

CHAPTER 4 RESULTS

4.1 Re-gridding the Result of Rainfall Pattern from Microphysics Parameterizations WRF Model

This study used the interpolation technique to get finest resolution for re-gridding degree of study domain from grids spacing 0.02 degrees to 0.25 degrees for the same TRMM data. The interpolation technique is bilinear interpolation for re-gridding the result of rainfall pattern from Microphysics Parameterizations WRF Model using the Grid Analysis and Display System (GRADS) program. GRADS program suggest bilinear interpolation for re-gridding to a finest resolution in domain3.

4.1.1 Re-gridding the Result of Rainfall Pattern on 3 Hourly-Rainfalls During 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

The area average fourteen experiment original results compare with the area average fourteen experiment re-gridding results by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 are show in Table 4.1, 4.2, and 4.3.

Table 4.1 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0000 UTC 28 March 2011 to 0600 UTC 28 March 2011

Exp	0000 UTC		0300 UTC		0600 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	0.282	0.267	1.388	1.367	1.946	1.872
Exp02	0.394	0.388	1.653	1.606	2.236	2.153
Exp03	0.398	0.388	1.426	1.370	1.879	1.746
Exp04	0.373	0.365	1.443	1.325	2.041	1.946
Exp05	0.245	0.239	1.195	1.182	1.688	1.721
Exp06	0.377	0.371	1.527	1.400	2.056	1.909
Exp07	0.316	0.303	1.485	1.490	1.982	1.970
Exp08	0.364	0.346	1.555	1.499	1.974	1.913

Table 4.1 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0000 UTC 28 March 2011 to 0600 UTC 28 March 2011 (Cont.)

Exp	0000 UTC		0300 UTC		0600 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp09	0.355	0.348	1.468	1.462	2.002	1.828
Exp10	0.379	0.372	1.294	1.258	1.681	1.591
Exp11	0.265	0.264	1.294	1.248	1.890	1.843
Exp12	0.272	0.276	1.371	1.336	1.921	1.811
Exp13	0.366	0.352	1.529	1.534	2.080	2.010
Exp14	0.365	0.344	1.527	1.496	2.066	1.980

Table 4.2 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0900 UTC 28 March 2011 to 1500 UTC 28 March 2011

Exp	0900 UTC		1200 UTC		1500 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	2.235	2.049	2.735	2.602	2.863	2.821
Exp02	2.404	2.366	2.596	2.524	3.023	2.962
Exp03	2.067	2.009	2.182	2.223	2.340	2.277
Exp04	2.307	2.287	2.512	2.513	2.779	2.682
Exp05	1.987	1.942	2.281	2.203	2.443	2.329
Exp06	2.257	2.196	2.392	2.382	2.724	2.546
Exp07	2.313	2.195	2.521	2.472	2.820	2.625
Exp08	2.137	2.018	2.338	2.176	2.583	2.460
Exp09	2.140	2.072	2.249	2.230	2.520	2.446
Exp10	1.920	1.934	2.169	2.135	2.383	2.353
Exp11	2.180	2.126	2.506	2.473	2.840	2.786
Exp12	2.151	2.107	2.386	2.253	2.710	2.621
Exp13	2.396	2.281	2.682	2.574	2.897	2.760
Exp14	2.329	2.290	2.666	2.574	2.835	2.799

Table 4.3 The area average original results compare with the area average re-gridding results by bilinear interpolation during 1800 UTC 28 March 2011 to 0000 UTC 29 March 2011

Exp	1800 UTC		2100 UTC		0000 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	3.235	3.123	3.302	3.058	3.361	3.272
Exp02	3.344	3.219	3.362	3.293	3.541	3.437
Exp03	2.612	2.641	2.989	2.861	2.947	2.928
Exp04	3.127	3.088	3.531	3.380	3.640	3.561
Exp05	2.704	2.628	3.099	3.072	3.323	3.302
Exp06	3.029	2.838	3.463	3.307	3.543	3.658
Exp07	3.261	3.277	3.670	3.584	3.854	3.730
Exp08	2.976	2.809	3.021	2.869	2.844	2.823
Exp09	2.795	2.701	3.084	3.128	3.044	3.124
Exp10	2.583	2.593	2.844	2.879	2.974	2.905
Exp11	3.156	3.092	3.529	3.430	3.750	3.637
Exp12	3.007	2.951	3.413	3.303	3.518	3.492
Exp13	3.074	2.985	3.248	3.204	3.349	3.297
Exp14	3.033	2.910	3.245	3.128	3.435	3.342

The area average of fourteen experiment re-gridding result by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 are closely value of the area average fourteen experiment original result show in Table 4.1, 4.2 and 4.3. The example comparison of rainfall distribution pattern between the area average original results and the area average re-gridding results by bilinear interpolation at 0000 UTC, 1200 UTC 28 March 2011, and at 0000 UTC 29 March 2011 of Exp01 and the rainfall distribution pattern area average re-gridding results by bilinear interpolation are show closely with the rainfall distribution pattern area average original results, as show in Figure 4.1. The example comparison of rainfall distribution pattern between the original results and the re-gridding results by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 of Exp01, Exp02, and Exp03 are show in Appendix A.

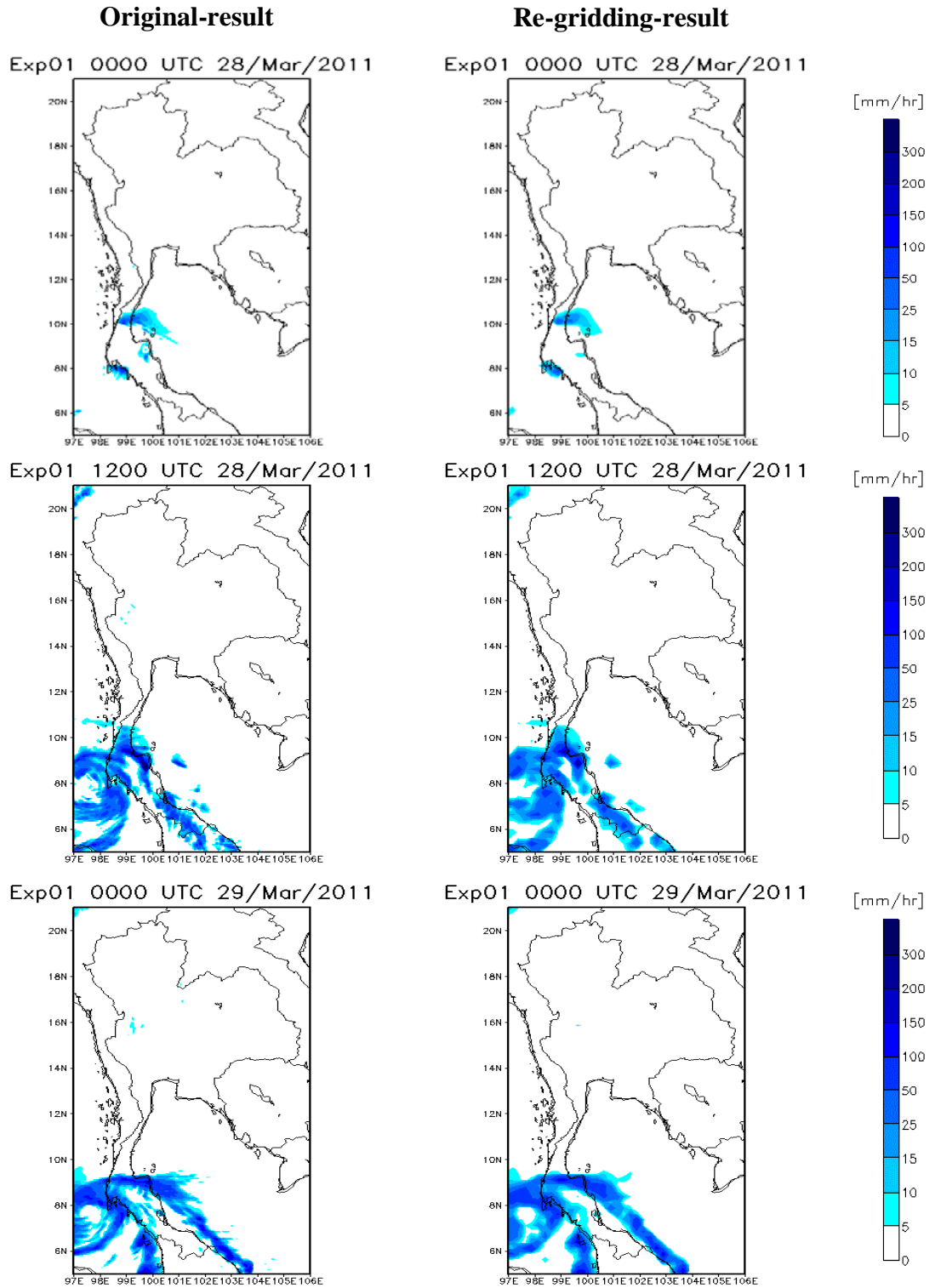


Figure 4.1 The comparison of the rainfall distribution between the area average original results and the area average re-gridding results at 0000 UTC, 1200 UTC 28 March 2011 and 0000 UTC 29 March 2011 of Exp01

The comparison mean area average fourteen experiment between original result and the re-gridding result by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 show about closely data between original result and re-gridding result by bilinear interpolation, as shown in Figure 4.2.

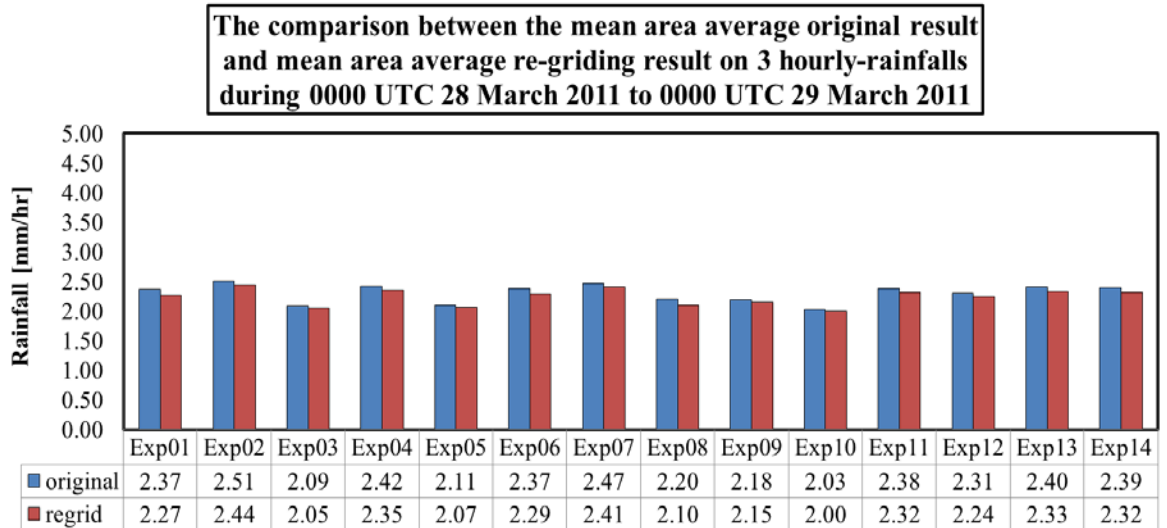


Figure 4.2 The comparison between mean area average original results and the mean area average re-gridding results on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

4.1.2 Re-gridding the Result of Rainfall Pattern on 3 Hourly-Rainfalls During 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

The area average fourteen experiment original results compare with the area average fourteen experiment re-gridding results by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 are show in Table 4.4, 4.5, and 4.6.

Table 4.4 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0000 UTC 10 September 2011 to 0600 UTC 10 September 2011

Exp	0000 UTC		0300 UTC		0600 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	0.117	0.101	1.356	1.341	2.090	2.114
Exp02	0.339	0.332	1.937	1.923	2.487	2.497
Exp03	0.366	0.360	1.775	1.652	2.273	2.301
Exp04	0.325	0.308	1.711	1.641	2.504	2.480
Exp05	0.276	0.279	1.310	1.340	1.952	1.928
Exp06	0.330	0.318	1.786	1.728	2.417	2.458
Exp07	0.269	0.250	1.590	1.570	2.146	2.184
Exp08	0.211	0.194	1.632	1.663	2.323	2.374
Exp09	0.336	0.316	1.496	1.488	2.109	2.045
Exp10	0.319	0.307	1.290	1.281	1.756	1.781
Exp11	0.208	0.201	1.638	1.615	2.338	2.339
Exp12	0.215	0.210	1.753	1.801	2.355	2.355
Exp13	0.252	0.255	2.152	2.140	2.555	2.591
Exp14	0.254	0.254	2.144	2.156	2.564	2.614

Table 4.5 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0900 UTC 10 September 2011 to 1500 UTC 10 September 2011

Exp	0900 UTC		1200 UTC		1500 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	2.541	2.538	2.687	2.722	3.003	2.988
Exp02	3.238	3.266	3.206	3.336	4.145	4.040
Exp03	2.544	2.597	2.376	2.430	3.122	3.098
Exp04	2.929	2.956	2.877	3.000	3.673	3.753
Exp05	2.178	2.245	2.616	2.672	3.458	3.510
Exp06	2.914	2.889	2.859	2.882	3.634	3.616
Exp07	2.736	2.842	2.601	2.657	3.322	3.252
Exp08	2.876	2.853	2.506	2.447	3.083	3.106
Exp09	2.721	2.736	2.549	2.525	3.058	3.077
Exp10	2.317	2.202	2.149	2.175	2.696	2.740
Exp11	2.784	2.705	2.759	2.755	3.438	3.461

Table 4.5 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0900 UTC 10 September 2011 to 1500 UTC 10 September 2011 (Cont.)

Exp	0900 UTC		1200 UTC		1500 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp12	2.890	2.807	2.816	2.889	3.562	3.670
Exp13	3.110	3.097	3.371	3.402	4.256	4.350
Exp14	3.121	3.107	3.364	3.349	4.242	4.321

Table 4.6 The area average original results compare with the area average re-gridding results by bilinear interpolation during 1800 UTC 10 September 2011 to 0000 UTC 11 September 2011

Exp	1800 UTC		2100 UTC		0000 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	3.550	3.609	3.687	3.855	3.870	3.798
Exp02	4.694	4.668	4.758	4.825	4.487	4.479
Exp03	3.702	3.730	3.979	3.866	3.849	3.775
Exp04	4.380	4.347	4.850	4.737	4.827	4.728
Exp05	3.993	4.021	4.265	4.229	4.189	4.259
Exp06	4.215	3.985	4.586	4.487	4.523	4.563
Exp07	4.145	4.229	4.915	4.908	4.919	4.878
Exp08	3.764	3.736	4.138	4.119	4.162	3.982
Exp09	3.607	3.401	4.026	3.947	4.236	4.221
Exp10	3.283	3.306	3.714	3.711	3.855	3.730
Exp11	4.280	4.258	4.720	4.687	4.480	4.521
Exp12	4.117	4.211	4.389	4.446	4.272	4.192
Exp13	5.055	4.967	5.281	5.335	4.950	4.783
Exp14	5.026	5.061	5.261	5.052	4.770	4.749

The area average of fourteen experiment re-gridding result by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 are closely value of the area average fourteen experiment original result show in Table 4.4, 4.5 and 4.6. The example comparison of rainfall distribution pattern between the area average original results and the area average re-gridding results by bilinear interpolation at 0000 UTC, 1200 UTC 10 September 2011, and 0000 UTC 11 September 2011 of Exp01 and the rainfall distribution pattern area average re-gridding

results by bilinear interpolation are show closely with the rainfall distribution pattern area average original results, as show in Figure 4.3 and Figure 4.4. The example comparison of rainfall distribution pattern between the original results and the re-gridding results by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 10 September 2011 of Exp01, Exp02, and Exp03 are show in Appendix B.

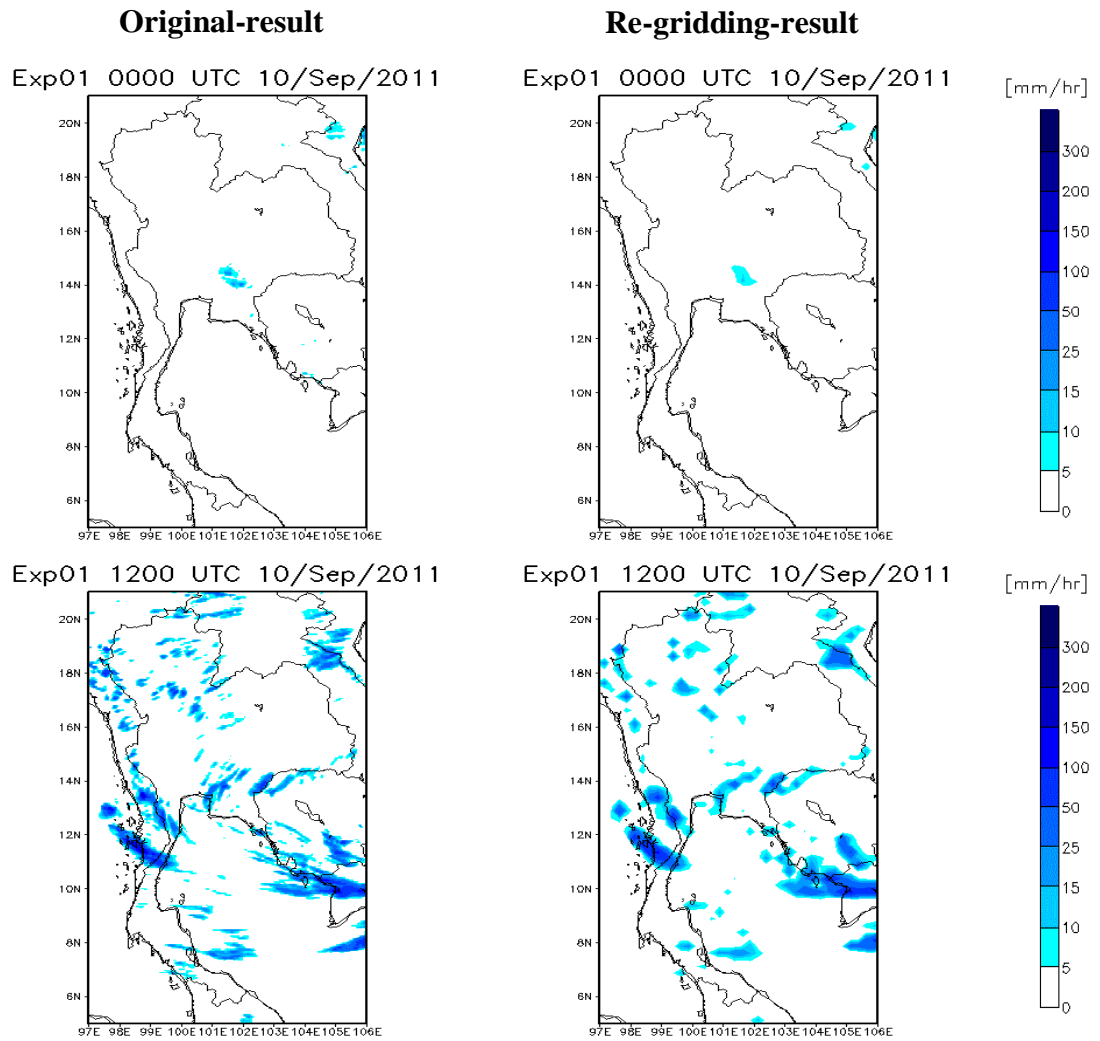


Figure 4.3 The comparison of the rainfall distribution between the area average original results and the area average re-gridding results at 0000 UTC, 1200 UTC 10 September 2011 of Exp01

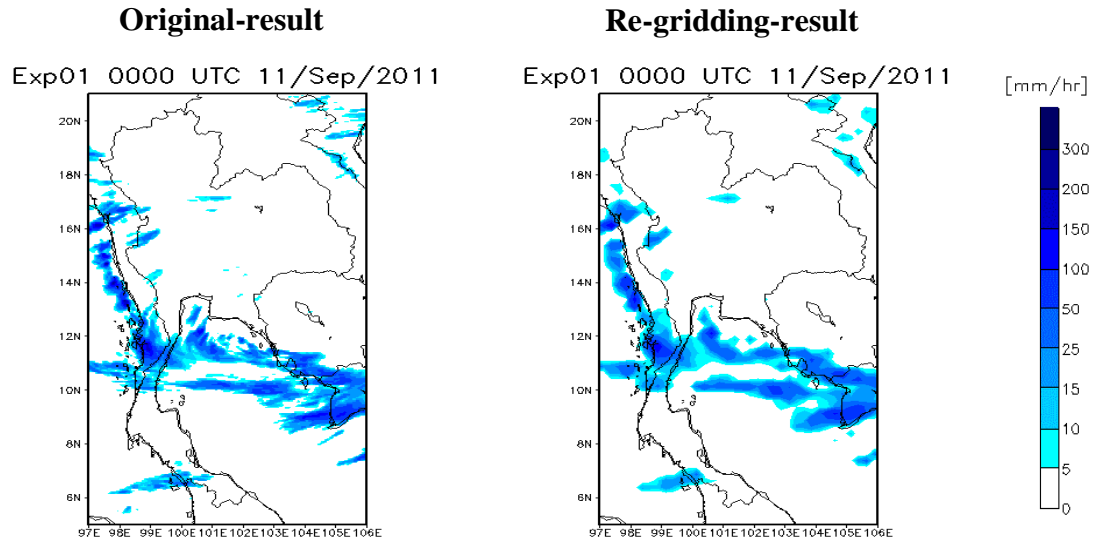


Figure 4.4 The comparison of the rainfall distribution between the area average original results and the area average re-gridding results at 0000 UTC 11 September 2011 of Exp01

The comparison mean area average fourteen experiment between original result and the re-gridding result by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 show about closely data between original result and re-gridding result by bilinear interpolation, as shown in Figure 4.5.

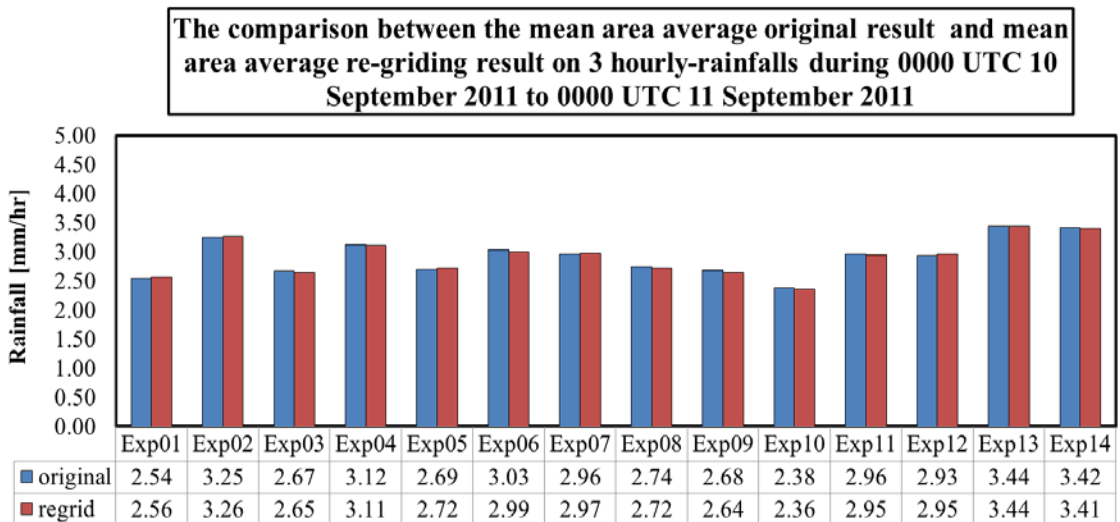


Figure 4.5 The comparison between mean area average original results and the mean area average re-gridding results on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

4.1.3 Re-gridding the Result of Rainfall Pattern on 3 Hourly- Rainfalls During 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

The area average fourteen experiment original results compare with the area average fourteen experiment re-gridding results by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 are show in Table 4.7, 4.8, and 4.9.

Table 4.7 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0000 UTC 23 November 2011 to 0600 UTC 23 November 2011

Exp	00:00 UTC		03:00 UTC		06:00 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	0.071	0.068	0.219	0.206	0.344	0.354
Exp02	0.199	0.193	0.431	0.378	0.680	0.673
Exp03	0.192	0.184	0.346	0.344	0.503	0.499
Exp04	0.185	0.175	0.358	0.325	0.531	0.558
Exp05	0.144	0.143	0.269	0.267	0.410	0.438
Exp06	0.186	0.178	0.381	0.344	0.606	0.574
Exp07	0.181	0.178	0.293	0.284	0.433	0.420
Exp08	0.124	0.121	0.347	0.320	0.560	0.530
Exp09	0.191	0.186	0.292	0.283	0.436	0.423
Exp10	0.183	0.174	0.291	0.266	0.419	0.377
Exp11	0.126	0.119	0.386	0.360	0.479	0.480
Exp12	0.130	0.124	0.412	0.386	0.572	0.512
Exp13	0.235	0.218	0.559	0.556	0.808	0.790
Exp14	0.234	0.220	0.556	0.525	0.750	0.723

Table 4.8 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0900 UTC 23 November 2011 to 1500 UTC 23 November 2011

Exp	0900 UTC		1200 UTC		1500 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	0.662	0.590	0.892	0.854	0.821	0.807
Exp02	1.059	1.023	1.128	1.109	0.961	0.908

Table 4.8 The area average original results compare with the area average re-gridding results by bilinear interpolation during 0900 UTC 23 November 2011 to 1500 UTC 23 November 2011 (Cont.)

Exp	0900 UTC		1200 UTC		1500 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp03	0.785	0.780	0.839	0.803	0.787	0.837
Exp04	0.848	0.882	0.996	0.920	0.931	0.878
Exp05	0.674	0.702	0.808	0.779	0.680	0.687
Exp06	1.009	1.017	1.114	1.081	0.866	0.906
Exp07	0.726	0.701	0.741	0.676	0.778	0.757
Exp08	0.871	0.857	0.931	0.903	0.815	0.790
Exp09	0.672	0.649	0.717	0.670	0.720	0.718
Exp10	0.603	0.585	0.658	0.596	0.700	0.675
Exp11	0.773	0.769	0.982	0.918	0.832	0.819
Exp12	0.946	0.975	1.037	1.062	0.874	0.896
Exp13	1.257	1.183	1.368	1.382	1.175	1.157
Exp14	1.171	1.210	1.319	1.292	1.206	1.190

Table 4.9 The area average original results compare with the area average re-gridding results by bilinear interpolation during 1800 UTC 23 November 2011 to 0000 UTC 24 November 2011

Exp	1800 UTC		2100 UTC		0000 UTC	
	Original	Re-ridding	Original	Re-ridding	Original	Re-ridding
Exp01	0.579	0.608	0.491	0.483	0.455	0.462
Exp02	0.654	0.701	0.606	0.624	0.667	0.671
Exp03	0.575	0.535	0.530	0.528	0.635	0.661
Exp04	0.652	0.596	0.604	0.558	0.534	0.557
Exp05	0.614	0.631	0.457	0.444	0.530	0.530
Exp06	0.600	0.564	0.563	0.563	0.537	0.511
Exp07	0.618	0.626	0.555	0.541	0.552	0.581
Exp08	0.607	0.578	0.617	0.568	0.416	0.360
Exp09	0.484	0.473	0.498	0.467	0.466	0.436
Exp10	0.551	0.562	0.579	0.561	0.539	0.529
Exp11	0.612	0.598	0.642	0.616	0.660	0.673
Exp12	0.593	0.625	0.571	0.523	0.687	0.697
Exp13	0.985	1.003	1.048	1.045	1.029	1.110
Exp14	0.924	0.874	1.039	1.049	1.044	0.990

The area average fourteen experiment re-gridding result by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 are closely value of the area average fourteen experiment original result show in Table 4.7, 4.8 and 4.9. The example comparison of rainfall distribution pattern between the area average original results and the area average re-gridding results by bilinear interpolation at 0000 UTC, 1200 UTC 23 November 2011, and 0000 UTC 24 November 2011 of EXP01 and the rainfall distribution pattern area average re-gridding results by bilinear interpolation are show closely rainfall distribution with the area average original results, as show in Figure 4.6 and Figure 4.7. The example comparison of rainfall distribution pattern between the original results and the re-gridding results by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 of Exp01, Exp02, and Exp03 are show in Appendix C.

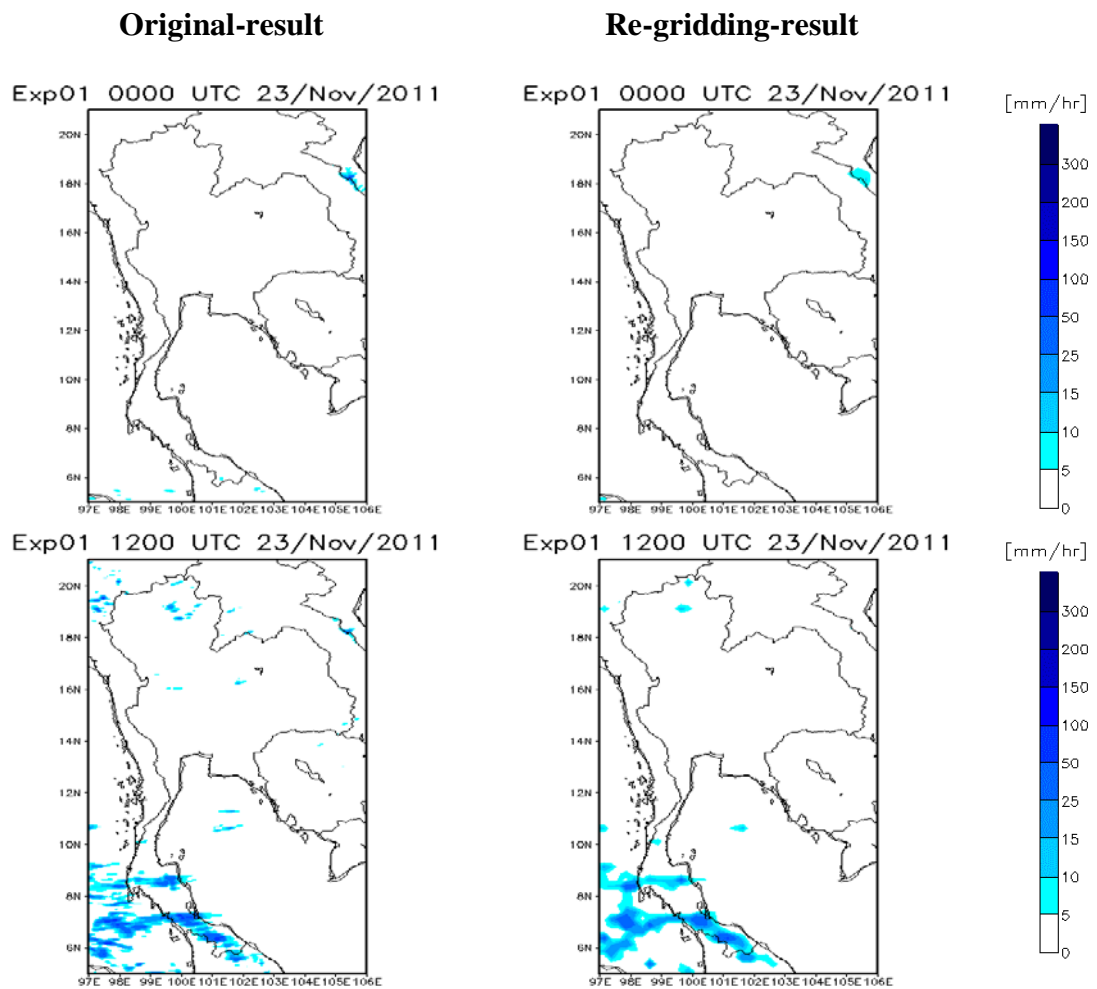


Figure 4.6 The comparison of the rainfall distribution between the area average original results and the area average re-gridding results at 0000 UTC, 1200 UTC 23 November 2011 of Exp01

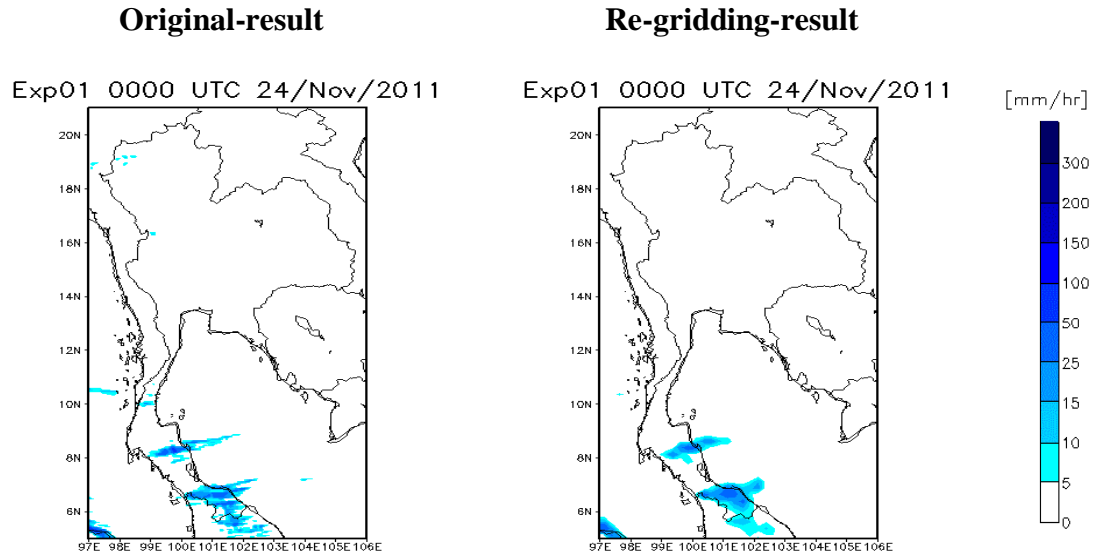


Figure 4.7 The comparison of the rainfall distribution between the area average original results and the area average re-gridding results at 0000 UTC 24 November 2011 of Exp01

The comparison mean area average fourteen experiment between original result and the re-gridding result by bilinear interpolation on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 show about closely data between original result and re-gridding result by bilinear interpolation, as shown in Figure 4.8.

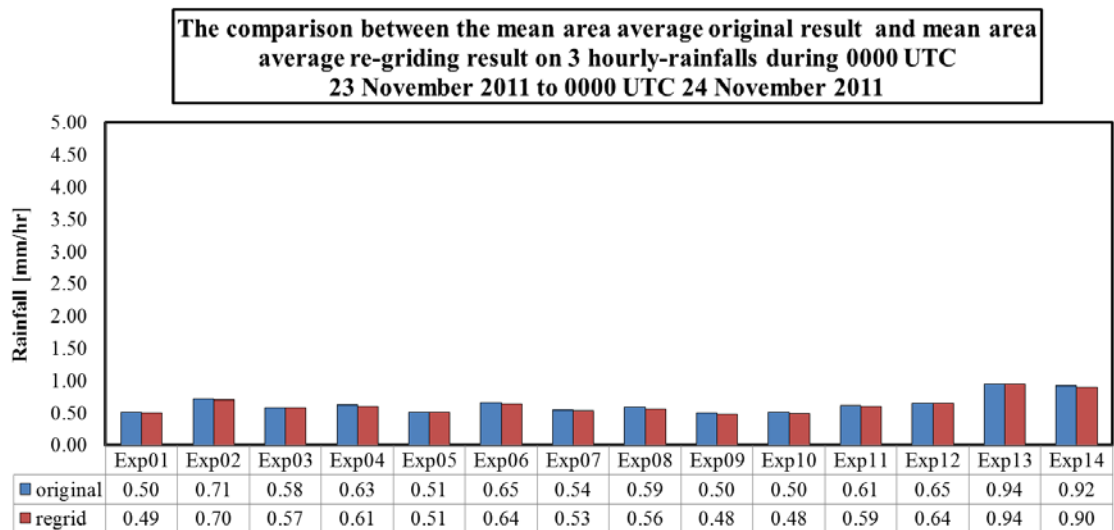


Figure 4.8 The comparison between mean area average original results and the mean area average re-gridding results on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

4.2 Comparison of Rainfall Pattern between Microphysics Schemes of WRF Model and TRMM Observation Data on 3 Hourly-Rainfalls During 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 (Summer Season)

The results were calculated to present the rainfall amounts for each microphysics parameterizations. The rainfall value over the finest domains observation was given by the TRMM data. The fourteen microphysics parameterizations simulation were compared. In This study, to use statistical method was correlation, mean error, and mean absolute error. The statistical methods were calculated for analyzing to each microphysics parameterizations with TRMM data. The comparisons of the correlation value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show correlation on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011. The correlation of 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 is positive correlation. Because the result of correlation between two data are shows a positive value and the positive correlation means two data between the result of microphysics parameterizations and TRMM observation data are same direction, as shown in Table 4.10.

Table 4.10 The correlation on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	0.152	0.142	0.156	0.161	0.244	0.275	0.228	0.216	0.294
Exp02	0.146	0.165	0.176	0.188	0.292	0.207	0.199	0.243	0.325
Exp03	0.164	0.172	0.156	0.199	0.236	0.230	0.190	0.276	0.413
Exp04	0.155	0.158	0.167	0.194	0.282	0.251	0.253	0.264	0.400
Exp05	0.118	0.157	0.158	0.255	0.256	0.267	0.227	0.273	0.415
Exp06	0.154	0.154	0.173	0.155	0.287	0.205	0.229	0.335	0.404
Exp07	0.155	0.139	0.134	0.161	0.205	0.218	0.233	0.269	0.389
Exp08	0.139	0.150	0.129	0.163	0.212	0.195	0.201	0.342	0.277
Exp09	0.154	0.148	0.153	0.171	0.236	0.248	0.213	0.404	0.427
Exp10	0.176	0.152	0.183	0.176	0.177	0.178	0.207	0.347	0.408
Exp11	0.177	0.202	0.183	0.210	0.265	0.237	0.241	0.347	0.362

Table 4.10 The correlation on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 (Cont.)

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp12	0.171	0.192	0.147	0.187	0.280	0.253	0.209	0.285	0.354
Exp13	0.190	0.150	0.152	0.267	0.313	0.414	0.246	0.270	0.345
Exp14	0.181	0.152	0.156	0.234	0.294	0.417	0.221	0.262	0.432

The mean correlation between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 has positive correlation. Since the all result of mean correlation between two data are shows a positive value. So the data between result of microphysics parameterizations and TRMM observation data are same direction, as shown in Figure 4.9.

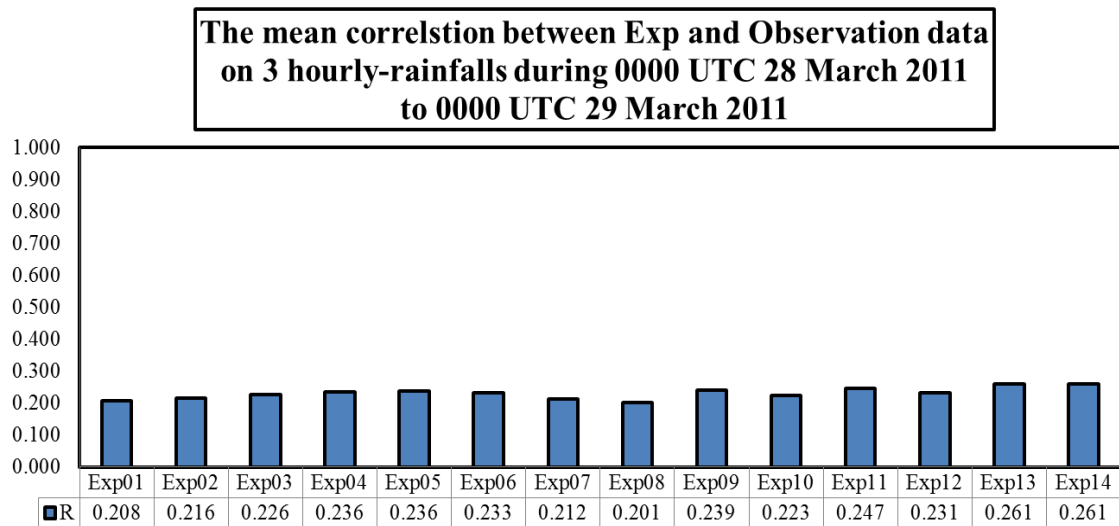


Figure 4.9 The mean correlation between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

The comparison of the mean error value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show mean error on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011. Mean error allow positive and negative value measure for two data between the result from model and observation data. If mean error = 0, there is no bias, if mean error > 0, simulation are too high, and if mean error < 0,

simulation are too low. The mean error of some experiments at 06000 UTC, 1800 UTC 28 March 2011, 0000 UTC 29 March 2011 and all experiments at 2100 UTC 28 March 2011 are too high. Because the result of mean error between two data are shows a positive value and the positive value means the mean error of microphysics parameterizations is more than the mean error of TRMM observation data, as shown in Table 4.11. But the mean error of all experiments at 0000 UTC, 0300 UTC, 0900 UTC, 1200 UTC, 1500 UTC 28 March 2011 and some experiment at 0600 UTC, 1800 UTC 28 March 2011 and 0000 UTC 29 March 2011 are too low. Because the result of mean error between two data are shows a negative value and the negative value is mean the mean error of microphysics parameterizations is less than the mean error of TRMM observation data, as shown in Table 4.11.

Table 4.11 The mean error on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	-1.653	-0.284	-0.065	-0.425	-0.365	-1.069	0.194	0.441	0.222
Exp02	-1.532	-0.045	0.216	-0.107	-0.443	-0.928	0.289	0.677	0.386
Exp03	-1.532	-0.281	-0.191	-0.464	-0.744	-1.613	-0.288	0.244	-0.122
Exp04	-1.555	-0.326	0.009	-0.186	-0.453	-1.208	0.159	0.764	0.511
Exp05	-1.682	-0.469	-0.216	-0.532	-0.763	-1.561	-0.301	0.456	0.252
Exp06	-1.549	-0.251	-0.028	-0.277	-0.585	-1.344	-0.092	0.691	0.607
Exp07	-1.617	-0.161	0.032	-0.278	-0.494	-1.265	0.348	0.968	0.679
Exp08	-1.574	-0.152	-0.025	-0.455	-0.791	-1.430	-0.120	0.253	-0.228
Exp09	-1.573	-0.189	-0.110	-0.402	-0.737	-1.444	-0.228	0.512	0.074
Exp10	-1.548	-0.393	-0.347	-0.540	-0.832	-1.537	-0.337	0.263	-0.146
Exp11	-1.657	-0.403	-0.094	-0.347	-0.494	-1.103	0.162	0.814	0.587
Exp12	-1.645	-0.315	-0.127	-0.366	-0.713	-1.269	0.022	0.687	0.442
Exp13	-1.568	-0.117	0.073	-0.193	-0.393	-1.130	0.056	0.587	0.247
Exp14	-1.577	-0.155	0.042	-0.183	-0.393	-1.091	-0.019	0.511	0.292

The mean of mean error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 of all experiment has mean error value less than observation data. Since the result mean of mean error between two data are shows a negative value. So the data of microphysics parameterizations is lower than TRMM observation data, as shown in Figure 4.10.

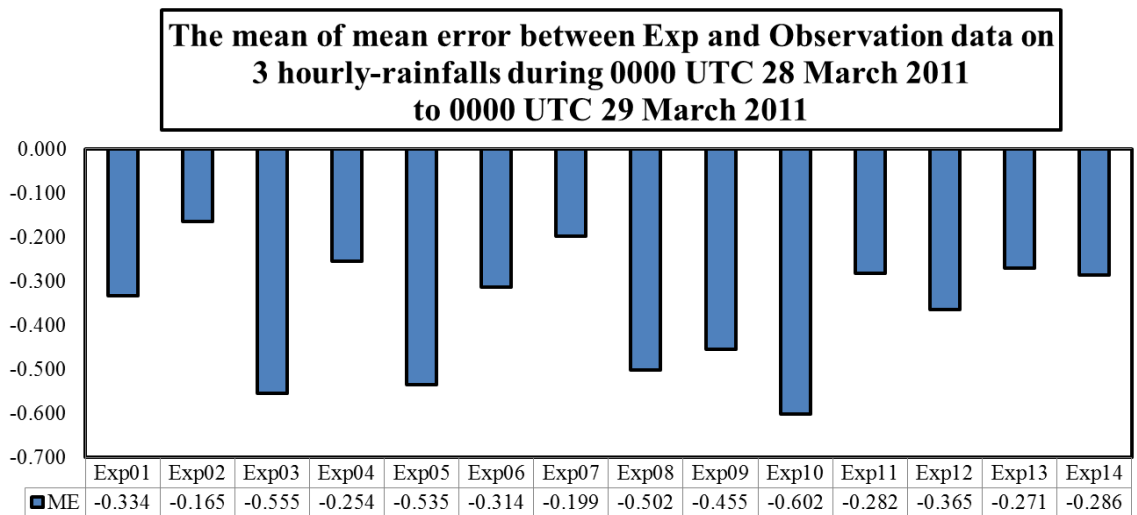


Figure 4.10 The mean of mean error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

The comparison of the mean absolute error value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show mean absolute error value of 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011. Mean absolute error is a scalar accuracy measure for two data between the result from model and observation data. If mean absolute error value is nearly zero, the result from model is better, as shown in Table 4.12.

Table 4.12 The mean absolute error on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	1.854	2.345	2.963	3.310	3.693	4.666	4.288	4.046	4.510
Exp02	1.885	2.495	3.041	3.412	3.533	4.764	4.209	4.158	4.432
Exp03	1.863	2.261	2.769	3.209	3.411	4.163	3.811	3.692	3.842
Exp04	1.868	2.265	2.853	3.295	3.495	4.470	3.997	4.022	4.132
Exp05	1.919	2.161	2.782	2.960	3.376	4.140	3.558	3.730	3.741

Table 4.12 The mean absolute error on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 (Cont.)

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp06	1.869	2.330	2.832	3.403	3.422	4.397	3.891	3.961	4.359
Exp07	1.875	2.420	2.927	3.401	3.677	4.431	4.067	4.155	4.264
Exp08	1.872	2.397	3.010	3.281	3.499	4.528	3.884	3.589	4.034
Exp09	1.866	2.405	2.774	3.259	3.409	4.315	3.711	3.703	3.734
Exp10	1.858	2.201	2.593	3.142	3.586	4.543	3.589	3.284	3.537
Exp11	1.850	2.084	2.752	3.168	3.504	4.530	4.026	3.980	4.245
Exp12	1.854	2.139	2.806	3.335	3.279	4.466	4.022	4.021	4.157
Exp13	1.810	2.342	2.937	3.228	3.512	4.112	3.834	3.746	3.958
Exp14	1.806	2.291	2.864	3.263	3.587	4.087	3.709	3.680	3.811

The mean of mean absolute error value between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 is show in Figure 4.12. The simulation is given by the EXP10 (SBU-YLin scheme) smallest error of mean absolute error value than another experiments and the mean absolute error value of SBU-YLin scheme is 3.148, as show in Figure 4.11.

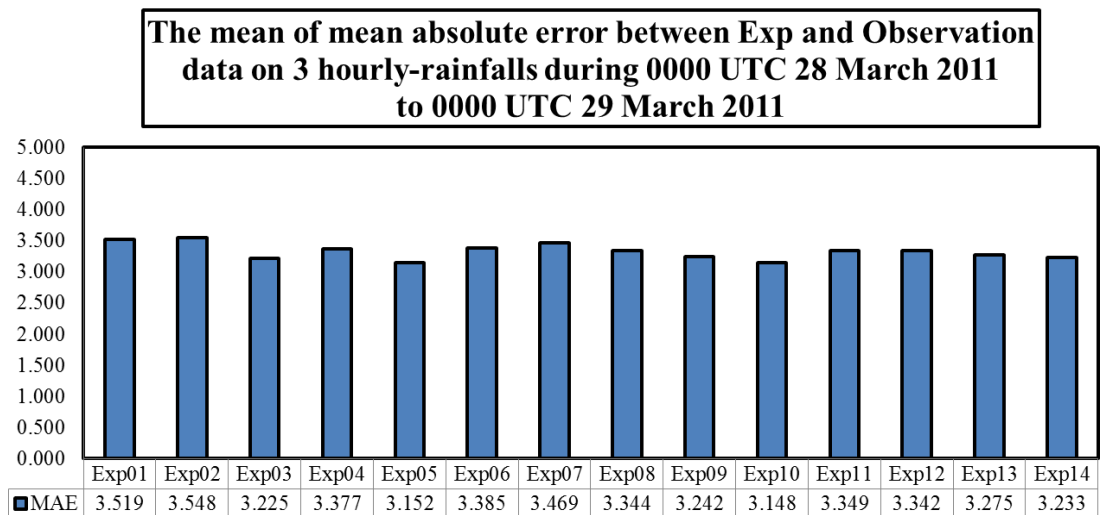


Figure 4.11 The mean of mean absolute error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

The simulation that is given by the EXP10 (SBU-YLin scheme) gives the smallest error of mean absolute error is 3.148, Exp05 (Eta scheme) gives the error of mean absolute error is 3.152, and Exp03 (WSM3 scheme) gives the error of mean absolute error is 3.225 on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 respectively, as shown in previous Figure 4.11. The rainfall distribution pattern on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 is also quite similar to the rainfall distribution pattern given by TRMM data is show in Figure 4.12, 4.13, and 4.14, respectively. The rainfall distribution patterns from the simulation of Exp05 (Eta scheme), and Exp03 (WSM3 scheme) are show in Appendix D.

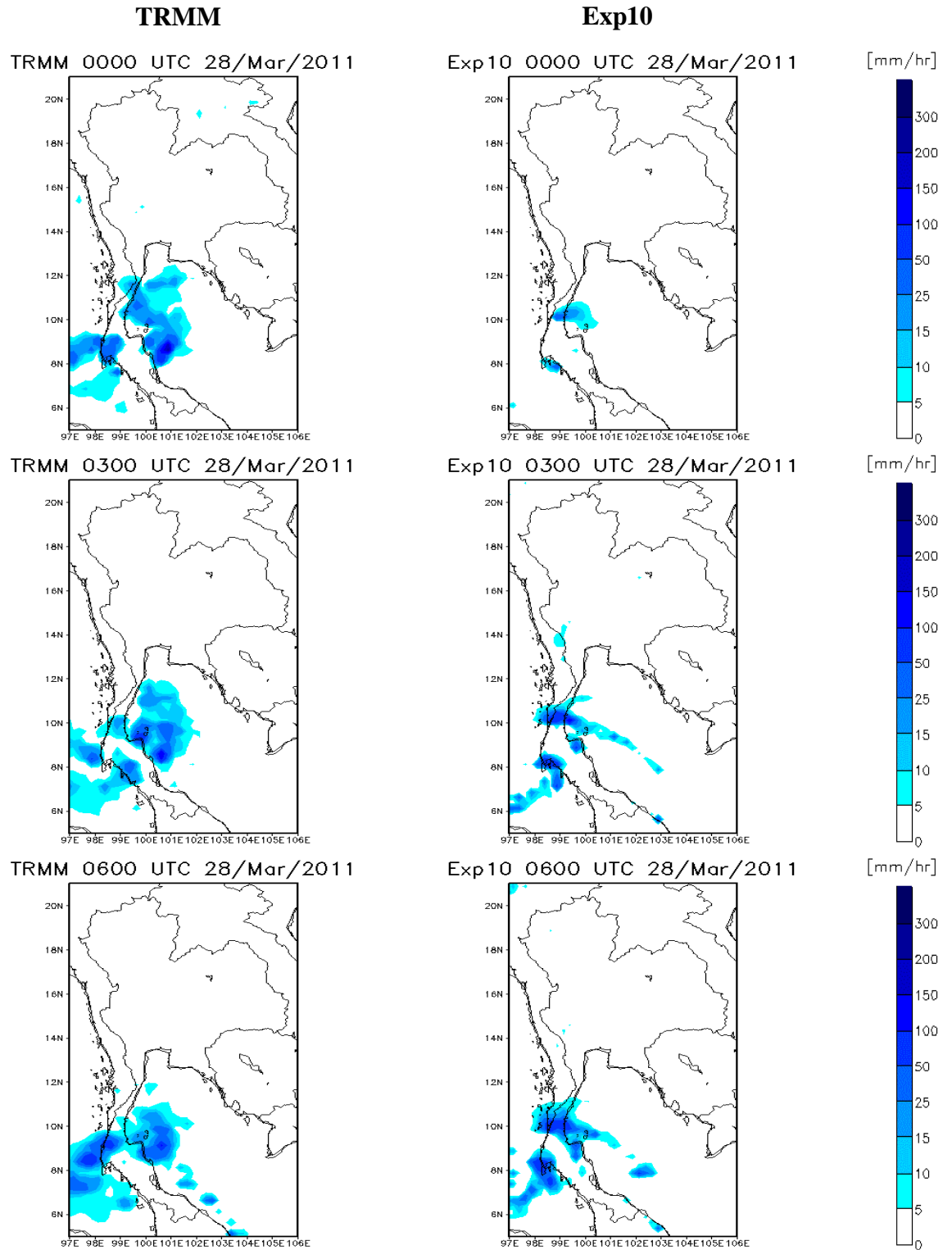


Figure 4.12 The comparison of rainfall distribution between observation data and EXP10 during 0000 UTC to 0600 UTC 28 March 2011

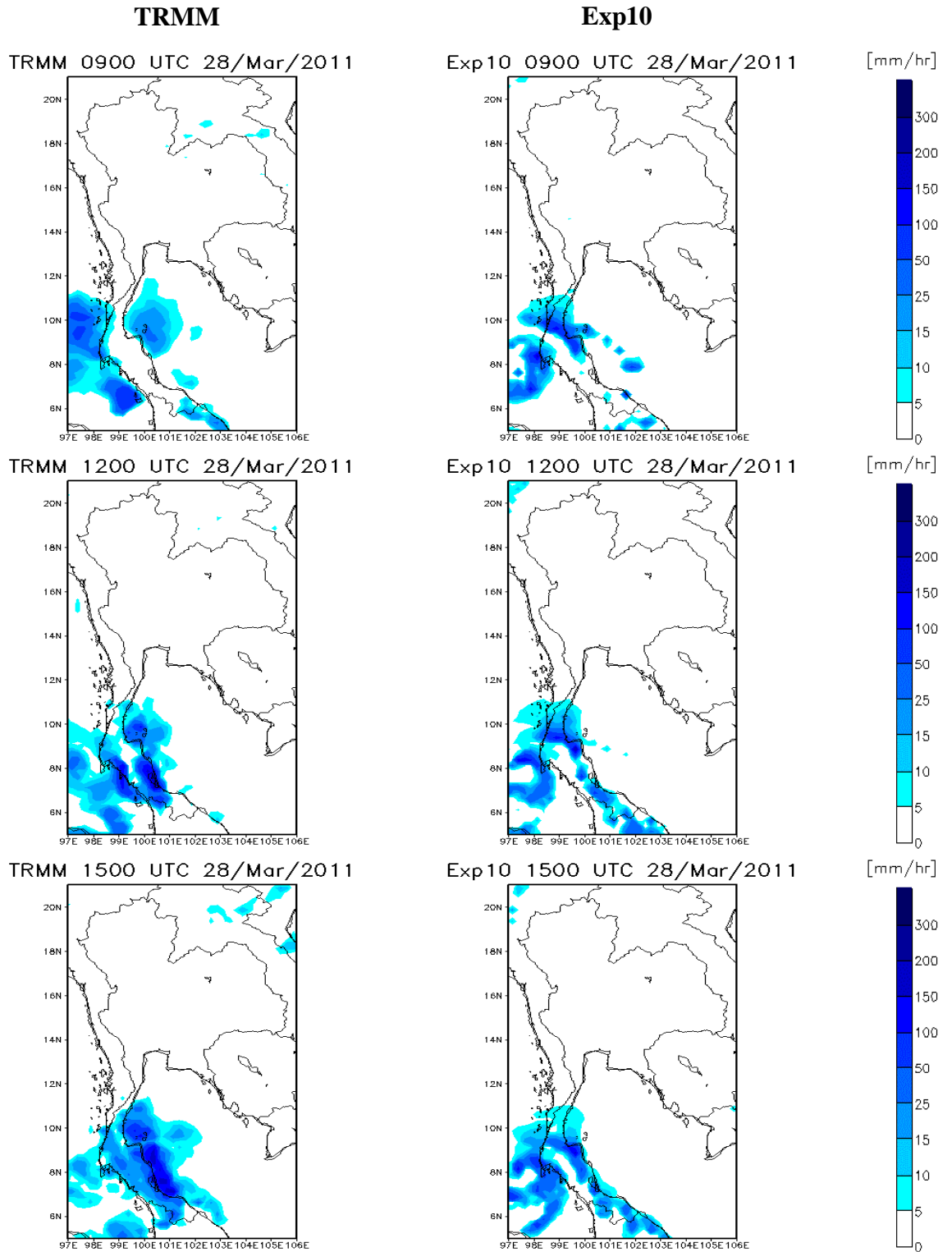


Figure 4.13 The comparison of rainfall distribution between observation data and EXP10 during 0900 UTC to 1500 UTC 28 March 2011

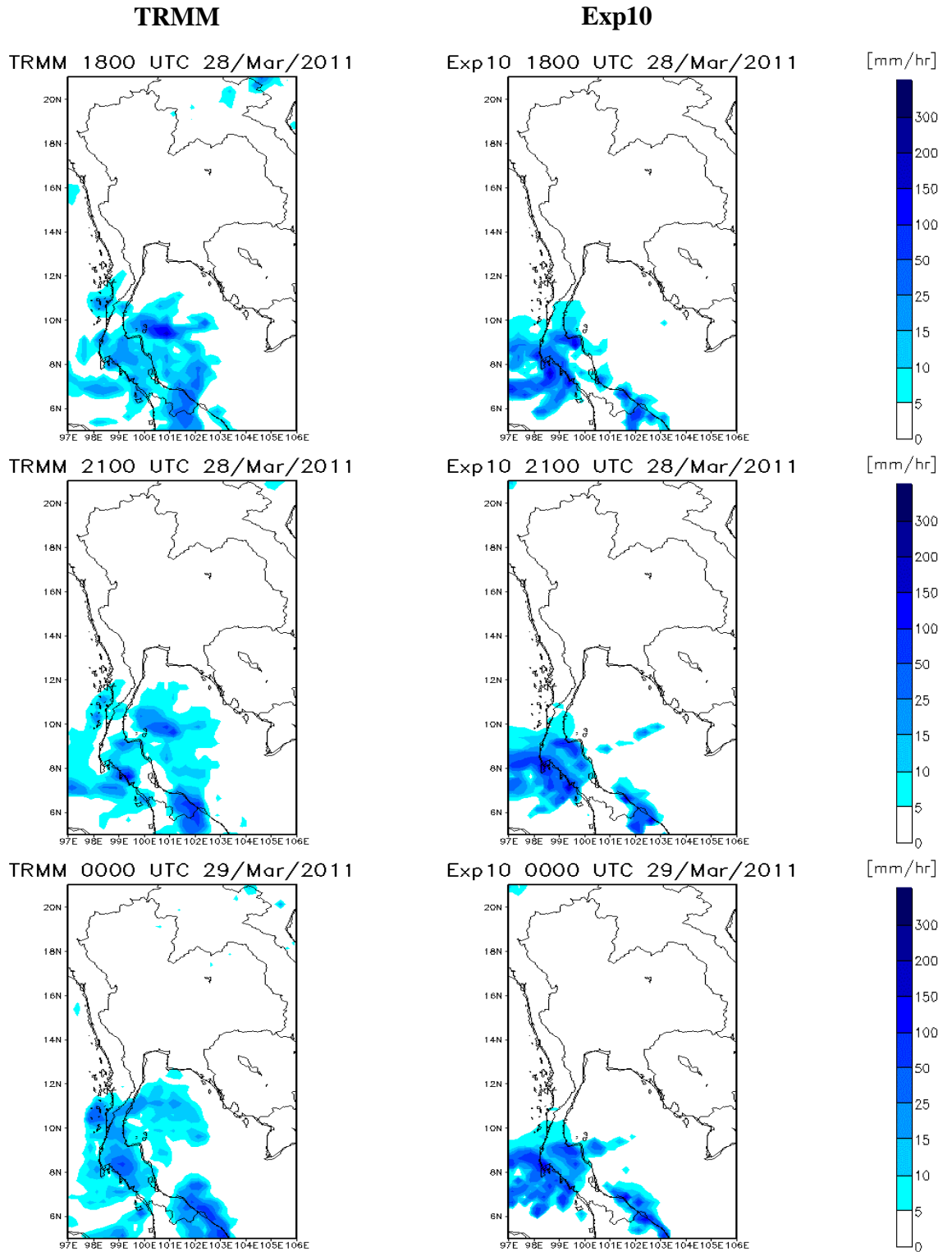


Figure 4.14 The comparison of rainfall distribution between observation data and EXP10 during 1800 UTC 28 March 2011 to 0000 UTC 29 March 2011

The different of rainfall distribution pattern between TRMM observation data and EXP10 at 0000 UTC 28 March 2011 is show rainfall distribution under estimation (blue color) over the Gulf of Thailand nearly southern part of Thailand, over Andaman sea nearly southern part of Thailand and over southern part of Thailand, at 0300 UTC 28 March 2011 is show rainfall distribution under estimation (blue color) over the Gulf of Thailand nearly southern part of Thailand, over Andaman sea nearly southern part of Thailand and over southern part of Thailand but rainfall distribution over estimation (red color) over southern part of Thailand, at 0600 UTC, 0900 UTC, 1200 UTC, 1500 UTC, 1800 UTC, 2100 UTC, and 0000 UTC 28 March 2011 is show rainfall distribution under estimation (blue color) over the Gulf of Thailand nearly southern part of Thailand, over Andaman sea nearly southern part of Thailand and over southern part of Thailand but rainfall distribution over estimation (red color) over the Gulf of Thailand nearly southern part of Thailand, over Andaman sea nearly southern part of Thailand and over southern part of Thailand, as show in Figure 4.15 and Figure 4.16. The different of rainfall distribution pattern between observation of Exp03 (WSM3 scheme), and Exp05 (Eta scheme) on 28th March 2011 are show in Appendix E.

Exp10

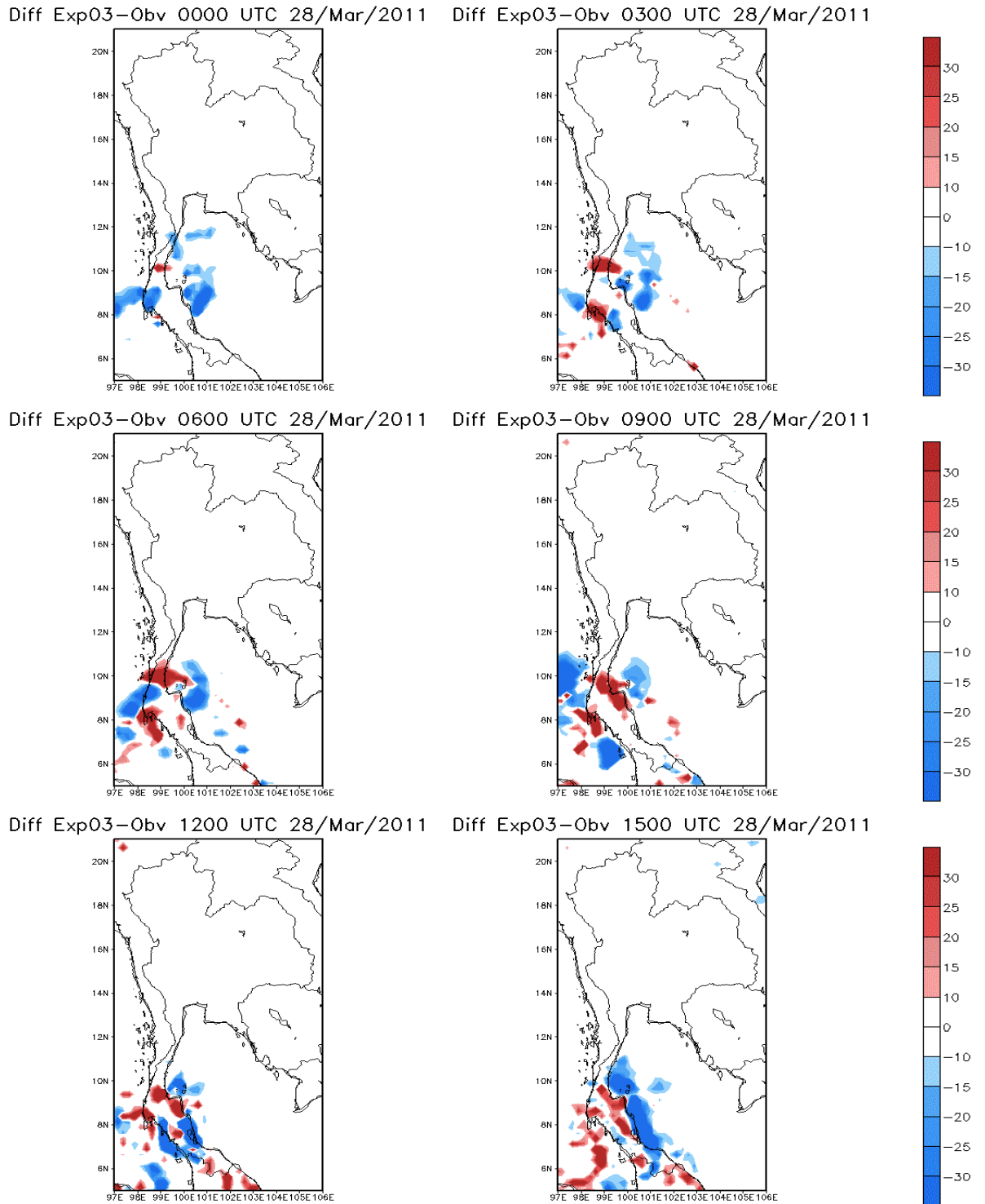


Figure 4.15 The different of rainfall distribution between observation data and EXP10 during 0000 UTC to 1500 UTC 28 March 2011

Exp10

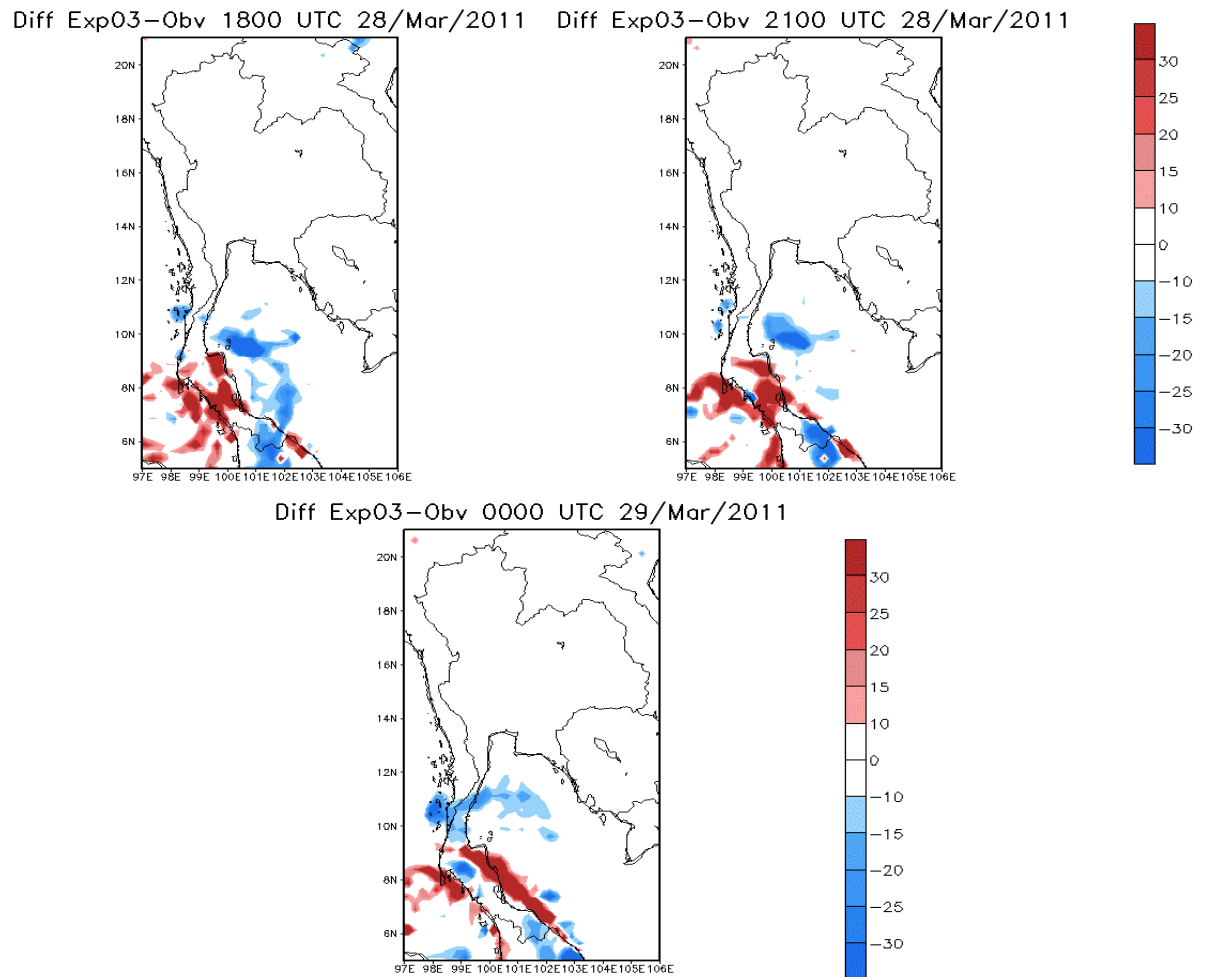


Figure 4.16 The different of rainfall distribution between observation data and EXP10 during 1800 UTC 28 March 2011 to 0000 UTC 29 March 2011

4.3 Comparison of Rainfall Pattern between Microphysics Schemes of WRF Model and TRMM Observation Data on 3 Hourly-Rainfalls During 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 (Rainy Season)

The results were calculated to present the rainfall amounts for each microphysics parameterizations. The rainfall value over the finest domains observation was given by the TRMM data. The fourteen microphysics parameterizations simulation were compared. In This study, to use statistical method was correlation, mean error, and mean absolute error. The statistical methods were calculated for analyzing to each microphysics parameterizations with TRMM data. The comparisons of the correlation

value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show correlation on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011. The correlation of all experiment at 0000 UTC, 0300 UTC, 0600 UTC, 1500 UTC, 1800 UTC, 2100 UTC 10 September 2011, 0000 UTC 11 September 2011 and some experiment at 0900 UTC, 1200 UTC 10 September 2011 are positive correlation. Because the result of correlation between two data are shows a positive value and the positive correlation means two data between the result of microphysics parameterizations and TRMM observation data are same direction but The correlation of some experiment at 0900 UTC, 1200 UTC 10 September 2011 are negative correlation. Because the result of correlation between two data are shows a negative value and the negative correlation means two data between the result of microphysics parameterizations and TRMM observation data are opposite direction, as shown in Table 4.13.

Table 4.13 The correlation on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	0.199	0.231	0.091	-0.038	-0.032	0.027	0.149	0.057	0.107
Exp02	0.248	0.241	0.143	-0.006	0.002	0.072	0.099	0.088	0.145
Exp03	0.321	0.227	0.150	-0.004	0.040	0.023	0.079	0.071	0.062
Exp04	0.287	0.238	0.129	-0.042	-0.024	0.011	0.045	0.143	0.112
Exp05	0.259	0.264	0.146	-0.040	-0.003	0.082	0.036	0.090	0.054
Exp06	0.292	0.229	0.156	-0.031	-0.028	0.076	0.035	0.174	0.069
Exp07	0.250	0.245	0.147	-0.051	0.021	0.037	0.121	0.145	0.095
Exp08	0.235	0.266	0.121	-0.043	-0.030	0.018	0.118	0.086	0.047
Exp09	0.273	0.269	0.109	-0.027	-0.026	0.052	0.053	0.082	0.149
Exp10	0.318	0.262	0.099	-0.036	-0.009	0.073	0.090	0.228	0.116
Exp11	0.257	0.261	0.119	-0.051	-0.050	0.043	0.106	0.178	0.097
Exp12	0.264	0.277	0.163	-0.036	-0.024	0.073	0.104	0.079	0.049
Exp13	0.267	0.281	0.166	-0.034	0.013	0.089	0.196	0.128	0.191
Exp14	0.273	0.269	0.131	-0.040	-0.009	0.102	0.182	0.134	0.163

The mean correlation between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

of all experiment has less than observation data. Since the result mean of mean error between two data are shows a negative value. So the data of microphysics parameterizations is less than TRMM observation data, as shown in Figure 4.17.

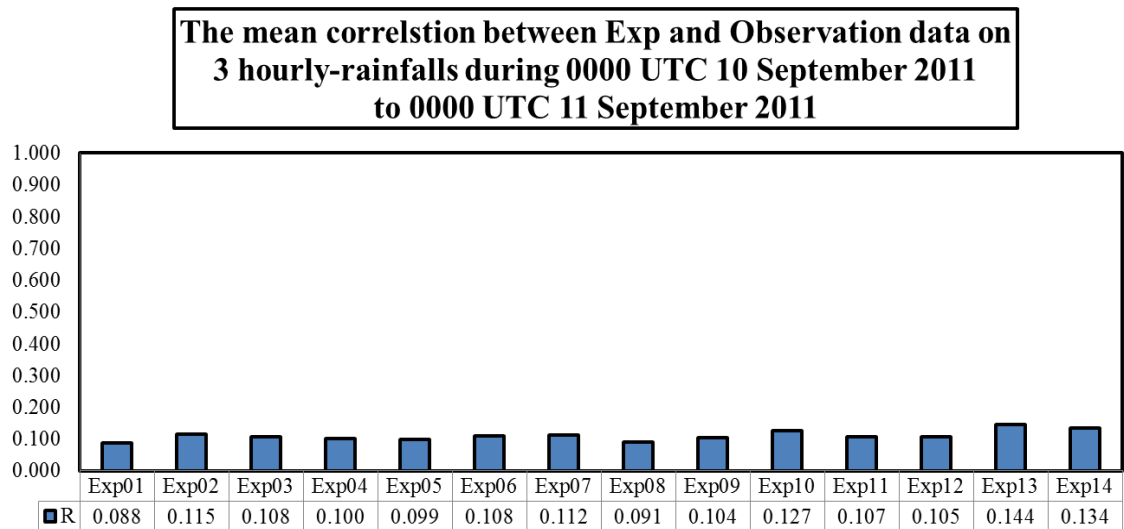


Figure 4.17 The mean correlation between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

The comparison of the mean error value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show mean error on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011. Mean error allow positive and negative value measure for two data between the result from model and observation data. If mean error = 0, there is no bias, if mean error > 0, simulation are too high, and if mean error < 0, simulation are too low. The mean error of some experiment at 0900 UTC 1200 UTC 1800 UTC 2100UTC 10 September 2011 and all experiments at 0000 UTC 11 September 2011 are too high. Because the result of mean error between two data are shows a positive value and the positive value means the mean error of microphysics parameterizations is more than the mean error of TRMM observation data, as shown in Table 4.14. But the mean error of all experiments at 0000 UTC, 0300 UTC, 0600 UTC, 1500 UTC 28 March 2011 and some experiment at 0900 UTC, 1200 UTC, 1800 UTC and 2100 UTC 28 March 2011 are too low. Because the result of mean error between two data are shows a negative value and the negative value is mean the mean error of

microphysics parameterizations is less than the mean error of TRMM observation data, as shown in Table 4.14.

Table 4.14 The mean error on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	-3.202	-1.220	-0.872	-0.446	-0.116	-1.416	-0.062	-0.482	0.325
Exp02	-2.971	-0.638	-0.488	0.283	0.498	-0.364	0.996	0.488	1.006
Exp03	-2.944	-0.909	-0.685	-0.387	-0.408	-1.306	0.058	-0.471	0.303
Exp04	-2.995	-0.920	-0.505	-0.028	0.162	-0.651	0.675	0.400	1.255
Exp05	-3.024	-1.221	-1.058	-0.738	-0.166	-0.894	0.350	-0.108	0.787
Exp06	-2.985	-0.833	-0.528	-0.095	0.044	-0.789	0.313	0.150	1.090
Exp07	-3.053	-0.992	-0.801	-0.141	-0.181	-1.152	0.558	0.571	1.405
Exp08	-3.109	-0.898	-0.612	-0.131	-0.391	-1.298	0.064	-0.218	0.510
Exp09	-2.987	-1.074	-0.940	-0.248	-0.313	-1.328	-0.271	-0.390	0.749
Exp10	-2.996	-1.280	-1.205	-0.782	-0.663	-1.665	-0.366	-0.626	0.258
Exp11	-3.102	-0.946	-0.647	-0.278	-0.083	-0.943	0.587	0.350	1.049
Exp12	-3.093	-0.760	-0.631	-0.176	0.051	-0.734	0.540	0.109	0.720
Exp13	-3.048	-0.421	-0.394	0.113	0.564	-0.054	1.296	0.998	1.310
Exp14	-3.049	-0.405	-0.372	0.124	0.511	-0.083	1.389	0.715	1.276

The mean of mean error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011 of Exp01, Exp02, Exp03, Exp04, Exp05, Exp06, Exp07, Exp08, Exp09, Exp10, Exp11, and Exp12 have mean error value less than observation data. Since the result mean of mean error between two data are shows a negative value. So the data of microphysics parameterizations is lower than TRMM observation data but Exp13 and Exp14 Exp12 have mean error value more than observation data. Since the result mean of mean error between two data are shows a positive value. So the data of microphysics parameterizations is higher than TRMM observation data, as shown in Figure 4.18.

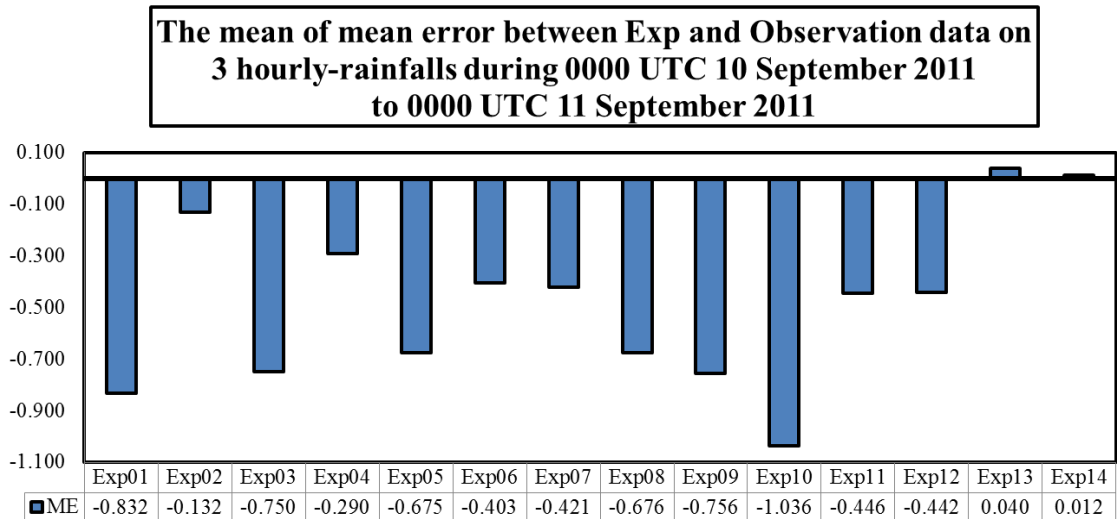


Figure 4.18 The mean of mean error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

The comparison of the mean absolute error value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show mean absolute error value of 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011. Mean absolute error is a scalar accuracy measure for two data between the result from model and observation data. If mean absolute error value is nearly zero, the result from model is better, as shown in Table 4.15.

Table 4.15 The mean absolute error on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	3.279	3.035	4.092	4.893	5.025	6.347	5.706	6.690	5.794
Exp02	3.266	3.395	4.133	5.187	5.272	6.458	6.334	7.107	5.809
Exp03	3.230	3.218	3.983	4.603	4.310	6.064	5.790	6.322	5.664
Exp04	3.239	3.219	4.146	5.106	4.999	6.529	6.413	6.506	6.111
Exp05	3.249	2.911	3.698	4.510	4.684	6.061	6.022	6.366	5.834
Exp06	3.239	3.246	4.107	4.967	4.887	6.178	6.091	6.366	6.123
Exp07	3.257	3.136	3.939	5.029	4.693	5.950	5.886	6.838	6.374
Exp08	3.263	3.131	4.087	5.019	4.628	6.135	5.530	6.330	5.852
Exp09	3.249	3.011	3.908	4.872	4.650	5.955	5.622	6.286	5.762

Table 4.15 The mean absolute error on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 (Cont.)

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp10	3.230	2.937	3.656	4.491	4.408	5.672	5.487	5.658	5.113
Exp11	3.257	3.129	4.038	4.910	4.852	6.205	5.899	6.658	6.048
Exp12	3.255	3.221	3.969	4.951	4.836	6.165	5.867	6.630	5.798
Exp13	3.251	3.420	4.109	5.145	5.116	6.492	6.120	7.042	5.588
Exp14	3.249	3.457	4.095	5.214	5.145	6.343	6.041	6.677	5.690

The mean of mean absolute error value between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 is show in Figure 4.20. The simulation is given by the EXP10 (SBU-YLin scheme) smallest error of mean absolute error value than another experiments and the mean absolute error value of SBU-YLin scheme is 4.157, as show in Figure 4.19.

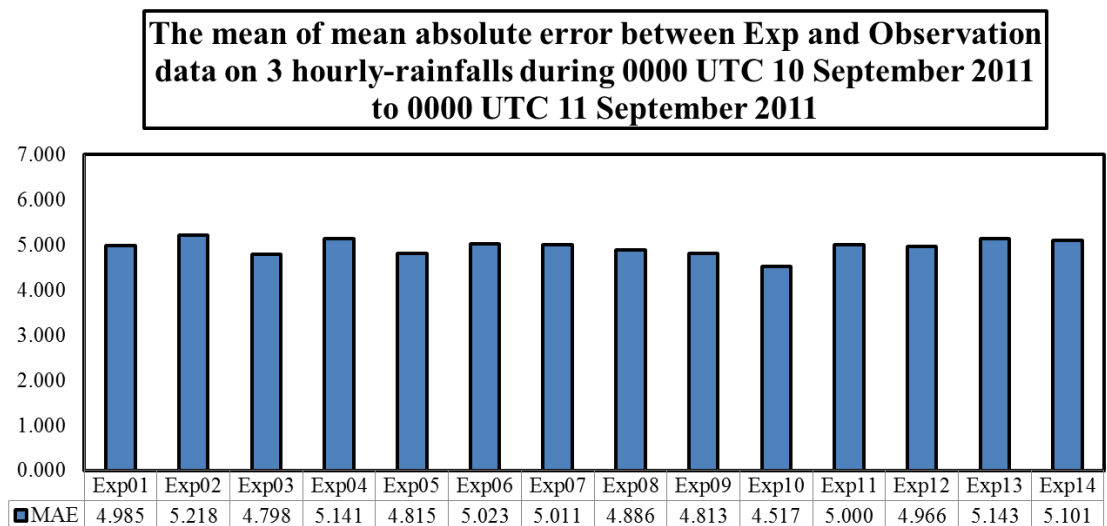


Figure 4.19 The mean of mean absolute error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 28 March 2011 to 0000 UTC 29 March 2011

The simulation that is given by the EXP10 (SBU-YLin scheme) gives the smallest error of mean absolute error is 4.157, Exp03 (WSM3 scheme) gives the error of mean

absolute error is 4.798, and Exp09 (Morrison scheme) gives the error of mean absolute error is 4.813 on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 respectively, as shown in previous Figure 4.19. The rainfall distribution pattern on 3 hourly-rainfalls during 0000 UTC 10 September 2011 to 0000 UTC 11 September 2011 is also quite similar to the rainfall distribution pattern given by TRMM data is show in Figure 4.20, 4.21, and 4.22, respectively. The rainfall distribution patterns from the simulation of Exp03 (WSM3 scheme), and Exp09 (Morrison scheme) are show in Appendix F.

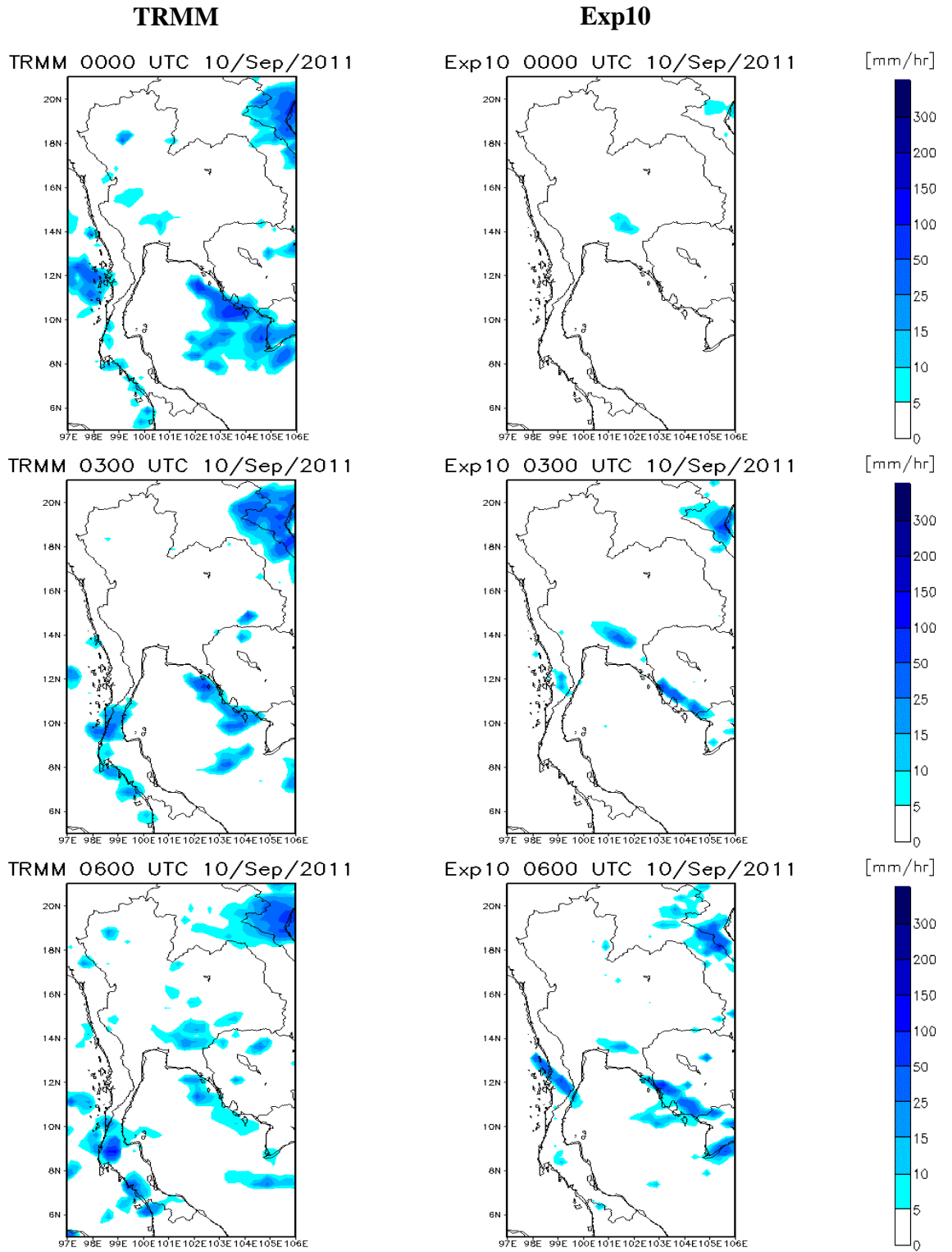


Figure 4.20 The comparison of rainfall distribution between observation data and EXP10 during 0000 UTC to 0600 UTC 10 September 2011

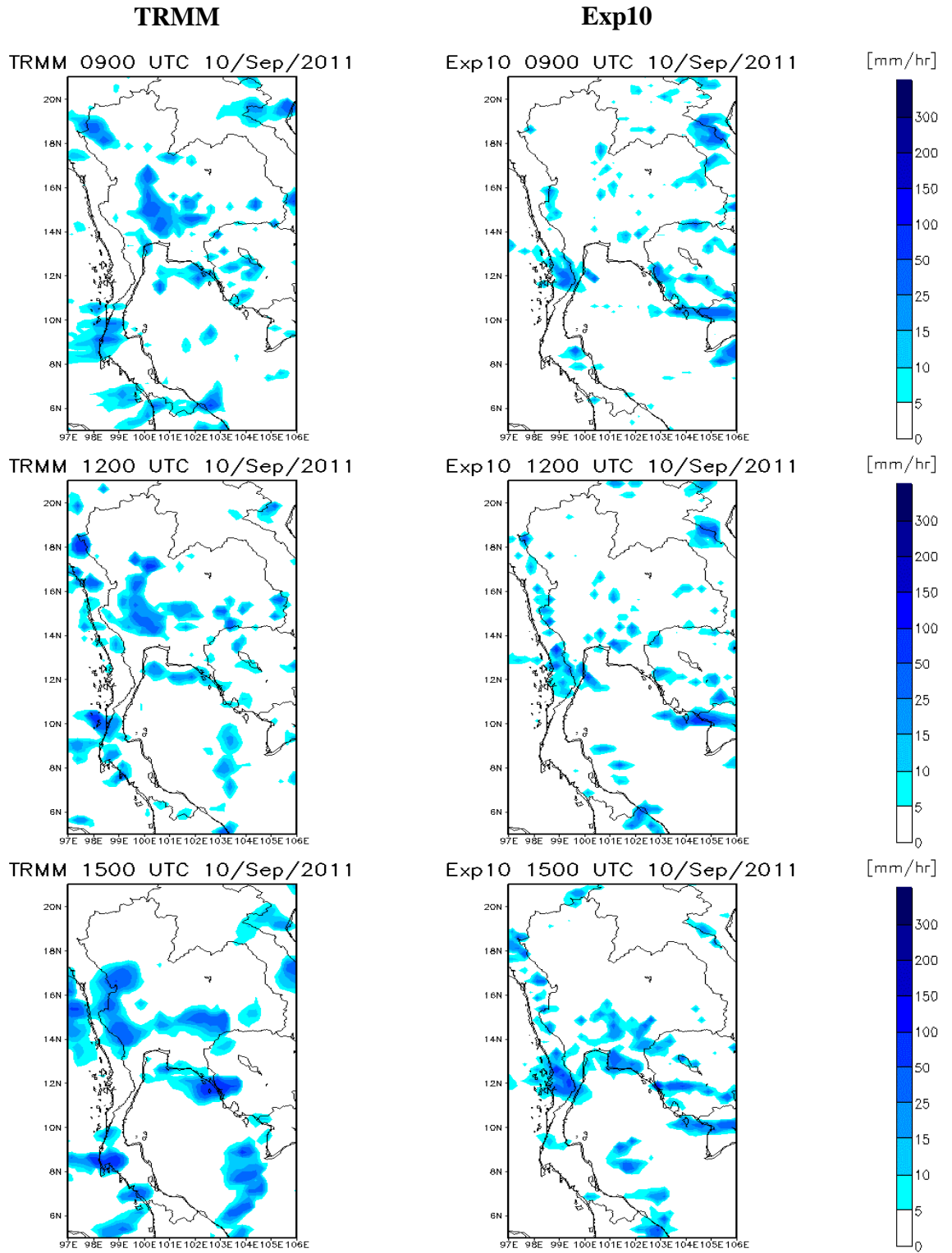


Figure 4.21 The comparison of rainfall distribution between observation data and EXP10 during 0900 UTC to 1500 UTC 10 September 2011

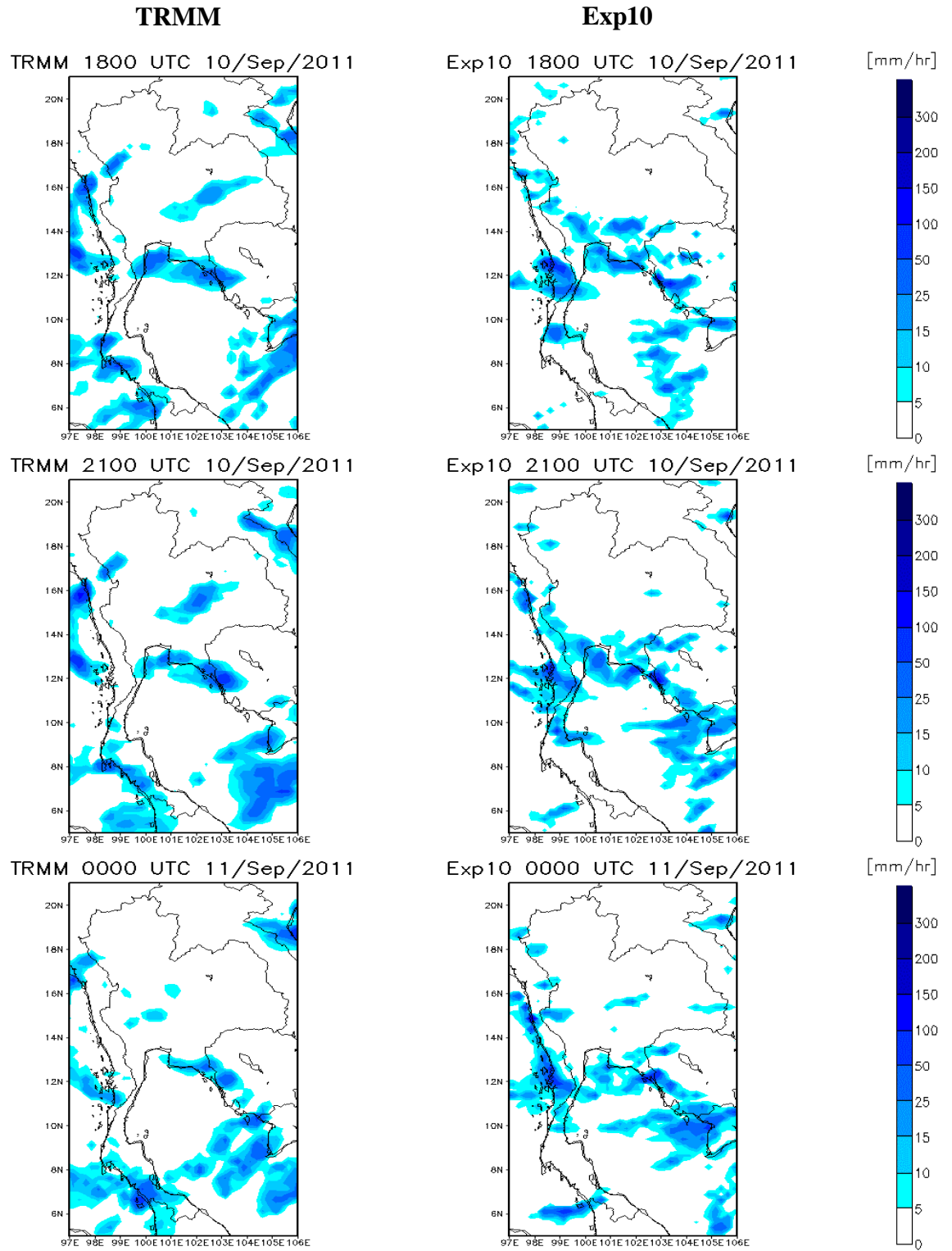


Figure 4.22 The comparison of rainfall distribution between observation data and EXP10 during 1800 UTC 10 September 2011 to 0000 UTC 11 September 2011

The different of rainfall distribution pattern between TRMM observation data and EXP10 at 0000 UTC 10 September 2011 is show rainfall distribution under estimation (blue color) over nearly northern part of Vietnam, over Andaman sea nearly southern part of Myanmar, over the Gulf of Thailand sea nearly southern part of Cambodia and Vietnam, at 0300 UTC 10 September 2011 is show rainfall distribution under estimation (blue color) over nearly northern part of Vietnam, over southern part of Thailand, over the Gulf of Thailand sea nearly southern part of Cambodia and Vietnam but rainfall distribution over estimation (red color) over east coast of Thailand and over southern part of Cambodia, at 0600 UTC 10 September 2011 is show rainfall distribution under estimation (blue color) over nearly northern part of Vietnam, over southern part of Thailand, over the Gulf of Thailand sea nearly southern part of Cambodia but rainfall distribution over estimation (red color) over southern part of Cambodia, Myanmar and Vietnam, and over nearly northern part of Laos, at 0900 UTC, 1200 UTC, 1500 UTC 10 September 2011 are show rainfall distribution under estimation (blue color) over southern part of Thailand, over the Gulf of Thailand, over nearly southern part of Cambodia, over central part of Thailand but rainfall distribution over estimation (red color) over southern part of Cambodia, Myanmar and Vietnam, and over nearly northern part of Laos, at 1800 UTC, 2100 UTC 10 September 2011 and 0000 UTC September 2011 are show rainfall distribution under estimation (blue color) over of southern part of Thailand, over the Gulf of Thailand nearly southern part of Vietnam, over nearly southern part of Cambodia and east coast of Thailand, over nearly northeastern part of Thailand but rainfall distribution over estimation (red color) over southern part of Cambodia, Myanmar and Vietnam, and over nearly central part of Thailand, as show in Figure 4.23 and Figure 4.24. The different of rainfall distribution pattern between observation of Exp03 (WSM3 scheme), and Exp09 (Morrison scheme) on 10th September 2011 are show in Appendix G.

Exp10

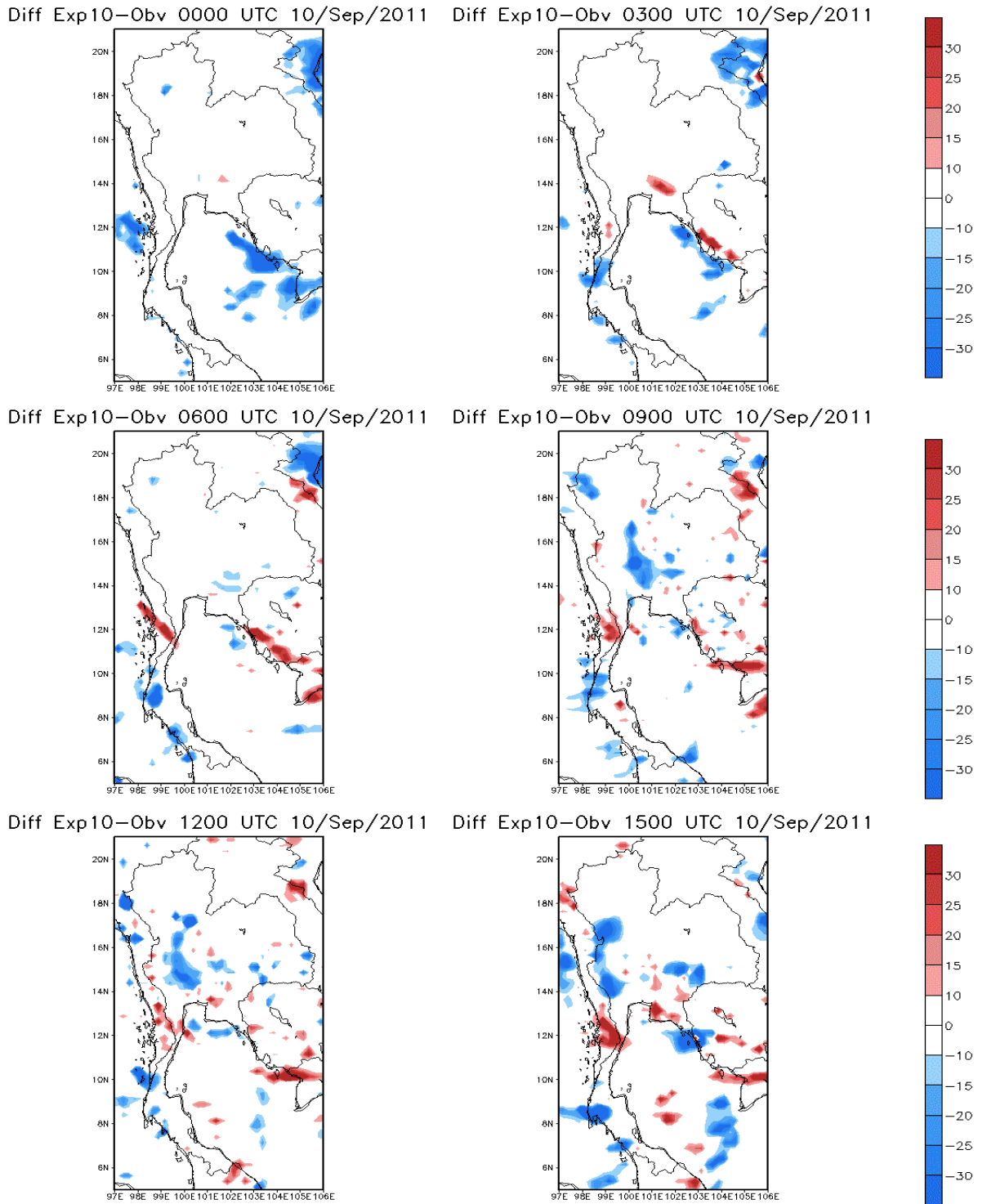


Figure 4.23 The different of rainfall distribution between observation data and EXP10 during 0000 UTC to 1500 UTC 28 March 2011

Exp10

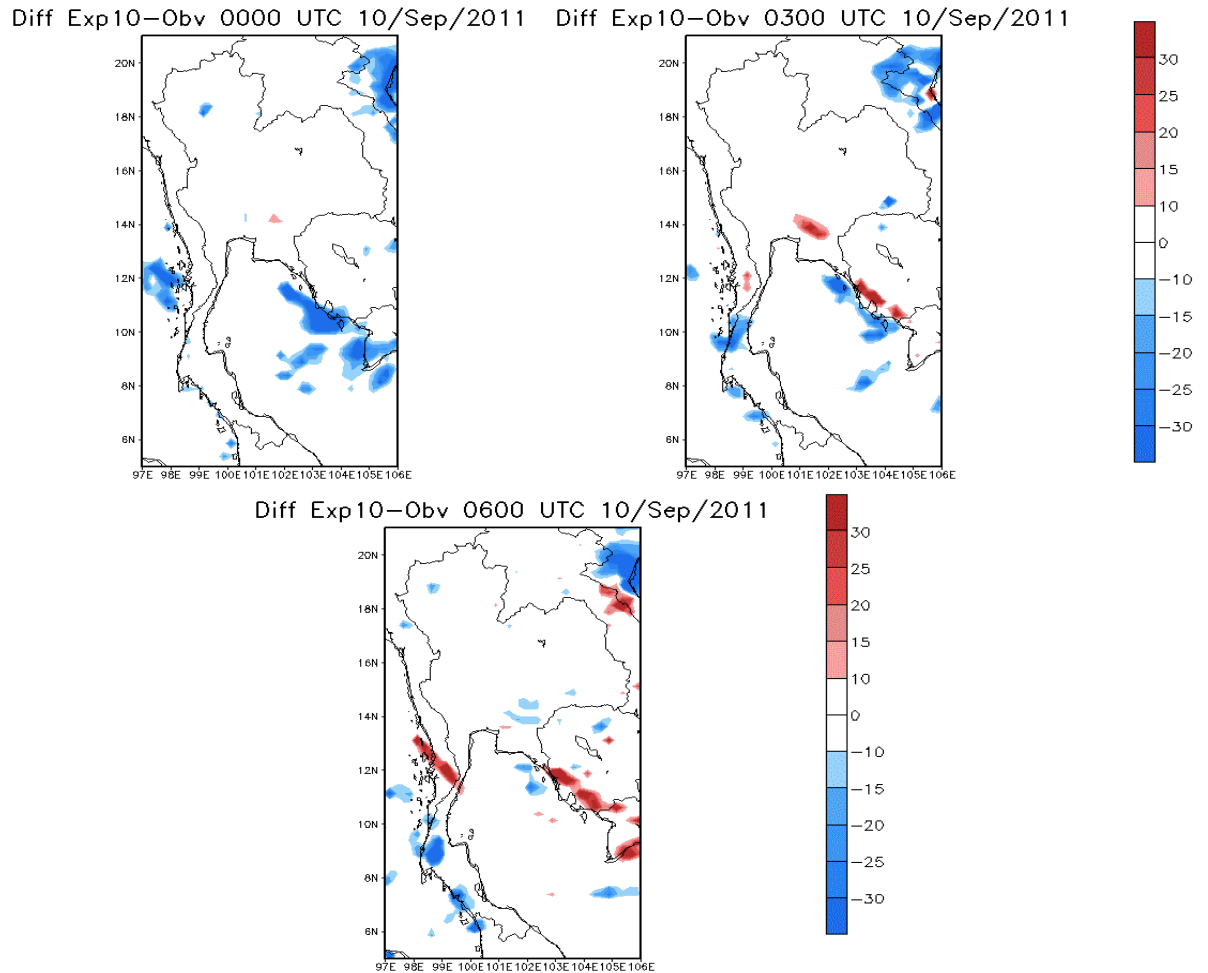


Figure 4.24 The different of spatial pattern between rainfall distribution observation data and EXP10 during 1800 UTC 28 March 2011 to 0000 UTC 29 March 2011

4.4 Comparison of Rainfall Pattern between Microphysics Schemes of WRF Model and TRMM Observation Data During 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011(Winter Season)

The results were calculated to present the rainfall amounts for each microphysics parameterizations. The rainfall value over the finest domains observation was given by the TRMM data. The fourteen microphysics parameterizations simulation were compared. In This study, to use statistical method was correlation, mean error, and mean absolute error. The statistical methods were calculated for analyzing to each

microphysics parameterizations with TRMM data. The comparisons of the correlation value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show correlation on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011. The correlation of 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 is positive correlation. Because the result of correlation between two data are shows a positive value and the positive correlation means two data between the result of microphysics parameterizations and TRMM observation data are same direction, as shown in Table 4.16.

Table 4.16 The correlation on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	0.105	0.270	0.579	0.189	0.122	0.069	0.078	0.081	0.052
Exp02	0.249	0.344	0.637	0.456	0.186	0.248	0.192	0.087	0.098
Exp03	0.227	0.321	0.633	0.272	0.099	0.115	0.129	0.052	0.085
Exp04	0.189	0.250	0.625	0.311	0.127	0.164	0.151	0.100	0.127
Exp05	0.287	0.300	0.560	0.205	0.232	0.207	0.079	0.042	0.052
Exp06	0.204	0.280	0.614	0.390	0.140	0.220	0.203	0.100	0.072
Exp07	0.246	0.244	0.577	0.291	0.077	0.212	0.160	0.083	0.043
Exp08	0.123	0.263	0.639	0.432	0.129	0.227	0.131	0.192	0.073
Exp09	0.216	0.229	0.653	0.266	0.076	0.169	0.146	0.173	0.064
Exp10	0.194	0.326	0.583	0.245	0.075	0.223	0.109	0.205	0.037
Exp11	0.137	0.298	0.632	0.333	0.198	0.167	0.105	0.042	0.075
Exp12	0.147	0.297	0.559	0.481	0.194	0.217	0.247	0.091	0.089
Exp13	0.247	0.373	0.572	0.554	0.252	0.309	0.191	0.101	0.309
Exp14	0.229	0.397	0.546	0.498	0.228	0.309	0.211	0.119	0.254

The mean correlation between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 has positive correlation. Since the all result of mean correlation between two data are shows a positive value. So the data between result of microphysics parameterizations and TRMM observation data are same direction, as shown in Figure 4.25.

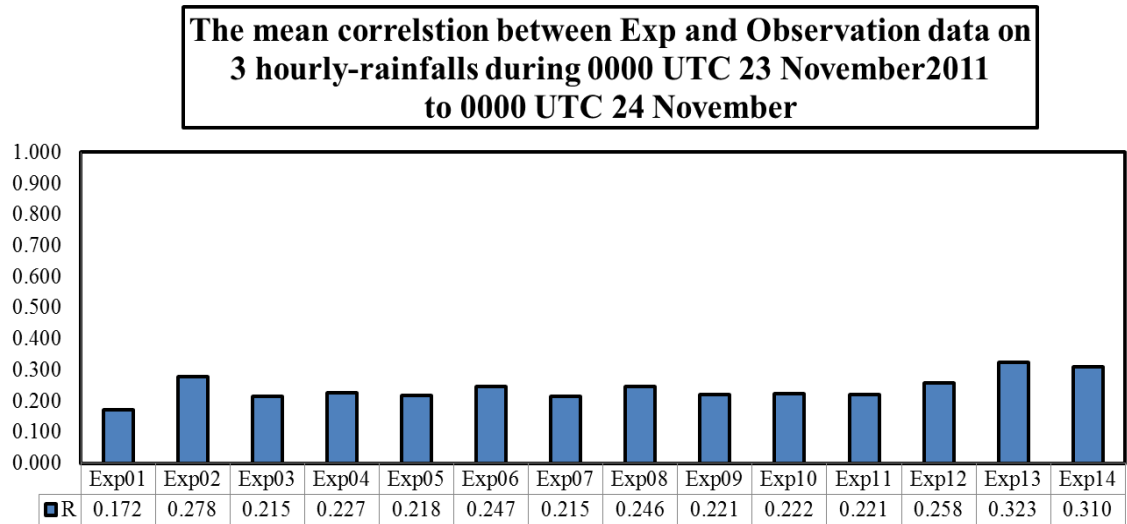


Figure 4.25 The mean correlation between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

The comparison of the mean error value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show mean error on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011. Mean error allow positive and negative value measure for two data between the result from model and observation data. If mean error = 0, there is no bias, if mean error > 0, simulation are too high, and if mean error < 0, simulation are too low. The mean error of some experiments at 0000 UTC 24 November 2011 is too high. Because the result of mean error between two data are shows a positive value and the positive value means the mean error of microphysics parameterizations is more than the mean error of TRMM observation data, as shown in Table 4.17. But the mean error of all experiment during 0000 UTC to 2100 23 November 2011 and some experiment at 0000 UTC 24 November 2011 is too low. Because the result of mean error between two data are shows a negative value and the negative value is mean the mean error of microphysics parameterizations is less than the mean error of TRMM observation data, as shown in Table 4.17.

Table 4.17 The mean error on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	-1.209	-0.758	-0.852	-0.584	-1.161	-0.590	-1.128	-0.545	-0.117
Exp02	-1.084	-0.586	-0.532	-0.328	-0.905	-0.489	-1.035	-0.403	0.092
Exp03	-1.093	-0.621	-0.707	-0.635	-1.212	-0.560	-1.200	-0.500	0.082
Exp04	-1.102	-0.640	-0.647	-0.518	-1.094	-0.519	-1.140	-0.470	-0.022
Exp05	-1.134	-0.698	-0.768	-0.658	-1.235	-0.710	-1.104	-0.583	-0.048
Exp06	-1.099	-0.621	-0.632	-0.357	-0.934	-0.491	-1.171	-0.465	-0.068
Exp07	-1.099	-0.681	-0.785	-0.762	-1.338	-0.640	-1.110	-0.486	0.003
Exp08	-1.156	-0.644	-0.675	-0.534	-1.111	-0.607	-1.157	-0.460	-0.219
Exp09	-1.091	-0.682	-0.783	-0.767	-1.344	-0.679	-1.263	-0.561	-0.142
Exp10	-1.103	-0.699	-0.828	-0.841	-1.418	-0.722	-1.173	-0.466	-0.050
Exp11	-1.158	-0.605	-0.725	-0.520	-1.097	-0.578	-1.137	-0.411	0.094
Exp12	-1.153	-0.579	-0.693	-0.375	-0.952	-0.502	-1.110	-0.505	0.118
Exp13	-1.059	-0.409	-0.415	-0.056	-0.632	-0.241	-0.732	0.018	0.531
Exp14	-1.058	-0.439	-0.482	-0.146	-0.723	-0.207	-0.861	0.021	0.411

The mean of mean error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 of all experiment has mean error value less than observation data. Since the result mean of mean error between two data are shows a negative value. So the data of microphysics parameterizations is lower than TRMM observation data, as shown in Figure 4.26.

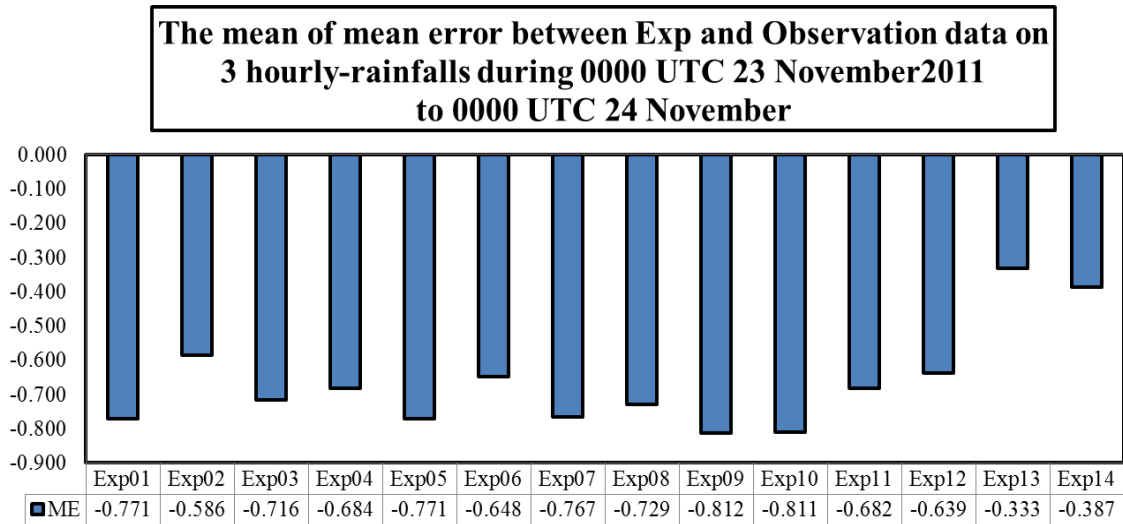


Figure 4.26 The mean of mean error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

The comparison of the mean absolute error value over the study domain among fourteen experiments (fourteen microphysics parameterization simulations) and TRMM observation data show mean absolute error value of 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011. Mean absolute error is a scalar accuracy measure for two data between the result from model and observation data. If mean absolute error value is nearly zero, the result from model is better, as shown in Table 4.18.

Table 4.18 The mean absolute error on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp01	1.284	0.940	1.066	1.878	2.450	1.876	2.158	1.250	0.928
Exp02	1.262	1.004	1.050	1.788	2.461	1.784	2.004	1.399	1.065
Exp03	1.271	1.007	1.011	1.764	2.369	1.785	2.028	1.367	1.069
Exp04	1.283	1.028	1.035	1.744	2.425	1.851	2.035	1.327	0.951
Exp05	1.245	0.972	1.073	1.678	2.174	1.633	2.121	1.302	0.985
Exp06	1.280	1.027	1.058	1.779	2.542	1.798	1.960	1.361	0.963
Exp07	1.265	1.005	1.099	1.587	2.339	1.638	2.038	1.353	1.033
Exp08	1.294	0.993	1.035	1.645	2.410	1.706	2.023	1.253	0.842
Exp09	1.282	1.004	1.043	1.656	2.332	1.695	1.951	1.177	0.897

Table 4.18 The mean absolute error on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 (Cont.)

Exp	UTC(Time)								
	0000	0300	0600	0900	1200	1500	1800	2100	0000
Exp10	1.290	0.954	1.085	1.604	2.259	1.577	2.035	1.210	1.012
Exp11	1.277	1.023	1.035	1.735	2.339	1.794	2.063	1.461	1.101
Exp12	1.277	1.036	1.077	1.703	2.459	1.822	1.919	1.335	1.088
Exp13	1.265	1.063	1.200	1.797	2.586	1.842	2.212	1.694	1.241
Exp14	1.274	1.024	1.186	1.762	2.536	1.839	2.116	1.690	1.187

The mean of mean absolute error value between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 is show in Figure 4.27. The simulation t is given by the EXP10 (SBU-YLin scheme) smallest error of mean absolute error value than another experiments and the mean absolute error value of SBU-YLin scheme is 1.447, as show in Figure 4.27.

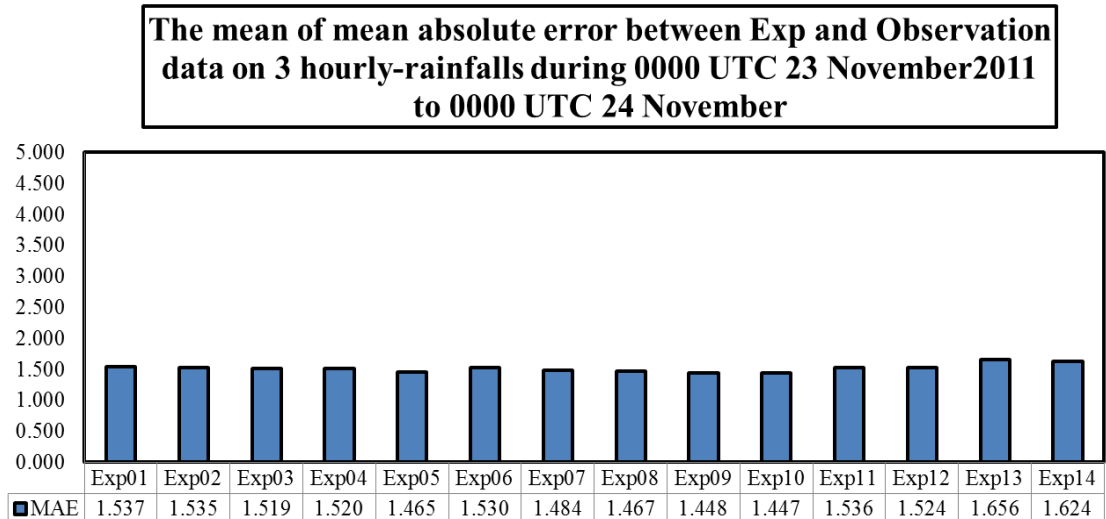


Figure 4.27 The mean of mean absolute error between fourteen experiments and TRMM observation data on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011

The simulation that is given by the EXP10 (SBU-YLin scheme) gives the smallest error of mean absolute error is 1.447, Exp09 (Morrison scheme) gives the error of mean absolute error is 1.448, and Exp05 (Eta scheme) gives the smallest error of mean

absolute error is 1.465 on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 respectively, as shown in previous Figure 4.27. The rainfall distribution pattern on 3 hourly-rainfalls during 0000 UTC 23 November 2011 to 0000 UTC 24 November 2011 is also quite similar to the rainfall distribution pattern given by TRMM data is show in Figure 4.28, 4.29, and 4.30, respectively. The rainfall distribution patterns from the simulation of Exp09 (Morrison scheme), and Exp05 (Eta scheme) are show in Appendix H.

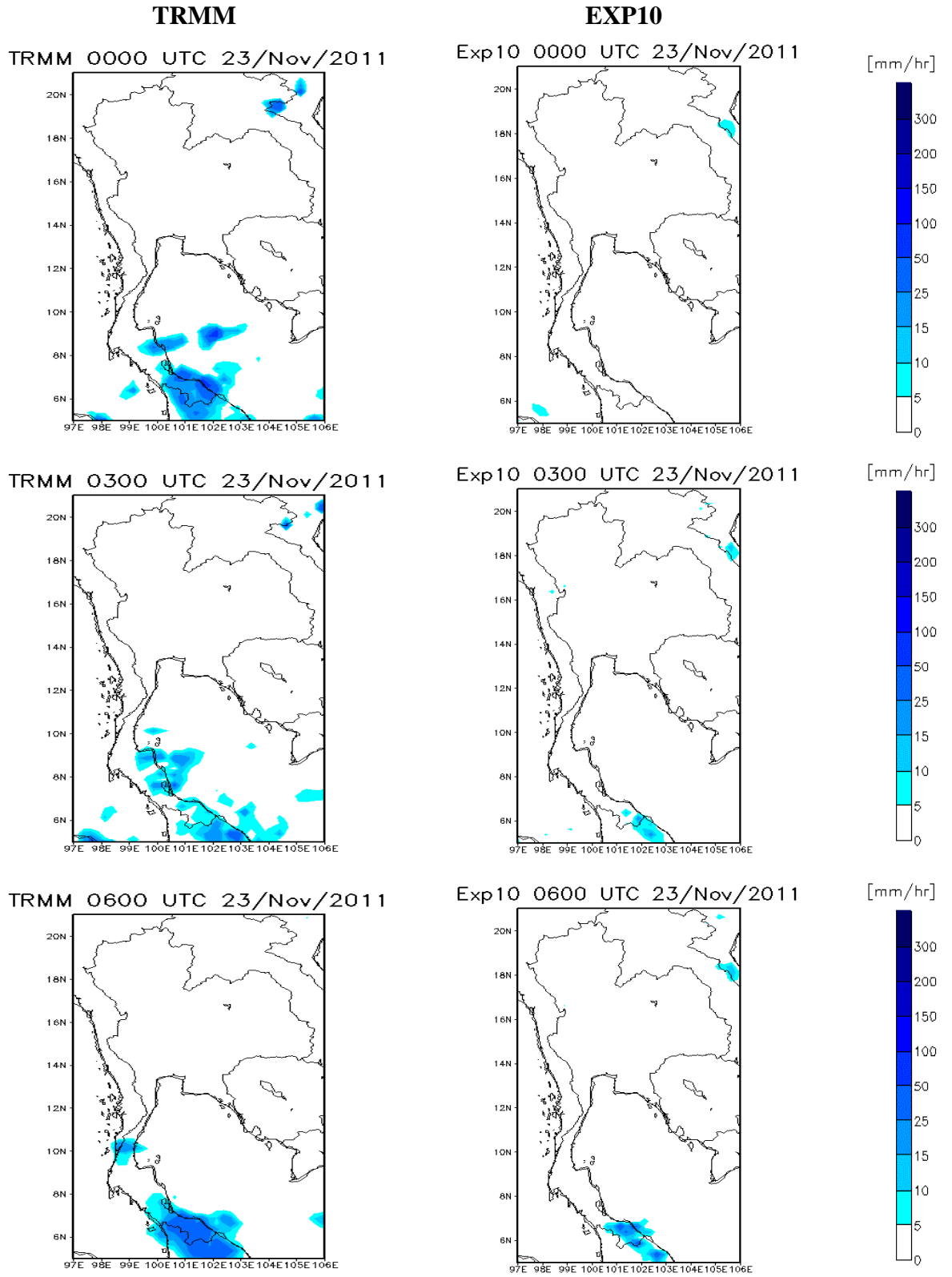


Figure 4.28 The comparison of rainfall distribution between observation data and EXP10 during 0000 UTC to 0600 UTC 28 March 2011

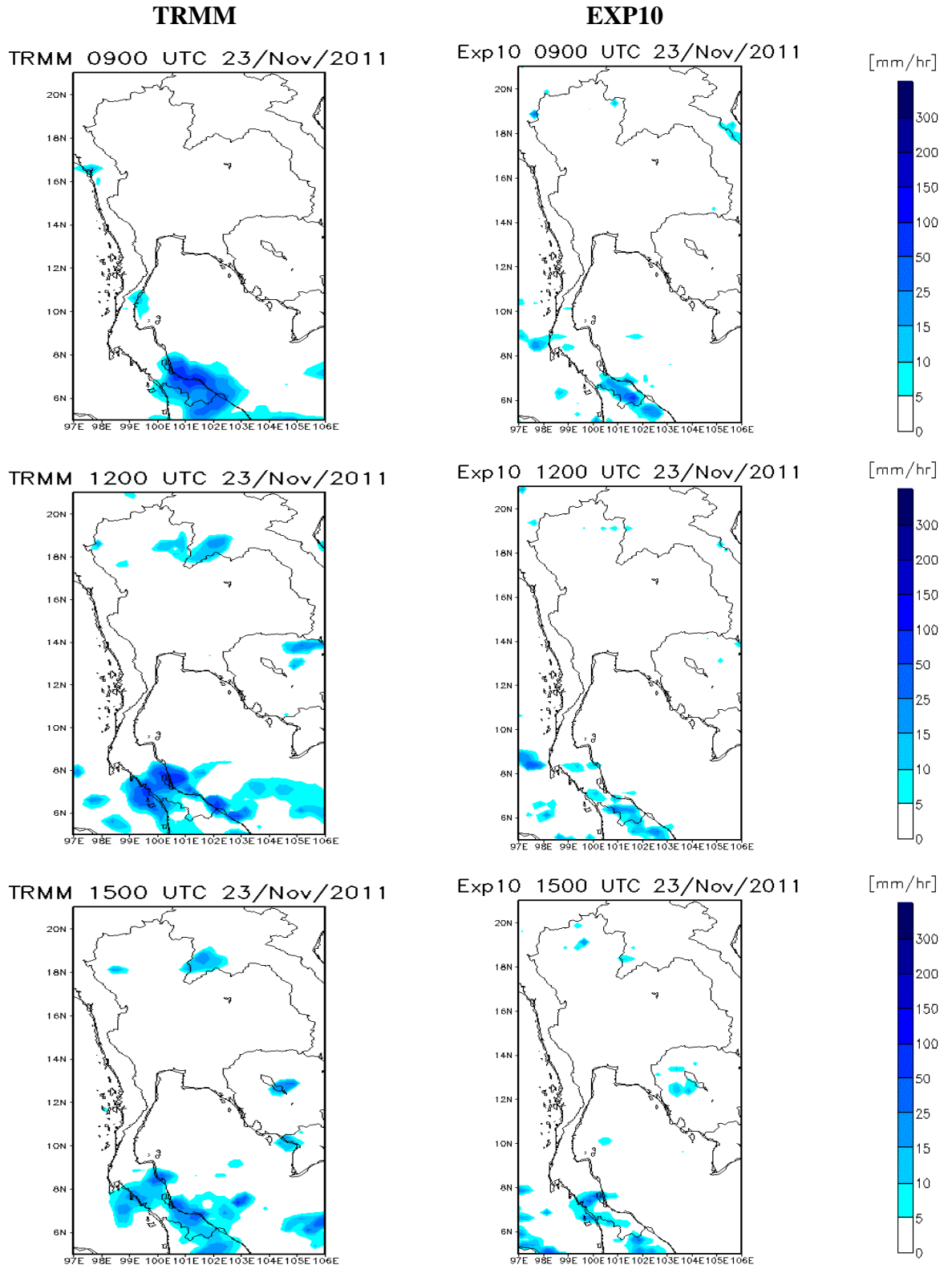


Figure 4.29 The comparison of rainfall distribution between observation data and EXP10 during 0900 UTC to 1500 UTC 28 March 2011

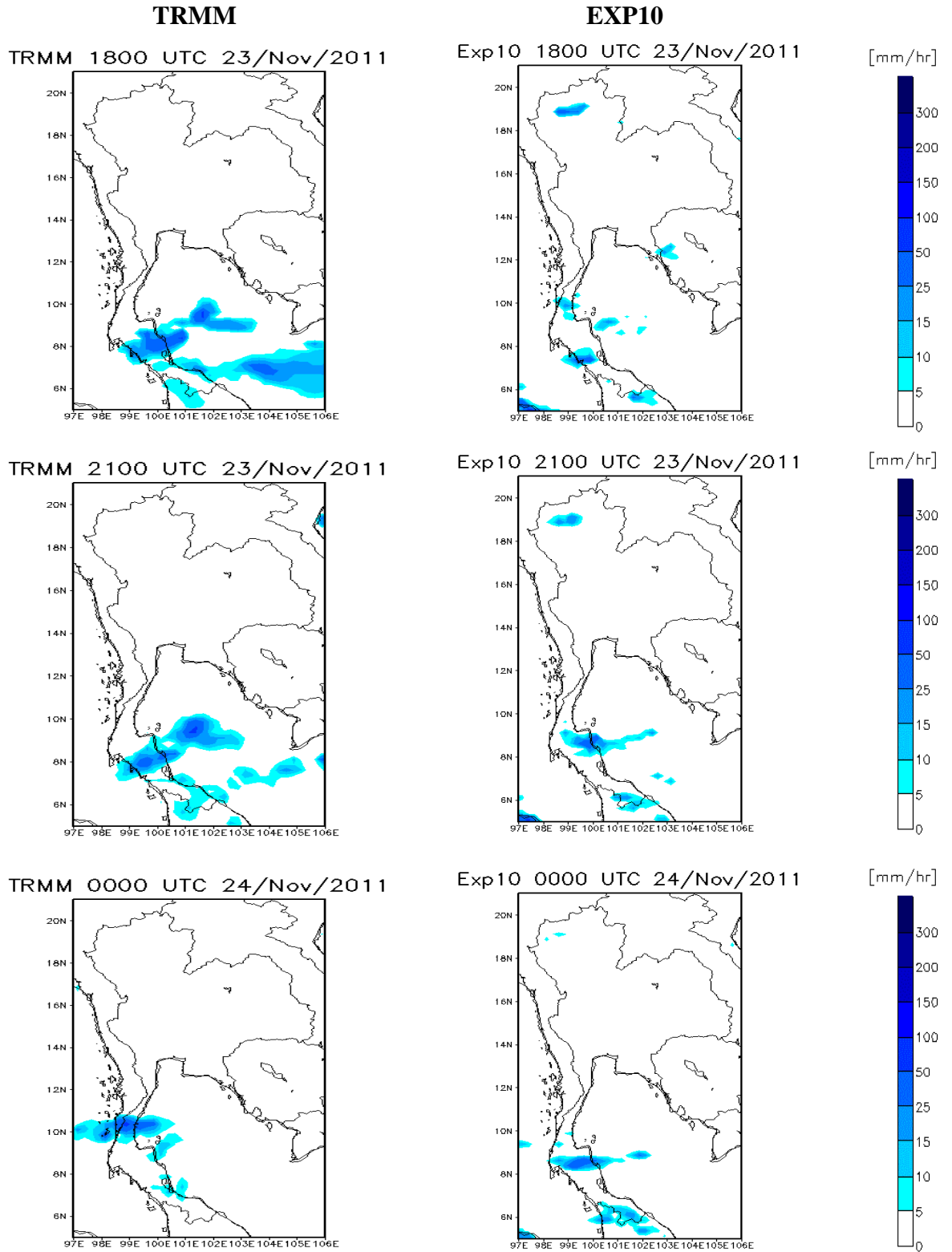
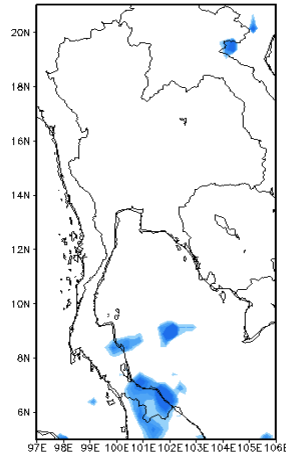


Figure 4.30 The comparison of rainfall distribution between observation data and EXP10 during 1800 UTC 28 March 2011 to 0000 UTC 29 March 2011

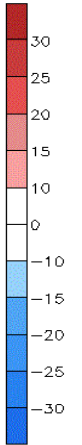
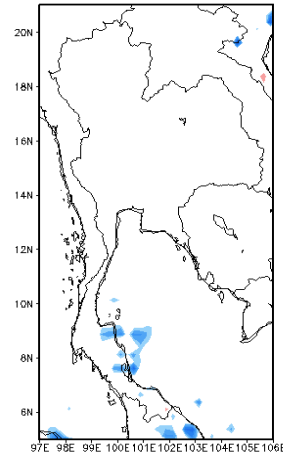
The different of rainfall distribution pattern between TRMM observation data and EXP10 at 0000 UTC, 0300 UTC, 0600 UTC, 0900 UTC 23 November 2011 are show rainfall distribution under estimation (blue color) over southern part of Thailand and northern part of Malaysia, at 1200 UTC, 1500 UTC 23 November 2011 are show rainfall distribution under estimation (blue color) over southern part of Thailand but rainfall distribution over estimation (red color) over southern part of Thailand and northern part of Thailand, at 1800 UTC, 23 November 2011 is show rainfall distribution under estimation (blue color) over the Gulf of Thailand nearly southern part of Cambodia and Vietnam, at 2100 UTC 23 November 2011 and 0000 UTC 24 November 2011 are show rainfall distribution under estimation (blue color) over southern part of Thailand but rainfall distribution over estimation (red color) over southern part of Thailand and northern part of Malaysia, as show in Figure 4.31 and Figure 4.32. The different of rainfall distribution pattern between observation of Exp09 (Morrison scheme), and Exp05 (Eta scheme) on 23th November 2011 are show in Appendix I.

Exp10

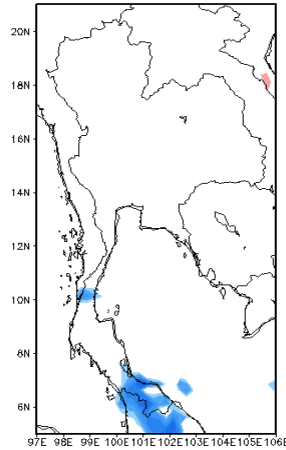
Diff Exp10–Obv 0000 UTC 23/Nov/2011



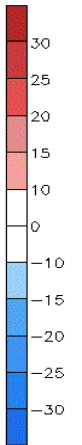
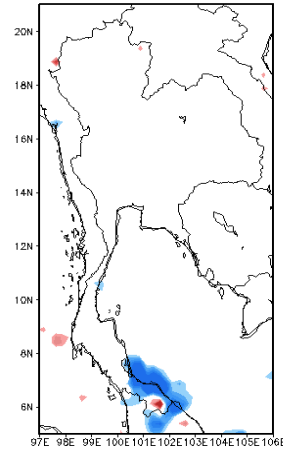
Diff Exp10–Obv 0300 UTC 23/Nov/2011



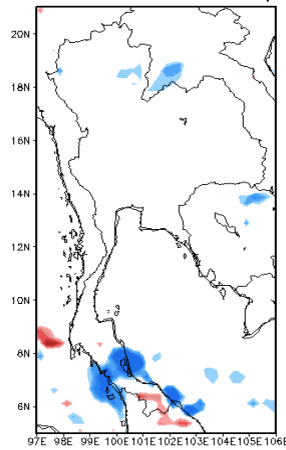
Diff Exp10–Obv 0600 UTC 23/Nov/2011



Diff Exp10–Obv 0900 UTC 23/Nov/2011



Diff Exp10–Obv 1200 UTC 23/Nov/2011



Diff Exp10–Obv 1500 UTC 23/Nov/2011

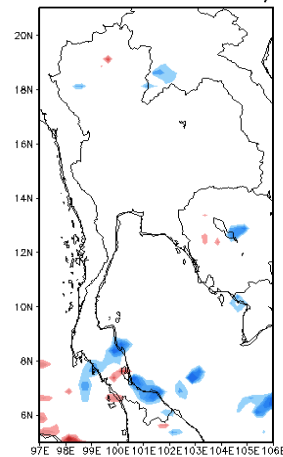


Figure 4.31 The different of rainfall distribution between observation data and EXP10 during 0000 UTC to 1500 UTC 23 November 2011

Exp10

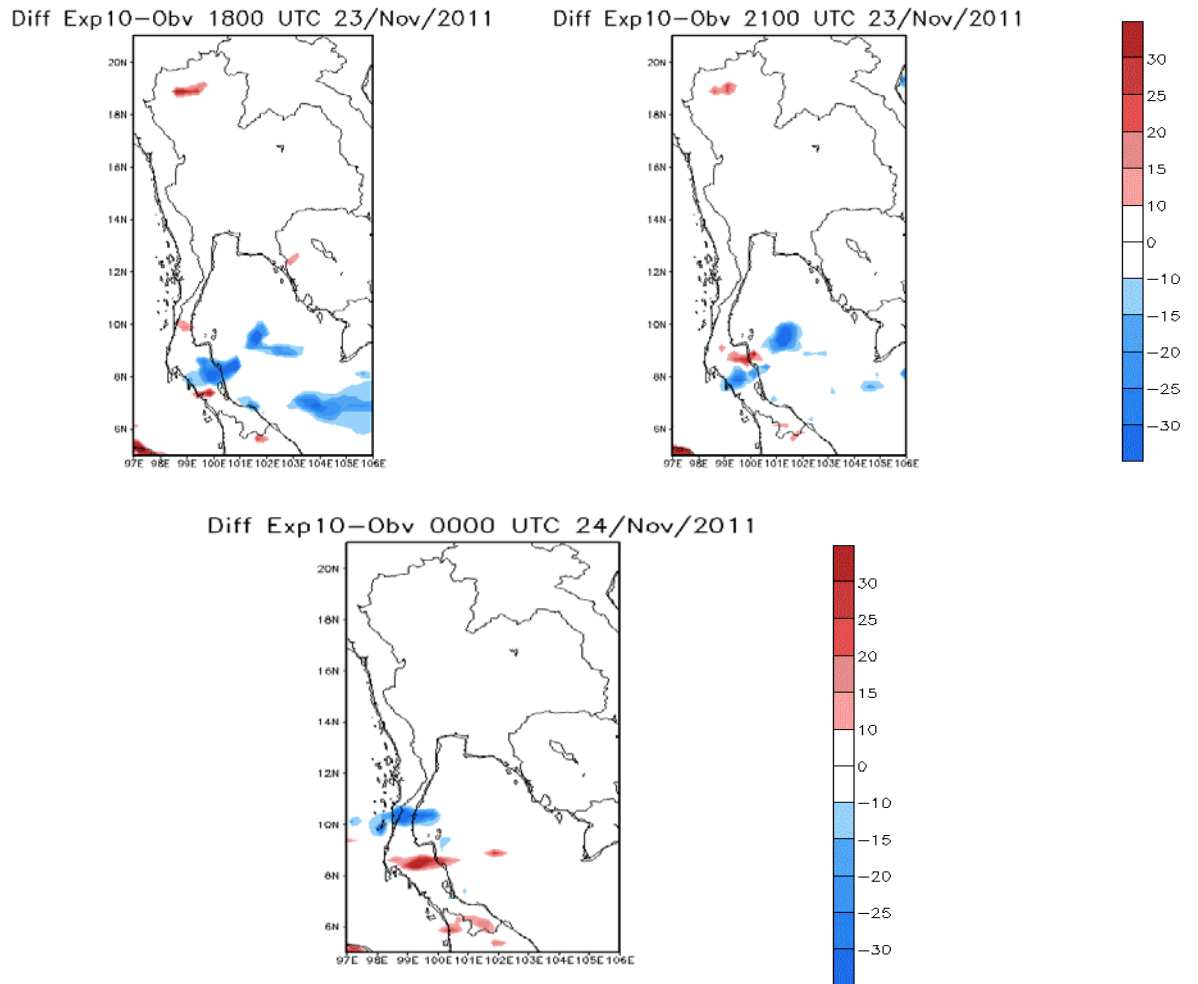


Figure 4.32 The different of rainfall distribution between observation data and EXP10 during 1800 UTC 23 November 2011 to 0000 UTC 24 November 2011