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A strong El Niño developing in 2026 could drive global surface temperatures to record highs

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The El Niño–Southern Oscillation (ENSO) is the most dominant mode of interannual variability in the global climate system,[1] and its warm (cold) phase is called El Niño (La Niña), which is associated with notable warming (cooling) and persistently anomalous westerly (easterly) wind in the tropical central and eastern Pacific. ENSO is often measured by the Niño3.4 index, which is defined as sea surface temperature anomalies averaged in 5°S-5°N, 170°W-120°W. ENSO can trigger widespread socioeconomic and ecological disruptions. Following the notable 2023–2024 El Niño,[2] which contributed to record-breaking global surface temperatures,[3] the climate community has remained vigilant in monitoring the tropical Pacific for precursors of the next major El Niño event. Recent observations and numerical model forecasts suggest that a strong El Niño may develop in the second half of 2026, raising urgent concerns about its potential impacts on global surface temperatures and climate systems.

POTENTIAL OF A STRONG EL NIÑO IN 2026

Strong subsurface ocean warming along the equatorial Pacific thermocline (https://ftp.cpc.ncep.noaa.gov/godas/monthly/) was observed in April 2026 (Figure 1C). Strong warming was also evident along the central and eastern equatorial Pacific thermocline in April 1997 and 2015 (Figures 1A-B), and both witnessed historical super El Niño events later that year (Figures 1D-E). Overall, the April subsurface maximum warming along the equatorial Pacific thermocline in 2026 (Figure 1C) is comparable to that in 1997 (Figure 1A) and 2015 (Figure 1B). Noticeably, compared with the warming pattern in February-March 1997 and 2015, the warming distribution along the Pacific thermocline is more homogeneous, probably due to the weak Kelvin wave activity in the early boreal spring of 2026.

To evaluate the predictability, we compare the North American Multi-Model Ensemble (NMME) hindcasts and forecasts with initial conditions (ICs) in early May 1997, 2015, and 2026 (https://ftp.cpc.ncep.noaa.gov/NMME). Although the NMME mean successfully predicted the super El Niño events in 1997 and 2015, it slightly overestimated their peak amplitudes (Figures 1D-E). Specifically, the December 1997 Niño3.4 index was forecast at 2.4°C, which was 0.2°C higher than the observed value (Figure 1D). Similarly, the forecast for December 2015 was 2.7°C, an overestimate of 0.2°C (Figure 1E). The forecast initialized in May 2026 predicts that the Niño3.4 index will reach 3.1°C by December 2026 (Figure 1F). This prediction indicates a high likelihood of a strong El Niño event developing in the second half of 2026, with a predicted intensity expected to surpass that of the 1997 and 2015 events, potentially being another extreme event (Figures 1D-F).

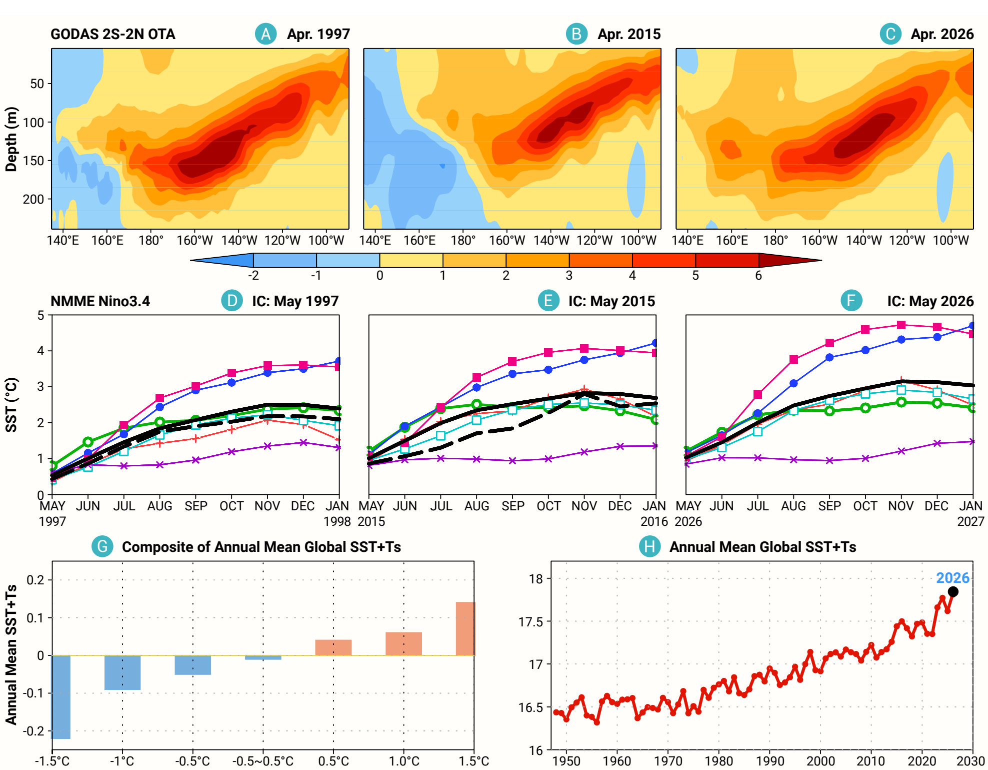

Figure 1. Pacific Ocean subsurface temperature anomalies averaged in 2°S-2°N in April (a) 1997, (b) 2015, and (c) 2026 Six NMME models hindcast or predict Niño3.4 index with initial conditions in May (d) 1997, (e) 2015, and (f) 2026. In (d-f), each colored curve represents an ensemble mean from a model, and the black curves are the means of all models (equal-weighted averages across the six model ensemble means), and the black dashed curves represent the observations (ERSSTv5-based Niño3.4). (g) Composites of annual mean GMST anomalies (y-axis) with the Niño3.4 index in November-December-January (NDJ) < -1.5°C, < -1.0°C, < -0.5°C, -0.5°C ~0.5°C, > 0.5°C, > 1.0°C, and > 1.5°C (x-axis), based on ERSSTv5, which represent strong La Niña, moderate-strong La Niña, all La Niña, neutral, all El Niño, moderate-strong El Niño, and strong El Niño, respectively. (h) Evolution of annual mean GMST. The black dot in (h) is the projected value for 2026. The data span the period of January 1948-December 2025, and the anomalies are referred to the monthly mean climatologies in the entire period in (g). The unit is °C.

Nevertheless, some models in NMME predicted stronger El Niños in two years, which is consistent with the low skill in model predictions with initialized in boreal spring,[4] implying a considerable uncertainty in the predictions, especially for the strength of El Niño in 2026. The uncertainty implies that subsurface thermal anomalies are an important precursor for ENSO evolution, but they are neither sufficient nor always necessary for a strong El Niño. Some other factors — including wind burst activity in the western and central tropical Pacific, the North Pacific Meridional Mode, Arctic sea ice, the Arctic Oscillation, and the Pacific Decadal Oscillation — may modulate how efficiently subsurface heat translates into surface warming, affecting the ENSO evolution and the strength of an El Niño or La Niña.

HISTORICAL CONTEXT OF ENSO AND GLOBAL TEMPERATURE

The influence of ENSO on global mean surface temperature (GMST), including over land (Ts; https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.psl.dataset.Climate_Prediction_Center_CPC_Global_Land_Surface_Air_Temperature_Analysis) and in the ocean (Extended Reconstructed Sea Surface Temperature (SST) version 5 (ERSSTv5); https://www.ncei.noaa.gov/products/extended-reconstructed-sst), is profound.[2,3] By categorizing historical ENSO events in 1948-2025 based on their intensity—weak (Niño3.4 index of 0.5°C–1.0°C), moderate (of 1.0°C–1.5°C), and strong (> 1.5 °C) El Niño, as well as La Niña and neutral phases—a clear signal emerges (Figure 1G). During strong El Niño years, GMST anomaly is typically elevated by more than 0.1°C above the long-term mean. Conversely, during strong La Niña years, the anomaly can be depressed by over 0.2°C (Figure 1G). This historical evidence underscores the substantial warming potential of strong ENSO events on GMST. Here, the composite is constructed from annual-mean GMST anomalies in ENSO development years. Nevertheless, ENSO events tend to peak in boreal late-autumn and winter, and their maximum impact on GMST may appear in their decay years. This delayed impact is relevant to whether the potential development of a strong El Niño event in the 2nd half of 2026 primarily warms GMST in 2026 or 2027.

Compared with the preindustrial period (1850-1900), GMST annual anomalies were 1.48°C, 1.60°C, and 1.47°C in 2023, 2024, and 2025, respectively, according to the Copernicus report (https://climate.copernicus.eu/global-climate-highlights-2025). Considering that the 2025-2026 winter was under weak La Niña conditions (leading to about 0.05°C cooling, Figure 1G), the GMST anomaly in 2026 is expected to reach 1.66°C (Figure 1H) if a strong El Niño materializes in the second half of 2026 (leading to about 0.14°C warming, Figure 1G). That implies a substantial probability that 2026 could become the hottest year on record, surpassing the record set in 2024.[3] Nevertheless, the surface temperature anomalies in other basins, such as the Indian and Atlantic Oceans, as well as over land, also contribute to GMST.

SIGNIFICANCE AND PROACTIVE PLANNING

Such a development of a strong El Niño would have far-reaching consequences. A strong El Niño can exacerbate marine heatwaves, disrupt global crop production, and trigger extreme weather events, including droughts and floods across various continents. The probability of record-breaking regional temperatures would increase substantially, posing serious risks to human health, water resources, and food security. For regional climate responses in East Asia to an El Niño event, for example, dry conditions are favorable in eastern China during summer and in the Yellow River basin during autumn, while floods may occur in southern China during autumn and winter.[5]

The potential emergence of a strong El Niño in 2026 is not merely a scientific curiosity; it would represent a major test of our preparedness for extreme climate events in a warming world. Climate model predictions, combined with advanced data assimilation systems, have significantly improved our monitoring and prediction capabilities. Yet the biases in the peak intensity of ENSO in past forecasts highlight that both observational and modeling advances are needed, alongside better characterization of irreducible uncertainty. The systematic overestimation of extreme El Niño amplitude in the latest NMME predictions for 1997 and 2015 El Niños (Figures 1D-E) likely reflects both model deficiencies (e.g., insufficient representation of westerly wind bursts, biases in the mean-state thermocline depth) and fundamental stochastic uncertainty. Such improvements are critical for providing accurate early warnings that enable timely action.

Given the likelihood of significant global impacts, the scientific community, policymakers, and disaster management agencies must engage in proactive planning. Enhanced early warning systems, infrastructure resilience measures, and international coordination for food and water security will be crucial in mitigating the potential risks. The prospect of a potentially strong or extreme event in 2026–2027, therefore, warrants close monitoring and immediate preparatory actions.

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AUTHOR CONTRIBUTIONS

Yunyun Liu: Writing – original draft, Conceptualization, Formal analysis; Zeng-Zhen Hu: Conceptualization, Methodology, Visualization; Shaoyu Zhang, Leng Sun, Chen Sheng, and Wei Tan: Writing – review & editing. All authors contributed to the manuscript and approved the final version.

DECLARATION OF INTERESTS

The authors declare no competing interests.