CHAPTER 4

CUMULUS PARAMETERIZATIONS

In order to determine the optimal parameterization schemes for prediction of extreme events, two convective cumulus parameterizations were selected. The Betts-Miller-Janjic (BMJ) scheme is the most popular for tropical systems. The Kain-Fritsch scheme (KF) has not been run extensively in the tropics but it has been configured as the standard configuration. The simulations of rainfall and temperature using the Betts-Miller and Kain-Fritsch cumulus parameterization for the base-year 1995 have been carried out. The results presented in terms of correlation coefficient and biases between model and station data on annual basis.

4.1 Rainfall

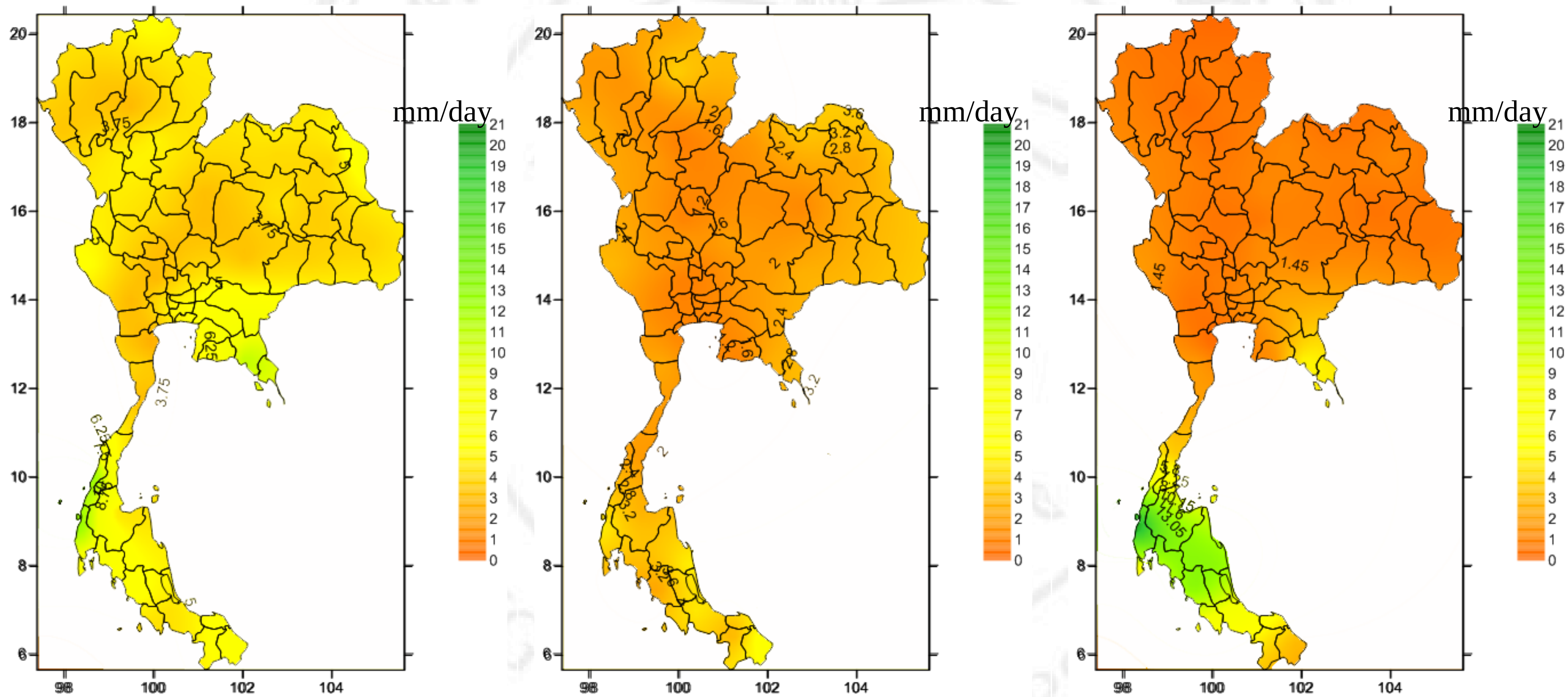
As shown in Figure 4.1, the spatial distributions of rainfall show similar patterns among the observation and both simulations using BMJ and KF schemes. The amounts of rainfall are within 2.44-13.07, 0.87-6.08, and 0.13-20.65 mm/day in the observation, BMJ, and KF scheme simulations, respectively. The large amount areas, including the south-west and east, are more obviously represented in the simulation using KF scheme than the others. However there is too much rainfall in the south when using KF scheme as shown in Figure 4.1(c); the overestimated rainfall is within 3.74-8.04 mm/day at the stations in this area. The biases of rainfalls from the RCM simulation using the Kain-Fritsch scheme show both higher and lower values than those from observation; the biases are within -6.62 - 8.04 mm/day (Figure 4.2(b)).

Figure 4.2(a) presents the biases of rainfall from RCM using BMJ scheme compared to the observation. It can be seen that the rainfalls are underestimated in all stations throughout the country; the biases are within -0.01 - -10.07 mm/day. The high biases are noticed in the stations in the east and south where the large rainfalls are addressed.

The correlation coefficients between the annual rainfalls from the observation and the simulations using both schemes are presented in figures 4.2(c) and 4.2(d). In general, the rainfall from the simulation using BMJ scheme is more in agreement with the observed rainfall than when using KF scheme. The correlation coefficients are in the range of 0.08-0.36 and 0.06-0.25 in BMJ and KF scheme simulations. The high correlation coefficients are presented at the stations in the central, south, and east in BMJ scheme simulation.

4.2 Maximum temperature

The maximum temperatures are within the range of 31.77-34.70°C, 28.40-31.54°C, and 29.90-33.08°C for the observation, BMJ, and KF scheme simulations, respectively (Figure 4.3). The spatial pattern of maximum temperatures from BMJ scheme simulation is more similar with the observation than that from KF scheme simulation in general. Figures 4.4(a) and 4.4(b) show the biases between the observed and model maximum temperatures.



(a) (b) (c)

Figure 4.1 the annual averages of rainfall from (a) observation, (b) RCM using BMJ, and (c) RCM using KF scheme

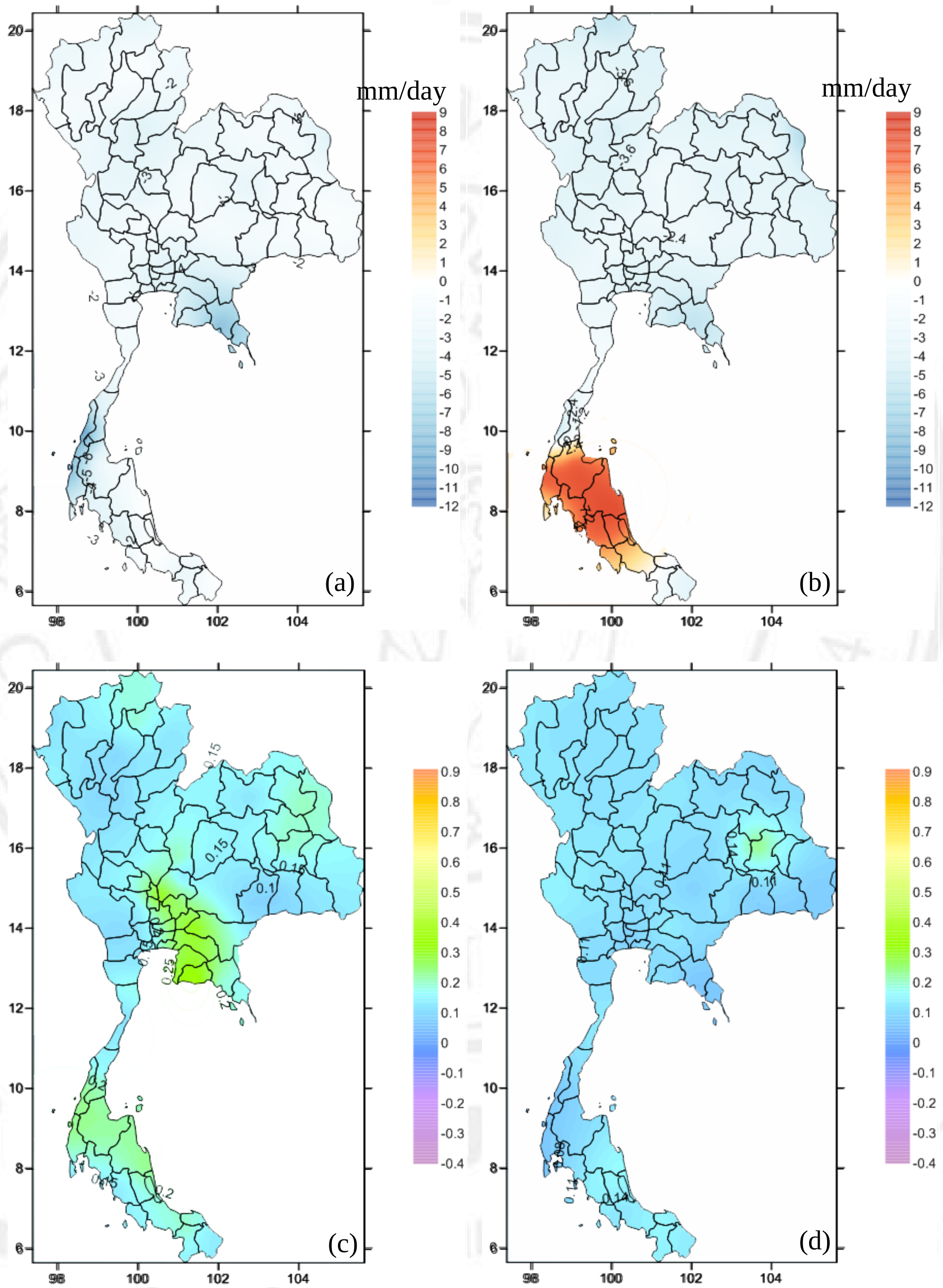
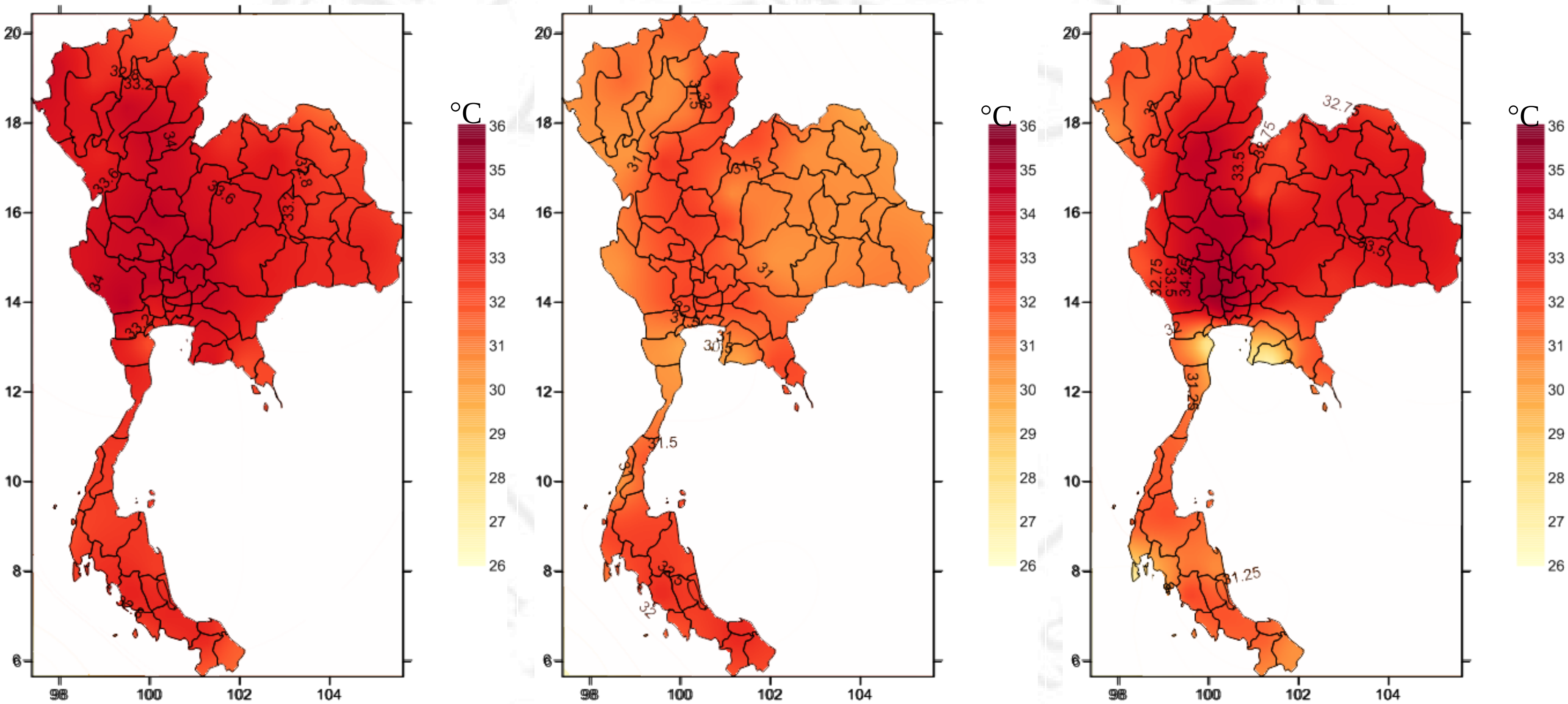


Figure 4.2 The rainfall biases between the observations and simulations using BM (a) and KF(b) scheme along with the correlation coefficients between the observations and simulations using BM (c) and (d) KF schemes

The BMJ scheme temperature is lower than the observed at all stations throughout the country; the biases are within -0.01 - -3.83°C (Figure 4.4(a)).

The maximum temperatures at the stations in the south are better simulated when using BMJ scheme; the small biases compared to the other stations are clearly shown. The maximum temperatures from the KF scheme simulation show both higher and lower values than the observation (Figure 4.4(b)); the biases are within -7.14 – 1.64°C. The positive biases are presented mostly at stations in upper Thailand while the negative biases are found in some stations in the east, west, north and south.

Figures 4.4(c) and 4.4(d) show the correlation coefficients between the observed and RCM maximum temperatures. The correlation coefficients range from 0.05-0.54 and -0.32-0.51 when using BMJ and KF schemes. The maximum temperatures from KF scheme simulation are more in agreement with the observed than the BMJ scheme simulation in the north and northeast while in the rest of the country BM scheme simulation shows more correlated temperatures. Simulation using KF scheme shows a weak capacity in simulating maximum temperatures at the stations in the east and south where the small and negative correlation coefficients are presented (Figure 4.4(d)).



(a) (b) (c)

Figure 4.3 The annual average of maximum temperatures from (a) observation, (b) RCM using BMJ, and (c) RCM using KF Scheme

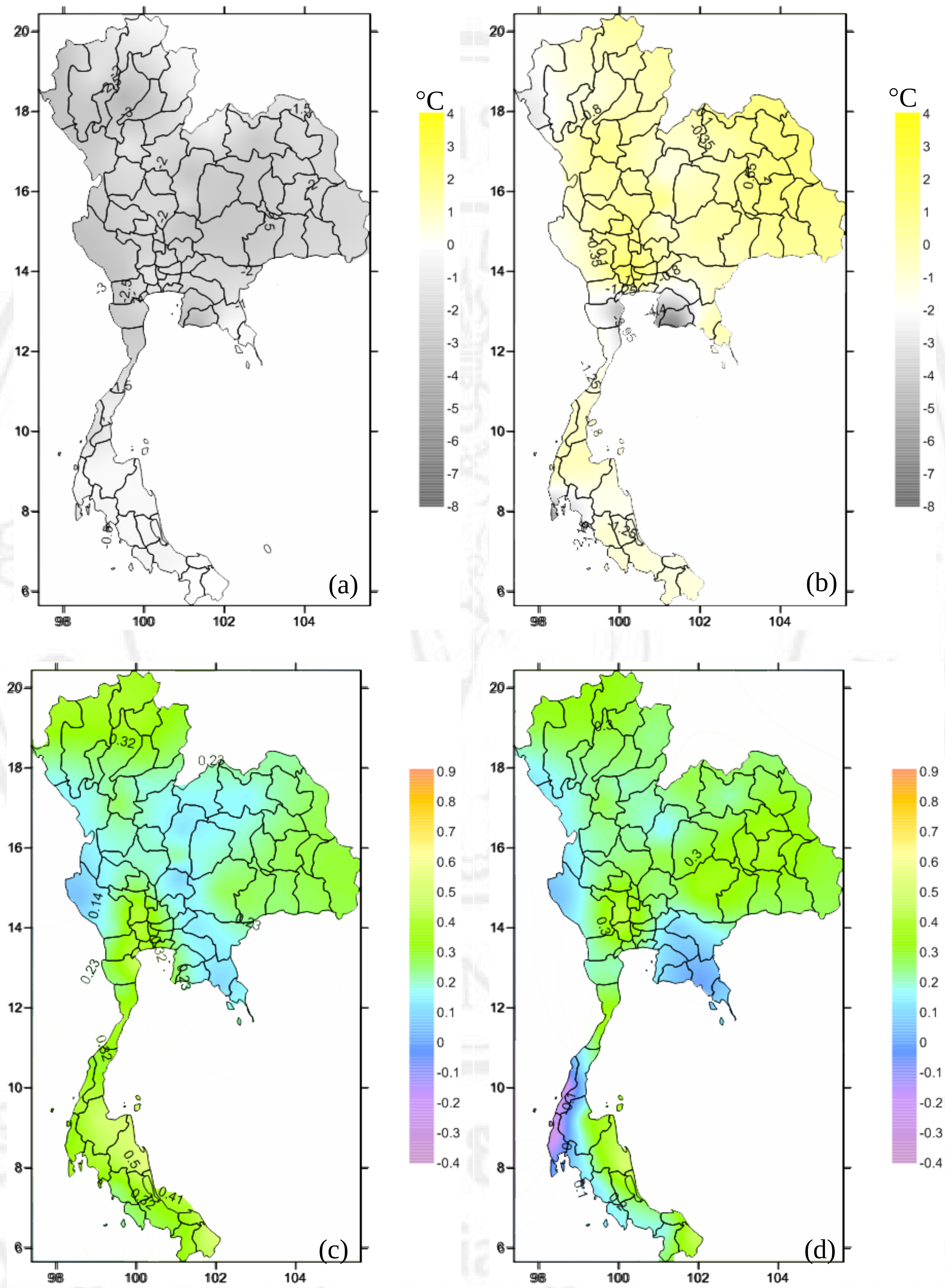


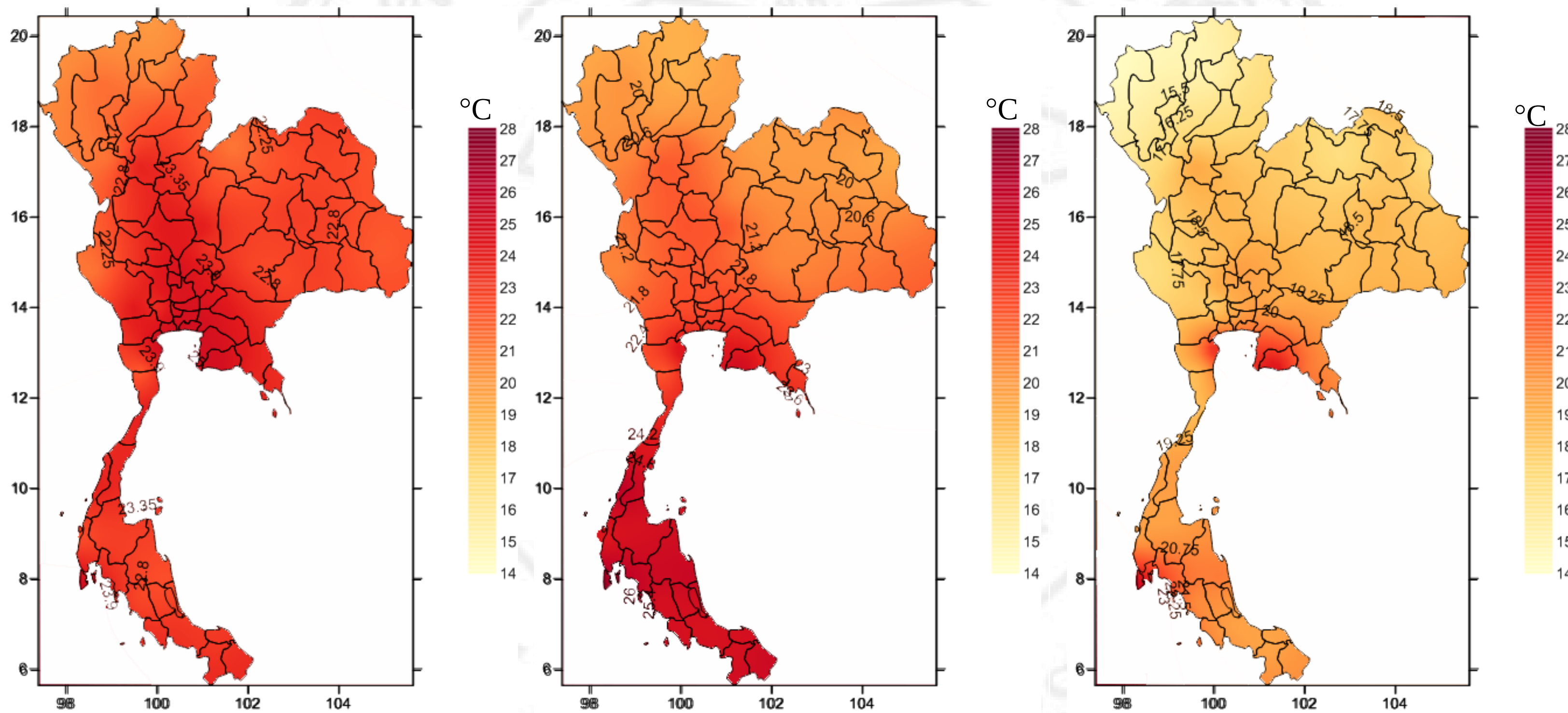
Figure 4.4 The maximum temperature biases between the observations and simulations using BM (a) and KF(b) scheme along with the correlation coefficients between the observations and simulations using BM (c) and (d) KF schemes

4.2 Minimum temperature

The minimum temperatures range from 20.11-25.25°C, 19.04-27.18°C, and 14.32-25.47°C from the observation, simulation using BMJ and KF schemes, respectively (Figure 4.5). Similar to the results of maximum temperatures, the spatial distribution pattern of minimum temperatures from the RCM using BMJ scheme is more similar to the observed. The high minimum temperatures are presented at the stations in the south in BMJ scheme simulation and in the east in KF scheme simulation.

The biases of BMJ scheme simulations are revealed in the stations in the south, some stations in the east and west (Figure 4.6(a)). The negative biases within -0.17 - -3.09°C are also revealed in the remaining stations. The large positive biases are noticed at all stations in the south where the higher 1.12-3.09°C temperatures are displayed. The minimum temperatures from the RCM using KF scheme are lower than the observed at most stations except some stations in the south. The differences between the observed and the RCM using KF scheme are within -6.25 – 0.22°C.

The correlation coefficients between the observed and the RCM minimum temperatures are presented in Figure 4.6. The minimum temperatures from BMJ scheme simulation agree with the observed one with the correlation coefficients within 0.11 – 0.80. The higher correlation coefficients greater than 0.60 are revealed at some stations in the upper north and west. The lower correlation coefficients within 0.11 – 0.48 are found at most stations in the central, east, and south.



(a) (b) (c)

Figure 4.5 The annual average of minimum temperatures from (a) observation, (b) RCM using BMJ, and (c) RCM using KF scheme

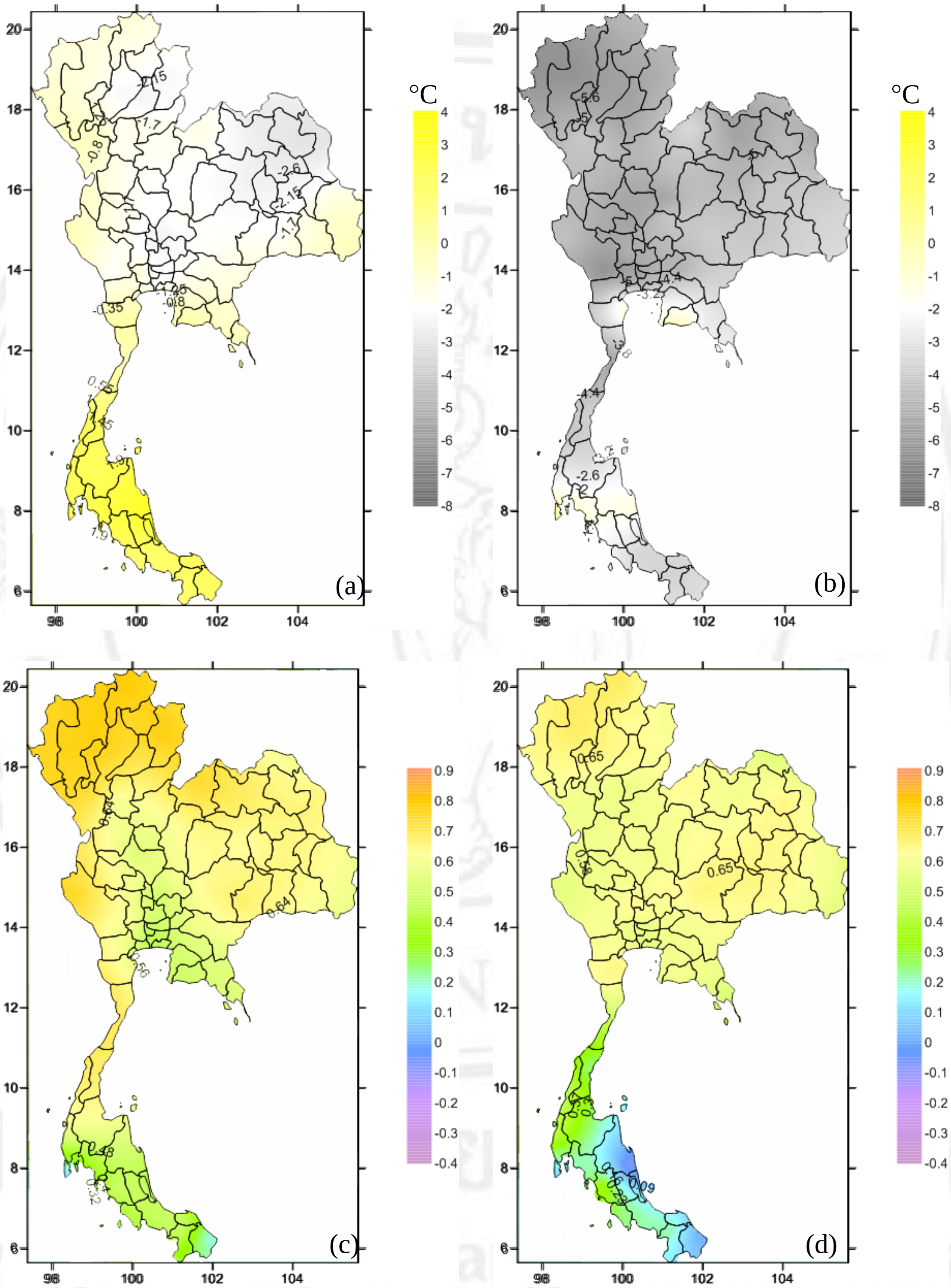


Figure 4.6 The minimum temperature biases between the observations and simulations using BM (a) and KF (b) scheme along with the correlation coefficients between the observations and simulations using BM (c) and (d) KF scheme

In general, the minimum temperatures from the RCM using KF scheme are in agreement with the observed ones with correlation coefficients within 0.55 -0.69 at the stations in upper Thailand (Figure 4.6(a)). A small correlation is found in the south with coefficients within -0.08 – 0.43.

All results of the minimum temperatures (Figures 4.5-4.6) indicate that the model using BMJ scheme is better in simulating the minimum temperatures than the other. (more similar distribution pattern, less biases, and higher correlation coefficient).

The statistical variables of the model using both schemes, including the mean correlation coefficient, minimum and maximum bias, and mean absolute bias, are summarized in table 4.1.

When considering in term of the bias, the RCM using BMJ scheme is better in simulating the rainfall and minimum temperatures while the KF scheme generates the better maximum temperatures. All variables are better simulated by the model with the BMJ scheme when the correlation coefficients are considered. In the research that the outputs from the RCM have to be adjusted the correlation coefficient might be the term to

Table 4.1 The statistic variables of RCM using both schemes

Statistic variable	Betts-Miller Janjic scheme	Kain-Fritsch scheme
1. Rainfall		
1.1 Correlation coefficient	0.17	0.11
1.2 Minimum bias	-10.07	-6.62
1.3 Maximum bias	-0.01	8.04
1.4 Mean absolute bias	2.55	3.54
2. Maximum Temperature		
2.1 Correlation coefficient	0.28	0.23
2.2 Minimum bias	-3.82	-7.14
2.3 Maximum bias	-0.01	1.64
2.4 Mean absolute bias	1.81	1.20
3. Minimum temperature		
3.1 Correlation coefficient	0.65	0.53
3.2 Minimum bias	-3.04	-6.25
3.3 Maximum bias	3.09	0.22
3.4 Mean absolute bias	1.66	4.31

be considered more than the bias, which can be reduced later in the bias-correction processes. It is reasonable to assert that the better scheme to be used is the BMJ scheme.

This result is consistent with the previous study e.g. Chotamonsak et. al., [42] who revealed that “Overall, the BMJ scheme produced the smallest biases, both averaged over domain and locally. In particular, BMJ produced the best probability distribution of precipitation”