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BAYESIAN STATISTICAL MODELLING FOR ANALYZING AND PREDICTING THE EVOLUTION OF SMALL COASTAL STREAMS WATER TEMPERATURES

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Abstract:
Water temperature is a key factor that influences many other physical and chemical parameters as well as the biology of aquatic organisms like Atlantic salmon by controlling both their metabolism and growth. The research program GICC2 (*) seeks to address questions such as: In the context of global warming, could salmon populations adapt to climate change? To address this question, a proper analysis of water temperature time series is necessary. However these series are often short and/or incomplete. By contrast, time series of air temperature are more easily available and often of better quality. Moreover, they are often the only available output of models for global warming scenarios. Therefore, providing proper and robust statistical method to analyze times series of water temperature and to predict the evolution of these temperatures from other environmental variable such as air temperature and/or water flow is a key methodological issue.
In this study, we provide a Bayesian statistical modeling approach to analyze time series of water temperature on three French small coastal streams together with the correlation with time series of air temperature and water flow.
This approach is based on the decomposition of the time series in two components: a long term trend, represented by the evolution of the annual mean temperature, and a seasonal (sinus) component. Correlation analyses reveal that in spite of a very high positive correlation between air and water temperature at fine temporal scale (due to synchrony in the seasonal component), the correlation between the annual mean temperature is much weaker (for example, $R^2 = 0.219$, p-value =1.61x10-2). This result indicates that long term trends in air temperature are weak predictor of long term trends in water temperatures. Therefore, the prediction of small stream water temperatures under global warming scenario seems to be quite uncertain. By adding up water flow parameters in our model, we provide better estimations of water temperature.