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Validation of non-stationary precipitation series for site-specific impact assessment: comparison of two statistical downscaling techniques

Donal Mullan (1), Xunchang Zhang (2), and Jie Chen (3)

(1) School of Natural Sciences & Psychology, Liverpool John Moores University, Liverpool, England, UK (D.J.Mullan@ljmu.ac.uk), (2) USDA-ARS, Grazinglands Research Laboratory, El Reno, Oklahoma, USA (John.Zhang@ARS.USDA.GOV), (3) Department of Construction Engineering, École de Technologie Supérieure, Universitié de Québec, Montreal, Canada (Jie.Chen@etsmtl.ca)

The generation of realistic future precipitation scenarios is crucial for assessing their impact on a range of environmental and socio-economic impact sectors. A scale mismatch exists, however, between the coarse spatial resolution at which general circulation models (GCMs) output future climate scenarios, and the finer spatial scale at which impact modellers require projections. Statistical downscaling (SD) methods have become a popular, low-cost and accessible means of addressing this scale mismatch, with various different SD techniques used for a wide range of applications across the world. The Generator for Point Climate Change (GPCC) method involves first spatially downscaling GCM/RCM (regional climate model) monthly precipitation projections from a grid box to target station using transfer functions, and then temporally disaggregating monthly projections into daily series using the CLIGEN weather generator. The Statistical Downscaling Model (SDSM), in contrast, develops transfer functions between observed precipitation for a target station and large-scale atmospheric variables from a grid box at a daily resolution, and a subsequent forcing of these transfer functions using the same set of large-scale atmospheric variables as output by GCMs for the future. This paper compares these two contrasting SD methods in terms of their ability to generate precipitation series under non-stationary conditions in a wide range of climatic zones. Ten stations were selected to reflect a broad range of global climates, with observed precipitation series split into a calibration and validation period in a manner which maximised the difference of mean annual precipitation between the two records. The mean, maximum and a selection of distribution statistics for daily, monthly and annual precipitation were compared between the models and the observed series for the validation period. Results indicate that both methods generally produce precipitation series that compare closely with the daily and monthly mean for the validation period, though in some instances the annual mean differs by as much as 50%. The distribution of precipitation series is also generally well simulated at all temporal resolutions, but the GPCC method tends to overpredict higher precipitation amounts, whilst SDSM tends to underpredict these. The results reveal that two contrasting SD methods can generate daily precipitation series that generally closely mirror observed series for a wide range of non-stationary climates, but in a minority of instances simulated series can be considerably different from the observed period for both means and distributions. This illustrates the importance of users performing a thorough validation in order to determine the influence of simulated precipitation on their impact sector.