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Changes in isotopic composition of precipitation in Germany during the last three decades

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Climate scientists have concluded that the earth's surface air temperature increased by 0.6 °C during the 20th century, and that warming induced by increasing concentrations of greenhouse gases is likely to continue in the 21st century, inducing changes in the hydrologic cycle. Various studies were conducted to detect changing hydrological parameter by time series analysis. However, there is a lack of information about the behaviour of isotopic composition of precipitation during the 20th century, even though knowledge about this behaviour is very important for hydrological research. Therefore, the monthly O-18 time series of selected stations in Germany have been analysed for decadal trends as potential indicators of changes in the hydrological cycle. Only eight stations supplied sufficiently long time series to perform statistical trend test analysis. The period of the study covers 1978-2006. The non-parametric Mann-Kendall test was used to calculate the significance ($p \leq 0.1$) of trends. The method of Sen was applied for the calculation of the direction and magnitude of trends. Corrections for serial correlation were carried out. In northern german inland stations a strong change was detected for January to June, with the highest rate of change during March in Braunschweig (0.161 $\permil$/yr, p=0.001). Those inland stations showed slight lighter isotopic composition of precipitation from August to December with no significance compared to the beginning of the time series. The only station located at the coast (Cuxhaven) showed significant changes only in June and July. The southern german stations of Stuttgart and Wuerzburg showed a similar behaviour with significantly heavier precipitation in June and lighter ones in September and November. Isotopic

compositions in the northern Alps became significantly heavier from March to June with a maximum change of 0.179 $^{0}/_{00}$/yr in April, which led to 5.2 $^{0}/_{00}$ heavier isotope signature of April precipitation compared to the late seventies of the last century. Preliminary results showed a partial relationship between the strength and direction of the temperature trends to the trends of the isotopic composition of precipitation (R^2=0.39). But this relation can not explain the strong change in isotopic composition of precipitation on it's own. The changing isotopic composition must be considered during studies handling longer isotopic time series of groundwater and river runoff, because the precipitation probably also leads to trends in groundwater and runoff isotopic composition.