

Review of “*Persistent episodes of the Euro-Atlantic upper-level jets in summer: precursors, maintainers and impacts*”.

### Summary

The underlying ideas regarding Euro-Atlantic jet persistence are interesting, but the manuscript needs substantial restructuring. In its current form, the study is weakened by imprecise language, motivations that are not always clear, and somewhat overstated goals, as several claims appear broader than the analysis can support. The figures are often visually dense and read as an extensive compilation of results rather than a curated selection intended to support a focused narrative. The reader is not kept in mind enough throughout the study, which would be substantially stronger if it were more concise.

Given the substantial comments I provide below, a resubmission may serve the manuscript better than a major revision.

### Major comments:

- **Statistical aggregates are construed as physical mechanisms.** The manuscript sets out to elucidate the mechanisms responsible for jet persistence, and while the  $n = 30$  compositing results provide context to understand environmental conditions associated with some jet configurations' persistence, I do not think that this context alone provides a generalized mechanistic understanding. For the STJ persistence, the first mechanism (see L365) consists of an initial condition for the STJ that is weakly linked to references but not to the results in the analysis. It remains to be understood why the STJ would be at its winter position at the onset of a summertime persistent spell. The second mechanism (L371) and third mechanism (L377) are similarly based on co-occurrence of conditions from a small sample at the extreme end of the persistence metric distribution defined in the study, and they do not demonstrate causality. Case in point, only weak links were found between organized tropical convection and jet persistence. The same points apply to the EDJ persistence mechanisms, which are in fact formulated as hypotheses in places. It would be informative to composite events not solely based on persistence, but also based on the composited favorable environmental conditions, to establish whether there is a two-way correspondence with persistence. In light of these comments, the title of the manuscript does not faithfully reflect the analysis and should be revised accordingly.
- **The abstract needs a thorough revision:** As is, motivations for the study are not clear enough (What knowledge gap is being addressed? Which jet configurations persist? What makes the new toolbox the best tool for this study?), the word count is not used particularly judiciously (method details L6-8 are not needed at this point, stating that different jets/composites show different behavior L10-12 is somewhat insubstantial and arguably does not belong in the abstract), and the take home message L14-15 could be stated more clearly and with added detail about the implications.
- **The objectives are spliced into too many subcomponents (Q1-Q6)** (L67-74): The underlying ideas here are interesting, and it's good to clearly state the question(s) you are addressing. That being said, presenting six distinct research questions feels overly broad and ambitious for this format, and leads to structural and conceptual redundancy. Referring to six different questions across the rest of the paper makes the result feel more like a catalog or a research proposal, rather than a focused contribution. I recommend consolidating into 2 or 3 more precise questions. This would give the reader a clearer roadmap of the core objectives.
  - Q1 is difficult to parse out: what does “objective” mean here? Observer-independent? Climate-independent? What does “represent” mean? Is a “scalar time series” just a metric?

- Q2: previous studies have laid out their own “specific characteristics”, so the question seems not to be about specificity but rather about portability or objectivity. Q2 essentially seems to be a pre-requisite question to answer before asking Q1.
- Q3 is a special case of Q2.
- Q5 also seems like a question to ask before Q1: defining persistence in an *objective* manner seems sensible only if one knows how said persistence arises in the first place.
- Q6 is a special case of Q5.
- **The choice of methods needs better justification and contextualization.** The use of the Banderier et al. (2025) jet identification scheme is not adequately justified. There are other methods to choose from and compare to, formulated for a wide range of applications. As it stands, the primary rationale for choosing this specific method appears to be author familiarity. The particular strengths of this method for the present application should be clearly stated and put in context of the existing literature. In addition, labeling the method as “objective” (L448) is a bit misleading; an algorithm can be mathematically objective while still relying on arbitrary heuristics. The limitations of the methods should be discussed earlier than L484. For instance, if jet features meant to represent the eddy-driven jet are extracted from filtered wind fields, are the transient eddy momentum fluxes that drive the jet actually captured? If not, what do these features physically represent? If they are the waves themselves, how are they related to the waveguide? What other aspect(s) of the EDJ are/ aren’t captured in this perspective? Similar questions apply to STJ-related jet features, which could capture transient fluctuations in the broader thermally direct jet stream itself. The statement that “There does not seem to be an easy way to separate eddies from instantaneous jet axes” (L496) may likely be read as the dismissal of an important methodological limitation. The manuscript could instead refer to the dynamical systems literature, where the perspective on jets as Lagrangian coherent structures or transport barriers does provide a synoptic description of jets that is distinct from a collection of eddies.
- **Methodological details are glossed over.** I do not think that a long data section would be particularly pleasant to read, but several questions come up: L85: can you discuss the possible implications of stitching together variables across an ~5km altitude span? L87: “smoothed daily climatology” smoothed how? L89: 330K is arguably high for the EDJ— please discuss. L92-96: it is difficult to understand how the RWB algorithm works with this description. I would suggest removing the technical details to the benefit of a higher-level explanation of the concept behind the detection algorithm. Some level of detail about the method from Banderier et al. (2025) should similarly be provided. L111: what is the tilt of a jet core? What about the width? How is waviness calculated? L113-114: it sounds like the weighted mean of properties across different and possibly unrelated jet features is being calculated regardless of its physical meaning? L120-122: I am not convinced that “implicitly track[ing] the jets” this way is reasonable for the purpose, and the statement “more stable under complicated situations” demands justification. L124: the Fréchet distance should be briefly explained (perhaps using the dog walking analogy or something along the lines of “minimum peak separation required to map all points along one continuous path to another.”), and it should also be stated that it was chosen because it preserves the sequential ordering of the jet cores, unlike other measures of curve-to-curve distance like the Hausdorff distance. You could also explain why this distance is in the persistence metric’s denominator. L132: are you changing the quantile summer-to-summer to force the extraction of 30 events per summer? Are there several quantile thresholds? Regarding along/across-jet composites: double interpolation may smooth the data, which becomes a relevant point of discussion since you mention the “across-jet gradient” of the composites.
- **Substantial text edits are needed.** I include a list below for the first portion of the manuscript, to illustrate the degree to which I believe the manuscript should be edited for concision and clarity.

### **Minor comments up to L138 and for some of the figures:**

- Title: “maintainers” feels awkward to me. Could consider “drivers” or perhaps “maintenance mechanisms”?
- L43-45 “Therefore [...] RWB”: I am not fully following the logic of the argument about jets’ anomalous position/persistence and “additional momentum” because I could conceive momentum acting to disturb these jets rather than reinforce them in place. Could you clarify how momentum comes into this picture?
- Definition of “jet” and “persistence”: Given the paper’s stated goal to discuss what “jet” means in the first place, it would be good upon the first few mentions of jet-relevant processes (L49 “equatorward flank of the jet”, L61 “persistent conditions for the jet”, etc) to clarify what “jet” means in that instance. It is a bit hard to read an introduction about jets, EDJs, and STJs, knowing that their very definition may be in question. The first explicit definition of jet only comes at L105. In that same vein, the paragraph L61-64 about jet persistence comes as a surprise given the central goal of the study to determine how this persistence arises in the first place. Currently, some readers may be under the impression that the study is tackling a solved problem.
- L78 “the bulk of the research on jet dynamics focuses on winter” I think this is a good point and could be expanded upon in light of your particular perspective on jets.
- L110: “about twenty properties” is the kind of language that makes the reader feel like you’re just doing things because you can. It’s important to be specific about how many quantities are calculated and why. Quantities that are not used should not be included.
- Fig. 1: I would advise using more neutral colors. The x-axis labels should have a title and units. Dates could be labeled like “JUN-15” for clarity. Please split the y-axis between the top and bottom rows. Is there a specific reason other than aesthetics why kernel density estimates are shown instead of raw distributions? This should be stated especially because (i) you are using different KDE parameters seemingly arbitrarily and (ii) KDEs do produce artifacts, as I suspect is visible at the minimum episode length (5 days) in the last column, and especially for small samples such as the one you are using (30 events, if I understood correctly). With the current setup, the KDEs may not be very representative of the actual distribution (for instance, artificial gaps due to small sampling are likely to be emphasized by the KDEs). Why does the single value  $b$  refer to several bandwidths? In the caption, “scaled arbitrarily” does not explain what the scaling does.
- L138: the result that the STJ produces more persistent jets seems to be largely a result of the methodological setup; EDJ features are more likely than STJ features not to be tracked from one time step to the next because of the use of a jet core length threshold.
- Fig. 2: colors are unnecessarily saturated, and it is not stated what they represent. If you cut your composites at +5 days you could get rid of the shading at the bottom of the subplots, which currently makes the figure feel busy and is not easily interpretable. Using the same y-axis limits between STJ and EDJ would allow visual comparison.
- Fig. 8/9: this is an overwhelming amount of information. The five different color schemes clash, and it is difficult to parse out any patterns.

### **Text edit suggestions up to L163:**

- Throughout: “mid latitudes” might better be spelled as “mid-latitudes” or “midlatitudes”
- L10: unclear what “the two jet categories” are in this paragraph L10-11. The EDJ and STJ? Please clarify. Note that EDJ and STJ would have to be defined in the abstract if used (L15).
- L10-11 statement “The precursors, [...] commonalities exist” is not substantial and should be advantageously replaced with more specifics about the results.
- L14: “We a significant increase” is missing a verb.
- L17: earlier references seem more appropriate for this argument.

- L22: “if these” -> whether these?
- L23: “if the” -> whether the?
- L44: is “equatorward shifted” used as a compound adjective like “poleward-shifted” at L50?
- L44: “Therefore” -> Therefore,
- L46: “cycles” -> cycle? Is it really a cycle though?
- L49: could remove “wave breaking” to avoid repetition.
- L50: “CWBs are” -> CWB is? Since you are referring to the breaking process itself.
- L53-54: “The interaction of” what type of interaction is this referring to?
- L58 “both jets are linked to” clashes with “A stationary EDJ”
- L63: “Consequently” -> Consequently,
- L67: to me, “episodic” is redundant with “persistence” because in this context persistence already implies a temporary departure from a reference state.
- L119: this sentence is only accessible to the reader who is already familiar with Limbach et al. (2012).
- L120: what does “successful” mean here?
- L123: I do not think the notation for overlap and distance needs to be so complex since it is only used once more at L126 and without the need for the index c nor t. Small “o” is not the best notation.
- L126: I would not choose “simple” to describe this metric. Its units alone (s/m) are not simple to me.
- L133: I do not understand what is meant by “moderate number allows us to study each event individually.” Presumably, you could analyze any individual event regardless of the total sample size?
- L135: I would be more cautious here and add “The STJ episodes *defined as such* are more likely”
- L136: your conclusion that “EDJ episodes happen throughout the year” does not match the seasonally specific plots shown in the figure.
- L137: “then” -> than. Add comma after “than the STJ”
- L146-7: 2000 km and 100 km would read more easily than the exponent notation. What are “segment points”? I think the explanation of the method is contrived. Stating that 2D fields are bilinearly interpolated onto the along-jet and across-jet direction could be sufficient, along with a statement that across-jet = orthogonal to the horizontal wind direction (rather than orthogonal to the local jet core direction). Providing a range of min to max jet core lengths would help contextualize what the [0,1] domain captures and how to interpret Fig. 6/7.
- L152: “No special consideration is applied...” why not? What proportion of the data sampled does this apply to?
- L154-5: I do not understand this statement.
- L162-3: what p-values are calculated? What is the false discovery rate here?