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Uncertainty assessment of future hydroclimatic predictions: Methodological framework and a case study in Greece

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A stochastic framework for climatic variability and uncertainty is presented, based on the following lines: (1) a climatic variable is not a parameter constant in time but rather a variable representing the long-term (e.g. 30-year) time average of a certain natural process, defined on a fine scale; (2) the evolution of climate is represented as a stochastic process; (3) the distributional parameters of the process, marginal and dependence, are estimated from an available sample by statistical methods; (4) the climatic uncertainty is the result of at least two factors, the climatic variability and the uncertainty of parameter estimation; (5) a climatic process exhibits a scaling behaviour, also known as long-range dependence or the Hurst phenomenon; (6) due to this dependence, the uncertainty limits of future are influenced by the available observations of the past. The last two lines differ from classical statistical considerations and produce uncertainty limits that eventually are much wider than those of classical statistics. A combination of analytical and Monte Carlo methods is developed to determine uncertainty limits for the nontrivial scaling case. The framework developed is applied with temperature, rainfall and runoff data from a catchment in Greece, for which data exist for about a century. The uncertainty limits are then compared to deterministic projections up to 2050, obtained for several scenarios from several climatic models combined with a hydrologic model.