

Following advice from referee #3, we have revised the manuscript to include more context in the results section (section 4) on why each analysis is presented to guide the reader. We have also improved our explanations of how financial aid claims were associated with storms. Kindly see our responses to referees #1 and #2 for details on other modifications applied to the text.

Detailed responses to comments by anonymous referee #3 are given below, with the reviewer's comment in black and our response in blue. Quoted text from the revised manuscript is given in italics. The line and page numbers in the responses refer to the original version of the manuscript.

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**Assessing the contribution of extratropical cyclones to river floods that caused property damage in Quebec, Canada**

**Responses to Anonymous Referee #3**

This is a well-structured manuscript where authors have quantified contribution of extratropical cyclones to river flooding in southern Quebec region. The manuscript provided sufficient background information and reference studies in defining the knowledge gap and setting up the research question/objective of the study. I believe the time period is long enough and the types of data used and their sources were also adequate. The data including their sources were described well. The arguments made by the authors were supported by results shown through clear and well descriptive graphs and tables. However, my concern is in the methods used in the study. While authors claim, "quantification of contribution", the adopted methods are quite imperial in nature and at times difficult to follow. The adopted method explains the data well individually (e.g. explaining characteristics of flood events, and ETCs), but when it comes to quantifying ETC contribution to flooding, the method becomes more description oriented than quantification, apology if I did not explain it well. Below are few other points to consider.

1. Specific comments :

1.1 Ln 415-16: 5 most impactful floods account for 51% of the aid claim, I was wondering if the magnitude of those 5 floods were known? In general, 2-yr return period is used as flooding threshold, however, one can imagine these 5 floods were at significantly higher magnitude than 2-yr return period flooding.

Thank you for your comment. It is indeed an interesting question that our study did not focus on. We defined the flood in relation to the two-year recurrence interval and the fact that damage occurred within this timeframe, regardless of the magnitude of the peak flow. As we focused more on the atmospheric aspect and evaluated the damage in terms of financial aid claims, which we believe are probably somewhat

correlated to the magnitude of the flood, the hydrological aspect of the flood event was not studied. It should be noted that these river discharge values are derived from a model and may not accurately reflect the severity of each event (see section 2.1 of the paper). We propose carrying out this analysis in a subsequent study.

So that brings up the questions of what were the characteristics of the flood ETCs that were the cause of these 5 floods? Additionally, what made these ETCs unique enough to result in such extensive flooding? I believe explaining these would be beneficial to readers.

It is true we did not describe more specifically the ETCs associated with more extensive flooding (i.e. top five), other than the comparison shown in section 4.3.3 and Figure 10. In section 3.3.3, it is explained how financial aid claims were paired with flood ETCs, but the case of more than one flood ETC per local flood was not explicitly described. Thus, we propose to revise the text as follows to improve clarity on the association of financial aid claims to storms:

- p. 13, lines 270–272: *For each local flood event, claims were assigned to the flood ETC that contributed the most to the cumulative rainfall of the event, **meaning that for local floods with more than one flood ETC, only one got attributed the claims.** This also meant that a specific storm could be allocated claims relating to more than one local flood event, since local flood events often occurred concurrently in different watersheds.*
- p. 21, lines 427–428 (added sentence): *All storms associated with flooding in more than five watersheds and leading to more than 345 financial aid claims originated from these two clusters. **It is important to note that 80 flood ETCs are not pictured on Figure 10b, as they had lower percentages of cumulated rainfall than those portrayed, and since financial aid claims were associated with flood ETCs with the highest percentage of cumulated rainfall per flood event.***
- p. 22, lines 430–432 (Figure 10 caption):
- **Figure 10.** (a) *Impact (number of financial aid claims associated) of flood ETCs, by importance, showing all flood ETCs with at least 100 financial aid claims associated (N = 24), their respective cluster of genesis location and the time of the flood event/storm.* (b) *Number of financial aid claims and watersheds affected (number of local floods) of flood ETCs **associated with financial aid claims (121/200)** and their cluster.*

1.2 Although it is mentioned in section 3.1.1, it would be good to mention it in section 2.3 that “HydroBASINS level-7” is used in this study.

Yes, we agree and have revised the following lines accordingly (changes shown in bold):

- p. 7, lines 139-141: *HydroBASINS features 12 nested, hierarchical sub-basins levels, ranging from largest (level 1) to the smallest (level 12). The average size of level 12 sub-basins globally is 130.6 km<sup>2</sup> (Lehner and Grill, 2025). **The level 7 polygons were used in this study.***

1.3 Ln 209: It would be beneficial to have the spring season defined in section 3.2.1 the same way it is defined for other seasons, since its is not defined anywhere else in the manuscript.

Yes, done.

1.4 In section 4. Graphs and tables were well described as findings/results; however, it would be quite helpful if authors can briefly state what they implies to, e.g. the “why” part. While reading, I was hoping that section 5 would have that, but missed to find them adequately.

Thank you for your remark, it is true that the purpose presented behind graphs and tables are not always stated. We propose to revise the text as follow to make it easier for the reader to understand the need for each table and graph:

- Section 4.1:

- p. 14, lines 286–287: *Table 1 shows the seasonal distribution of the 498 local floods identified at the watershed level in southern Quebec between January 1991 and December 2020, **and shows the disparity in the number of flood events by season.***
- p. 14, lines 298–299: *Seasonal variability of impacts and extent of regional flood events is **presented in Figure 5, where the annual and monthly distribution of the 85 regional flood identified between January 1991 and December 2020 is shown.***

- Section 4.2:

- p. 15, lines 312–313: *Figure 6 shows the level of ETC contribution to flooding by season for all local flood events. **The figure allows to visualize the range of ETC contribution by season, compare between seasons, and highlight modes as well as least frequent season–ETC contribution combinations.** Considering all seasons combined, 40.2 % of flood events had a very high ETC contribution.*

- Section 4.3.1:
  - p. 16, lines 327–328: *Figure 7a shows the number of storms in each season and indicates whether or not they contributed to a flood event. **The figure also shows typical seasonal differences in number of storms per season, highest in DJF and lowest in JJA.** Of the 6,277 Baseline Southern Quebec storms, 602 occurred during a flood event*
  - p. 16, lines 337–338: ***Differences in lifetime of storms inside the Baseline Southern Quebec search domain were studied for flood vs non-flood ETCs.** Figure 7b shows the lifetime distribution per type, along with their respective medians (white line).*
  - p. 17, line 346: ***Beside their lifetime in the Baseline Southern Quebec domain, cyclogenesis locations were also compared between the two groups of storms (flood and non-flood ETCs), in order to highlight any differences.** Figure 8 shows the density of cyclogenesis locations for both flood (Fig. 8a) and non-flood (Fig. 8c) ETCs.*
  - p. 18, lines 358–360: *Figure 8 also shows the track density for flood (Fig. 8b) and non-flood (Fig. 8d) ETCs. **As genesis locations varied between the two groups of storms (Figs 8a, c), it was also necessary to compare the tracks of flood vs non-flood ETCs, since genesis locations often dictate trajectories of storms.** The flood ETCs tracks, which originated mostly in the central and eastern United States, had streamlined trajectories that went roughly northeast, passing through the Great Lakes region and fanning out as they entered Quebec from the SW.*
- Section 4.3.2:
  - p. 19, line 374: *Dots circled in black show flood ETCs, **allowing easy comparison of their spatial distribution with that of non-flood ETCs.***
  - p. 19, line 378: *Figure 9b shows the distribution of genesis locations for the two groups of storms as percentages, **highlighting the differences in region of origin between non-flood and flood ETCs.***
  - p. 19, line 396: ***Similar to how Figure 7, which compared differences in lifetime in the domain for flood ETCs vs non-flood ETCs,** Figure 9c shows the distribution of lifetimes per cluster along with their respective medians (white line).*
  - p. 20, line 399–400: *These two clusters had lower lifetime medians: 17 h for Quebec–Maritimes storms, and 28 h for Western Canada–Pacific Ocean storms. **Concurrently, storms from these two clusters were also in lower proportions among flood ETCs.***

- Section 4.4:
  - o p. 22, line 434–435 (added sentence): *Figure 11 shows the percentage distribution of genesis location of flood ETCs, as identified through the three alternative scenarios and the control case, resulting from the application of the method to the 372 spring flood events. **The figure allows to notice the impact of varying the different parameters of the methodology to the constitution of the flood ETCs group (number of flood ETCs identified and cluster).***