不同類型颱風之定量降雨機率預報分析與區域校驗結果

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Outline

- Introduction
- PQPF and Verification Methods
- Verification Results
- Future Works
- Summary

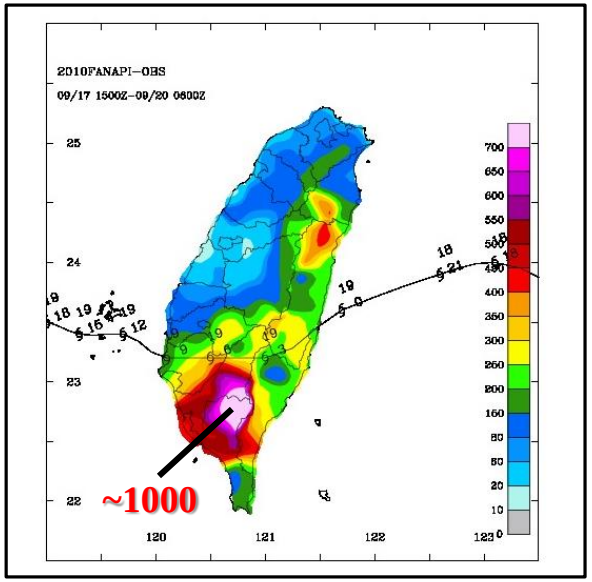
Date : 2015.09.17

Introduction

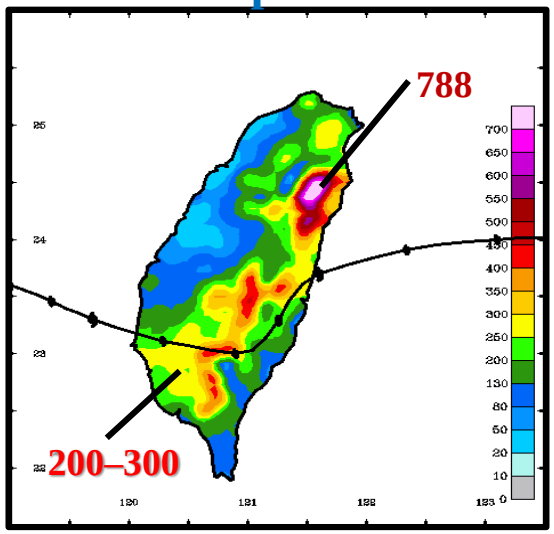
- A **typhoon rainfall climatology model** and **some deterministic forecasting models** (MM5, WRF) were developed and used many years ago.
- Although the topographical lifting of typhoon circulation (topography-locking effect) could be mainly controlled by the climatology model or single deterministic model, they might fail to provide reasonable rainfall estimates for typhoons with special convective features.

Fannapi (2010)

Observation



Model output



Inner rainband re-organized after the typhoon center moved across the mountain range causing serious flooding in Kaohsiung area.

(Lee et al., 2006; 2013)

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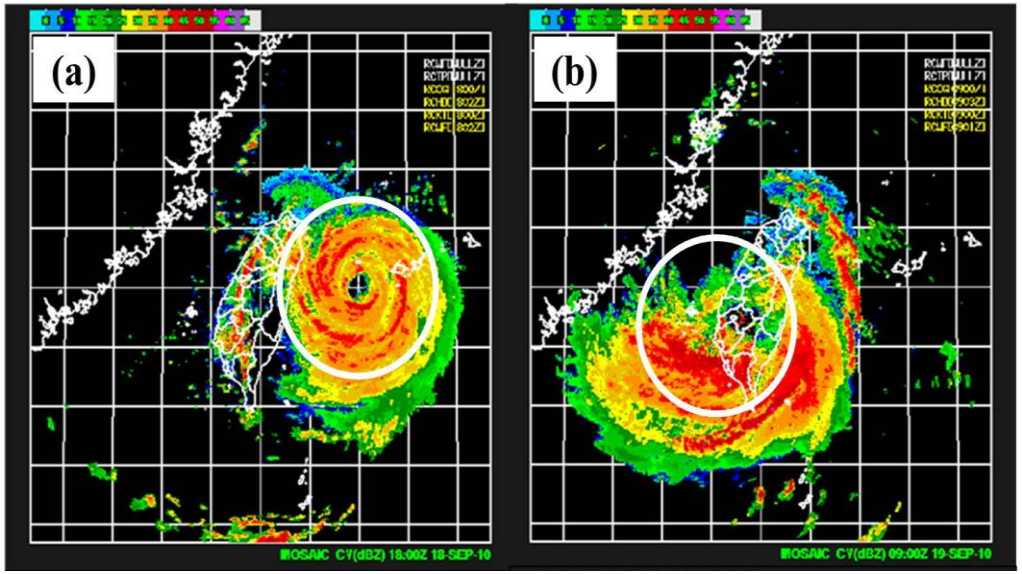
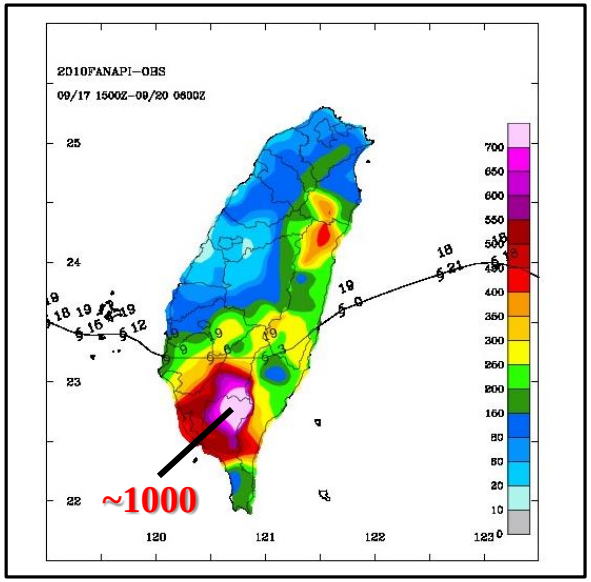


Fannapi (2010)

Observation



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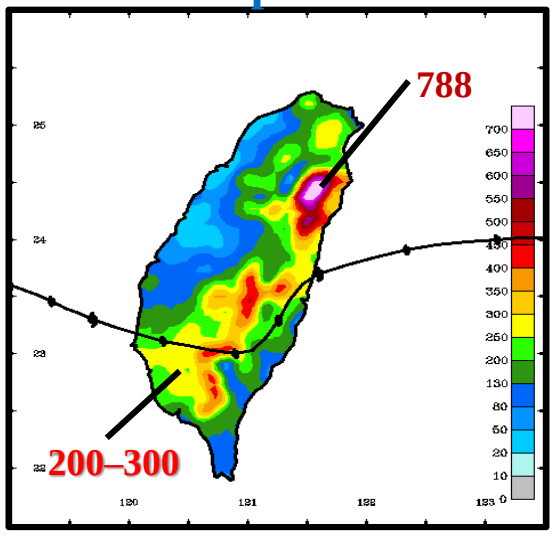


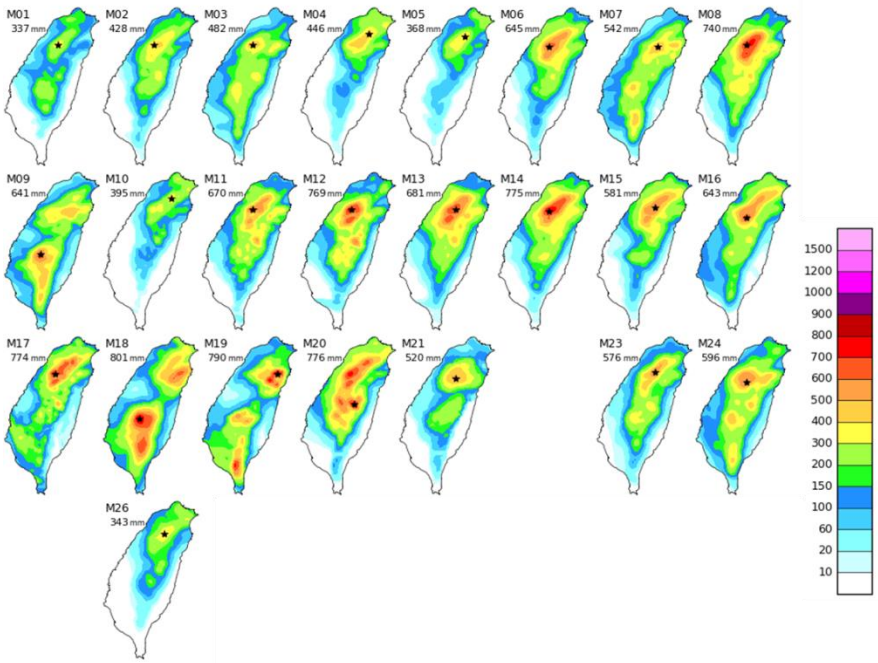
Inner rainband re-organized after the typhoon center moved across the mountain range causing serious flooding in Kaohsiung area.

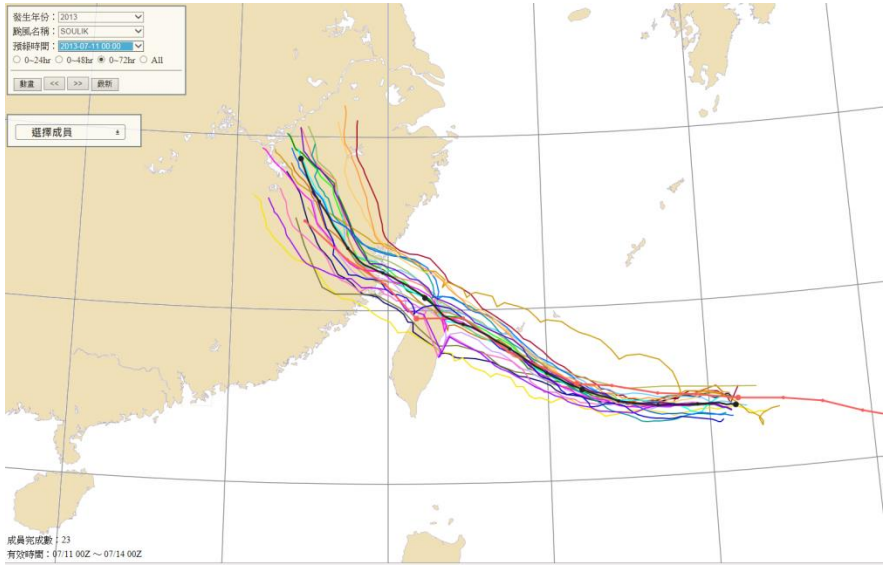
(Lee et al., 2006; 2013)

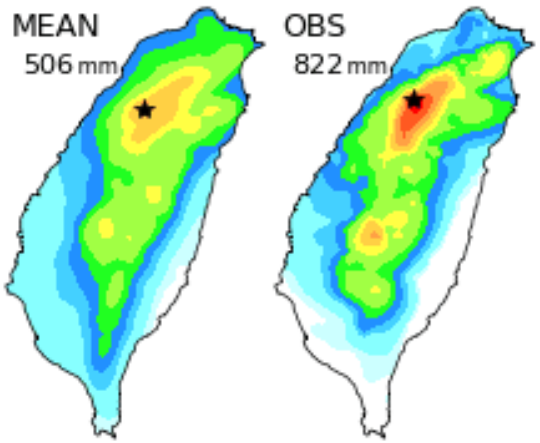
Ensemble mean

24 hr accumulated rainfall

2013 typhoon Soulik
Initial time：2013071100Z







Ensemble mean

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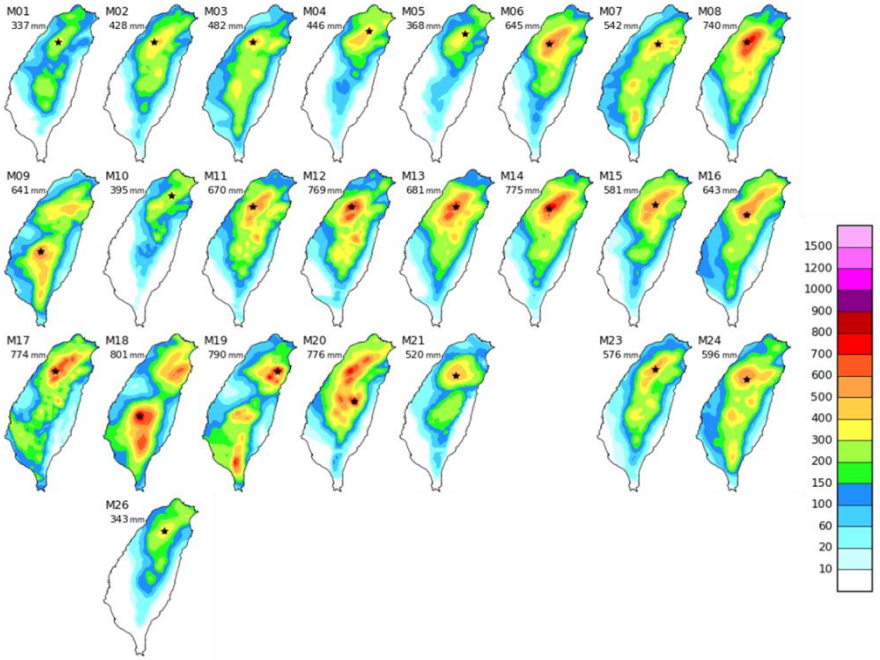
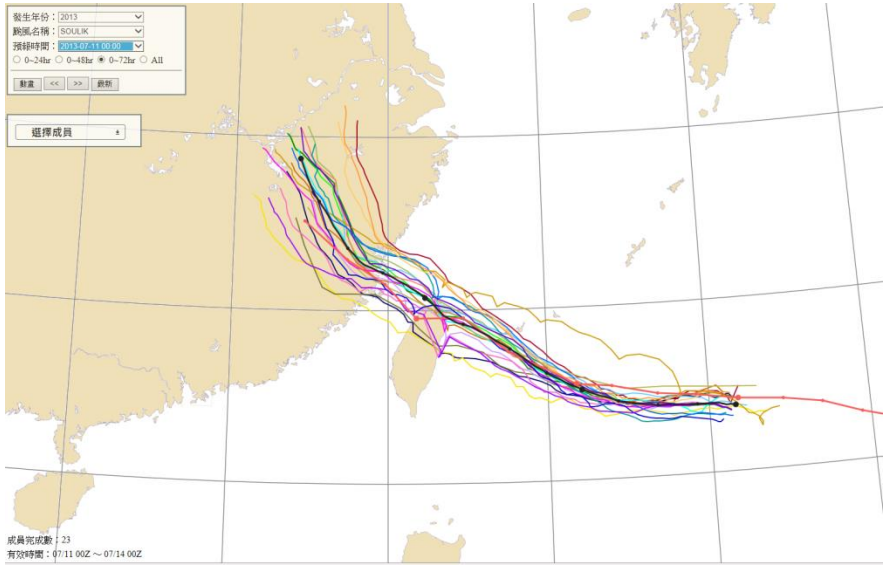
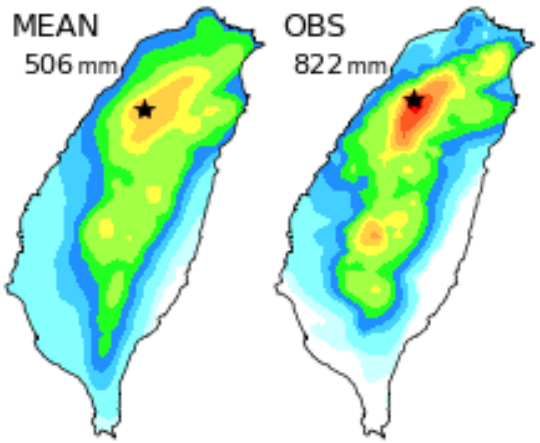






Probability Forecast?

- Ensemble mean can not show the uncertainty
- To quantify the uncertainty of the ensemble precipitation forecast, the probabilistic quantitative precipitation forecast (PQPF) is developed.

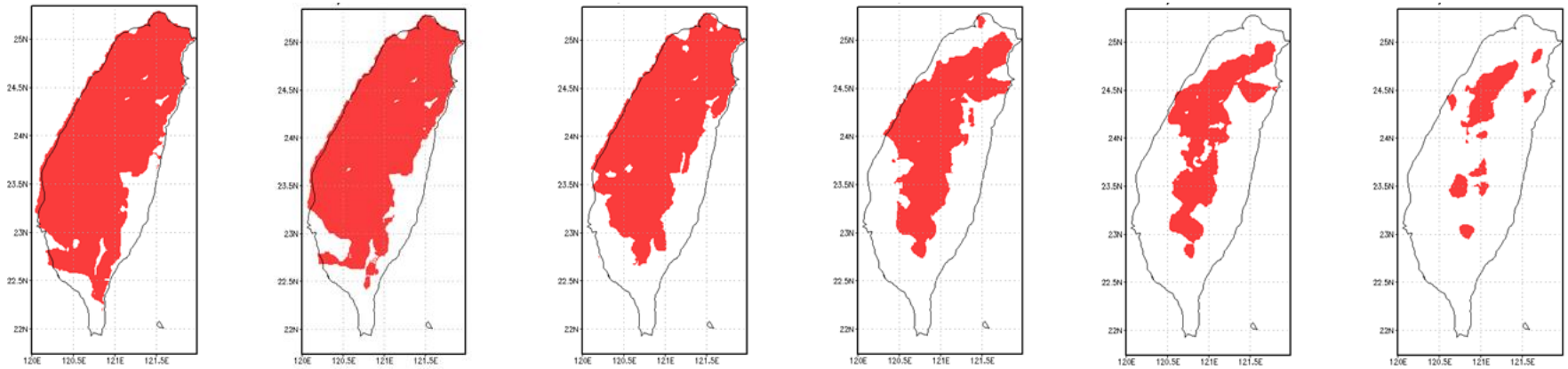
Probabilistic Quantitative Precipitation Forecast

24 hr accumulated rainfall

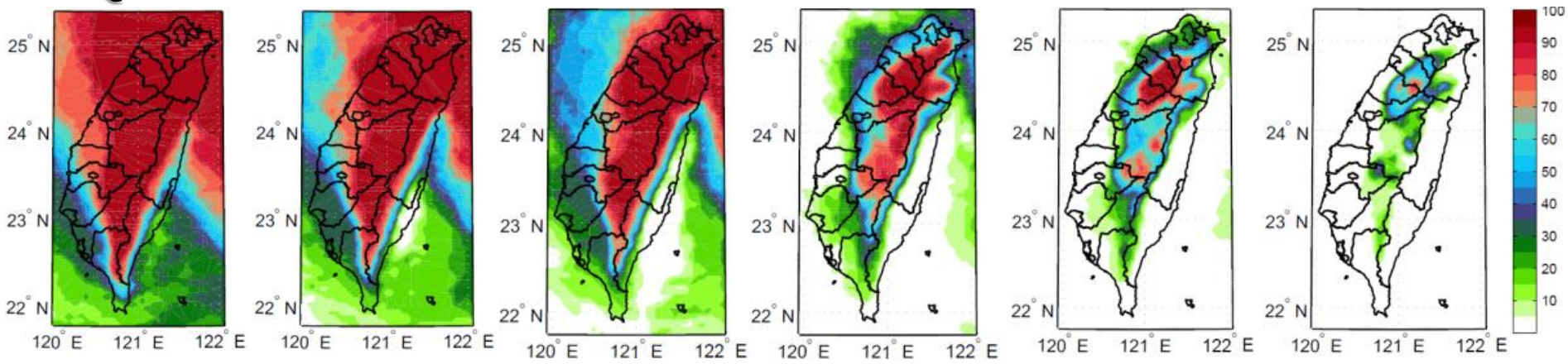
2013 typhoon Soulik
Initial time：2013071100Z

≥ 10mm	≥ 25mm	≥ 50mm	≥ 130mm	≥ 200mm	≥ 350mm

Observation



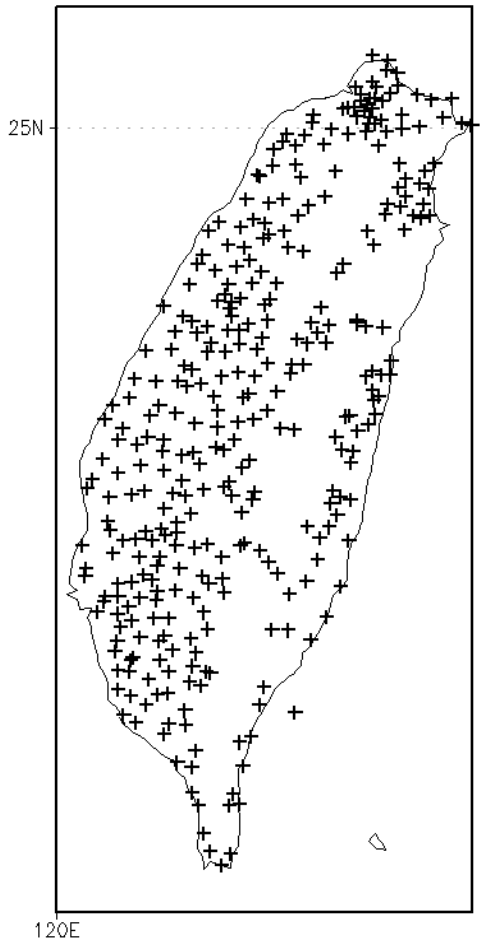
PQPF



Verification

- **Reliability diagram (RD)**
  - plots the observed frequency against the forecast probability
- **Relative operating characteristic (RC)**
  - plots hit rate and false alarm rate
  - RC area ≥ 0.7：well skill
- **Brier score (BrS)**
  - Measures the mean squared probability error
  - $BrS = \frac{1}{n}\sum_{j=1}^{n}(p_j - o_j)^2$
- **Rank probability score (RPS)**
  - Measures the sum of squared differences in cumulative probability space for a multi-category probabilistic forecast
  - $RPS = \frac{1}{M-1}\sum_{m=1}^{M}\left(\sum_{j=1}^{m} p_f(j) - \sum_{j=1}^{m} p_o(j)\right)^2$

Interpolate ENS values to 499 raingauge station



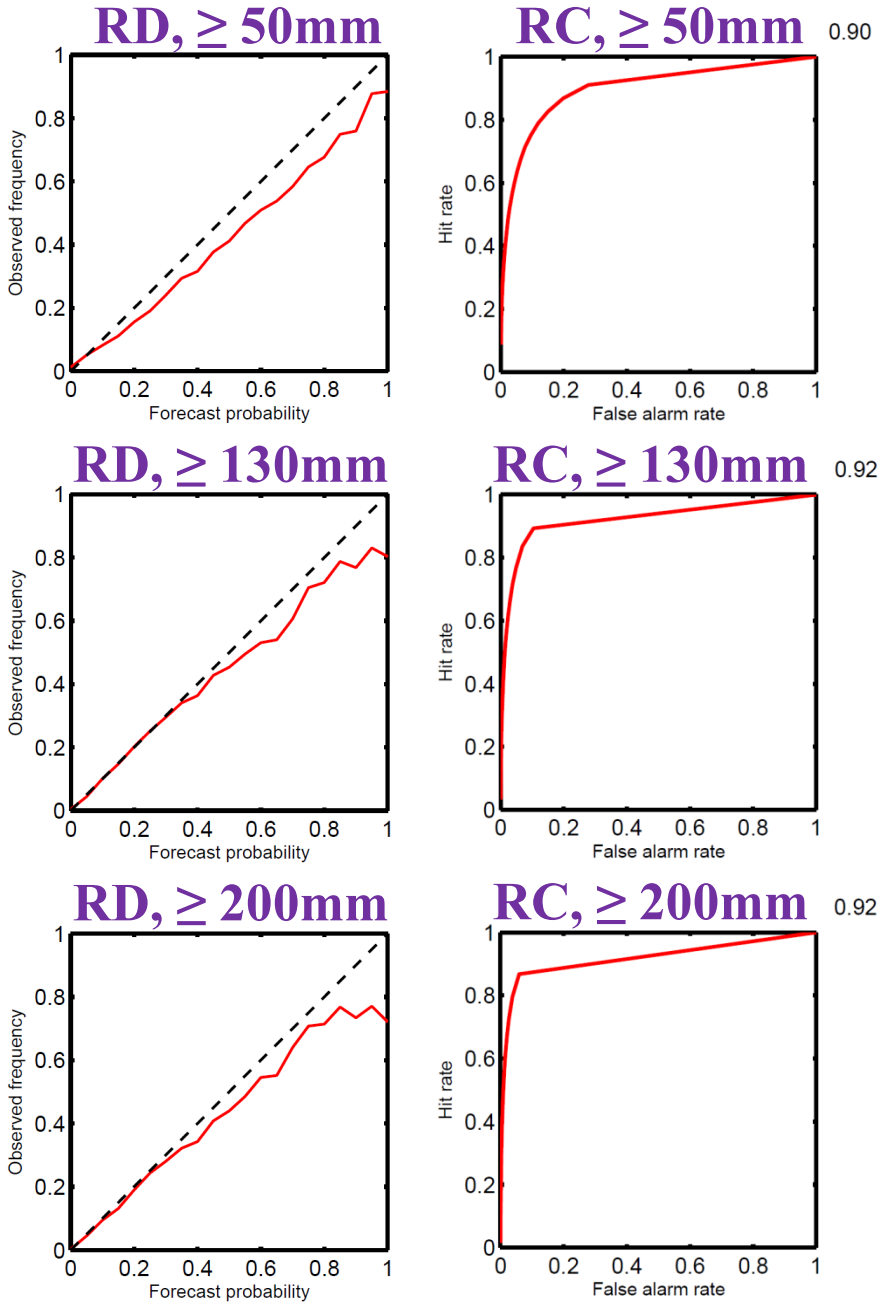
(http://www.cawcr.gov.au/projects/verification)

Verification Results

- Targets of analysis
  - **Different tracks of typhoon**
  - **Different sizes of typhoon**
  - **Specific regions in specific period**
  - Different years
  - Different intensities of typhoon
  - Different motion speeds of typhoon

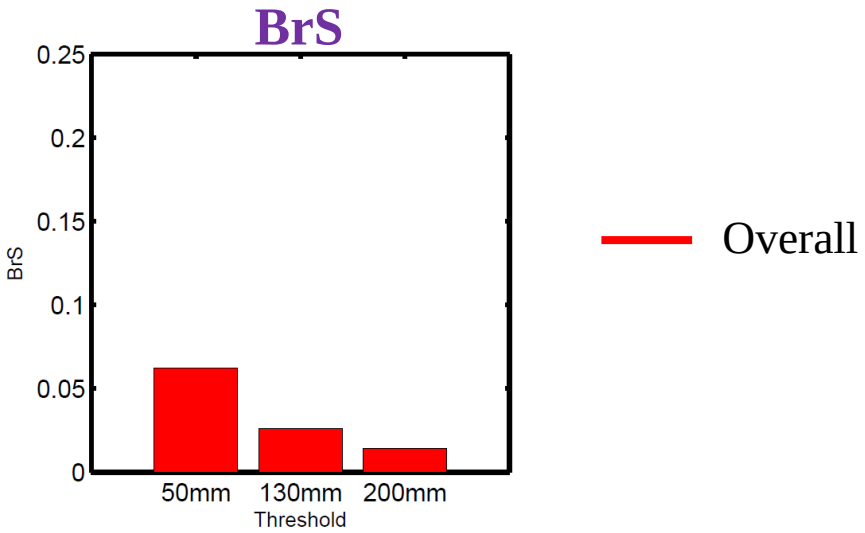
- The results of verification are significantly affected by the track and size of typhoon.

Year	Name	Track
2014	FUNG-WONG	---
2014	MATMO	W
2014	HAGIBIS	---
2013	FITOW	W
2013	USAGI	W
2013	KONG-REY	N
2013	TRAMI	W
2013	CIMARON	---
2013	SOULIK	W
2012	JELAWAT	---
2012	TEMBIN	---
2012	KAI-TAK	---
2012	HAIKUI	---
2012	SAOLA	W
2012	DOKSURI	---
2012	TALIM	N
2011	NANMADOL	W
2011	MUIFA	---
2011	MEARI	---
2011	SONGDA	---



Verification Results

- Overall, 2011-2014
- Rainfall in 24 hr
- Perform well (?!)
  - RD：overestimate for high probability value
  - RC area > 0.7
  - BrS：small



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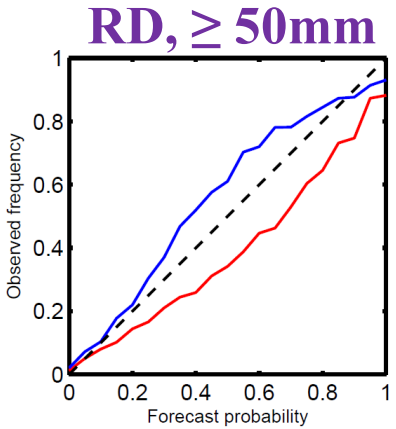
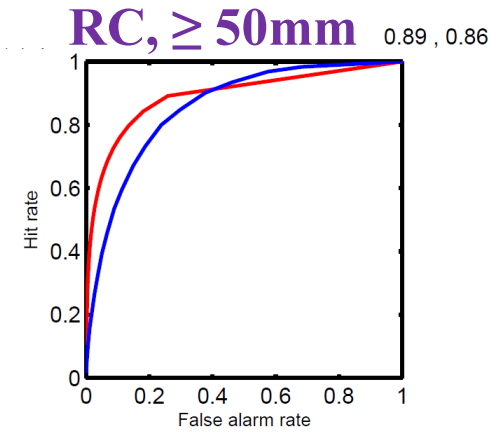
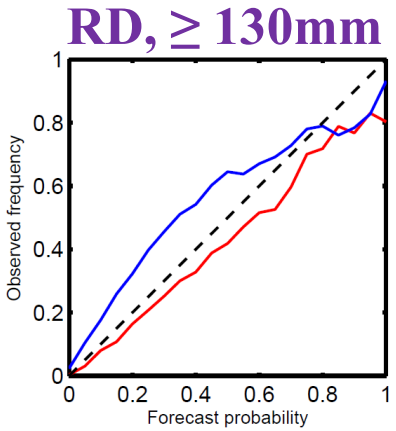
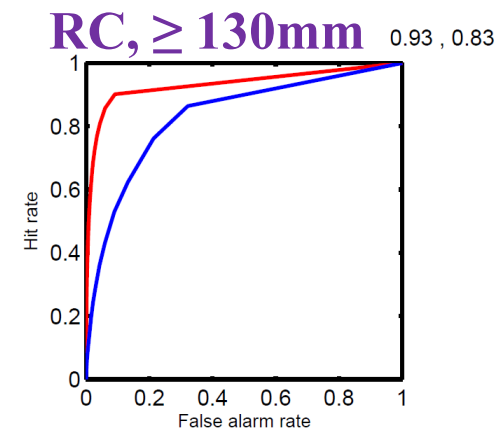
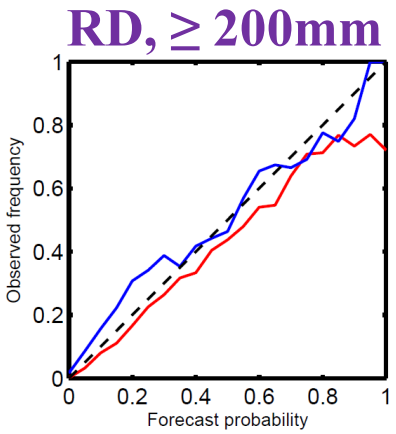
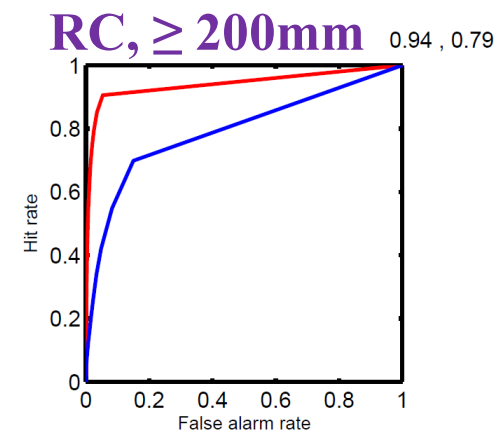




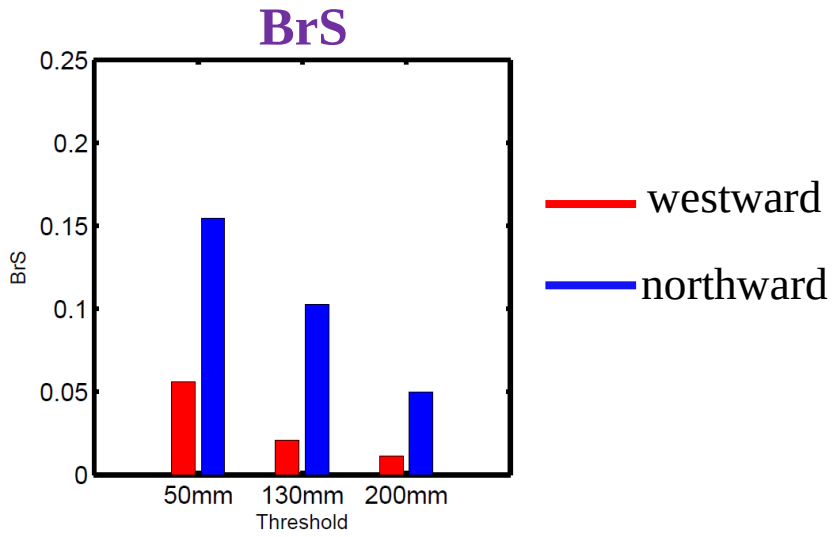






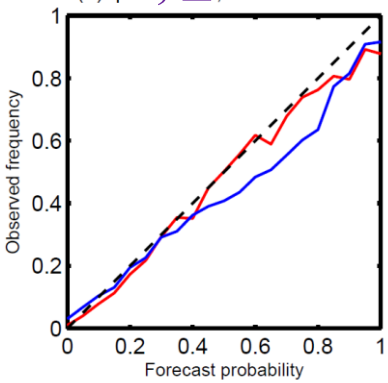


- Analysis of **different typhoon tracks**
  - Westward：track 1-5 in CWB
  - Northward：track 6-9 in CWB
- The performance for the westward typhoon is better than the northward typhoon, because the track uncertainty of the northward typhoon is more significant.

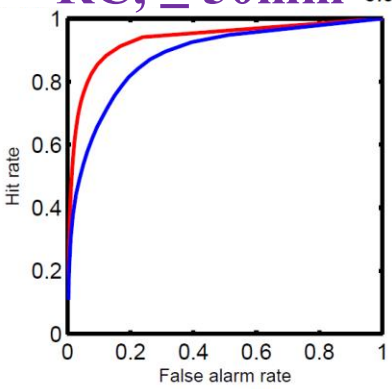


Verification Results

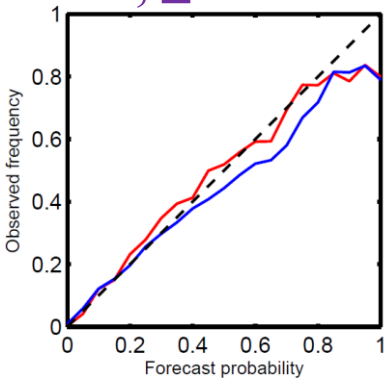
RD, ≥ 50mm



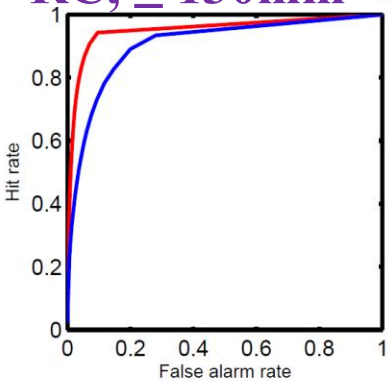
RC, ≥ 50mm 0.93 , 0.88



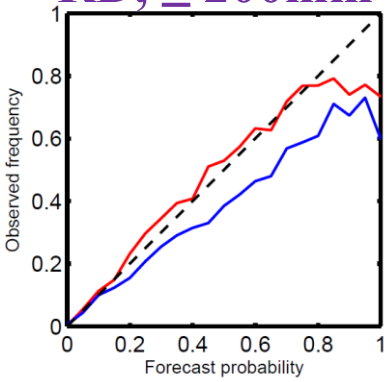
RD, ≥ 130mm



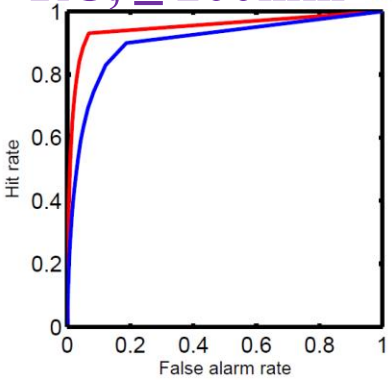
RC, ≥ 130mm 0.95 , 0.90



RD, ≥ 200mm

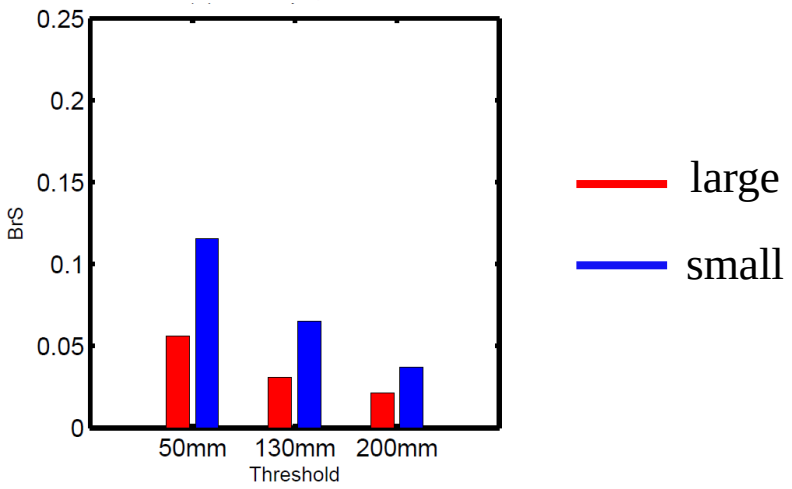


RC, ≥ 200mm 0.95 , 0.90



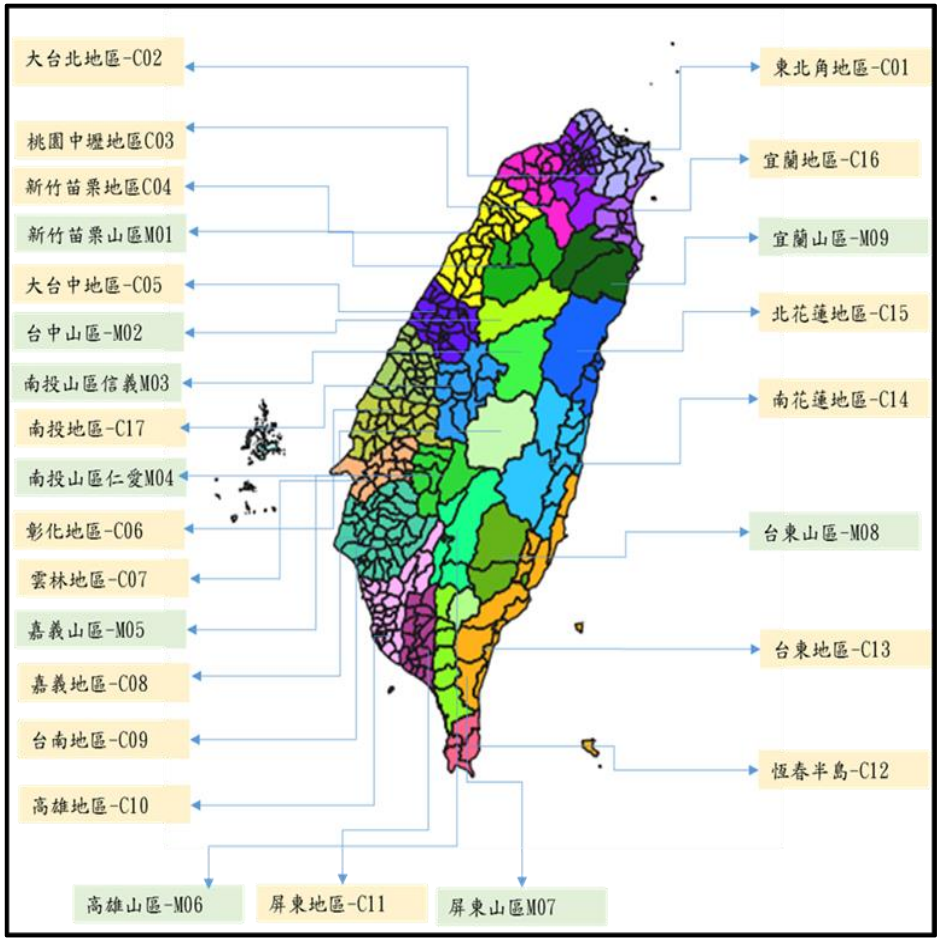
- Analysis of **different typhoon sizes**
  - Large：radius of 15 m/s ≥ 200km
  - Small：radius of 15 m/s < 200km
- The performance for the large typhoons is better than the small typhoons, because the effect of the track error will be emphasized in the small typhoons.

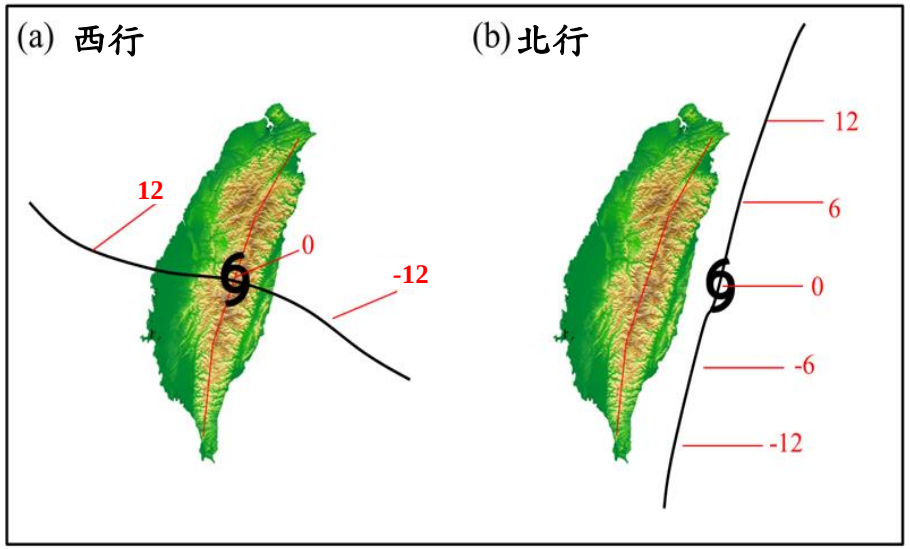
BrS

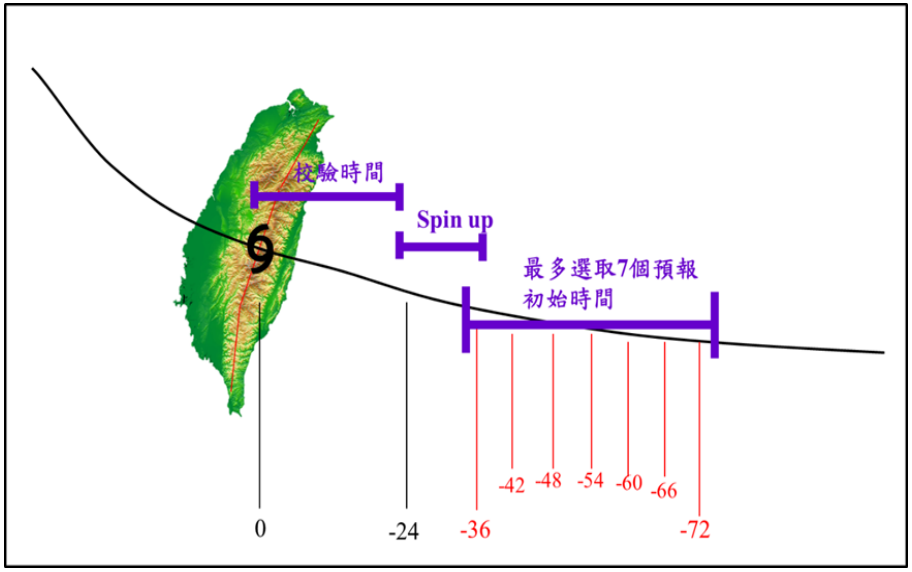


Verification Results

依地形、行政區將臺灣地區分為17個平地校驗區、9個山地校驗區，共26個校驗區。







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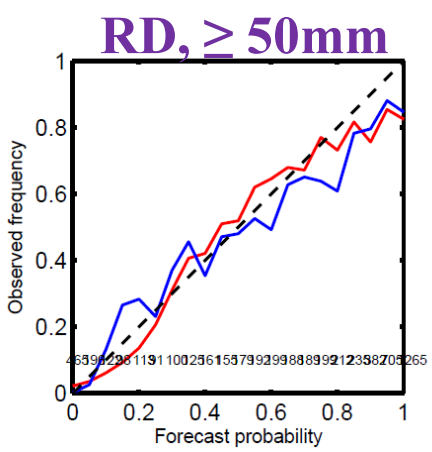
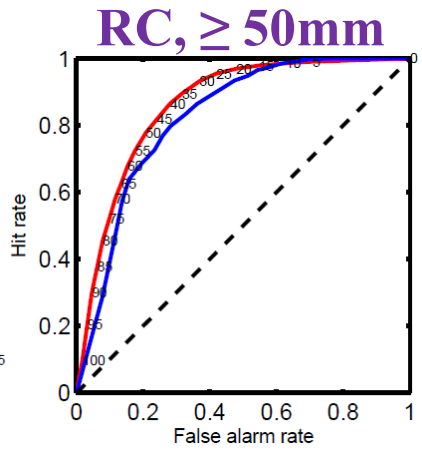
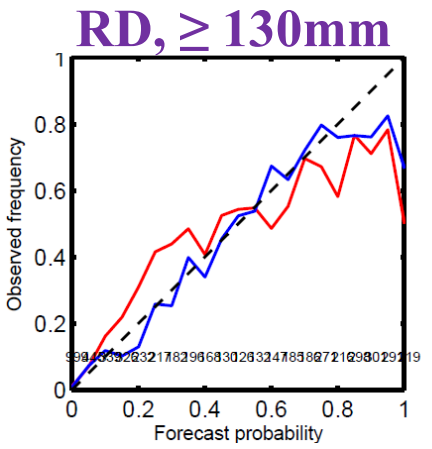
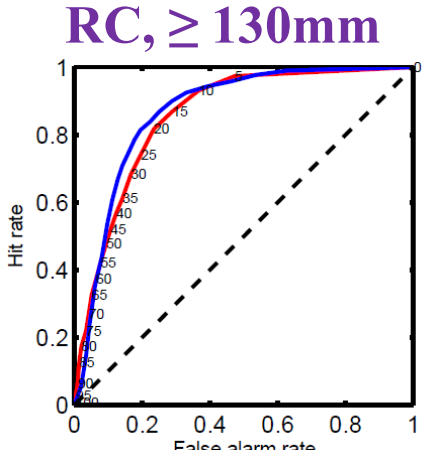
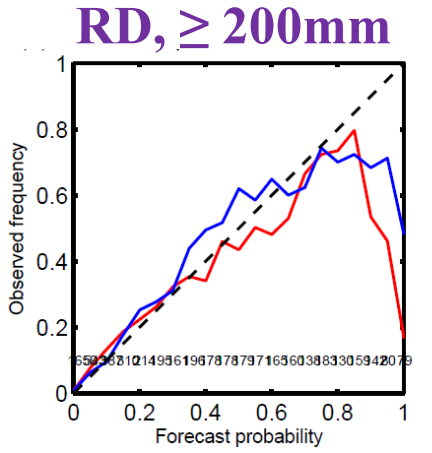
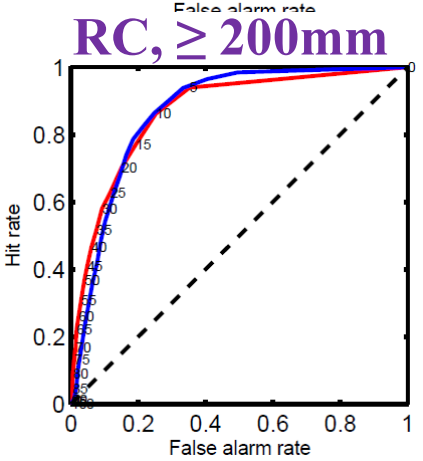




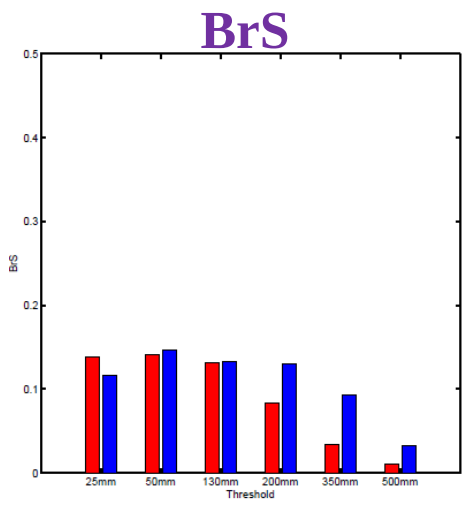








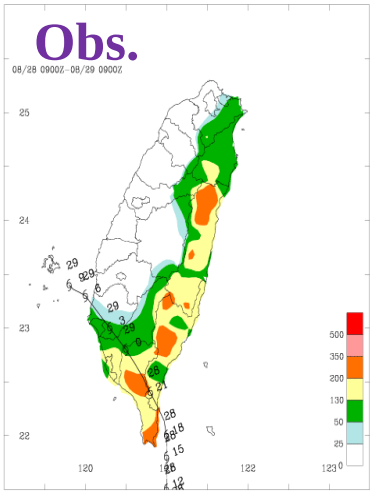
- Analyze the difference between the **city and mountain regions** during the major affecting period.
- Both are overestimated for high probability value in high rainfall threshold.

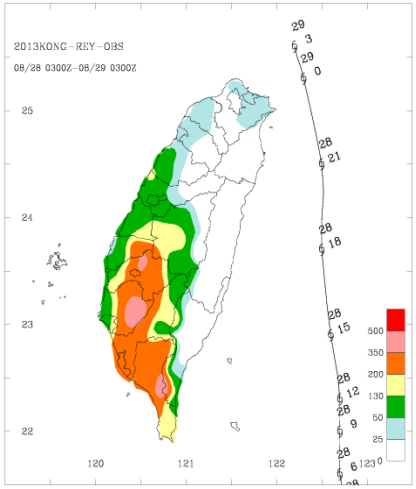


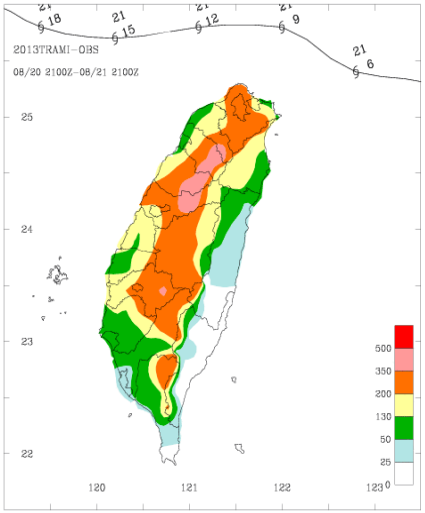
Remote Rainfall

2011 Nanmadol	2013 Kong-rey	2013 Trami

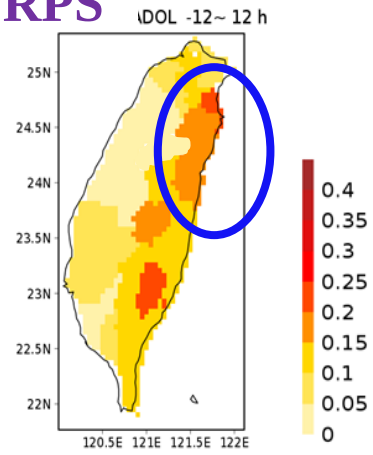
Obs.

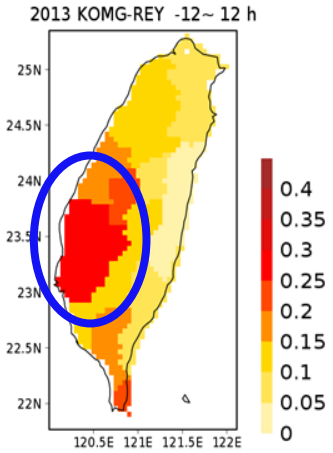


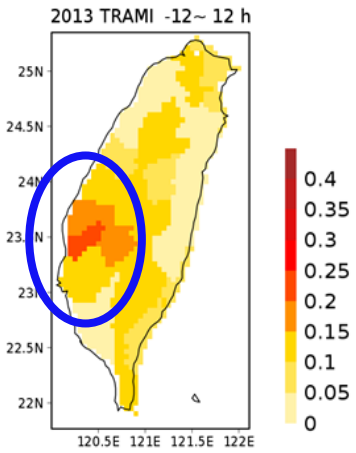




RPS

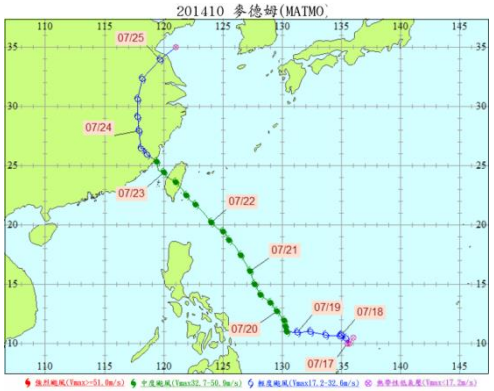




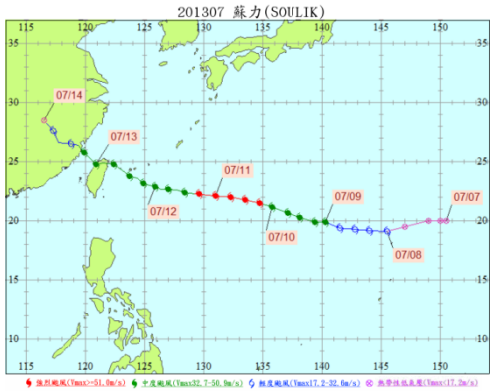


- **Remote rainfall** in the event of the typhoon tends to be **significantly underestimated** in this ensemble system.

Matmo (2014)

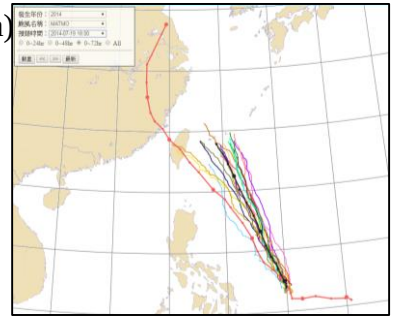


Soulik (2013)

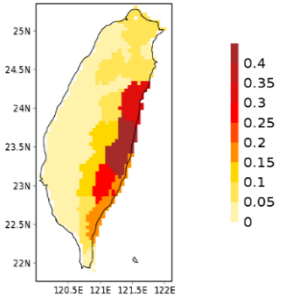


前期 (-24~0)

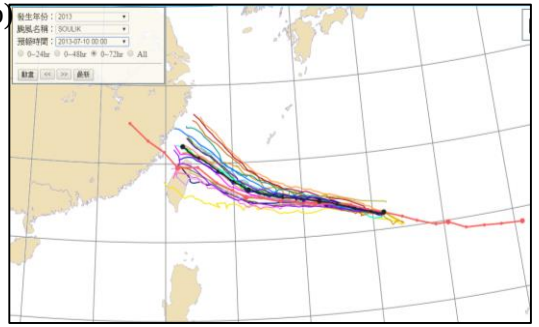
(a)



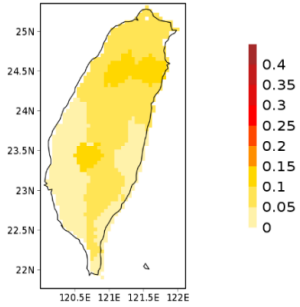
RPS



(b)

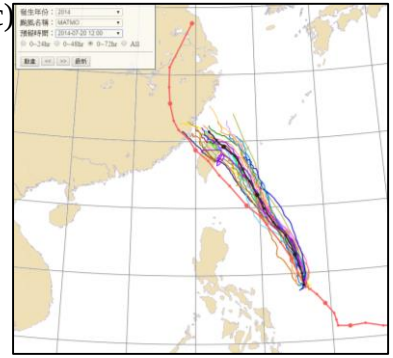


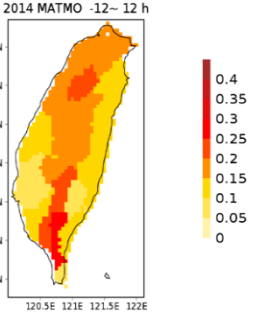
RPS



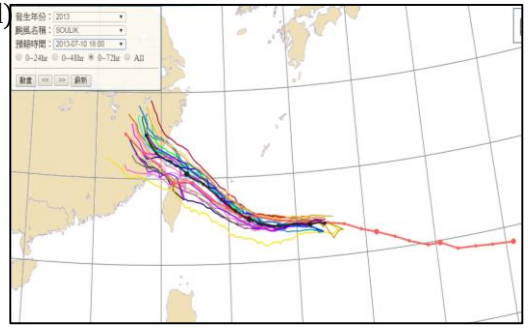
中期 (-12~12)

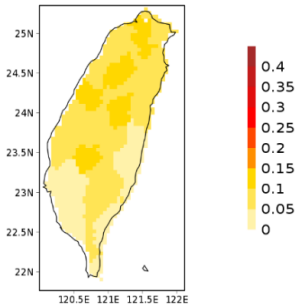
(c)





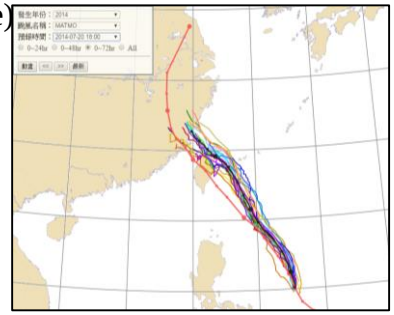
(d)

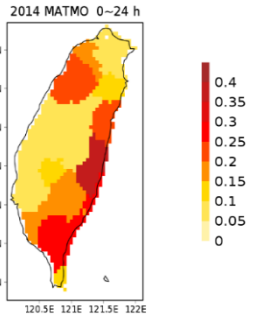




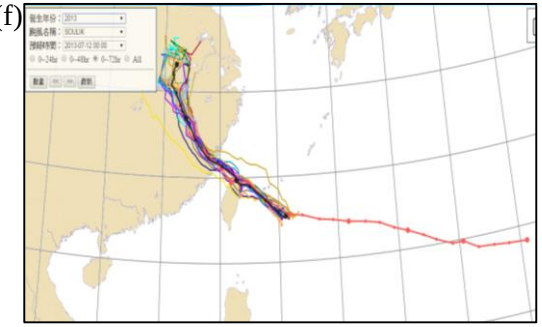
後期 (0~24)

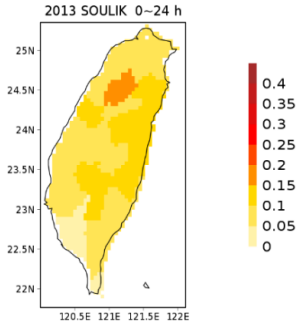
(e)





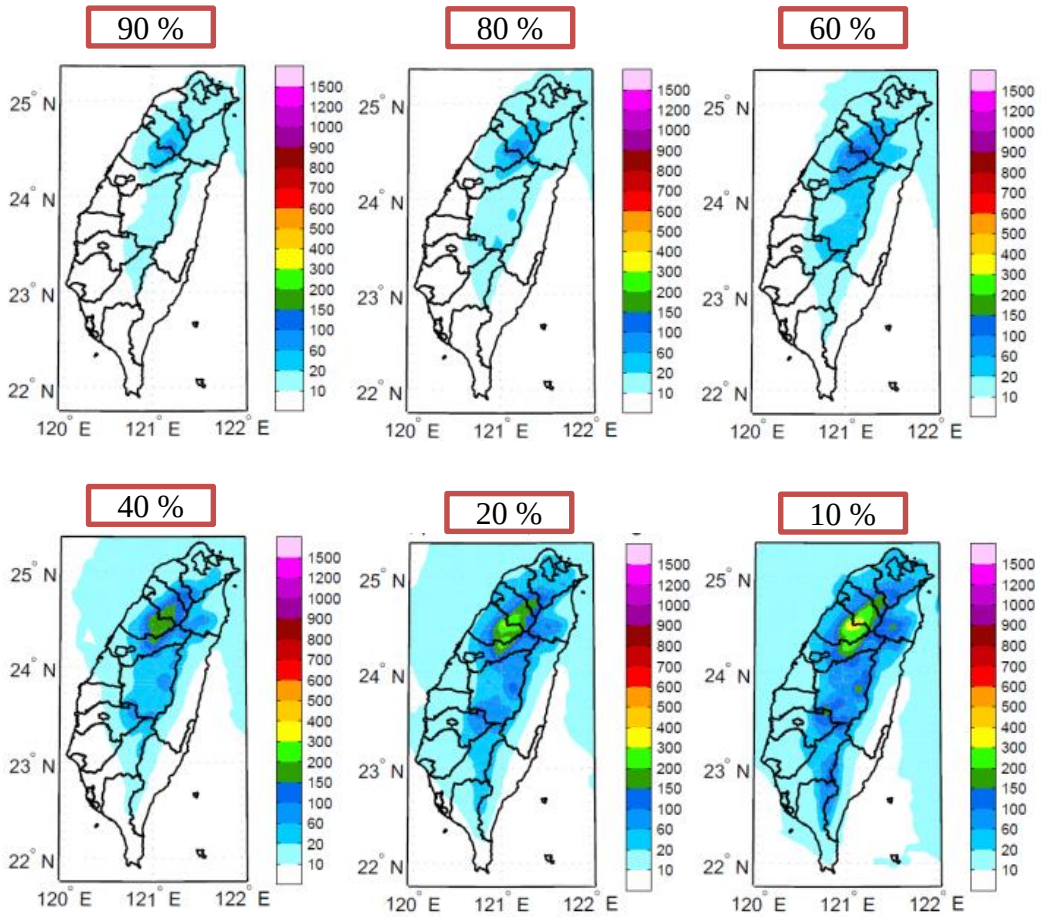
(f)



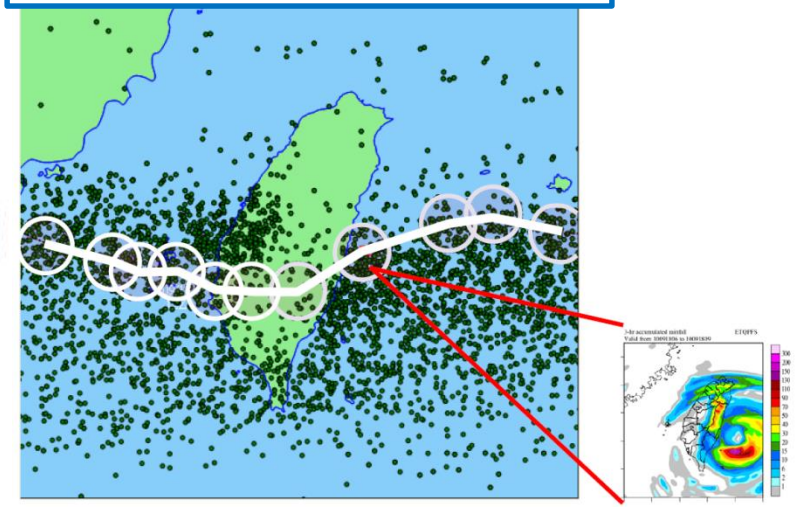


Quantitative Precipitation Forecasts Probability (QPFP) based on Typhoon Track

2013 typhoon Soulik, Initial time：2013071100Z



ETQPF (Hong et al.,2015)



- Because the probability can't be accumulated. To present the uncertainty of the forecast, the technology combining the **QPFP** and the idea of **ETQPF** may be developed in the future.

Summary

- *This study uses Taiwan cooperative precipitation ensemble forecast experiment (TAPEX) data to* ***analyze the probabilistic quantitative precipitation forecast (PQPF) and the probabilistic verification****.*
- ***Four methods of verification****, including the reliability diagram* ***(RD)****, relative operating characteristic* ***(RC)****, Brier score* ***(BrS)****, and ranked probability score* ***(RPS)****, are used to verify the probabilistic rainfall forecast.*
- *The PQPF of the* ***typhoon with smaller radius*** *during 2011–2014 is usually* ***overestimated for high probability value****.*
- ***The averaged error of PQPF for the northward typhoon is larger than the westward typhoon****, because the track uncertainty of the northward typhoon is more significant.*
- *The main future study challenges in this ensemble system are the significant underestimation of the* ***remote rainfall*** *and the* ***consistent ensemble tracks shifting****.*

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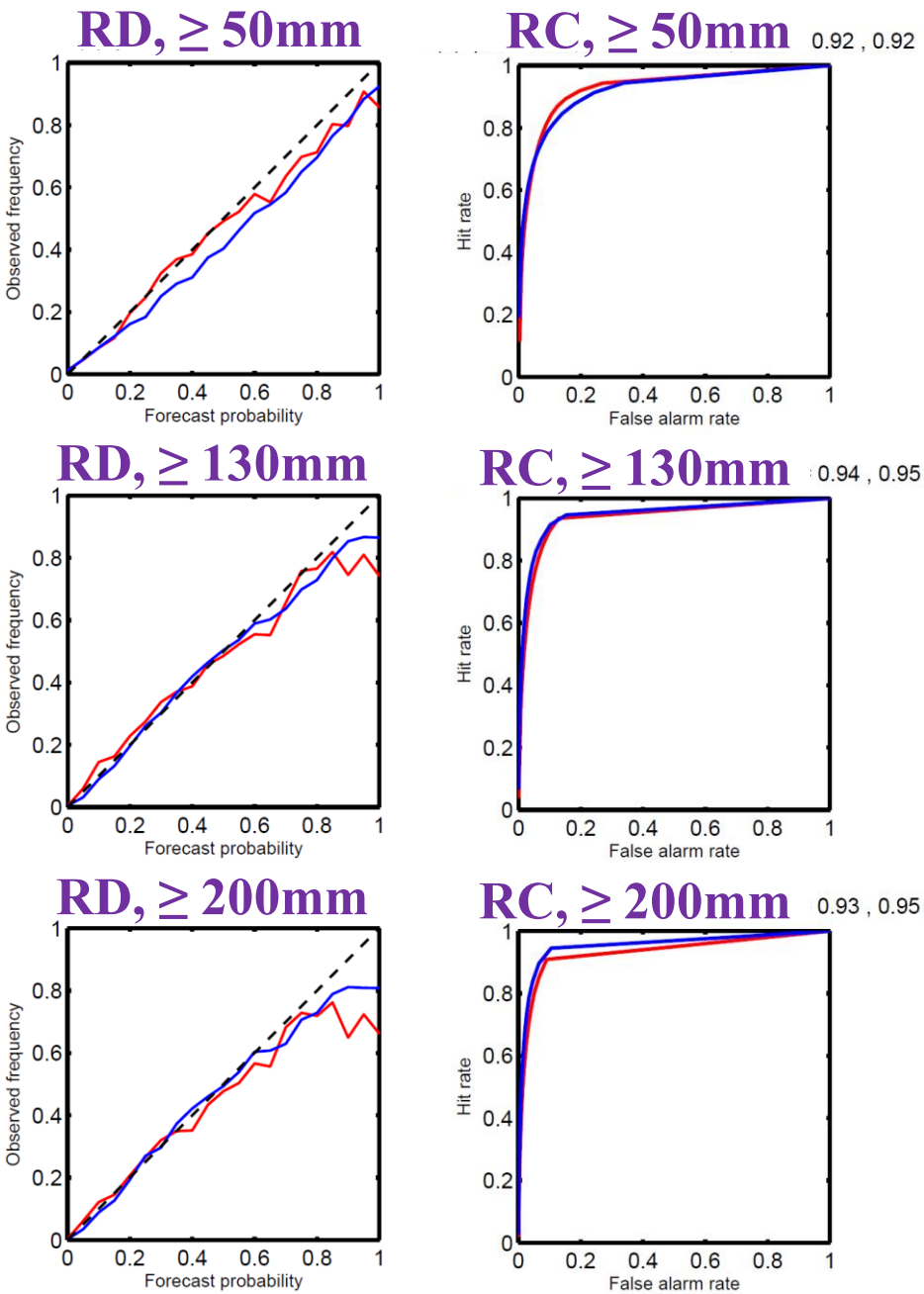
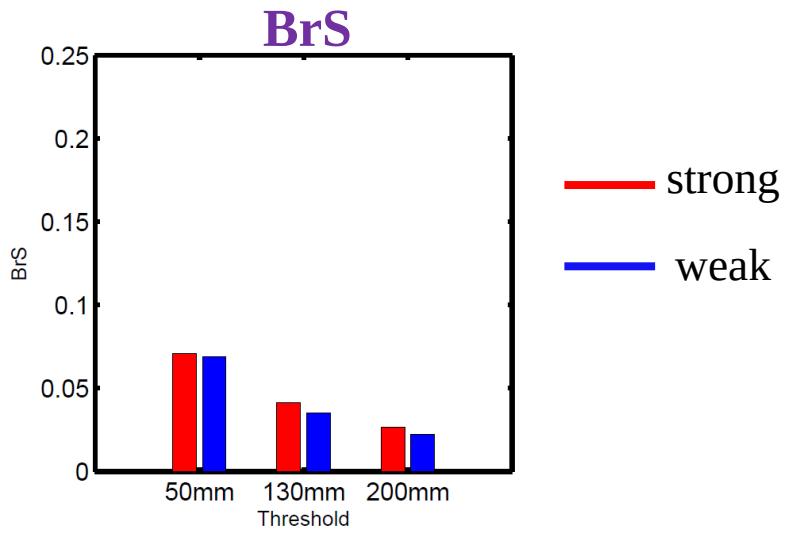
~The End~

Thank you for your attention!

Verification Results



- Analysis of different typhoon intensity
  - strong：Cat 3, Cat 4, and Cat 5
  - weak：TS, Cat 1, and Cat 2
- The performance is no significant difference between the strong typhoons and the weak typhoons.