

Review of “On the Mechanisms that Control the Rainy Season Transition Periods in the Equatorial Congo Basin” by Worden and Fu. [MS No., egusphere-2025-4330]

This study presents a comprehensive investigation of the mechanisms that govern the onset of spring and fall rainy seasons in the equatorial Congo Basin, with a primary focus on the roles of local evapotranspiration and regional circulations, based on satellite and reanalysis data. The authors conduct a detailed analysis of how horizontal moisture transport (regional circulations), local factors (evapotranspiration and topography), and atmospheric dynamics (e.g., CAPE and wind shears) and thermodynamics (lower-tropospheric stability) evolve across before-, early-, and late-transition stages of the rainy seasons. Particular attention is given to variations in moisture sources by examining moisture transport across the different Congo Basin boundaries. The differences of onset mechanisms between two seasons (spring vs. fall) and between two regions (equatorial vs. southern Congo Basin) are also discussed.

The paper is overall well written and organized, very easy to follow. This study provides a useful process-based framework for understanding rainy season onset, and its outcomes may also help identify the precursors of rainy season onset in the Congo Basin, critical for rainy season prediction. However, there are some limitations or necessary clarifications related to the definition of the rainy season onset and the interpretation of the physical mechanisms. If these limitations, along with the minor issues listed below, are addressed, I believe the manuscript would be very suitable for publication in ACP.

Major comments:

1. In Section 2.2, the authors define the onset and end of the rainy seasons, using criteria based on the number of pentads exceeding or falling below the climatological mean (i.e., X out of Y pentads). But both X and Y seem to differ between the onset and end definitions, as well as between spring and fall seasons. It would be helpful if the authors could clarify how these numbers were selected and whether the identified rainy season onset and end pentads are sensitive to the choice of these numbers.

A related suggestion is to reorganize Figure 2. The authors may consider merging RSO and RSE in a single panel for each season, with year on the y-axis and pentad (also with months indicated) on the x-axis. Such a format would allow readers to more easily spot the start, end, and length of a spring/fall rainy season in each year. The authors can also easily test if this figure is sensitive to the different X and Y number choices.

2. The moisture flux convergence ($\nabla \cdot \text{MF}$) can be decomposed into the moisture convergence term ($q\nabla\vec{V}$) and the moisture advection term ($\vec{V}\nabla q$). In Figure 4, the authors presented only the convergence term, without analyzing or discussing the advection component, which represents the effect of winds transporting moisture across humidity gradients. Please clarify why only the convergence term is shown or whether the advection term is negligible or secondary. A brief quantitative comparison would strengthen the interpretation of the moisture budget.

3. It is great to see the authors have a thorough examination of the roles of multiple dynamic and thermodynamic processes in the onset of the rainy seasons. However, the relative importance of

these difference process has not been quantitatively assessed. The authors may consider providing a quantitative estimate of their respective contributions. For example, a simple multilinear regression (MLR) framework could be used to relate rainfall rate changes to variations in the key physical processes across the transition period, and the explained variance associated with each process could indicate the contribution.

4. The authors provide a clear summary of how different dynamic and thermodynamic processes changes during the early and late transition period of rainy season onset. To facilitate comparison among seasons, processes, and transition phases, the authors may consider adding a summary table that synthesizes the changes in key physical processes during each phases. This would help readers quickly identify the important precursors and better understand how different processes contribute to the onset.

Minor comments:

Line 13 (L13): Please also indicate the East African Rift in Figure 15 if possible.

L33: Please make the tick labels in Figure 1b slightly smaller.

L65: Suggest changing “likely reflect” to “are likely related to”

L85: Please clarify what “6 per mile” means? It seems like count number.

L123: The duration between spring RSO and fall RSE seems to be 58 (64 minus 6). The order of spring RSO and fall RSE is important.

L156: Suggest removing “be able to”.

L160: Suggest revising “the first component of the moisture convergence term ($-q \times \nabla \vec{V}$)” to “the first component of the moisture flux convergence (named the moisture convergence term, $-q \nabla \vec{V}$)”

L235: Please add the description and colormap for the color shading.

L268: The increase in boundary layer moisture cannot be clearly spotted from Figure 8. I’d suggest adding the third column showing the difference between the panels (b) and panel (a) to highlight the changes.

L295: Suggest adding the pressure level (e.g., 925-875 hPa) to the left side of each row to improve readability.

L367: “As” to “At”

L369: “20°C” to “20°E”

L383: Remove the extra “comma”