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Density Currents in a Tributary of Three Gorges Reservoir, China

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The Xiangxi River is one of the important tributaries of the Three Gorges Reservoir (TGR) located on the upper reach of the Yangtze River in the southwest of China. With the complication of the Three Gorges Dam (TGD) and the impoundment of the TGR, the Xiangxi River became a reservoir tributary of the TGR and the water velocity in it declined drastically. Since then, the algae bloom frequently happened in the Xiangxi River and several field investigation and numerical simulation studies have been conducted to examine the mechanisms that lead to eutrophication and algae bloom. Generally, the density current caused by temperature variation was considered as one of the important factors having effect on them.

To examine the pattern of the density current and the factors influencing it in the Xiangxi River, a three dimensional thermal-hydrodynamic model for the Xiangxi River was set up based on Delft3D-Flow package. Various factors were considered in the model, including water level fluctuation, inflow flux, water and air temperature, and wind force. The model was validated against field measured velocity and temperature data. The results showed that the model simulated velocity and temperature distributions agreed well with the measured data and the model was capable of reproducing the density current pattern in the Xiangxi River. The analysis on the flow and temperature distributions in various operation periods of the reservoir indicated that density current and temperature stratification exist over the whole year. The water from the main stream of the Yangtze River intrudes into the Xiangxi River through various depths, which was determined by the relative difference of temperature in the Xiangxi River and the main stream of the Yangtze River. The analysis on the temporal and spatial variations of the flux in transects along the Xiangxi River indicated the flux was also controlled by the temperature stratification, and the water exchange between the Xiangxi River and the Yangtze River was closely related to the temperature distribution. All the facts indicate that the water temperature in the Xiangxi River should be a key in order to understand the mechanisms of algae bloom and the water quality in the Xiangxi River.