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Improving flow forecasting through stochastic model for estimating the forecast residues

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The methods normally used for predicting the flow can be differentiated according to the variables employed and in accordance with the calculation methods. Regarding the calculation methodologies used, the models can be classified into empirical, conceptual or combined. The empirical models have the advantage that setting and operation are simple, while the conceptual model works best with events that go beyond those that were used during calibration. The use of models combined between empirical and conceptual can have benefit of both types. One way to reduce forecasting errors is through the process of updating the model, which can be understood as a recursive process of determining state variables and parameters, based on the observed data of variables such as precipitation, temperature, flow , volume and stored soil moisture. A new set of parameters can be done after each forecast, but this is usually applied when the model structure is quite simple, as in the case of empirical models. Distributed hydrological models has a large quantity of parameters and state variables and the updating process become complex.

The analysis of errors, or residues of the forecast, is an alternative for forecasts correction and updates. In this case the correction is made only the with the output variable of the model (flow rate). The correction is done externally to the model and simplifies the upgrade process. The persistence in the errors can be used to develop a procedure for forecasting. A simple framework for an error model can be obtained using a stochastic autoregressive AR, but error models with greater complexity can be tested, such as ARMA or ARIMA stochastic models or transfer function, which allow you to enter other variables such as rainfall and state variables of the hydrological model.

Based on this discussion, this study sought to improve short-term flow forecasting (up to 14 days in advance) through the integrated use of an atmospheric model and a conceptual model rainfall-runoff, supplemented by a stochastic model to predict the resulting residue of the forecast. The model has the following components: (a) the precipitation forecast by the ETA regional model; (b) rain-flow transformation through Great Basin Hydrological Model - MGB-IPH; (c) stochastic model to estimate the waste. The ETA model was used to generate forecasts of rain in 40 km resolution over the entire South America. The short term forecast is performed on a weekly basis and, at the beginning of each forecast, are updated the state variables of the hydrological model based on observed flows to date. The results are analyzed in terms of weekly average flows.

The stochastic model of residue is a transfer function type, which relates a set of input variables (moisture in the soil layers, forecasts of precipitation, ...) to a variable output (weekly flow) and the forecasts residues. The methodology was applied to the São Francisco river basin, which has an area of about 639,000 km2 and has its main course length of 2,700 km. The basin area accounts for approximately 8% of the country and covers parts of six states and the federal district. The basin has a number of large hydropower plants installed, adding about 10,000 MW of power. Therefore, the results were analyzed with a focus on inflows from these plants.

The results show that the approach presented promising results when compared with the currently technique used by the electric sector in Brazil, which employs purely stochastic models. Besides the gains in terms of average relative errors, the method also showed good performance in forecasting events of high gradients of flow, where the purely stochastic models have greater difficulties.