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Interannual analysis of high spatially-resolved δ18O and δ2H data in precipitation across North-East Italy

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Stable water isotopes are widely-used tracers to investigate hydrological processes occurring in the atmosphere and to determine the geospatial origin of water, i.e. to acquire useful information about the hydrological cycles over catchment basins and to find the origin of water recharging rivers, aquifers, and springs. Mapping the isotopic composition of precipitation provides hydrological and climate information at regional and global scales. However, the isotopic composition of precipitation is usually analyzed at large scales with a limited spatial resolution. In Italy, a few studies mapped the oxygen stable isotopes using annually-averaged data, not accounting for the strong seasonality of the isotopic composition linked to climatic and weather factors. To partially fill this gap, the present study proposes a detailed analysis of more than 2250 isotope data ($\delta^{18}O$, $\delta^{2}H$, and deuterium excess) related to precipitations collected in the Friuli Venezia Giulia (FVG) region (Italy) with monthly or seasonal frequency in 36 sites between 1984 and 2015.

The FVG region lies at the north-eastern end of Italy, bordering Austria in the North and Slovenia in the East, and extends over ~$7.9 \cdot 10^3$ km^2. From a hydrogeological point of view, FVG is an interesting case study. Large highly-permeable carbonate aquifers are present in the Alps and Prealps, while the southern part of the region is characterized by an alluvial plain, split by the spring belt into two sectors: the High Plain in the North, characterized by an highly-permeable unconfined aquifer, and the Low Plain in the South, characterized by a system of confined and artesian aquifers. All the aquifers are recharged by the effective precipitations which in the FVG exhibits among the highest annual precipitation rates in Italy (with peaks >3000 mm/year).

For the present research, the isotopic data were used: (i) to analyze the spatial and seasonal variability of isotopic composition; (ii) to relate water isotopes with orography and weather parameters collected from meteorological stations as well as using ECMWF ERA5 reanalysis; (iii) to reconstruct the local meteoric water lines across the FVG at annual and seasonal bases; (iv) to quantify interannual trends and analyze their spatial distribution; and (iv) to model the spatial distribution of isotope content in precipitation and create annual and seasonal maps.

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