The KC Brazil Water Deficit Signal: A TERRACLIMATE PET-AET Drought Lens for Arabica

Why monthly water deficit (potential evapotranspiration minus actual evapotranspiration) across Cerrado and Sul-Minas, z-scored on a 10-year rolling window, delivers a clean monotone phase pattern on forward 60-day Arabica returns across 24 years.

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The signal with the limits stated upfront

Three things the reader must know before the rest of this brief lands.

First, the full-distribution daily Spearman information coefficient against Arabica forward 60-day returns is plus 0.050 at p-value 9.9e-05 on a sample of 5,951 daily observations. Significant, economically modest. Phase +1 (Water Deficit) delivers plus 1.18 percentage points above baseline across 2,031 trading days (33.8 percent of sample); Phase –1 (Water Surplus) delivers minus 0.79 percentage points below baseline across 3,139 days (52.2 percent). 1.97 pp directional spread with a clean monotone pattern.

Second, the non-overlapping independence test at 60-day sampling is sign-consistent but not independently significant. Across 100 independent samples the Spearman is plus 0.079 with p-value 0.43. The daily IC is reliable in sign but should be paired with other signals rather than used standalone.

Third, the 10-year z-score window is young by climate standards. TERRACLIMATE data begins in 2000-01; the usable signal starts 2002-12 after the first 10-year window matures. Early-sample readings carry less precision than mature-window readings. Monthly TERRACLIMATE cadence also means the signal updates slowly (15 to 30 day lag).

The thesis: PET-AET captures HOT-DRY interaction

Brazil produces roughly 35 percent of the world Arabica coffee crop, concentrated in Cerrado (Minas Gerais state) and Sul-Minas (the broader southern coffee belt). Arabica is a rainfall-dependent crop; yield is determined by soil-water availability during flowering (September through January) and cherry-development (October through March).

TERRACLIMATE captures the HOT-DRY interaction that pure-precipitation metrics miss. Rainfall can be normal but high potential evapotranspiration (temperature plus vapor pressure deficit) still stresses yield by pulling water out of the plant faster than roots can replenish. The signal takes the

monthly PET minus AET deficit, z-scores it on a 10-year rolling window, and tanh-bounds. Positive composite equals severe water deficit (drought) equals yield stress equals bullish Arabica.

The 10-year window matters. Climate drift means absolute water-deficit levels have risen over the 2000-present era; the 10-year rolling z-score isolates the drought-of-record anomaly from the longer-term climate trend. TERRACLIMATE data begins 2000-01; the usable signal starts 2002-12 after the first 10-year window matures.

What the firings have actually done

The directional edge concentrates in the extreme buckets. Computed over 6,011 daily observations post-warmup from December 2002 through November 2026.

> **Baseline Arabica forward 60-day return:** mean plus 2.72 percent / median plus 0.59 percent across the live-window sample. (Median-mean gap reflects fat-tailed Arabica return distribution with drought-driven rally spikes.)
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> **Daily Spearman IC (fwd 60d):** plus 0.050, p-value 9.9e-05, N equals 5,951.
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> **Daily Pearson IC (fwd 60d):** plus 0.068, p-value 1.5e-07.
>
> **Non-overlap IC (60-day step):** plus 0.079, p-value 0.43, N equals 100. Sign-consistent with daily IC but not independently significant at 5 pct.
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> **Phase-conditional forward 60-day Arabica returns:** Phase +1 (Water Deficit, 2,031 days / 33.8 pct): plus 3.90 percent, edge plus 1.18 pp. Phase 0 (Normal Balance, 841 days / 14.0 pct): plus 2.78 percent, edge plus 0.06 pp. Phase –1 (Water Surplus, 3,139 days / 52.2 pct): plus 1.93 percent, edge minus 0.79 pp.
>
> 1.97 pp directional spread between Phase +1 and Phase –1.

Three findings. The pattern is monotone across phases (Water Deficit positive, Normal mid, Water Surplus negative), consistent with the stated yield-stress mechanism. The 1.97 pp directional spread is tighter than long-lead ENSO or realized-price signals but faster-updating (1-3 month lead vs 3-9 months). The signal is best used as a stacked overlay in combination with the ENSO signal (long-lead ocean forcing) and the Cecafe realized-price signal (short-lead transaction confirmation).

Three cases that frame how to read the signal

The canonical anchors are the 2014 drought-of-record, the 2020-2021 compound drought preceding the 2021 frost, and the 2009-2010 wet-Brazil regime.

Case 1: The 2014 Brazil drought-of-record

Water Deficit extreme firing began January 2014 as TERRACLIMATE PET-AET surged across Cerrado and Sul-Minas. The 2014 Brazilian drought became the drought-of-record for the modern era; the composite stayed in Phase +1 territory through much of the January-March 2014 flowering window, anticipating the 2014-2016 Arabica rally. Forward 60-day return at the January 30, 2014 trigger was plus 65.67 percent reflecting the sharp yield-stress-driven rally. This is the signature anchor for how the signal reads a drought-of-record event.

Case 2: The 2020-2021 compound drought

Water Deficit firing began July 2020 as La Nina conditions combined with Southeast Brazil winter drought. The compound deficit extended through 2021 and intersected with the late-June 2021 Minas Gerais frost, producing the broadest Brazilian yield shock since 1994. The composite anchored the Phase +1 regime that preceded the 2021-2022 Arabica rally. Multi-quarter Phase +1 anchor. Compound-stressor case where water deficit and frost combined.

Case 3: The 2009-2010 wet-Brazil regime

Water Surplus firing began October 2009 as abundant moisture returned to Cerrado and Sul-Minas after the 2008-2009 La Nina transitioned toward neutral. The composite held in Phase −1 territory for 125 trading days through early 2010, consistent with the loose-supply regime. Forward 60-day at the trigger was plus 5.13 percent, counter to the stated bearish-polarity expectation. This case illustrates Phase −1 heterogeneity: individual wet-Brazil episodes can still deliver positive Arabica returns when non-water supply shocks (Vietnamese Robusta, policy, speculative flows) dominate.

How to use this signal today

Composite is currently reading minus 0.742 in the Water Surplus band. The STRESS phase began December 2025, 234 trading days ago, meeting the BTD danger threshold. TERRACLIMATE PET-AET across Cerrado and Sul-Minas has run significantly below its 10-year trend; actual evapotranspiration is keeping up with potential demand.

Pair with the following for stacked conviction: the ENSO signal (long-lead ocean forcing — the current El Nino regime is consistent with the water-surplus reading), the Cecafe realized-price signal (short-lead transaction confirmation), ICE Europe COT positioning, and USDA FAS Brazil coffee attache reports. The water-deficit signal leads by 1 to 3 months; use it as a short-lead confirming layer for the long-lead ENSO signal.

Reader rule: Phase +1 firings are short-lead bullish Arabica setups with historical conviction in drought-of-record episodes. Phase −1 firings are short-lead bearish-Arabica setups with meaningful heterogeneity across individual triggers.

Methodology

Data source: TERRACLIMATE monthly potential-evapotranspiration (PET) and actual-evapotranspiration (AET) for Cerrado and Sul-Minas Brazilian coffee growing regions. Computation: monthly water deficit equals PET minus AET in millimeters, averaged across the Cerrado plus Sul-Minas region; z-scored on a 10-year rolling window; tanh-bounded to plus or minus one. State thresholds plus or minus 0.2 (moderate) and plus or minus 0.5 (extreme). Phase +1 at composite above +0.3, phase −1 below −0.3. Target: ICE US Coffee C first-nearby close.

Historical window: TERRACLIMATE data begins 2000-01; usable signal starts 2002-12 after the 10-year warmup.

Validation computed on 6,011 post-warmup daily observations. Daily Spearman IC plus 0.050 at p-value 9.9e-05 across 5,951 observations. Phase +1 per-day forward return plus 3.90 percent (plus 1.18 pp above plus 2.72 percent baseline). Phase −1 per-day forward return plus 1.93 percent (minus 0.79

pp below baseline). 1.97 pp directional spread. Non-overlap IC (every-60-day) sign-consistent at plus 0.079 but not independently significant (p-value 0.43, N equals 100).

What this signal does not cover

The signal does not cover non-water supply shocks (Brazilian frost outside water-deficit periods, policy changes, Vietnamese Robusta substitution flows). It does not cover ICE futures positioning (CFTC COT is a separate layer). It does not cover ENSO dynamics directly (see the sibling ENSO Dry Season signal for ocean-forcing long-lead view). It does not deliver a reliable signal in very short horizons (monthly TERRACLIMATE cadence makes the signal slow-moving). Individual Phase −1 triggers show heterogeneity, so the bucket aggregate is a weaker guide on the wet-Brazil side than on the drought side.

The signal is a short-to-medium-lead TERRACLIMATE water-deficit lens for Brazilian Arabica. Use as part of a stacked view with ENSO and realized-price signals.

Disclaimer

This brief and the signal it describes are for informational purposes only and do not constitute investment, legal, tax, or trading advice. Hypothetical or simulated performance results have certain inherent limitations. Unlike an actual performance record, simulated results do not represent actual trading. Also, since the trades have not been executed, the results may have under- or over-compensated for the impact, if any, of certain market factors, such as lack of liquidity. Simulated trading programs in general are also subject to the fact that they are designed with the benefit of hindsight. No representation is being made that any account will or is likely to achieve profits or losses similar to those shown. The phase-conditional forward-return stats reported above are a full-sample unconditional measurement. Readers should consult a licensed financial professional before taking any trading action.

References

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