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Investigating UK Summer precipitation variability using a Lagrangian approach

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Northwest Europe has been faced with a succession of exceptionally wet summers in 2007, 2008, 2009 and 2012. In 2007, although June-July rainfall was over 200% of the average for England and Wales, 38% of this rain fell in only 3 events associated with slow-moving cyclones. This paper attempts to explain the UK Summer precipitation variability by partitioning it into changes in the origin of air masses, changes in the environment at those origins and local storm dynamics (e.g.,stronger ascent above the UK).

Reverse domain filling back trajectories are calculated from meteorological analyses and variables are interpolated to the trajectories. It is shown that moisture changes along the last 6 hours of trajectories account for 76% of the precipitation observed by the gauge network. The results are also consistent with precipitation forecasts made as part of the ERA-Interim analysis cycle in the ECMWF IFS. Therefore, the trajectories can be used to explore the variability in water vapour above the UK and the associated precipitation.

The back trajectories are used to link to the origins of air masses contributing to the precipitation over the UK. For this purpose, the last contact with the boundary layer defines the "origins". Conservation of specific humidity is not assumed: the trajectories are used to link changes occurring in the ECMWF model following the resolved flow. Results suggest that precipitation for the wettest summer months originates from different regions when compared to the climatological origins. Part of this signal can be linked to the mid-latitude storm track variability. Anomalous temperature and humidity at the origins during wet months are below the local long term average, showing that the extreme monthly precipitation for the UK cannot be explained by a simple "warmer climate, higher humidity" argument. The changes in circulation patterns are crucial.