

**Linking ENSO and heavy rainfall events over Coastal British Columbia through a
weather pattern classification**

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General comments and recommendation

The manuscript presents an analysis on the relationship between El Niño Southern Oscillations (ENSO) and characteristic weather patterns as captured by analysis geo-potential analysis from NOAA's Twentieth Century Reanalysis Project, and their influence in the magnitude of the precipitation events in the coastal region of Oregon, Washington State and British Columbia.

The presented study is certainly interesting and the presented results and discussion are relevant. However, the motivation of the study should be better introduced, and the organization of the manuscript and, particularly, the presentation of the methodology require some re-organization.

Therefore, I cannot recommend the publication of the manuscript in *Hydrology and Earth System Sciences* in its present form, and I encourage the authors to make major modifications.

Major comments

- 1) As mentioned above, the motivation of the study should be better presented in the Introduction, and the use of the chosen methodology should be better justified.
- 2) Section 2 is very difficult to follow for a reader not familiar with the used methodology. I miss (1) a brief conceptual description of the methodology of Garavaglia et al. (2010), (2) some introduction on the available datasets, and (3) the specific objectives of the presented Methodology. I suggest re-organizing and combining sections 2 and 3, to specifically mention what are the datasets used in each of the steps and how each dataset has been used.
- 3) There is a general lack of justification of some of the elections made throughout the study and the discussion of the expected impact of these elections is also missing:
 - a. Line 25 page 11737 – Line 3 page 11738: Why is the geopotential height used to identify Weather Patterns?
 - b. Lines 6-10 page 11738: why top 20% days are selected as rainy days? By choosing this threshold, what is the cut-off value of recorded rainfall?

- c. Lines 10-12, page 11739. The use of the 700 hPa and 1000 hPa geopotential fields are justified based on the results obtained in France and Austria. Can these results be extrapolated to the use of the same information over BC?
- d. Section 2.3. The section requires significant re-organization for a better understanding of the objective and how the analyses have been performed.
- e. Line 5, page 11743: How were the 177 stations selected? Are these all the available stations?
- f. Line 18 page 11743: Please, make explicit the criterion used to select the domain where Weather Patterns have been defined. Why 338 points?
- g. Why were 5 WPs used in the study? How was this number selected?

Minor comments

- 1) Line 9, page 11738: 20 years corresponds to approximately 7305 days. However the total number of reported days adds up to 7660. Please, explain why.
- 2) Lines 21-23, page 11739. This part of the description is unclear. If I understand correctly, the authors refer to the “non-rainy class” as defined in section 2.1.1 and to the “rainy classes” identified with the HAC method of section 2.1.2. I would suggest rewriting this part of the text to improve its clarity.
- 3) Lines 7-9, page 11740. “The four distances between the four geopotential height fields”. Is this the Euclidean distance?
- 4) Section 2.1.4. The result of the re-assignment performed here can be in contradiction with the results of the HAC of section 2.1.2. How would this affect the definition of the Weather Patterns? Also, please, state more clearly that not only the “rainy days” (defined in section 2.1.1 as the top 20% rainy days) were used in the Weather Pattern classification.
- 5) Lines 11-12, page 11740. A brief description of the approach introduced by Garavaglia (2010) is necessary. The definition of “centred rainy events” needs some further clarification. Similarly, in equation (1), could you please confirm that CR is the 24-hour rainfall averaged over the analyzed weather stations?
- 6) Line 3, page 11741. To my understanding, the definition of Weather Pattern (WP) is not yet consolidated enough at this point of the manuscript. I would suggest emphasizing the definition of Weather Patterns in sections 2.1.3 and 2.1.4.

- 7) Lines 3-8, page 11742. It is the first time that the authors mention the bootstrap analysis. I would suggest introducing the motivation of the presented analysis before describing it.
- 8) Line 11 page 11743: Should not “Western Washington” be referred to as “Washington State”?
- 9) Line 18 page 11743: Please, use “grid spacing” instead of “resolution”.
- 10) Section 4.1. I needed reading the text several times to fully follow the discussion and Figure 3. I would suggest revising the text for clarity and state more clearly that each point in the panels of figure 3 corresponds to 1 station. In the panels of figure 3, would the 1:1 line help the interpretation of the results? I would also suggest making the same range for x and y axes for each panel. Page 11745, lines 19-25: Referring to concrete elements of Figure 3 would help the reader to follow the discussion (e.g. “... also show an unclear signal...”; where?).
- 11) Page 11749, line 28 – page 11750, line 8. Pointing at the specific panels of Figure 7 would help the reader understand the presented arguments.
- 12) Lines 9-10 page 11750: “noted P_{1000} hereafter, expressed in mm”. Should not “*expressed*” be “*expressed*”?
- 13) Figure 7 and related discussion (page 11749-11750). By looking at the variability of the different parameters separately, the authors implicitly assume that the role of the 3 fitted parameters is independent. How would the results change when one of the parameters is set constant? Could you please comment on this aspect and on how this could affect the interpretation of your results?
- 14) Section 5: I miss some discussion about how the presented results compare to findings by other authors (some of them introduced in section 1). As an example, in page 11736 the authors state “Kenyon and Hegerl (2010) did not find a clear, significant difference between El Niño winter extremes and other winters over BC”. Some discussion on how this agrees or not with the obtained results would be interesting.
- 15) In many parts of the text, the authors refer to periods like 1951-2001 and 1983-2003 as 50-year and 20-year periods. Note that if the two extremes are included these are 51-year and 21-year periods.
- 16) Please, make all the panels of the figures larger (specially, Figures 3-7 and 9). The presented results and text are hardly visible.