Precipitation isotope time series predictions from machine learning applied in Europe

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Hydrogen and oxygen isotope values of precipitation are critically important quantities for applications in Earth, environmental, and biological sciences. However, direct measurements are not available at every location and time, and existing precipitation isotope models are often not sufficiently accurate for examining features such as long-term trends or interannual variability. This can limit applications that seek to use these values to identify the source history of water or to understand the hydrological or meteorological processes that determine these values. We developed a framework using machine learning to calculate isotope time series at monthly resolution using available climate and location data in order to improve precipitation isotope model predictions. Predictions from this model are currently available for any location in Europe for the past 70 y (1950-2019), which is the period for which all climate data used as predictor variables are available. This approach facilitates simple, user-friendly predictions of precipitation isotope time series that can be generated on demand and are accurate enough to be used for exploration of interannual and longterm variability in both hydrogen and oxygen isotopic systems. These predictions provide important isotope input variables for ecological and hydrological applications, as well as powerful targets for paleoclimate proxy calibration, and they can serve as resources for probing historic patterns in the isotopic composition of precipitation with a high level of meteorological accuracy. Predictions from our modeling framework, Piso.AI, are available at https://isotope. bot.unibas.ch/PisoAI/.
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