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Evaluation of a spatial rainfall generator and an interpolation methods for the creation of future gridded data sets over complex terrains

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Space-time variability of precipitation plays a key role as a driver of many processes in different environmental fields like hydrology, ecology, biology, agriculture, and natural hazards. The objective of this study was to compare two approaches for statistical downscaling of precipitation from climate models. The study was applied to the island of Cyprus, an orographically complex terrain. The first approach makes use of a spatial temporal Neyman-Scott Rectangular Pulses (NSRP) model and a previously tested interpolation scheme (Camera et al., 2014). The second approach is based on the use of the single site NSRP model and a simplified gridded scheme based on scaling coefficients obtained from past observations. The rainfall generators were evaluated on the period 1980-2010. Both approaches were subsequently used to downscale three RCMs from the EU ENSEMBLE project to calculate climate projections (2020-2050).

The main advantage of the spatial-temporal approach is that it allows creating spatially consistent daily maps of precipitation. On the other hand, due to the assumptions made using a stochastic generator based on homogeneous Poisson processes, it shows a smoothing out of all the rainfall statistics (except mean and variance) all over the study area. This leads to high errors when analyzing indices related to extremes. Examples are the number of days with rainfall over 50 mm (R50 - mean error 65%), the 95th percentile value of rainy days (RT95 – mean error 19%), and the mean annual rainfall recorded on days with rainfall above the 95th percentile (RA95 – mean error 22%). The single site approach excludes the possibility of using the created gridded data sets for case studies involving spatial connection between grid cells (e.g. hydrologic modelling), but it leads to a better reproduction of rainfall statistics and properties. The errors for the extreme indices are in fact much lower: 17% for R50, 4% for RT95, and 2% for RA95.

Future projections show a decrease of the mean annual rainfall (for both approaches) over the study area between 70 mm (≈15%) and 5 mm (≈1%), in comparison to the reference period 1980-2010. Regarding extremes, calculated only with the single site approach, the projections show a decrease of the R50 index between 25% and 7%, and of the RT95 between 8% and 0%. Thus, these projections indicate that a slight reduction in the number and intensity of extremes can be expected. Further research will be done to adapt and evaluate the use of a spatial-temporal generator with nonhomogeneous spatial activation of raincells (Burton et al., 2010) to the study area.

Burton, A., Fowler, H.J., Kilsby, C.G., O'Connell, P. E., 2010a. A stochastic model for the spatial-temporal simulation of non-homogeneous rainfall occurrence and amounts, Water Resour. Res. 46, W11501. DOI: 10.1029/2009WR008884

Camera, C., Bruggeman, A., Hadjinicolaou, P., Pashiardis, S., Lange, M. A., 2014. Evaluation of interpolation techniques for the creation of gridded daily precipitation (1 × 1 km2); Cyprus, 1980–2010. J. Geophys. Res. Atmos., 119, 693-712. DOI: 10.1002/2013JD020611.