Geophysical Research Abstracts
Vol. 17, EGU2015-4198, 2015
EGU General Assembly 2015

A rainfall spatial interpolation algorithm based on inhomogeneous kernels

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Rainfall fields constitute the main input of hydrological distributed models, both for long period water balance and for short period flood forecast and monitoring. The importance of an accurate reconstruction of the spatial pattern of rainfall is, thus, well recognized in several fields of application: agricultural planning, water balance at watershed scale, water management, flood monitoring. The latter case is particularly critical, due to the strong effect of the combination of the soil moisture pattern and of the rainfall pattern on the intensity peak of the flood.
Despite the importance of the spatial characterization of the rainfall height, this variable still presents several difficulties when an interpolation is required. Rainfall fields present spatial and temporal alternance of large zero-values areas (no-rainfall) and complex pattern of non zero heights (rainfall events). Furthermore, the spatial patterns strongly depend on the type and the origin of rain event (convective, stratiform, orographic) and on the spatial scale. Different kind of rainfall measures and estimates (rainfall gauges, satellite estimates, meteo radar) are available, as well as large amount of literature for the spatial interpolation: from Thiessen polygons to Inverse Distance Weight (IDW) to different variants of kriging, neural network and other deterministic or geostatistic methods.
In this work a kernel-based method for interpolation of point measures (raingauges) is proposed, in which spatially inhomogeneous kernel are used. For each gauge a particular kernel is fitted following the particular correlation structures between the rainfall time series of the given gauge and those of its neighbors. In this way the local features of the field are considered following the observed dependence spatial pattern. The kernel are assumed to be Gaussian, whose covariance matrices are fitted basing on the values of the correlation of the time series and the location. A similar approach is used on a binary variant to reconstruct the rainfall – no rainfall areas, to be used as mask of the continuous rainfall interpolated field.
The method was applied on a set of 8 years of measurements (2006-2013) of raingauges in Northern Italy.