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Importance of stream temperature to climate change impact on water quality

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Abstract. The sensitivity of some aspects of water quality to climate change was assessed in the Seine River (France) with the biogeochemical model RIVERSTRAHLER, which describes the transformations and fluxes of C, N, P and Si between the main microbiological populations, the water column and the sediment, along the entire river network. Point and diffuse sources are prescribed, stream temperature undergoes a sinusoidal annual cycle constrained by observations, and runoff is calculated by a physically-based land surface model. The reference simulation, using meteorological forcing of 1986–1990 and point sources of 1991, compares very well with observations. The climate change simulated by a general circulation model under the SRES emission scenario A2 was used to simulate the related changes in runoff and stream temperature. To this end, a statistical analysis was undertaken of the relationships between the water and air temperatures in the Seine watershed over 1993–1999, using 88 points that correctly sampled the variability of the tributaries. Most of stream temperature variance was explained by the lagged moving average of air temperature, with parameters that depended on Strahler stream order. As an interesting simplification, stream temperature changes could be approximated by air temperature changes. This modelling framework was used to analyse of the relative influence of the water warming and discharge reduction induced by climate change on biogeochemical water quality in Paris and downstream. Discharge reduction increased phytoplankton growth and oxygen deficits. Water warming decreased dissolved oxygen, increased phytoplankton biomass during the growth period, and reduced it afterwards, when loss factors dominate. It was also shown that these impacts were enhanced when point source inputs of nutrient and organic carbon increased.

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