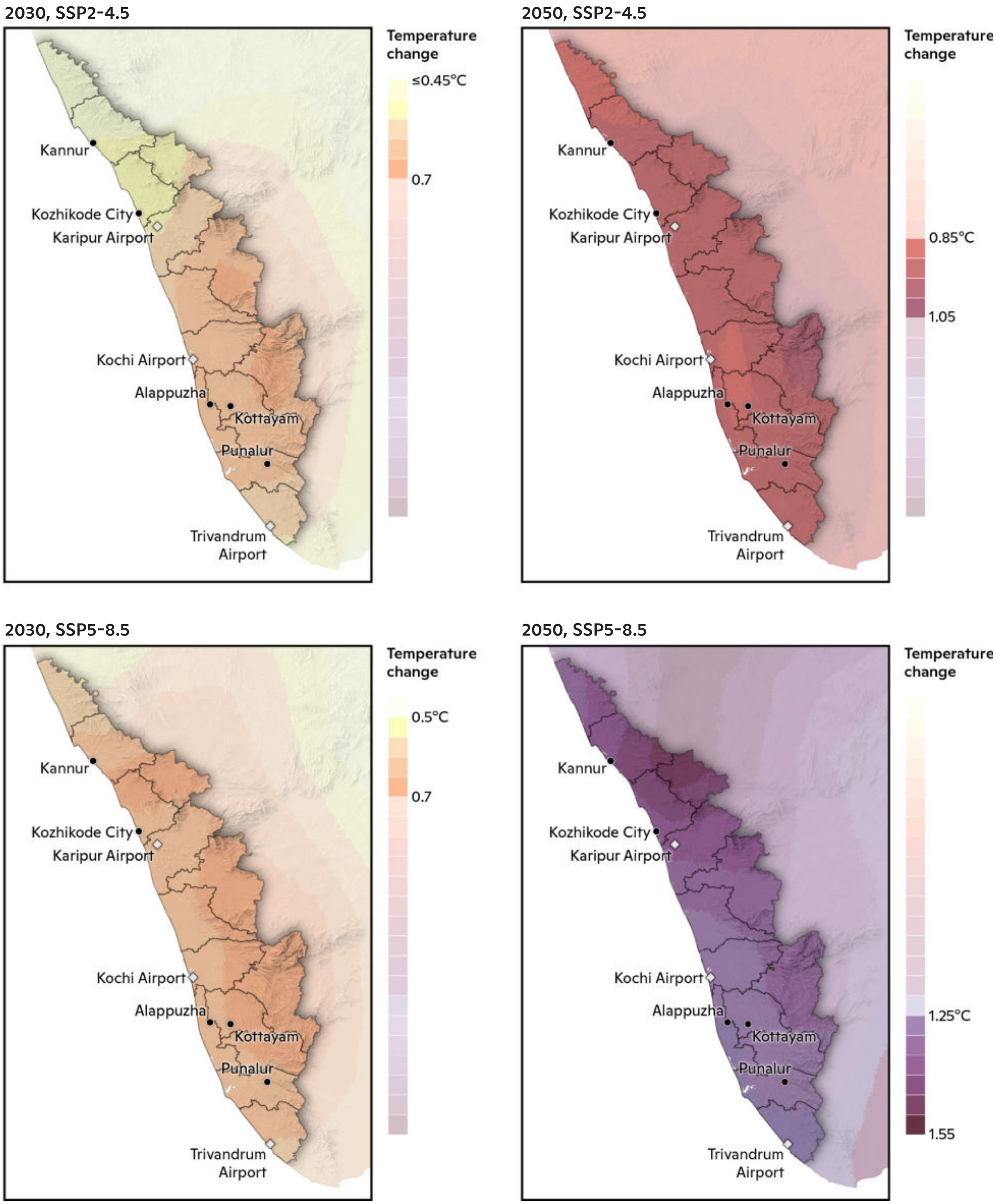


Figure 3. The projected increase in March $T_{as,max}$ under two time periods: 2030 (2020–2040) (left) and 2050 (2040–2060) (right), and two scenarios: SSP2-4.5 (top) and SSP5-8.5 (bottom). The colorbar range is consistent across subplots.

In the near-future (2030), March temperatures are projected to increase between 0.45 and 0.7°C under both scenarios. By mid-century (2050), the two scenarios diverge, with an increase of ~1°C under SSP2-4.5, and an increase of 1.25–1.55°C under SSP5-8.5.

In Kerala, summer has been arriving earlier and lasting longer. Considering the expanding summer season (February–May), we show that extreme temperatures[3] will rise even more than the monthly averages. Under the SSP2-4.5 scenario, the 95th percentile temperature is expected to increase by at least 1°C by mid-century (Figure 4). Under the SSP5-8.5 scenario, the 95th percentile temperature is expected to increase by at least 1.5°C by mid-century, with the change at some stations approaching 2°C (Figure 5).

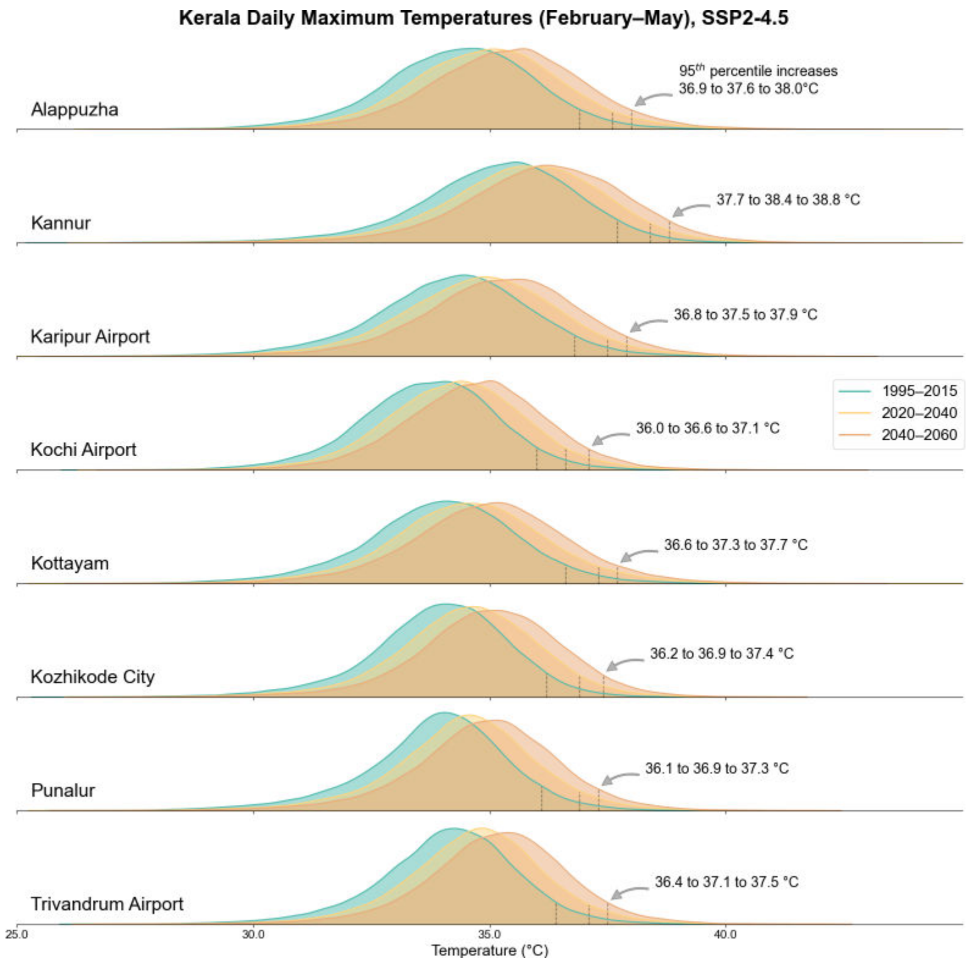


Figure 4. Projected daily $T_{as,max}$ distributions for February–May under the SSP2-4.5 scenario at each station. The 95th percentile temperature is highlighted for the historical (1995–2015), 2030 (2020–2040), and 2050 (2040–2060) time periods.

[3] CHELSA-downscaled daily W5E5 data is described in the Appendix.

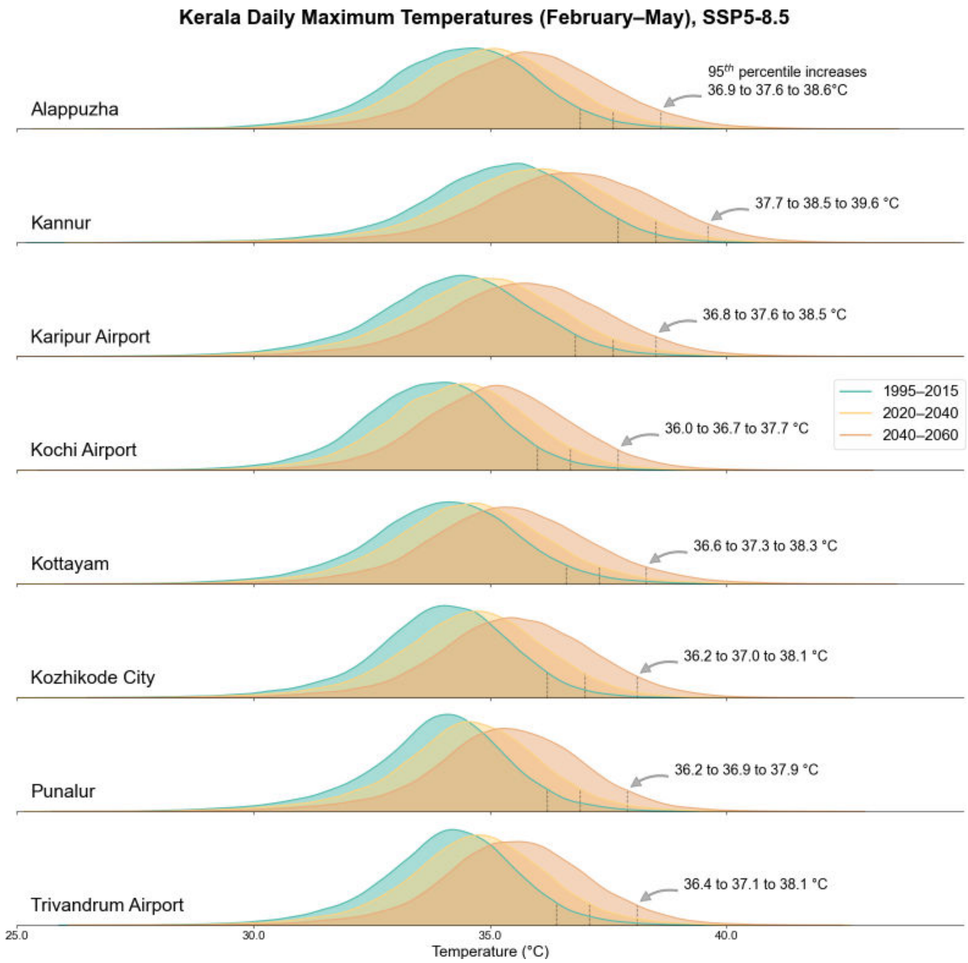


Figure 5. Projected daily $T_{as,max}$ distributions for February–May under the SSP5-8.5 scenario at each station. The 95th percentile temperature is highlighted for the historical (1995–2015), 2030 (2020–2040), and 2050 (2040–2060) time periods.

The impacts of climate change on the frequency and severity of physical hazards are putting many communities at risk. As the threat of climate change grows, so too does the need for accessible information, tools, and expertise to support climate-resilient decision making across multiple scales, from communities to countries. Woodwell Climate Research Center believes there is a need to localize and customize climate risk assessments. This information is critical for local government leaders as they make planning decisions, but it is not available to all communities. Woodwell Climate believes that this science should be freely and widely available. To address this gap, Woodwell Climate works with communities across the world, including the State of Kerala, India, to provide community climate risk assessments, free of charge.

Naegele, A.C., Lute, A.C., and Gassert, K.N. (2024). *Heat Analysis for Kerala, India*.
https://woodwellclimate.org/assessments/kerala

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149 Woods Hole Road, Falmouth, MA 02540 USA ▪ +1 508 540 9900 ▪ **woodwellclimate.org**