REGIONAL CLIMATE SIMULATION OF 1998 SUMMER FLOOD IN EAST ASIA

Wen-Yih Sun and Jiun-Dar Chern
Dept. of Earth and Atmospheric Sciences, Purdue University,
W. Lafayette, IN 47907-1397

Abstract

During the summer of 1998, persistent and heavy precipitation caused a catastrophic flood in China and Korea. In this study, the Purdue Regional Climate Model (PRCM) is used to simulate the atmospheric circulation and weather patterns in July and August of 1998. The preliminary results from monthly integrations show the model is capable of reproducing the large-scale atmospheric circulation that characterized the summer monsoon in East Asia. The spatial and temporal variations of trough over East China and subtropical high over western Pacific are well simulated. The location and movement of the Mei-yu front is in good agreement with observation. The low-level jet was very persistent over the Yangtze River Valley in July but was gradually weakened in August. The withdrawal of the summer monsoon was very rapid and the low-level jet was completely disappeared during the last 10 days of August. The flood in Korea in early August was well simulated by the model. The location of persistent and heavy rain over China was successfully reproduced. However, the model tends to over estimate the precipitation amount and the strength of the system. Further study of the role of cumulus parameterization on the precipitation will be carried out to improve the model performance.

1. Introduction

The 1988 summer floods in Asia had caused 3656 fatalities, affected 290 millions population and destroyed over 17 millions houses and swamped over 21.8 millions hectares in China. Floods had also caused more than 300 casualties and tremendous damages in Korea. In order to study the weather system during the summer of 1998, we applied the Purdue Regional Model to simulate four months (May-August). Here will present the preliminary results of the flooding in July and August of 1998, when the floods were most severe.

2. Purdue Regional Model (PRM)

The basic equations and the PRM can be found in Chern (1994). The model has prognostic equations for momentum, heat, surface pressure, turbulent kinetic energy (TKE), and all phases of water, including vapor, cloud water, ice, snow, rain, and supercooled water (Chern 1994; Haines et al. 1997). The model thermodynamic variable is the equivalent ice potential temperature. The radiation parameterization is developed by Chou and Suarez (1994). The cumulus parameterization developed by Sun and Haines (1996) and Kuo-type schemes (Anthes 1978; Molinari 1982) are included in the model.

The horizontal advection scheme developed by Sun (1993a) is used to calculate the advection terms. This scheme is more accurate than Crowley fourth-order advection scheme or Gadd advection scheme. The truncation error of the pressure gradient force terms near steep topography has also been greatly reduced by using a local reference to calculate the pressure differences (Sun 1995).

The PBL parameterization is a 1.5 order closure scheme that includes TKE as a prognostic variable (Sun 1988, 1993b) and has provided remarkable results for many different PBL numerical studies. Sun (1993b, c) showed that the model could predict the convective PBL and the development of a nocturnal low level jet during the Wangara Experiment. The land-vegetation package was developed by Bosilovich and Sun (1995). Richards' equation and the diffusion equation are used to predict the moisture and temperature within the soil. The land-vegetation package also considers the presence of vegetation above the soil, biophysical resistance to the release of water, and transpiration and evaporation of liquid water (either intercepted precipitation or dew formation) from the surface of the vegetation.

The PRM has been successfully applied to simulating the cold air outbreak (Sun and Hsu 1988), cellular convection over warm water surface (Hsu and Sun 1991), the 1988 midwestern drought (Chern and Sun 1997), vortex shedding in the lee side of Taiwan (Sun et al. 1991; Sun and Chern 1993; 1994), the low-level jet and Mei-Yu front in southeast Asia during the Taiwan Area Mesoscale Experiment (TAMEX) (Hsu and Sun 1994; Sun and Chern 1998), the formation and diurnal movement of the Dryline (Sun and Wu 1992), the sever winter storm over High Plains (Chern 1994), the Valentine's Day storm during WISP 1990 (Haines et al. 1997), the soil temperature and soil moisture of the FIFE experiment (Bosilovich and Sun 1998), the 1993 Midwestern flood (Bosilovich and Sun 1998, 1999a,b).

3. Numerical Results:

Six sets of 10-days average wind at 800 mb and precipitation from ECWMF and PRM are shown here. Overall, the PRM reproduce the geopotential and wind pattern reasonably well. The low-level-jet existed between July 1 and July 20. It diminished near the end of August. Meanwhile, we also observe that the strength of simulated LLJ is stronger than the observed, because of much larger precipitation generated in the model, which can be 50% more than the observed precipitation.

One of the striking phenomena is the oscillation of the Mei-Yu front, which did not move from south toward north when time increased, as suggested in text books. The location of the front seemed quite unpredictable in July and August. Hence, more research is required to understand the mechanism of the movement of the front. We are also working on sensitivity test of CPS and other physics, so we can improve the simulation and have better understanding of the physics.

Acknowledgement:

We are grateful to Drs. W. R. Hsu, Wen-Shiung Kau, and Huang-Hssiung Hsu at National Taiwan University as well as Dr. Jack Lin at Central Weather Bureau for their useful discussions.

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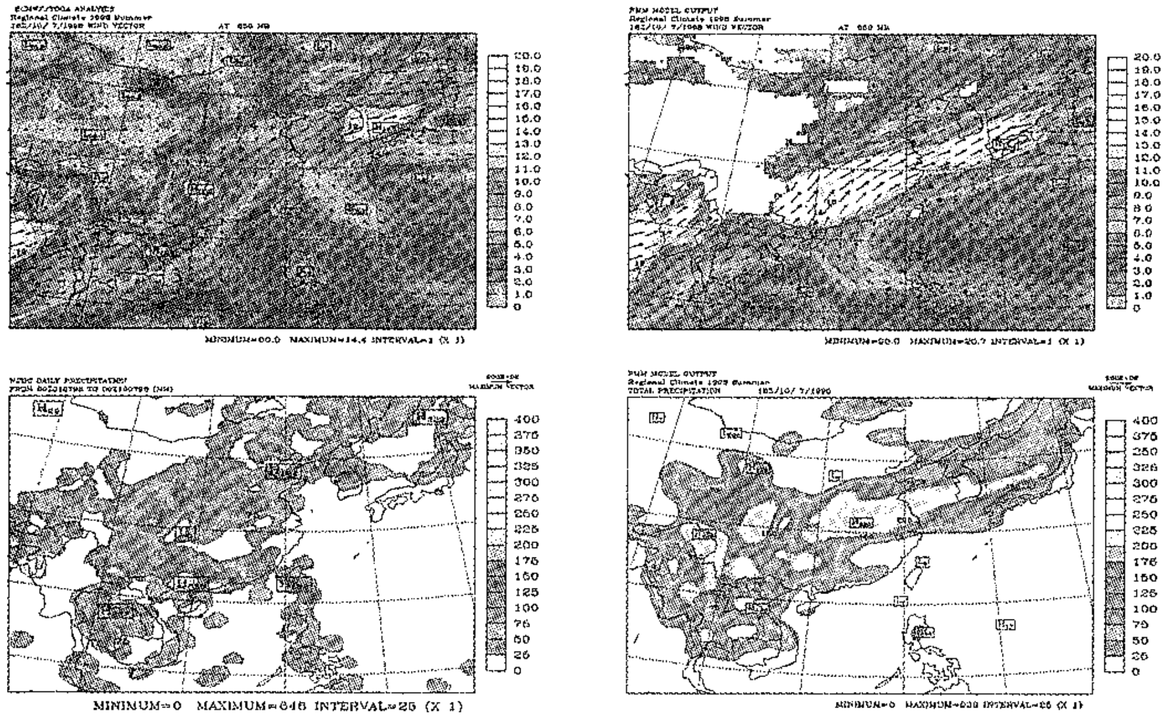

Figure 1. Mean 10-day wind vectors at 850 mb and total precipitation from observation (left) and PRM (right) during July 1 –July 10.

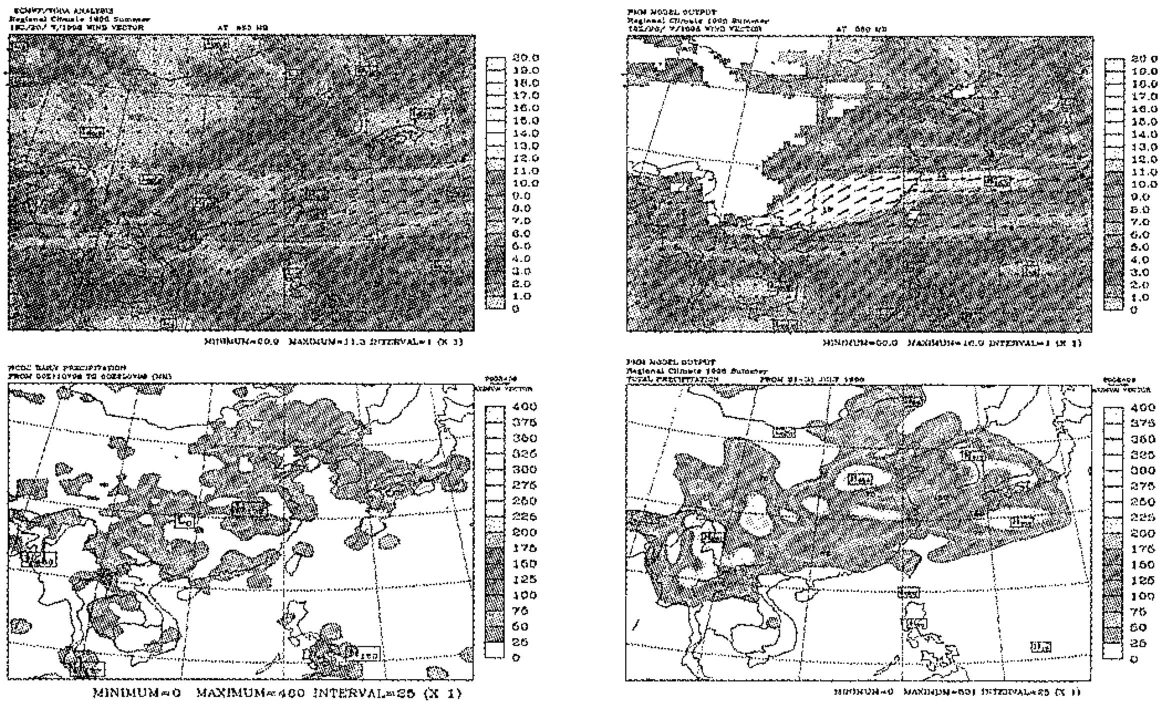

Figure 2. Mean 10-day wind vectors at 850 mb and total precipitation from observation (left) and PRM (right) during July 11 –July 20.

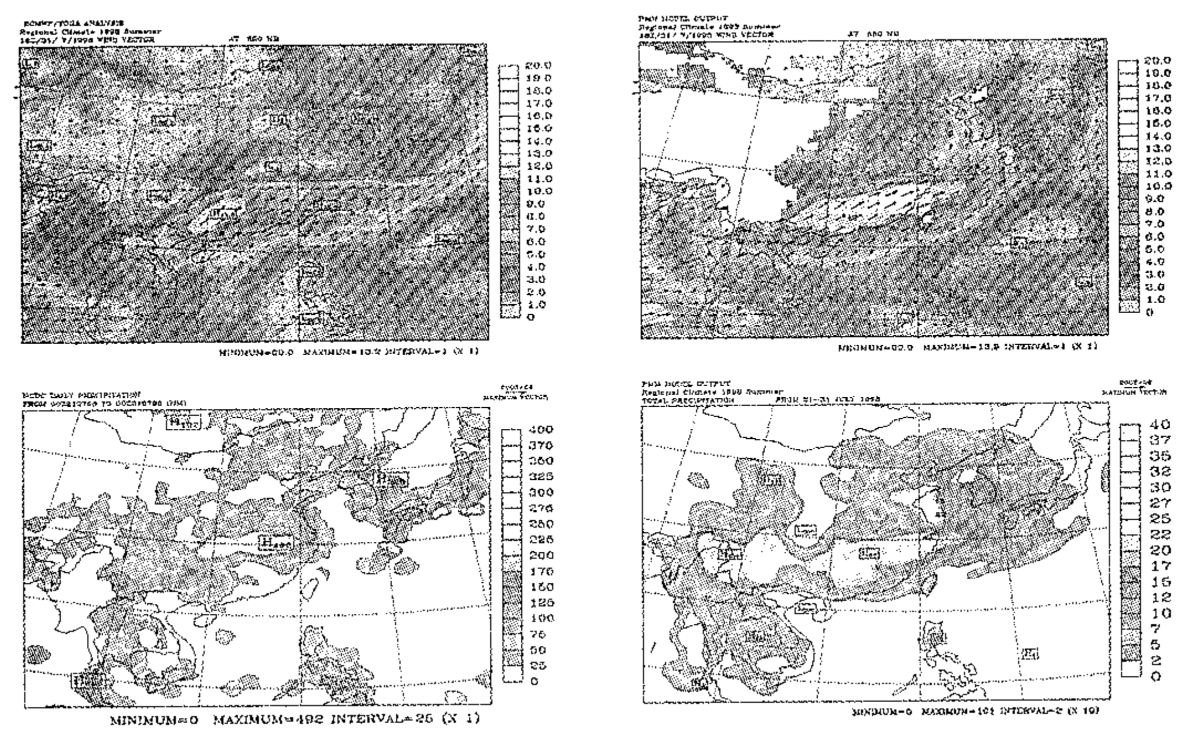

Figure 3. Mean 10-day wind vectors at 850 mb and total precipitation from observation (left) and PRM(right) during July 21-31.

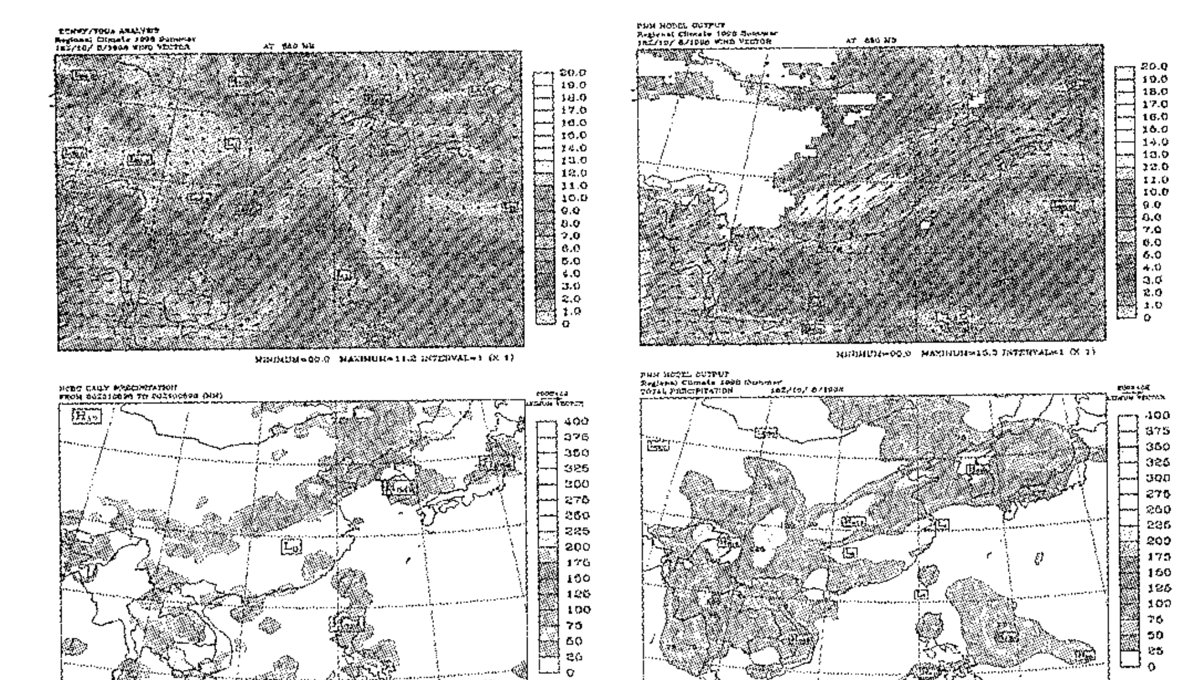

Figure 4. Mean 10-day wind vectors at 850 mb and total precipitation from observation (left) and PRM(right) during August 1-10.

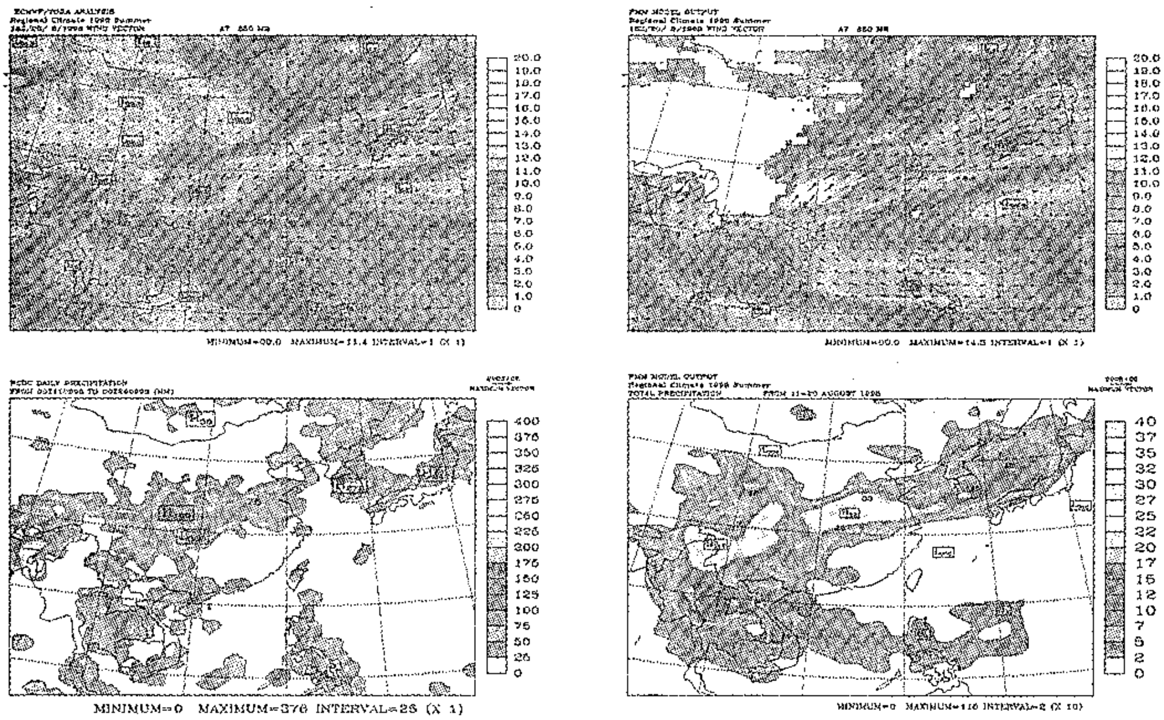

Figure 5. Mean 10-day wind vectors at 850 mb and total precipitation from observation (left) and PRM(right) during August 11-20.

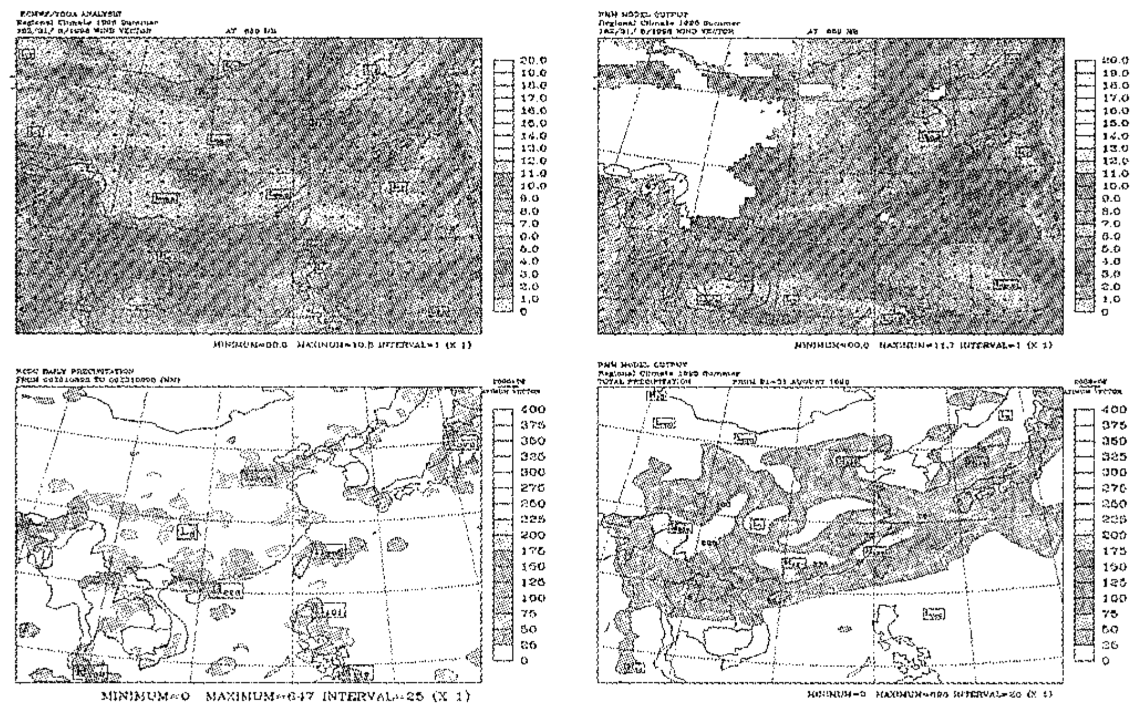

Figure 6. Mean 10-day wind vectors at 850 mb and total precipitation from observation (left) and PRM(right) during August 21-31.