A review of EGUsphere-2026-1156 (Subseasonal predictability and Rossby wave dynamics of blocking high during transitional seasons: Insights from three successive events in May–June 2023) by Zhixiang Li et al. (2026)

Recommendation: Major revisions

Li et al. (2026) takes a case study approach to examining three consecutive blocking events across the Northern Hemisphere in May and June 2023. Through the calculation of certain blocking diagnostics, the paper helps to establish a dynamic connection between the three successive events. In the second half of the paper, the predictability of these events is examined using the ECMWF subseasonal-range ensemble prediction system.

The paper is interesting and offers a nice foundation for a climatological assessment of similar dynamically linked blocking events. The scope and analysis are of high quality, but I find that there is insufficient context that motivates many of the analysis choices and how the motivation of extreme weather is incorporated into the main paper. I think with additional context, this will be a highly successful paper.

Response: **Thanks for your positive evaluation on our manuscript and very constructive comments.**

General comments

- While I am familiar with the metrics and calculations used in this paper (wave activity flux, stationary wavenumber, Tibaldi and Molteni blocking index), there is little context for what these metrics show and what the benefits/limitations of these metrics are. For example, what should the reader take away from the observed zonal wavenumber (k) falling below the stationary wavenumber (K_s)? I think a better description of how these metrics help us to understand the dynamics of these events could improve the paper greatly.

Response: **Thanks for your comments, and we have followed your suggestions by adding in the manuscript more description about these metrics and how they help us to understand the dynamics. Some corresponding modifications in our revised manuscript are:**

1. **We modify the reasons and benefits for using K_s in the Introduction, Lines 115-120: "**In addition, the stationary wavenumber K_s provides a reference for the zonal scale at which Rossby waves tend to become quasi-stationary under a given background flow (Hoskins and Ambrizzi, 1993) and has recently been used in the studies of quasi-stationary waves (Fei and White, 2025; White and Mareshet Admasu, 2025). Therefore, comparing K_s with our diagnosed wavenumber could provide an additional perspective for understanding the propagating behavior of blocking system.**"**
2. **The benefits of wave activity flux in Method, Lines 185-188: "**In order to reveal the possible dynamical linkages among the three successive blocking episodes, we use wave activity flux (WAF) to indicate the horizontal propagation of quasi-stationary Rossby wave energy, since the vectors of WAF correspond to the direction of local group velocity of quasi-stationary Rossby waves in the WKB limit (Takaya and Nakamura, 2001).**"**
3. **A description of how we specifically use K_s in Method, Lines 197-200: "**As discussed in the introduction, K_s is used as a reference for the propagating characteristics of blocking systems.

Specifically, we investigate whether blocking systems remain quasi-stationary when $k \approx K_s$ or slightly smaller, retrograde when $k < K_s$, and propagate eastward when $k > K_s$."

4. **Add descriptions about *k* and K_s in the Results and Summary and discussion**

   Lines 289-292 (in episode 1): "In episode 1, the comparison between k and K_s provide a reasonable indicator of the movement characteristics of blocking (i.e., blocking remain quasi-stationary when k approaches the K_s, retrograde when $k < K_s$, and propagate eastward when $k > K_s$)."**.**

   Lines 319-321 (in episode 2): "a rapid decrease in phase speed and zonal wavenumber occurs, with $k < K_s$ when the system migrates westward (Fig. 5e, k), followed by a rapid increase in wave amplitude (Fig. 5h).**"**

   Lines 346-348 (in episode 3): "In this period the zonal wavenumbers remain between 3 and 4 with $k < K_s$, thereby favoring westward movement of the blocking system.**"**

   Lines 510-515 (Summary and discussion): "Furthermore, we find that the evolution of wavenumber is also important for blocking movement (Yeh et al., 1962; van Mourik et al., 2025). Comparisons between k and K_s in these cases suggest that blocking generally moves westward during its onset with $k < K_s$, moves rapidly eastward after collapse with $k > K_s$, and maintains quasi-stationary or slow movement when k approaches K_s. However, cases with $k < K_s$ but eastward movement can also occur after the collapse of blocking.**"**

5. **We also suggest that the planetary-scale Rossby wave anomalies could contribute to the large spatial extent of surface weather extremes:**

   Lines 265-266 (in episode 1): "The planetary-scale blocking circulation also contributes to the exceptionally large spatial extent of Canadian wildfires (Jain et al., 2024; Luo et al., 2025).**"**

   Lines 475-478 (Summary and discussion): "The zonal wavenumbers, lower than their climatological values, favor the quasi-stationary or westward movement of the blocking system and contributes to the exceptionally large spatial extent of the associated weather extremes.**"**

- The figures in this paper, especially figures 3 and 4, need to be enlarged for ease of viewing. Much of the results of section 3.1 rely on interpretation of these figures, and the WAF vectors are very difficult to see.

Response: **We fully agree with your comment and enlarged figures have been replaced in the revised manuscript.**

- Outside of the introduction, there is very little mention of the connection between the three blocking events and the sensible weather extremes of Canadian wildfires, extreme precipitation in Italy and East Asia, and a heatwave over Northwest Europe. There is also very little literature cited that looks at the dynamic connection between blocking and these weather extremes outside of these specific events. Adding this context would help to connect this work to the broader literature on blocking better.

Response: **Your suggestions are very useful. Since we mainly focus on blocking events over Canada, the Ural Mountains, and Europe, we have added more connections between these blockings and the Canadian wildfires, persistent precipitation in East Asia, and heatwave over Northwest Europe in the revision. In addition, more relevant references have been properly included in the revised manuscript. Some corresponding modifications in our revised manuscript are:**

1. **Lines 265-266 (Canadian wildfires): "**The planetary-scale blocking circulation also contributes to the exceptionally large spatial extent of Canadian wildfires (Jain et al., 2024; Luo et al., 2025).**"**
2. **Lines 276-278 (Canadian wildfires): "**These two distinct extreme values also occur close in time to the pronounced surface warm anomalies and the associated wildfires in Canada (see Figs. 2g–h in Luo et al., 2025).**"**
3. **Lines 303-305 (Canadian wildfires): "**In this episode, wave amplitude over Canada remains anomalously strong (Fig. 3f), likely contributing to the continued severity of wildfires in late May and early June (Jain et al., 2024; Luo et al., 2025).**"**
4. **Lines 310-316 (precipitation in East Asia): "**Therefore, the slowly moving, large-amplitude, planetary-scale pattern of the Ural ridge and East Asian trough provides a stable background circulation that facilitates continuous southward transport of cold air into East Asia, as reflected in the cold anomalies downstream of Ural blocking in Fig. 1c. This pattern, together with a northward-shifted and enhanced western Pacific subtropical high and associated moisture transport (Gao and Gao, 2023), contributes to the persistent precipitation anomalies in East Asia during episode 2.**"**
5. **Lines 328-330 (Canadian wildfires): "**In episode 3, both the intensity and spatial extent of the large-amplitude anomaly over Canada decrease markedly (Fig. 3i), consistent with relatively weaker Canadian wildfires during 12–20 June (see Fig. 2h in Luo et al., 2025).**"**
6. **Lines 337-340 (heatwave in Europe): "**The European blocking in the third episode is also dominated by zonal wavenumbers 2–4 (Fig. 4e), consistent with negative phase speed anomalies there (Fig. 3h), favorable for the occurrence of heatwaves over northwestern Europe, through the mechanisms proposed by Berthou et al. (2024).**"**
7. **Some references on blocking and weather extremes outside of these specific events have been added to the Introduction, Lines 67-72: "**Beyond these specific events, the dynamical linkages between blocking and heatwaves (Black et al., 2004; Bartusek et al., 2022; White et al., 2023), cold surges (Ding et al., 2008; Yao et al., 2023), and floods (Lau and Kim, 2012; Martius et al., 2013; Xu et al., 2023) have been revealed, but research has focused on specific regions and solstice seasons (for reviews, see Woollings et al., 2018; Lupo et al., 2020; Kautz et al., 2022; Wang et al., 2026).**"**

- In section 3.3, the predictability and potential sources of said predictability in the ECMWF ensemble forecasts are discussed. Given that this paper emphasizes the dynamical connection between the three events, could the enhanced predictability of the Ural block in late May be linked to the blocking over Canada in early May? For example, do the best ensemble members for the Ural block successfully capture the block over Canada? This is not a necessary edit, but I wanted to suggest it as a possibility.

Response: **Thank you very much for the suggestion. Indeed, we've checked the ensembles and found that the best ensemble members for the Ural block are those better capture the later evolution (collapse and then energy dispersion) of the Canadian block, and so in this regard your conjecture is right. The main modifications are:**

1. We add a new figure (Figure 9) comparing the horizontal propagation of wave energy (using WAF) between the good and bad ensembles. We find that:

Lines 431-437: "For episode 2 and 3, the good ensemble also captures the downstream dispersion of wave energy following the collapse of the Canadian blocking, as well as the subsequent formation of planetary-scale trough-ridge patterns (Fig. 9c, e; also Figs. 8b–c). In contrast, the Rossby waves in the bad ensemble primarily propagated as synoptic-scale waves along the subtropical or mid-latitude jet, showing limited amplification into blocking patterb (Fig. 9b, d, f). The bad ensemble even predicts an erroneous intensification of the Canadian ridge in episode 3."

2. Furthermore, partly inspired by your suggestion, we investigated whether, for a given initialization time, good ensemble members that capture the Canadian blocking also yield better predictions of the Ural blocking. The corresponding results are now included in Figure 10 and

Lines 447-451: "Indeed, in forecasts initialized on 17 April, ensemble members with a strong Canadian ridge in episode 1 (good ensemble) predict a stronger Ural ridge in late May after the collapse of the Canadian ridge, with a lead time exceeding 33 days (Fig. 10a). In contrast, ensemble members that miss the Canadian ridge (bad ensemble) also fail to predict the Ural ridge in episode 2 (Fig. 10b)."

Overall, these results indicate that the dynamical connection between the three events also exists in S2S predictions. And we further suggest that the exceptionally strong Canadian blocking provide a window of opportunity for the longer-than-2-week predictability of the Ural and European blockings.

Line-by-line comments

Lines 32–33: The three blocking episodes are not defined before being mentioned here.

Response: The episodes will be defined explicitly in the revision. The modification is:

Lines 20-22: "This study investigates the dynamical linkages, Rossby wave characteristics, and subseasonal predictability of three successive atmospheric blocking episodes over Canada, the Ural Mountains, and Europe in May–June 2023**"**

Line 48: "Northern Hemisphere" should be capitalized.

Response: Thank you for the suggestion, and we have modified it.

Lines 169–172: The timing and occurrence of the blocking events have only been alluded to at this point through Figure 1. It might make sense to more explicitly state when and where the blocks occurred, and how they are temporally related to the weather extremes mentioned in lines 53–63.

Response: We agree with your comments, and we will revise the manuscript accordingly. Here is a revised version:

Lines 207-211: *"*Based on the timing of the Canadian blocking (1–19 May), the Ural blocking (quasi-stationary ridge between 20 May to 5 June), and the European blocking in mid-June, corresponding to the occurrences of the Canadian wildfires (May to June), East Asian precipitation anomalies (between 20 May to 5 June), and the European heatwave (June), we divided May–June 2023 into three consecutive episodes (Fig. 2).***"***

Line 223: What is meant by “scale effects” here?

Response: The term “scale effects” here follows Hoskins et al. (1985), meaning that for a given amplitude of disturbance, a larger spatial scale leads to a faster westward propagation relative to the eastward zonal mean flow. We use this term to explain the dynamical reason why a smaller wavenumber results in slower or even westward wave propagation.

We have clarified this in the Introduction in the revised manuscript by adding a brief explanation and the appropriate citation,

Lines 99-101: “The scale effect, which means that a larger spatial scale leads to enhanced westward propagation relative to the eastward zonal mean flow for a given disturbance amplitude (Hoskins et al., 1985), provides an intuitive explanation.”

Line 384: You mentioned that $k<K_s$, but there is not much context for the significance or interpretation of this fact. Tying into my first general comment, more text discussing the implications of your calculations would be helpful.

Response: We agree with that the significance of k<Ks deserves more discussion. In the revised manuscript, we have expanded this section to explain that when the local zonal wavenumber is much smaller than the stationary wavenumber, Rossby waves can propagate westward. In addition, a larger spatial scale also corresponds to a broader area of influence for extreme weather events (e.g., the extent of Canadian wildfires). We have linked this to the phase speed diagnostics (the observed westward propagation), and the spatial extent of extreme weather impacts (with appropriate citations) during the blocking episodes.

Please find out our modifications in your first General Comment.

Line 401: How is “meaningful” benchmarked in terms of predictability? Probabilities of blocking also fell in subsequent forecasts, so is the enhanced predictability just random change?

Response: This is a valuable comment. We use "meaningful" subseasonal predictability to refer to cases where more than 40% of ensemble members correctly predict the positive Z500 anomaly, with very few members indicating a negative anomaly, at lead times of 15–19 days. We have replaced “meaningful subseasonal predictability” with “high subseasonal predictability” in the revised manuscript.

We acknowledge that predictability varies with initialization date, and we have added a discussion noting that this reflects the real windows of predictability rather than random chance in section 4. In fact, we find that this >2-week predictability originates from the accurate prediction of upstream wave precursors, as shown in the Hovmöller diagram in Figure 8. To further illustrate this, we add a new figure comparing the horizontal propagation of wave energy between good and bad ensemble members (Figure 9), where the good ensemble successfully forecast planetary-scale Z500 anomalies and the associated WAF that closely resemble those in ERA5. Therefore, we suggest the predictability beyond 2 weeks does exist for these three blocking episodes. See Lines 429-437 in our revised manuscript.

Line 402: Change “ensembles” to “ensemble members”

Response: Thank you for the suggestion, and we have modified it.

Lines 425–435: If SSTs are considered a possible driver of planetary-scale wave structures, why were they not examined in the ECMWF ensemble?

Lines 429–431: I am not sure how your results "highlight the importance of midlatitude SST anomalies for the evolution of circulation patterns" when the analysis is only mentioned at the very end of the summary and discussion section.

Response: The discussion about SST has be removed in the revision. Logically only interactive SST will play a role in predictability, but here the SST are prescribed in the experiments.

Reviewer #2

Recommendation: Major Revisions

General Comments:

This study analyzes three consecutive blocking events that occurred in May-June 2023. Li et al. (2026) present a novel analysis of each event through the diagnosis of Rossby wave parameters, as calculated using a Hilbert transformation. Through this, the authors successfully demonstrate the interconnected nature of these three events. Additional work is shown to examine the predictability of the three blocking events using the ECMWF S2S model. They show maxima in predictability for each event at 15-19 day lead times and shortly before the initiation of each blocking event.

The analysis presented, especially those of Rossby wave parameters, are excellent and do well to establish a useful perspective on the temporal and spatial evolution of blocking events. My primary concern for improving this manuscript is the need for additional contextualization of the methodology utilized. Additionally, there is a real need to reevaluate several figures, both in their visual presentation and the utilization of the analysis within the text. Further, the motivation for this study could use bolstering. Upon revision, I believe this study would prove an excellent addition to literature of atmospheric blocking.

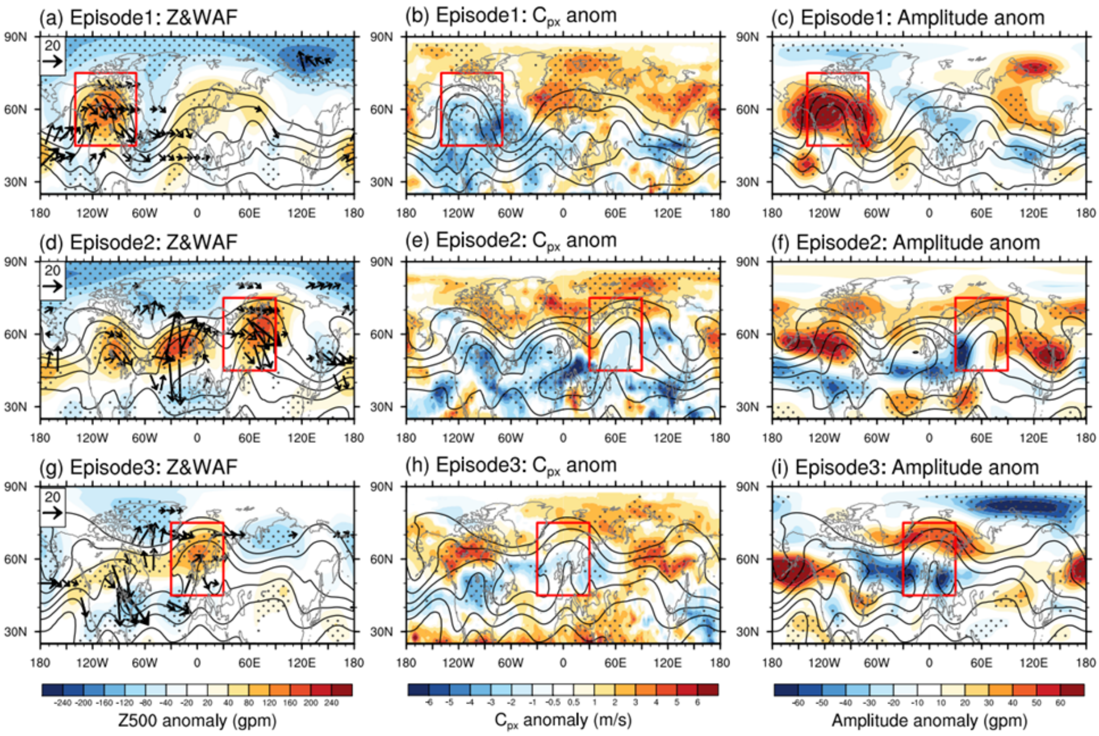
Response: We appreciate very much your encouraging evaluation and useful comments on our manuscript.

Specific Comments:

* Many figures are difficult to decipher due to their size within the manuscript, specifically Figs. 1, 3, and 4. Figure 3 is far too small, especially given how critical this figure proves to be for the analysis presented in sections 3.1 and 3.2. It is very difficult to distinguish the WAF vectors from the stippling in the left column. One other potential improvement to Figure 3 could be the contouring of WAF convergence, given that this quantity proves important to the interpretation of the figure. If this makes the figure too busy and less legible, it would be understandable to leave out.

Response: We agree that Figures 1, 3, and 4 should be presented more clearly. In the revised manuscript, we have enlarged all figures and the WAF vectors. Regarding WAF convergence, however, as the reviewer anticipated, this would make the figure excessively busy, especially given the dense information already present (Z500 anomalies, Z500 contours, WAF vectors, stippling). Therefore, we have chosen to keep the current format.

The new Figure 3, shown below as an example, illustrates this improvement.



New Figure 3.

* Fig. 1 is seemingly the motivation for the study, as it shows the extreme impacts of the three blocking events; however, these results are utilized throughout the study. There is little reference to either Fig. 1 or to literature to specifically tie the blocking events to the weather extremes. How is the blocking event in Canada explicitly connected to the wildfires? What connects the blocking event in the Ural Mountains to the anomalous precipitation in East Asia? What dynamics force the European heatwave? I do not mean to suggest more analysis needed; rather, the text needs to explicitly address these questions through references to Fig. 1 and literature.

Response: We thank the reviewer for this suggestion. In the revision, we add a paragraph in the introduction explaining how these three blocking events caused the respective extreme events, with appropriate citations, as shown below, Lines 60-67:

"*Specifically, the Canadian blocking is suggested to enhanced surface temperature and vapor pressure deficit while suppressing precipitation and soil moisture, thereby promoting severe Canadian wildfires (Barnes et al., 2025; Luo et al., 2025). The Ural ridge and associated East Asian trough are widely considered to lead southward cold-air transport, thereby favoring anomalous precipitation in East Asia (Tao, 1980; Diao et al., 2023). The European blocking contributed to the Northwest Europe heatwave via sustained subsidence and clear skies, further amplified by marine heatwave feedbacks (Berthou et al., 2024).*"

New citations:

Barnes, C., Jain, P., Keeping, T., Gillett, N., Boucher, J., Gachon, P., Heinrich, D., Kirchmeier-Young, M., and Boulanger, Y.: Disentangling the roles of natural variability and climate change in Canada's 2023 fire season, Environ. Res.: Climate, 4, 035013, https://doi.org/10.1088/2752-5295/adec0f, 2025.

Luo, B., Xiao, C., Luo, D. et al. Atmospheric and oceanic drivers behind the 2023 Canadian wildfires. Commun. Earth. Environ., 6, 446, https://doi.org/10.1038/s43247-025-02387-x, 2025.

Tao, S. Heavy Rainfalls in China (in Chinese), Science Press, Beijing, China. 225 pp., ISBN 130311305, 1980.

Diao, Y., Guo, J., Zhang, Y. et al. Trend turning of North China summer extreme precipitations around early 2000s and its possible reason. Clim Dyn 61, 5367–5386, https://doi.org/10.1007/s00382-023-06860-1, 2023.

* In the current form of the manuscript, references to SST add minimal to the analysis produced. If the authors intend to use SST as a source of predictability, the current analysis should be expanded. This should likely be included in the results section, following the discussion of predictability in the S2S model, rather than at the end of the summary and discussion.

Response: We thank the reviewer for this constructive suggestion. As already discussed in response to the first reviewer (last two line-by-line comments), we think the discussion on the role of SST in predictability of blocking irrelevant, so will remove this part in the revision.

However, to better illustrate the sources of subseasonal predictability, we have added Figure 9, which compares the horizontal propagation of wave energy (using WAF) between the good and bad ensemble members. This figure shows that only those ensemble members capable of better capturing the (planetary-scale) Rossby wave energy propagation can successfully predict the blocking events at a 2-week lead time. Moreover, in our new Figure 9 and Figure 10, we suggest that the Canadian blocking provides a window of opportunity for the extended predictability of the subsequent Ural and European blockings through their dynamical interconnections. Please refer to our response to the last General Comment of Reviewer 1, and Lines 429-453 in the revised manuscript.

In this way, through both observations and S2S prediction, our results highlight the critical importance of upstream wave precursors and Rossby wave energy propagation for both the formation and the subseasonal predictability of these three blocking episodes.

* The mentions of WAF and Ks could use additional physical contextualization. While these methods are often encountered in other studies, the present work would be improved with a brief discussion in the methods section or results of how these two measures are used to bolster the compelling evidence presented from the Rossby wave dynamics analysis.

Response: We thank the reviewer for the valuable suggestion. In the revised manuscript, we have clarified the benefits for using WAF and Ks in the introduction and methods. The WAF has already been described in detail in Section 3.1. We have added additional discussions concerning Ks and Rossby wave parameters in the "Results" and the "Summary and Discussion" sections.

Please refer to our response to the first General Comment of Reviewer 1 for detailed modifications.

* 2b-c are only referenced once within the text, despite showing an interesting result. Based on this figure, there is a key difference in episode 2, relative to the other two periods, as the primary blocking signal seems to be dominated by higher wavenumber variations, whereas episodes 1 and 3 are more attributable to planetary scale waves.

Response: Thank you for pointing this out. Indeed, as shown in Figs. 2b–c, in the later stage of Episode 2 (28 May–5 June 2023), the Ural blocking exhibited a signal close to zonal wavenumber 4, whereas in the earlier stage of Episode 2 (20–27 May 2023), it was still dominated by a distinct zonal wavenumber 2. This is also consistent with our Hilbert-transform-based calculation, which shows a time-mean local zonal wavenumber of approximately 2–3 over Episode 2 (Fig. 4c), while the temporal evolution of zonal wavenumber (Fig. 5k) exhibits a transition from wavenumber 2 to wavenumber 4. However, the Hovmöller diagram has the disadvantage of losing spatial (meridional) locality and cannot directly yield quantitative wavenumber magnitudes.

In the revised manuscript, we have added several references to Figures 2b–c, in Lines 321-324: "However, during the maintenance stage, the Ural quasi-stationary ridge exhibits C_{px} oscillating around 1.5 m s^{-1} (Fig. 5e), suggesting weak eastward propagation characteristics (as also shown in Figs. 2a–c). In this stage, the zonal wavenumbers oscillate around the K_s (Fig. 5k; Fig. 2c)"

* Why was 2.5-degree resolution used for ERA5 data? It's my understanding that native resolution is .25-degree. This is a minor concern, but I am just curious if this was a data choice or if the data were regridded and, if so, why.

Response: The 2.5°×2.5° resolution was a deliberate choice (regridded) for the following reasons. **(1)** Our study focuses on the evolution of large-scale circulation and the Rossby wave parameters. Excessively high resolution would introduce small-scale waves (e.g., gravity waves) that are not of interest to this study. Moreover, the diagnosis of Rossby wave parameters requires filtering out the influence of these small-scale waves; otherwise, physically unreasonable results may occur (although we would set these points to missing values), as demonstrated in our previous study (Li et al., 2025). Therefore, a 2.5° resolution is both sufficient and reasonable for our analysis.
(2) The wave activity flux calculations (Section 2.4) need large-scale background flow, for which 2.5° resolution is better than 0.25°.

We have stated the main reason for using the 2.5° resolution in the revised manuscript, i.e.,

Lines 143-147: "We use the ERA5 2.5°×2.5° resolution rather than its original 0.25° resolution, because the present study focuses on large-scale circulation and Rossby wave dynamics. A very high resolution would introduce small-scale waves that are irrelevant to this study and could lead to physically unreasonable results in the wave parameter diagnosis of blocking circulation (Fragkoulidis and Wirth, 2020; Li et al., 2025)."

Li, Z., Lu, J., and Liu, Y.: The Period and Phase Speed of Upper-tropospheric Planetary- and Synoptic-scale Waves during the Solstice Seasons: Climatology and Trends during 1979–2023, Adv. Atmos. Sci., 42, 2223–2234, https://doi.org/10.1007/s00376-024-4236-1, 2025.

- The paragraph at the end of section 3.3 is structured in a confusing manner to me. I think it would make more sense to discuss the predictability of the 3 episodes in the order in which they occurred, rather than beginning with episode 2.

Response: Thank you for this valuable comment. In the revised manuscript, we have reorganized the discussion of predictability for the three episodes in Lines 393-403, presenting them in the order in which they occurred.

Technical Corrections:

The grey lines in Figs. 5 and 6 are very difficult to make out for me. Perhaps these could be darkened slightly.

Response: Thank you for pointing this out. Following the suggestion, we have darkened the grey lines in both Figures 5 and 6 in the revised manuscript to improve their clarity.

- The previous studies mentioned in L57-58 should be cited.

Response: We have now cited appropriate citations, see your Specific Comments No. 2.

It would be worthwhile to cite literature on the interactions between planetary- and synoptic-scale waves at L228.

Response: Thank you for the suggestion. We have added some appropriate citations at the indicated location. Here is a revised version:

Lines 268-271: "*suggesting the 'block' of the eastward progression of synoptic waves and possible interactions between planetary-scale blocking and surrounding synoptic-scale waves, as documented in Shutts (1983), Yamazaki and Itoh (2013), and Luo et al. (2014, 2023).*"

Luo, D., Cha, J., Zhong, L., and Dai, A.: A nonlinear multiscale interaction model for atmospheric blocking: The eddy-blocking matching mechanism, Q. J. R. Meteorol. Soc., 140, 1785–1808, https://doi.org/10.1002/qj.2337, 2014.

Luo, D. H., Luo, B. H., and Zhang, W. Q.: A perspective on the evolution of atmospheric blocking theories: From eddy-mean flow Interaction to nonlinear multiscale interaction. Adv. Atmos. Sci., 40(4), 553−569, https://doi.org/10.1007/s00376-022-2194-z, 2023.

Shutts, G. J.: The propagation of eddies in diffluent jetstreams: Eddy vorticity forcing of 'blocking' flow fields. Q. J. R. Meteorol. Soc., 109, 737–761, https://doi.org/10.1002/qj.49710946204, 1983.

Yamazaki, A., and Itoh, H.: Vortex–vortex interactions for the maintenance of blocking. Part I: The selective absorption mechanism and a case study. J. Atmos. Sci., 70, 725–742, https://doi.org/10.1175/JAS-D-11-0295.1, 2013.

The vertical levels of ERA5 data utilized should be mentioned at L107.

Response: Only data at 500 hPa are used, we have clarified it in "Data" in our revised manuscript.

A number of minor word choice suggestions or grammatical corrections are listed below:

Insert ‘the’ at the end of L48

Use ‘is’ instead of ‘are’ in L61

Insert ‘the’ at beginning of L78

The phrase ‘scale itself’ at the end of L82 is slightly awkward

Use ‘has’ instead of ‘have’ in L94

Use ‘shifts’ instead of ‘shifted’ at L237

Use ‘approaches’ instead of approaching at L241

Use ‘occurring’ instead of occurred at L245

Use ‘predict’ instead of predicting at L310

Use ‘research’ or ‘literature’ or similar instead of ‘researches’ at line 416

Insert a comma after ‘amplitude’ on L417

Response: We sincerely thank the reviewer for carefully identifying these errors. All corrections have been made in the revised manuscript.