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Hydrological modeling using a very high resolution climatological dataset in Portugal

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Hydrological models require reliable meteorological variables for accurate assessment of regional hydrology. The study of climate variability in Portugal, is often restricted by the lack of high resolution gridded datasets at daily timescales and available for sufficiently long time periods. To overcome this limitation, we develop very high resolution gridded datasets (∼1 km) of daily precipitation and of daily minimum, maximum and mean air temperatures over Portugal. The grid has a regular 0.01º horizontal resolution and spans the period from 1950–2015. Daily precipitation is downscaled by ordinary kriging from a coarser gridded dataset (∼20 km). Daily temperatures are downscaled from gridded temperatures (∼25 km). A two-step approach was followed, under the assumption that daily temperature variability in Portugal is mainly controlled by atmospheric large-scale forcing, while local processes are mostly expressed as strong spatial gradients. First, monthly baseline patterns were estimated at 1 km grid resolution by applying multivariate linear regressions (exploratory variables: elevation, latitude and distance to coastline). A kriging of residuals from baseline normals of 36 weather stations was applied for bias-corrections. Second, bilinear interpolated daily temperature anomalies were then added to the daily baseline patterns to obtain the final datasets. The performances of the Hydrological Simulation Program – FORTRAN (HSPF henceforth) model, driven by either a single weather station or the new gridded datasets are compared for a target watershed. The results clearly hint at an improved model performance when using our dataset (based on the Nash-Sutcliffe coefficient of efficiency). A satisfactory performance was also found in reproducing flood peak events. An average deviation of 10% was found between observed and simulated flood peaks. The output of HSPF was subsequently to determining flood hazard areas for a 10, 50 and 100 year return periods. Although the advantage of using these novel climatic datasets for hydrologic modeling in Portugal is demonstrated herein, they can be applied to other areas of research, such as ecology, agriculture and forestry, contributing to more accurate decision support systems to assist decision-makers and stakeholders.