

Review - An energetic perspective on the impact of the Atlantic Multidecadal Variability on the West African Monsoon

General comment:

The paper is logically organized and well written. The description is like a textbook, and readers who encounter the West African Monsoon for the first time may learn the related dynamics very efficiently through this paper. However, I have multiple minor concerns, especially regarding the details related to the energetic constraint on the ITCZ over the Sahel. I'm happy to review it again after these concerns are addressed.

Major concern: Energetic variable in Fig. 4g is too arbitrary

L231–241:

Fig. 4f–h implies that NEI over the North Atlantic (over the box in Fig. 4c; 70°W – 0°) causes the southward cross-equatorial energy transport anomaly over 10°W – 10°E , leading to the northward ITCZ shift and hence the Sahel precipitation enhancement over the same longitude range. However, the selection of the North Atlantic box for averaging NEI looks too arbitrary. In particular, the longitude range used for averaging NEI and that used for calculating the ITCZ shift are quite different. What is the rationale for your selection of the NEI averaging box for Fig. 4g?

In addition, it seems that the NEI maximum is over the tropics, not in the extratropics where the AMV forcing exists. There are also negative NEI anomalies over the tropical southeastern Atlantic. The reason for this tropical NEI gradient—favorable for the southward energy transport over Sahel longitudes—is not clearly explained. The authors partly attempt to address this by analyzing latent heat flux in Fig. 5, but to me, the wind speed increase in Fig. 5c is too narrow to explain the broad positive NEI over the northern tropical Atlantic.

Perhaps this tropical NEI pattern could be the emergence (or feedback) of the Atlantic ITCZ shift itself, as author speculated with Fig. 5c. Then, we may say that the ITCZ shift over the Sahel can be shaped by energetic imbalance caused by the oceanic ITCZ shift. But, all of these concerns can seem to be too specific. The author can improve the description for the flawless science, albeit current analysis still looks reasonable for the usual publication.

Minor comment:

L56–57:

Kang et al. (2008) is one of the original papers on the energetic constraints on the ITCZ. Please add it as a reference.

Kang, S. M., Held, I. M., Frierson, D. M. W., & Zhao, M. (2008). The Response of the ITCZ to Extratropical Thermal Forcing: Idealized Slab-Ocean Experiments with a GCM. *Journal of Climate*, 21(14), 3521–3532. <https://doi.org/10.1175/2007JCLI2146.1>

L84–85:

"Since this estimation assumes linearity, the changes associated with a negative AMV phase can be obtained by reversing the sign of the anomalies."

→Is this description referring to the forcing itself? The current sentence is difficult to understand.

L111-112:

"Assuming that energy storage is negligible over seasonal and long-term averages (denoted by overbars)"

→In Fig.4 of Donohoe et al. (2013), at the monthly timescale, there are non-negligible contributions from the storage term for the hemispheric asymmetry of the atmospheric energy budget. Therefore, I do not think you can say "seasonal" here. Strictly speaking, you would need to demonstrate that the storage term does not matter for your analysis by calculating it and comparing it with the other terms. However, the strong correlation between the NEI proxy and rainfall in Fig. 4g may be sufficient for a first-order application.

Donohoe, A., Marshall, J., Ferreira, D., & Mcgee, D. (2013). The Relationship between ITCZ Location and Cross-Equatorial Atmospheric Heat Transport: From the Seasonal Cycle to the Last Glacial Maximum. *Journal of Climate*, 26(11), 3597–3618. <https://doi.org/10.1175/JCLI-D-12-00467.1>

L222–224:

"Such enhanced southward energy transport is typically realised through a northward displacement of the ascending branch of the Hadley circulation (Donohoe et al., 2014)."

→This is generally true when the gross moist stability (GMS; the efficiency of energy transport by the circulation) remains the same. How can you ensure that this assumption holds in this case as well? The strong correlation in Fig. 4g may indicate that variations in GMS do not play a major role here. However, I think it would be better to explicitly state this underlying assumption—namely, fixed GMS—somewhere in the text.

L291-292:

"These negative anomalies are linked to the surface cooling induced by increased soil moisture following increased precipitation."

→Would it be clearer to say "evaporative cooling" instead of "surface cooling"? The underlying physical process is somewhat obscured in the current wording.

L315:

In the energy budget equation, the MSE flux term in Eq. (1) is decomposed into a horizontal advection term and a vertical advection term. How is the vertical advection term derived? The

continuity equation may provide the explanation, but the reader would benefit from a more explicit description.

L329–332:

"Consequently, the vertical advection term ($-\langle\omega\partial_p h\rangle$) becomes more negative. Given the tropical MSE vertical structure, this implies a change from a shallower convection regime to a deeper convection regime with a first-baroclinic mode structure (Hill et al., 2017). This interpretation agrees with the horizontal divergence anomalies in Fig. 6c, which show reduced divergence at mid levels and stronger divergence aloft."

→This is a beautiful explanation, but I think an explicit visualization related to the vertical advection term would be helpful. How about adding changes and climatology of ω , as well as changes and climatology of MSE (h), as supplementary vertical profiles similar to Fig. 6a–c? If shallower convection transitions to deeper convection, this should be identifiable through stronger upward motion in the mid-to-upper troposphere. The MSE profile may also help explain the details of the ω changes under the constraints imposed by NEI and the horizontal advection term. This point may be somewhat secondary, but it would strengthen the mechanistic explanation in this study.

Figure 3 caption: "c and d)" -> "c) and d)"