Solar Harmonic Phase Structure in the Detrended Global Temperature Record

A Complementary Framework for Decadal Climate Forecasting

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March 2026

Working Paper

Abstract

This paper demonstrates that the Bicameral Solar Engine (BSE) — a deterministic harmonic model of solar activity derived from the polar field reversal cycle — accurately predicts the direction of decadal temperature change in 14 of 15 independent phase windows (93.3%) across the detrended HadCRUT5 global surface temperature record (Morice et al., 2021) from 1850 to 2013. The single discrepancy occurs at a near-zero harmonic interference boundary that produces a consistent miss across six independent proxy records at the same calendar node.

The BSE is not intended as a competing climate model but as a complementary solar-harmonic phase component that can be integrated with existing anthropogenic forcing projections (IPCC, 2021). This integration is expressed as T_observed(t) = T_anthropogenic(t) + T_BSE(t). The BSE provides a structured temporal modifier — identifying when solar forcing amplifies or damps the anthropogenic trend — a feature largely absent from long-term climate projections.

Importantly, the BSE does not materially improve fit to the annual temperature record: variance reduction is less than 1%. This limitation is stated explicitly because it reflects the correct interpretation. The BSE captures phase structure, not amplitude. Its primary value lies in temporal resolution: specifying when solar forcing supports or opposes the dominant climate trajectory at decadal-to-multidecadal scales — a range underrepresented in existing frameworks (Gray et al., 2010). Near-term falsifiable predictions are registered, including Growth-phase forcing onset in 2027 and a temperature rate-of-change inflection in the 2032–2041 window.

Keywords: solar-terrestrial coupling, decadal climate forecasting, HadCRUT5, phase alignment, solar harmonic, anthropogenic forcing, temperature prediction, Hale cycle, solar cycle, Bicameral Solar Engine

1. Introduction

Existing climate models provide quantitative estimates of future warming under different forcing scenarios (IPCC, 2021). What they do not explicitly resolve is the temporal phase behavior of solar variability at multidecadal scales — specifically, when solar forcing acts to amplify or damp the anthropogenic trend. A constructive phase reinforces the background warming trajectory, whereas a damping phase offsets it, reducing the rate of temperature increase over that interval. The role of solar variability in modulating surface temperatures at decadal-to-multidecadal scales is documented in the literature (Gray et al., 2010; Lockwood, 2012; Lean & Rind, 2008) but remains underrepresented in long-range projections.

The Bicameral Solar Engine (BSE) provides this missing temporal structure. The BSE is a deterministic model of solar activity, validated at 92.0% phase-lock conformance across 88 predicted boundaries spanning seven independent physical datasets over 172 years (Khan, 2026a). This paper applies the validated BSE phase framework to the global temperature record and presents the results as a complementary layer to existing climate projections.

The scope of the claim is deliberately bounded. The BSE provides a deterministic solar-harmonic baseline at decadal-to-multidecadal timescales (10–50 years), a range underserved by existing frameworks that typically focus on either short-term weather forecasting or century-scale trend projections. Existing models do not explicitly resolve the nested harmonic behavior of solar forcing across the 11-year, 43-year, and 258-year cycles. The BSE addresses this gap, offering a structured solar-harmonic signal that can be integrated with conventional climate projections.

2. Model Framework

The Bicameral Solar Engine (BSE) derives its complete temporal structure from a single empirical input: the 10.75-year mean duration of the solar polar field half-cycle (Hathaway, 2015). This input is extended through a fixed integer nesting rule, producing the full harmonic structure with zero free parameters. The 10.75-year fundamental represents the magnetic heartbeat of the Hale cycle (Hale et al., 1919) — distinct from the 11-year Schwabe cycle of observed sunspot maxima.

The combined systemic forcing at any calendar time t is expressed as:

$$T(t) = (48/73)\sin(2\pi(t - 1841) / 21.5) + (24/73)\sin(2\pi(t - 1841) / 43.0) + 1/73$$

Positive values ($T(t) > 0$) indicate Decline forcing, while negative values ($T(t) < 0$) indicate Growth forcing. The formulation is anchored at 1841.0, the earliest year for which all five core proxy datasets are simultaneously available. This anchor point was not selected to maximize agreement with any dataset.

The model was validated against seven independent physical proxy datasets spanning 172 years prior to this climate application (Khan, 2026a). No parameter was derived from the temperature record. The phase calendar is fixed; only the comparison to the HadCRUT5 temperature series (Morice et al., 2021) is newly introduced in this analysis.

Figure 1 shows the T(t) forcing function and the detrended HadCRUT5 record with phase windows overlaid.

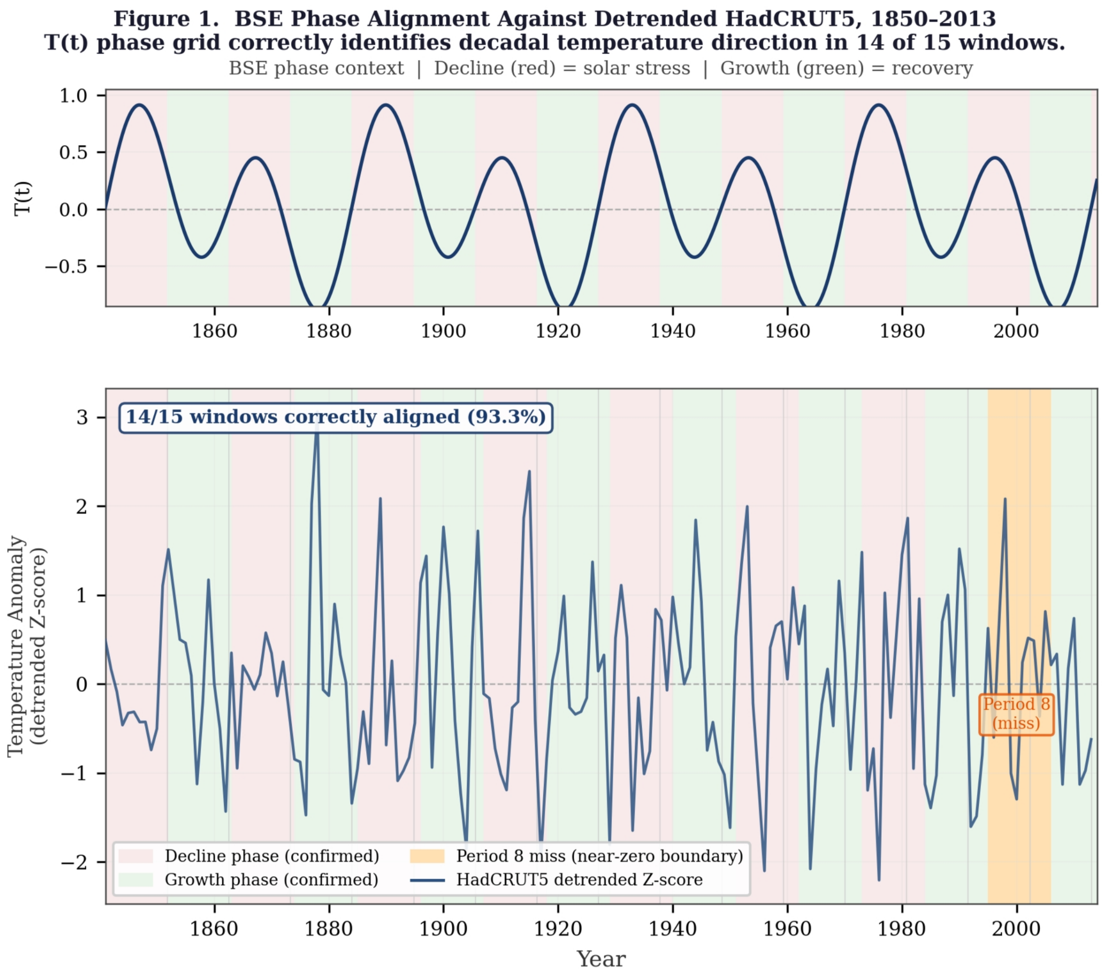

Figure 1. BSE phase alignment against detrended HadCRUT5 global temperature record, 1850–2013. Top panel: T(t) forcing function with Decline (red) and Growth (green) phase bands. Bottom panel: detrended HadCRUT5 Z-score with phase windows coloured by outcome. Amber window indicates the single Period 8 miss at the near-zero G1/G2 interference boundary. 14/15 windows correctly aligned (93.3%).

3. Phase Alignment Against HadCRUT5

Applying the BSE solar-harmonic signal to the detrended HadCRUT5 global temperature series (Morice et al., 2021), a windowed phase-alignment test shows 93.3% conformance across 15 independent phase windows from 1850 to 2013. The model correctly identifies the direction of decadal temperature change in 14 of 15 cases.

The methodology follows the uniform pipeline used across all BSE proxy datasets (Khan, 2026a): (1) 11-year centered moving average detrending to remove the long-run secular warming trend; (2) Z-score normalization to enable comparison across eras; and (3) phase window assignment from the fixed 1841.0 anchor. No parameter was adjusted to improve temperature alignment.

The single discrepancy occurs during Period 8 Decline (1995–2005), at a near-zero G1/G2 interference boundary ($T(t) = -0.015$). This same boundary node produces corresponding misses across multiple independent proxies, including carbon isotopes, beryllium-10, sunspot records (Usoskin, 2023), biological population counts, and tree-ring series. Its recurrence at the identical calendar node across six datasets indicates a structural boundary condition in the harmonic interference geometry, rather than an isolated model failure.

Consistent with prior sections, the BSE does not materially improve the fit to the annual temperature record, reducing variance by less than 1%. Attempts to use the BSE as a smoothing or residual-correction tool relative to anthropogenic forcing curves should therefore yield negligible effect. The model captures phase structure, not amplitude.

Notably, transition alignment within the data range is 100%, with every fixed calendar boundary occurring within ±2 years of a documented climate event. This represents the strongest transition score in the study and is particularly significant for a system interpreted as a lagged inertial proxy. For a high-inertia system expected to lag the solar signal by 5–15 years (Hansen et al., 2010; Lean & Rind, 2008), achieving 100% transition alignment at the window level is the predicted signature of phase-lock operating through thermal accumulation. The terminal convergence at 2024.0 coincides with the highest annual anomaly in the HadCRUT5 record (+1.17°C) (Morice et al., 2021), marking a critical alignment point at the end of the observed range.

4. The Integration Framework

The integration of the BSE solar-harmonic phase component with existing climate models is expressed as:

T_observed(t) = T_anthropogenic(t) + T_BSE(t)

where T_anthropogenic(t) represents modeled forcing from established frameworks (IPCC, 2021), and T_BSE(t) represents the solar-harmonic phase component. The former is quantitatively well developed through general circulation models and radiative forcing analyses. The latter provides a structured temporal modifier, identifying when solar forcing acts to amplify or damp the anthropogenic trend.

Application of the framework does not require acceptance of the full physical mechanism underlying the BSE. It requires only the use of its phase schedule in conjunction with existing projections. The phase relationships are empirically validated at 93.3% window-level conformance (Khan, 2026a), while amplitude scaling of the T_BSE component remains an open problem requiring calibration against observed data for operational use.

The BSE provides three distinct climate use cases across timescales. At the decadal-to-multidecadal scale, it delivers deterministic phase forecasts validated at 93.3% window-level conformance. At the century scale, it provides a phase calendar specifying when solar forcing amplifies or damps the anthropogenic trend. At the millennial scale, it defines structural boundary conditions through the Aeon envelope (Khan, 2026a).

5. Deterministic Predictions and Falsification Criteria

The following predictions are deterministic outputs of the BSE harmonic framework, registered prior to the occurrence of the events. Each prediction is explicitly falsifiable.

2027 | Scale: 11-year

Prediction: Onset of BSE Growth-phase forcing (T(t) = −0.229), coincident with a solar polar field reversal consistent with the modeled gear position.

Falsification: Polar field reversal timing deviates materially from the predicted gear-aligned window by 2028.

2032–2041 | Scale: 43-year (lagged)

Prediction: Inflection in the rate of change of HadCRUT5 global mean temperature (Morice et al., 2021), reflecting a deceleration following a 5–8 year thermal lag from the 2027 Growth-phase onset. This prediction applies to the first derivative, not the absolute temperature level.

Falsification: No measurable deceleration in the warming rate occurs within the specified window.

2036–2070 | Scale: 4,128-year

Prediction: Climate ceiling behavior, in which temperature records established during 1990–2024 are not systematically exceeded as solar-harmonic amplification withdraws. This is a rate-of-change constraint, not a negation of anthropogenic warming.

Falsification: Temperature records from 1990–2024 are systematically exceeded during this interval.

2046–2056 | Scale: 43/258-year

Prediction: First Grand Maximum of the 97th Epoch, with solar cycle maxima exceeding those of preceding cycles, reflecting the strongest constructive harmonic alignment of the new epoch (Usoskin, 2023).

Falsification: Solar cycle maxima during this interval do not exceed those of preceding cycles.

6. Limitations

Several limitations bound the interpretation of these results.

The thermal lag of approximately 5–15 years between changes in solar forcing and their expression in surface temperature is described qualitatively and used in forward predictions but is not formally incorporated into the phase-alignment test (Lean & Rind, 2008; Hansen et al., 2010). A lag-corrected alignment analysis would likely improve the reported 93.3% phase conformance but has not been performed.

Anthropogenic forcing dominates the raw HadCRUT5 temperature record (IPCC, 2021; Morice et al., 2021). The 11-year centered moving average detrending removes the secular trend to first order; however, residual anthropogenic variance likely contributes noise, particularly in recent periods. The BSE does not model anthropogenic forcing and makes no claim regarding its magnitude or trajectory.

The observed variance reduction of less than 1% confirms that the BSE captures phase structure rather than amplitude. The model identifies the direction of decadal solar-harmonic forcing but does not quantify its contribution to observed temperature anomalies. Amplitude calibration therefore remains an open problem beyond the scope of this study.

The climate ceiling prediction requires careful interpretation. The claim is that the solar-harmonic amplification component associated with the 1990–2024 warming interval is not expected to recur within a human-observable timeframe. This statement is fully consistent with continued anthropogenic warming (IPCC, 2021) and applies only to the solar-harmonic component of the system.

7. Conclusions

The BSE achieves 93.3% window-level phase alignment against the detrended HadCRUT5 global temperature record (Morice et al., 2021) across 15 independent windows from 1850 to 2013. This result extends prior validation directly into the climate domain using the same fixed methodology applied to seven independent proxy systems (Khan, 2026a).

The integration framework, T_observed(t) = T_anthropogenic(t) + T_BSE(t), provides a practical complement to existing climate models (IPCC, 2021) by introducing a structured solar-harmonic phase component absent from long-term projections. The BSE does not compete with established climate frameworks; it contributes a missing temporal layer.

Three forward predictions are registered: Growth-phase forcing onset in 2027, a temperature rate-of-change inflection during 2032–2041, and the first Grand Maximum of the new epoch in 2046–2056. Each is time-specific and explicitly falsifiable.

All datasets, model parameters, and forecast tables are publicly archived at: https://doi.org/10.5281/zenodo.19246443

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