Input variable selection for interpolating high-resolution climate surfaces for the Western Cape

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Abstract

Accurate climate surfaces are vital for applications relating to groundwater recharge modelling, evapotranspiration estimation, sediment yield, stream flow prediction and flood risk mapping. Interpolated climate surface accuracy is determined by the interpolation algorithm employed, the resolution of the generated surfaces, and the quality and density of the input data used. Although the primary input data of climate interpolations are usually meteorological data, other related (independent) variables are frequently incorporated in the interpolation process. One such variable is elevation, which is known to have a strong influence on climate. This research investigates the potential of 4 additional variables for inclusion in the interpolation process. Three of the variables, namely, slope gradient, slope aspect and hillshade, are related to topography, while the fourth is related to large water bodies (i.e. distance to oceans). Correlation analyses were used to determine the suitability of each of the 4 variables for interpolating climate surfaces in the Western Cape Province, South Africa. Although moderate correlations were identified between climate records and distance to oceans, no significant correlation was found for slope gradient, slope aspect and most variations of hillshade. However, a moderate correlation was identified between rainfall records and hillshade with a 180° azimuth. This variable was consequently used in various combinations with distance to oceans and elevation to generate 8 sets of high-resolution (i.e. 3 arc second) climate surfaces of the Western Cape. According to an accuracy assessment of the resulting surfaces, distance to oceans reduced the mean error of monthly mean maximum daily temperature interpolations by 27%. Distance to oceans also improved the accuracy of monthly mean minimum daily temperature interpolations for October through April. Although hillshade (180° azimuth) did not improve accuracies for temperature interpolations, it did improve the accuracy of monthly rainfall surfaces for 4 months of the year. The combinations of input variables that produced the lowest monthly mean errors were used to generate a new set of surfaces using all available meteorological data. A pair-wise comparison of the new interpolated surfaces with existing climate surfaces revealed that the surfaces created using our methodology are, in general, more accurate than any existing interpolations.

Keywords: climate, surface, interpolation, rainfall, temperature