EGU23-1553, updated on 15 Apr 2024
https://doi.org/10.5194/egusphere-egu23-1553
EGU General Assembly 2023

Sources of Moisture to Extreme Atmospheric Rivers: a storm Denis case study

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Moisture transport within atmospheric rivers (ARs) is a complex combination of processes, with convergence of moisture with different origin and its changes over the life cycle of an AR. The water vapour budget in an AR enables us to understand the contribution of the different moisture sources and sinks (horizontal transport, local evaporation and precipitation). Here, we focus on how these contributed to the formation and development of the exceptional AR associated with storm Denis that occurred in February 2020 leading to the 3rd highest UK average daily rainfall since 1891[1].

We use the WRF-ARW numerical limited-area atmospheric model to simulate the life-cycle of the AR in the North Atlantic basin. We use a resolution of 0.09º, and a domain covering both the AR's formation region close to the Gulf of Mexico to the landfall region in northern and central Europe. Moreover, we performed two sets of sensitivity experiments by reducing the tropical moisture transport, and the sensible heat flux in specific areas of the oceanic basin to assess how these two main components affect the water vapour balance within the AR. We also defined a threshold to map the AR and used a centroid-based method to track its path in order to measure the shift of its location and intensity through time in the different experiments.

Our findings reveal significant relationships between the reduction of tropical moisture and a change of the location of the AR. The analysis also detected regional and temporal changes in the water vapour budget due to the perturbations done in the sensitivity experiments. In addition, relative importance of moisture sources are assessed. As such, our work provides a new case study to unravel feedback processes and the influence to the AR characteristics when perturbing the water vapour balance.

[1] Davies, Paul A., et al. "The wet and stormy UK winter of 2019/2020." *Weather* 76.12 (2021): 396-402.