

## ***Interactive comment on “The Role of Atmospheric Rivers in compound events consisting of heavy precipitation and high storm surges along the Dutch coast” by Nina Ridder et al.***

### **Anonymous Referee #1**

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This paper presents a novel analysis of the association between atmospheric rivers (ARs) and compound events (concurrent high precipitation and high sea water level) along the Dutch coast. The study represents a step further to understand the impacts of ARs beyond the traditional focus on precipitation alone, and may help extend the consideration of ARs in situational awareness and forecast of extreme events to regions where ARs have received relatively less attention in the science and/or applications community.

The analysis procedures are sound for the most part, but needs improvement/amendment as described in my specific comments below. A major missing com-

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ponent is a robust accounting of the statistical significance in the differences between CEs with and without ARs, and between ARs with and without CEs. In the only case where significance test is conducted (Figure 7), the test results do not seem to make physical sense (see specific comments below), which makes me worry about whether the significance test was properly conducted.

Specific comments:

Near Line 5: “accompanied by the presence of an AR”, “up to seven days before”: does this mean an event is considered AR-accompanied if an AR is present up to seven days before the event? In any case, it would be useful to define “accompanied by an AR”.

Near line 10: “local ARs”: it is not totally clear what “local” means here. Some ARs travel a longer distance than other ARs, but I’m sure that’s what “local” aims to convey here.

Near line 5: “sever”: typo of “severe”.

Near line 5: “future development of future flood risk”: awkward construction.

Near line 15: “in relation with extra-tropical cyclones”: it would be more consistent with the definition in AMS Glossary of Meteorology to say “typically in relation with . . .”

Near line 15: “400 - 600 km”: add a reference for the quantitative description, or make it qualitative with something like “several hundred km”.

Near line 25: “a characteristic not previously assessed”: change to something like “, a characteristic not previously assessed for ARs affecting the Europe”, because there’s at least one study that has examined the effect of ARs on sea water level in western US; see <https://agupubs.onlinelibrary.wiley.com/doi/abstract/10.1002/2016GL070086>

Near line 30: “projected frequency enhancement and intensification of ARs”: Espinoza et al. 2018 could also be cited here to support this statement where they systematically examined and compared such changes across the globe; see

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<https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2017GL076968>

Near line 5: change “on both, ” to “on both”.

Near line 10: change “both, precipitation and water level,” to “both precipitation and water level”.

Near line 10: “identify days with the presence of an AR”: for the sake of symmetry with CEs, a brief, high-level description of how AR days are identified is warranted here, i.e., based on certain quantile thresholds on intensity and geometry?

Near line 20: change “namely” to “namely”.

Near line 15: “and provided online by Bin Guan”: consider removing as the information like this should be (and already is) in the acknowledgement section.

Near line 25: Guan et al. (2018) could also be cited here which provides more validation of the AR database based on comparing to field observations; see <https://journals.ametsoc.org/doi/abs/10.1175/JHM-D-17-0114.1>

Near line 15: “centred three-day precipitation”: I have difficulty understanding what “centred” conveys in this sentence. That is, the word seems unnecessary. If precipitation amounts on day 1, 2, and 3 are a, b, and c mm, respectively, the 3-day precipitation is simply a+b+c mm, i.e., there’s no “centering” needed to be done in the calculation.

Near line 20: “number of compound events”: the numbers are not fully meaningful without first defining what an “event” is, i.e., is an event counted as a day, a 3-day period, or a continuous period  $\geq 3$  days?

Near line 20: “within  $\pm 1$  days of the event”: Now I sort of understand what “centred” meant in the earlier sentence. In the example I gave above, does it mean the resulting value of a+b+c is assigned to day 2, and the 3-day period centered on day-2 is considered AR-related if an AR occurred on one or more days of day 1, 2, or 3? Please use the answer to make clarifications in the data section in terms of how a CE is defined,

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how an “event” is counted (e.g., if a CE lasted 6 continuous days, is it counted as one event, 2 events, or 6 events?), when a CE is considered to be AR-related or not AR-related, what “day of event” means, etc. Without clear and unambiguous definitions of terms, the statistics presented are hard to make sense of.

Near line 30: “climatological” is a typo of “climatology”, and “esembling” a typo of “resembling”.

Near line 15: “probability density”: for a probability density function, if the function is integrated over all possibilities, the result should be one. But that does not appear to be the case in Figure 5. If you integrate the values over the x-y plane in Figure 5, what does the resulting number represent? That determines how the values contoured in the figure should be called.

Near line 20: add “for” in front of “compound events without”.

Near line 10: “absolut” is a typo of “absolute”.

Near line 15: “persistent throughout the week before an event”: this makes me think that there are conditions during the week prior to the AR that favors the development of warm SSTs and the AR, and in that regard the ARCE (AR+CE) perhaps should be emphasized as indicative of the interplay between these conditions, instead of one causing the other.

Near line 15: “loose” is a typo of “lose”.

Near line 25: “Difference AR with CE and those without”: please fix the grammar.

Near line 5: “noARCEs”: did you mean “noCEARs”? This makes think whether there’s a better way to name these events that works better for both the authors and readers, because names like noARCEs and noCEARs are just a bit too cryptic, and when used together with names like ARCEs and CEARs (which I think are identical?) they may cause unnecessary confusions to both the authors and the readers. How about something more descriptive like the following: - CEs with ARs - CEs without ARs - ARs with

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CEs (identical to CEs with ARs) - ARs without CEs

Near line 30: “early identification of compound events . . . one week in advance”: to make this statement and, more importantly, to make the main analysis of the paper more compelling, it is recommended to show that precursor conditions during the week leading to the CEs are statistically different than conditions leading to no CEs. It would be convenient to build on Figure 9 for this purpose, i.e., by expanding it to include the week before (similar to Figures 6 and 7), and adding significance test for the difference between “ARs with CEs” and “ARs without CEs”. Significance test is also suggested to be added to Figures 6 and 8 and fixed in Figure 7 for the difference between “CEs with ARs” and “CEs without ARs”. The paper heavily relies on statistical analysis (as opposed to dynamics-oriented analysis), so a robust accounting of the statistics is highly desirable.

Near line 10: “a specific definition of ARs”: this sounds like there’re many different definitions, which I don’t think is true. My opinion is that the diversification in AR detection methods (perhaps 20 methods or more exist now) is a manifestation of the difficulty in detecting ARs, not because there’re that many different definitions.

Near line 15: “their effect would be marginal”: consider removing this statement given the large variations across different AR detection methods (see <https://www.geosci-model-dev.net/11/2455/2018/>).

Near line 25: change “based on their poleward transport” to “based on their lacking of poleward transport”.

Table 1 and where applicable in the text: “on day of event”, “one day before or after event”: given that the precipitation is a 3-day total, and CEs are defined using a 3-day window, descriptions like these are quite ambiguous. For example, if a CE occurred during the period of January 1-3, then common sense is that “one day before event” is December 31, and “one day after event” is “January 4”. But that doesn’t seem to be what the authors intended in indicate here. Again, an unambiguous definition of terms

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is needed to avoid potential confusions of this kind, as also suggested earlier.

Figure 2 caption: please define “area covered by AR”, or how it was calculated. Area would have units of  $m^2$ , but it doesn’t seem to be the case here. Did you mean AR frequency of occurrence (percent of time steps)? The latter is a more widely used and understood terminology in at least the AR community.

Figure 3: “over NL”: what does NL refer to or is it defined somewhere? Are the numbers per single month (i.e., the climatological mean), or the total over the given month? Suppose something happens 3 times in January, and is repeated for the past 100 years, it is more sensible to say it happens 3 times per month, instead of 300 times per month, right?

Figure 6: the plots and fonts are too small. Also, the caption says “The right two columns” twice, the first one of which should be “The left two columns”.

Figures 6, 7, 8: “Anomalies CE with AR” etc.: please change to “Anomalies during CEs with ARs”, etc. for clarity.

Figure 7 caption: “Grey areas mark regions with a p-value below 0.05”: given that a small p-value indicates high significance, do you mean the grey areas are where the values are significant, and the color shadings are where the values are NOT significant? That makes no sense because that would mean you are highlighting the non-significant values, and obscuring the significant values. Also, it is against intuition that the strongest anomaly values (darkest shading in the figure) are with large p-values, i.e., non-significant.

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2018-204>, 2018.

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