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Stable isotope investigation of groundwater recharge in the Carpathian Mountains, East-Central Europe

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Rapid growth in water usage in NW Romania has led to an increased pressure on the available water resources; however, the relationships between precipitation, surface and groundwater in the region are poorly understood. Here, we have analyzed the stable isotopes of oxygen and hydrogen in precipitation, river and groundwater to gain information on moisture sources feeding precipitation in the area and establish the main links between the large-scale atmospheric circulation, precipitation amount and discharge. Thus, in this study we have analyzed 157 groundwater samples, 64 precipitation samples from two collection sites (one in mountain area and another one in plateau area) and 54 rivers samples from two rivers. Furthermore, we have directly linked the changes in the isotopic composition of the d-excess parameter in the precipitation with the processes linked to large-scale atmospheric circulation. Isotopes in precipitation water resulted in two LMWLs (δ2H=7.4*δ18O+2.7 at 350 m asl and δ2H=8.1*δ18O+12.4 at 1530 m asl), with a clear seasonal signal, further enhanced by secondary evaporative processes in summer. Moisture in the lowlands was mostly delivered along easterly trajectories, while that in the mountain area from the westerlies. Surface water analyses show the same trend as precipitation, but with reduced amplitude between summer and winter values. Throughout the winter season, the δprec is strongly related with different climate teleconnection patterns like the East Atlantic (EA), the North Atlantic Oscillation (NAO) and the Arctic Oscillation (AO), while during summer, the δprec shows a strong correlation with the Atlantic Multidecadal Oscillation (AMO) and the summer EA. Maps of δ18O and d-excess distribution in groundwaters show a depletive trend from NW to SE, generated in principal by topography. The waters in the aquifers show no clear patterns and altitude effect.