STAHY2017-29
STAHY 2017 workshop,
21–22 September 2017, Warsaw, Poland
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Stochastic modeling of hydrological variability, a Fokker-Planck-Kolmogorov equation approach

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Ongoing global processes, as global warming and climate change, alter inputs to hydrological systems. Local and regional transformation processes also affect hydrological basins functioning. Hydrological variability is a key concept for understanding of hydrological regime changes. Studying hydrological processes as composed by seasonal (structured) and random signals becomes useful to unveil how hydrological risk evolves under non-stationary climate conditions but also to infer how local perturbations can disturb the present level of hydrological risk. In this light, present work applied stochastic processes theory to implement a Fokker-Planck-Kolmogorov model to simulate the evolution of conditioned probability density curves that describes both the seasonal and random component of hydrological processes. A numeric scheme for the 2-Dimensional Fokker-Planck-Kolmogorov Equation allowed modelling of two lag auto-correlated hydrologic process not neglecting cross covariance components. Developed scheme served as the kernel for an optimization problem where the structure of drift and diffusion coefficients was established. Optimized drift and diffusion parameters of Fokker-Planck-Kolmogorov equation are linked, through regression, to basin external signals and to basin internal parameter perturbations in order to understand how hydrological variability changes. Modelling results show that changes in rainfall modal values controls the drift of conditioned probability density curves, while changes of internal basin parameters rule process diffusivity. A major finding shows that changes in internal basin parameters overcome the influence of external signal over hydrological process variability. This result indicates that perturbations of internal parameters are key factors governing the process uncertainty.