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Combined event-based tritium and air mass back-trajectory analysis of Mediterranean precipitation events

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Climate models are in need of improved constraints for water vapor transport in the atmosphere and tritium can serve as a powerful tracer in the hydrological cycle. Although general principles of tritium distribution and transfer processes within and between the various hydrological compartments are known, variation on short timescales and aspects of altitude dependence are still under debate. To address questions for tritium sources, sinks and transfer processes, sampling of individual precipitation events in Corte on the island of Corsica in the Mediterranean Sea was performed between April 2017 and April 2018. Tritium concentrations of 46 event samples were compared to their moisture origin and corresponding air mass history. Air mass back-trajectories were generated from the novel high-resolution ERA 5 data set of the ECMWF (European Centre for Medium-Range Weather Forecasts). Geographical source regions of similar tritium concentrations were predefined using generally known tritium distribution patterns, such as a 'continental effect', and from data records derived at long-term measurement stations of tritium in precipitation across the working area. Our model-derived source region tritium concentrations agreed well with annual mean station values. Moisture that originated from continental Europe and the Atlantic Ocean was most distinct regarding tritium concentrations with values up to 8.8 TU and near 0 TU, respectively. Seasonality of tritium values ranged from 1.6 TU in January to 10.1 TU in May and exhibited well-known elevated concentrations in spring and early summer due to increased stratosphere-troposphere exchange. However, this pattern was interrupted by extreme events. The average altitude of trajectories correlated with tritium concentrations in precipitation, especially in spring and early summer and if outlier values of extreme tritium concentrations were excluded. However, in combination with the trajectory information, these outlier values proved to be valuable for the understanding of tritium movement in the atmosphere. Our work shows how event-based tritium research can advance the understanding of its distribution in the atmosphere.