台灣自動即時預報系統(TANC)之午後對流啟始預報評估

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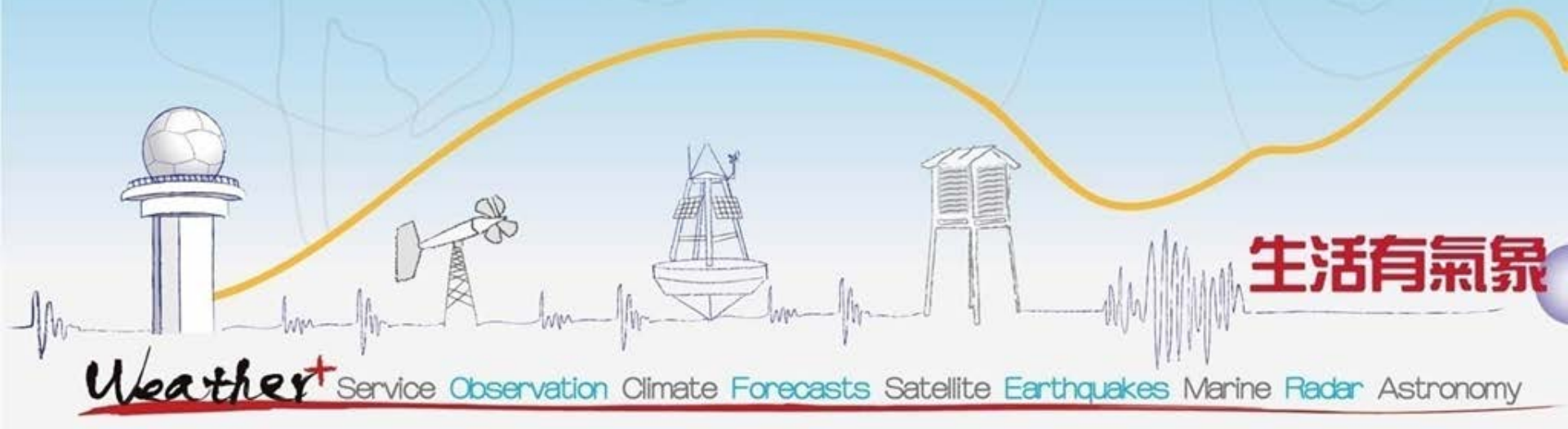
中央氣象局衛星中心



The nowcast of afternoon convective storm initiation is still a challenging task.

Afternoon convective storm cases in 2014

Case date: No. of validation times	*Start-end*
30 Jun (34)	*0606 - 0930 UTC*
01 Jul (24)	*0730 - 0948 UTC*
27 Aug (33)	*0618 - 0930 UTC*
29 Aug (30)	*0718 - 0906 UTC* *0930 - 1030 UTC*
09 Sep (20)	*0730 - 0930 UTC*
Total: 141 1-h nowcasts	

Outline

- *Verification and Analysis Methods*
- *Sensitivity Tests on Verification*
  - Sensitivity of Scores to Probability Thresholds
  - Sensitivity of Scores to Spatial Relaxation
  - Sensitivity of Scores to Temporal Relaxation
- *Comparison of TANC and STMAS-WRF*
- *Summary*

Verification and Analysis Methods

Conversion of probabilistic to Y/N forecasts

Forecast field

0.3	0.4	0.5
0.5	0.7	0.8
0.8	0.9	0.9

If Pt = 0.8

N	N	N
N	N	Y
Y	Y	Y

Verification field

0	0	3
0	2	2
0	2	1

N	N	N
N	Y	Y
N	Y	Y

c	c	c
n	m	h
f	h	h

0: no storm
1: new storm
2: ongoing storm
3: decaying storm

Obs \ Fcst	Y	N
Y	h (hits)	m (misses)
N	f (false alarms)	C (correct rejection)

Kuiper score (KS)

- Answers the question: How well did the forecast separate the events from the non-events?

$$KS = \frac{ch - mf}{(c + f)(h + m)} = H - F$$

Range : -1 to 1
1: perfect score
> 0: skillful forecast

H : hit rate
F : false alarm rate

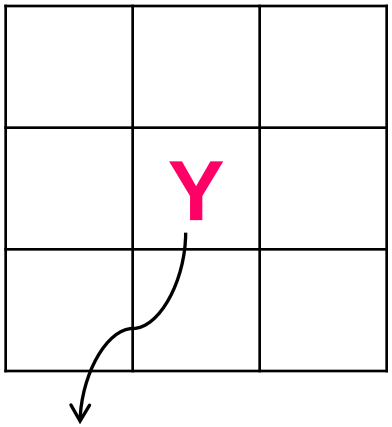
- Possesses "equitability" (Gandin and Murphy 1992)
- Is universally acceptable for evaluating Y/N forecasts for scientific purposes (Woodcock 1976)

Relaxation method

-from pixel–to-pixel to (2N+1) x(2N+1) neighborhood

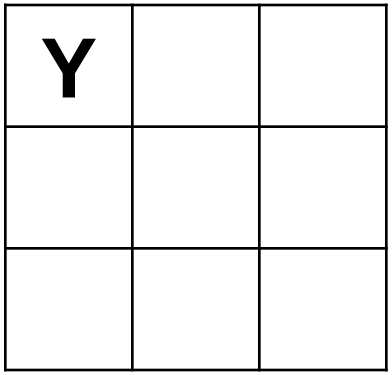
For example, N=1

Forecast field



Verifying grid point

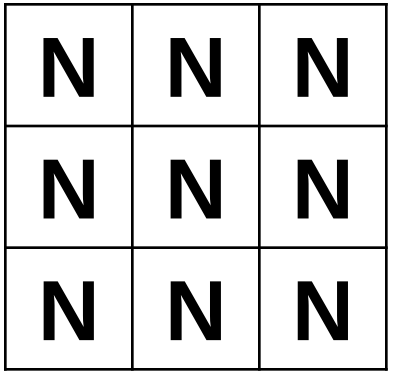
Verification field



There is “Y” within the 3X3 neighborhood

Hit

→***h*** increases



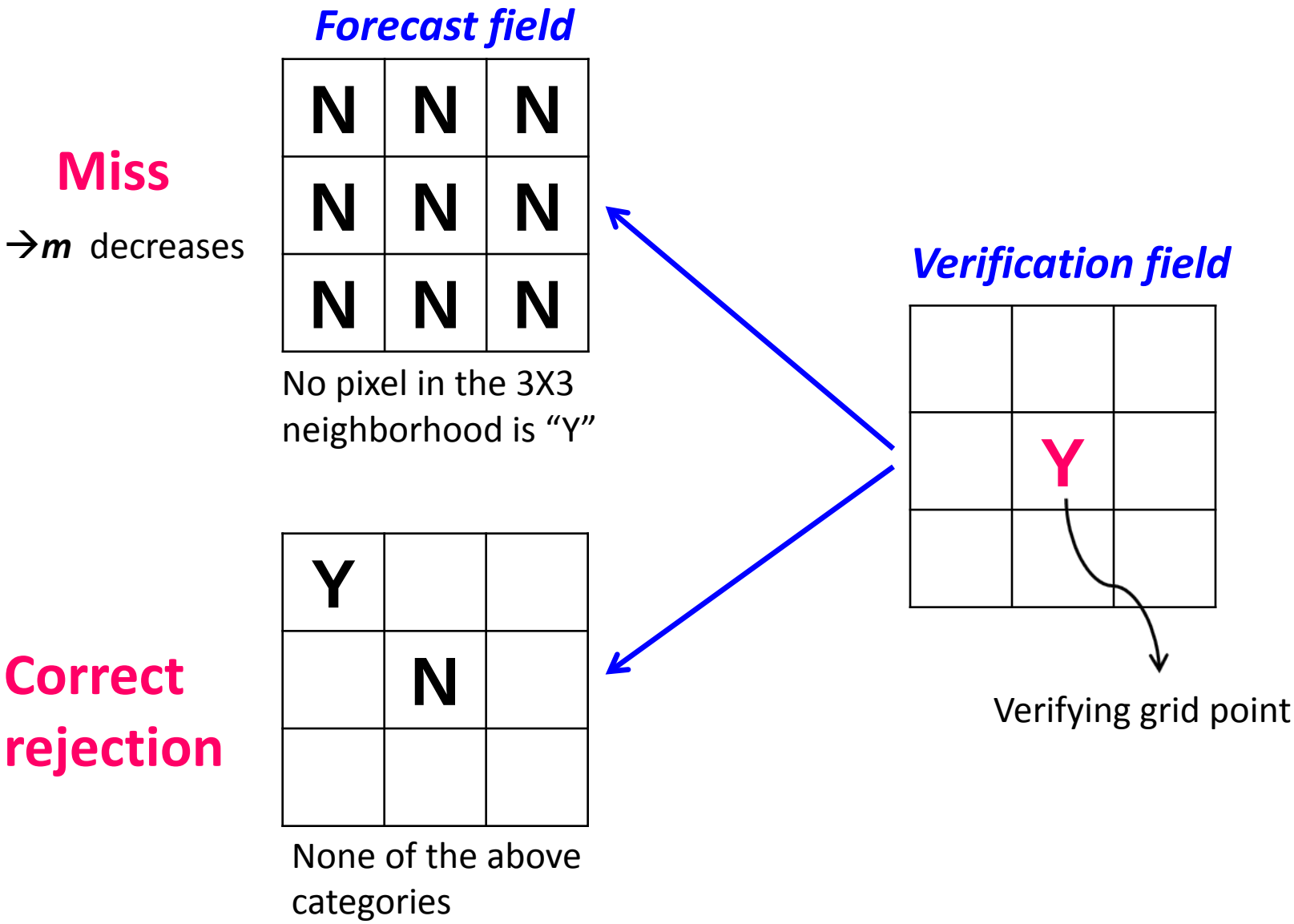
There is no “Y” within the 3X3 neighborhood

False alarm

→***f*** decreases

Relaxation method

-from pixel–to-pixel to (2N+1) x(2N+1) neighborhood



Sensitivity Tests on Verification

- *Sensitivity of scores to probability thresholds*
- *Sensitivity of scores to spatial relaxation*
- *Sensitivity of scores to temporal relaxation*

Sensitivity of scores to probability thresholds

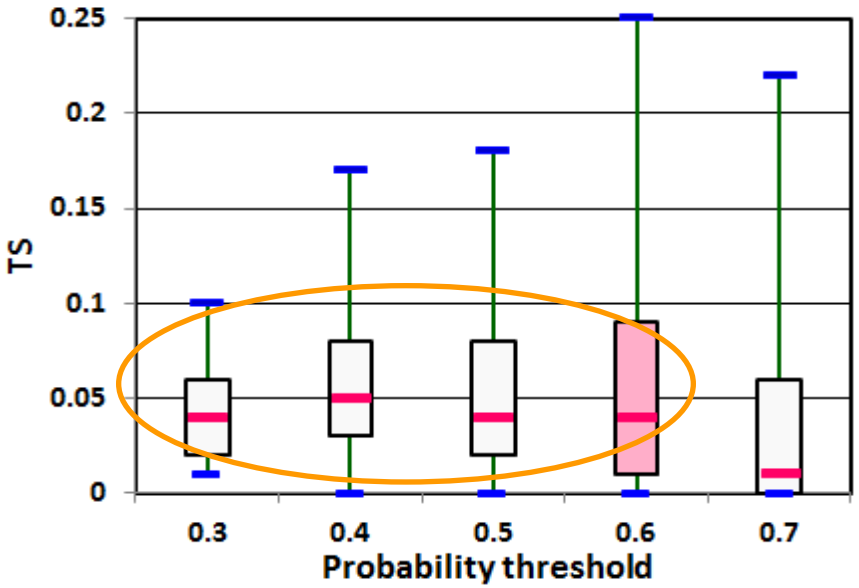
The TANC provides the likelihood of convective storm initiation.

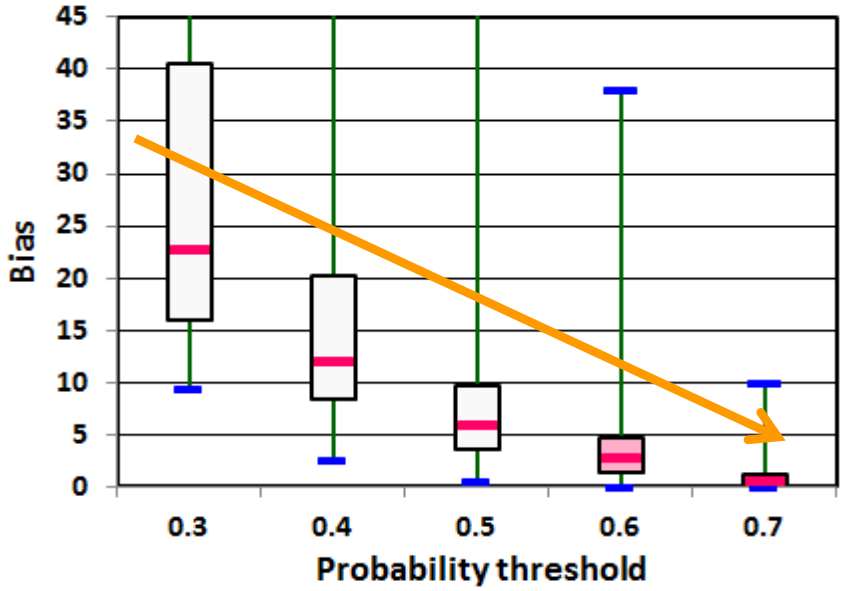
What probability means

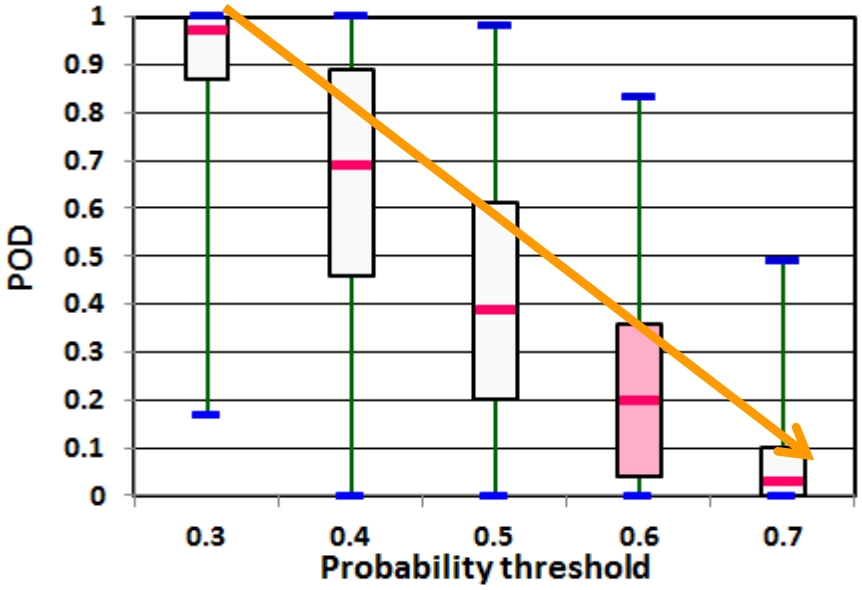
the event will happen?

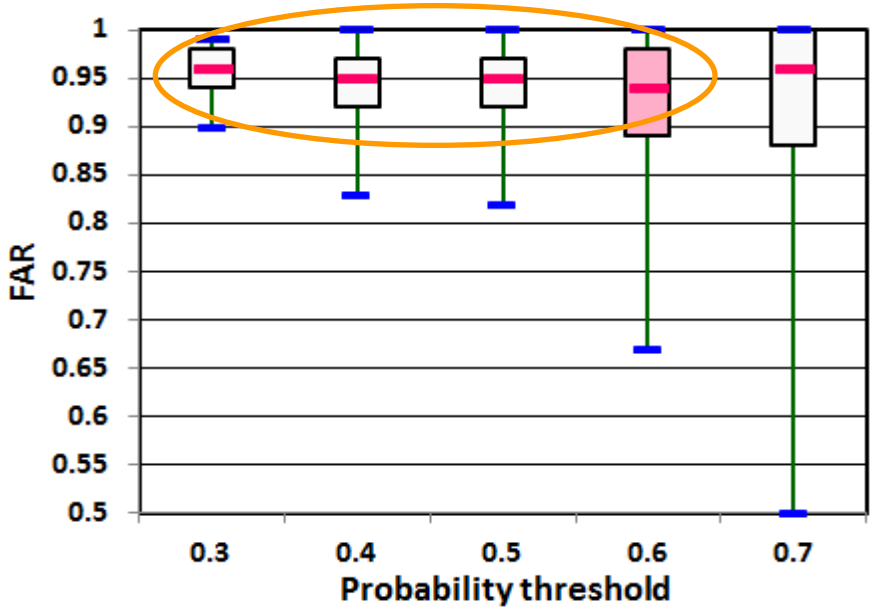
What's the optimal probability threshold?

Sensitivity of scores to probability thresholds





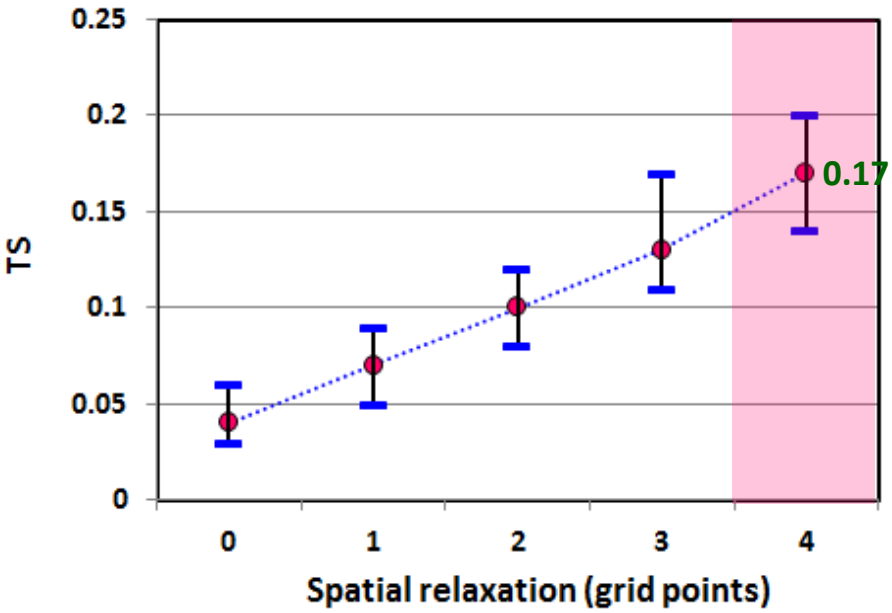


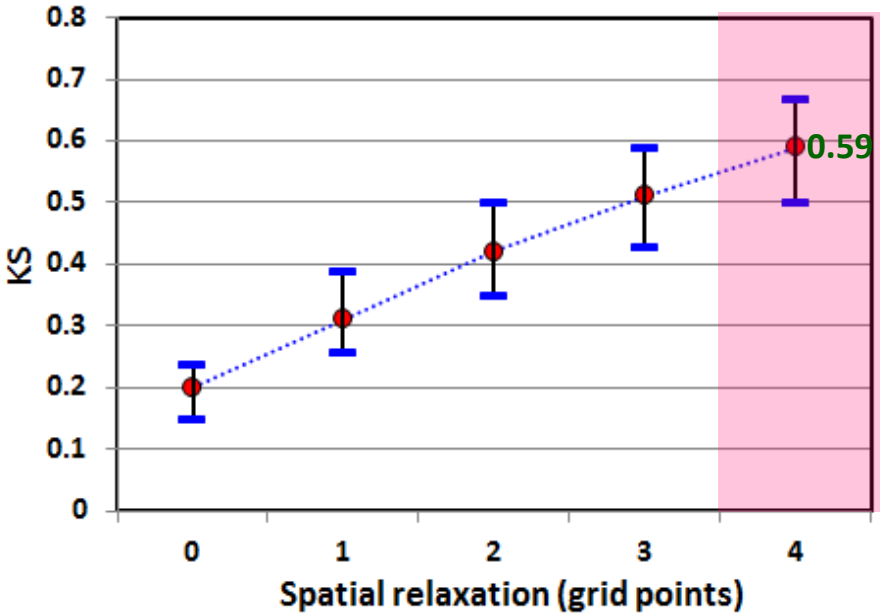


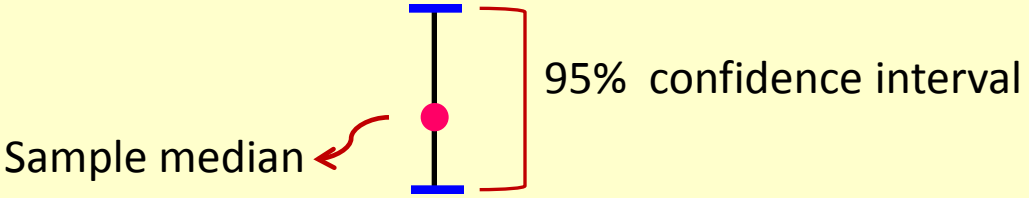
Q : How to choose the optimal probability threshold?

Sensitivity of scores to spatial relaxation (Pt=0.6)

- Score median with 95% confidence interval (CI)

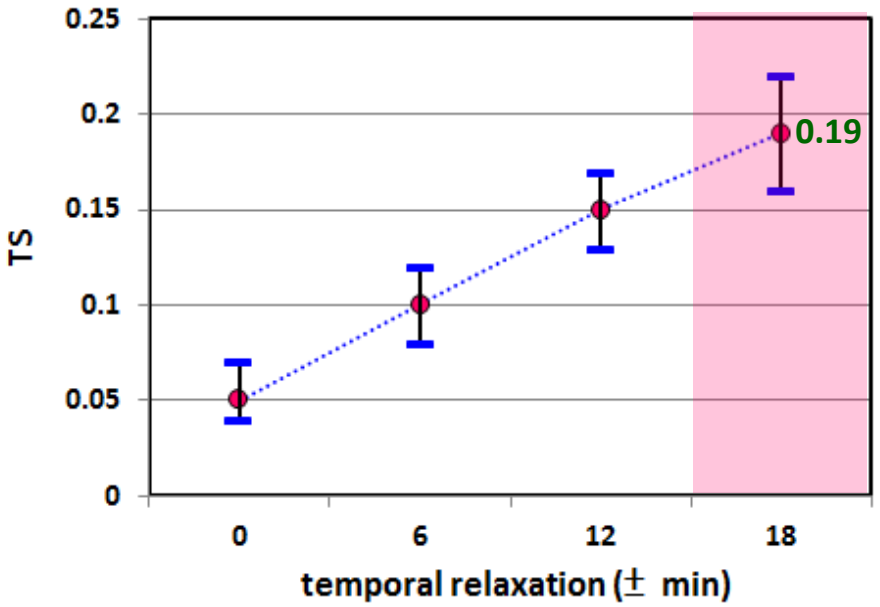


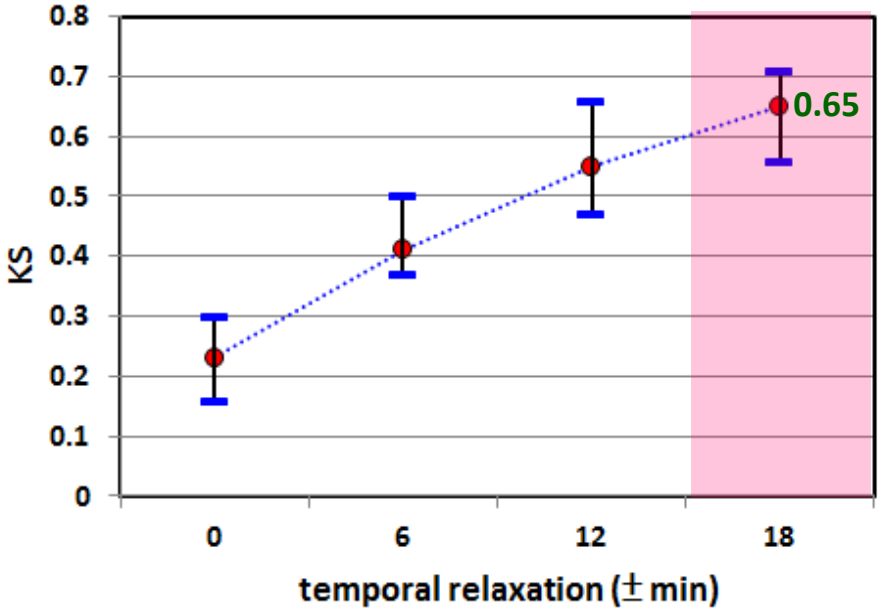




Sensitivity of scores to temporal relaxation (Pt=0.6)

- Score median with 95% confidence interval (CI)





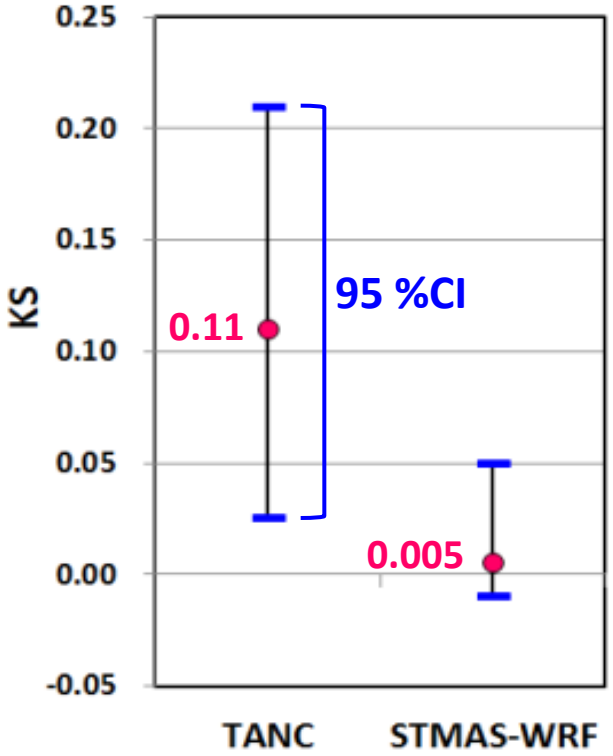
For nowcasts of afternoon convective storm initiation, the performance of TANC seems not satisfying…

Does it surpass other short-range models available currently?

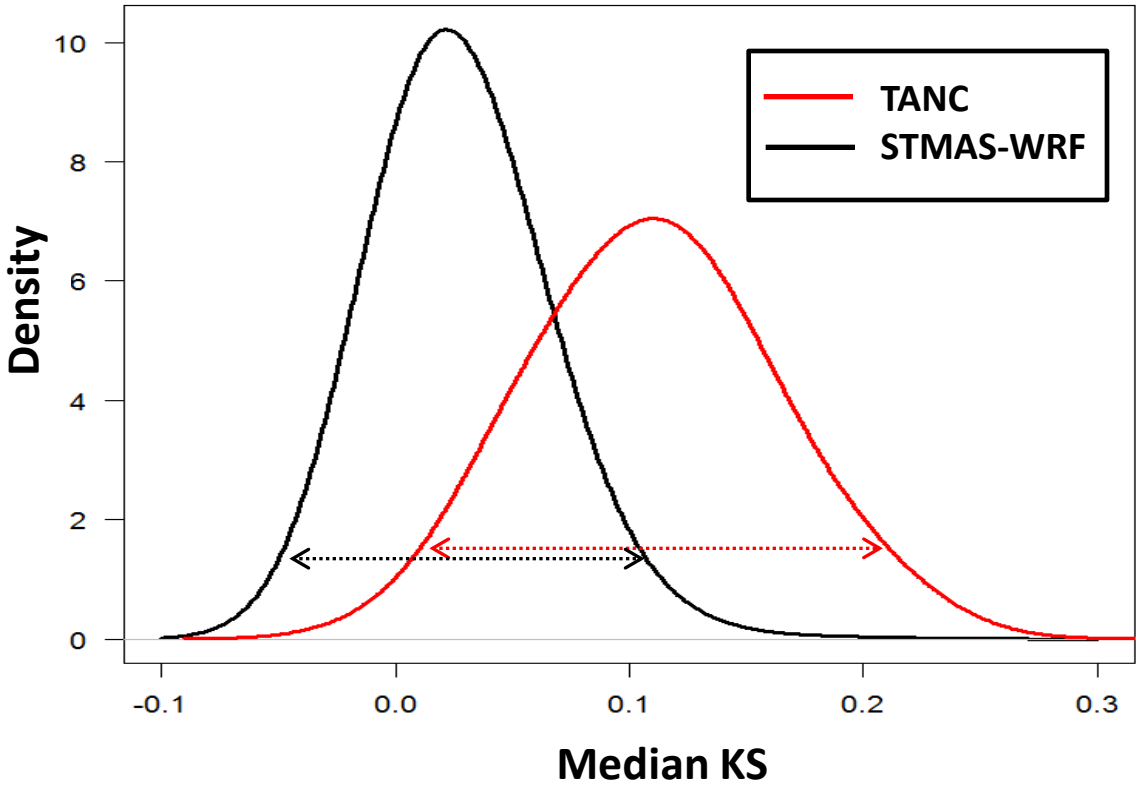
Comparison of TANC and STMAS-WRF

- bootstrap resampling process

(a) Sample median and 95%CI



(b) Resampling distribution



If adopting median KS as an index of forecast ability, the TANC is more skillful than the STMAS-WRF, but its sample variability is larger.

Comparison of TANC and STMAS-WRF

➢Mann-Whitney Test for Median Comparison

The Mann-Whitney test determines the p-value using a normal approximation, which is calculated as follows:

$$Z_w = \frac{\left| W - \frac{n(m+n+1)}{2} \right| - 0.5}{\sqrt{\frac{mn}{12}\left[(m+n+1) - \frac{\sum_{i=1}^{K} (t_i^3 - t_i)}{(m+n)(m+n-1)} \right]}}$$

W = Mann-Whitney test statistics
n = the size of sample 1 (STMAS-WRF)
m = the size of sample 2 (TANC)
i =1,2,…,K
K = the number of sets of ties
t_i = the number of tied values in the i-th set of ties

For median KS comparison:
P-value = 0.08
→The TANC and STMAS-WRF are significantly different at 10 % test level.

Summary

- Based on the 2014 cases, the optimal probability threshold (Pt) for the afternoon convective storms is 0.6
  - On the basis of this Pt, the TS (KS) is up to 0.17 (0.59) as a spatial uncertainty of 4 km is allowed.
  - The TS (KS) is up to 0.19 (0.65) as a temporal uncertainty of 18 minutes is allowed.

- For the prediction of afternoon storms, the TANC significantly surpasses the STMAS-WRF at the 10 % test level.