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Nowcast Guidance of Afternoon Convection Initiation (CI) Using TANC

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Background

*Currently nowcasts of afternoon convective storm **initiation** by numerical models are still a challenging task.*

Taiwan Auto-NowCaster (TANC)

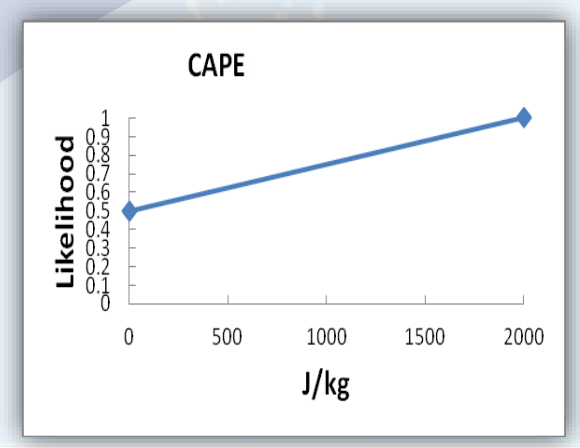
8 predictors (CAPE, CIN…)

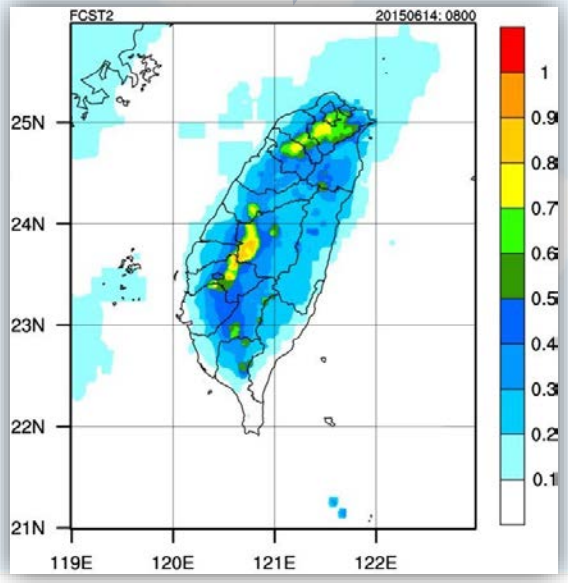
Fuzzy membership functions L_k

determine weights based on the relative importance of the predictors W_k

1-h likelihood of convective initiation (CI)

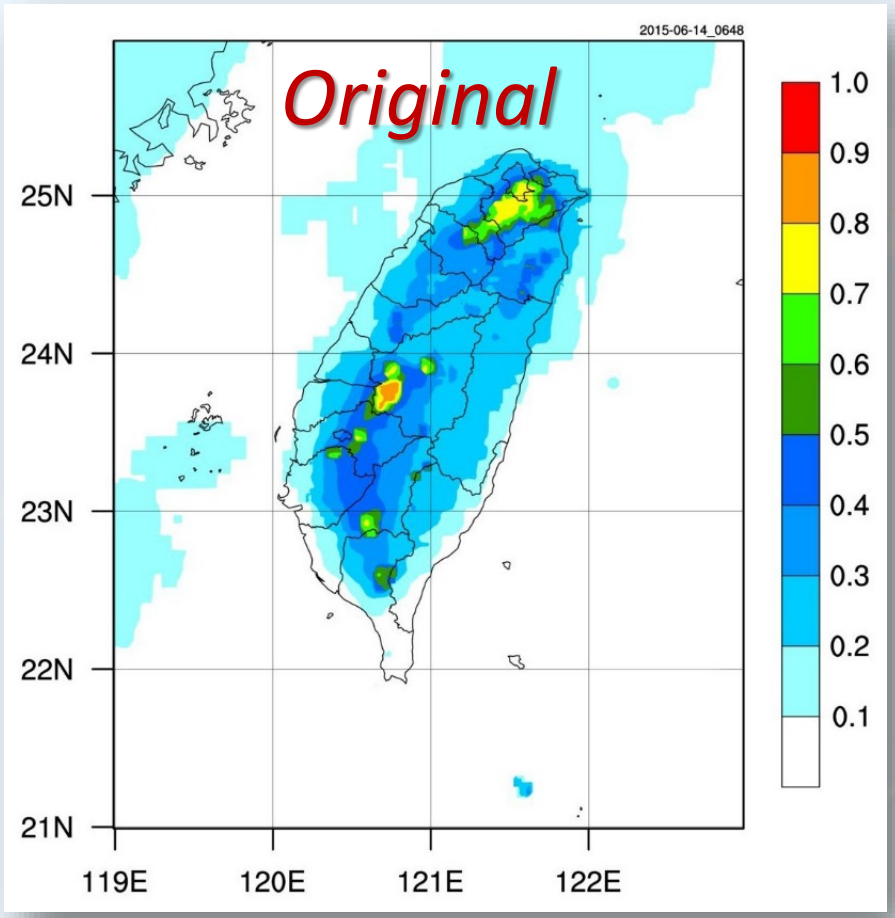
$$likelihood = \sum_k W_k \times L_k$$

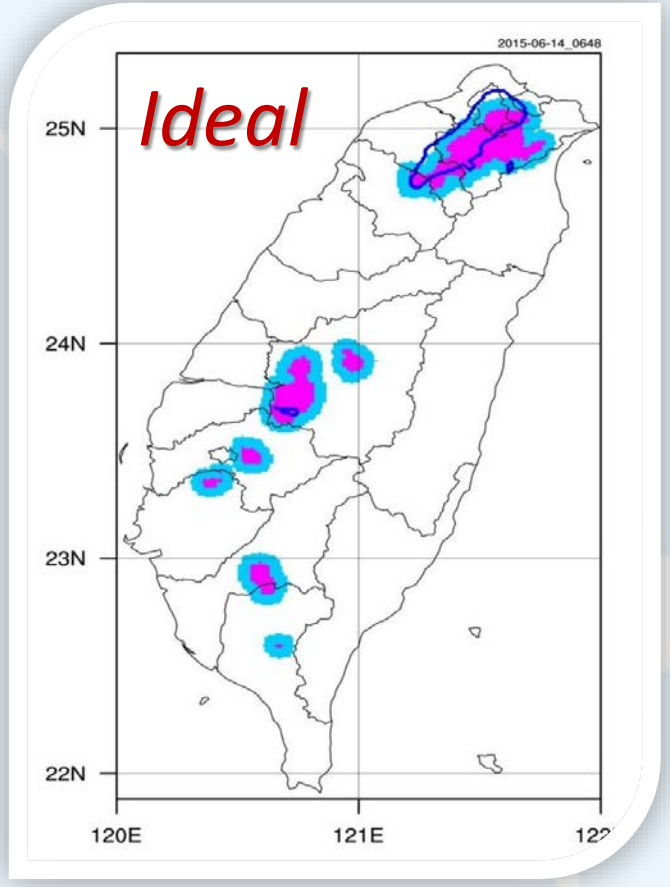




CI is defined as new convection with reflectivity ≧ 35 dBZ

Motivation


2015-06-14_0648
Original
25N
24N
23N
22N
21N
119E
120E
121E
122E
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1


2015-06-14_0648
Ideal
25N
24N
23N
22N
120E
121E

Outline

- Study data
- Verification Methodology
- Sensitivity Experiments
  - Sensitivity of Scores to Different Likelihood Thresholds
  - Sensitivity of scores to different combinations of spatial and temporal windows
- Summary

Study data

- Taiwan Auto-NowCaster (TANC)
  - provides 1-h likelihood of CI
  - runs every 6 minutes operationally
- Afternoon convective storm cases
  - 5 days in 2014 and 4 days in 2015
  - totally 312 1-h nowcasts for verification

Verification Methodology

Conversion from likelihood to Y/N forecasts

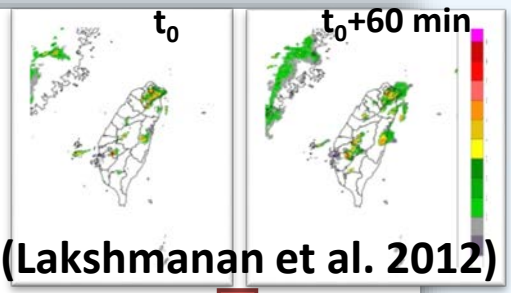
Forecast field

0.3	0.4	0.5
0.5	0.7	0.8
0.8	0.9	0.9

Lt = 0.8

N	N	N
N	N	Y
Y	Y	Y

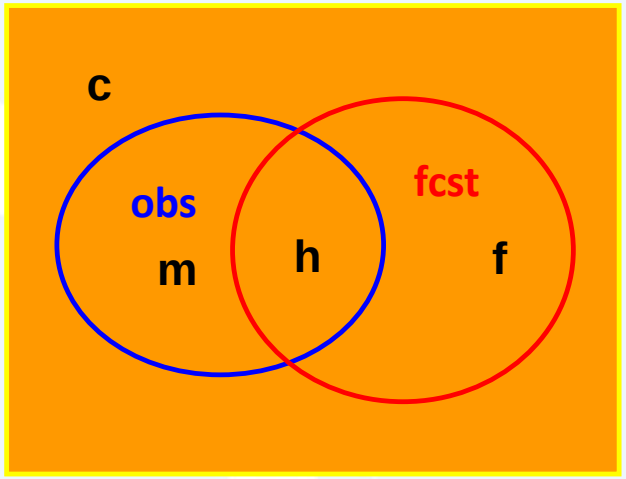
Verification field



(Lakshmanan et al. 2012)

N	N	N
N	Y	Y
N	Y	Y

c	c	c
n	m	h
f	h	h



Obs \ Fcst	Y	N
Y	h (hit)	m (miss)
N	f (false alarm)	c (correct rejection)

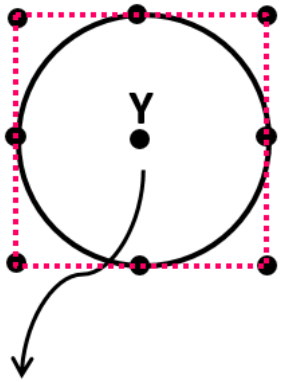
→ *Dichotomous verification scores : TS, BIAS, POD, FAR, ETS and KS*

Spatial Relaxation

- from a pixel-to-pixel verification into a verification of a circle with r = N gridpoints

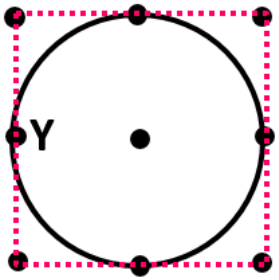
For example, N=1 gridpoint

Forecast field



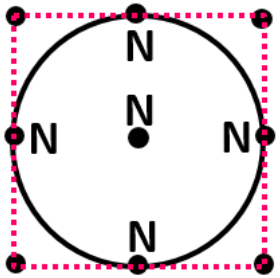
Convective initiation (CI)

Verification field



Hit

"CI" was observed within
a circle neighborhood



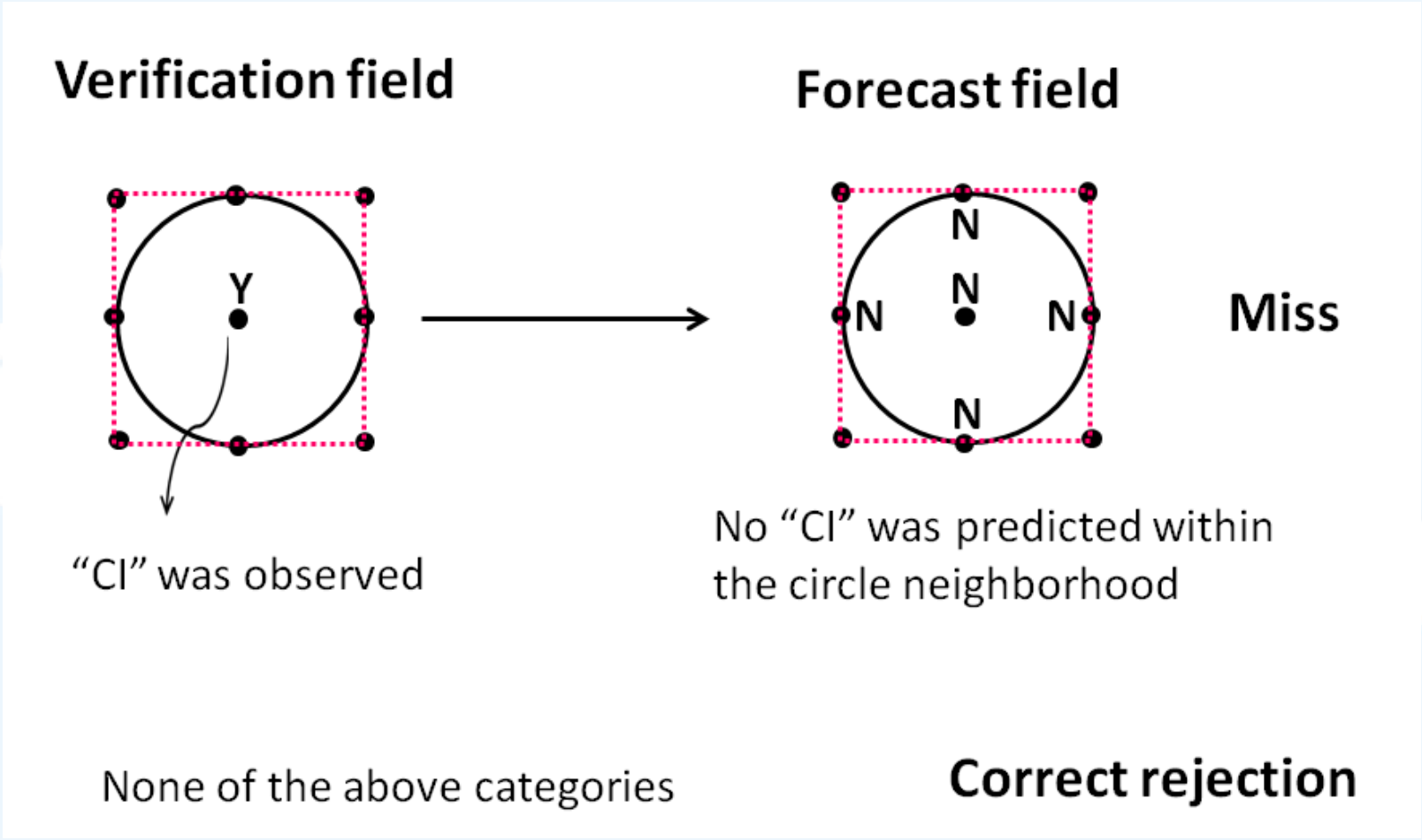
False alarm

No "CI" was observed within
a circle neighborhood

Square area: based on Lakshmanan et al. 2012
Circle area: modified by Chang et al. 2017

Spatial Relaxation

- from a pixel-to-pixel verification into a verification of a circle with r = N gridpoints

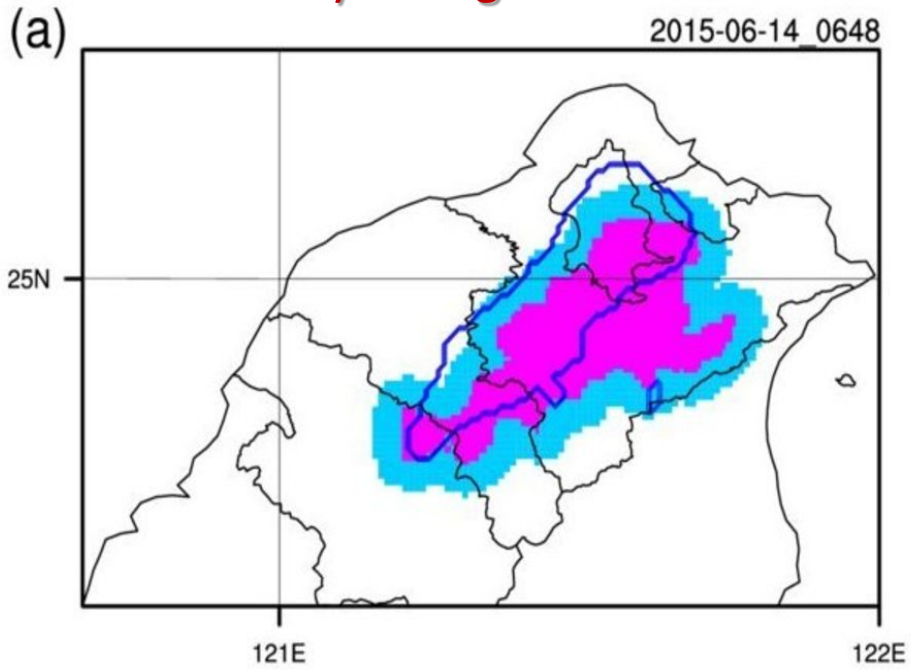


Square area: based on Lakshmanan et al. 2012
Circle area: modified by Chang et al. 2017

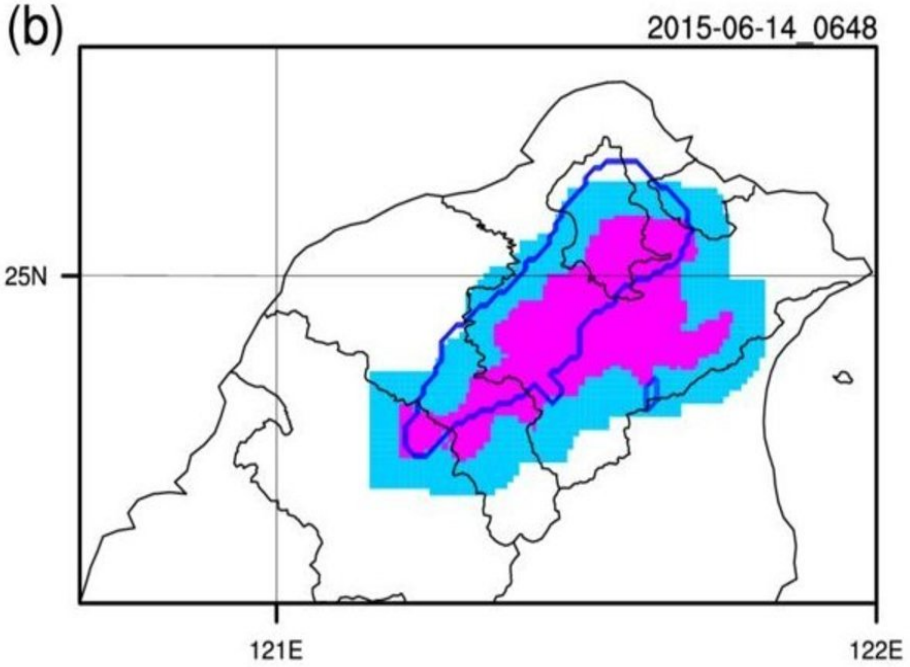
Spatial Relaxation

-with the optimal Lt of 0.6 and a spatial window of 5 grids

Modified by Chang et al. 2017



Based on Lakshmanan et al. 2012

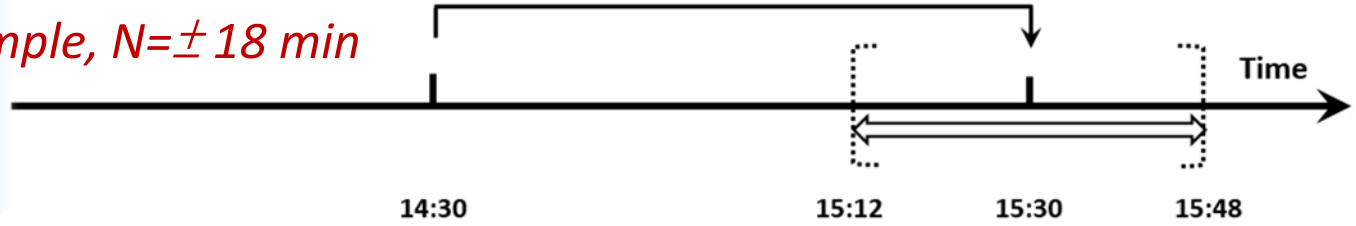


Pink shades : the most likely regions for CI (i.e., areas with likelihood $\geqq 0.6$)
Blue shades : the less likely but still possible areas of CI
Dark blue contours : observed CI

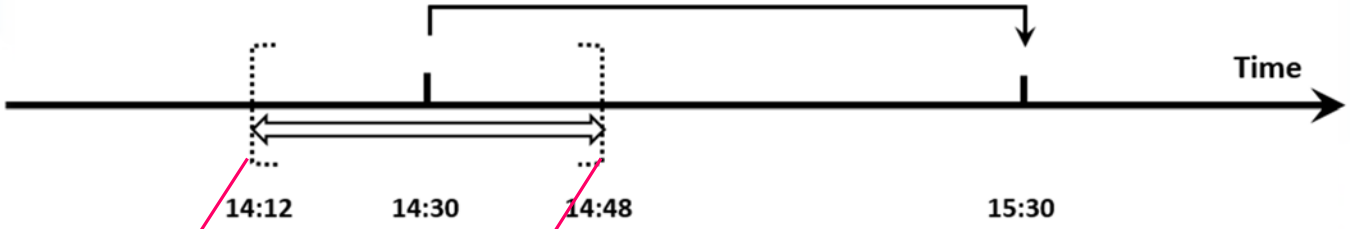
Temporal Relaxation

- A schematic diagram of temporal forecasting window

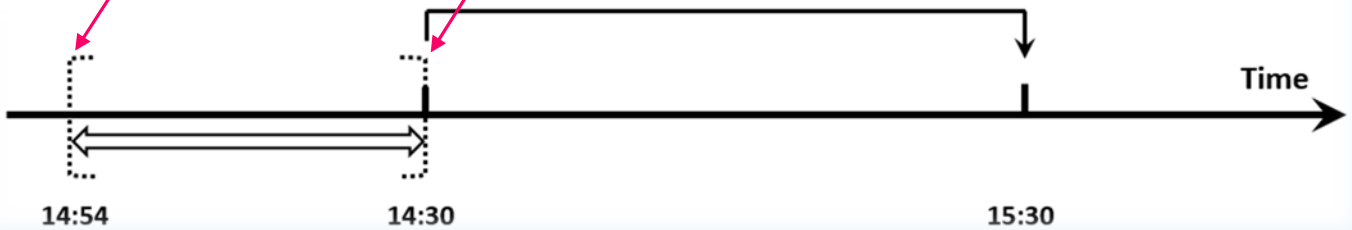
For example, N=±18 min



Temporal window setting I



Temporal window setting II



Sensitivity Experiments

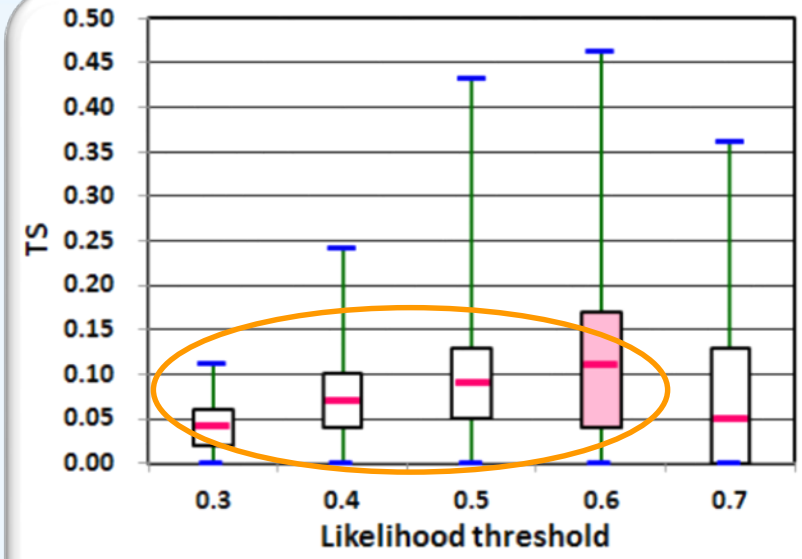
Sensitivity Experiments

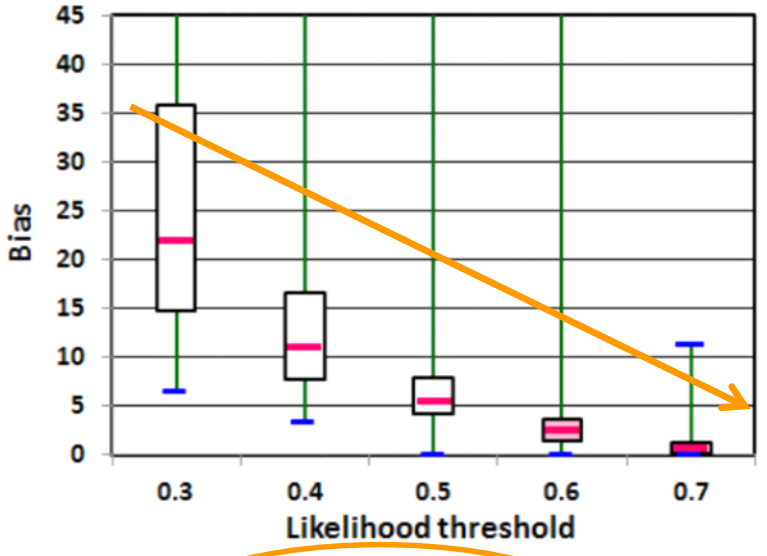
Sensitivity of scores to different likelihood thresholds (Lts)

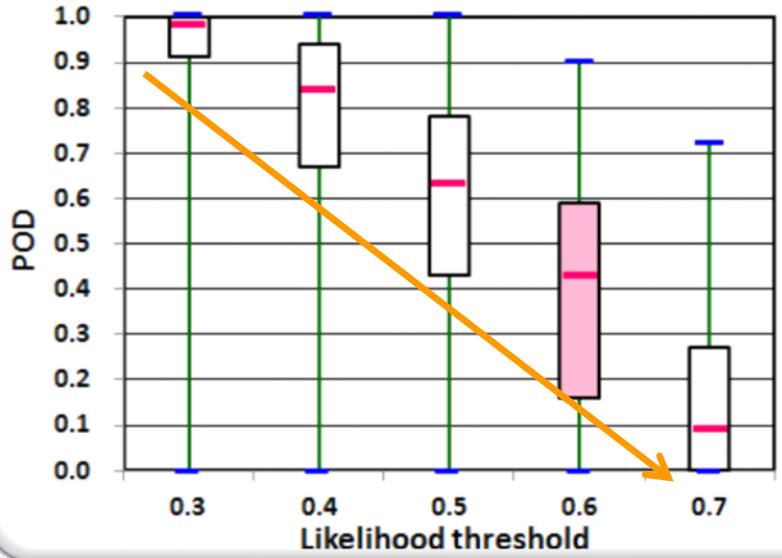
→ determine an optimal Lt to provide guidance on *the most likely region for CI*

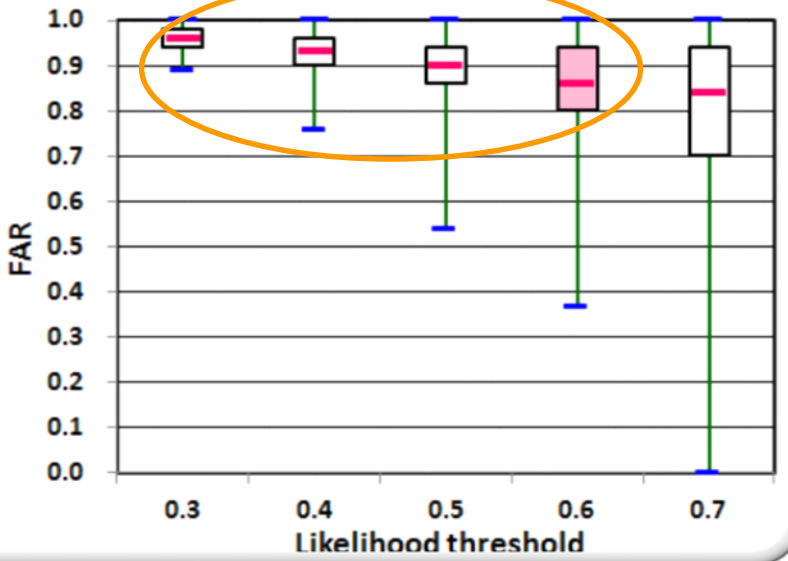
Sensitivity tests

- Sensitivity of scores to different likelihood thresholds (Lts)









How to choose the optimal likelihood threshold?

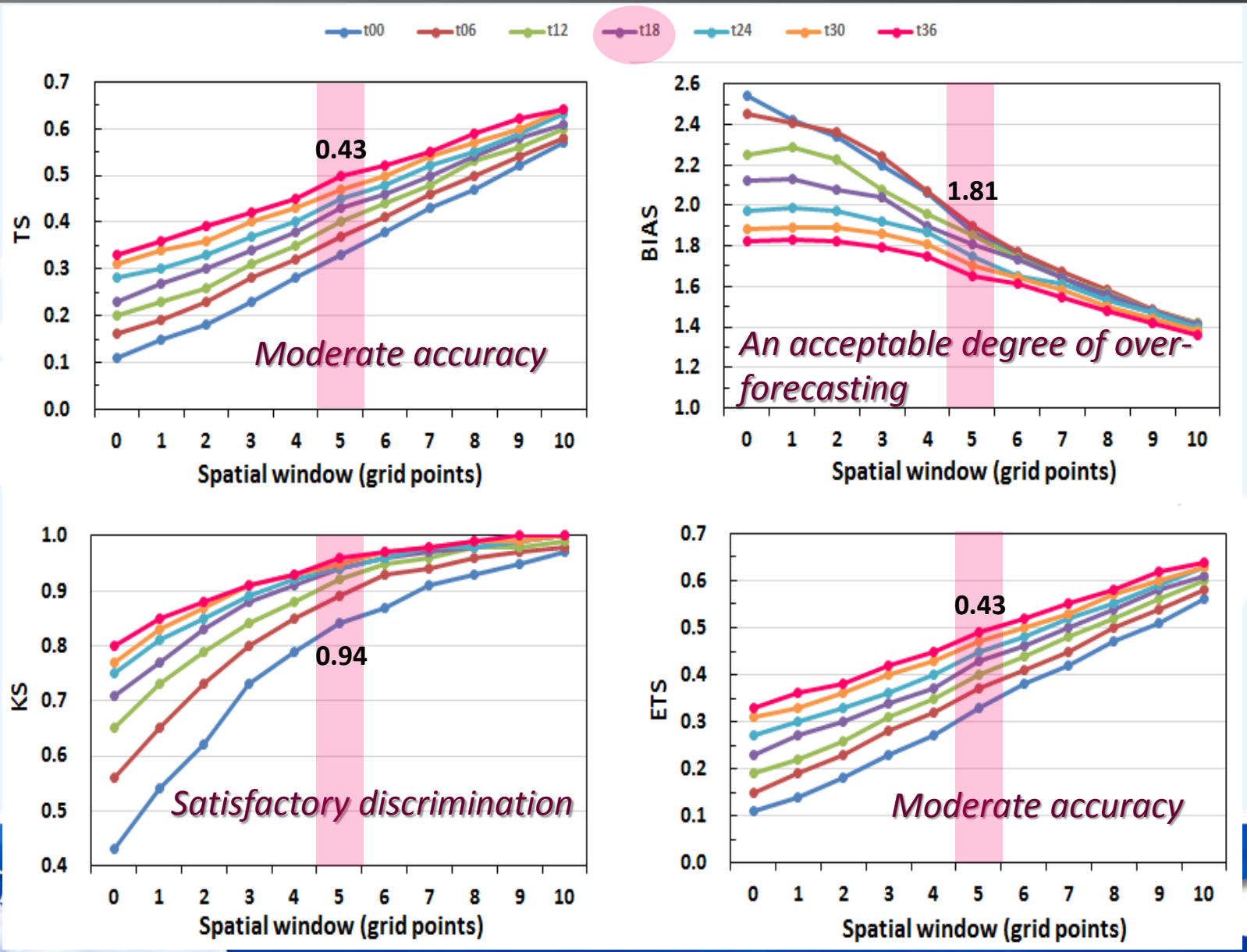
Sensitivity Experiments

Sensitivity of scores to different combinations of spatial and temporal windows

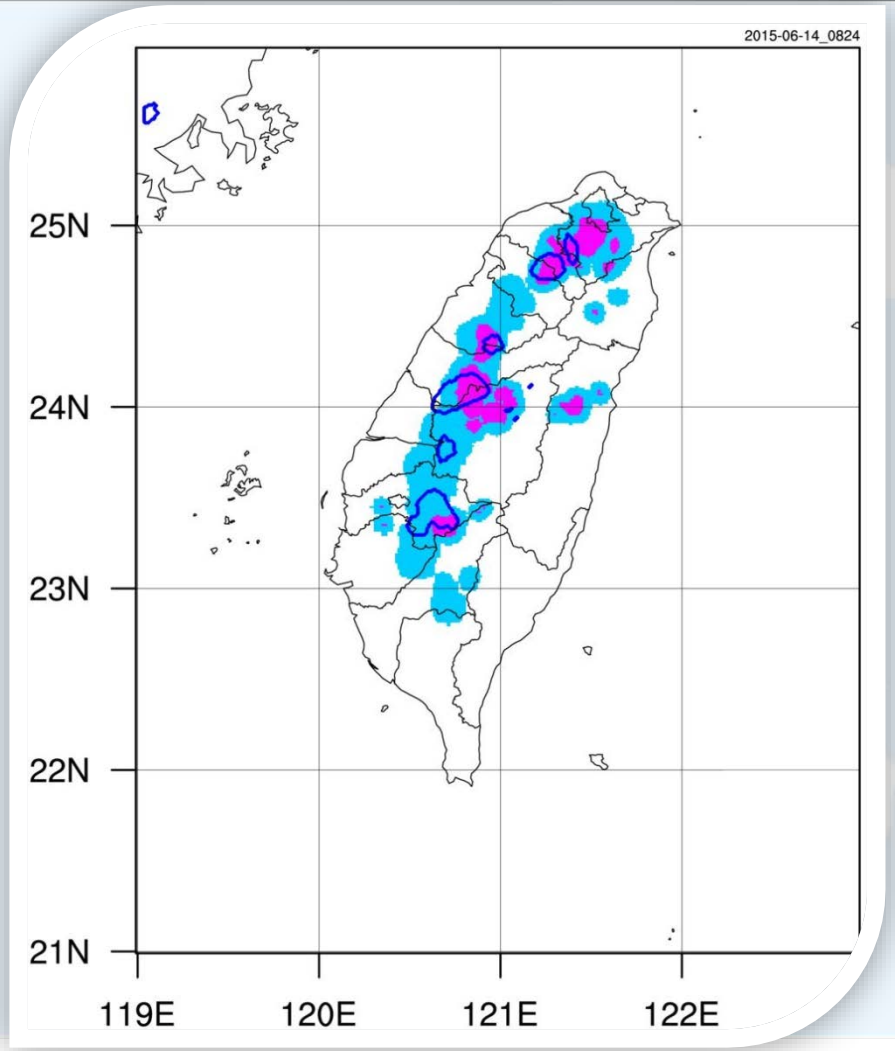
→determine acceptable uncertainty ranges to display *the less likely, but still possible, regions for CI*

Sensitivity tests

- *Sensitivity of scores to different combination of spatial and temporal windows (Lt=0.6)*



Nowcast guidance of afternoon CI



With the optimal Lt of 0.6, a spatial window of 5 grids, and a temporal window of 18 min.

Pink shades : the most likely regions for CI (i.e., areas with likelihood ≧ 0.6)

Blue shades : the less likely but still possible areas of CI

Dark blue contours : observed CI

Summary

- To provide guidance on the most likely region for CI, we determine an optimal Lt, which best corresponds to the observed CI. The criterion of threshold selection is optimized to balance the hits against false alarms in the forecasts.
- Forecast uncertainty information is incorporated in the nowcast products via spatial and temporal relaxation.
- The nowcast guidance displays moderate accuracy and satisfactory discrimination with an acceptable degree of over-forecasting.

Chang, H. L., B.G. Brown, P. S. Chu, Y. C. Liou, and W. H. Wang, 2017: Nowcast Guidance of Afternoon Convection Initiation for Taiwan. *Wea. Forecasting*, 32, 1801–1817.