Subject: High-level revision strategy for manuscript No.: egusphere-2026-725, "Synoptic drivers of the August 2024 record-breaking rainfall in the Chadian Sahara: Dynamics, thermodynamics, and socio-economic consequences"

Dear Peter,

We sincerely thank you for managing the review process and for your constructive guidance. We welcome the high-quality assessments provided by both reviewers. We fully acknowledge the seriousness of their core concerns specifically regarding the risk of overly simplistic interpretations, speculative inferences, or a lack of explicit physical connections between the multi-decadal trends and the synoptic drivers of the August 2024 extreme event.

To ensure the scientific content strictly substantiates every claim, we have designed a **comprehensive, high-level revision strategy** organized around three main pillars. We plan to restructure and enhance the manuscript as follows:

1. Transitioning from Descriptive Climatology to a Robust Statistical and Physical Baseline

The Issue: Reviewers noted that our original claims of an abrupt "tipping point" or "structural shift" around 2003 lacked visual and statistical support, leading to speculative hydrological conclusions.

Our Strategy: We are removing all speculative terminology (e.g., "tipping points", "hydrological regime shifts"). Instead, we are implementing a rigorous parametric framework by fitting a continuous **two-parameter Gamma distribution via Maximum Likelihood Estimation (MLE)** to the 1983 - 2024 precipitation series, which is the standard benchmark for highly asymmetrical Saharan regimes. This allows us to frame 2003 objectively as a *climatological transition threshold* where the forced multi-decadal linear trend crossed the long-term historical baseline mean, shifting the region into a consistently moister "new normal" background state.

2. Substantiating Inferences with Quantitative Multi-Decadal Atmospheric Forcing

The Issue: The reviewers rightly highlighted a gap in demonstrating whether the long-term precipitation evolution was physically forced by parallel atmospheric mechanisms, or if interpretations were shallow.

Our Strategy: To ground our conclusions in hard atmospheric physics, we have extracted and analyzed the 42-year (1983 - 2024) historical time series of **Integrated Vapor Transport (IVT)** from ERA5 over our Northern Chad domain. We are adding a new, highly robust diagnostic figure to the manuscript showing that IVT exhibits a statistically significant monotonic increase (Sen's slope: 1.28 $kg.m^{-1}.s^{-1}$/yr, $p < 0.001$, Relative Magnitude: +59.2%). This directly mirrors the rainfall trajectory, crossing its own baseline mean in 2003 and peaking at an unprecedented historical maximum in August 2024. This bridges the gap between long-term climatological humidification and the 2024 event.

3. Curing Interpretative Ambiguities in Synoptic and Thermodynamic Drivers

The Issue: Reviewers pointed out potential overinterpretations regarding sub-synoptic features (like individual Mesoscale Convective Systems - MCSs) or ambiguous spatial vector interpretations.

Our Strategy:

We have audited the Title, Abstract, and Text to strictly align them with our monthly synoptic scope, removing any overinterpretation regarding un-tracked high-frequency cloud lifetimes.

We are systematically applying a **Monte Carlo significance test (1,000 permutations)** on our anomaly fields, adding explicit stippling (95% confidence level) to ensure visual proof of field significance.

We have corrected technical ambiguities in our cross-sections (explicitly defining the *meridional-vertical circulation* vectors and clarifying the mathematical artifacts behind apparent subsidence

signs) and specified the thermodynamic layer analyzed (**850 hPa level** for Moist Static Energy and θ_e anomalies).

By anchoring the revised manuscript in this dual statistical-physical framework (Gamma-MLE return periods + multi-decadal IVT budget forcing + Monte Carlo significance), we are confident that the revised paper will provide a deep, mechanistic, and highly substantiated analysis perfectly suited for *Weather and Climate Dynamics*.

We look forward to your approval of this high-level plan before we proceed with submitting the final concrete changes.

Best regards,

Claudin WAMBA TCHINDA, on behalf all the authors