Geophysical Research Abstracts
Vol. 13, EGU2011-3829-1, 2011
EGU General Assembly 2011

Geostatistical interpolation of precipitation data over an Andean catchment in Central Chile

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The estimation of precipitation distribution over a catchment is often a major source of uncertainty in river flow forecasting. The choice of an appropriate precipitation interpolation method is crucial in catchments characterized by a complex topography, where a high spatial variability in precipitation amounts is likely to occur. This work presents the application of Kriging methods for the interpolation of monthly precipitation amounts in the Andean sub-catchment of Aconcagua River, located in Central Chile. This is a mountainous catchment with a relief influenced precipitation distribution and a sparse rainfall network. Precipitation in the study area is seasonal, both with respect to the long term expectation of monthly precipitation and with respect to the spatial correlation structure of monthly precipitation fields.

Two Kriging methods are applied, namely Universal Kriging and Universal Cokriging. In both cases, it is assumed that the spatial drift of long term mean precipitation can be approximated by a smooth surface that is a function of location on the horizontal plane. Precipitation data corresponding to each month of the calendar year are processed separately, thus incorporating the effect seasonality. In the case of Universal Cokriging, precipitation data from another month of the year is used as an auxiliary variable for interpolation, in an attempt to incorporate additional information that could help improve the quality of precipitation estimates. Anisotropy in the spatial correlation structure of precipitation is incorporated in the construction of semivariograms and cross semivariograms, by definition of an effective distance measure. In the calculation of the effective distance between terrain points, different seasonally varying weights are used for horizontal and vertical distances.

The goodness of point estimates of monthly precipitation obtained with these methods is assessed by cross validation experiments, in which data from chosen rain gauges are one at a time temporarily removed from the data set. The performance criteria used for evaluation are: root mean squared error relative to the mean observed value (RMSER), mean error relative to the mean observed value (MER), and Nash-Sutcliffe efficiency coefficient. In general, precipitation estimates obtained with Universal Kriging and Universal Cokriging are close to the observations. The RMSER and efficiency coefficient values obtained with both methods are similar. However, the incorporation of information from other months of the year through the application of Universal Cokriging instead of Universal Kriging allows some improvement in MER values during the dry season, spanning form October to April. Overall, the results of the study indicate that kriging techniques may a suitable alternative for precipitation interpolation in mountainous areas even in conditions of rainfall data scarcity.