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RCWIM – an improved global water isotope pattern prediction model using fuzzy climatic clustering regionalization

Stefan Terzer (1), Luis Araguás-Araguás (1), Leonard I. Wassenaar (2), and Pradeep K. Aggarwal (1)

(1) Isotope Hydrology Section, International Atomic Energy Agency, Vienna, Austria, (2) Isotope Hydrology Laboratory, International Atomic Energy Agency, Vienna, Austria

Prediction of geospatial H and O isotopic patterns in precipitation has become increasingly important to diverse disciplines beyond hydrology, such as climatology, ecology, food authenticity, and criminal forensics, because these two isotopes of rainwater often control the terrestrial isotopic spatial patterns that facilitate the linkage of products (food, wildlife, water) to origin or movement (food, criminalistics). Currently, spatial water isotopic pattern prediction relies on combined regression and interpolation techniques to create gridded datasets by using data obtained from the Global Network of Isotopes In Precipitation (GNIP). However, current models suffer from two shortcomings: (a) models may have limited covariates and/or parameterization fitted to a global domain, which results in poor predictive outcomes at regional scales, or (b) the spatial domain is intentionally restricted to regional settings, and thereby of little use in providing information at global geospatial scales. Here we present a new global climatically regionalized isotope prediction model which overcomes these limitations through the use of fuzzy clustering of climatic data subsets, allowing us to better identify and customize appropriate covariates and their multiple regression coefficients instead of aiming for a one-size-fits-all global fit (RCWIM – Regionalized Climate Cluster Water Isotope Model). The new model significantly reduces the point-based regression residuals and results in much lower overall isotopic prediction uncertainty, since residuals are interpolated onto the regression surface. The new precipitation δ2H and δ18O isoscape model is available on a global scale at 10 arc-minutes spatial and at monthly, seasonal and annual temporal resolution, and will provide improved predicted stable isotope values used for a growing number of applications. The model further provides a flexible framework for future improvements using regional climatic clustering.