Geophysical Research Abstracts
Vol. 12, EGU2010-10434, 2010
EGU General Assembly 2010
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Simulation of average and low flows through the regional calibration of a rainfall-runoff model, I: Regional analysis

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In several European countries, the emerging need for efficient water resources assessment is making the real world application of rainfall-runoff models a key instrument for simulating catchment streamflows and in particular the behaviour of low flows, that may lead to water scarcity conditions. One of the main obstacles to such applications is the scarce data availability, given that the hydrometric observations that are needed for the calibration of the model parameters are often sparse or unavailable.
In two companion presentations, we propose an approach for regional calibration of a rainfall-runoff model that may be applied also to ungauged or scarcely gauged catchments, since it is based on the knowledge of characteristics of the catchment and of its climate other than hydrometric measurements. In this first presentation, we describe the use of a regional procedure for estimating selected river flow statistics that describe the main properties of the river flows time series, on the basis of geomorphoclimatic attributes of the catchments. The companion presentation describes the calibration of the rainfall-runoff model by optimizing the simulation of the statistics derived here and then the analyses of the modelled streamflow in simulation mode, focussing in particular on the reproduction of average and low flows.
The study area includes 52 catchments located in northern central Italy where detailed geomorphologic and climatic attributes are available. Regional predictive models are developed for estimating the mean value, the standard deviation and the lag-1 autocorrelation coefficient of the actual river flows Q(t), on the basis of the above attributes.
Two kinds of regional predictive models are applied: i) traditional multivariate stepwise regression analysis (considering linear and exponential regression relationships) and ii) multilayer feedforward artificial neural networks, particularly suitable to the task because of their capability to flexibly reproduce also highly non-linear input-output relationships and not requiring the a priori knowledge of the form of such relationship.