Review of *Respati et al. (2026), submitted to WCD*

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The manuscript entitled *"The Moisture Mode-to-Gravity Wave Spectrum as a Framework to Define Tropical Weather Systems"* by Respati et al. proposes a novel framework for describing tropical weather systems using both spectral analysis and object tracking. The study classifies convectively coupled tropical motions into moisture modes, mixed systems, and inertio-gravity (IG) waves based on their phase speed, and investigates their thermodynamic, dynamical, and rainfall characteristics.

Overall, I found the manuscript conceptually interesting and potentially impactful. In particular, I appreciate the attempt to bridge large-scale tropical wave dynamics with object-based tropical weather systems to define and understand tropical weather phenomena and precipitation extremes. The paper also makes an important effort to connect theoretical ideas regarding moisture modes and balanced/unbalanced tropical dynamics with observational analyses.

The statistical analyses, both for weather system classification and for composites comparisons, are carefully conducted, the figures are clearly presented, and the manuscript is generally well written. Overall, this is a solid and well-executed study. I have a few specific comments below where the interpretation and presentation could be further strengthened. I recommend publication after **minor revisions**.

Main comments:

1. While it is elegant to apply wave dynamics to defining and classifying tropical weather systems, the manuscript would benefit from deeper discussion of how the filtered and tracked OLR objects relate to more tangible raw object-tracked systems such as MCSs and TCs. In particular, are the identified systems best interpreted as manifestations of idealized dynamical modes, theoretically grouped dynamical entities, or physical weather "objects" analogous to synoptic systems? I think adding more text discussing this would be helpful.

A related question: the current study filtered out TCs before applying the spectral analysis; if not filtered out, would TCs themselves be decomposed into the other three spectral weather types (moisture modes, mixed systems, and IG waves)?

2. There are a few places in the manuscript (e.g., L212–215) stating that "the ratio of DSE to latent energy anomalies increases with phase speed" or that "the relative role between moisture and buoyancy decreases with phase speed". What is the underlying physical reason for moisture anomaly amplitude decreasing with phase speed? A brief explanation of the mechanisms would strengthen the interpretation and help with understanding the three types of weather systems along the moisture mode-to-IG-wave spectrum.

A minor note on the use of “buoyancy” throughout the manuscript (e.g., L215): moisture perturbations themselves affect, and can strongly contribute to, buoyancy anomalies. It may therefore be clearer in some places to refer specifically to DSE or temperature perturbations, rather than using “buoyancy” in a general sense.

Minor comments:

The use of “perturbations” throughout the manuscript (e.g., L99, L201): it would help to clarify, at least for the early usages, the reference state relative to which the perturbations are defined (e.g., time mean, zonal mean, or anomalies relative to the surrounding environment outside the identified weather systems).

Section 3: Several important methodological steps are described in this section. Adding subsection subtitles/headings would improve the presentation and make the analysis flow easier to follow.

Figure 11: The violin plots show probability density (normalized by bin size and total counts). It would be clearer to explicitly note this in the caption. It may also be helpful to include the total sample counts for each system category.

Section 5 and Figure 12: Throughout this section, the authors refer to the probability of extreme precipitation occurrence associated with a given system category, normalized by the total probability of extreme precipitation occurrence (0.01), which is defined in Eq. 3, as “changes in the probability”. This phrasing can be somewhat confusing. It may be clearer to describe this quantity instead as the probability ratio (or probability enhancement) of extreme precipitation associated with system type X, or similar wording along these lines.

Relatedly, Eq. 3 and the associated description (L178-181) may benefit from minor adjustment. The text discussion appears conceptually close to a conditional probability (i.e., extreme precipitation conditioned on the occurrence of system X), whereas the numerator in Eq. 3 is currently written using “AND”. A conditional probability notation “|” may be instead intended.

L299–301: The discussion of “compound” influences could be clearer. Since the three non-TC categories are defined using non-overlapping phase-speed filtering ranges, I would have expected them to be mutually exclusive by construction. Does the “compound” contribution therefore mainly reflect TCs co-occurring with the other three system types? If so, clarifying this would be helpful.

L295–305 and Figure 10: The extreme rainfall attribution results are interesting. There could potentially be additional discussion comparing these results with attribution results based on purely object-based classifications of weather systems; for example, whether common object-based weather systems account for a similar fraction of total and extreme rainfall. This could also provide an opportunity to discuss how the weather systems defined through spectral analysis relate physically to more conventional object-tracked systems.

L360–362: What are the reasons for the differing N_{mode} results for IG waves and mixed systems across the studies discussed here? A brief explanation would help clarify the interpretation.

A minor note, the sentence “In other words, it is only the relative importance of moisture and temperature that changes with phase speed…” does not seem to most accurately fit the logic flow here. Since the preceding text already discusses that differences in moisture perturbation amplitude are the dominant contributor to the variations in N_{mode} and are closely associated with the corresponding phase-speed differences, it may be sufficient to simply emphasize in L362 that moisture perturbations remain non-negligible even in the faster-moving systems.

L396–397, also L365: I suggest being a little more careful in addressing the phase speed, or N_{mode}, as proxies for, or reflections of, thermodynamics. They are tightly connected to the dynamics.