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Analysis of cyclone water budgets in the North Atlantic and their role for Europe

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Europe's water budget is largely influenced by cyclones. We determine the time evolution of the water cycle of North Atlantic winter cyclones, and analyse their influence on Europe. The basis is a high-resolution climate simulation of the regional climate model REMO which is driven at the lateral boundaries by reanalysis data. Using a tracking algorithm for pressure lows, the spacial and temporal development of individual cyclones can be studied on different atmospheric height levels. The algorithm calculates a so-called "watershed area" around every cyclone center which separates different low pressure fields from each other and can be used as a definition of the cyclone extent area. In particular, we are interested in the time development of the vertically integrated total water vapour and liquid water content in the atmosphere within the cyclone extent areas. The trace of the cyclone center, the intensity, the spacial extent, as well as the amount of precipitation, evaporation, and moisture convergence, are calculated for each cyclone.

Special emphasis is drawn to the question, if there is a correlation between the water budget of the cyclone over the ocean and over land. We find that on average there is more precipitation than evaporation within the cyclone extent area, thus the additional moisture originates from advection into the extent area. There is a negative anomaly in atmospheric water content under cyclone influence over the North Atlantic where the cyclogenesis takes place, while cyclones accumulate moisture when travelling to Europe, where a large part of the moisture is precipitated. The amount of precipitation that a cyclone provides over Europe depends on its intensity in the first place, but to a much smaller extent on the amount of evaporated water over the ocean. A trend analysis in the modelled 40 years period between 1960 and 2000 shows a positive trend in cyclone frequency in the high-latitudes (>60°N).