C波段防災降雨雷達定量降雨估計法技術精進

中央氣象署 科技發展組-降水技術科

邱健倫、唐玉霜、張保亮、梁信廣

➢ C波段防災降雨雷達

掃描策略、最低可觀測高度、填補s-band雷達觀測死角

➢ C波段雷達定量降雨估計方法

資料流程、R(Z)和R(KDP)、三層降雨率最大(作業)和條件性最大(測試)

➢ QVS定量降雨校驗網頁

網頁介紹、長時段校驗統計分數

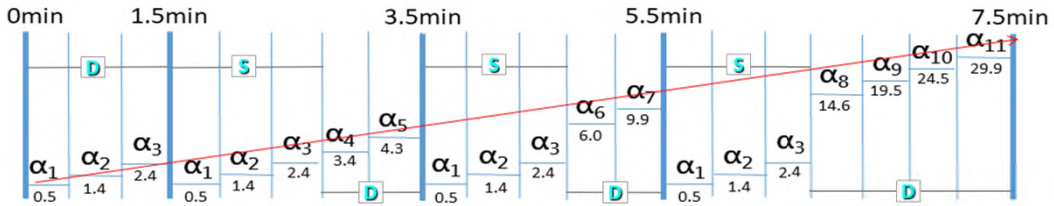
➢ 校驗結果比較

0611西南氣流、0705丹娜、0801西南氣流豪雨事等三個案統計校驗分析

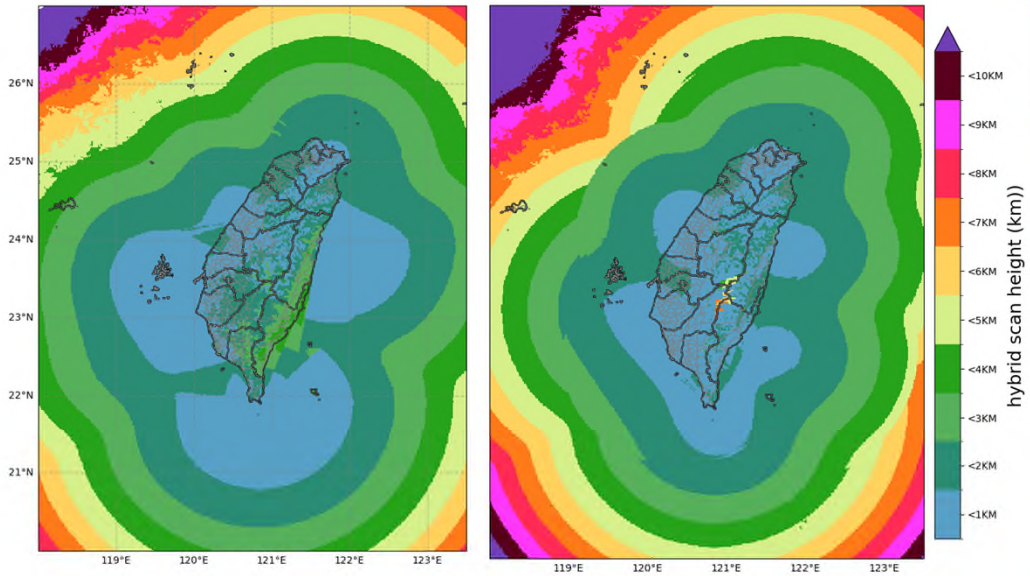
➢ 結論與未來工作

氣象署防災降雨雷達建置

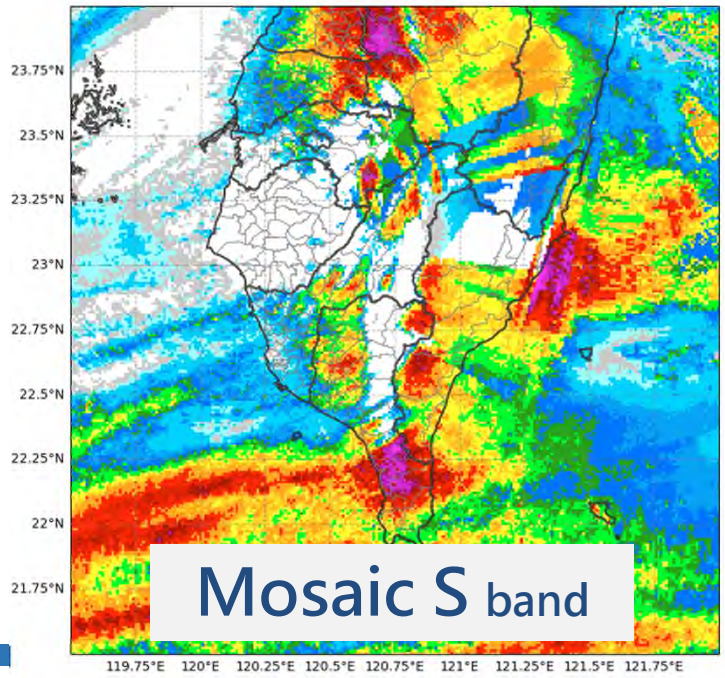
- 針對都會區及低窪易淹地區進行快速更新的雷達掃描

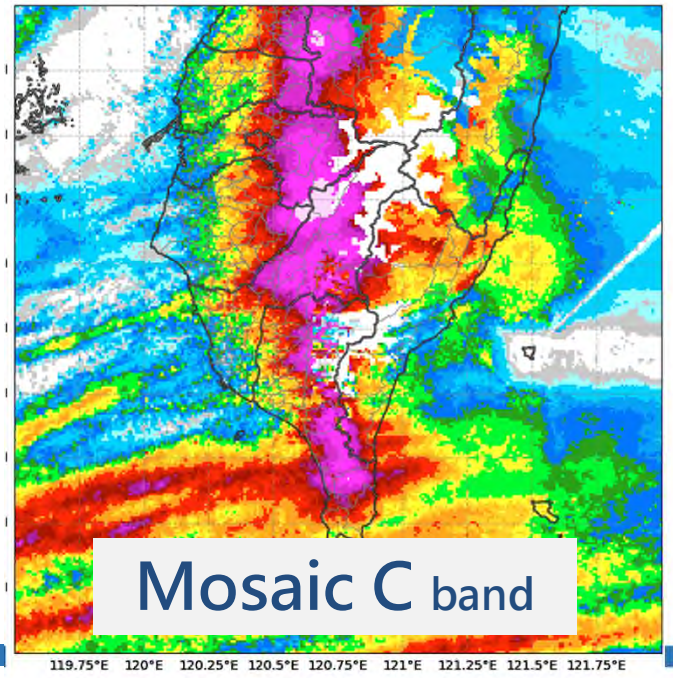


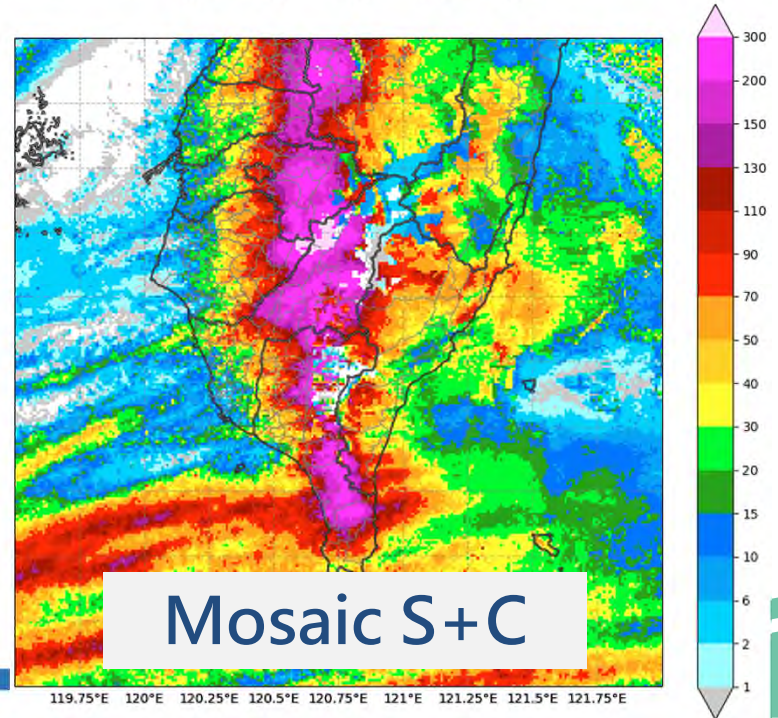
- 提供更低的最低可觀測高度
(利於更接近真實大氣降水的QPE)



- 填補S波段雷達面化QPE空洞







定量降水估計 (Quantitative Precipitation Estimation ; QPE)

- C-band 降雨雷達 QPE

operational
RadarBase.v1
RCSL, RCNT, RCLY,
RCMK, RCCK, RCGI

experimental
RadarBase.v2
RCSL, RCNT, RCLY,
RCMK, RCCK, RCGI

$R(K_{dp})$ 與 $R(Z)$

① if R(kdp) < 13mm/hr or Z < 30dBZ : $Z = 150\ R^{1.51}$

② else : $R = 35.4\ |K_{dp}|^{0.799}$

最低三層(0.5、1.4、2.4)

取降雨率R 三層中最大值
(maximum-rate)
OP

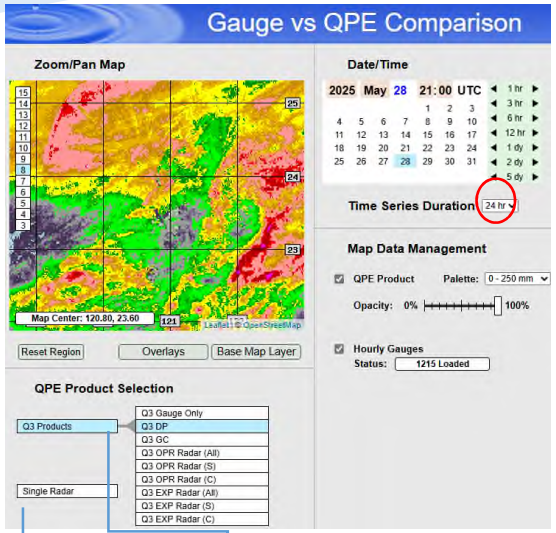
- 優點 : 避免因地形遮蔽導致的資料缺失或降雨低估
- 缺點 : 當取用高層仰角資料有可能在亮帶高度上造成降雨高估

最低三層(0.5、1.4、2.4)

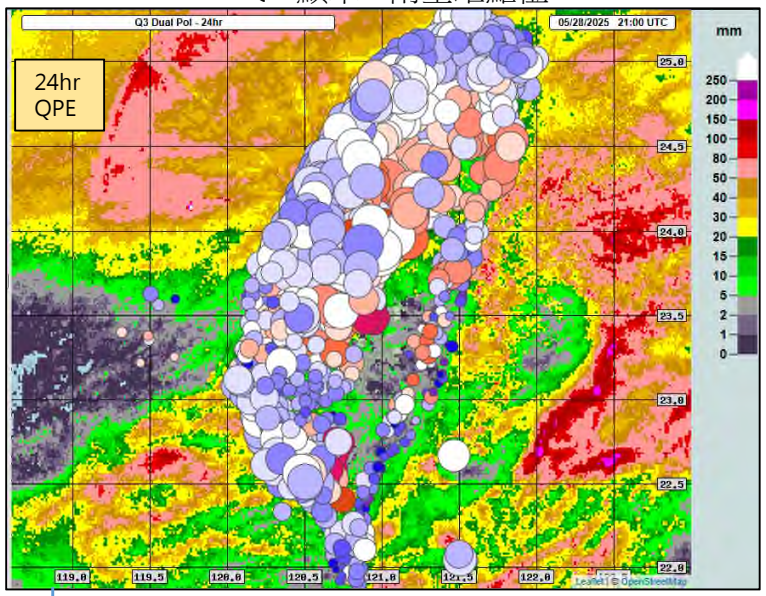
1) 僅在地形阻擋嚴重的區域取降雨率最大值
2) 僅在低層仰角資料出現空洞時才取次高層的資料
3) 其餘區域皆使用最低仰角數據
(conditional maximum-rate)
EXP

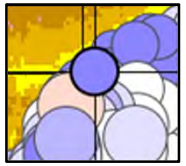
- 優點 : 確保格點R是在可用最低仰角層

QVS QPE校驗網頁 與NSSL合作引進之QPE校驗工具



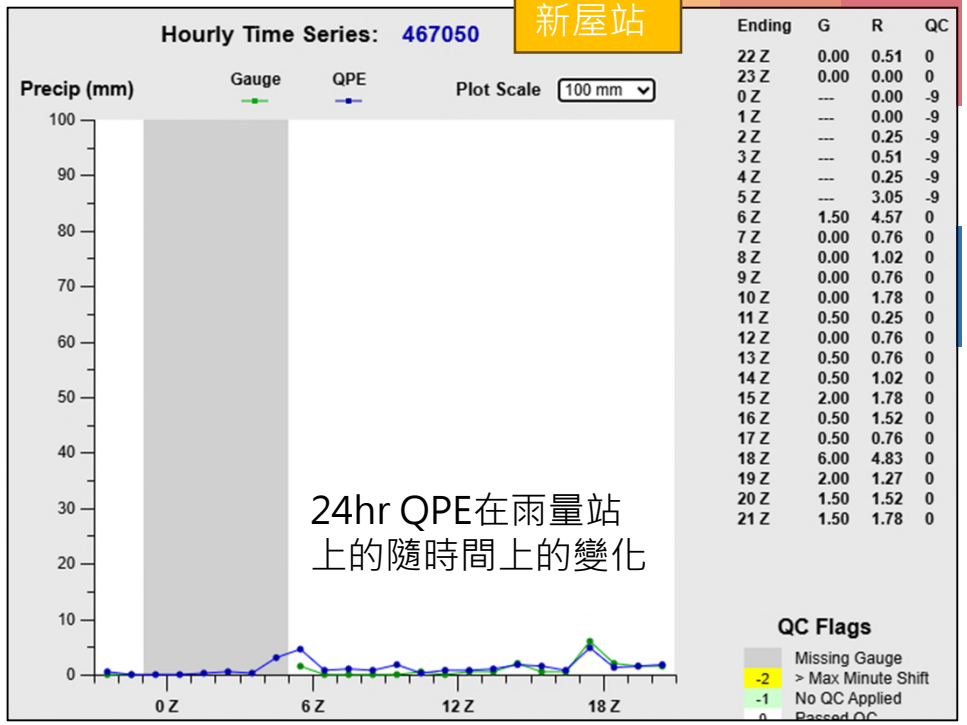
QPE顯示 x 雨量站點位

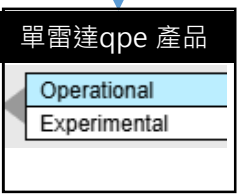


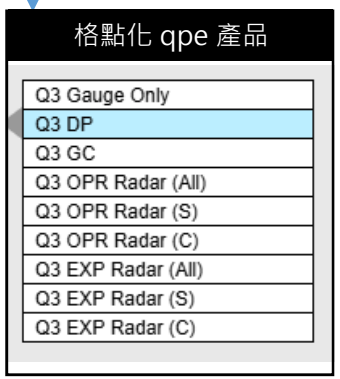


游標指到某個圓點即顯示QPE在雨量上的變化

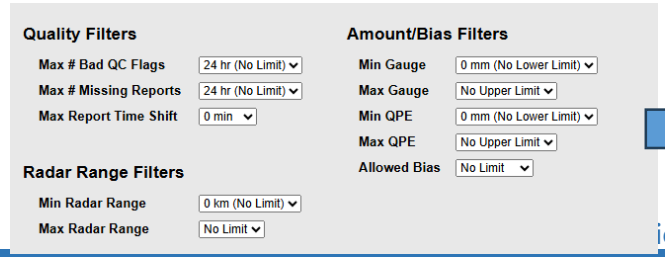
新屋站



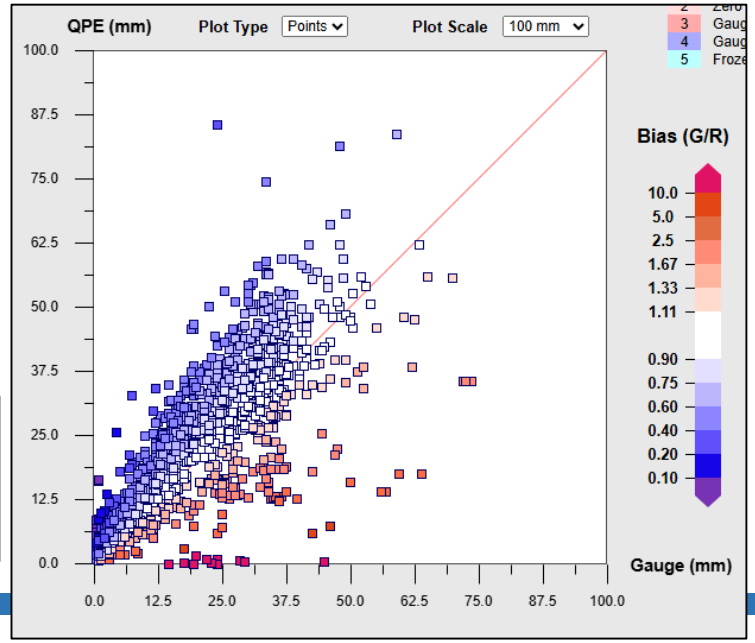




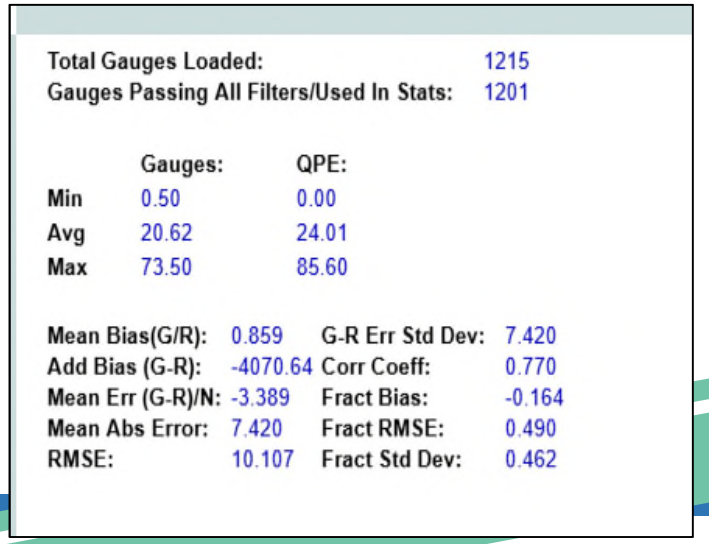
視窗doamin中，可指定特定filter，過濾掉不想要校驗的QPE和gauge



在指定的filter後，QPE在所有雨量站上的偏差



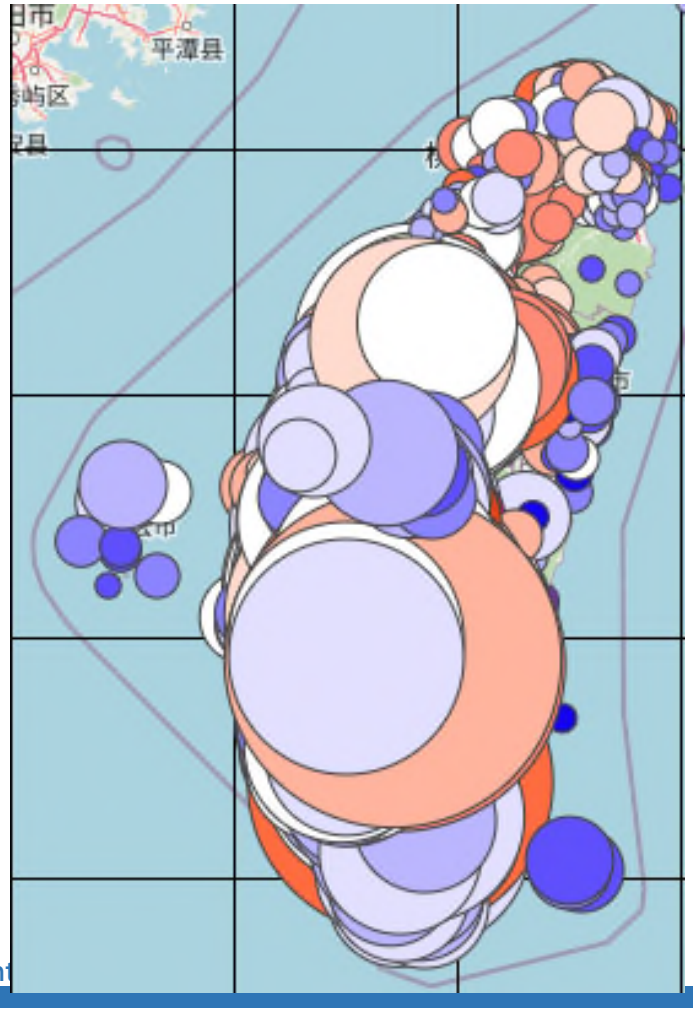
domain中，gauge和QPE定量上分數比較



QVS QPE校驗網頁 與NSSL合作引進之QPE校驗工具

- 長時段QPE校驗
- 輸入網址：

61.56.11.95:8080/qvs/legacy_web_api/get_gauge_qpe_stats_batch.php?nlat=25.50&slat=21.50&elon=122.00&wlon=119.00&start_year=2025&start_month=5&start_day=3&end_year=2025&end_month=8&end_day=19&end_hour=0&min_gauge=1&max_gauge=10000&product=144_RCLY&min_qpe=1&max_qpe=10000&allowed_bias=10000&allowed_bad=24&allowed_missing=24&allowed_tshift=0&gauge_group=madis

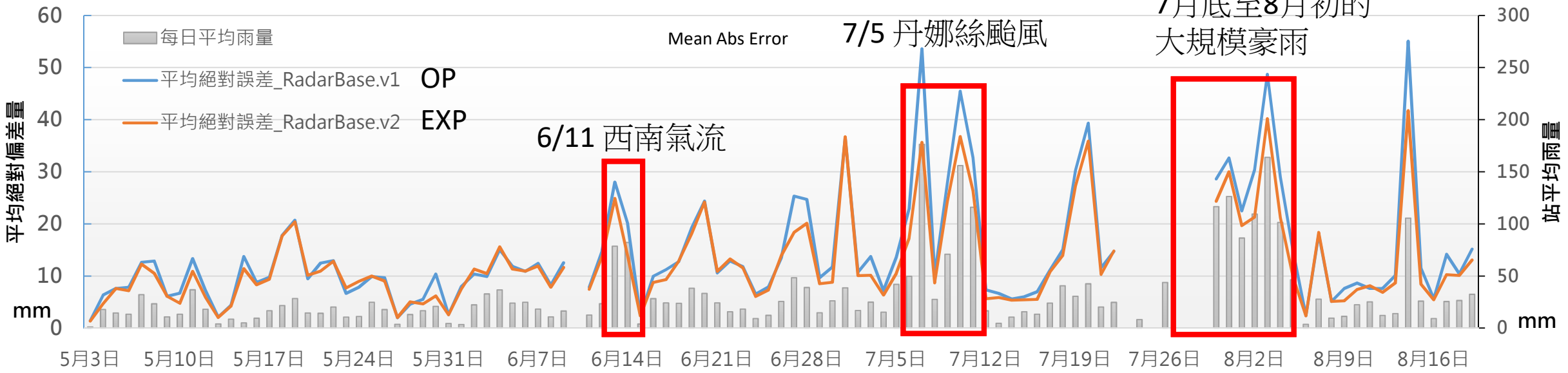


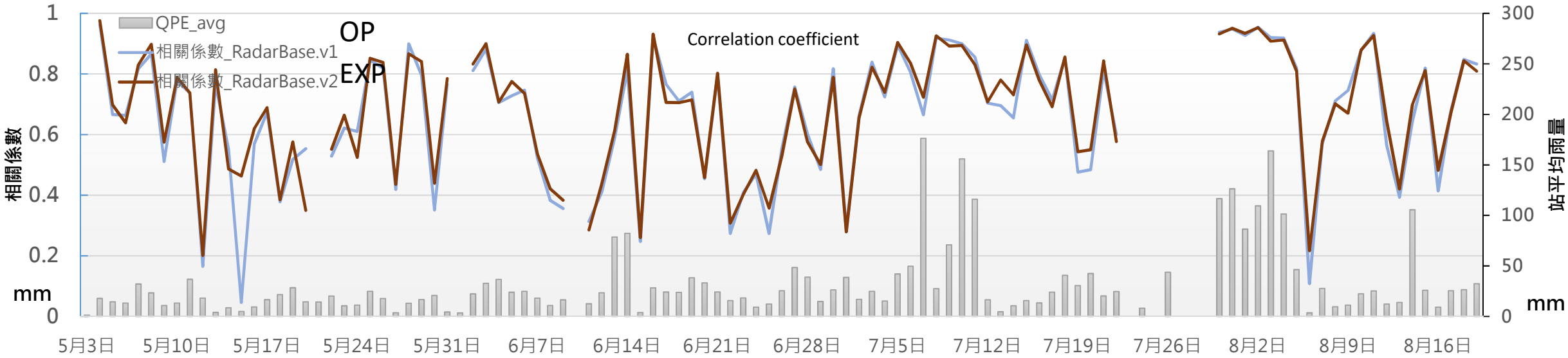
QPE: RCLY QPE from 144
Gauge: CoCoRaHS from real-time NMQ
Hourly gauges: (MADIS via MRMS)
Accumulation Period: 24hrs ending 0 Z

NLat: 25.50
SLat: 21.50
ELon: 122.00
WLon: 119.00
Minimum allowed gauge: 1
Maximum allowed gauge: 10000
Minimum allowed QPE: 1
Maximum allowed QPE: 10000
Allowed Bias: 10000 [A non-zero value of X means X<(Q/G bias)<1/X, so X=0.1 means a bias between 0.1 between 0 and 1.]
Allowed time shift window: 0 [min]
Maximum allowed bad QC hours: 24
Maximum allowed missing hours: 24
Gauge Group: madis

Date/Time	Gauge Count	Gauge Avg	Gauge Max	QPE Avg	QPE Max	Mean Bias (G/R)	Mean Abs Error	Corr Coeff
05/03/2025 00Z	2	3.00	3.50	1.65	2.30	1.818	1.350	-1.000
05/04/2025 00Z	39	14.05	187.00	16.61	180.20	0.846	4.690	0.976
05/05/2025 00Z	109	10.58	49.00	14.89	57.70	0.711	7.613	0.698
05/06/2025 00Z	25	6.32	26.00	12.41	38.60	0.509	7.168	0.639
05/07/2025 00Z	132	25.71	120.50	31.95	140.30	0.805	12.257	0.830
05/08/2025 00Z	30	12.33	63.00	20.71	118.30	0.595	10.487	0.898
05/09/2025 00Z	43	6.91	21.00	11.07	39.90	0.624	6.119	0.575
05/10/2025 00Z	220	8.19	71.50	11.11	49.00	0.737	4.770	0.788
05/11/2025 00Z	447	30.85	130.00	32.56	205.00	0.947	10.884	0.737
05/12/2025 00Z	473	13.13	64.50	15.22	478.40	0.863	5.920	0.201
05/13/2025 00Z	7	4.71	9.00	4.50	14.70	1.048	2.043	0.814
05/14/2025 00Z	6	6.25	12.00	8.83	21.20	0.708	4.217	0.486
05/15/2025 00Z	11	16.91	43.50	6.00	12.00	2.818	11.418	0.463
05/16/2025 00Z	35	12.90	64.00	8.17	53.10	1.580	8.329	0.620
05/17/2025 00Z	46	8.68	59.00	15.94	80.30	0.545	9.374	0.689
05/18/2025 00Z	167	19.32	157.00	21.82	116.10	0.886	17.700	0.385
05/19/2025 00Z	46	12.65	120.50	29.88	121.00	0.423	20.389	0.576
05/20/2025 00Z	16	7.16	25.50	13.63	57.70	0.525	10.138	0.350
05/21/2025 00Z	34	5.94	18.50	13.27	53.40	0.448	10.950	-0.027
05/22/2025 00Z	42	8.13	24.50	20.06	55.50	0.405	12.840	0.551
05/23/2025 00Z	12	8.25	19.00	11.34	39.40	0.727	7.692	0.664
05/24/2025 00Z	19	5.26	18.00	12.29	48.90	0.428	8.937	0.525

QVS 長時段校驗 ➢ RCLY 單雷達24hr QPE ➢ All Taiwawn domin(~150km)

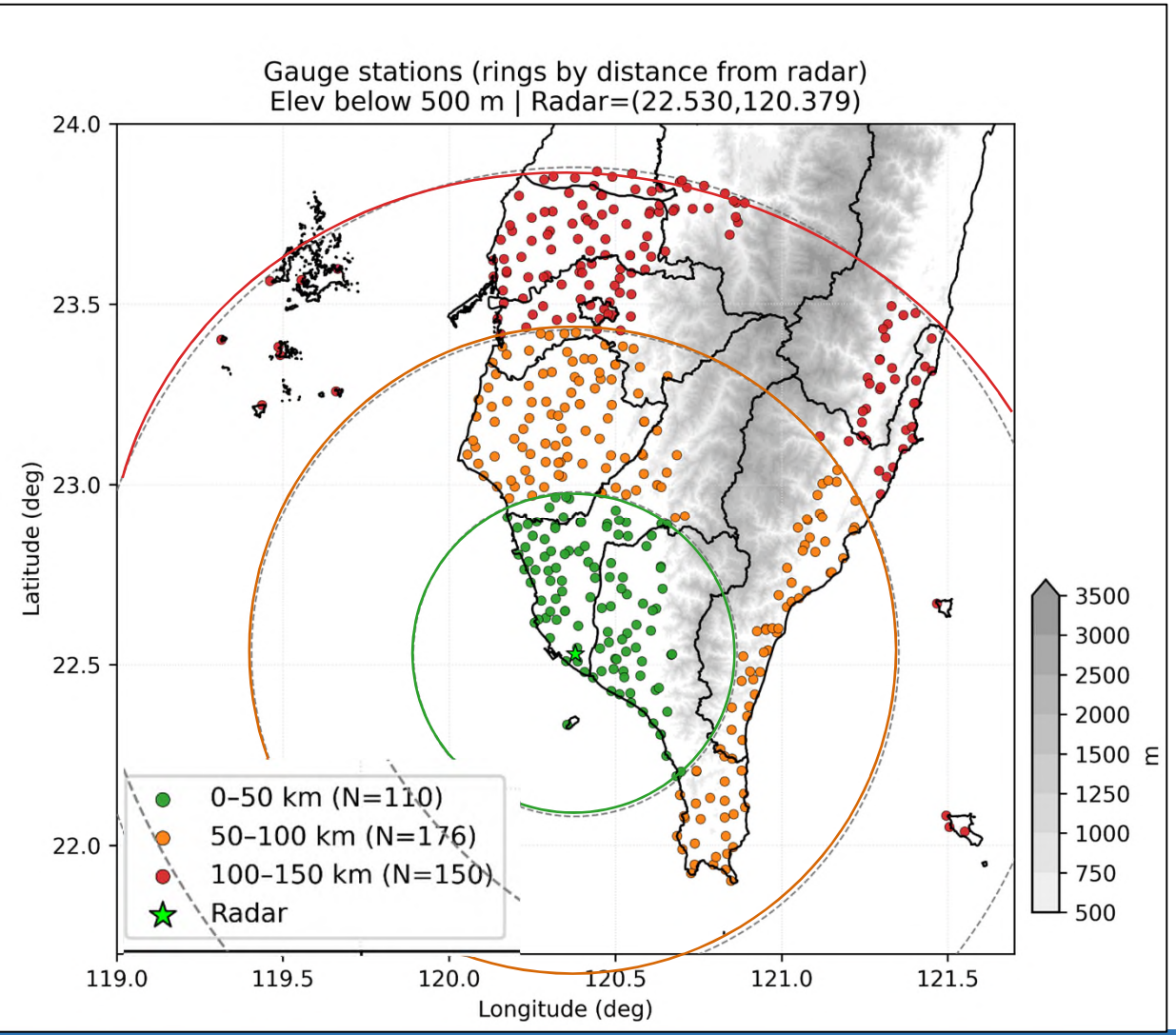


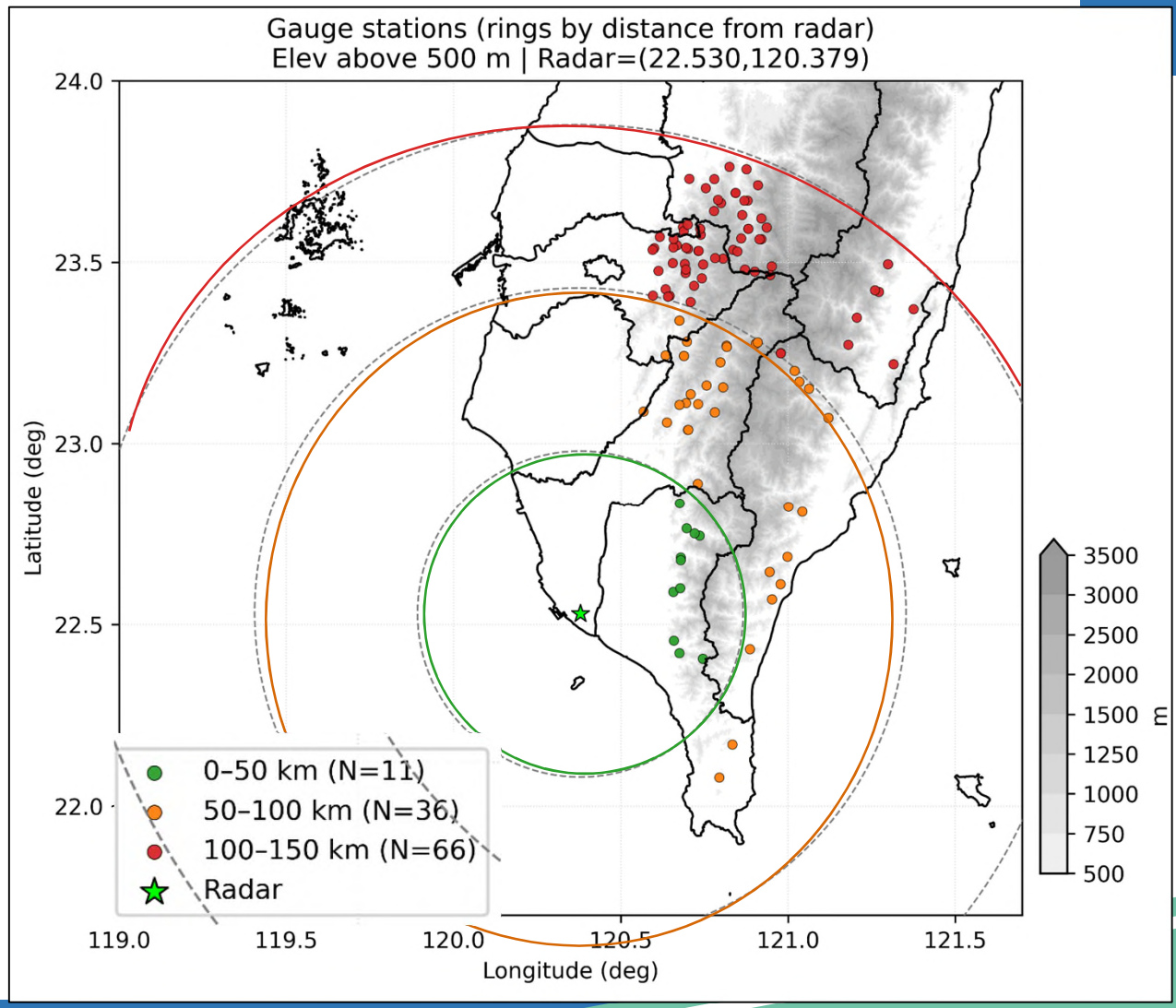


RCLY雷達為中心往外至150km的雨量站分布

Gauge 500m ↓

Gauge 500m ↑

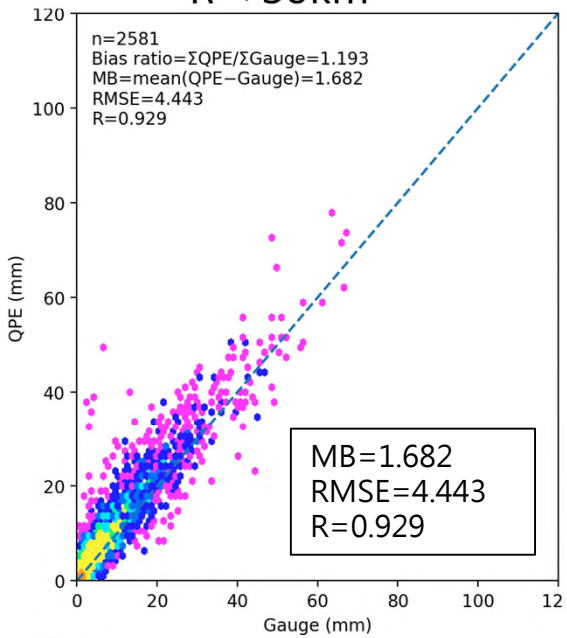


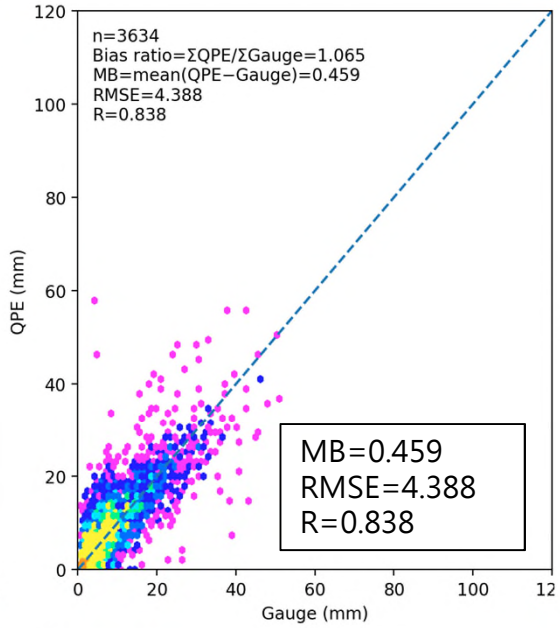


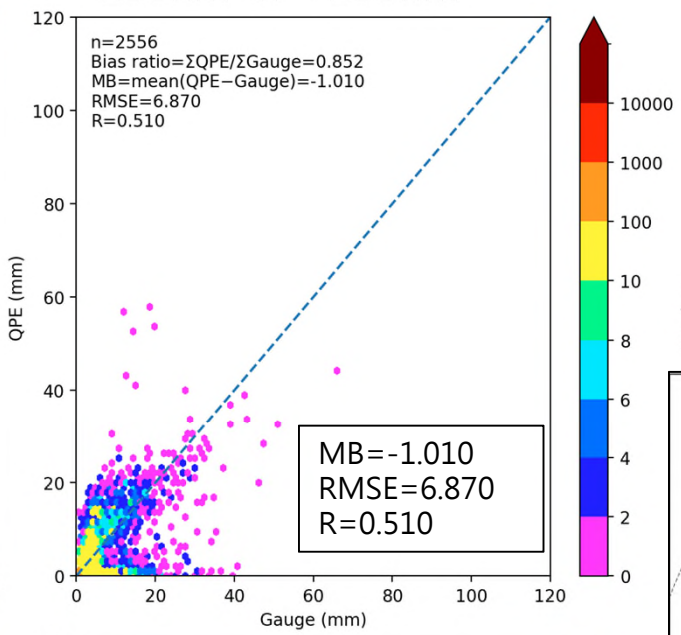
6/11-13 西南氣流

➢ RCLY 單雷達QPE vs gauge 海拔500m以下

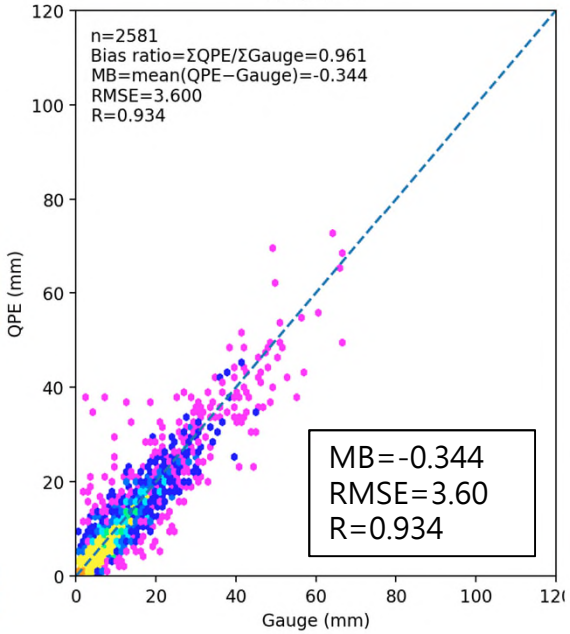
op

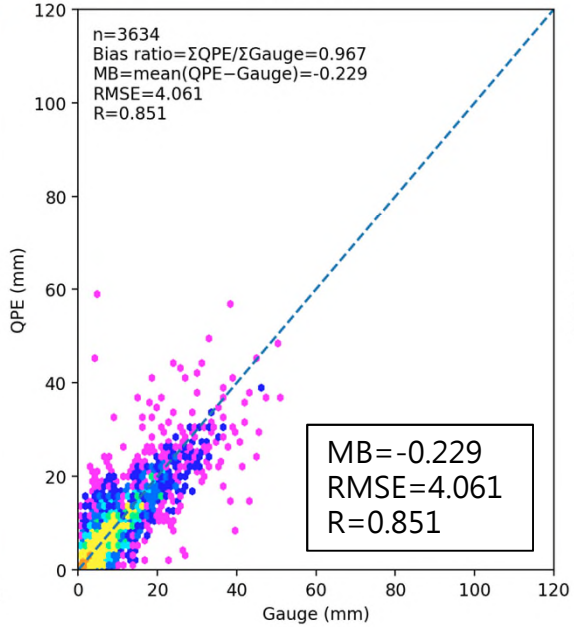


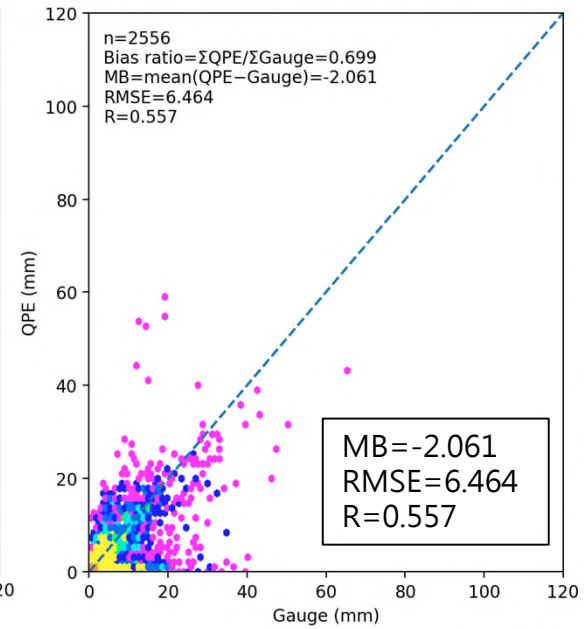


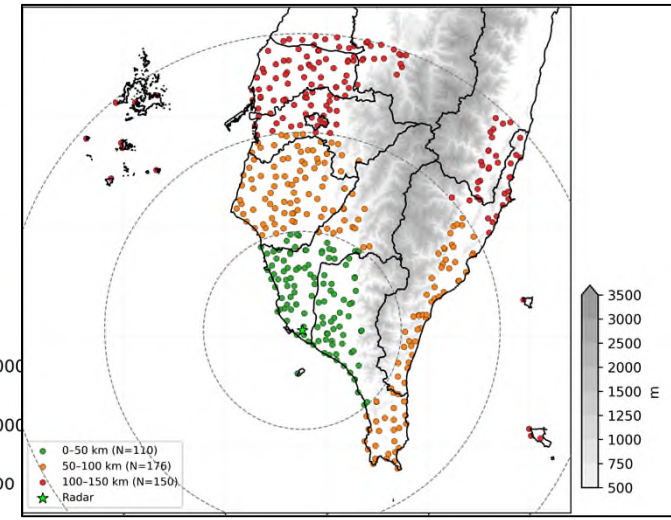


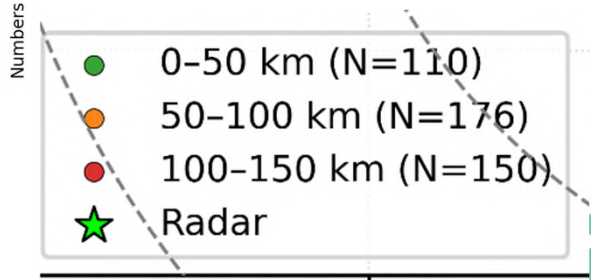
EXP











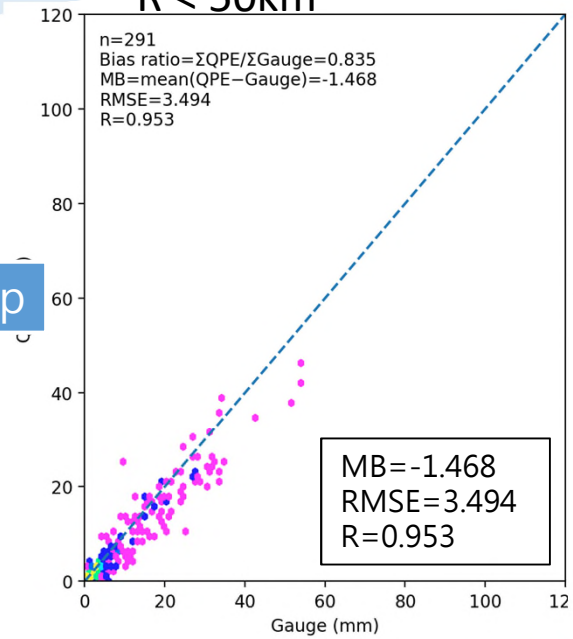
交通

6/11-13 西南氣流

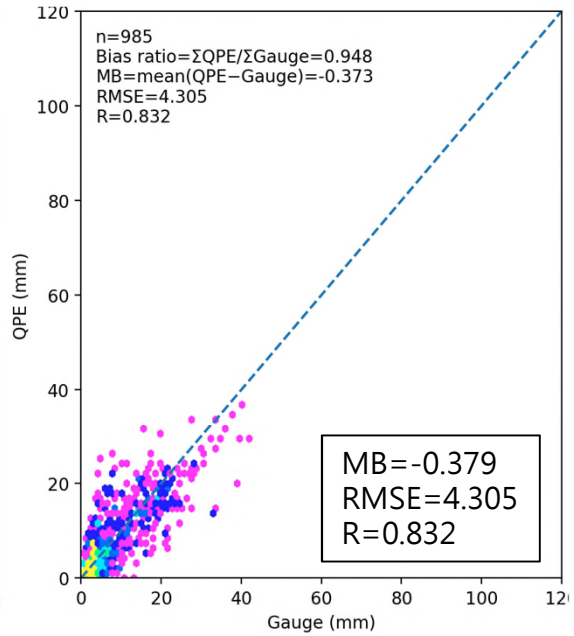
➢ RCLY 單雷達QPE vs gauge 海拔500m以上

op

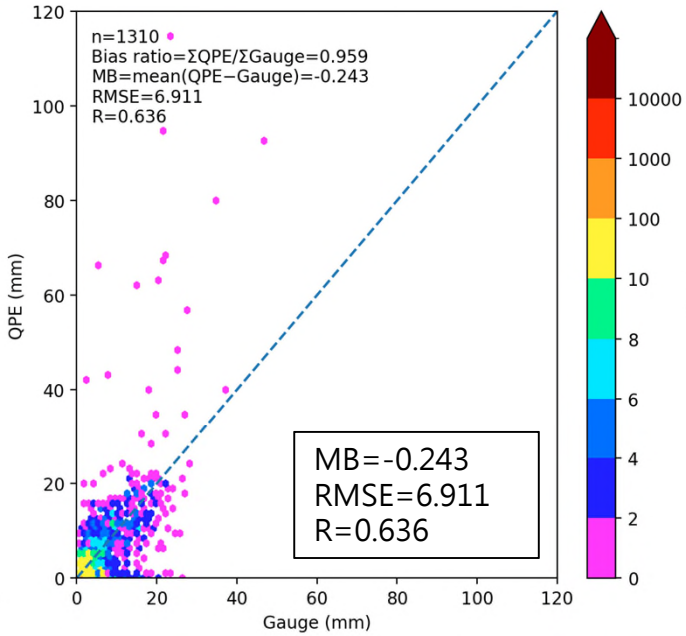
R < 50km



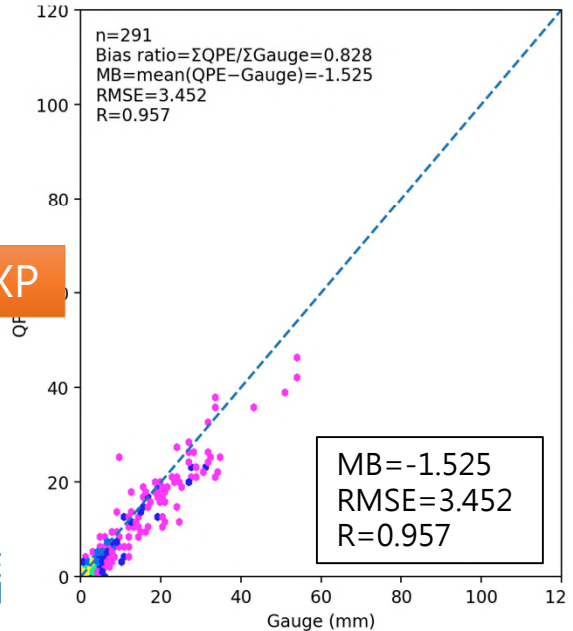
50km<R < 100km

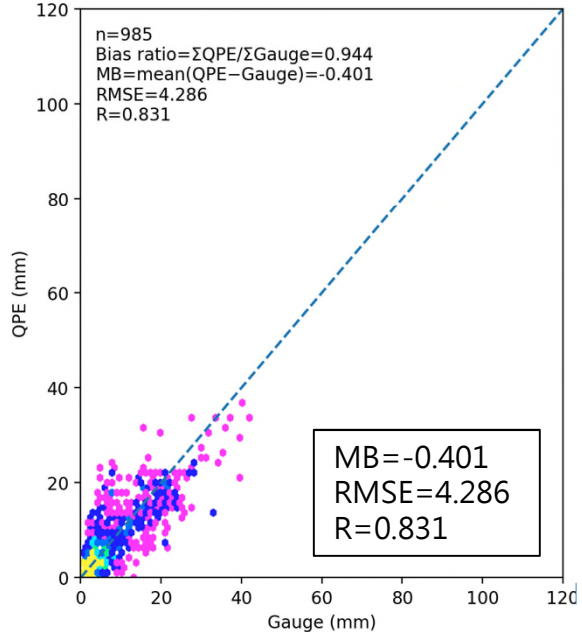


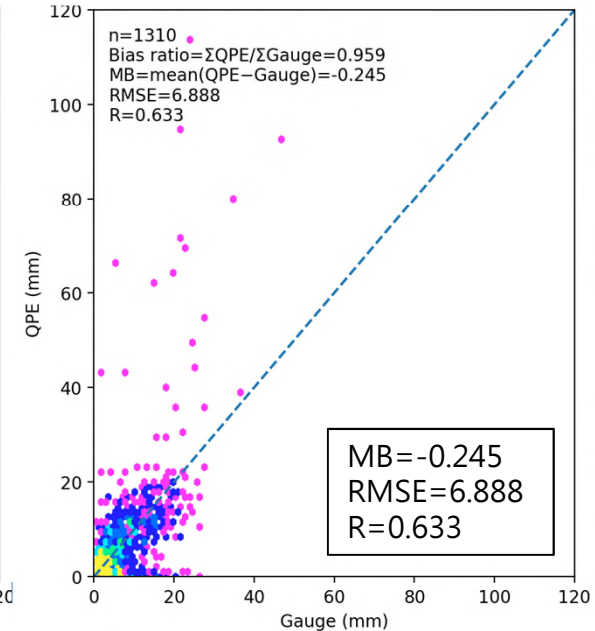
100km<R < 150km

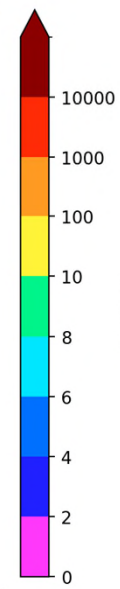


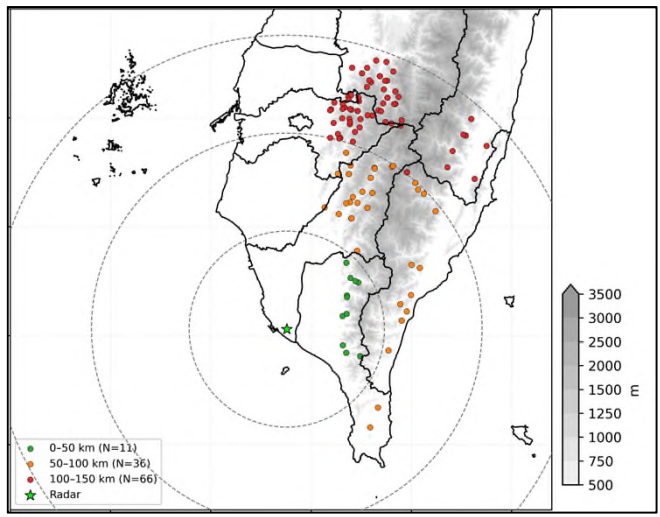
EXP

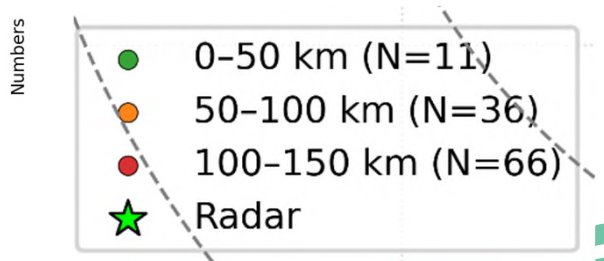






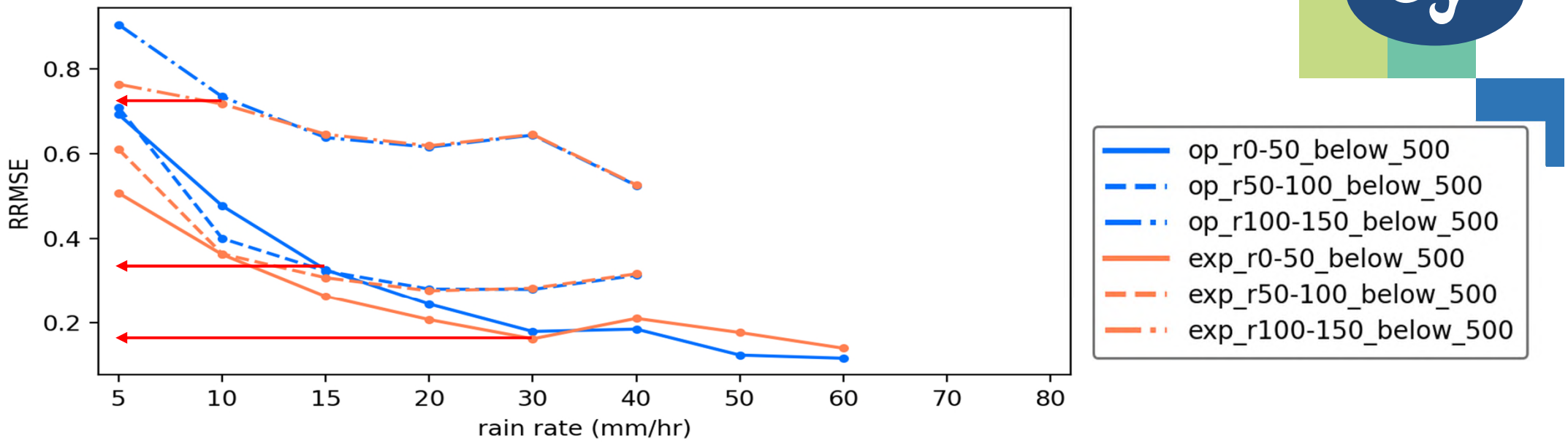




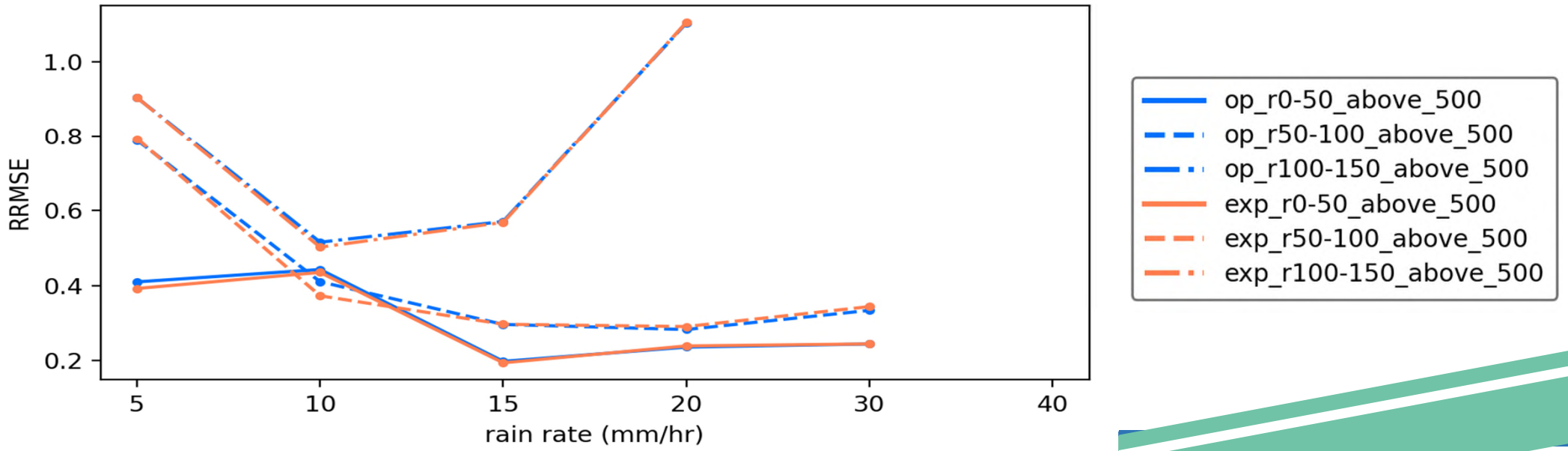


6/11-13 西南氣流 ➢ RCLY 單雷達1hr QPE 在各降雨強度上的表現

Gauge Below 500m



Gauge Above 500m



7/5-8 丹娜絲颱風

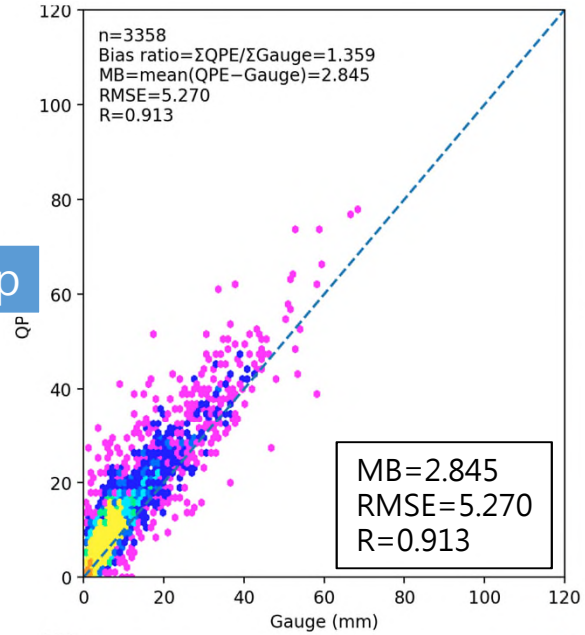
➢ RCLY 單雷達QPE vs gauge 海拔500m以下

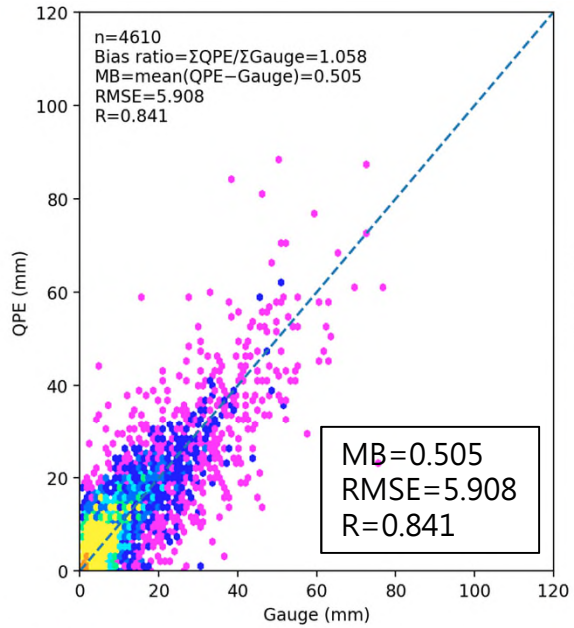
R < 50km

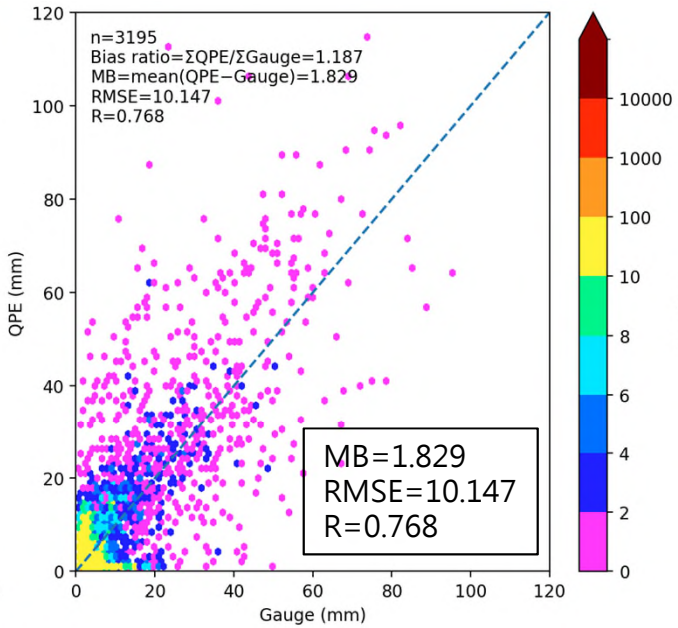
50km<R < 100km

100km<R < 150km

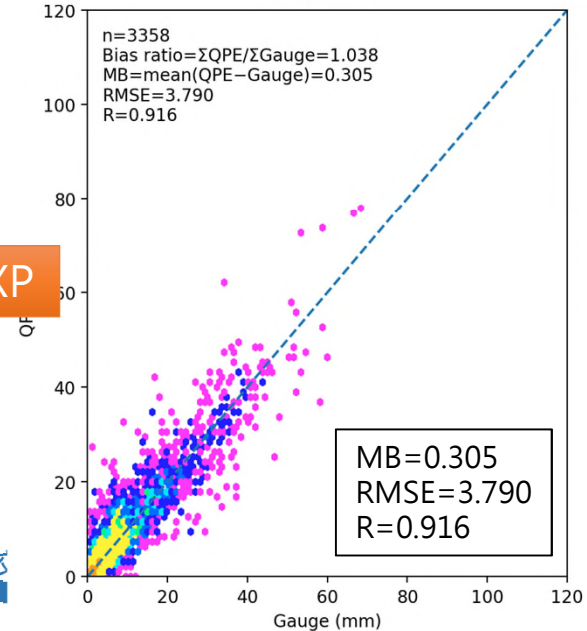
op

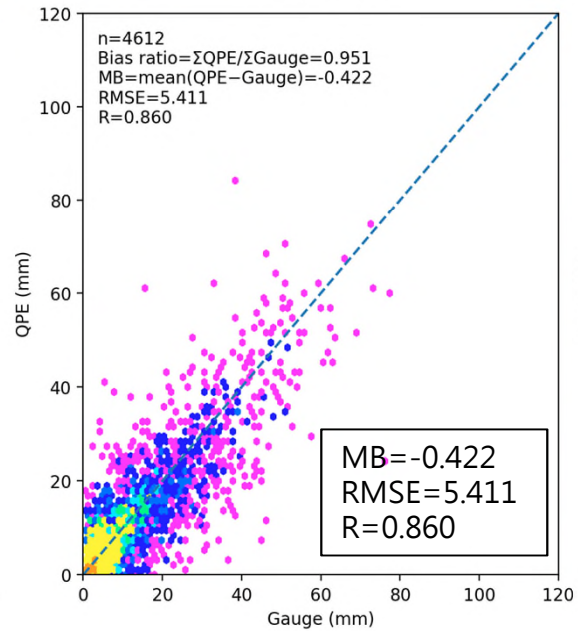


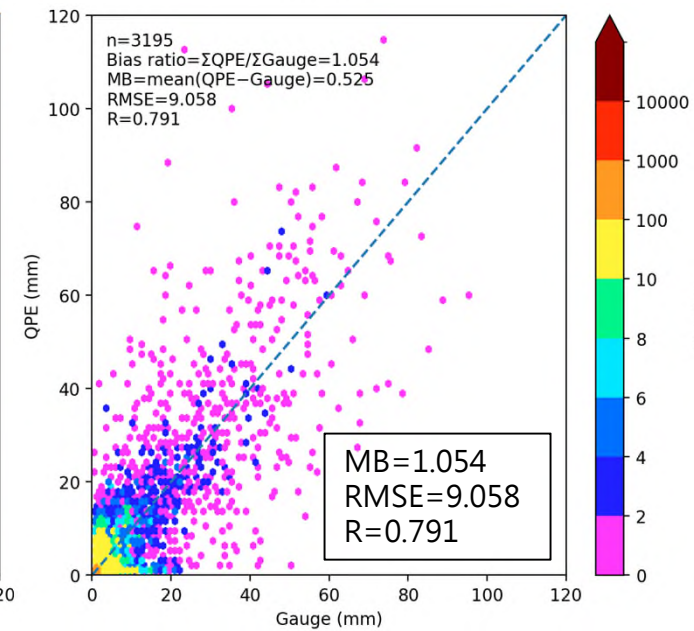


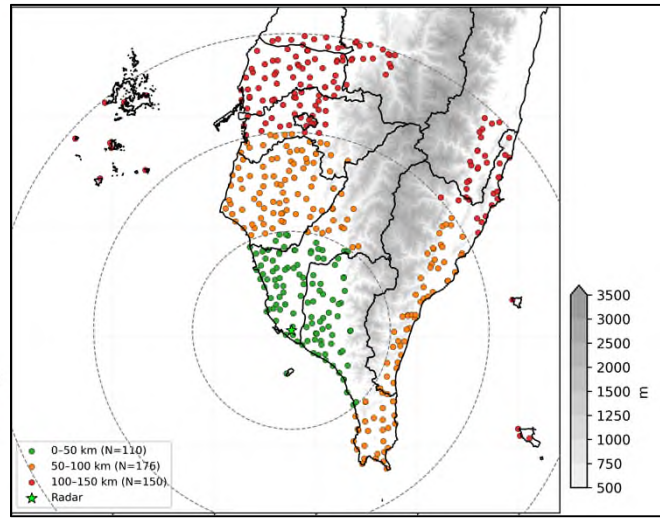


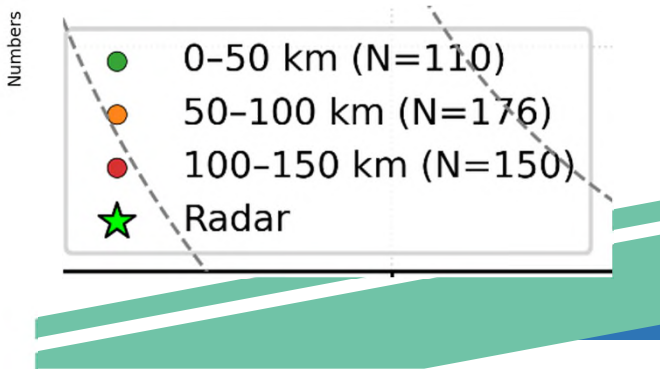
EXP











7/5-8 丹娜絲颱風

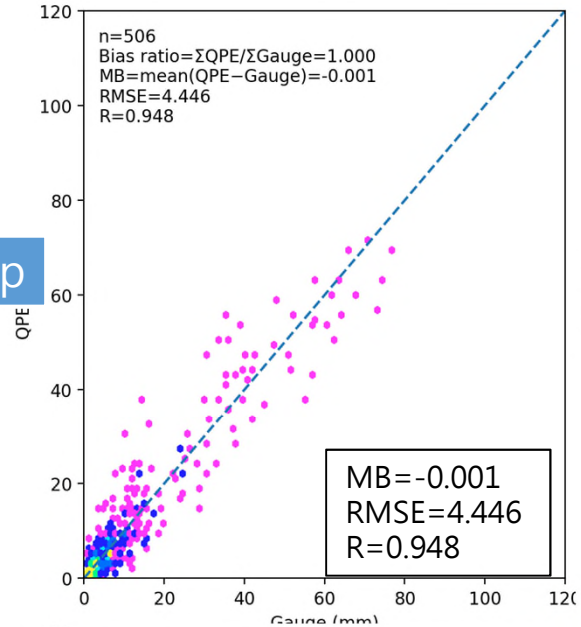
➢ RCLY 單雷達QPE vs gauge 海拔500m以上

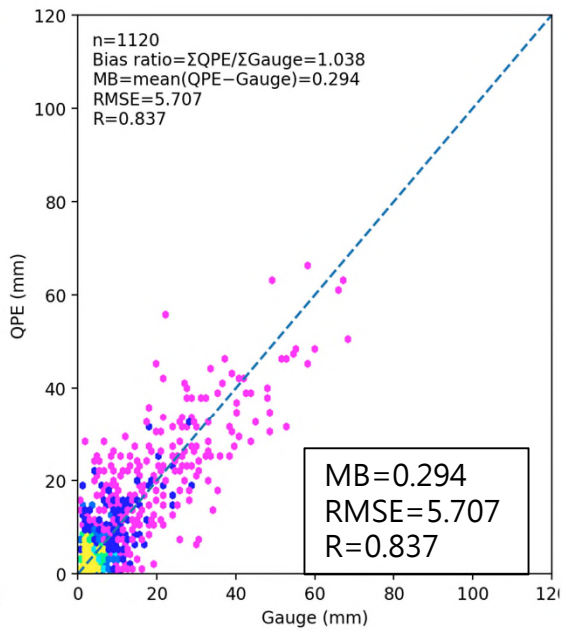
R < 50km

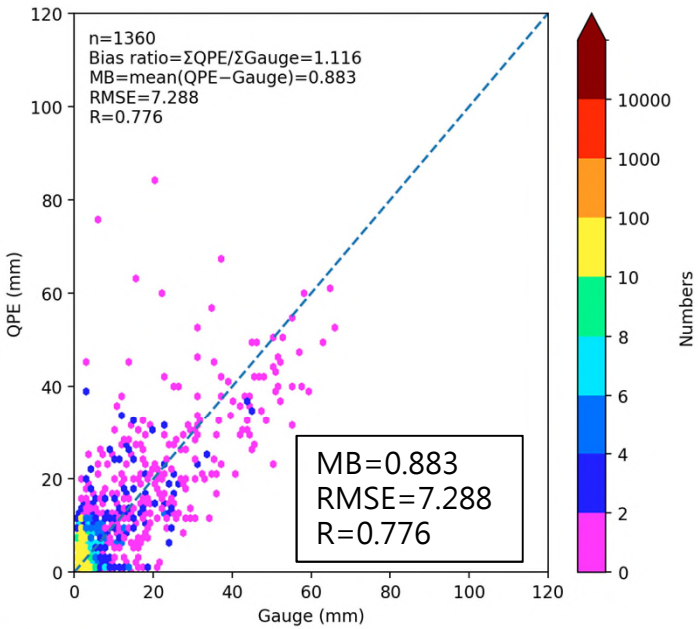
50km<R < 100km

100km<R < 150km

op







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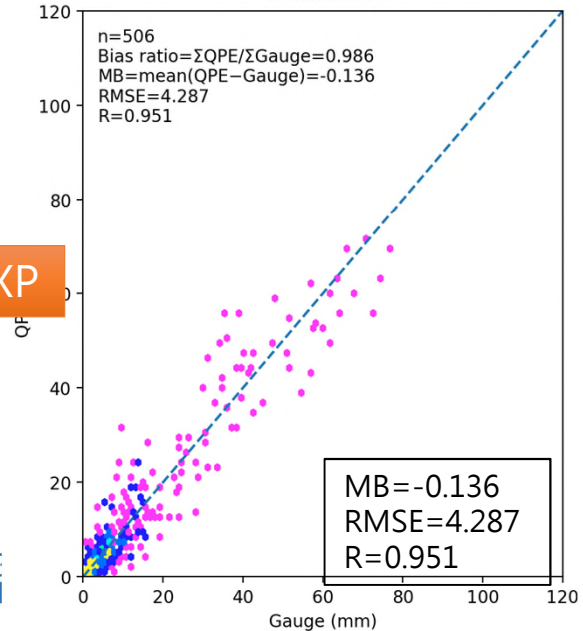
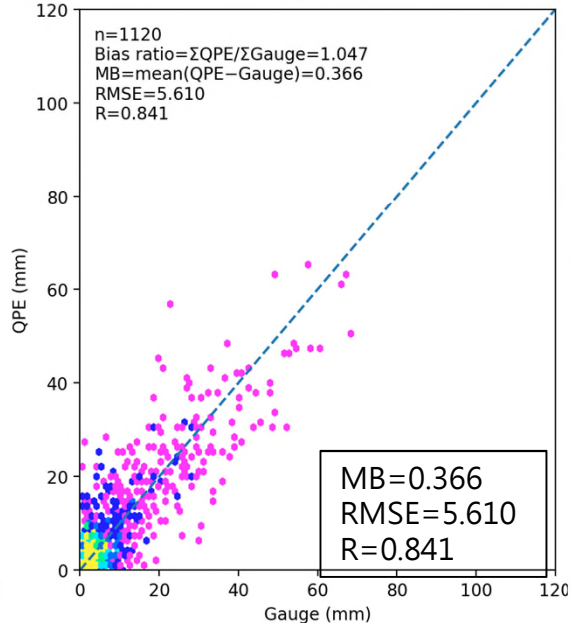
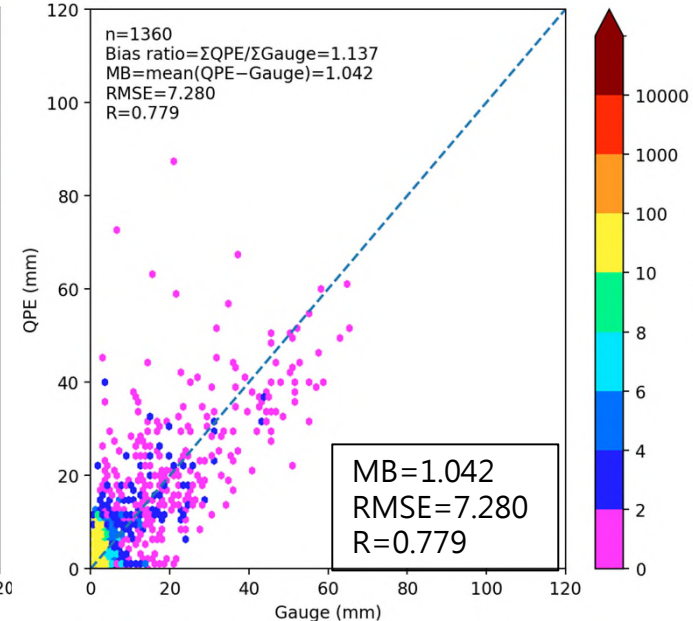
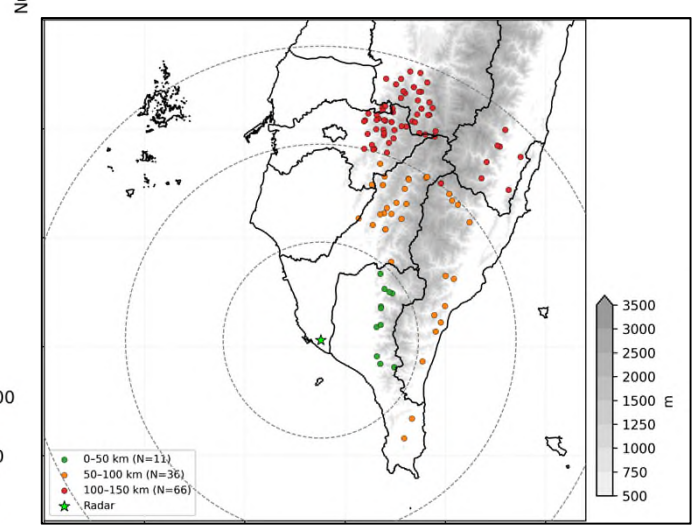
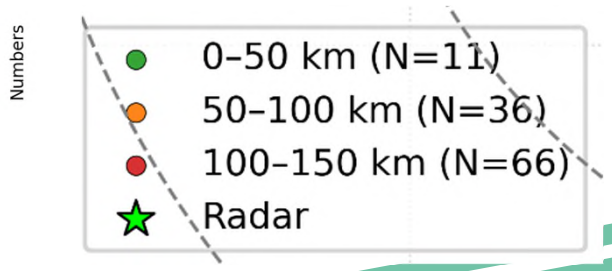






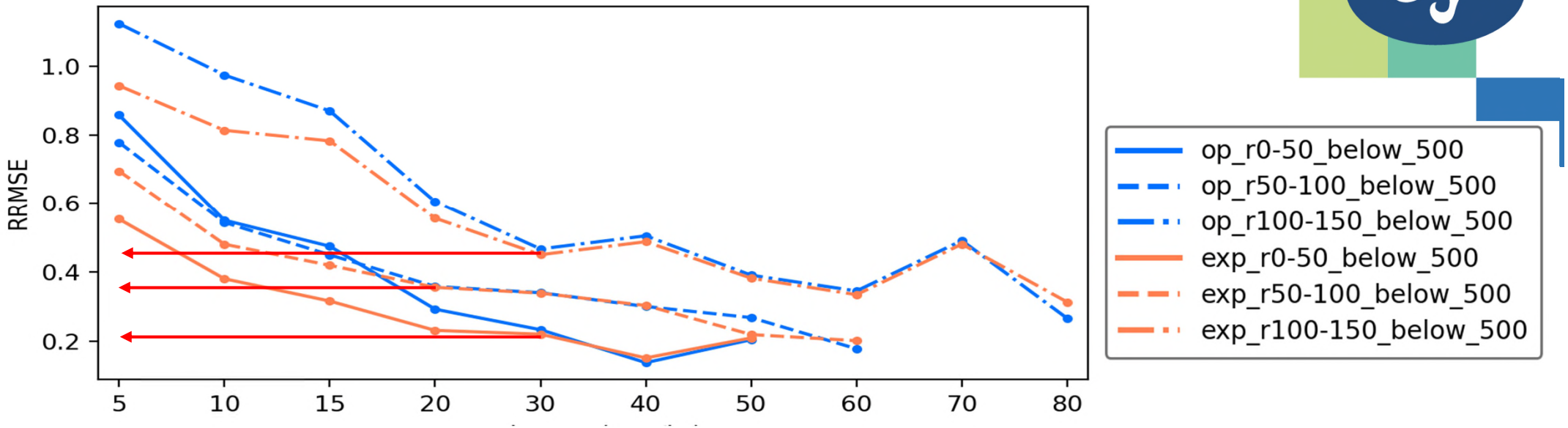




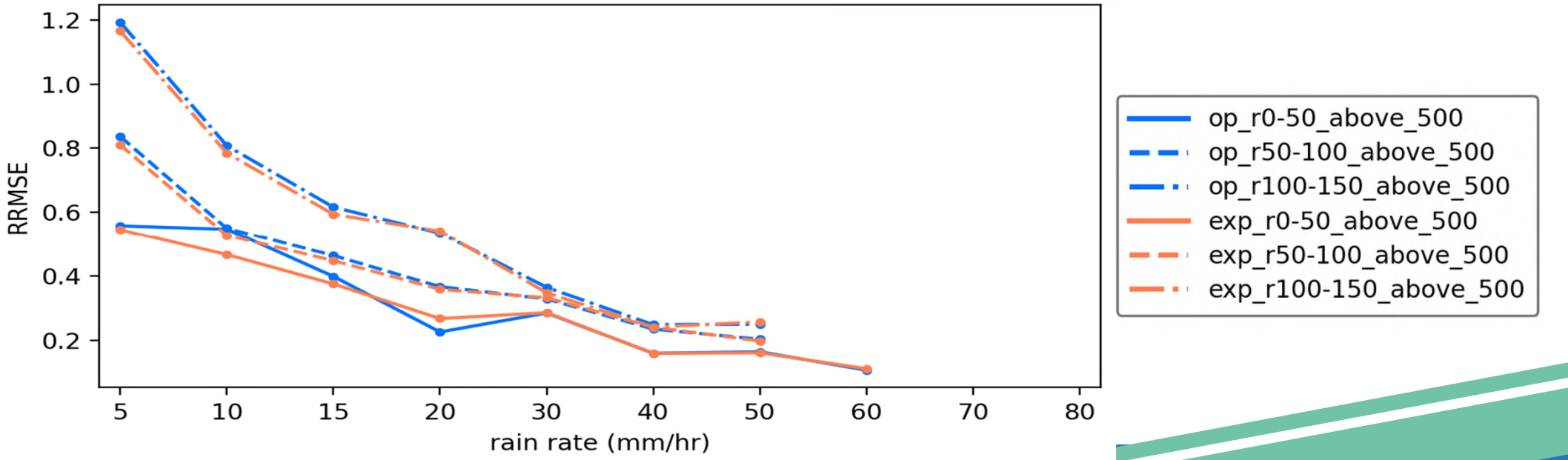
7/5-8 丹娜絲颱風

➢ RCLY 單雷達1hr QPE 在各降雨強度上的表現

Gauge Below 500m



Gauge Above 500m



8/1-5 西南氣流豪雨事件 第二波

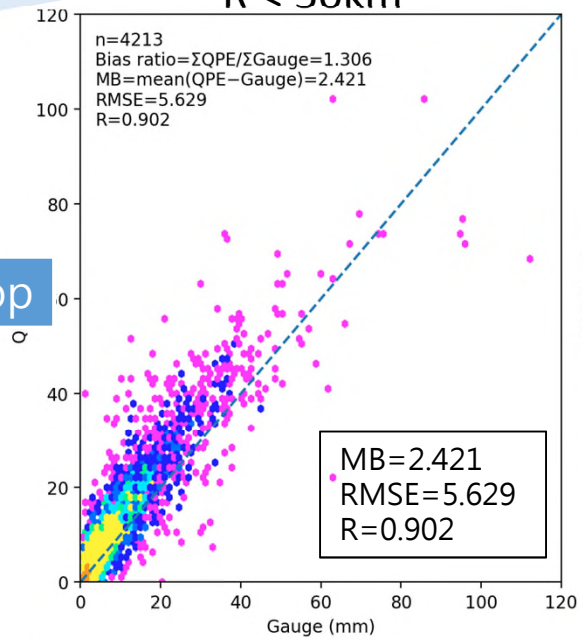
➢ RCLY 單雷達QPE vs gauge 海拔500m以下

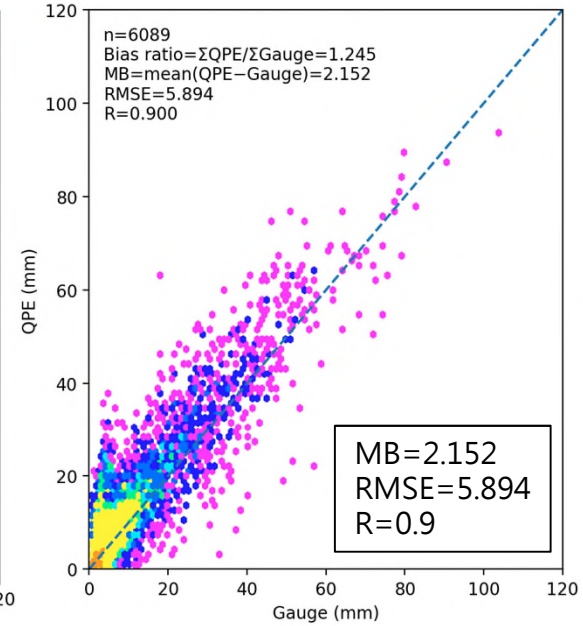
R < 50km

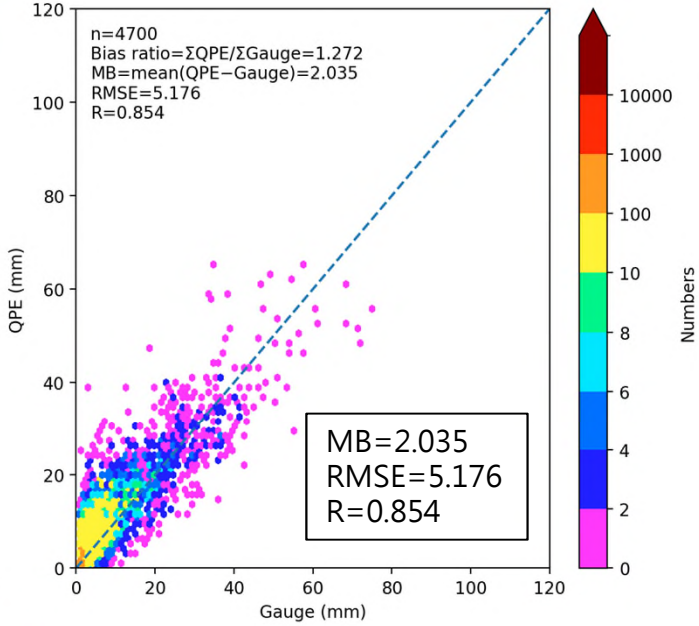
50km<R < 100km

100km<R < 150km

op







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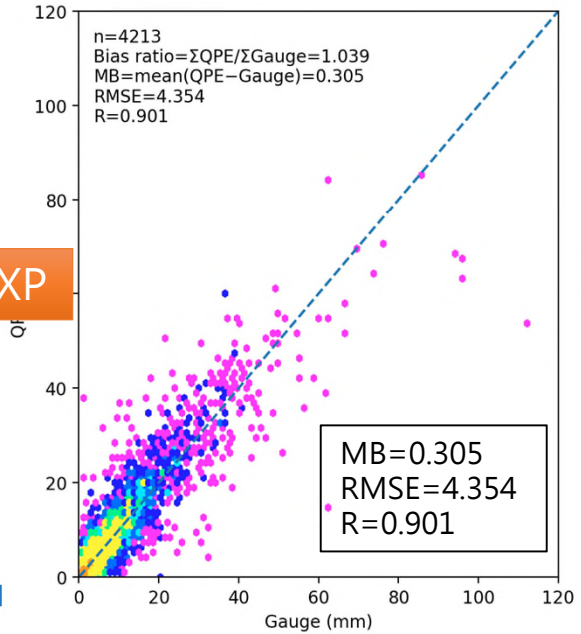
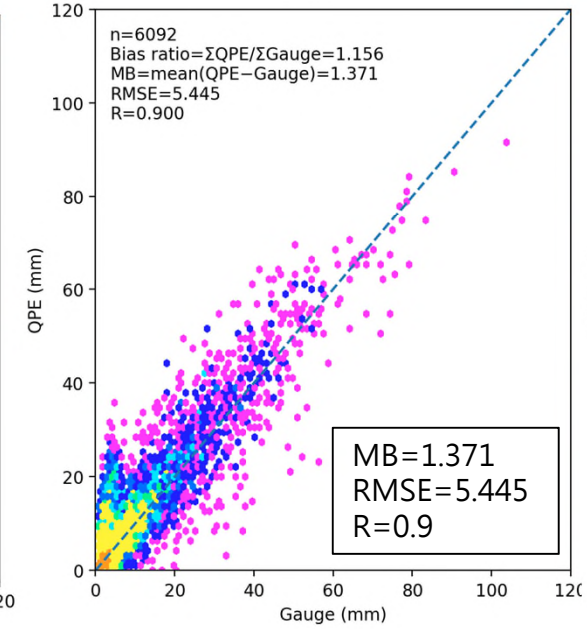
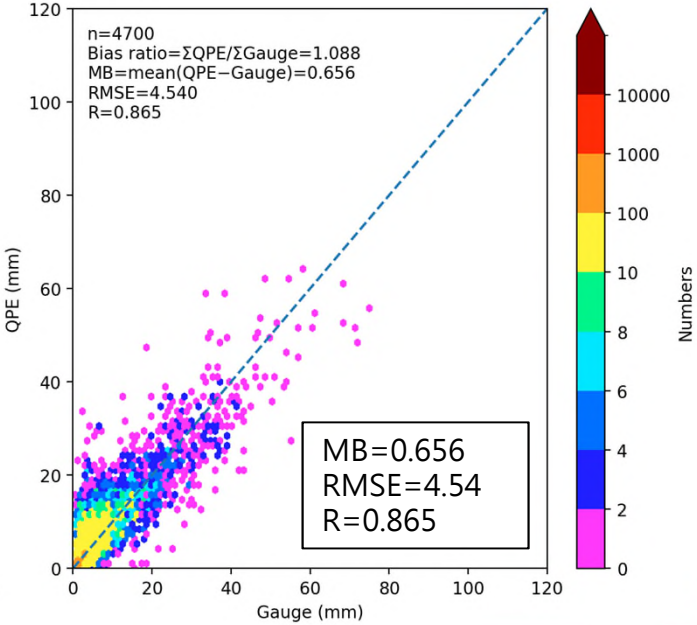
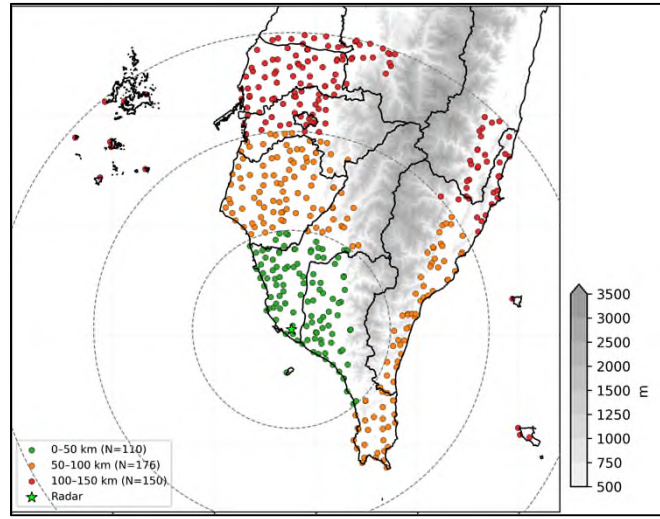
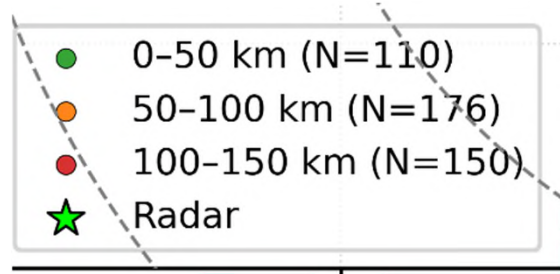










8/1-5 西南氣流豪雨事件 第二波

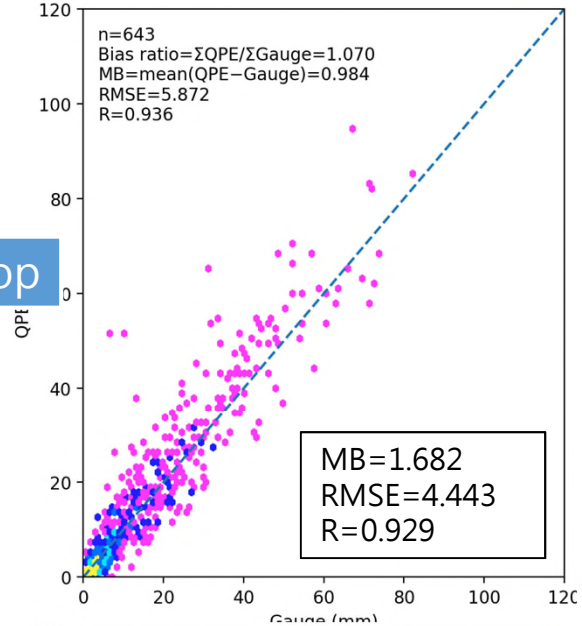
➢ RCLY 單雷達QPE vs gauge 海拔500m以上

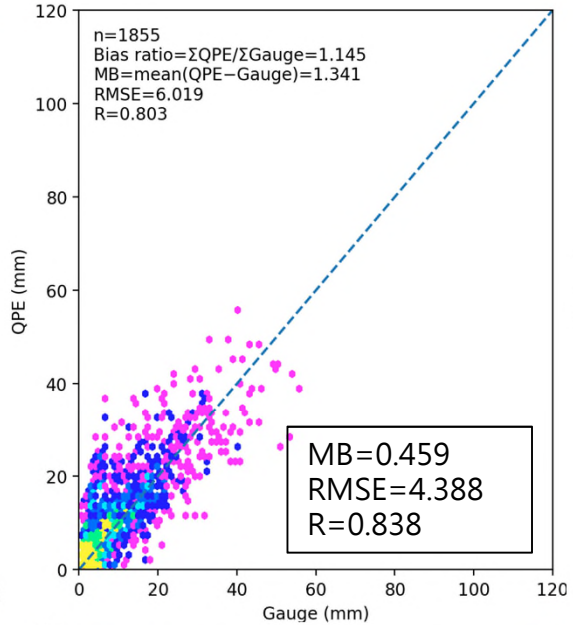
R < 50km

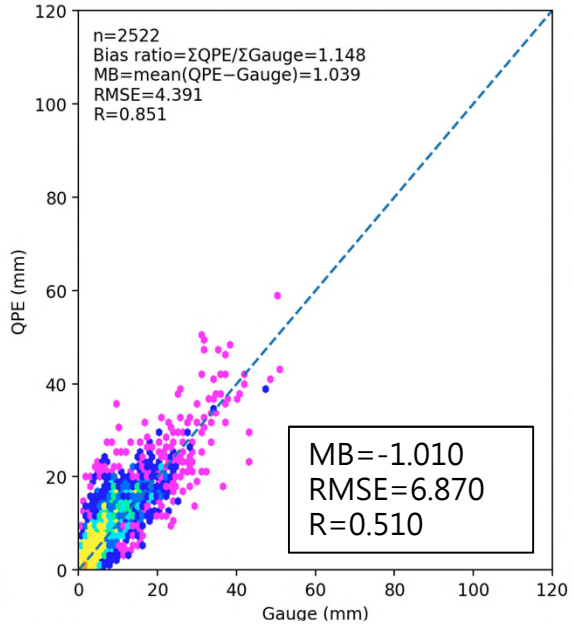
50km<R < 100km

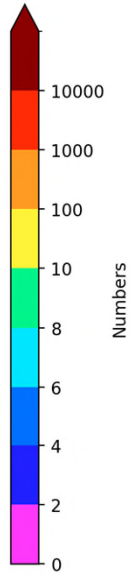
100km<R < 150km

op

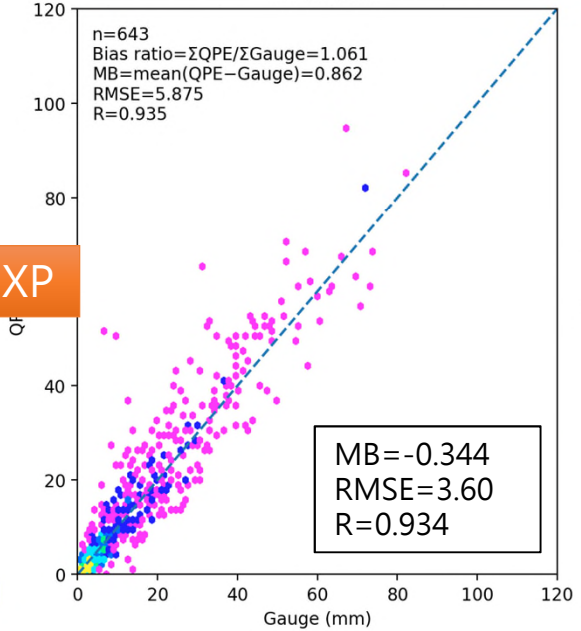


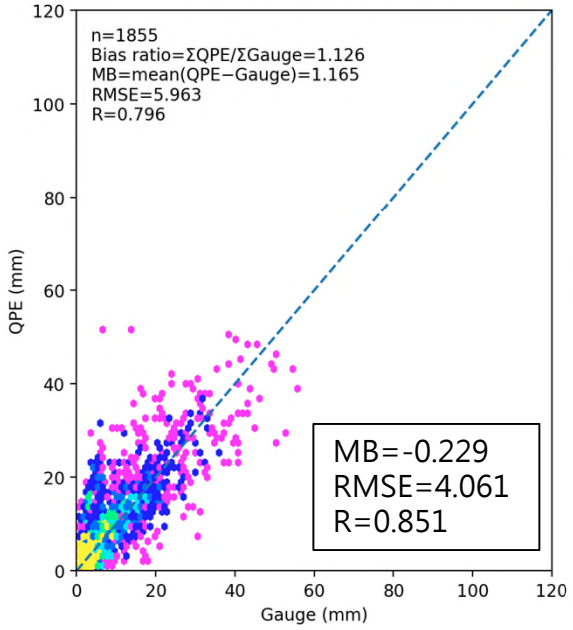


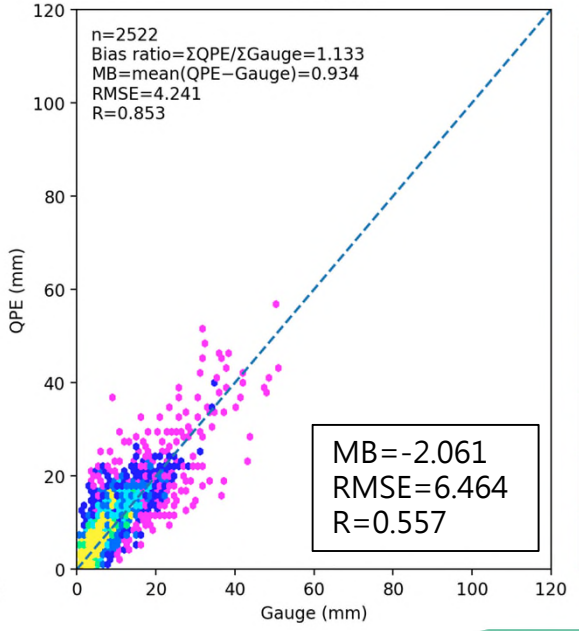


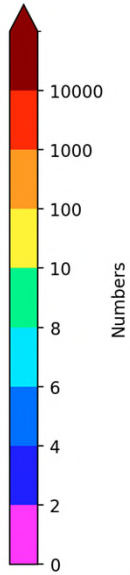


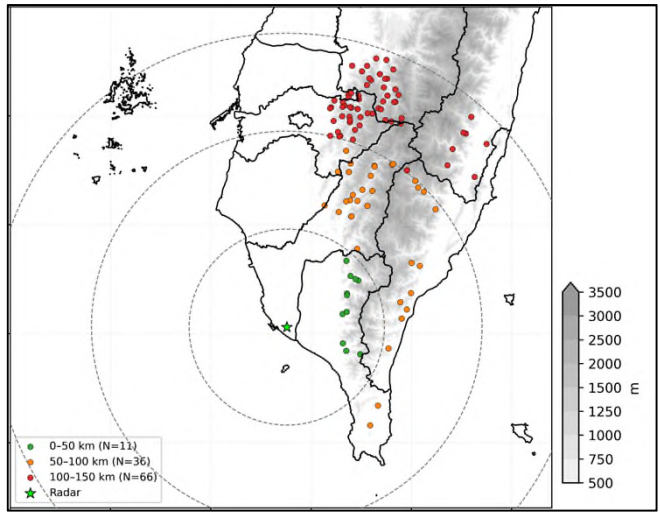
EXP

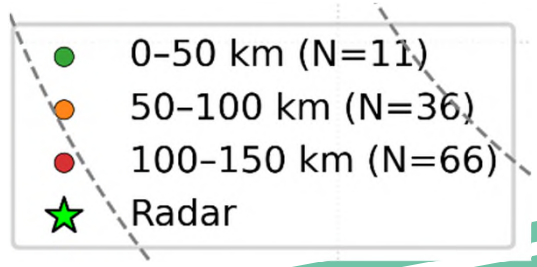






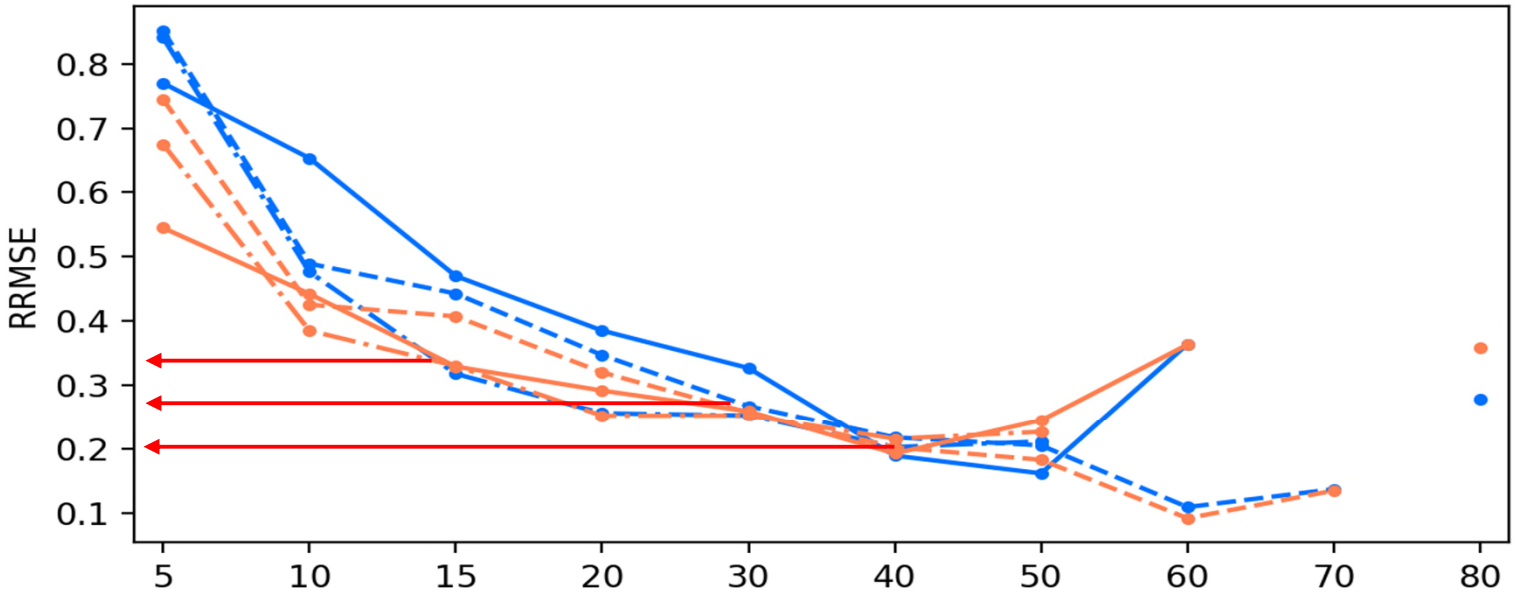




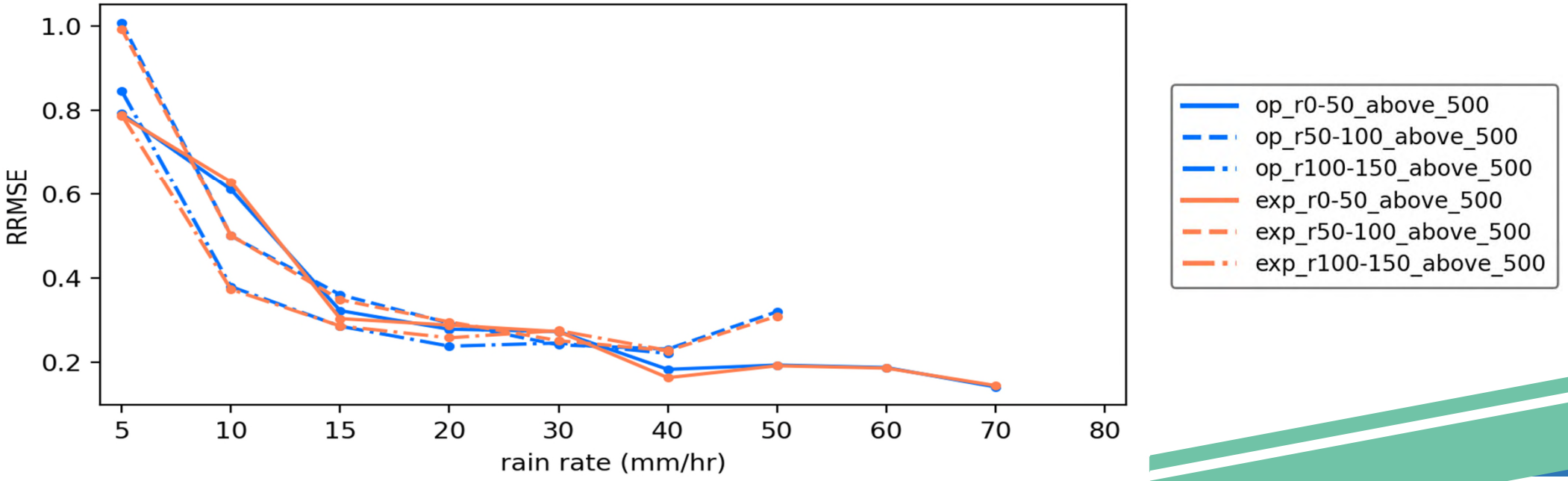


8/1-5 西南氣流豪雨事件 第二波 ➢ RCLY 單雷達1hr QPE 在各降雨強度上的表現

Gauge Below 500m



Gauge Above 500m



校驗小結

- 500m以下
  - ① 雨強30mm/hr 內 ，EXP能改善原OP中小雨高估的問題
  - ② 離雷達愈近的範圍，改善愈明顯

- 500m以上
  - ① 在各降雨強度區間，EXP幾乎與OP表現相似

結論與未來工作

- 林園降雨雷達能夠補足南部平地和中南部山區s波段雷達QPE的空洞，對於南部的降水觀測和防災預警非常重要
- 校驗結果顯示
  - Below 500m : R<50km內，條件性最大降雨率能改善舊方法中小雨(30mm/hr內)高估的問題 ; 50km < R < 150 km，高估問題也能夠獲得改善(20mm/hr內)
  - Above 500m : 不論離雷達中心多遠，新方法和舊方法校驗結果差異不大

    條件性最大本質上就是在QPE空洞多的地方和受遮蔽處會用最大值降雨率，所以兩個方法基本上在山區會是相似的結果)
- 未來工作:
  - 目前校驗的資料為RCLY七分鐘更新的降雨率來累積降雨，2分鐘更新的降雨率的校驗為後續目標