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Moisture origin of the extreme precipitation event in Western Europe in July 2021

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From the 12th to the 15th of July 2021, Western Europe was confronted with an abnormal amount of precipitation leading to extreme floods and enormous damage in western Germany, Belgium, Luxembourg and the Netherlands. Locally, almost thrice as much as the monthly precipitation amount was observed, up to 175 mm in two days. The large-scale weather pattern in Western Europe was characterised by an intense and stationary upper-level cut-off low.

In this study the atmospheric conditions resulting in this extreme precipitation are investigated, with a focus on understanding the enhanced moisture supply leading to the extreme precipitation amounts. Previous to the event, the Baltic area experienced a significant heatwave, and it was hypothesized that due to high evaporation rates more humid air over this region would be transported towards western Europe to result in these enormous amounts of rain.

We analysed the moisture origin of the extreme precipitation with the Lagrangian trajectory diagnostic LAGRANTO applied to both re-analysis data (ERA5) and simulations with the non-hydrostatic weather research and forecasting model (WRF). Both models represent the case rather well. In addition, the impact on precipitation by adapting the sea surface temperature (SST) of both the Baltic and the Mediterranean Sea was studied using WRF. This analysis showed that SST changes in the Mediterranean had the largest impact on precipitation in western Europe. Furthermore, first results indicate that the Mediterranean Sea, which had a positive SST anomaly of 2˚C, was the main moisture source preceding the precipitation event, contrasting our initial hypothesis.