

We would like to thank Referee #2 for her/his comments. Addressing these comments has helped to improve the manuscript. Below we address each point raised by Referee #2 (*marked in blue, italic*) individually. Our responses to comments are shown in black. Text passages from the manuscript are included in **red** with text changes highlighted by underlining them and choosing **red, bold** font.

Best regards,
Nina Ridder, Hylke de Vries and Sybren Drijfhout

My main concern is the statistical strength of the results obtained here. I am not a close friend to complicate the analysis with statistical test when they are not really necessary, but in this case I think they are. For example, in section 4.1, you say that almost 20% of days have AR detections. Then you say that 28% of days in Delfzijl does not show show AR-CE association, but you are analyzing the same day or within +/-1, which may become the former 20% in a 60% of the days that are considered in the analysis. So you are claiming that CEs occur 72% of the time in coincidence with a something that exists, in general, up to 60% of the time... can the null hypothesis be rejected with this values? Personally, I doubt it... I strongly suggest to include suitable statistical test in the final version of the manuscript.

If we understand the referee's concerns correctly, the referee is concerned about the significance of our finding in regards to the association of CEs to ARs compared to climatology. The Referee argues that due to the 20% chance of an AR at any given day, the chance of an AR occurring over a three-day period should be 60%. We do not see this in our data. We performed a simple test by counting the days without the presence of an AR over the Netherlands over a three-day period and compared it to the total number of days in the study period. We find that these days make up 61% of the total days, while those days with an AR over a three-day period occur only 39% of the time. Thus, the ratio of days without ARs (including +/-1day) and days with ARs on the day or the day before or after between climatology and CEs is significantly different, i.e. 61:39 (climatology) vs. 28:72 (CEs at Delfzijl). We therefore think that our conclusion that ARs play an important role in the occurrence of CEs is sufficiently supported by our results. To underline this in the manuscript we added the following sentences at the end of the first paragraph of Section 4.1:

"Only a small fraction of 18% (Harlingen) to 28% (Delfzijl) of CEs does not show any association to the presence of an AR over the Netherlands. This is significantly different to climatology with roughly 61% of days that lack the presence of an AR over a three-day period against 39% of days with an AR detected over the Netherlands either on the day itself or the day before or after. As a result, the chance of having a CE on a random day (ie. without knowledge on presence AR) is a factor three higher than

that on a day without an AR, whereas the chance on having a CE on a day with AR is a factor three to four higher than on a random day.”

Minor Comments:

P2 L14-17 : Please, update this figures regarding the poleward transport of water vapor, and the width/length ratio in ARs with Guan and Waliser, (2015). Guan, B., & Waliser, D. E. (2015). Detection of atmospheric rivers: Evaluation and application of an algorithm for global studies. Journal of Geophysical Research: Atmospheres, 120(24), 12514-12535.

We adjusted the manuscript as follows:

The vast geometric extent of ARs with a typical width of **several hundred kilometres (<1,000 km)** and lengths of over 2,000 km allows them to cover and affect large geographical areas simultaneously (Ralph et al. 2004; Guan and Waliser, 2015).

P2 L25 : Please, consider to add a sentence on the source regions of moisture for Atlantic ARs. Take a look at <https://www.earth-syst-dynam.net/7/371/2016/esd-7-371-2016.html>.

We added the following sentence to address this:

“[...] They [ARs] typically develop in relation with extra-tropical cyclones and move with the large-scale dynamic phenomena that produce them (hereafter AR system). In the case of Western Europe, the moisture contained in ARs hitting this region originates from evaporation over an area stretching from the subtropical North Atlantic (north of 20°N) over the central and western North Atlantic to the West European coast (Ramos et al., 2016). The vast geometric [...]”

P3 L7 : Replace “EOBS” by “E-OBS”.

Done.

P3 L21 : Please, add something like “when synoptic forcing conditions are favorable” after “precipitation events”.

We added the following:

Nevertheless, it has been shown that those ARs making landfall along the Dutch coast can lead to significant precipitation events **depending on the forcing conditions caused by the prevailing large-scale atmospheric conditions** (Waliser and Guan, 2017).

P3 L23 : Add more information about the stations. To whom they belong?

This section now reads:

[...] and the north-east of the Netherlands (hereafter NENL) for Delfzijl. All stations are operated by Dutch Ministry of Infrastructure and Water Management and are located in four different water boards. The stations

were chosen [...]

P4 L4-7 : I think that it is completely unnecessary to describe ERA-Interim. Please, consider to replace this needless description by a citation.

We followed the reviewer's advice and deleted part of the description. The section now reads:

The ERA-Interim reanalysis dataset is produced by the European Centre for Medium-Range Weather Forecast (ECMWF). It is the result of reanalysis simulations performed using a three-component forecast model (Integrated Forecasting System IFS release Cy31r2) for the time period from 1 Jan 1979 to present day (Berrisford et al., 2011; Dee et al., 2011). ~~The IFS uses the spectral grid T255 (~ 80 km) and has 60 vertical levels spanning from the surface up to 0.1 hPa. Analysis time steps are provided every six hours for most atmospheric variables, i.e. each day contains information about atmospheric conditions at 00:00, 06:00, 12:00 and 18:00.~~ This study uses data for mean sea level pressure, zonal and meridional wind components to force a numerical storm surge model, [...]

P5 L23 : "processes" is written two times in the same sentence. Consider to find an alternative.

We replaced the second "processes" with the word "mechanisms".

P6 L24 : replace "winter six months" by "extended winter".

Done.

P10 L6 : Do you mean Fig. 8a?

Reference was adjusted from 8b to 8a.

P10 L27 : Please, consider to rewrite the title of this subsection.

The new section title now reads:

Difference between ARs with and without association to CEs

P12 L14 : "we provide vital information"... consider to replace "vital" by "important", or similar.

We changed "vital" to "crucial"

Table 1 : Include the period (1979-2015) in the caption.

Done.

Figure 4 : Include “ARCEs”, “no ARCEs”, etc... in each box of the Figure.
 We added the labels requested by the reviewer to the Figure (see below).

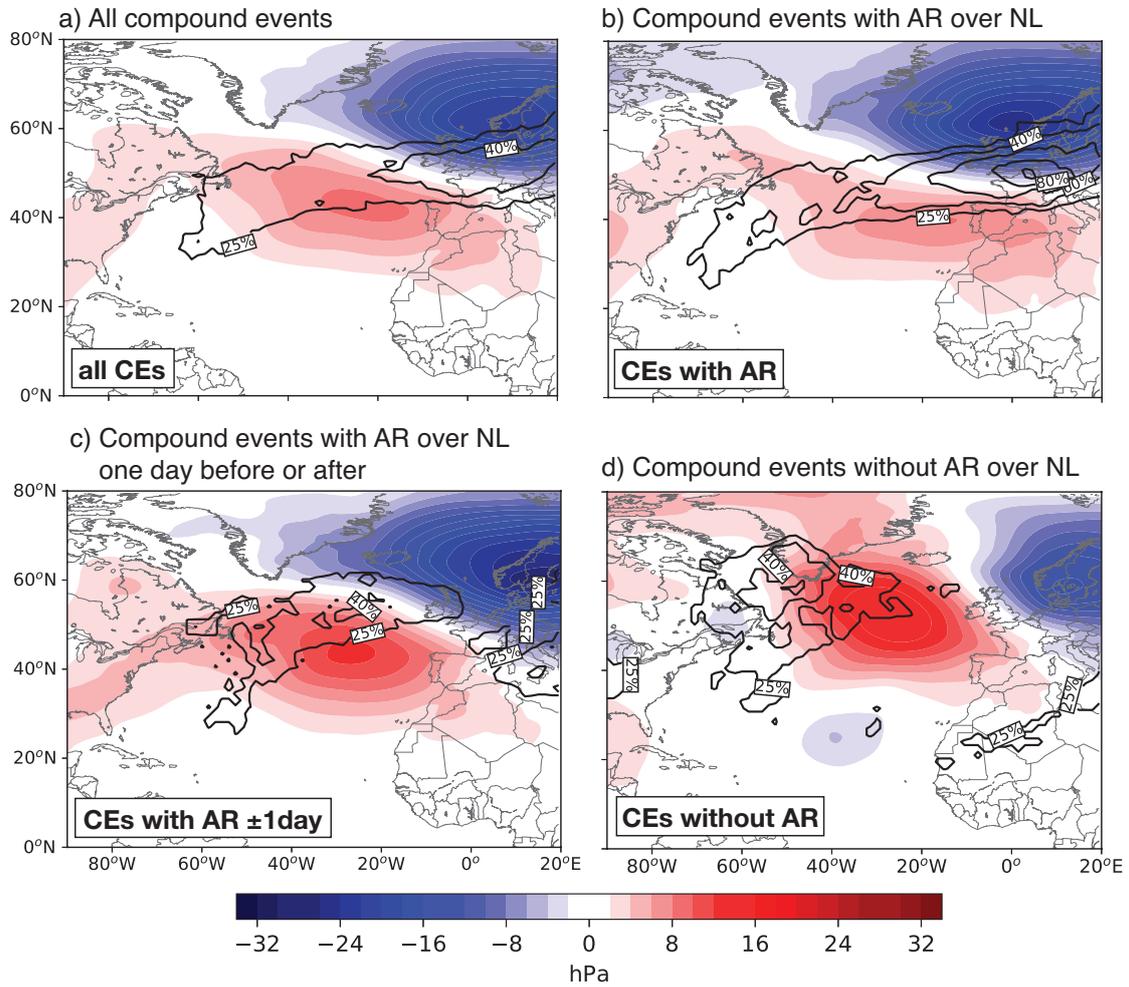


Figure 5 : This figure is very complete and helps a lot to understand the results, but, please, simplify the legend and be consisted. For example, if I understood properly, the only difference between red and black lines is AR and no-AR detection. Then, why do you say “days” for the red line, and “t-series” for the black one? The same applies to the dots.

We adjusted the caption and legend of the figure according to the Referee’s suggestion (see below).

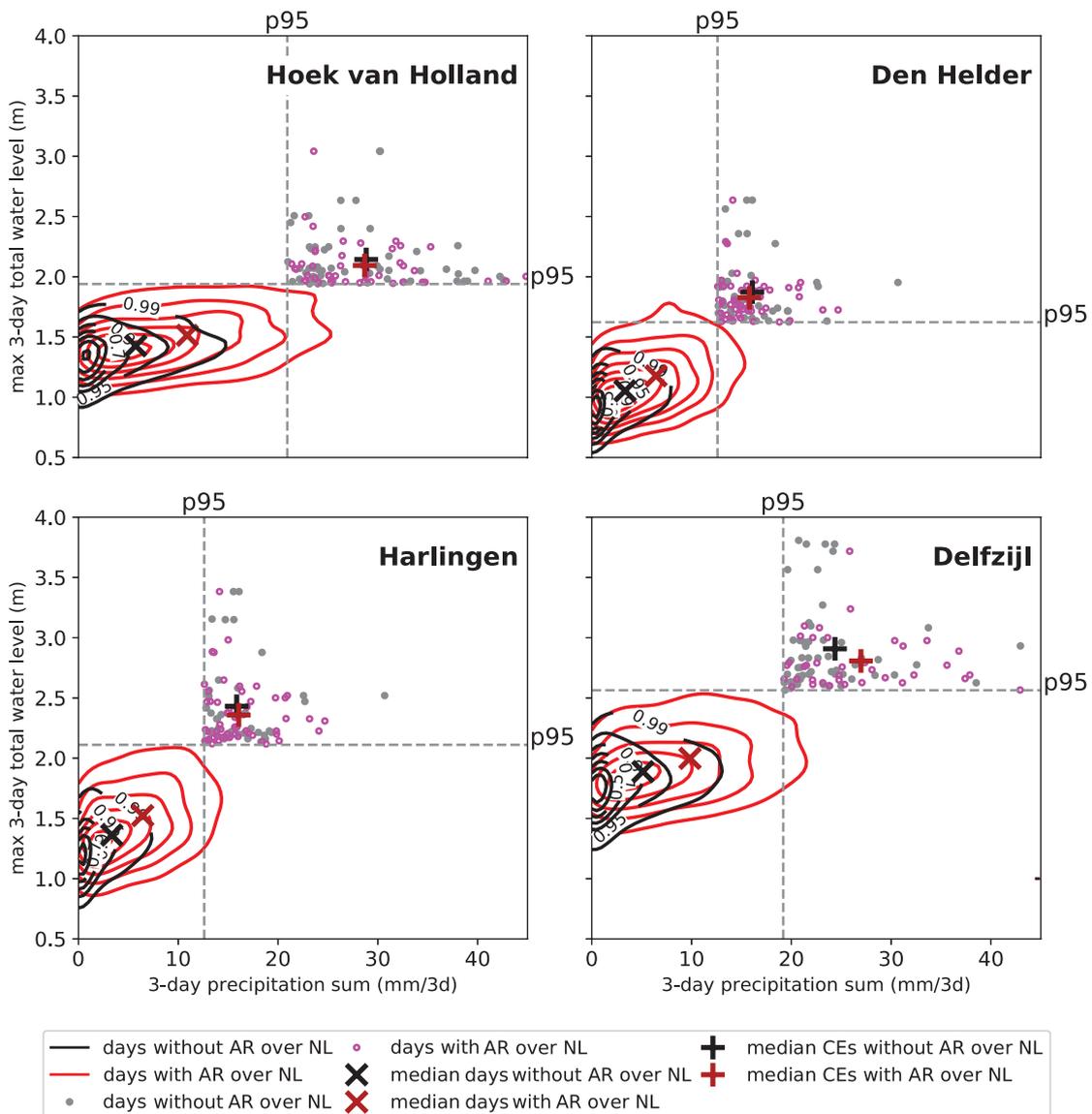


Figure 6 : This results refer to “Den Helder” only. Please, clarify somewhere in the caption.

We adjusted the caption of this figure to the following:

Temporal evolution of mean conditions seven (a-d) and four days (e-h) before a CE at Den Helder and on the day of the event itself (i-l). The left two columns, i.e. panels a, e, i and b, f, j, show the evolution of anomalies in SLP

(colour shading) and IVT (vector field) during CEs with and without AR association, respectively. The right two columns, i.e. panels c, g, k and d, h, l, show the same but for absolute values of daily mean SLP and IVT. **Results for the three other stations (not shown) are comparable.**

Figure A1 : Please, rewrite the last sentence in the caption.

The last sentence of the caption now reads:

Dashed horizontal lines indicate the climatological values for the different landfall locations.