REGIONAL CLIMATIC SIMULATION FOR HYDROLOGICAL MODEL USING WRF MODEL AROUND YELLOW RIVER BASIN

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1. INTRODUCTION

Water cycle process around the Yellow river basin has been studied using a hydrological model with the observation data (e.g. Ma et al., 2003). Ma et al. (2003) reported that the amount of river flow in 1990's is much smaller than that in 1980's. The climatic variation of the precipitation is indicated as the main factor of the decrease. However, the mechanism of the climatic variation is still unknown, although the large-scale climatic variation has been found by the statistical analysis studies (e.g. Endo et al, 2005).

The prediction of the annual variation of the precipitation and the river flow is also expected to manage the water resource. Hydrological models have been utilized to understand the water cycle system using an atmospheric numerical model output and an observed data. Ma et al, (2003) shows the total performances of his hydrological model using the observed data from 1980 to 2001 in the Yellow river basin. The amount and variation of discharge are well simulated in the both areas of upstream and down stream in the river. As the next step, we are trying to evaluate the model properties using the atmospheric model output. This method will be more useful to predict the variation of river flow due to the atmospheric climatic variation and the global warming. The similar studies have been done using a GCM or a regional climate model output. However, the model bias of precipitation is extremely large, and then the simulated discharge is quite difference from the observed one. The horizontal grid resolution might be not enough to well simulate the real precipitation.

In this study, the regional climatic simulation is conducted using the WRF model with 20km horizontal grid scale in 1984 and 1994. This model output will be utilized to calculate the discharge derived from the hydrological model (Ma and Fukushima, 2002), and compare to the observed discharge data in the future study.

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2. HYDROLOGICAL STUDY

A hydrological model has been developed at FRCGC. Ma and Fukushima (2002) investigate the model performance adapting various river basins (e.g. Lena river basin in East Siberia, Yura river basin in Japan, Selenge river basin in Mongolia, and Yellow river basin in China). The calculate discharges in those river basins are well corresponded to the observed discharge. In particular, this model has great ability to represent the discharge in the dry and irrigation areas, high latitudes areas. The schematic figure of the hydrological model is shown in Fig.1. This model has been used as the offline model.

Figure 2 shows the observation sites of river flow in Yellow river basin. The Lanzhou is located in the foot of Tibetan Plateau and the upstream area of the Yellow river. It is very important to investigate the discharge in Lanzhou for the downstream irrigation area.

Figure 3 shows the simulation and the observation results of the discharge in Lanzhou from 1980 to 2001. The upper and lower panels show the simulated discharge without dam control and with dam control, respectively. The amount of discharge of the dam control case well represents the observation.

Figure 1. Observation sites in the Yellow river basin.

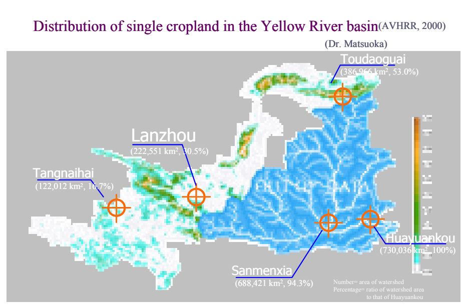


Figure 2. Schematic figure of Hydrological model (Ma and Fukushima, 2002)

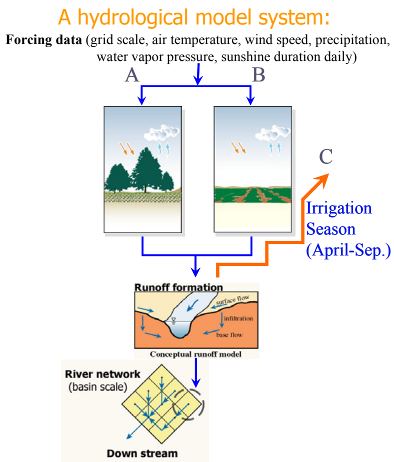
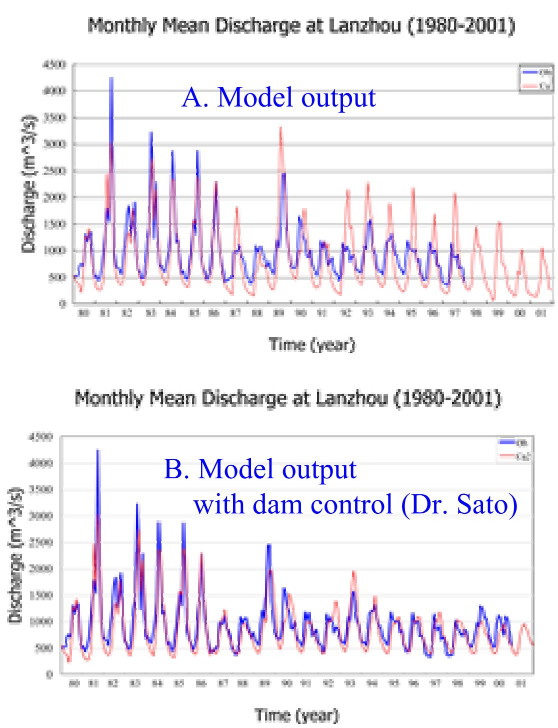


Figure 3.Observed and simulated discharge at Lanzhou from 1980 to 2001. Blue and red lines are the calculation and observation results, respectively



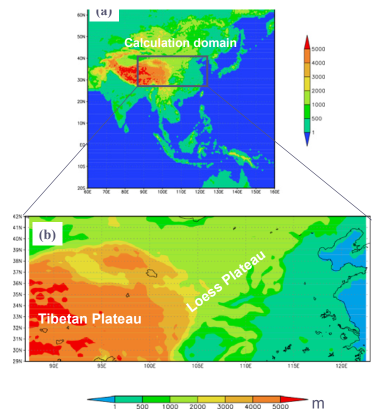
3. MODEL AND EXPERIMENTS

The WRF model, which has been developed by the WRF project members, is used in this study. The features of the model are shown in Table 1. The simulations are conducted in 1984 and 1994. The discharge in 1984 was lager than that in 1994. Fig.4 shows the calculation domain.

TABLE 1. Model features

Numerical Model	
WRF model（The Weather Research and Forecasting model）	
Dynomical Process	**full compressivily non-hydrostatic equations, mass-based terrain following coordinate**
Precipitation process:	Cloud microphysics (Lin et al) Cumulus convective parameterization (Kain-fritsch)
Horizontal grid space:	20km
Vertical layer:	31 WRF Eta levels

Figure 4. Calculation domain



4. RESULTS

Figure 5 shows the observation results of precipitation in 1984 (a), 1994 (b), and those differences (c) derived form The Climate Prediction Center (CPC) Global Summary of Day/Month Observation (DS512.0). There are large precipitations along the Loess Plateau. The precipitation in 1984 is larger than that in 1994 around the Plateau. The different amount of precipitation is more than 2mm/day.

Figure 5. Annual-averaged precipitation in 1984 (a), 1994 (b), and those differences (c) derived form The Climate Prediction Center.

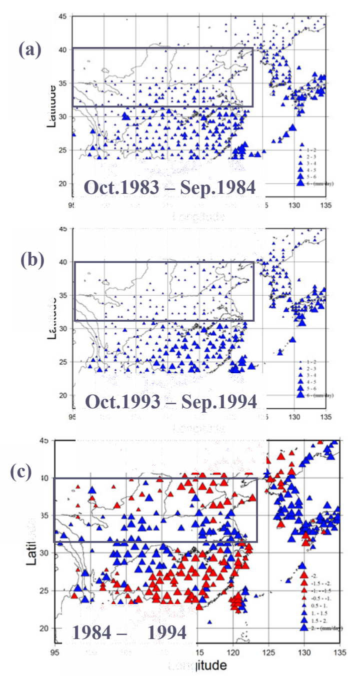


Figure 6 shows the simulation results of WRF model. The features of precipitation distribution and the difference between 1984 and 1994 are well simulated. However, the amount of simulated precipitation in mountain area seems to be somewhat larger than observed ones.

Figure 6. Annual averaged simulated precipitation from Oct. 1983 to Sep.1984 (a), from Oct. 1993 to Sep.1994 (b), and those difference (c).

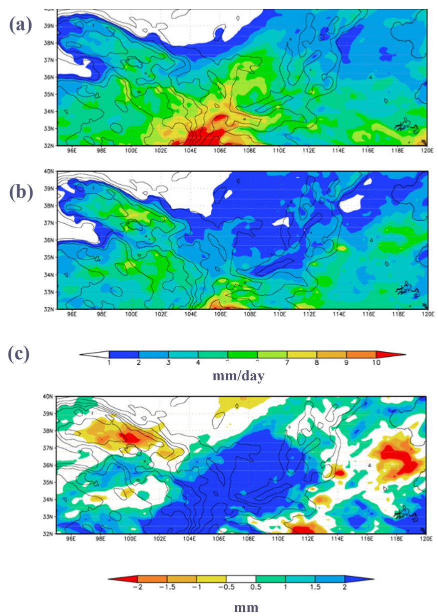
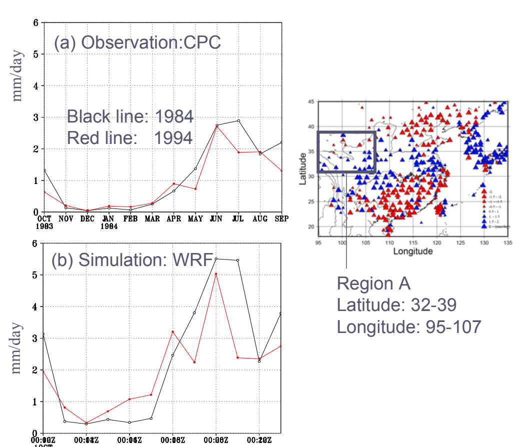


Figure 7 shows the area-averaged precipitation in the upstream are of Yellow river (Region A). The amount of simulated precipitation is larger than the observations, although the seasonal change of the precipitation is well simulated. This different might be crucial to estimate the discharge.

Figure 7. Monthly variation of the area-averaged precipitation in the upstream are of Yellow river (Region A) in 1984 and 1994.



5. SUMMARY

The climatic simulations are conducted using WRF model to evaluate the precipitation around the Yellow river basin. The features of precipitation distribution and seasonal change are well simulated around the river basin. However, the amount of the simulated precipitation in the mountain area is larger than the observations to some extend. This overestimation might be serious problem to estimate the discharge using a hydrological model.

6. REFERENCES

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