An Evaluation of Forecast Performance on Summertime Afternoon storms in Taiwan by the CReSS Model

CReSS模式對臺灣夏季午後陣雨預報能力評估

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Purpose

1. To evaluate performance of afternoon storms forecast by CReSS in Taiwan.

2. To evaluate performance of afternoon storms forecast in correct regions (Northern, Central, Southern, Eastern Taiwan) .

3. To evaluate performance of afternoon storms forecast accumulated rainfall in Taiwan.

Data Source

Observation :

CWB

Daily accumulated rainfall (updated every hour) ;

Satellite Visible (or IR) cloud image;

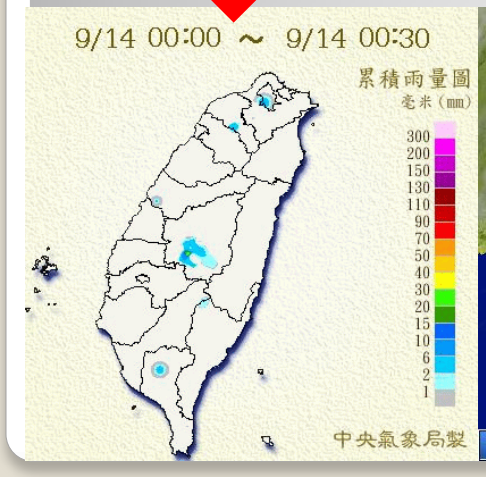
Surface weather map

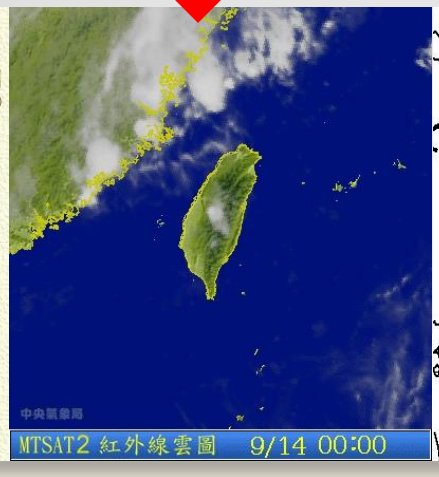
Forecast:

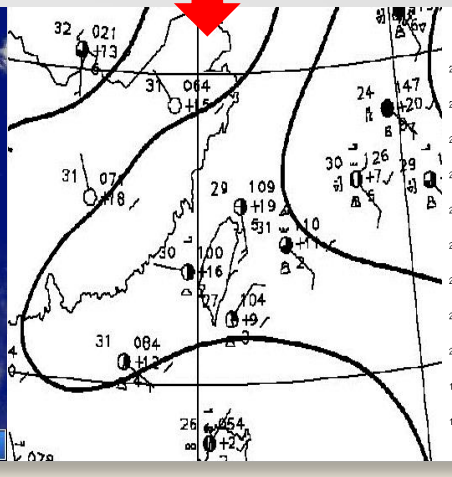
CReSS【*2.5km x 2.5km《Grid size》，72hr《forecast length》*】

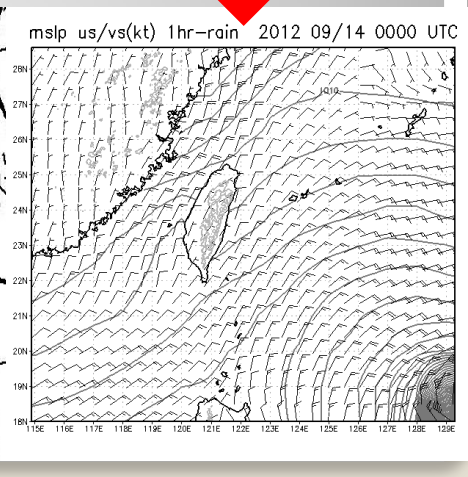
Hourly rainfall forecast

(0000UTC forecast made two days before，one day before and on that day.)









Method

1-1. Exclude the days which were affected by a typhoon or front.

1-2. Exclude the rainfall cases caused by clouds that move from the ocean.

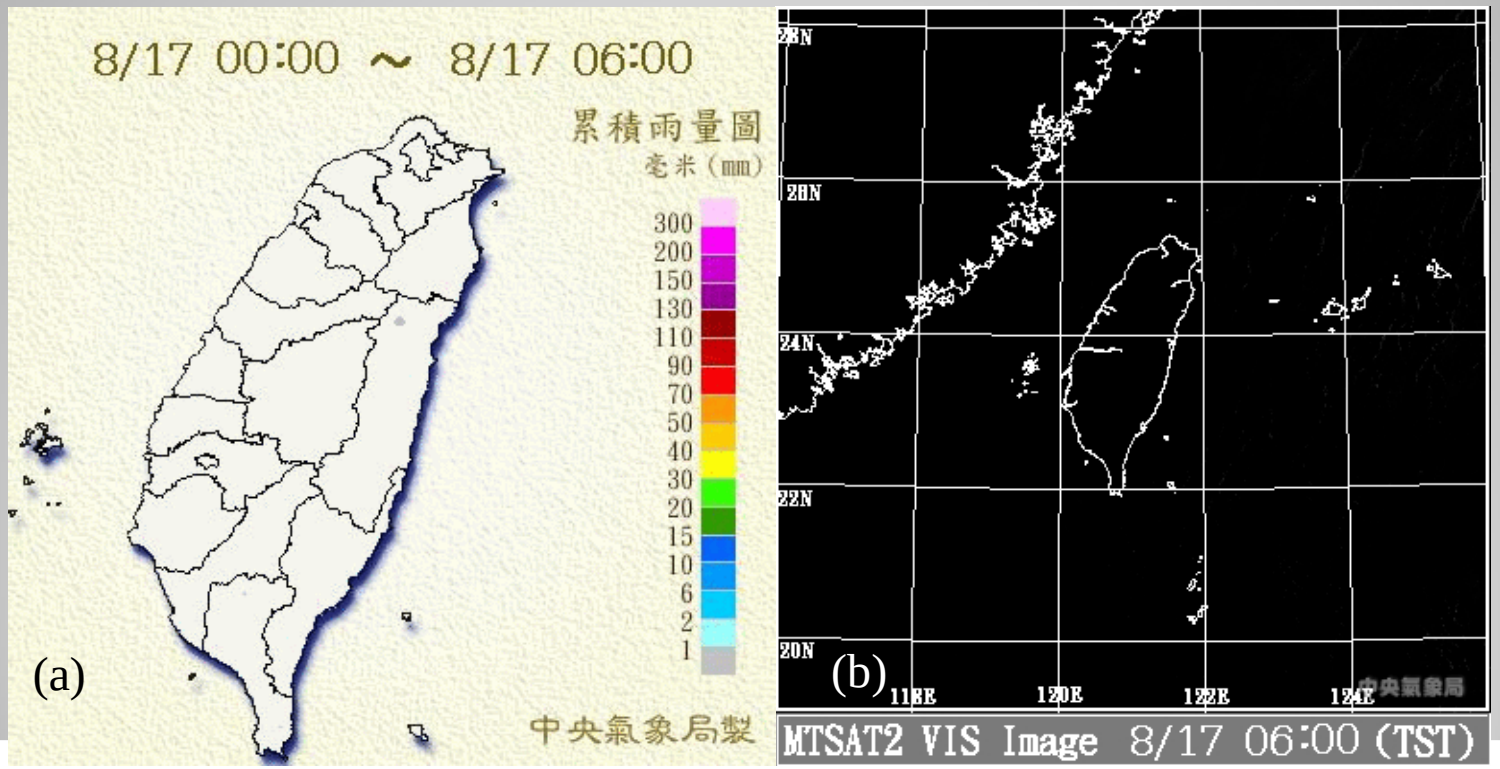
2. Record information (including accumulated rainfall, region, starting time) in observation and forecast.

3. Compute statistics and analyze the results.

What does afternoon storms look like

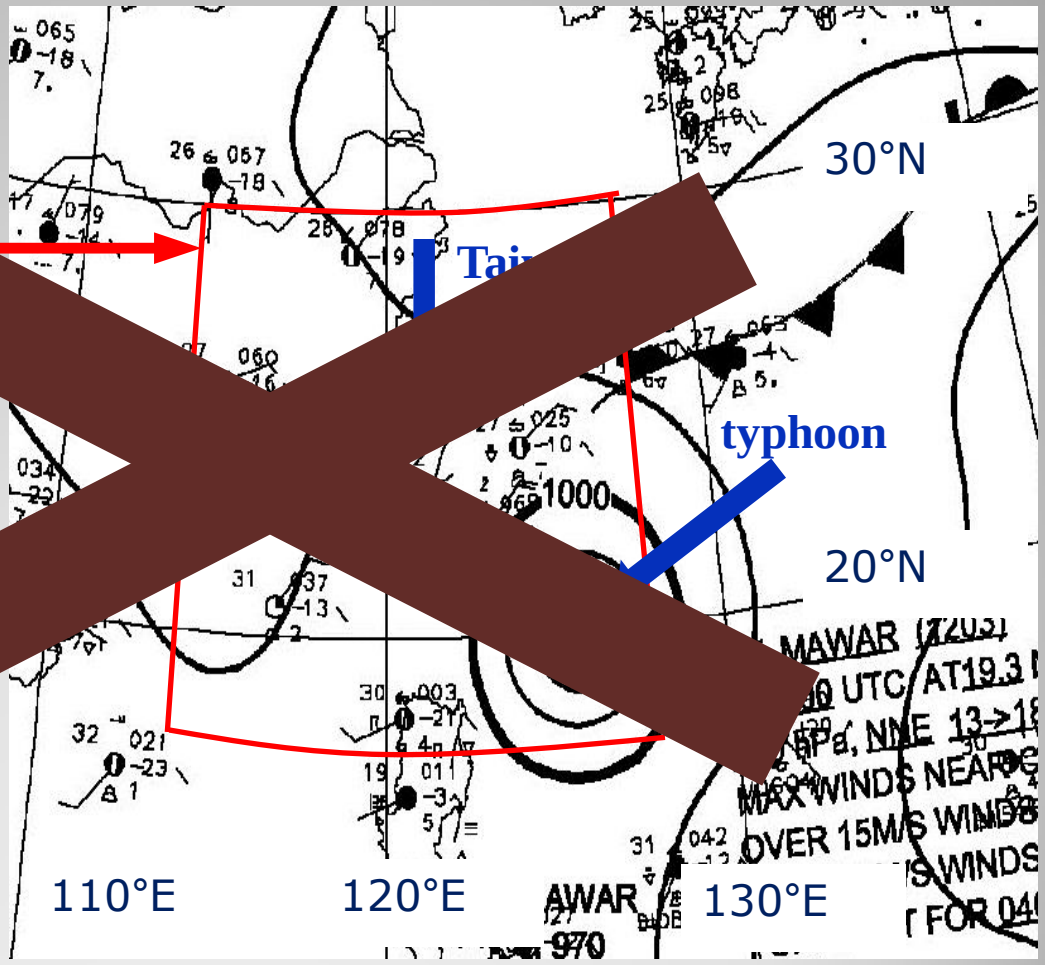
Clouds and rainfall both start from the inland (mountain).

Time it happened : 11~21 o’clock
Threshold of accumulated rainfall : over 10mm



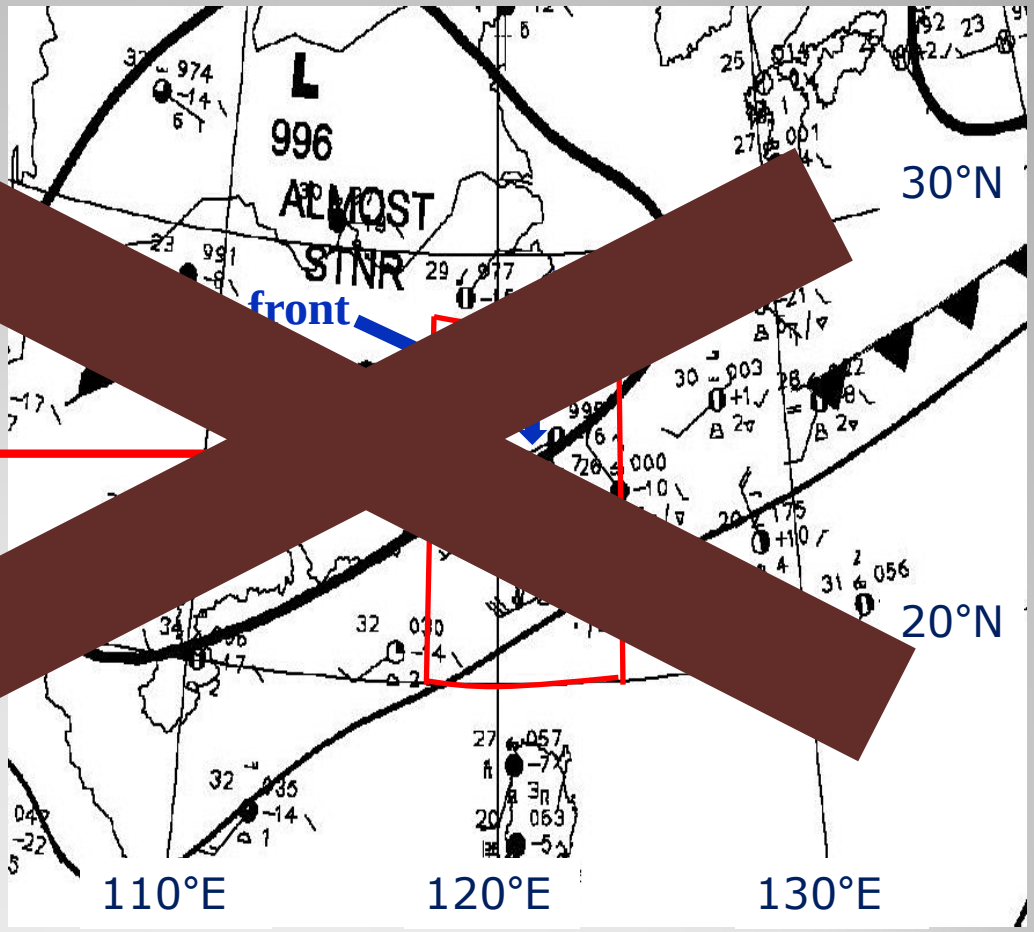
Affected by typhoon

17.5˚N～30˚N
114˚E～128˚



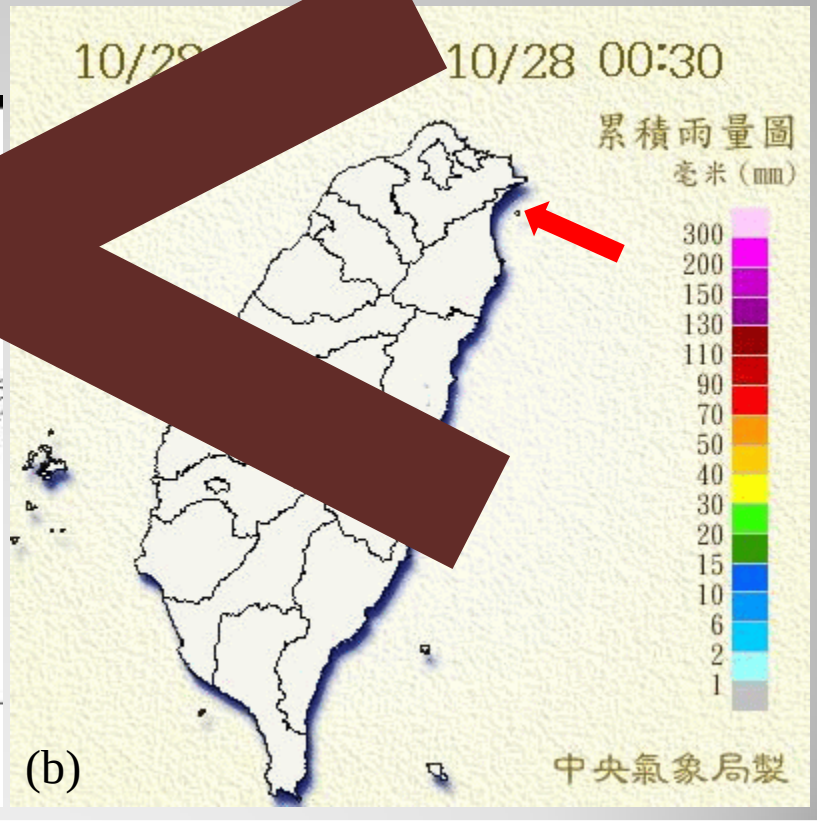
Affected by front

20˚N～28˚N
118˚E～124˚E



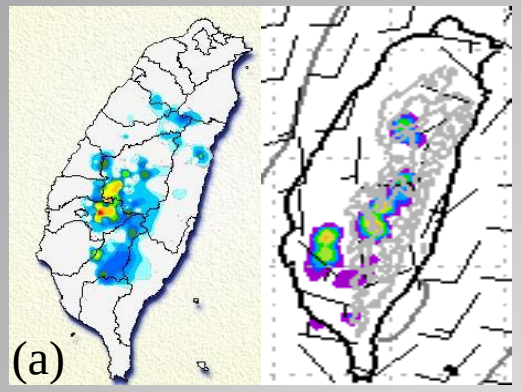
Affected by clouds moved from the ocean

Rainfall move from coast to inland and starting time is too early.

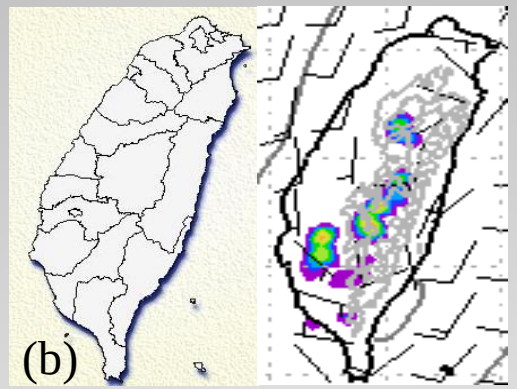


Categorical statistics & Skill score

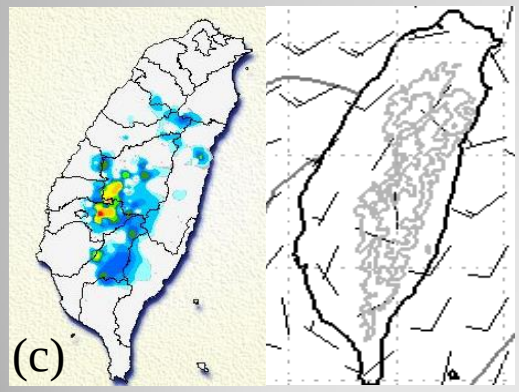
H (hit)



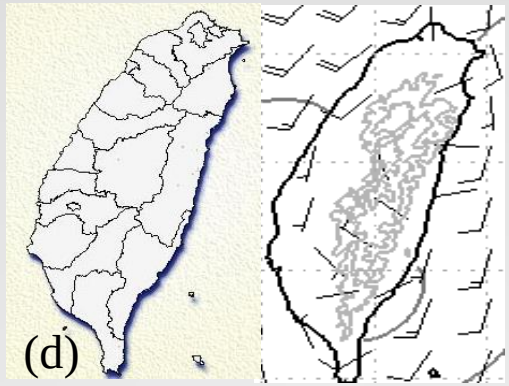
FA (false alarm)



M (miss)



CN (correct negative)



(e)

Forecast \ Observation	Y	N
Y	H	FA
N	M	CN

Categorical statistics & Skill score

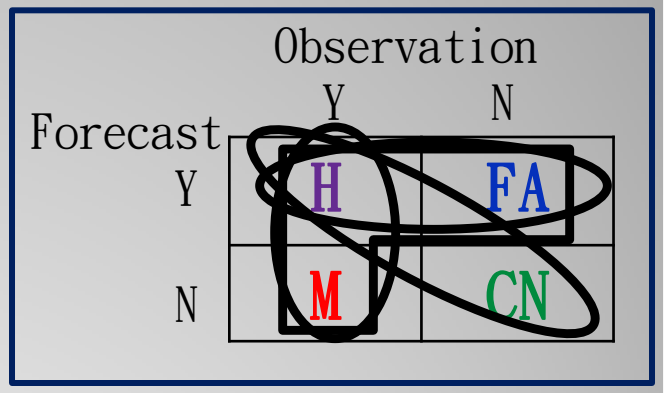
Prefigurance (PF) $= \dfrac{H}{H+M}$

Post agreement (PA) $= \dfrac{H}{H+FA}$

Threat score (TS) $= \dfrac{H}{H+FA+M}$

Accuracy (ACC) $= \dfrac{H+CN}{H+FA+M+CN}$

Bias (BS) $= \dfrac{H+FA}{H+M}$



Sample size (number of days)

	2011	*2012*	*2011&2012*
May	3	4	7
June	11	1	12
July	15	12	27
August	12	4	16
September	5	13	18
October	4	5	9
Total	50	39	89

Performance of afternoon storms forecast by CReSS

Forecast \ Observation	Y	N
Y	H	FA
N	M	CN

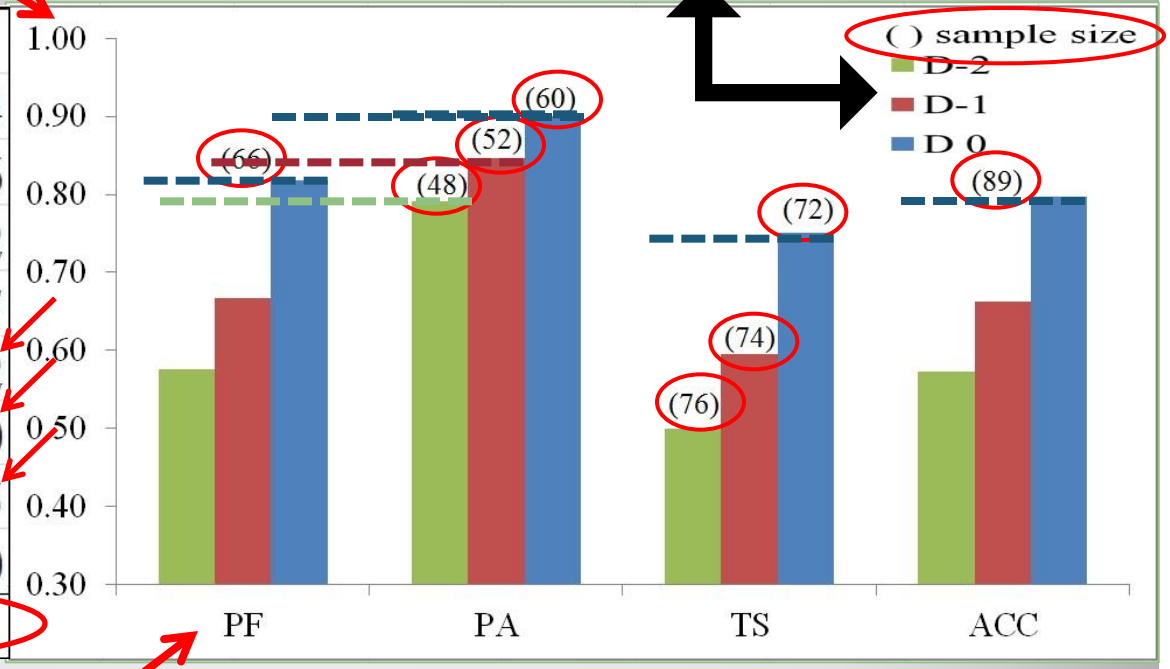
$$PF = \frac{H}{H+M}$$

$$PA = \frac{H}{H+FA}$$

$$BS = \frac{H+FA}{H+M}$$

D-2 = forecast made two days before
D-1 = forecast made one day before
D 0 = forecast made on that day

	D-2	D-1	D 0
H	38	44	54
FA	10	8	6
M	28	22	12
CN	13	15	17
PF	0.58	0.67	0.82
PA	0.79	0.85	0.90
TS	0.50	0.59	0.75
ACC	0.57	0.66	0.80
BS	0.73	0.79	0.91



score term

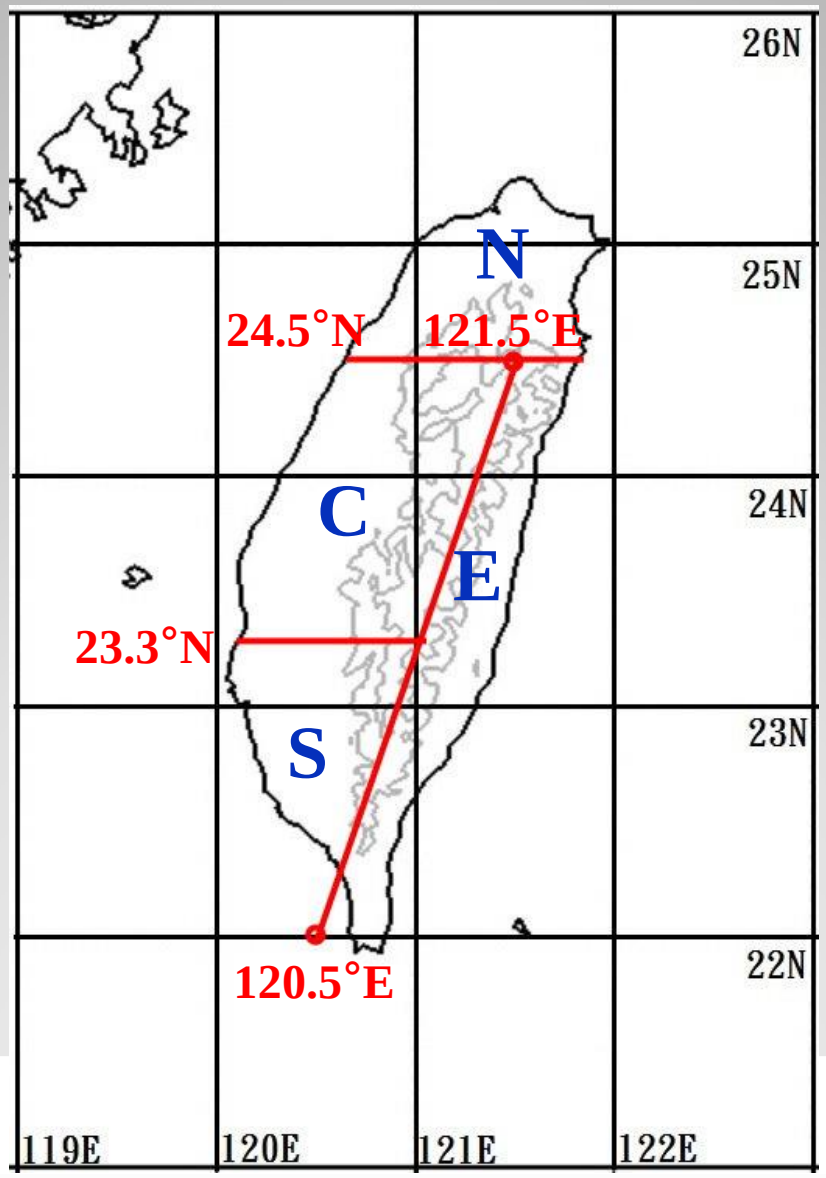
Subregion of Taiwan

N-Northern

C-Central

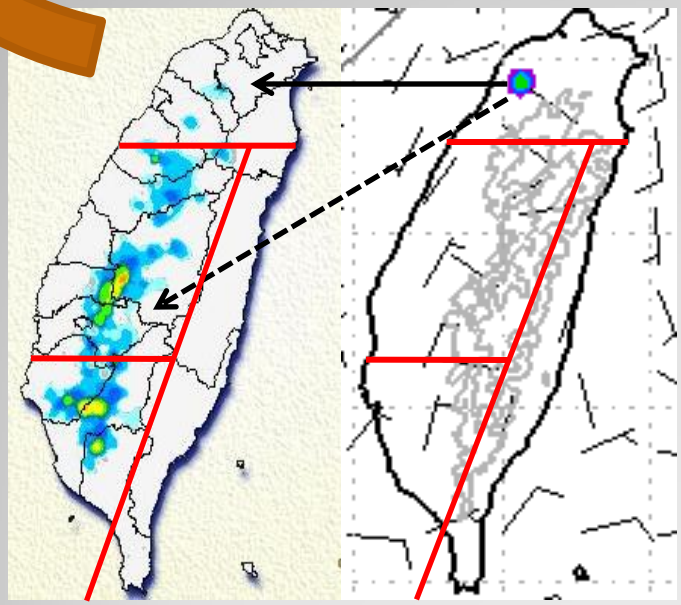
S-Southern

E-Eastern



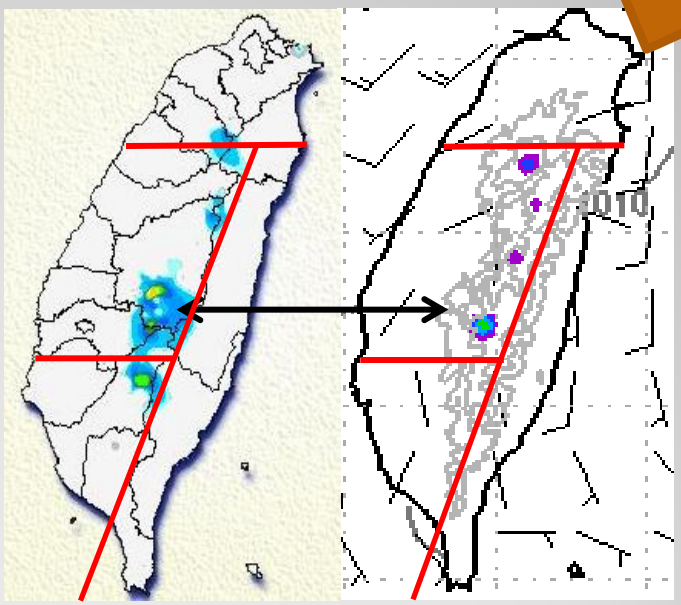
Categorical statistics

Northern - FA
Central - M
Southern - M
Eastern - CN



(a) In different region

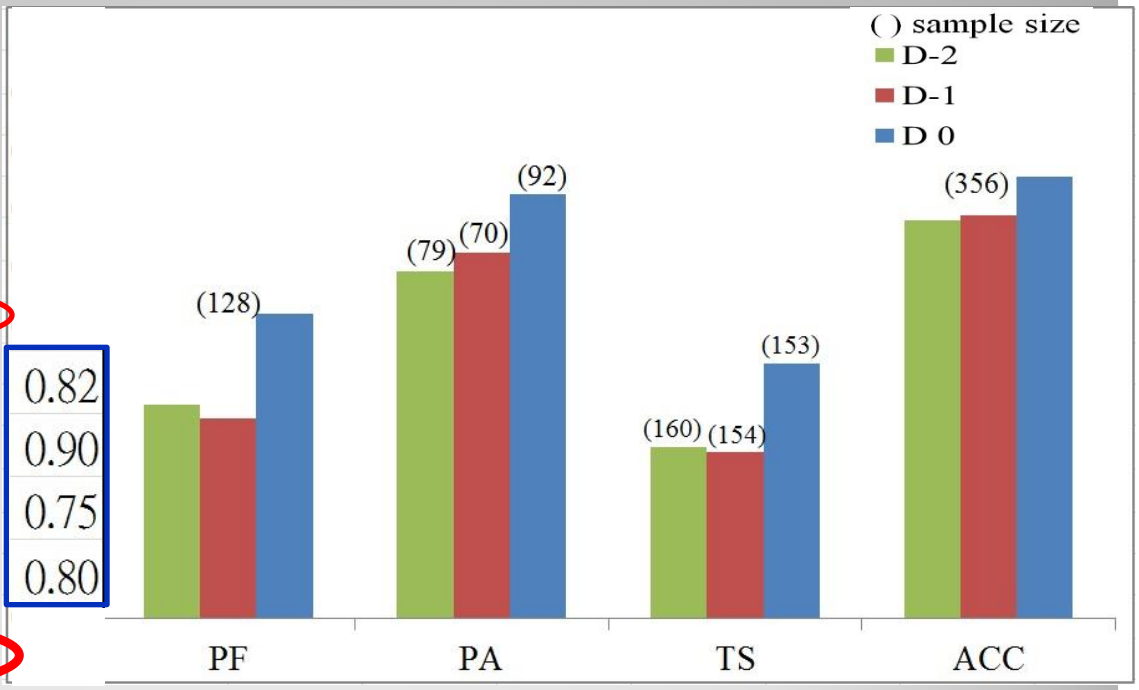
Northern - CN
Central - H
Southern - M
Eastern - CN



(b) In same region

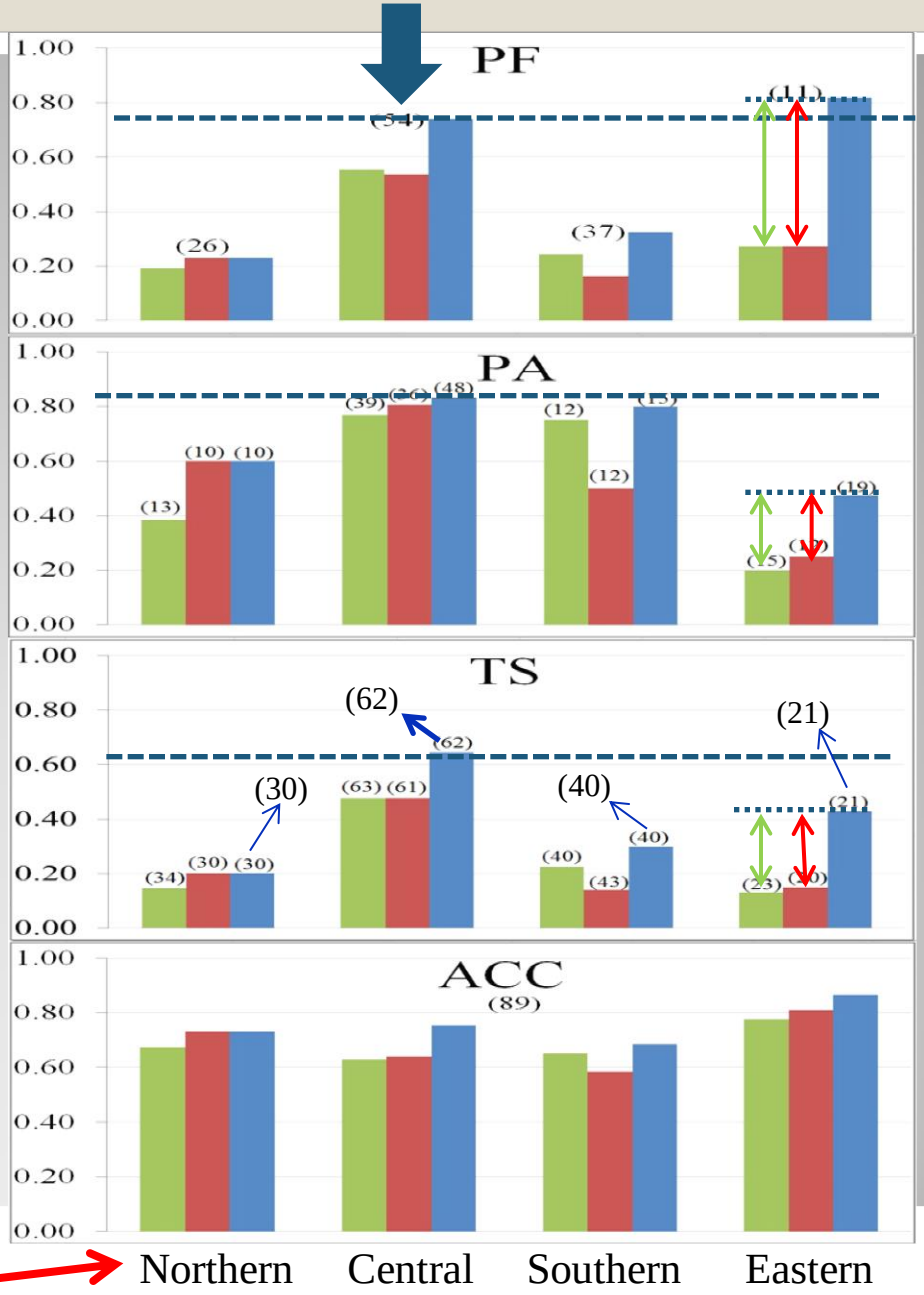
Performance of afternoon storms forecast in correct regions

	D-2	D-1	D 0	
H	47	44	67	
FA	32	26	25	
M	81	84	61	
CN	196	202	203	
PF	0.37	0.34	0.52	0.82
PA	0.59	0.63	0.73	0.90
TS	0.29	0.29	0.44	0.75
ACC	0.68	0.69	0.76	0.80
BS	0.62	0.55	0.72	

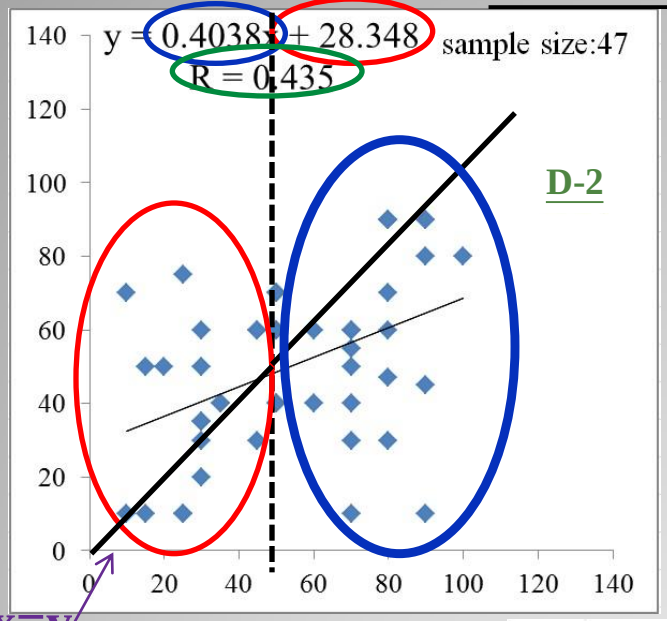


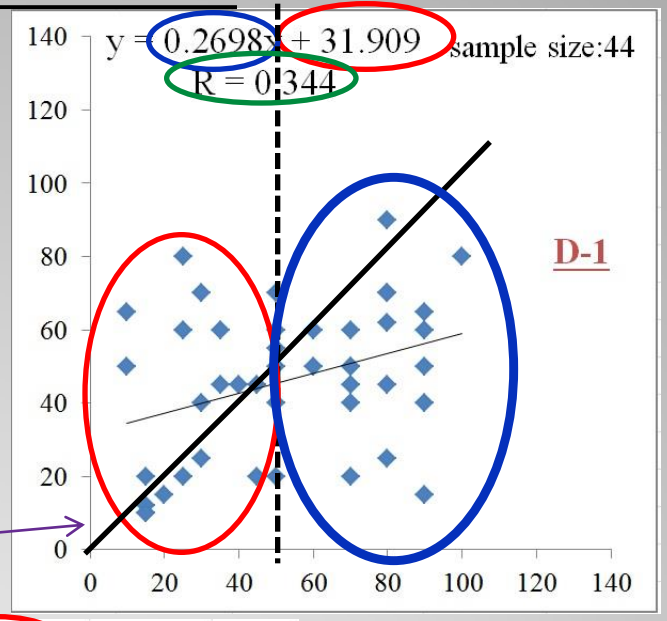
$$ACC = \frac{H+CN}{H+FA+M+CN}$$

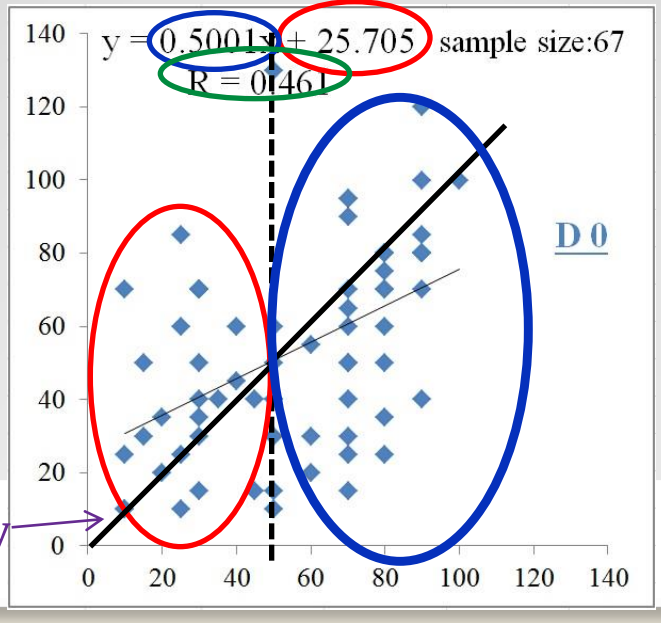
PF	D-2	D-1	D 0
Northern	0.19	0.23	0.23
Central	0.56	0.54	0.74
Southern	0.24	0.16	0.32
Eastern	0.27	0.27	0.82
PA	D-2	D-1	D 0
Northern	0.38	0.60	0.60
Central	0.77	0.81	0.83
Southern	0.75	0.50	0.80
Eastern	0.20	0.25	0.47
TS	D-2	D-1	D 0
Northern	0.15	0.20	0.20
Central	0.48	0.48	0.65
Southern	0.23	0.14	0.30
Eastern	0.13	0.15	0.43
ACC	D-2	D-1	D 0
Northern	0.67	0.73	0.73
Central	0.63	0.64	0.75
Southern	0.65	0.58	0.69
Eastern	0.78	0.81	0.87



Scatter plot of rainfall

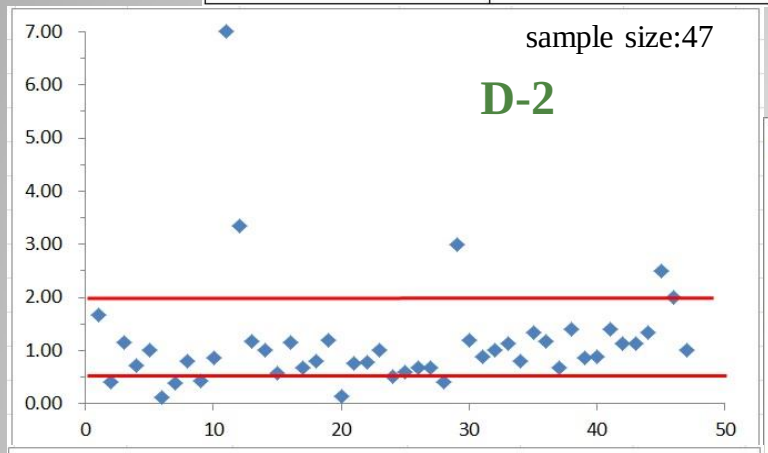


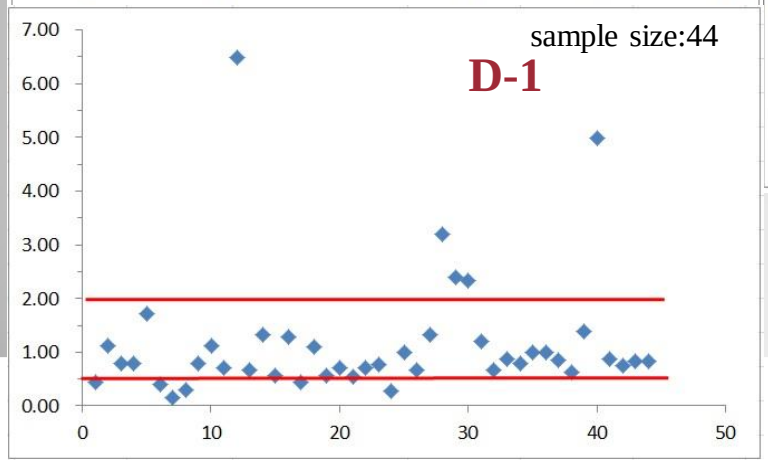


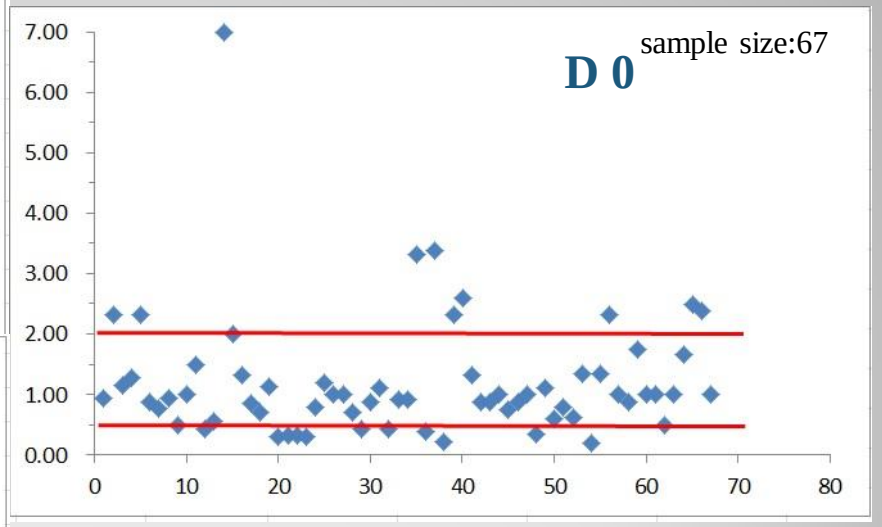


Bias of rainfall

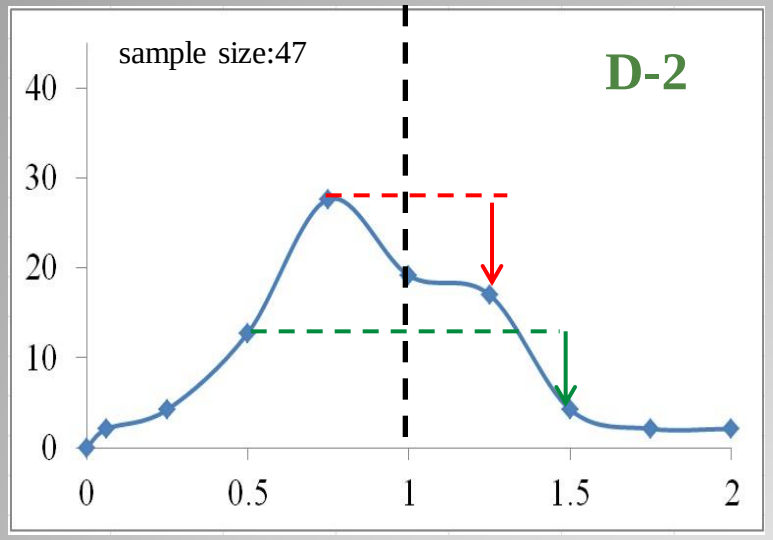
BS	D -2	D-1	D 0
over 2	4 (8.5%)	5 (11.4%)	10 (14.9%)
0.5 ～ 2	37 (78.7%)	33 (75.0%)	46 (68.7%)
less than 0.5	6 (12.8%)	6 (13.6%)	11 (16.0%)

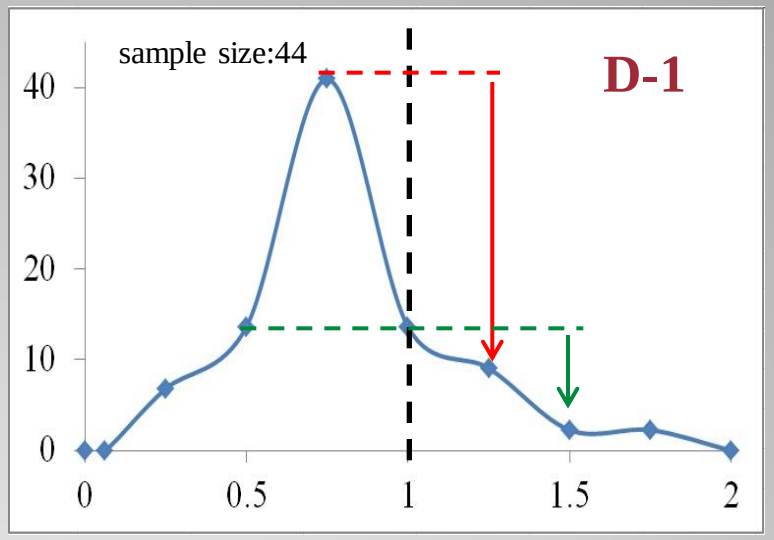


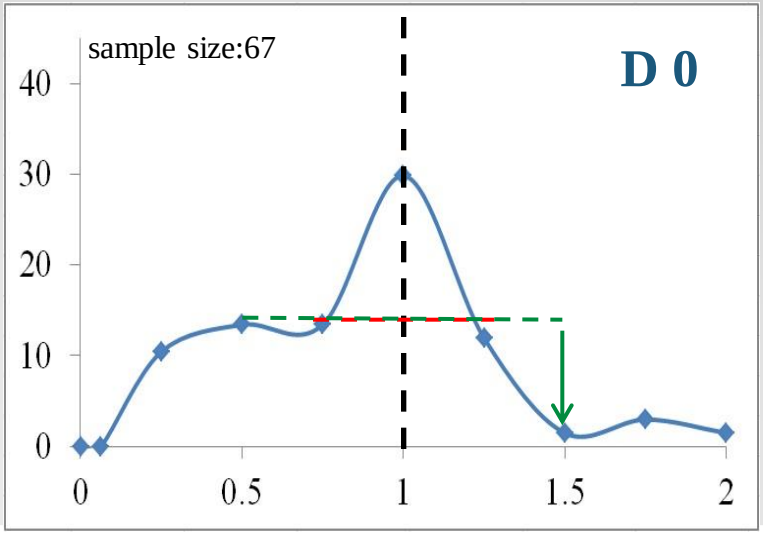


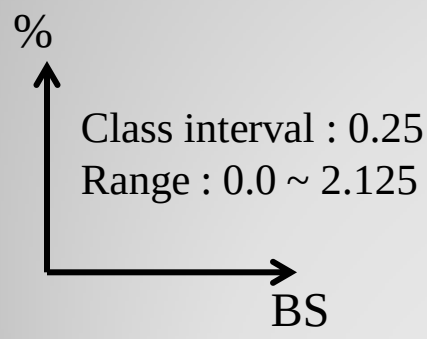


Distribution of Bias









Conclusion

- Model forecast of rainfall over entire Taiwan or in sub-regions

1. Forecast made on that day is the best (TS = 0.75 or 0.44).
2. Compare PF with PA, if model forecast rainfall occurrence, there is high chance to be correct, but model also misses some rainfall cases.
3. Rainfall occurrence frequency in forecast is lower than in observation.

- Compare four sub-regions

1. Performance in central region is the best, and it also has biggest sample size.
2. In eastern Taiwan, forecast made on that day is much better than those made one day or two days before.

- In rainfall amount

1. Model tends to forecast more rain in events with light rainfall, but increasingly less rainfall in events with heavier rainfall.
2. High percentage of events with BS in the range of 0.5~2 (68.7~78.7%).
3. When rainfall amount in forecast is close to observation, model tends to forecast a little less rainfall.