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Application of the SWAP model to simulate the field water cycle under deficit irrigation in Beijing, China

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ABSTRACT

The evaluation of the field water cycle under deficit irrigation plays an important role in studying mechanism of field water dynamics, optimization of agricultural water management strategies, and assessment of regional water resources. In this study, the agro-hydrological Soil–Water–Atmosphere–Plant (SWAP) model was used to evaluate the field water cycle for a winter wheat-summer corn double cropping system in Beijing, China under deficit irrigation. A carefully designed field experiment was carried out from 2007 to 2009 with six irrigation treatments. The SWAP model was calibrated with soil water contents of two treatments. The dataset of the main field water balance components including soil water content, profile water storage and water flux through the bottom of the root zone were used to validate the SWAP model. The average root mean square error (RMSE) and the mean relative error (MRE) values of predicted soil water contents were 2.4% and 8.0%, respectively. The dataset of predicted and measured values were close to the 1:1 scale line for both the profile water storage and soil water flux. As an application of the SWAP model, the optimal irrigation management practices for the hydrologic years of 75%, 50% and 25%, respectively, in the Beijing area were obtained. The simulated average amount of water saving and groundwater recharge under the optimal irrigation schedules were about 190 mm and 16.1 mm, respectively. This study indicates that the SWAP model can be used as a powerful tool to simulate the field water cycle and evaluate irrigation practices.

1. Introduction

The Haihe River Basin is one of the most important agricultural producers and densely inhabited regions in China. However, due to the limited annual precipitation (about 553 mm), but high water requirements of the winter wheat–summer corn double cropping system (about 870 mm) [1], agricultural development mainly relies on the groundwater resources in this area. As a result of heavy exploitation for supplementary irrigation, the groundwater table has fallen significantly. Regarding this menace, the need to reduce agricultural water use has been a principal concern in this region, especially in Beijing which is the central area of Haihe River Basin.

As a reliable water-saving practice, deficit irrigation has been widely used in arid and semiarid regions such as the Beijing area [2]. Due to the combing effects of water-saving agricultural practice and declining groundwater table, the field water cycle has strongly changed [3,4]. Vertical groundwater recharge from precipitation and irrigation return flow, soil

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