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# Leveraging machine learning for quantitative precipitation estimation from Fengyun-4 geostationary observations and ground meteorological measurements

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**Figures and Tables**

**Table S1: Classification of rainfall levels in different periods (Unit: mm)**

| Level | Rainfall in different periods | |
|---|---|---|
| | Rainfall in 1 hours | Rainfall in 24 hours |
| light rainfall | < 0.1 | < 0.1 |
| Light rain | 0.1 ~ 1.5 | 0.1 ~ 9.9 |
| Moderate rain | 1.6 ~ 6.9 | 10.0 ~ 24.9 |
| Heavy rain | 7.0 ~ 14.9 | 25.0 ~ 49.9 |
| Rainstorm | 15.0 ~ 39.9 | 50.0 ~ 99.9 |
| Heavy rainstorm | 40.0 ~ 49.9 | 100.0 ~ 249.9 |
| Extraordinary rainstorm | ⩾50.0 | ⩾250.0 |

**Table S2: Wavelengths of the 14 channels of the Fengyun-4 satellite and their application**

| Channel | NO. | Band (μm) | Application |
|---|---|---|---|
| Visible&Near-Infrared | 1 | 0.47 | Cloud, Aerosol |
| | 2 | 0.65 | Cloud, Snow |
| | 3 | 0.825 | Cloud, Aerosol, Vegetation |
| | 4 | 1.375 | Cirrus |
| | 5 | 1.61 | Cloud, Snow |
| | 6 | 2.25 | Cirrus, Aerosol |
| Shortwave Infrared | 7 | 3.75H | Fire |
| | 8 | 3.75L | Clouds, Fog |
| Water Vapor | 9 | 6.25 | WV |
| | 10 | 7.1 | WV |
| Longwave Infrared | 11 | 8.5 | Sand dust |
| | 12 | 10.7 | Cloud |
| | 13 | 12.0 | Cloud |
| | 14 | 13.5 | Cloud |

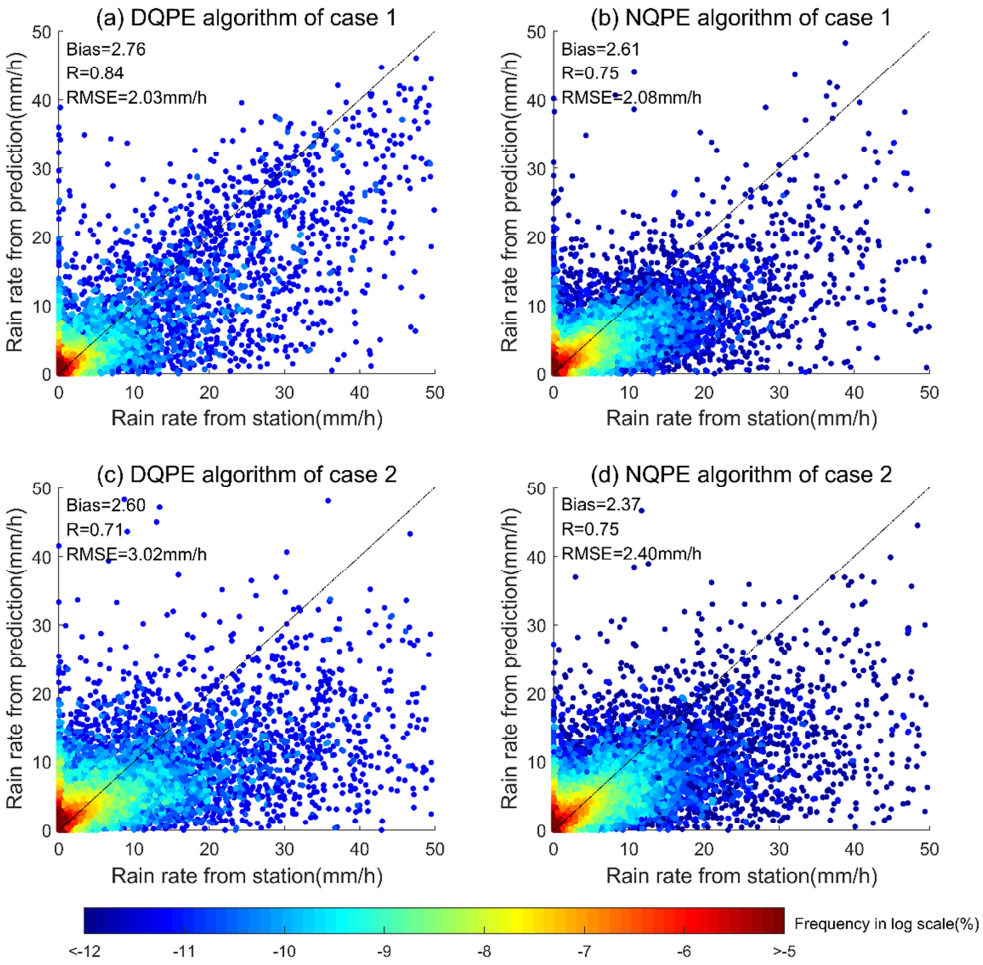


**Figure S1: Comparison of the precipitation measured by high-density automatic stations and that estimated by the QPE algorithm: (a) DQPE algorithm of case 1; (b) NQPE algorithm of case 1; (c) DQPE algorithm of case 2; (d) NQPE algorithm of case 2**

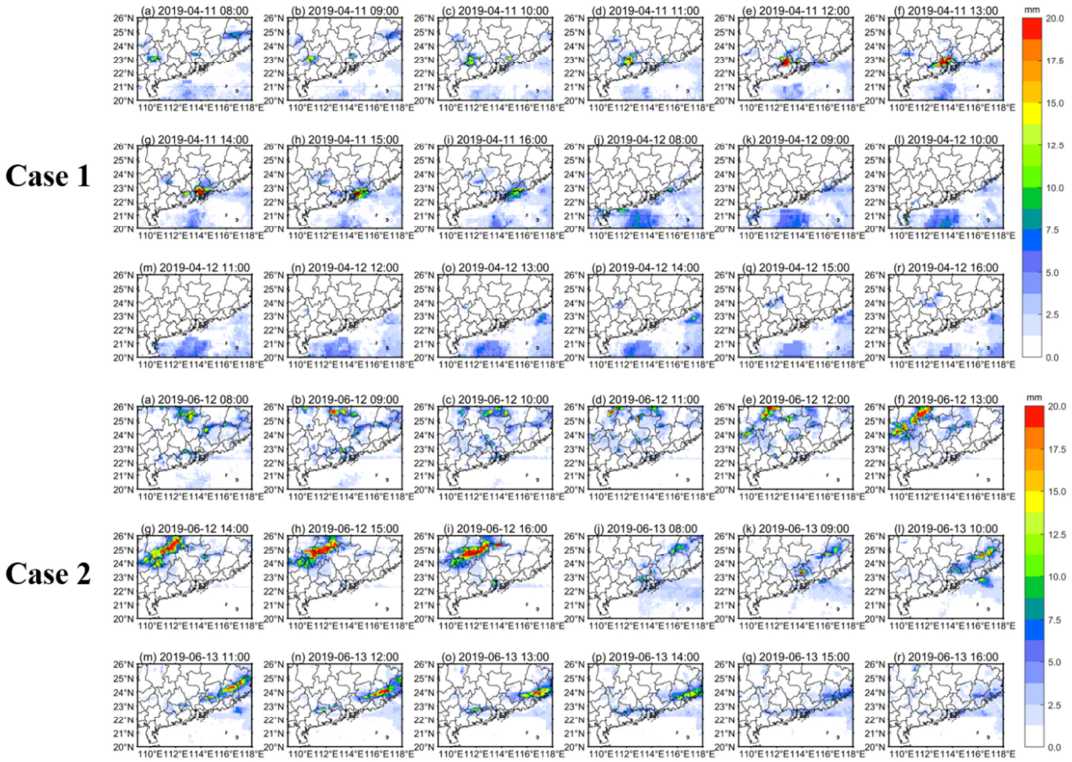


**Figure S2: Estimated precipitation of the DQPE algorithm: Case 1: (a–i) at 0800–1600 BJT on April 11; (j–r) at 0800–1600 BJT on April 12. Case 2: (a–i) at 0800–1600 BJT on June 12; (j–r) at 0800–1600 BJT on June 13.**

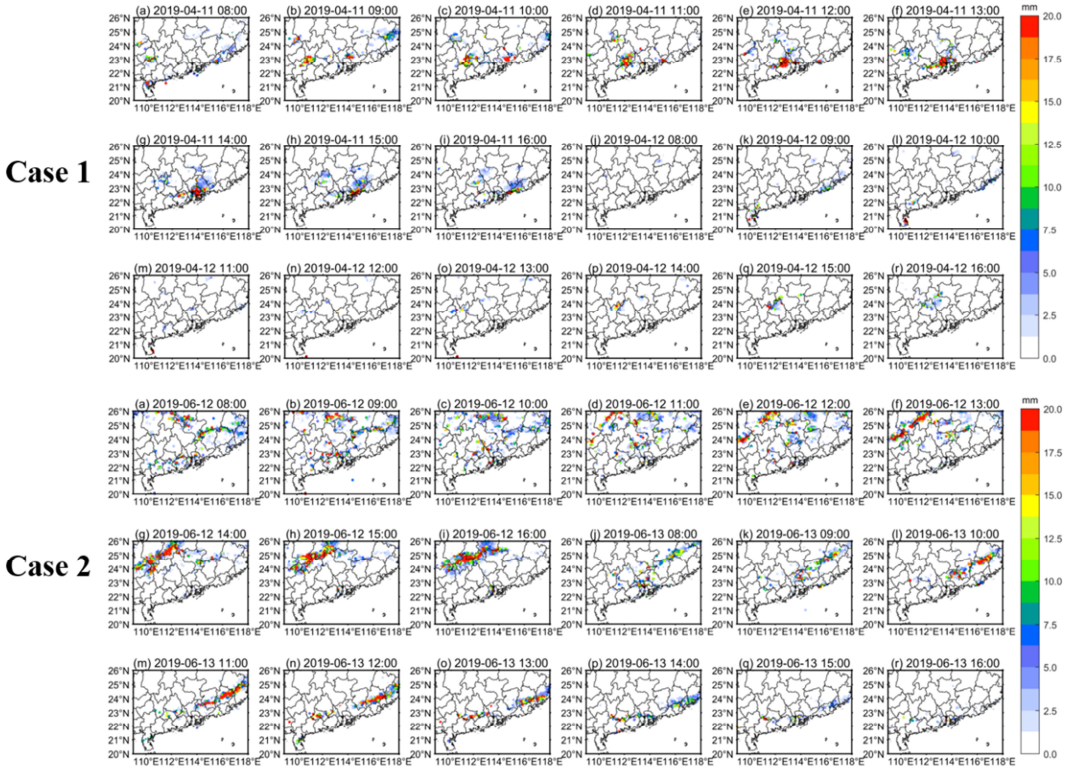


**Figure S3: Actual precipitation based on the high-density automatic stations: Case 1: (a–i) at 0800–1600 BJT on April 11; (j–r) at 0800–1600 BJT on April 12. Case 2: (a–i) at 0800–1600 BJT on June 12; (j–r) at 0800–1600 BJT on June 13.**

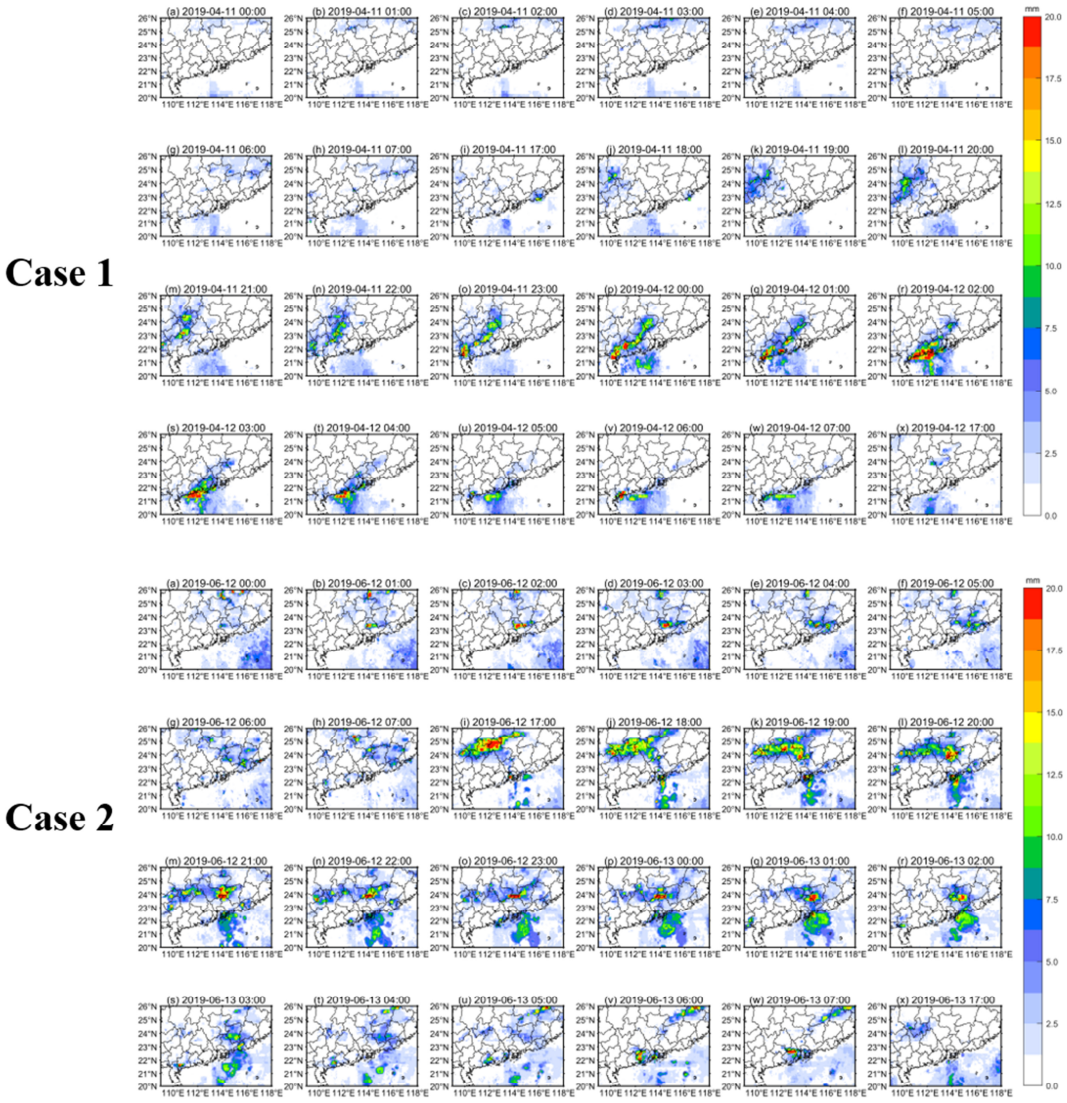


**Figure S4: Estimated precipitation of the NQPE algorithm: Case 1: (a–h) 0000–0700 BJT on April 11, (i–o) 1700–2300 BJT on April 11, (p–w) 0000–0700 BJT on April 12, and (x) 1700 BJT on April 12. Case 2: (a–h) 0000–0700 BJT on June 12, (i–o) 1700–2300 BJT on June 12, (p–w) 0000–0700 BJT on June 13, and (x) 1700 BJT on June 13.**

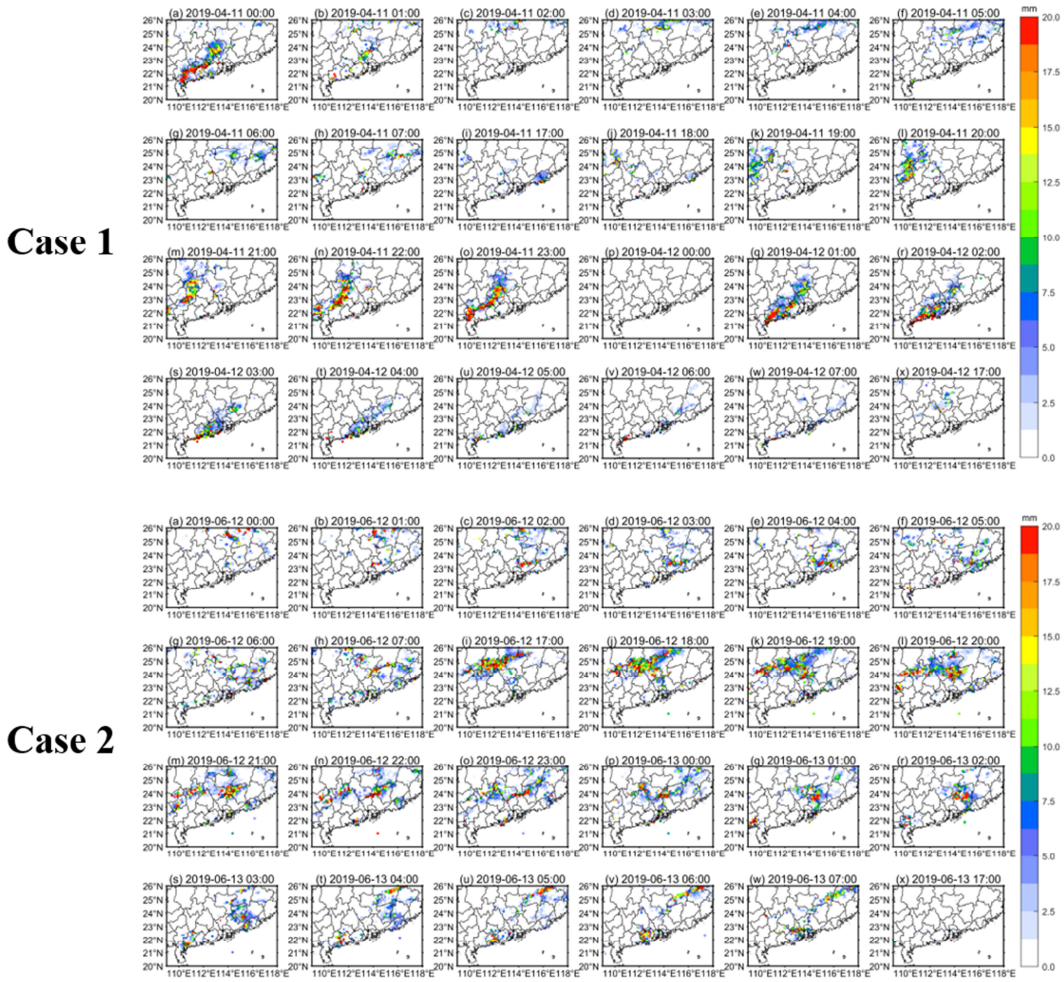


**Figure S5: Actual precipitation based on the high-density automatic stations: Case 1: (a–h) 0000–0700 BJT on April 11, (i–o) 1700–2300 BJT on April 11, (p–w) 0000–0700 BJT on April 12, and (x) 1700 BJT on April 12. Case 2: (a–h) 0000–0700 BJT on June 12, (i–o) 1700–2300 BJT on June 12, (p–w) 0000–0700 BJT on June 13, and (x) 1700 BJT on June 13.**

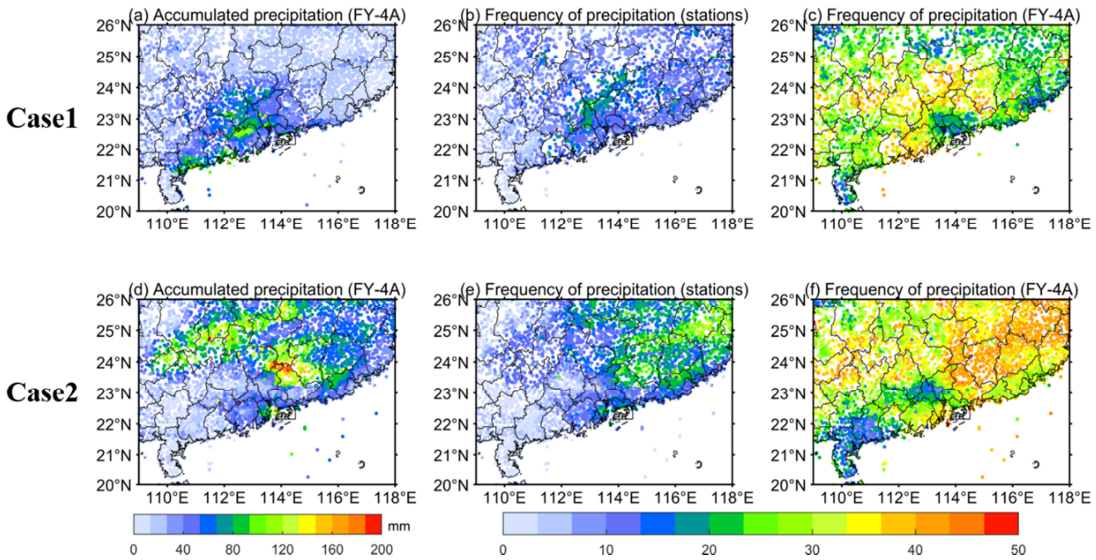


**Figure S6: Spatial distribution of accumulated precipitation: (a) accumulated precipitation estimated by the QPE algorithm in case 1; (b) actual precipitation frequency observed by high-density automatic stations in case 1; (c) precipitation frequency estimated by the QPE algorithm in case 1; (d) accumulated precipitation estimated by the QPE algorithm in case 2; (e) actual precipitation frequency observed by high-density automatic stations in case 2; (f) precipitation frequency estimated by the QPE algorithm in case 2.**

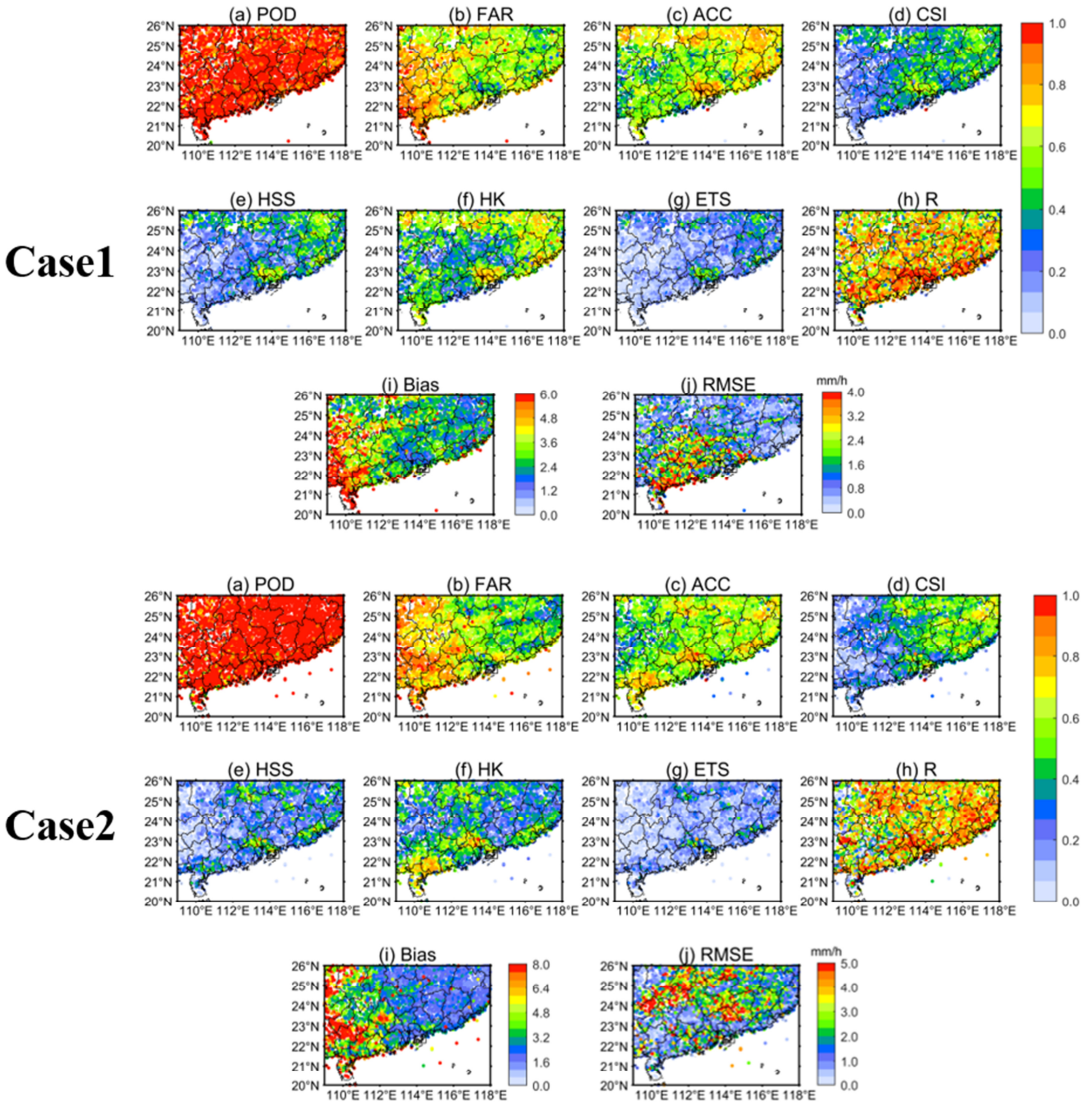


**Figure S7: Spatial distribution of evaluation indicators of the QPE algorithm for all stations: Case 1: (a) *POD*; (b) *FAR*; (c) *ACC*; (d) *CSI*; (e) *HSS*; (f) *HK*; (g) *ETS*; (h) *R*; (i) *Bias*; (j) *RMSE*. Case 2:(a) *POD*; (b) *FAR*; (c) *ACC*; (d) *CSI*; (e) *HSS*; (f) *HK*; (g) *ETS*; (h) *R*; (i) *Bias*; (j) *RMSE*.**

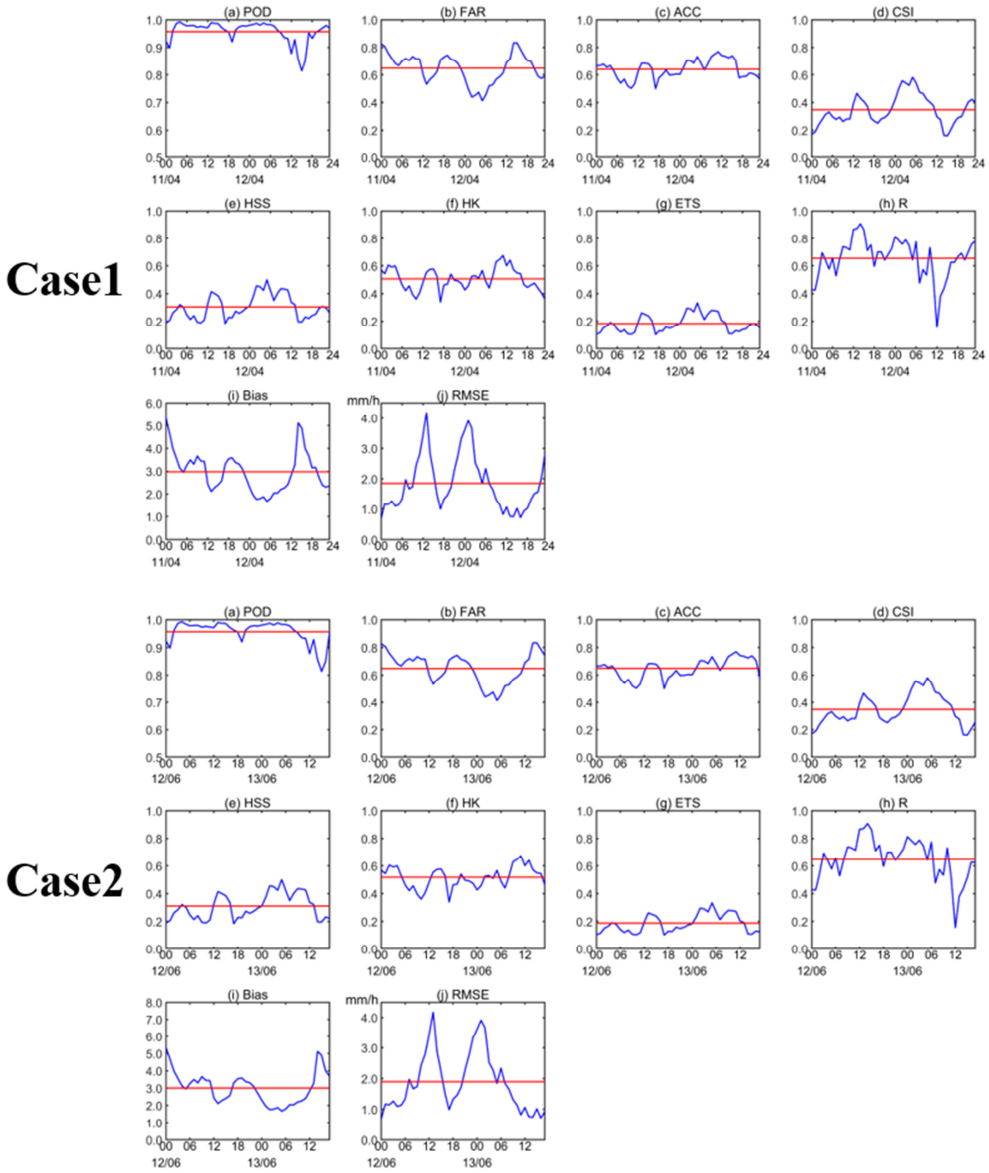


**Figure S8: Time series of evaluation indicators of the QPE algorithm for all stations at each time: Case 1: (a) *POD*; (b) *FAR*; (c) *ACC*; (d) *CSI*; (e) *HSS*; (f) *HK*; (g) *ETS*; (h) *R*; (i) *Bias*; (j) *RMSE*. Case 2:(a) *POD*; (b) *FAR*; (c) *ACC*; (d) *CSI*; (e) *HSS*; (f) *HK*; (g) *ETS*; (h) *R*; (i) *Bias*; (j) *RMSE*.**