Atmospheric Rivers in Europe: from moisture sources to impacts and future climate scenarios

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An atmospheric river (AR) detection algorithm is used for the North Atlantic ocean basin, allowing the identification of the major ARs affecting western European coasts between 1979 and 2012 over the winter half-year (October to March). The western coast of Europe was divided into five domains, namely the Iberian Peninsula, France, UK, Southern Scandinavia and the Netherlands, and Northern Scandinavia. Following the identification of the main ARs that made landfall in western Europe, a Lagrangian analysis was then applied in order to identify the main areas where the moisture uptake was anomalous and contributed to the ARs reaching each domain (Ramos et al., 2016). The Lagrangian dataset used was obtained from a FLEXPART model simulation between 1979 and 2012.

The results show that, in general, for all regions considered, the major climatological areas for the anomalous moisture uptake extend along the subtropical North Atlantic, from the Florida Peninsula to each sink region, with the nearest coast to each sink region always appearing as a local maximum. In addition, during AR events the Atlantic subtropical source is reinforced and displaced southwards. An example regarding the anomalous uptake of moisture is shown for the ARs that make landfall in the UK is shown in Figure 1.

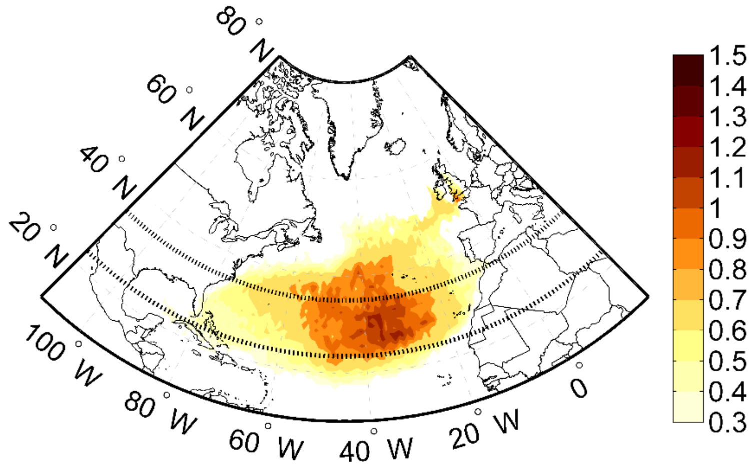

Figure 1. (E − P) > 0 anomaly field for AR days [(E-P)An] for the ARs that made landfall in the UK (Units in mm/day).

In addition, as shown by Lavers et al., 2013, there is a strong relationship between extreme precipitation across Europe and ARs. In the particular case of the Iberian Peninsula, the major AR events that affected the region were studied in detailed by Ramos et al., 2015. It was analyzed if the extreme precipitation days in the Iberian Peninsula are association (or not) with the occurrence of ARs. Results show that the association between ARs and extreme precipitation days in the western river basins is noteworthy, while for the eastern and southern basins the impact of ARs is reduced.

Since the ARs are associated with high impact weather it is of most importance to assess changes in the ARs frequency in future climate changes. Regarding Europe, changes in the vertically integrated horizontal water transport were analyzed using six global climate models. There is an increase in the vertically integrated horizontal water transport which lead to an increase in the ARs frequency for the 2074- 2099 period when compared with the historical simulation (1980-2005). This increase in future ARs frequency is estimated to be more visible in the high emission scenarios (RCP8.5) when it can more than double the annual mean of ARs obtained for the historical simulation, as shown in Figure 2 for the “Southern Scandinavia and The Netherlands” domain.

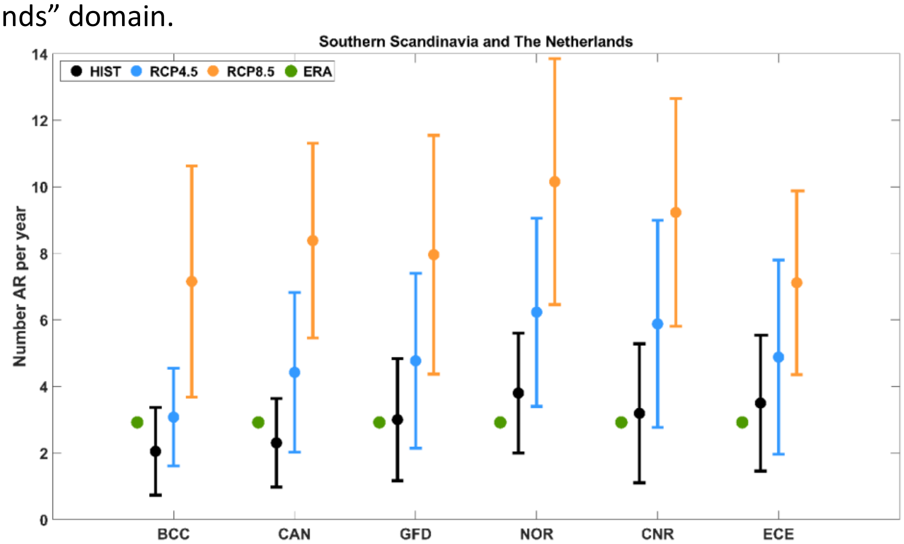

Figure 2. Mean ARs frequency per extended winter (ONDJFM) in two future climate scenarios (RCP4.5, blue and RCP8.5, orange) for each of the 6 CGMs. In addition, the results for the historical runs (black) and the ERA-Interim (green) are also shown. The intra-annual variability of the GCMs simulations is also highlighted.

References

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