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Rainfall Downscaling Conditional on Upper-air Variables: Assessing Rainfall Statistics in a Changing Climate

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Due to its intermittent and highly variable character, and the modeling parameterizations used, precipitation is one of the least well reproduced hydrologic variables by both Global Climate Models (GCMs) and Regional Climate Models (RCMs). This is especially the case at a regional level (where hydrologic risks are assessed) and at small temporal scales (e.g. daily) used to run hydrologic models.

In an effort to remedy those shortcomings and assess the effect of climate change on rainfall statistics at hydrologically relevant scales, Langousis and Kaleris (2013) developed a statistical framework for simulation of daily rainfall intensities conditional on upper air variables. The developed downscaling scheme was tested using atmospheric data from the ERA-Interim archive (http://www.ecmwf.int/research/era/do/get/index), and daily rainfall measurements from western Greece, and was proved capable of reproducing several statistical properties of actual rainfall records, at both annual and seasonal levels. This was done solely by conditioning rainfall simulation on a vector of atmospheric predictors, properly selected to reflect the relative influence of upper-air variables on ground-level rainfall statistics.

In this study, we apply the developed framework for conditional rainfall simulation using atmospheric data from different GCM/RCM combinations. This is done using atmospheric data from the ENSEMBLES project (http://ensembleseu.metoffice.com), and daily rainfall measurements for an intermediate-sized catchment in Italy; i.e. the Flumendosa catchment.

Since GCM/RCM products are suited to reproduce the local climatology in a statistical sense (i.e. in terms of relative frequencies), rather than ensuring a one-to-one temporal correspondence between observed and simulated fields (i.e. as is the case for ERA-interim reanalysis data), we proceed in three steps: a) we use statistical tools to establish a linkage between ERA-Interim upper-air atmospheric forecasts and climate model results, b) check and validate the stochastic downscaling scheme for the period when precipitation measurements are available, and c) simulate synthetic rainfall series based on future climate projections of upper-air indices.

The obtained results shed light to the effects of climate change on the statistical structure of rainfall.

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