Benefits of Using Higher Density Lower Reliability Weather Data from the Global Historical Climatology Network (GHCN) Monitors for Watershed Modelling

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April 26, 2023

Abstract

Hydrological models require a complete and accurate time series of weather inputs to adequately represent watershed-scale responses. The Global Historical Climatology Network (GHCN) is the most comprehensive ground-based global weather database and is often used in hydrological modeling studies. Since higher density, lower reliability precipitation measurements from private citizens collected by the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network data were integrated into the GHCN, hydrological modelers in the U.S. have access to a much greater amount of weather data. However, the benefit of using CoCoRaHS data has not been assessed. The objectives of this work were to develop a method for generating a complete weather data time series based on the combination of data from multiple GHCN monitors and to assess several methods for estimation of missing weather data. Weather data from GHCN monitors located within a specific radius of a watershed were obtained and interpolated using three estimation methods (Inverse Distance Weighting (IDW), Inverse Distance and Elevation Weighting (IDEW), and Closest Station), creating a seamless time-series of weather observations. To evaluate the performance of the methodologies, weather data obtained from each estimation method was used to force the Soil and Water Assessment Tool (SWAT) models of 21 U.S. Department of Agriculture-Conservation Effects Assessment Project watersheds in different climate regions to simulate daily streamflow for 2010-2021. Except for three watersheds, all SWAT models had Nash-Sutcliffe Efficiency above 0.5, the ratio of the root mean square error to the standard deviation of observations below 0.7, and percent bias from -25% to 25% with a satisfactory performance rating. Overall, IDEW and IDW performed similarly, and the Closest Station method resulted in the poorest streamflow simulation. A comparison with published SWAT model results further corroborated improved model performance using newly combined GHCN data with all Closest Station, IDW, and IDEW methods.

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