Project #8: Verification of deterministic precipitation forecasts

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Project #8
Verification of deterministic precipitation forecasts

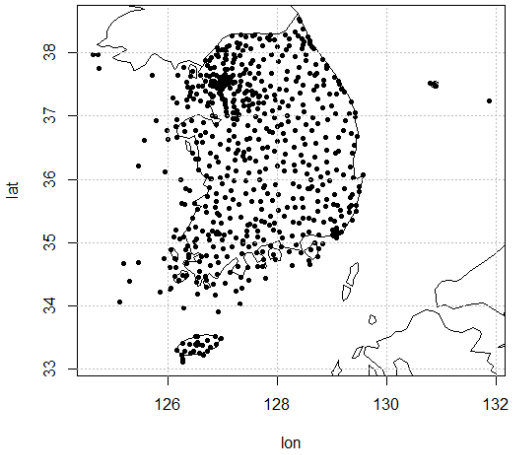
Daily precipitation 3 day prediction data

- By the KIAPS Integrated Model (KIM)
  : non-hydrostatic global NWP model on the cubed sphere
  : Resolution ~25km
- JJA 2016, DJF 15/16

Observation

- Rain gauge data from 617 stations over Korean peninsula
- Daily accumulated from hourly prcp.

[Location of observation stations]



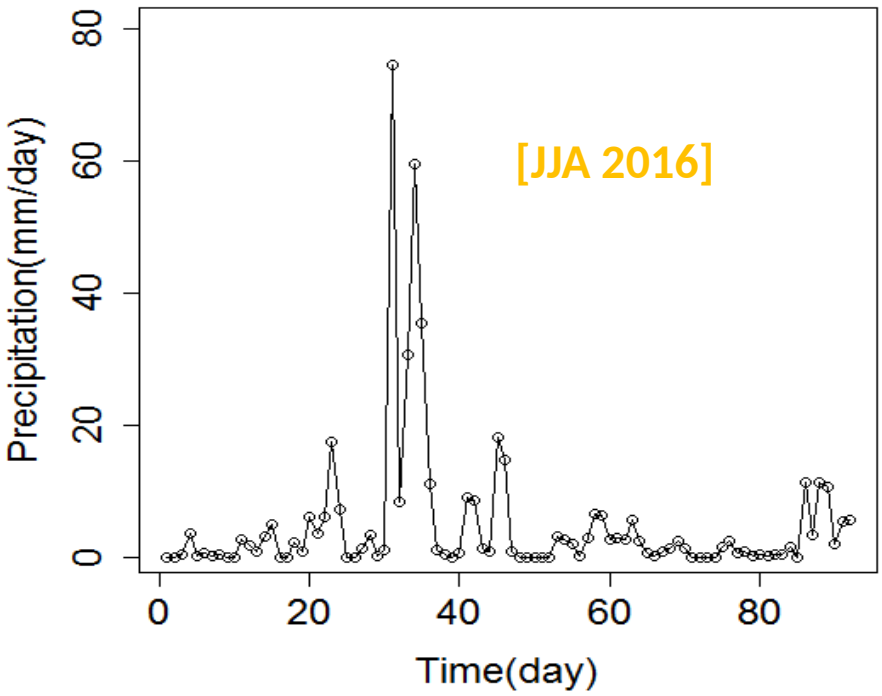
Verification

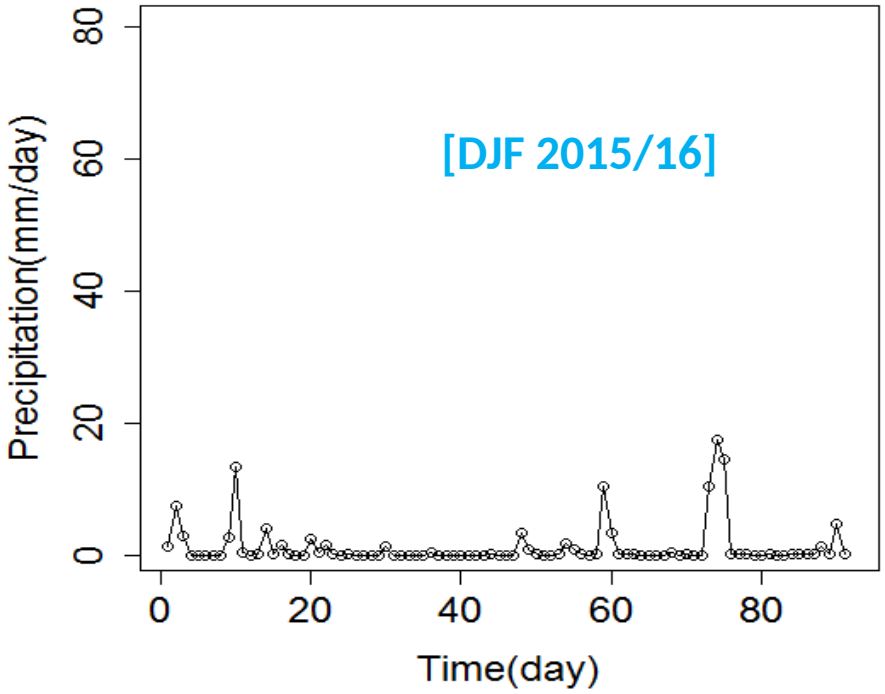
- Bilinear interpolation from model grid to obs. point
- Verified using contingency tables

Forecasts	Observations		
	HITS a	FALSE ALARMS b	Total Events Forecast a+b
	MISSED EVENTS c	CORRECT NEGATIVES d	Total non-events Forecast c+d
	Total Events Observed a+c	Total Non-Events Observed b+d	Sample size T=a+b+c+d

JJA vs. DJF precipitation

Daily precipitation (all station averages)



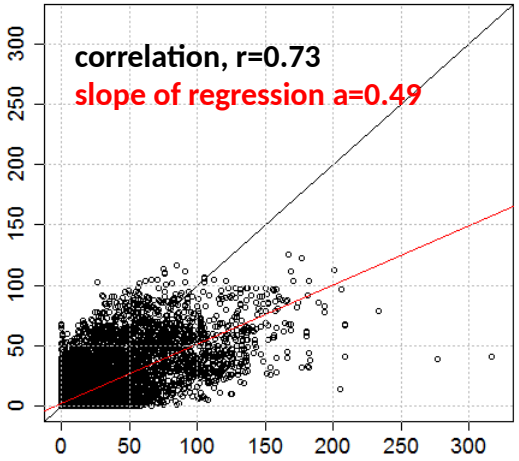


JJA ~ rainy, prevailing persistent monsoonal rain period
, followed by rainy days due to synoptic front, convective systems
DJF ~ relatively dry season, local rainy events..

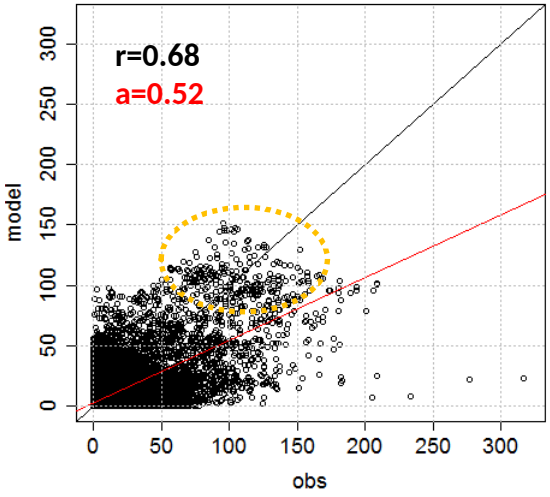
Data

JJA16

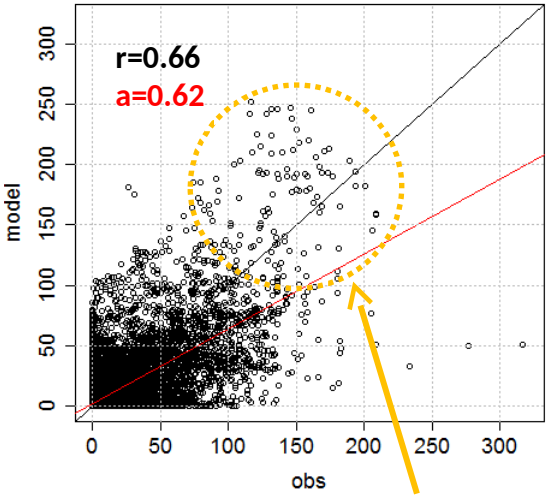
+24 h prediction



+48 h prediction



+72 h prediction

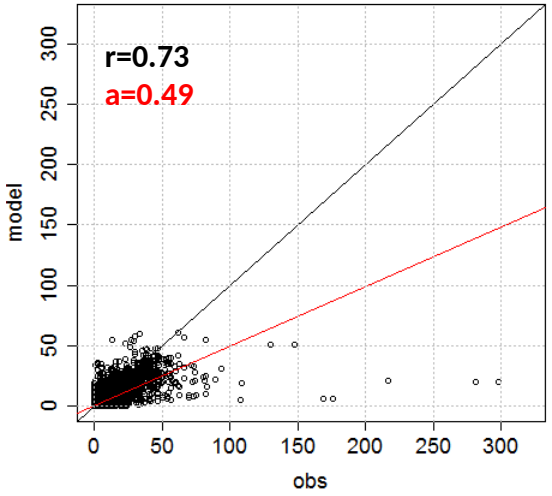


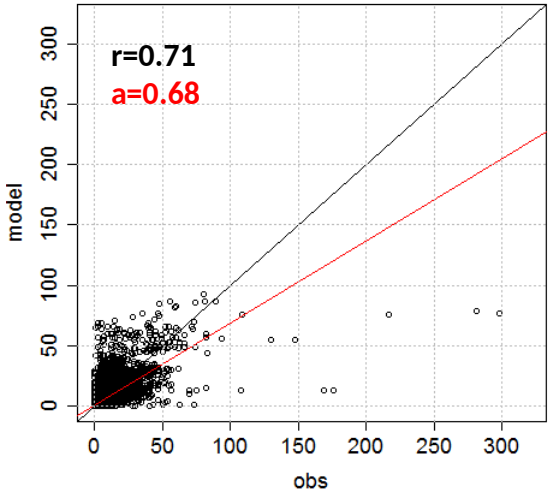
Model (mm/day)

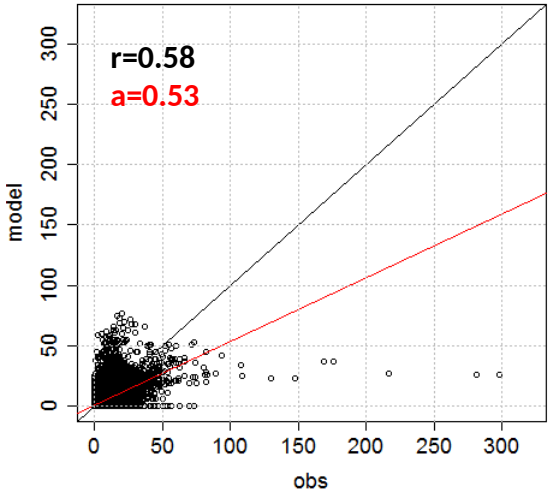
OBS. (mm/day)

For a longer lead time, Model tends to intensify rain system for some events

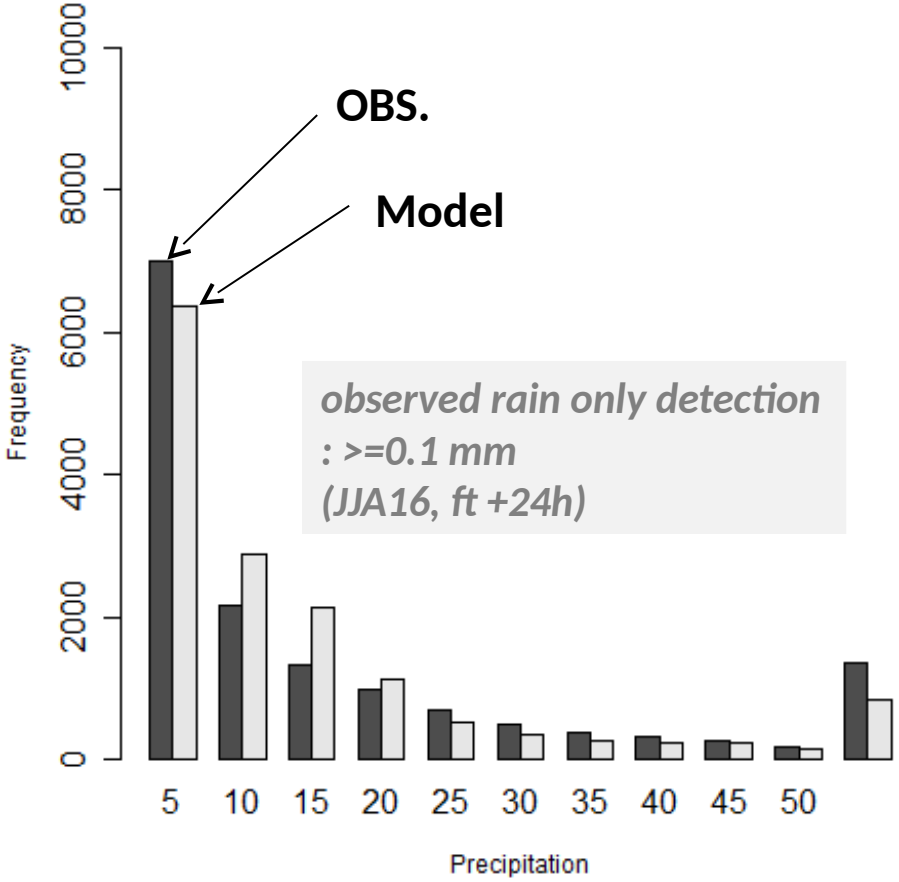
DJF15/16

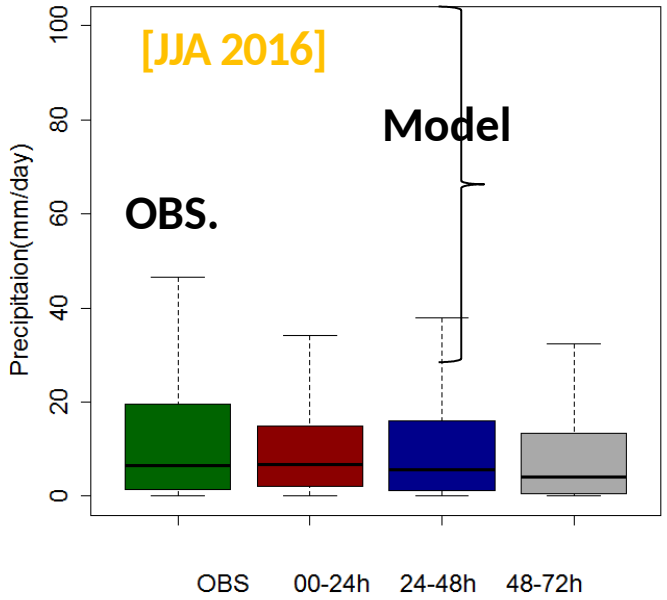


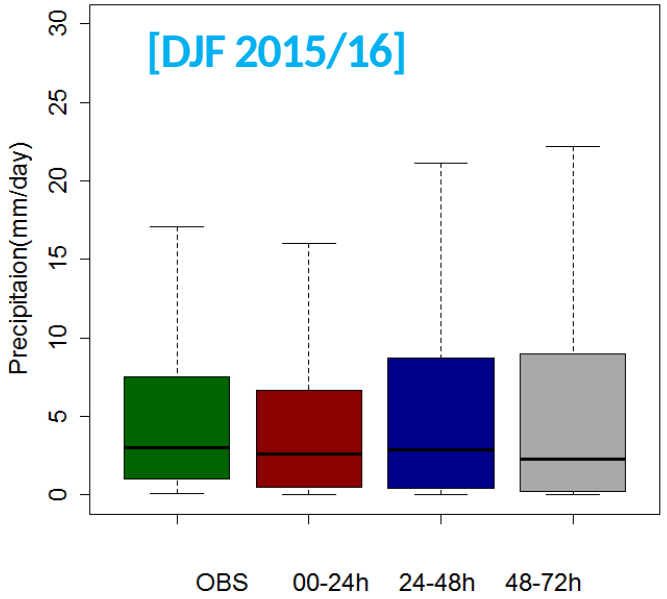




Data distribution & selected thresholds







Thresholds for contingency table verification

Heavy rainfall warning by KMA: 110 mm/12hr

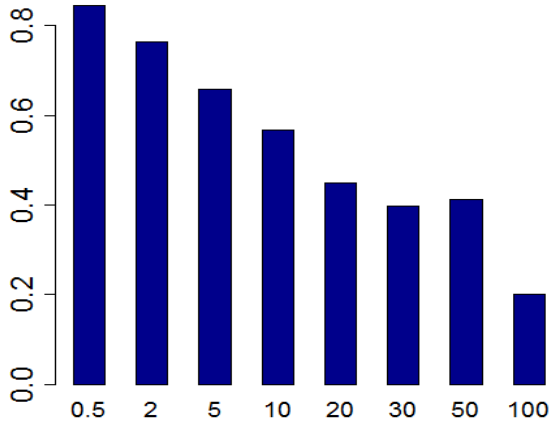
Lowest 0.5 mm, highest 100 mm/day

 0.5, 2, 5, 10, 20, 30, 50, 100 mm/day

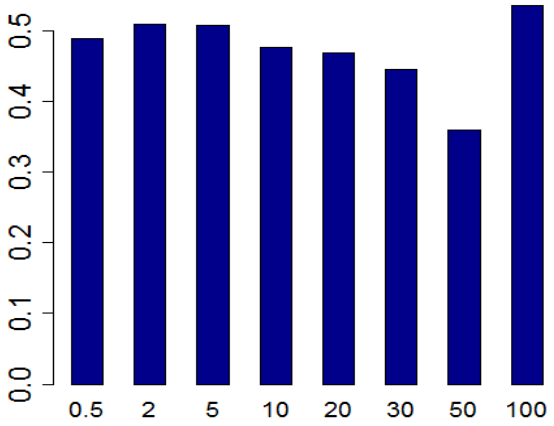
Verification results (+48 h prediction)

JJA

$$POD = \frac{hit}{obs."Yes"}$$



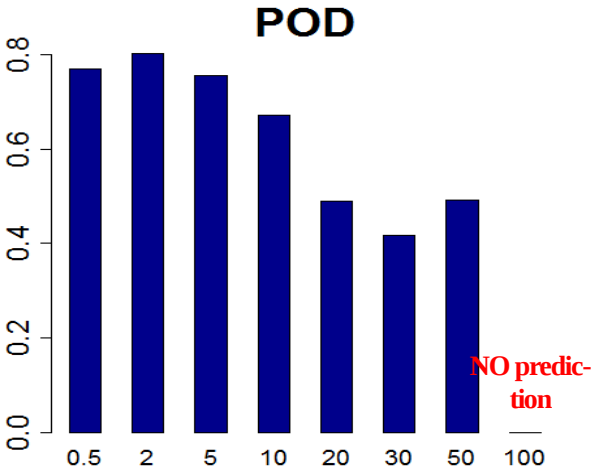
$$FAR = \frac{false\ alarm}{Predicted\ "Yes"}$$

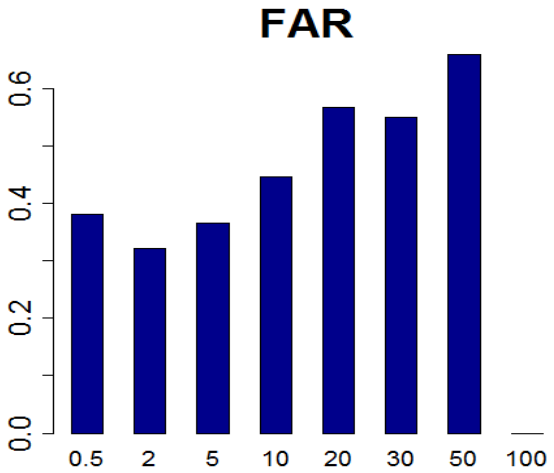


Higher hit rate for light rain for both JJA and DJF

Higher false alarm ratio for smaller thresholds in JJA

DJF



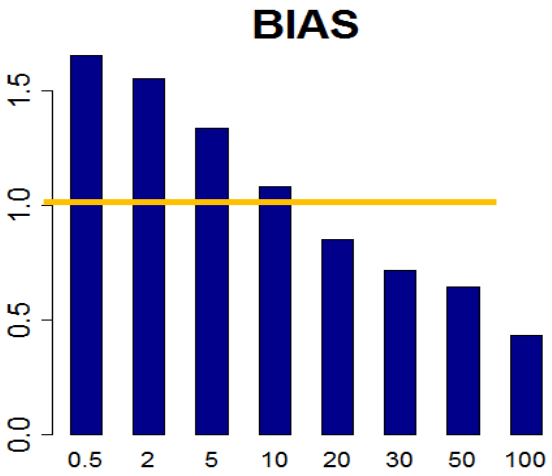


Higher false alarm ratio for heavier rain thresholds in DJF

Verification results (+48 h prediction)

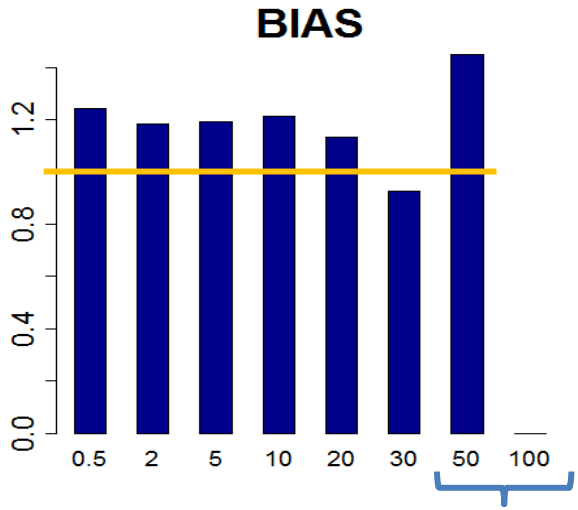
JJA

$$BIAS = \frac{pred."Yes"}{obs."Yes"}$$



Over-predicted light rain & under-predicted heavier summer rain

DJF



Is this meaningful?

Overall over-prediction for all precipitation ranges

Threshold = 50 mm/day			
1-day lead	OBS YES	OBS NO	Total
FCST YES	5	6	11
FCST NO	66	47462	47528
Total	71	47468	47539

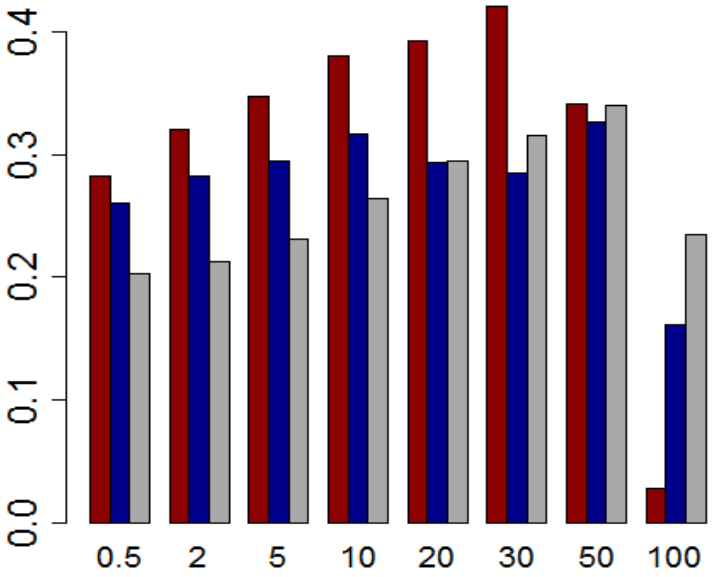
Threshold = 50 mm/day			
2-day lead	OBS YES	OBS NO	Total
FCST YES	35	68	103
FCST NO	36	47400	47436
Total	71	47468	47539

Verification results (with lead times)

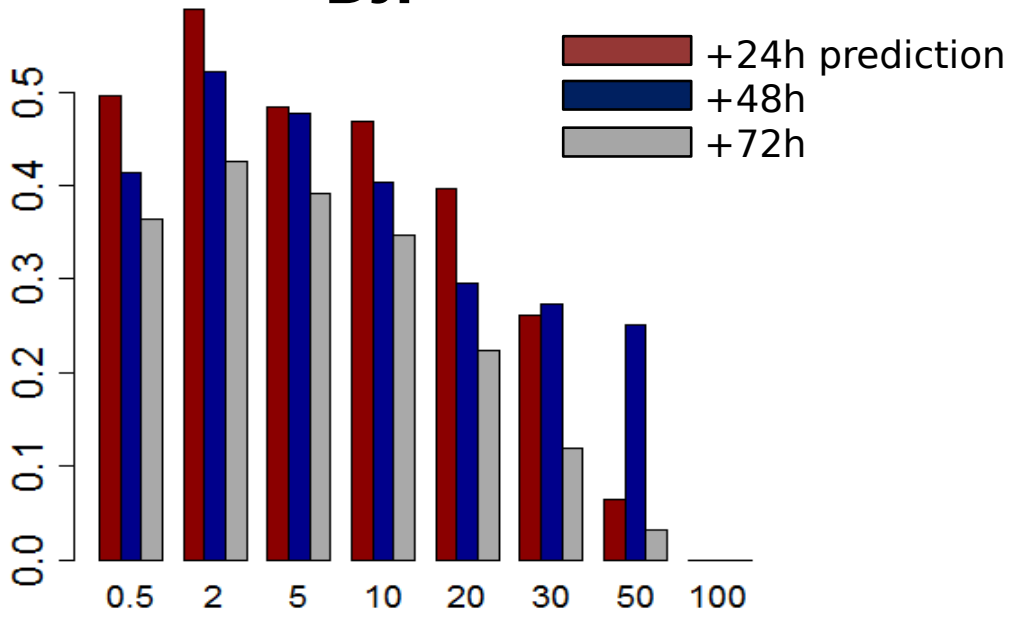
Equitable Threat Score

$$ETS = \frac{a - \frac{(a+b)(a+c)}{T}}{a+b+c-\frac{(a+b)(a+c)}{T}}$$

JJA



DJF

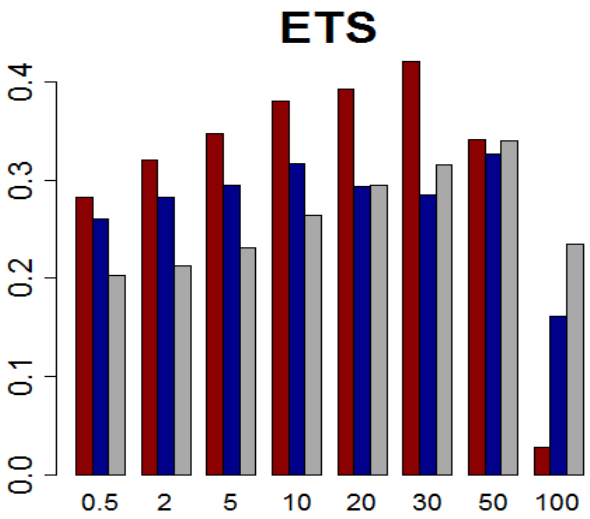


Better skill for higher thresholds in summer
Better skill for lower thresholds in winter
Prediction skill is better for winter?
Decrease of skill with forecast lead time shown in most thresholds range

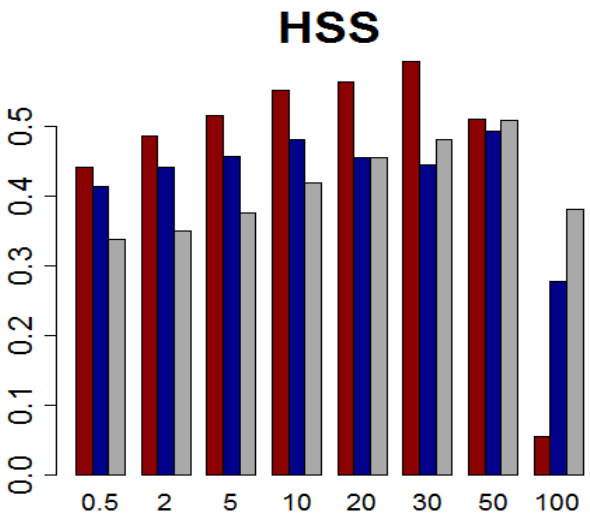
Verification results (various scores)

+24h prediction
+48h
+72h

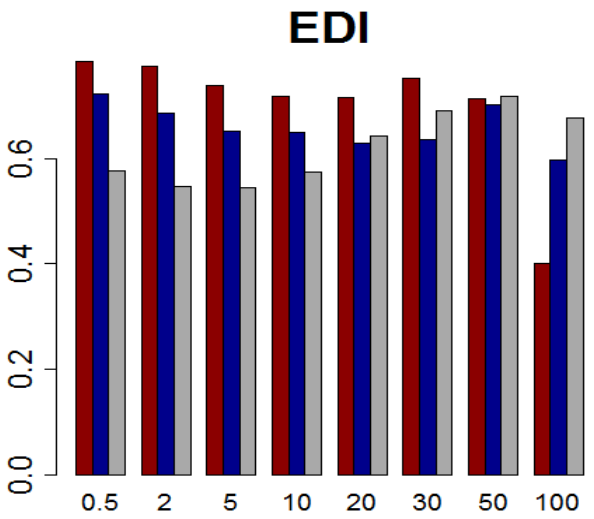
Result from JJA



$$ETS = \frac{a - \frac{(a+b)(a+c)}{T}}{a+b+c-\frac{(a+b)(a+c)}{T}}$$



$$HSS = \frac{(a+d) - \frac{(a+b)(a+c)+(c+d)(b+d)}{T}}{T-\frac{(a+b)(a+c)+(c+d)(b+d)}{T}}$$



$$\mathrm{EDI} = \frac{\log F - \log H}{\log F + \log H}$$

H = a / (a+c), hit rate

F = b / (b+d), false alarm rate

Various skill scores show different characteristics with thresholds
ETS, HSS increases with thresholds but not in EDI
Small samples size affects sharp decrease in certain skill score index like ETS, HSS

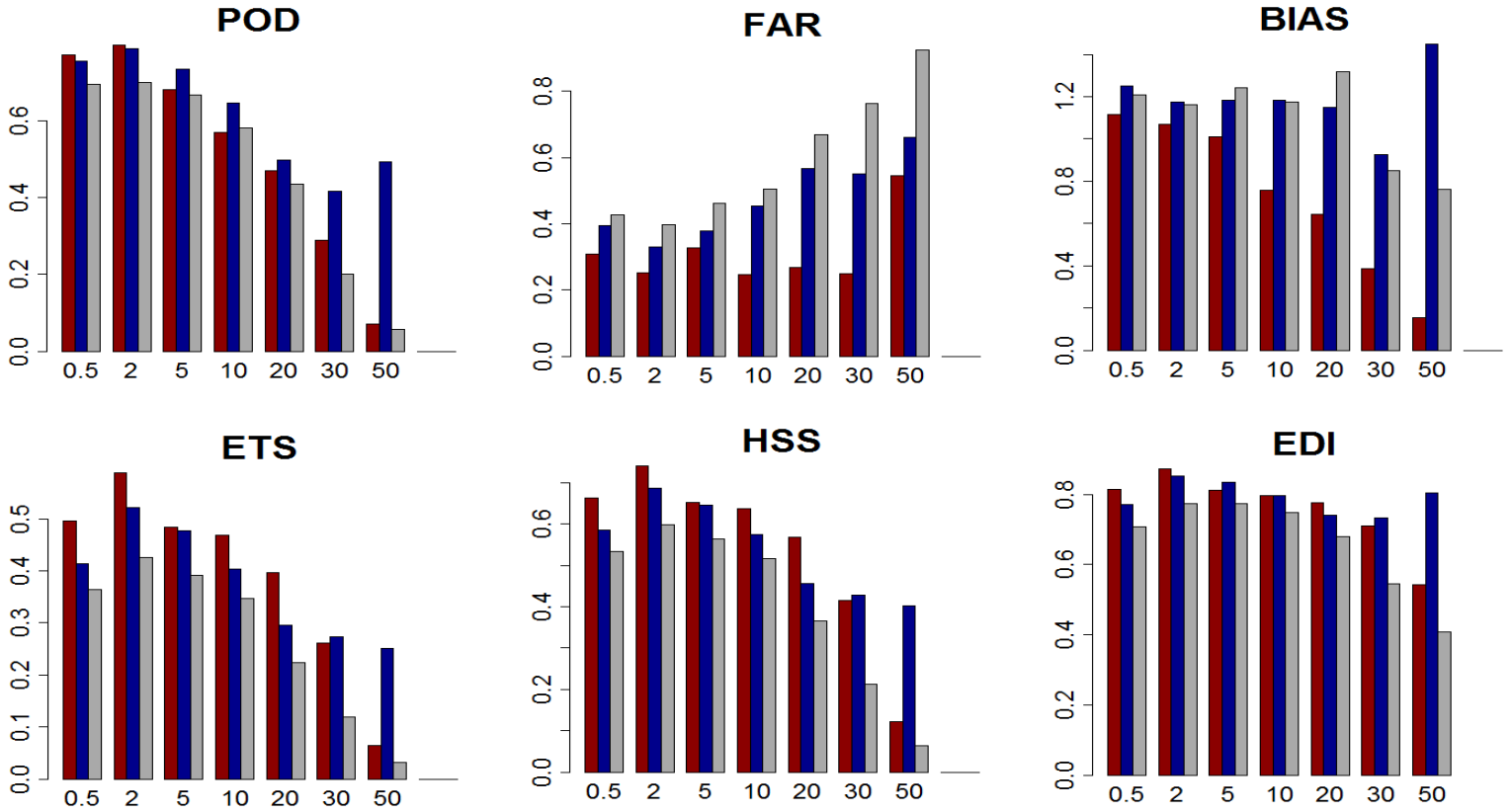
Summary

- Contingency table method is applied to verify deterministic precipitation forecasts against rain-gauge observation over Korea.
- Thresholds are selected in consideration with data distribution and extreme weather warning.

- Higher hit rate appears for light rain for both JJA and DJF.
- Higher false alarm ratio for smaller thresholds in JJA affects low skill score in summer, while higher false alarm ratio for heavier rain thresholds in DJF.
- Decrease of skill with forecast lead times is shown in most thresholds range.
- Small sample size affects certain skill scores.
- Extreme events are difficult to measure with this contingency table method.

- There are more issues about data quality control, grid-to-obs. interpolation, sample sizes, how to verify extreme events.

Verification results with lead times, DJF



As forecast lead time is longer,
POD decreasing False alarm increasing, BIAS increasing…
Skills decreasing

till sample number issues…

threshold = 100 mm/day			
	OBS YES	OBS NO	Total
FCST YES	11	13	24
FCST NO	366	49353	49719
Total	377	49366	49743

Threshold = 50 mm/day			
	OBS YES	OBS NO	Total
FCST YES	573	269	842
FCST NO	789	48112	48901
Total	1362	48381	49743

Threshold = 30 mm/day			
	OBS YES	OBS NO	Total
FCST YES	1295	447	1742
FCST NO	1209	46792	48001
Total	2504	47239	49743

JJA16

threshold = 100 mm/day			
	OBS YES	OBS NO	Total
FCST YES	0	0	0
FCST NO	9	47530	47539
Total	9	47530	47539

Threshold = 50 mm/day			
	OBS YES	OBS NO	Total
FCST YES	5	6	11
FCST NO	66	47462	47528
Total	71	47468	47539

Threshold = 30 mm/day			
	OBS YES	OBS NO	Total
FCST YES	93	31	124
FCST NO	229	47186	47415
Total	322	47217	47539

DJF15/16