Response to Reviewer 3

We thank the reviewer for the positive assessment and the detailed and constructive comments, which will help us to improve our manuscript. Reviewer comments are shown in italics; our responses follow in plain text.

Comment 1: *The separation of "dynamic" and "thermodynamic" contributions in the flow-analogue method is not sufficiently well defined*
This study uses a flow-analogue approach to decompose the T850 temperature anomaly, defining the "dynamic contribution" as the composite of the circulation analogues and the "thermodynamic contribution" as the residual between the observed anomaly and the analogue composite. While this is methodologically defensible, the terminology is somewhat misleading. The residual term does not purely represent background thermodynamic warming; it also captures other processes not fully encoded by the Z500 field, such as differences in vertical motion intensity, subtle variations in moisture transport, and land-surface feedbacks (e.g., soil moisture depletion). The authors acknowledge this caveat in the conclusions, but the abstract and main text repeatedly use the simplified term "thermodynamic amplification," which may lead readers to overestimate the method's ability to physically separate these processes.
***Suggestion**: In the Methods section, the authors should more clearly state that the residual is a "circulation-constrained approximation". I recommend using more neutral terminology such as "residual thermodynamic component" or "non-circulation component" to avoid over-interpretation.*

> **Response:** We fully agree. In the revised version of the manuscript, we will state that the residual is a circulation-constrained approximation of the thermodynamic contribution rather than a clean separation, and that it may contain unmatched circulation amplitude and processes not encoded in Z500, such as land-surface feedbacks. The term “thermodynamic amplification” will be replaced throughout, including in the abstract, by “non-circulation (residual) component”.

Comment 2: *The abstract and conclusions state that the June 2026 event represents a "new class" of early-summer heatwaves, characterized by intensity-dominance, record-shattering temperatures, and relatively compact duration. This is an appealing synthesis, but at present it appears to be a qualitative description based on a single event, rather than a formally defined classification. Without a quantitative criterion, the term "new class" reads more as a rhetorical summary than as a scientifically testable category.*
***Suggestion:** I recommend that the authors propose a more explicit definition for this classification. For example, one could define a metric based on the ratio of intensity to duration (number of heatwave days), or on the relative magnitudes of the dynamic and residual thermodynamic contributions.*

> **Response:** We agree that a single event cannot define a new class, and we will remove this term. Following the reviewer’s suggestion, we will use the ratio of cumulative intensity to duration, i.e., the mean exceedance per heatwave day. With 11.6 °C, the June 2026 event has the highest value of all 23 May–June heatwaves of the Germany-average record and exceeds all 60 May–September heatwaves of 1951–2025. Together with the rank analysis which we will add in the revised version of the manuscript (the intensity metrics are records under all tested definitions, the duration metrics are not), this defines the event quantitatively as intensity-dominated.

Comment 3: *A discussion of the PVy (potential vorticity meridional gradient) mechanism would strengthen the dynamical interpretation of the blocking persistence.*

The study convincingly demonstrates that the June 2026 heatwave was driven by a persistent omega-type blocking anticyclone. However, the manuscript does not explore the underlying dynamical mechanisms that enabled this blocking system to remain stationary and amplify over Central Europe for several consecutive days. The authors attribute the event to a "persistent blocking ridge" but do not offer a physical explanation for why this particular blocking events was so exceptionally resilient.

Recent studies have highlighted the crucial role of the meridional gradient of potential vorticity (PVy) in modulating atmospheric blocking persistence (Luo et al., 2023; Luo et al., 2025). A weakened PVy can impact the maintenance of quasi-stationary blocking ridges. Given that the June 2026 event was characterized by a remarkably stationary omega-blocking that persisted through the peak phase (25–29 June) and produced record-shattering temperatures, it would be highly instructive to examine whether anomalous PVy conditions preceded or accompanied this event.
Suggestion: I recommend that the authors extend their dynamical analysis by computing the PVy fields over the Euro-Atlantic sector during the June 2026 event, and comparing them against the climatological mean and against historical blocking episodes. Such an analysis would provide a mechanistic explanation for the exceptional persistence of the blocking system. This would substantially strengthen the paper's dynamical interpretation and place the 2026 event within the broader framework of recent advances in blocking dynamics.

Response: We thank the reviewer for this suggestion and we will add a new analysis in the revised version of the manuscript for daily ERA5 PV at 350 hPa, Z500 and blocked grid points for 25–29 June. Following Luo et al. (2019, 2023, 2025), we will compute the background meridional PV gradient, $PVy = \beta - \partial^2 u/\partial y^2 + u/L_d^2$ (L_d = 1000 km), from the time- and sector-mean 500 hPa zonal wind for the Euro-Atlantic (40° W–40° E) and European (10° W–30° E) sectors, and compared it with the same calendar periods in 1940–2025.