



(SRNW P-PEPS Calibration

Calibration

Calibration

Frans Alkemade

(credits to Ben Wichers Schreur, Kees Kok)

HRLAM /ALADN meeting, Brussels, 08-04-2008







## U kan βen Δ? P o u s s i b l e b e n e f i t s

- ナカニシテ オフラモテアツク 並行式 拍死クハツク 並 互PPオアモウ βソ Pアノオビツク 自 **calibrated modelspread** 自ウ自 内モウツク 自PPアウキヲ自β並シテ
- 乙自βヲアテラ 死ββββ Pアββββ並行式 拍死クハツク 乙自β 自モウアノモウ βソ 自モアツク 並並 **complete PDF's** 自自自 自PPカモアズ 自ββββ並シテ
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# ... BASIC PRINCIPLE



## 1) Bias Correction

$$y = c_k + d_k f_k$$

$y$  is the observed value

$f_k$  is the  $k$  th forecast

## 2) Bayesian Model Averaging (BMA)

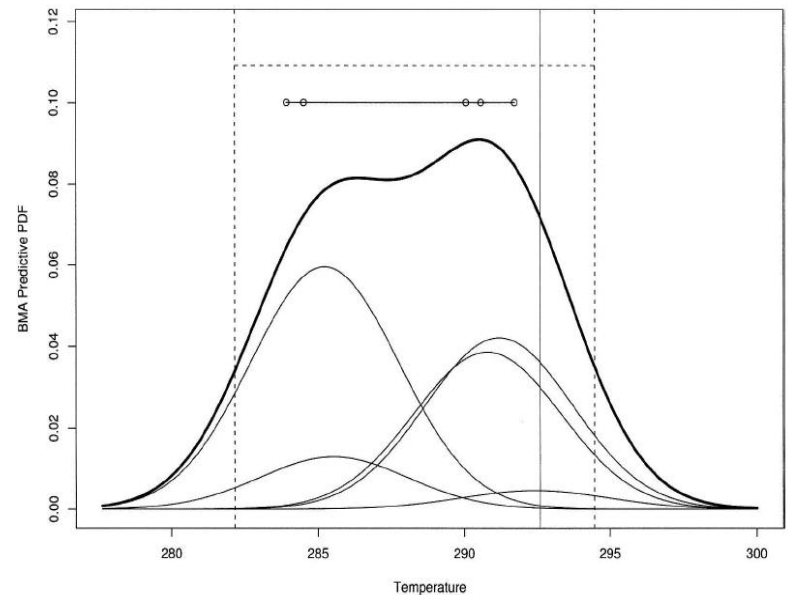
Adrian E. Raftery, Fadoua Balabdaoui, Tilmann Gneiting and Michael Polakowski, Department of Statistics, University of Washington, Seattle, Washington

$$p(y | f_1, \dots, f_k) = \sum_k w_k h_k(y | f_k)$$

weight

parametric error distribution

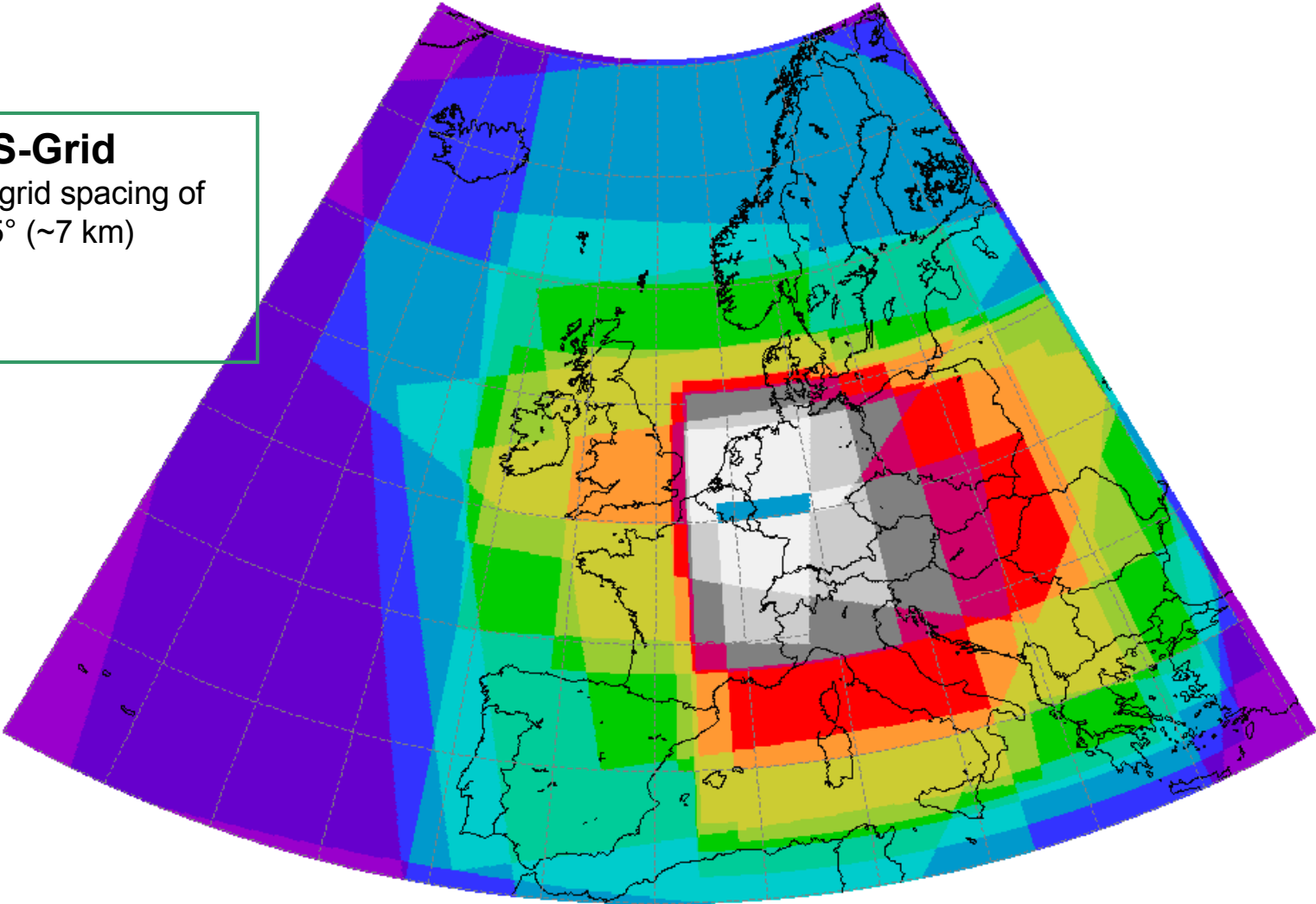
„The model is estimated from a training set of recent data by maximum likelihood using the EM algorithm.  
Good results with a **15-25-day training period.**“



# The SNRWP-PEPS ensemble:



**PEPS-Grid**  
with a grid spacing of  
 $0.0625^\circ$  (~7 km)







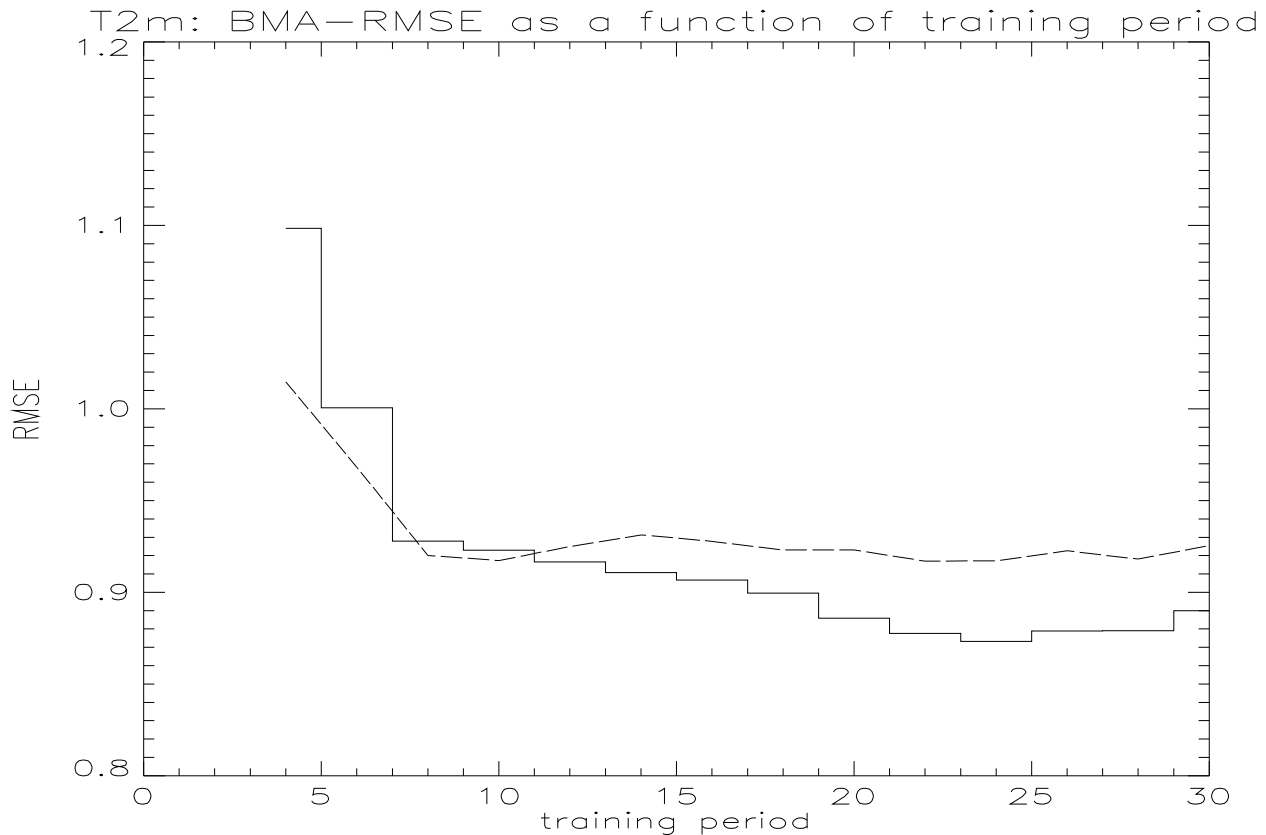


# 白粉地的気象 予報の精度向上:



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(予報の精度向上 = 予報内 予報の精度向上 予報内, ナニ 予報の精度向上 予報内 予報の精度向上 予報内 予報の精度向上, ナニ 予報の精度向上 予報内 予報の精度向上 予報内 予報の精度向上 予報内 予報の精度向上)

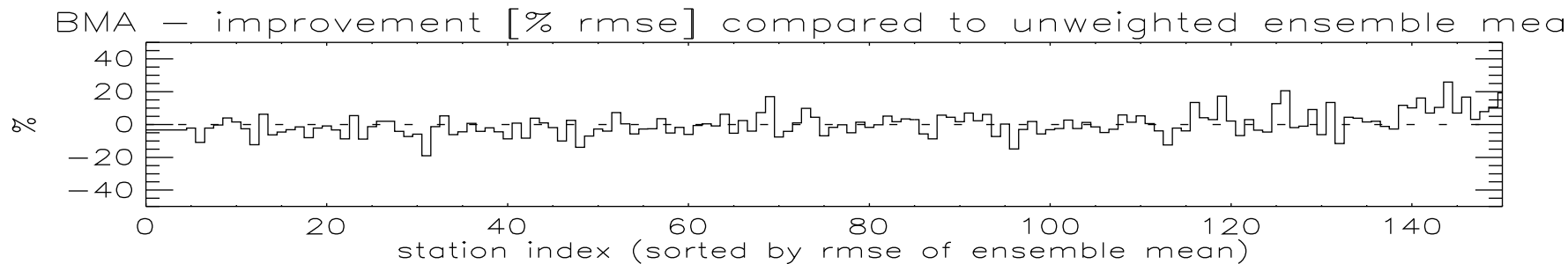
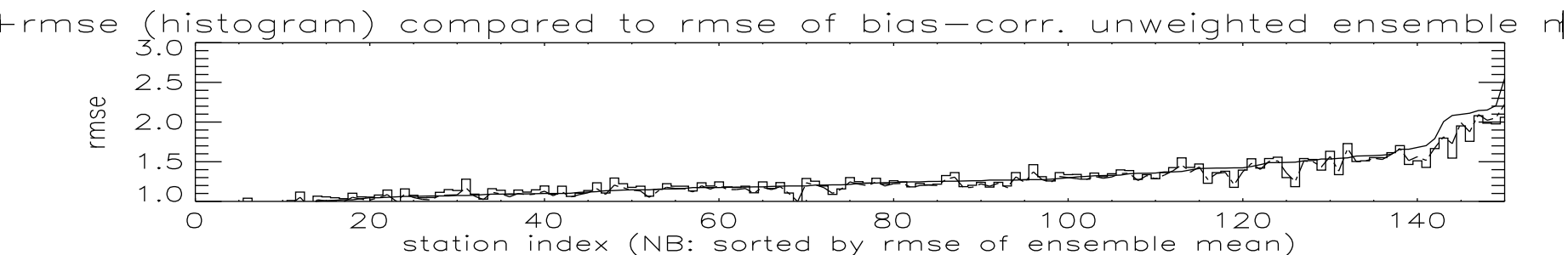
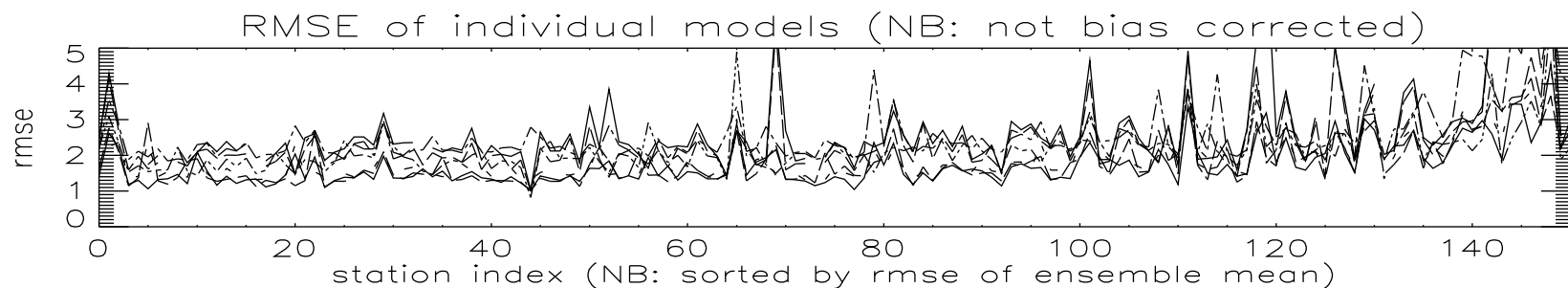
予報: ナニ 予報の精度向上





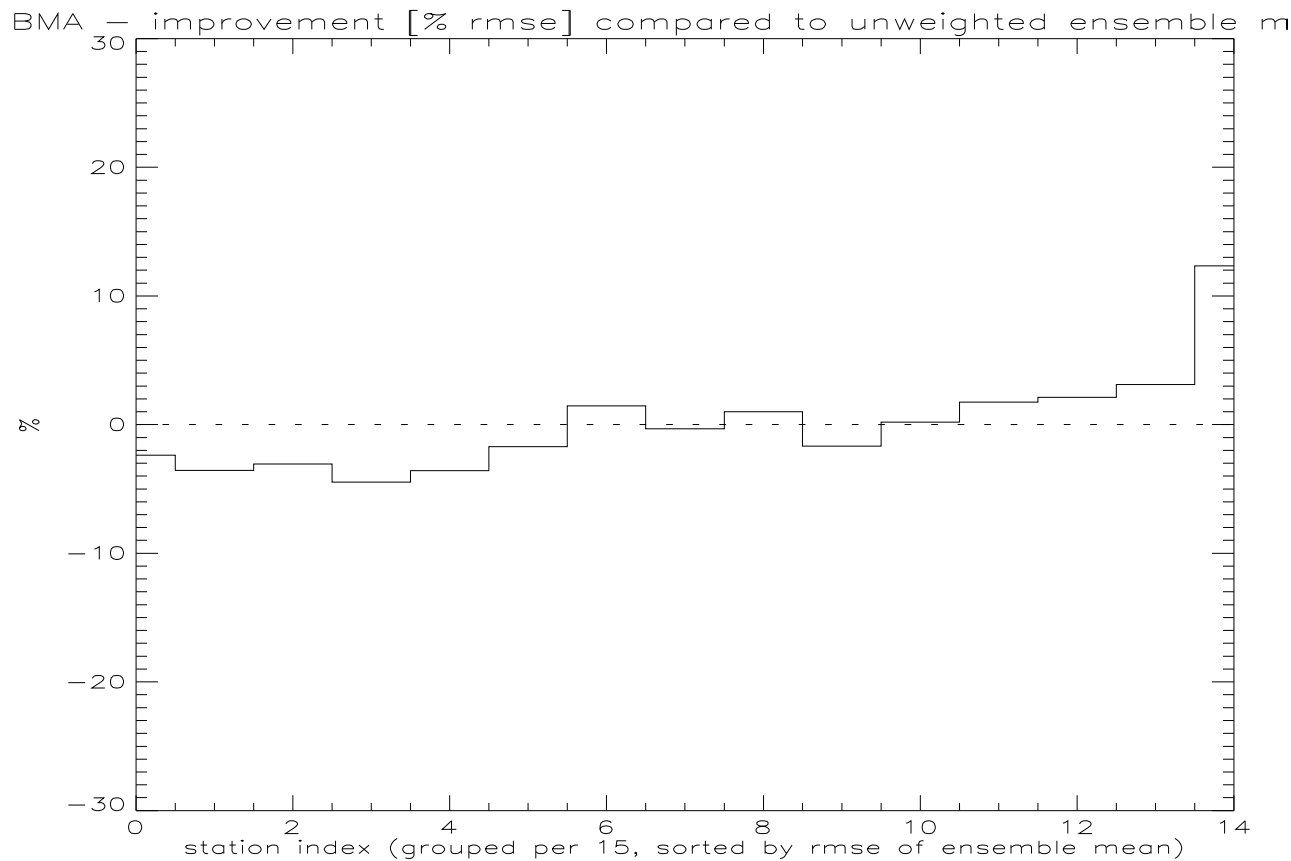
# △ BMA FOR OVERALL THE OF THE USE RESULTS (NOT) PER STATION

(NB: STATION IS SORTED BY THE RMSE OF ENSEMBLE MEAN)





# カウシ 内以カ ラモヲ 内△ 並ヲ知レモ 内ヲモ?

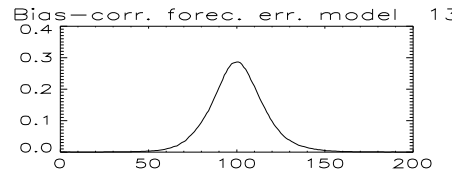
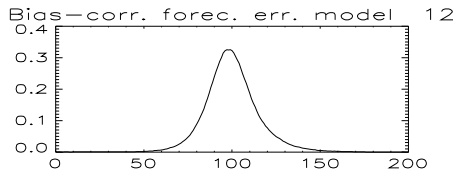
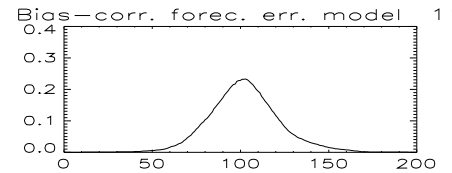
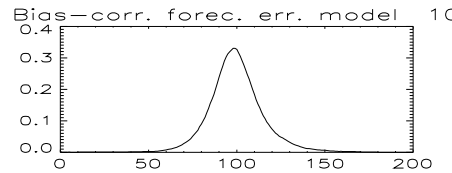
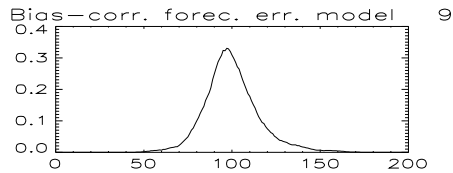
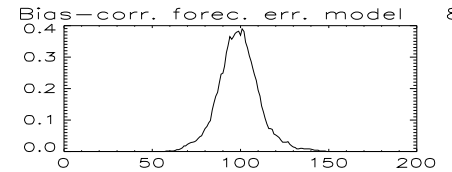
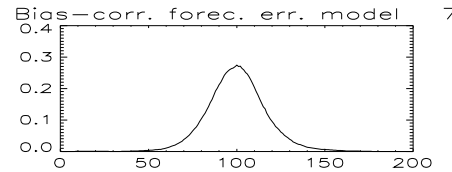
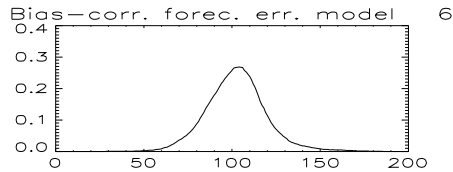
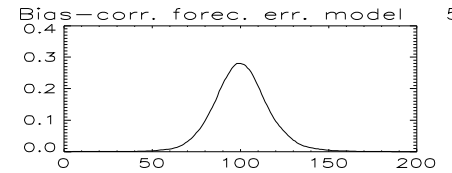
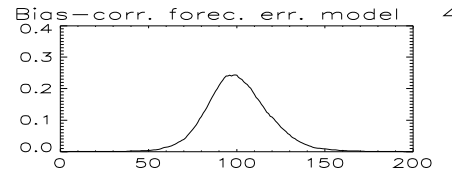
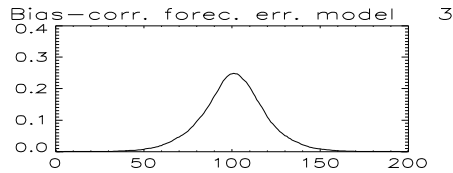
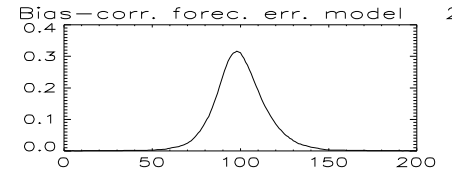
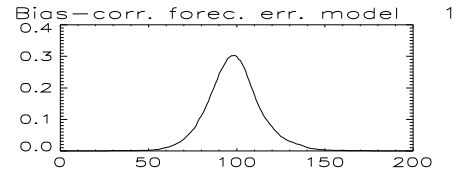
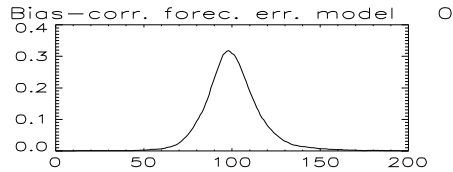






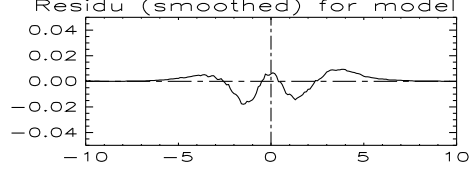
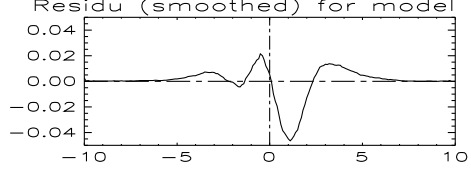
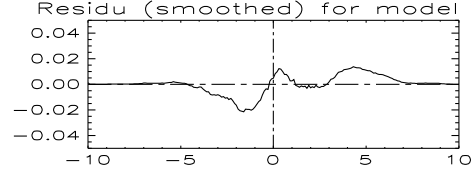
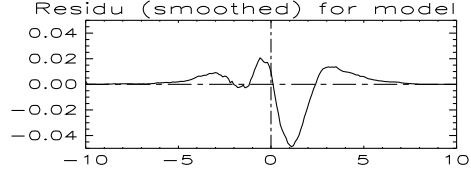
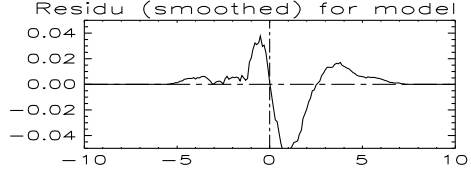
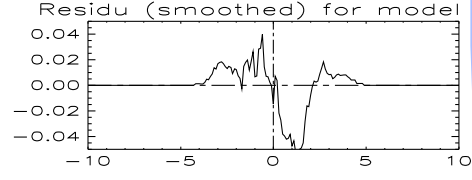
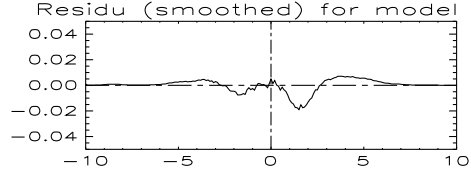
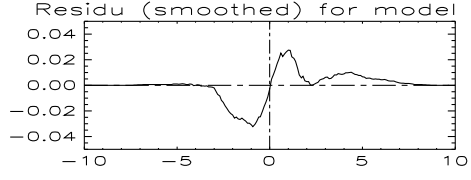
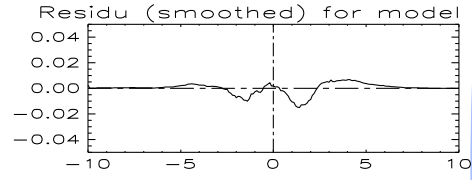
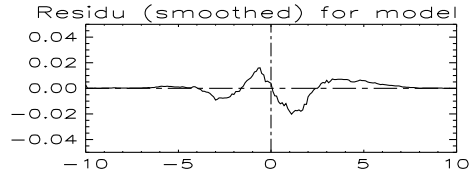
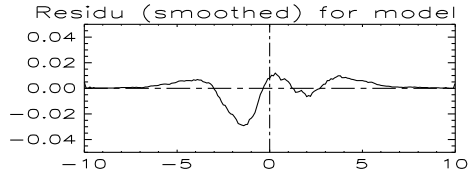
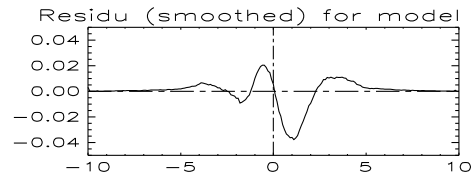
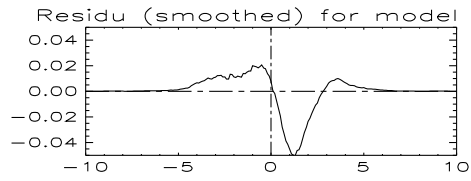
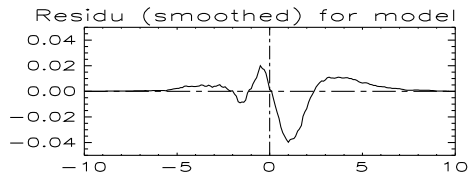


# 内 容 モ ジ ョ ン ア ロ ン 行 方 案 比 較 的 方 法 ( モ 内 P 並 本 方 法 )





# Residu (smoothed) for model



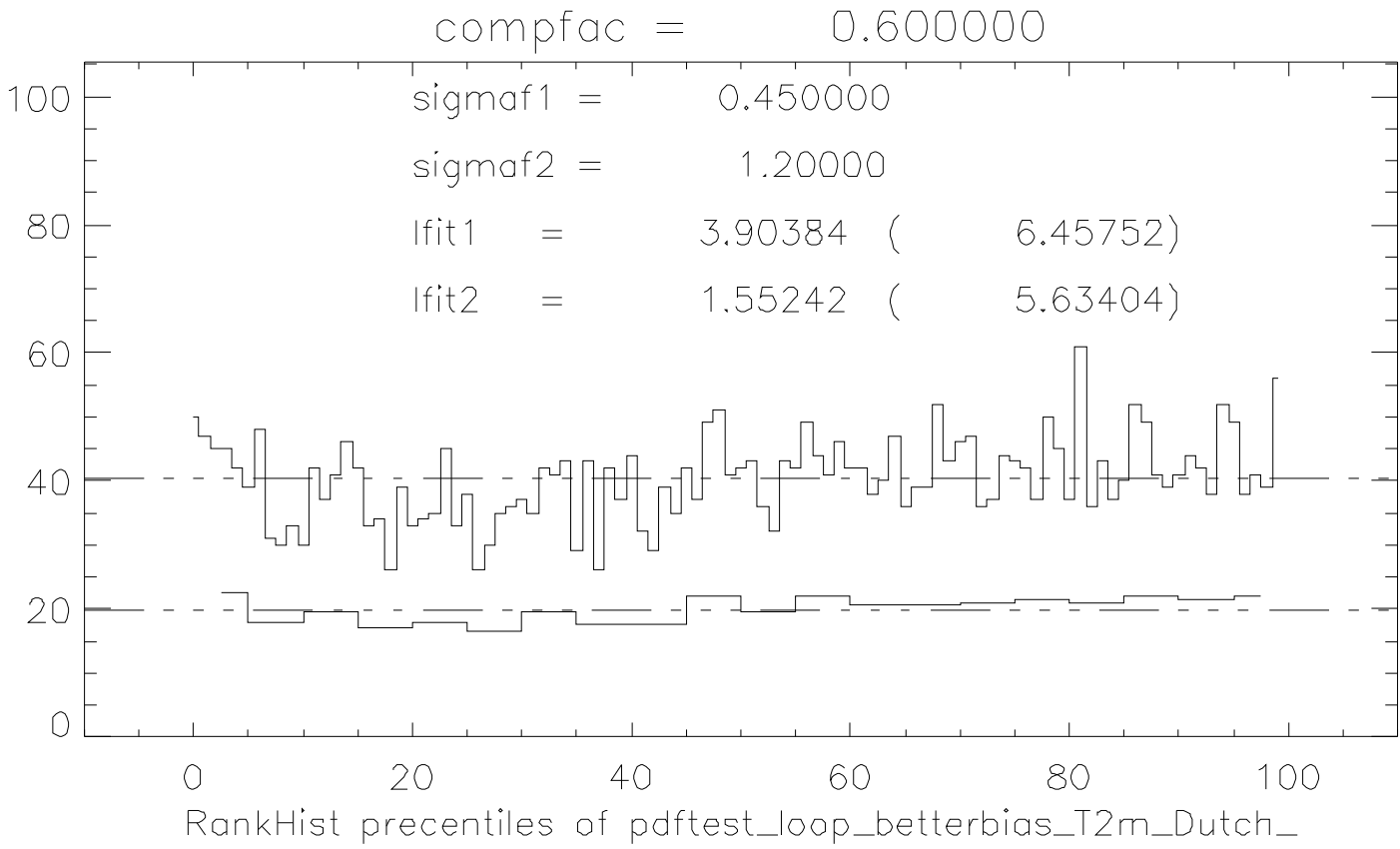
... **POSSIBLE TO FIND THE CORRELATION OF  
THE Δ IN THE TRENDS OF P AND T**



- The correlation between the trends of T and P is found, and the trend of P is found by the correlation coefficient between the trends of T and P.
- The trend of P is found by the correlation coefficient between the trends of T and P.
- The trend of P is found by the correlation coefficient between the trends of T and P.
  - $\rightarrow$  trend of P = 0.4 \* trend of T
  - $\rightarrow$  trend of P = 1.2 \* trend of T
  - $\rightarrow$  trend of P = 0.6 \* trend of T + 0.4 \* trend of T
- The trend of P is found by the correlation coefficient between the trends of T and P.

...

βのΔ への分布をよりよく説明するために、ランダムな分布をマージして見よう







## クアール・ベネッセ

- よろしくお伝えしたいお話を多くの方に届ける
- 国内各地に支店を設けて、お客様に身近なサービスを提供
- 地域に根ざしたサービスを提供する:

お客様に身近なサービスを提供する

## クアール・ベネッセの強み

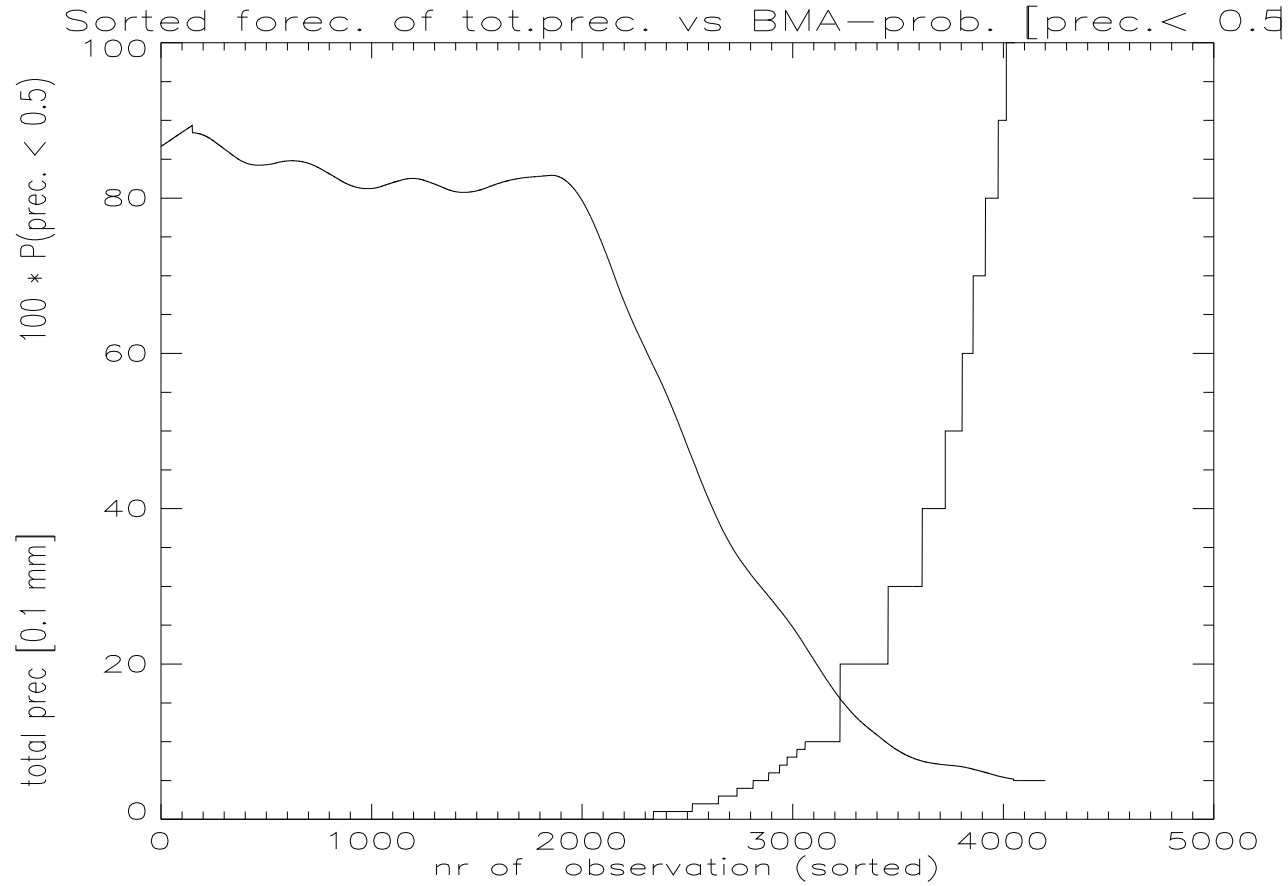
- 国内最大規模のネットワーク、豊富な人材とノウハウ
- 40年以上の歴史と実績
- 地域に根ざしたサービス



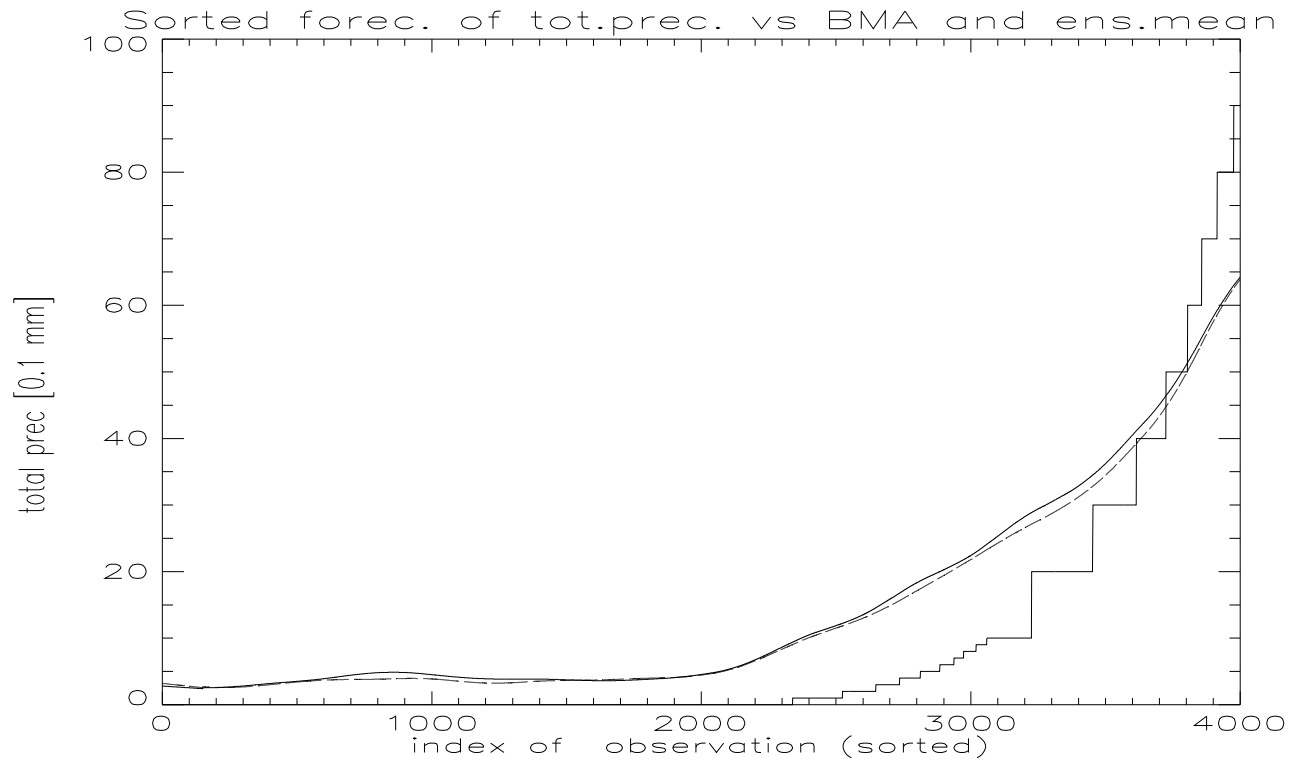


# β内Δ: P(降水.< 0.5 mm) の分布。

(内β: 観測された降水の分布)



●●●●  
 予報の精度を向上させるには、単一のモデルではなく、複数のモデルの  
 結果を組み合わせることで、*single averages per model* の代わりに、  
 複数のモデルの結果を組み合わせることで、精度を向上させることができる。

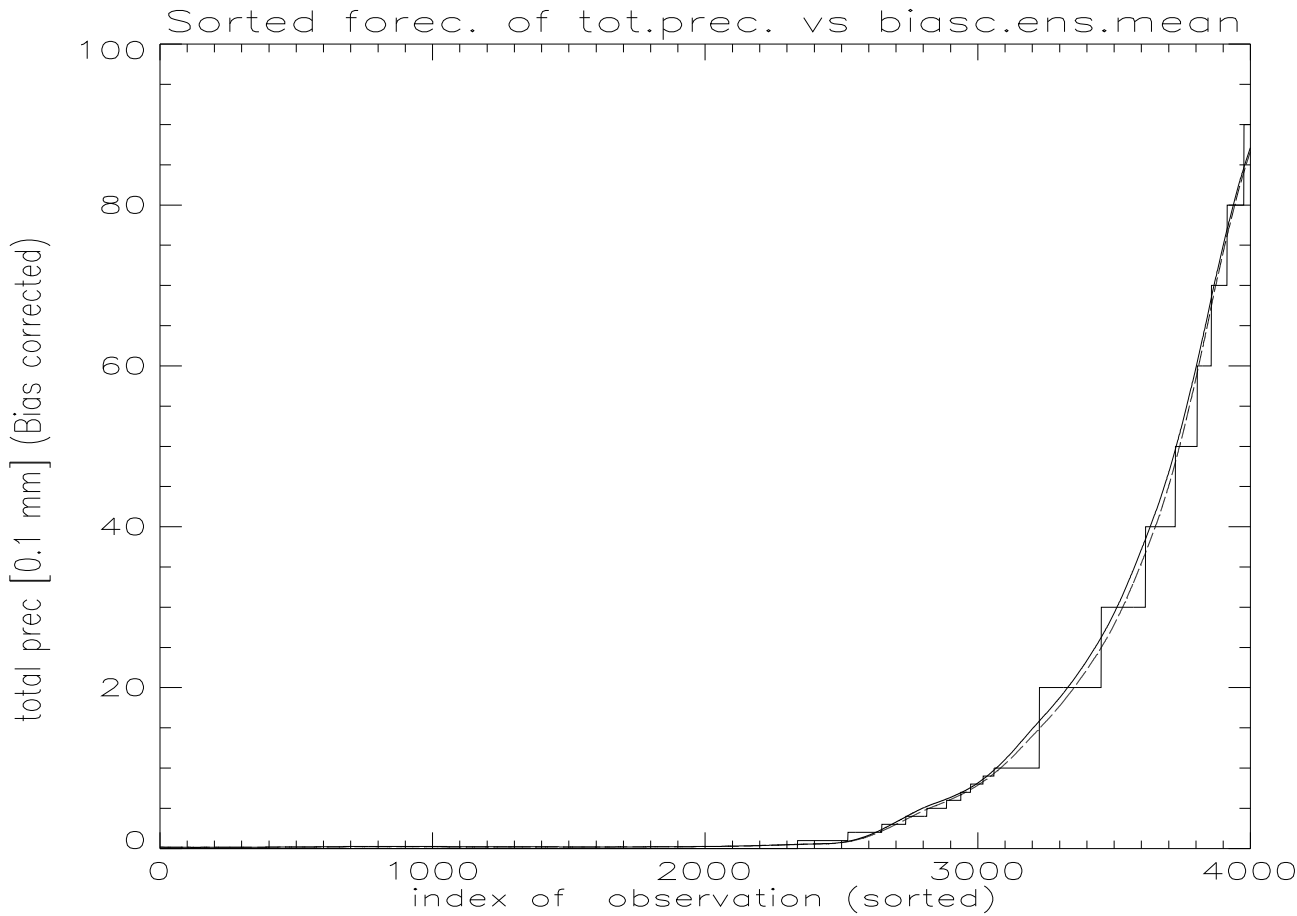




••••

**Solution: Bias correction perm m observed precipitation.**

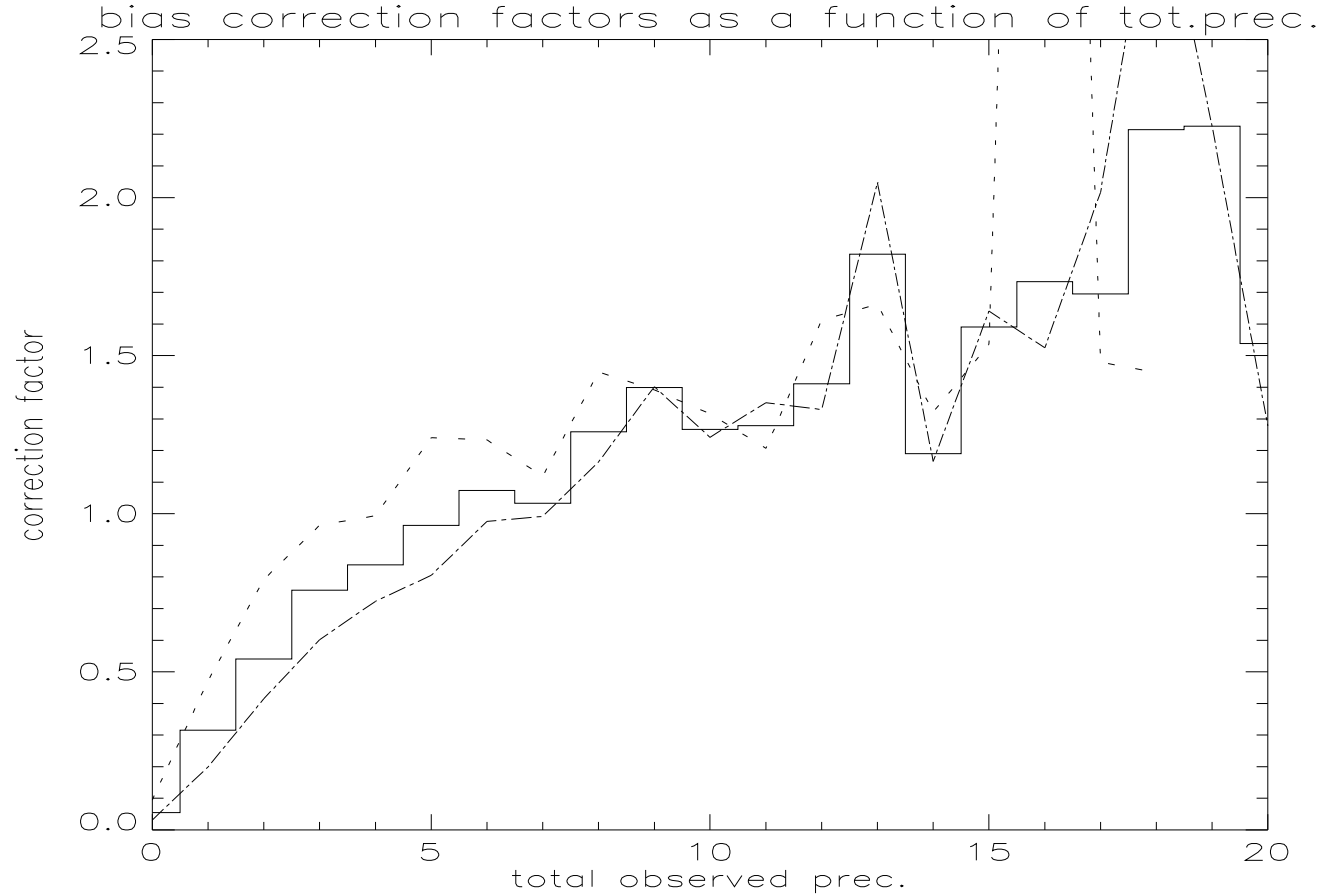
(forecast bias correction perm m observed precipitation)  
 (forecast bias correction perm m observed precipitation)



••••



**Good news:** 3 days of forecast errors are not significant  
 for the 10 days of forecast errors are not significant  
 for the 15 days of forecast errors are not significant  
 for the 20 days of forecast errors are not significant  
 for the 25 days of forecast errors are not significant  
 for the 30 days of forecast errors are not significant  
 for the 35 days of forecast errors are not significant  
 for the 40 days of forecast errors are not significant  
 for the 45 days of forecast errors are not significant  
 for the 50 days of forecast errors are not significant  
 for the 55 days of forecast errors are not significant  
 for the 60 days of forecast errors are not significant  
 for the 65 days of forecast errors are not significant  
 for the 70 days of forecast errors are not significant  
 for the 75 days of forecast errors are not significant  
 for the 80 days of forecast errors are not significant  
 for the 85 days of forecast errors are not significant  
 for the 90 days of forecast errors are not significant  
 for the 95 days of forecast errors are not significant  
 for the 100 days of forecast errors are not significant







....

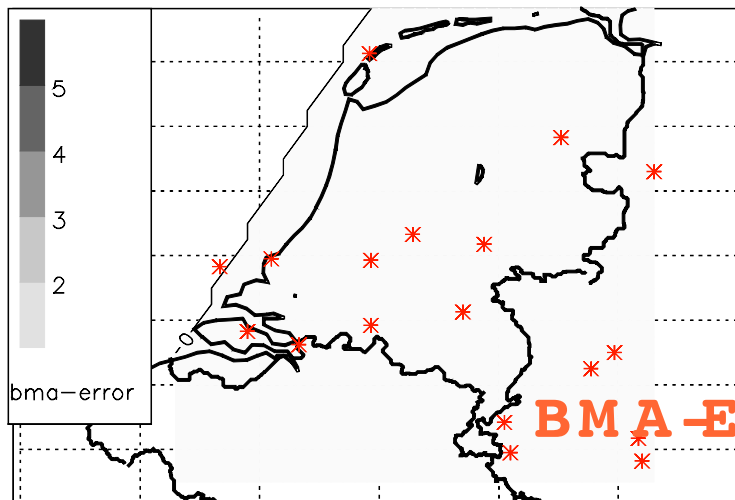
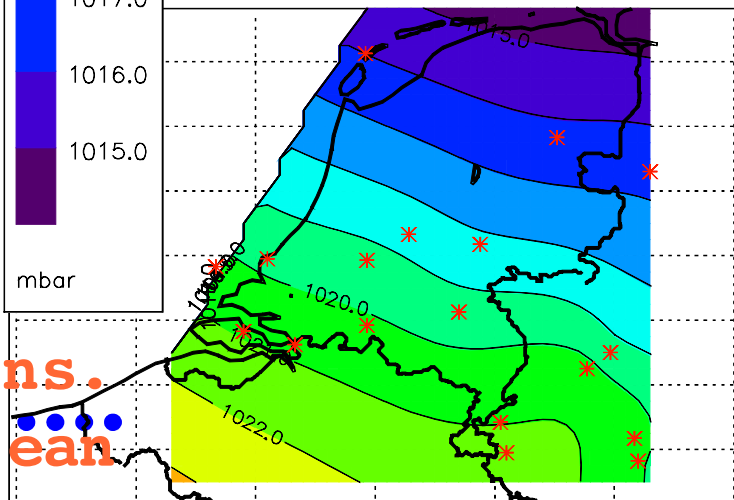
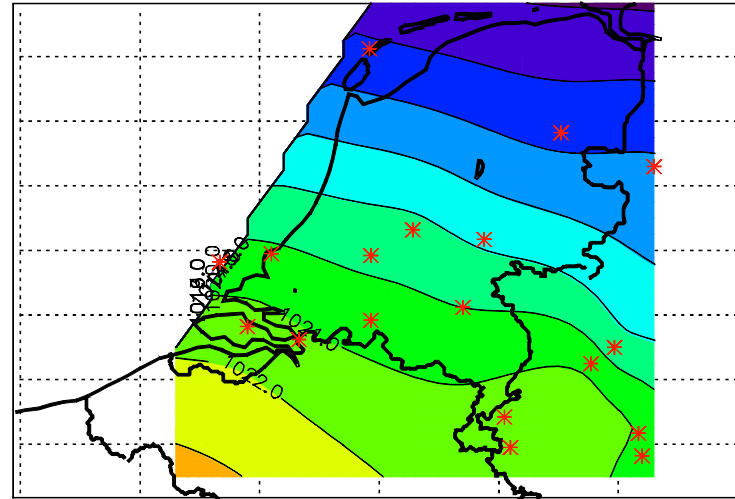
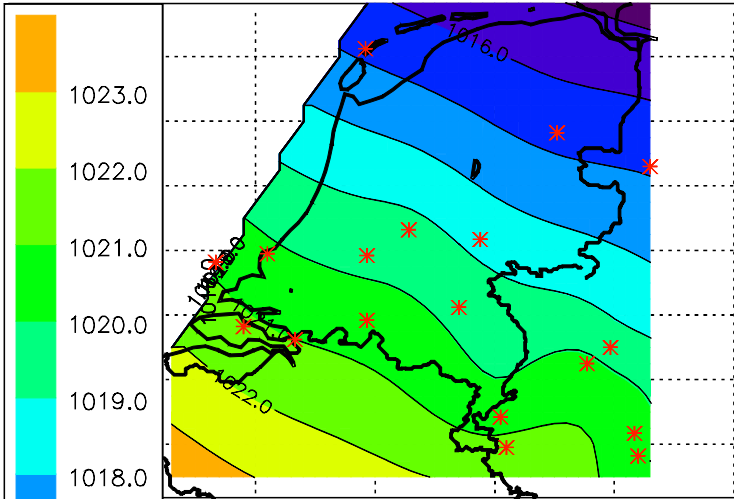
# 20080402 SRNWP-PEPS / MSLP: 00 UTC forecasts --> valid time is +30h



## Observ.

## BMA

20080402 SRNWP-PEPS / MSLP: 00 UTC forecasts --> valid time is +30h



## Ens. Mean

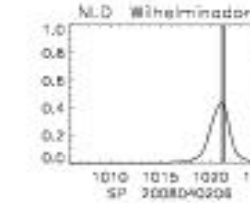
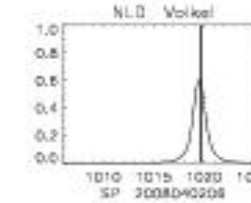
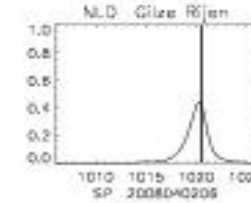
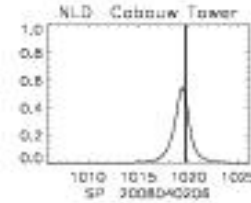
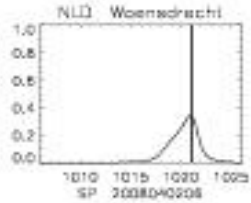
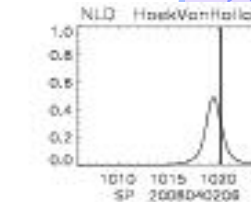
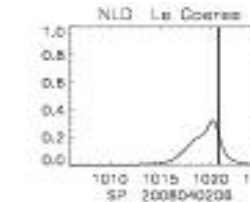
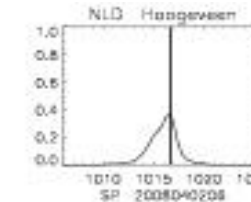
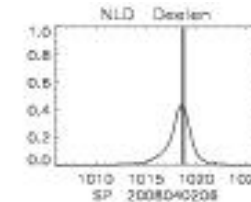
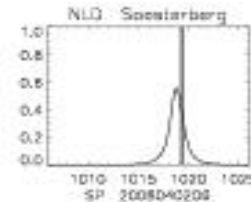
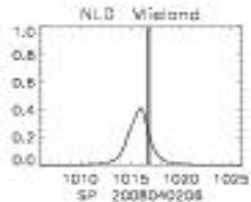
## BMA Error

....

# プラチナ時代 5P 拍死の府庁 (PのLをA/B/C/D/EのRで示す)



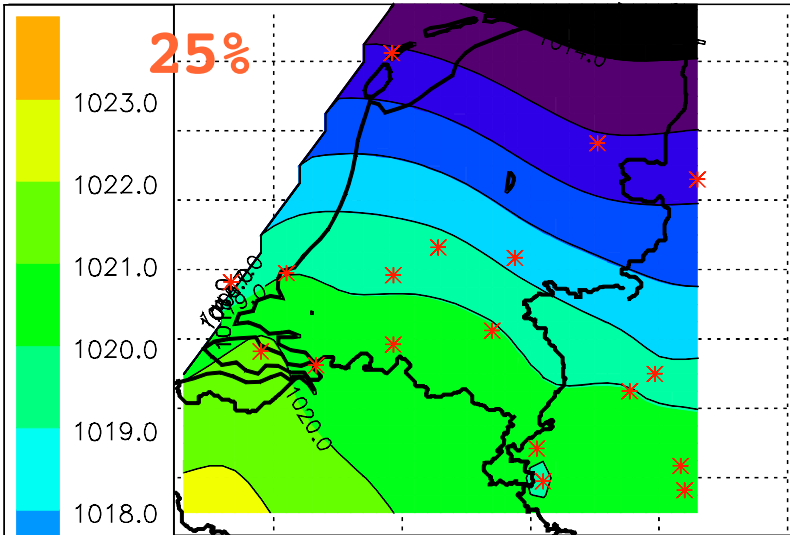
Koninkrijk



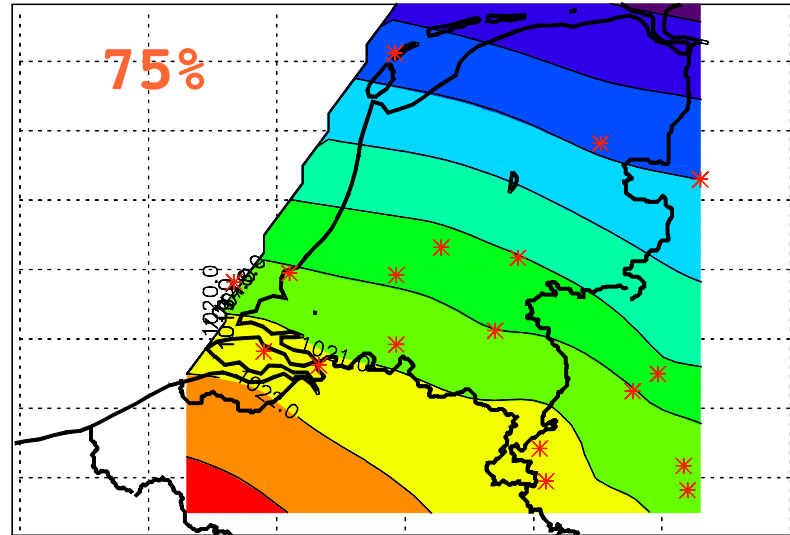
# ... 5P: Probabilistic Forecast



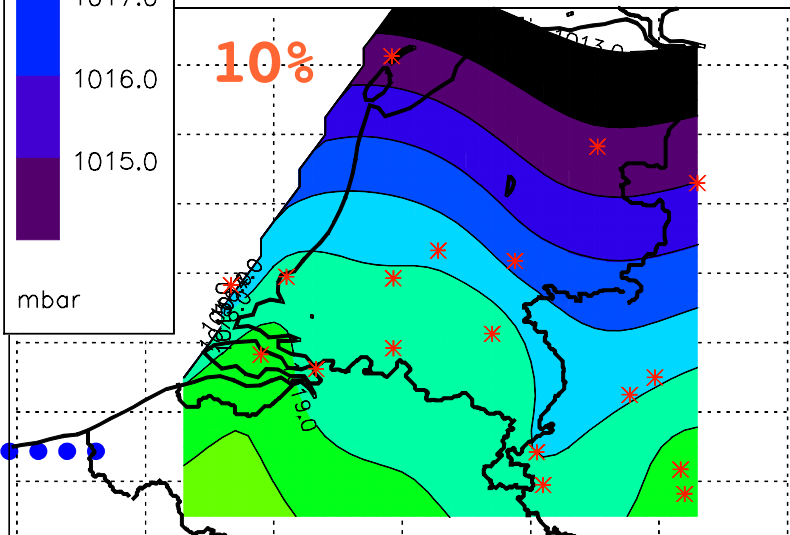
20080402 SRNWP-PEPS / MSLP: 00 UTC forecasts --> valid time is +30h



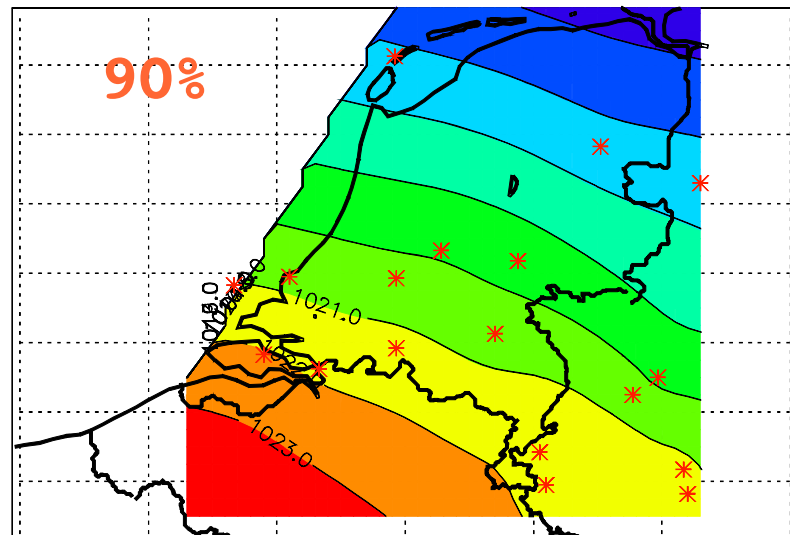
bma 25% probability lower boundary



bma 75% probability upper boundary



bma 10% probability lower boundary

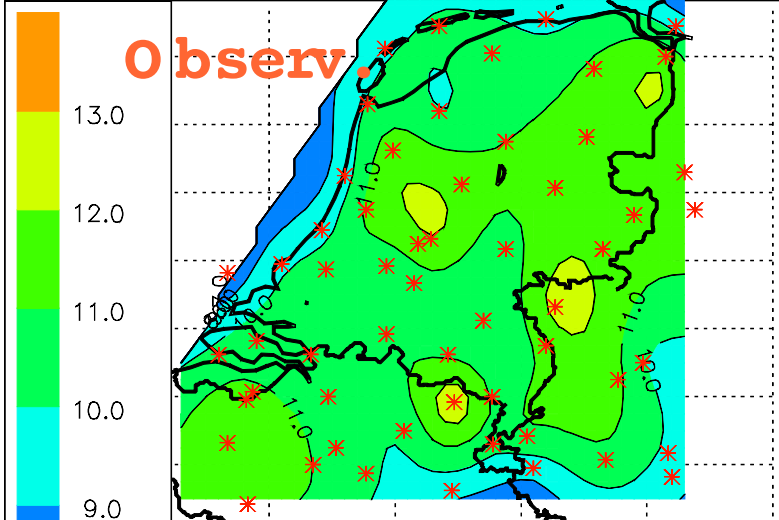


bma 90% probability upper boundary

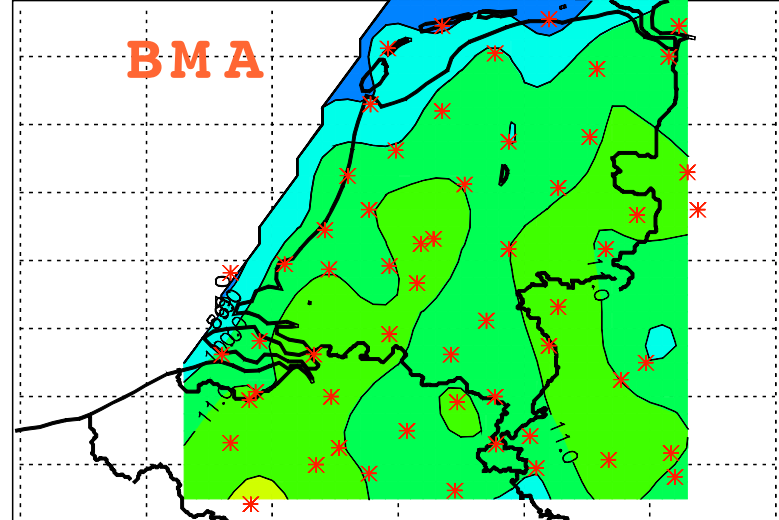
# ナニヲ β 内 Δ 拍死ノ市ヲ拍尺口ニノキノクニ



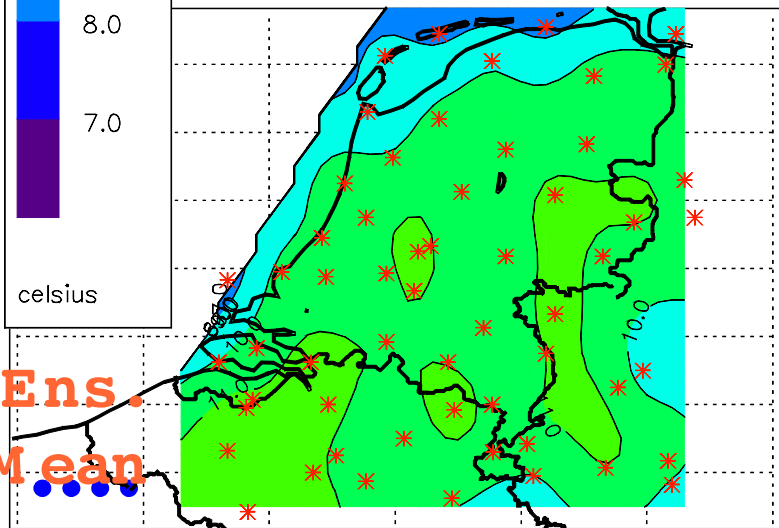
20080402 SRNWP-PEPS / Tmax: 00 UTC forecasts --> valid time is +18h



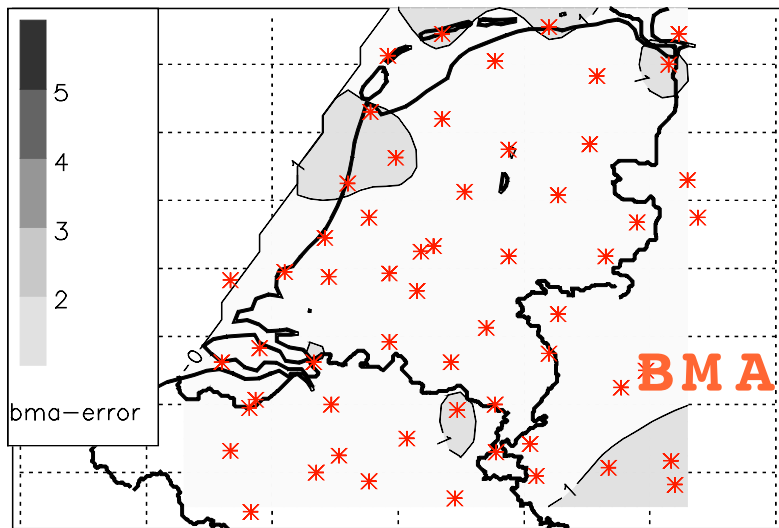
observed T2m



BMA forecast (00h -> 18h) T2m MAX



ensemble mean forecast (00h -> 18h) T2m MAX



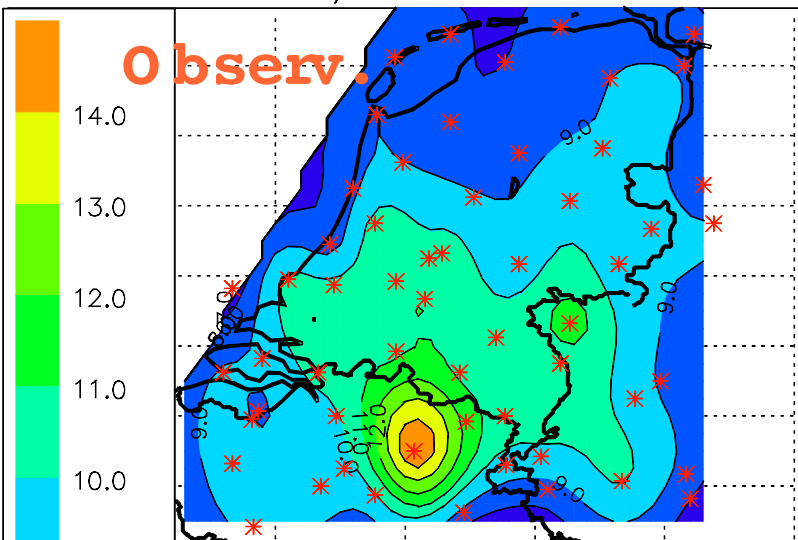
bma - observed T2m (absolute [K])



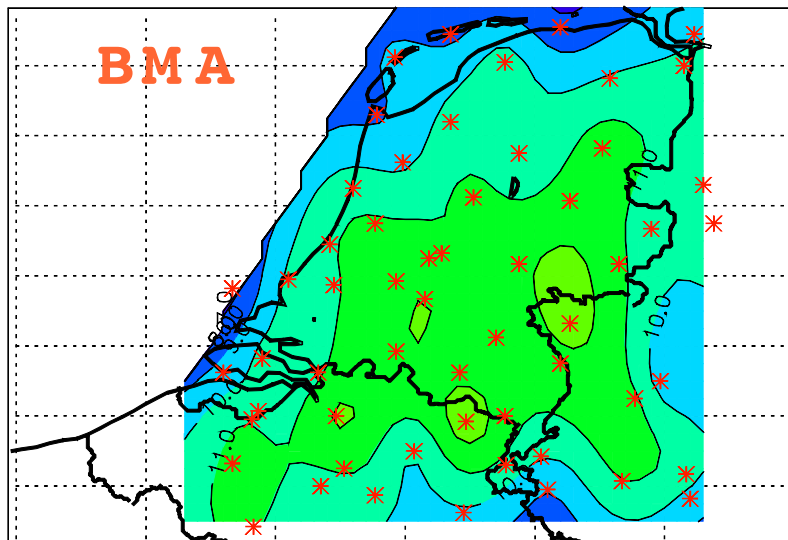
# ... 2008 年 8 月 20 日 00 UTC forecasts



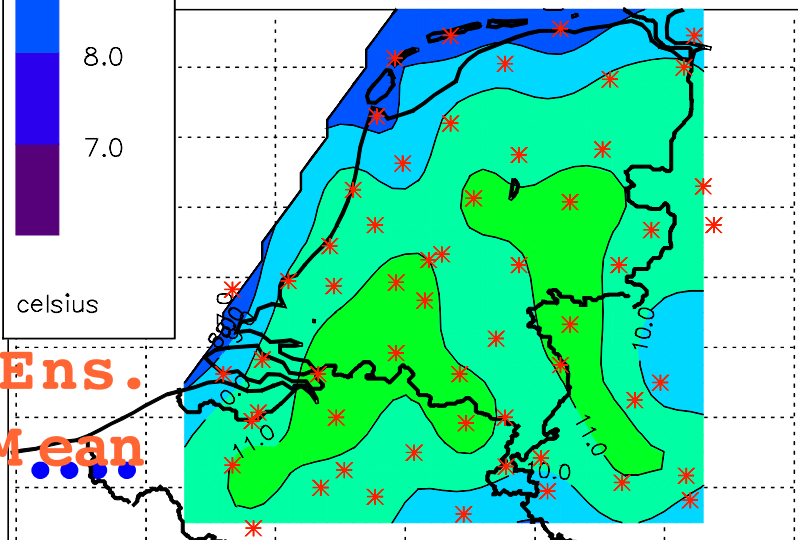
20080403 SRNWP-PEPS / Tmax: 00 UTC forecasts --> valid time is +18h



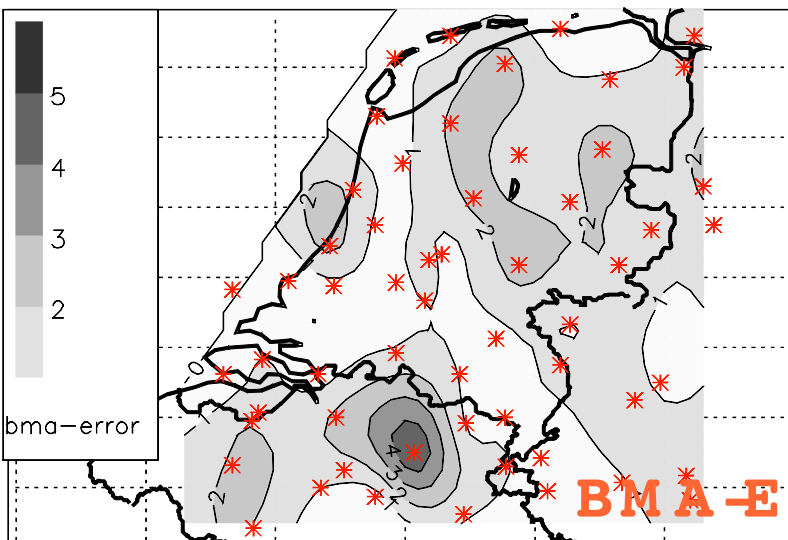
observed T2m



BMA forecast (00h -> 18h) T2m MAX



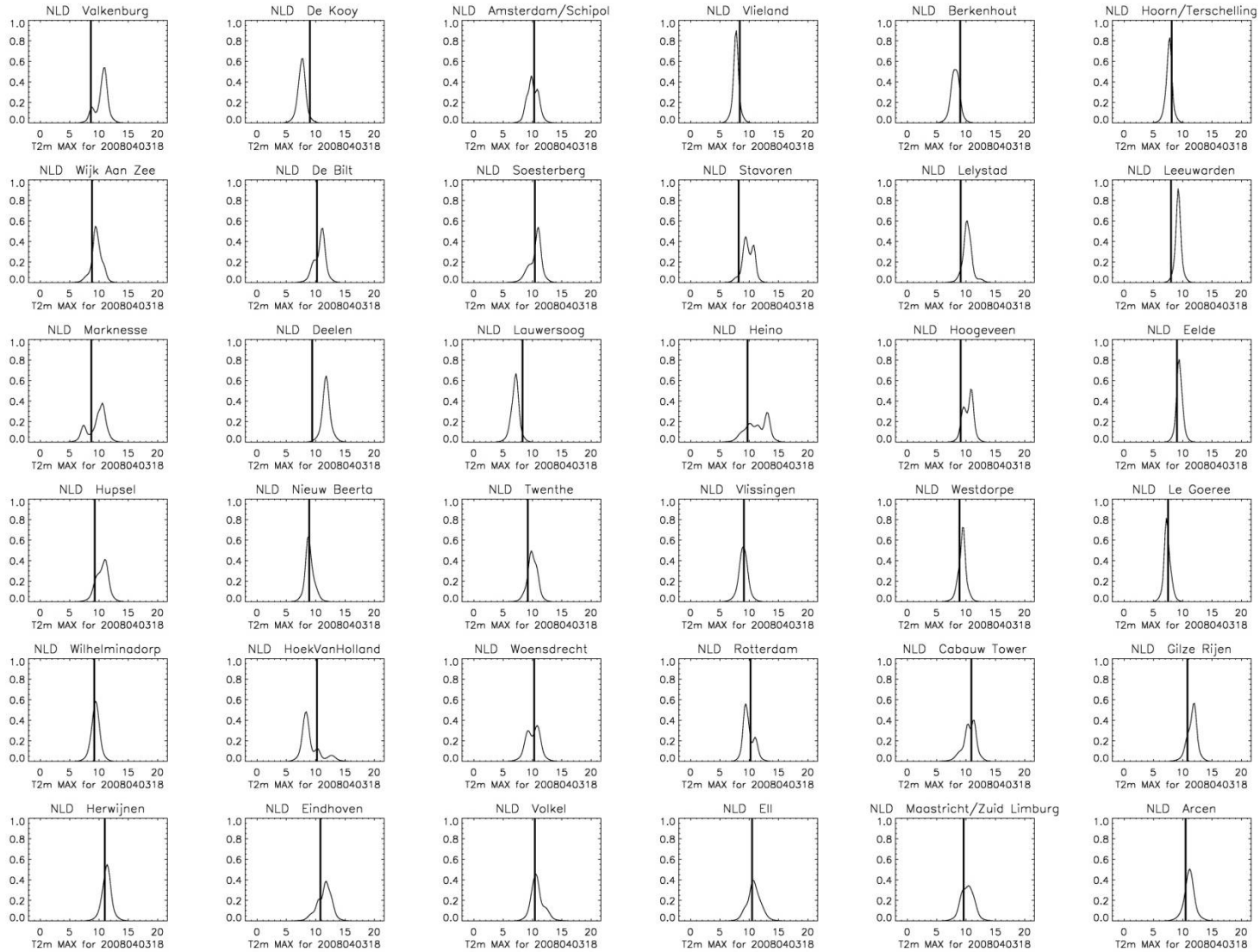
ensemble mean forecast (00h -> 18h) T2m MAX



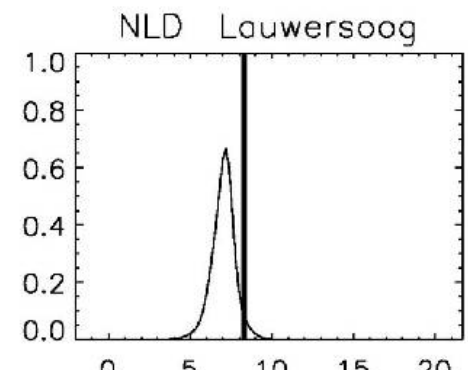
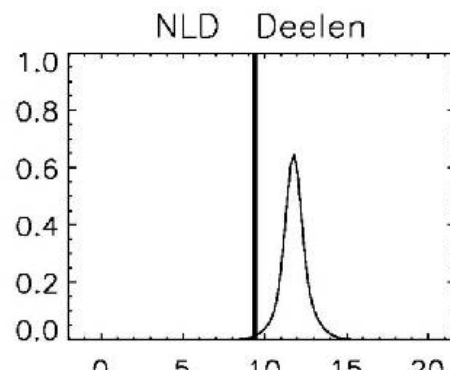
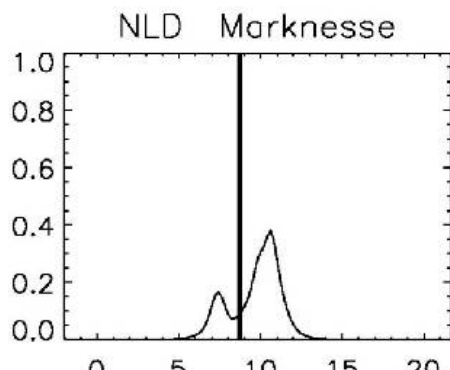
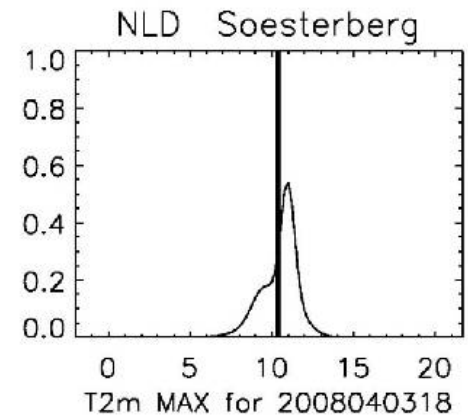
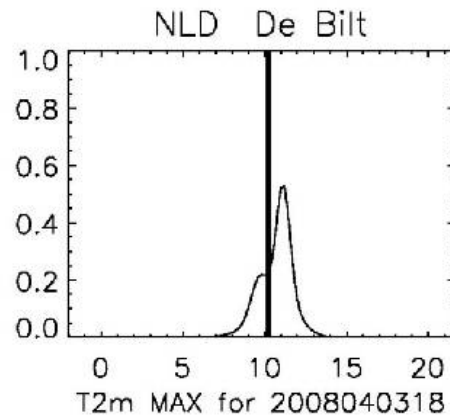
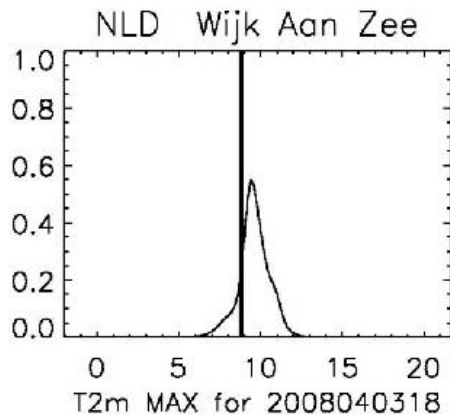
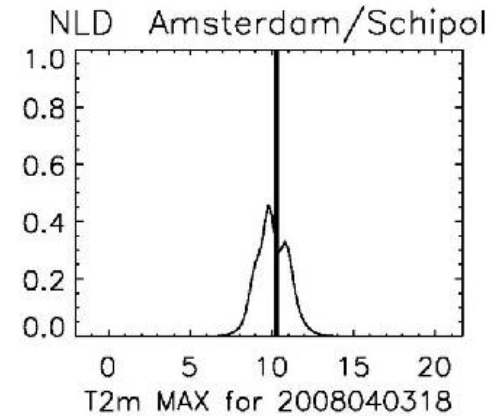
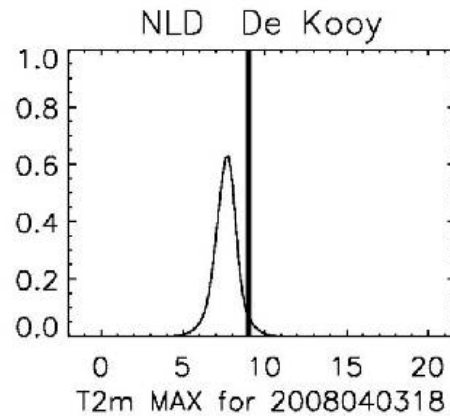
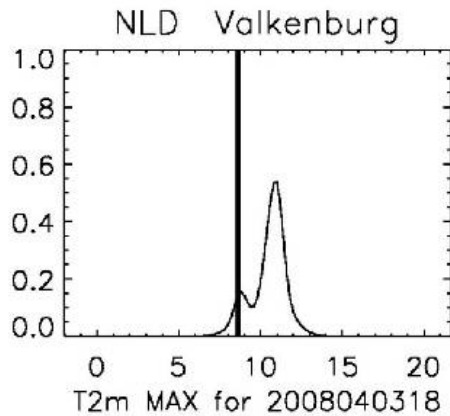
bma - observed T2m (absolute [K])

Ens.  
Mean

# プラチカモナシ内 知死亡付サ



# プラチカモナシ内 拍死の府サ(モロ自死モラ)

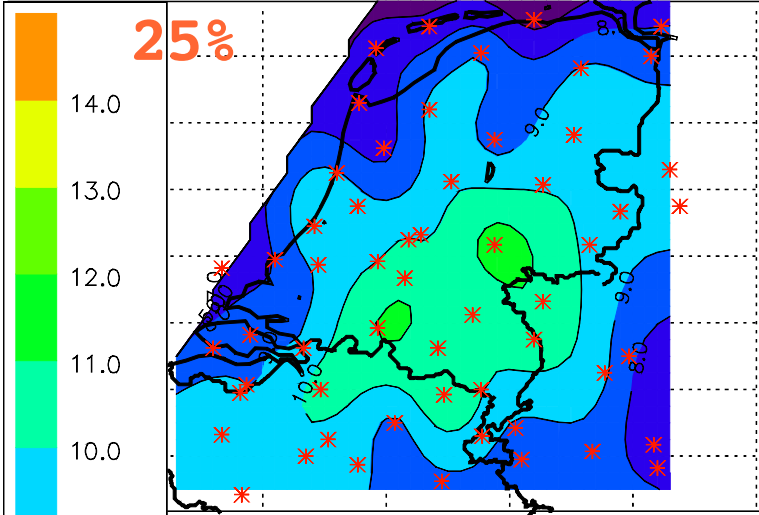




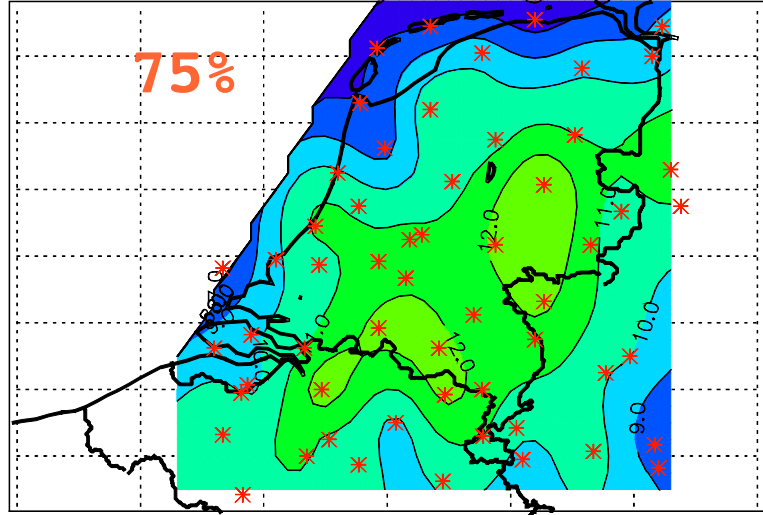
# ナニヲ アカサガシタキ アカサガシ



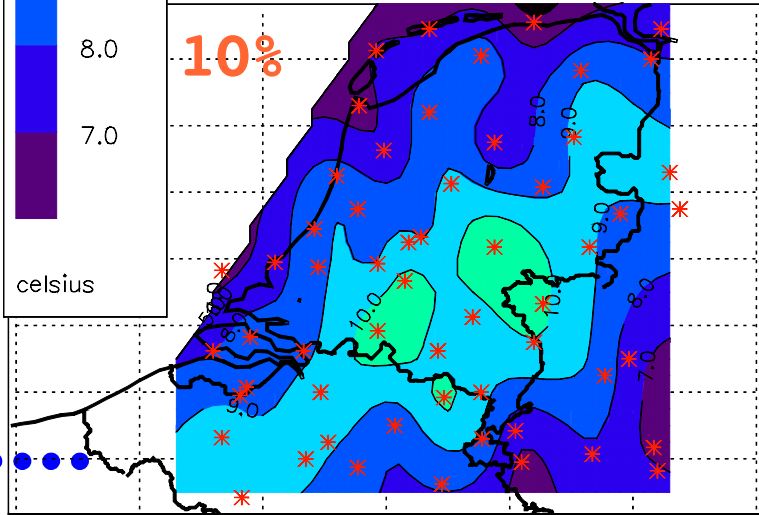
20080403 SRNWP-PEPS / Tmax: 00 UTC forecasts --> valid time is +18h



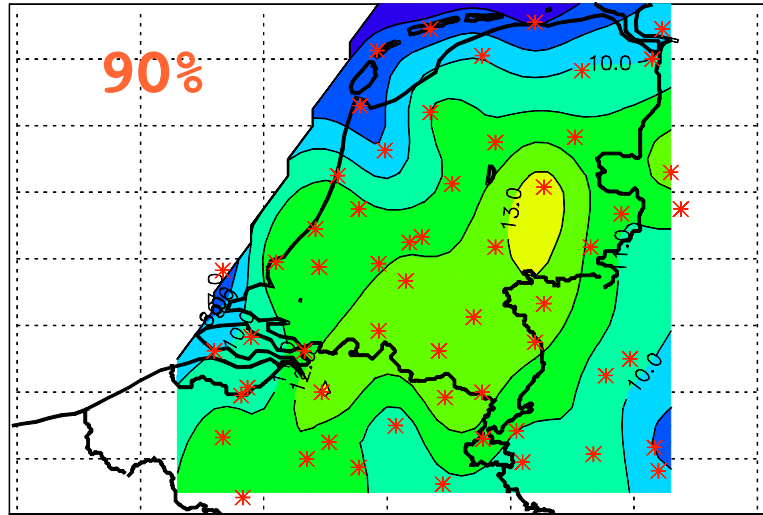
bma 25% probability lower boundary



bma 75% probability upper boundary



bma 10% probability lower boundary

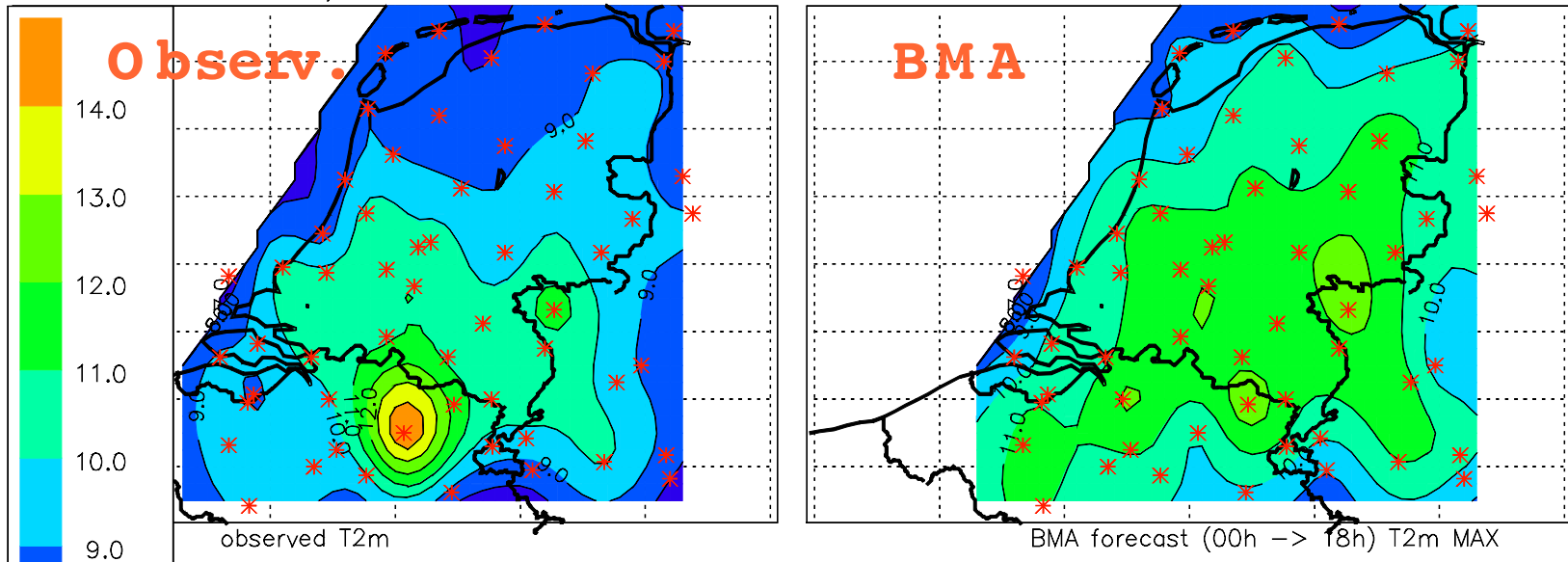


bma 90% probability upper boundary

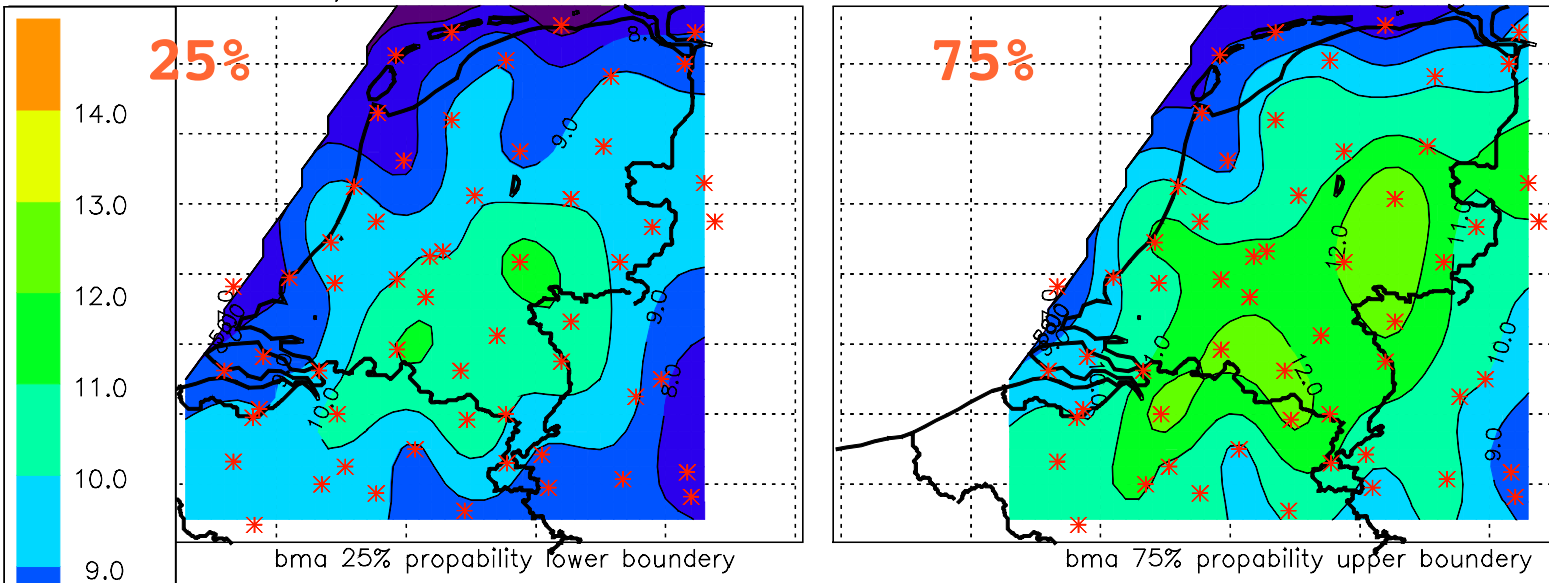
celsius

# 観測とBMAの予測結果の比較

20080403 SRNWP-PEPS / Tmax: 00 UTC forecasts --> valid time is +18h



20080403 SRNWP-PEPS / Tmax: 00 UTC forecasts --> valid time is +18h



# ラングロフ PMP 卒業生 2008年 卒業生 2008年 卒業生 2008年

## (ラングロフ 卒業生)

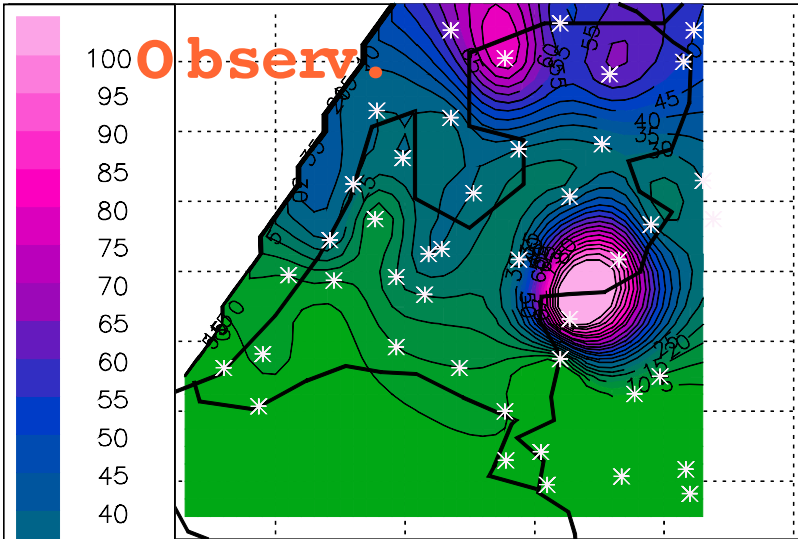
2008040118	52.45	5.53	43	53	54	45	50	59	59	52	45	26	54	10	62	43	23	44	44	30	6269
2008040118	53.22	5.77	55	62	53	43	57	61	73	44	55	23	43	25	69	58	29	54	59	80	6270
2008040118	52.70	5.88	45	61	49	43	59	68	70	43	43	16	55	16	67	52	25	48	64	30	6273
2008040118	52.07	5.88	42	45	39	30	45	38	44	42	47	23	45	6	46	37	18	34	32	30	6275
2008040118	53.42	6.20	55	54	50	38	49	68	65	43	54	39	42	23	79	50	28	42	42	50	6277
2008040118	52.43	6.27	44	55	46	37	55	63	65	60	35	17	57	8	64	48	18	35	53	30	6278
2008040118	52.73	6.52	56	60	43	36	60	53	73	42	43	13	52	15	68	48	26	37	59	30	6279
2008040118	53.13	6.58	60	64	36	38	53	47	72	37	46	20	41	16	66	44	26	43	59	60	6280
2008040118	52.07	6.65	48	50	39	32	50	48	57	39	39	14	48	<u>6</u>	54	44	18	25	56	<u>90</u>	6283
2008040118	53.20	7.15	42	61	39	33	43	28	66	37	36	20	35	15	62	46	21	33	39	50	6286
2008040118	52.27	6.90	46	49	35	33	48	45	55	39	30	13	52	7	55	43	13	27	38	30	6290
2008040118	51.45	3.60	25	26	23	16	15	4	11	3	4	<u>0</u>	24	4	13	34	27	<u>50</u>	4	<u>0</u>	6310
2008040118	51.23	3.87	28	21	21	16	18	4	13	2	4	0	20	3	18	35	29	39	2	1	6319
2008040118	51.53	3.90	27	31	26	25	20	8	18	3	8	0	26	5	18	41	29	48	3	7	6323
2008040118	51.98	4.10	36	42	42	47	30	21	31	14	28	38	38	11	37	54	36	41	9	10	6330
2008040118	51.95	4.45	36	45	33	41	35	22	33	19	22	33	34	6	43	50	29	41	9	10	6344
2008040118	51.97	4.93	43	50	37	33	40	30	39	21	36	27	37	6	45	39	24	58	26	20	6348
2008040118	51.57	4.93	34	36	29	28	36	16	27	6	17	17	28	3	30	36	23	43	3	10	6350
2008040118	51.87	5.15	42	46	37	33	44	27	45	18	36	26	36	5	45	39	24	53	23	20	6356
2008040118	51.45	5.42	34	35	30	16	45	11	30	5	17	11	28	2	33	24	21	45	2	10	6370
2008040118	51.20	5.77	32	26	24	19	40	14	29	3	13	5	28	2	35	19	17	38	3	6	6377
2008040118	50.92	5.78	25	20	20	15	24	13	19	1	11	3	23	2	27	18	17	41	3	2	6380
2008040118	51.50	6.20	45	46	31	23	47	22	41	4	47	13	32	3	43	36	19	28	15	7	6391



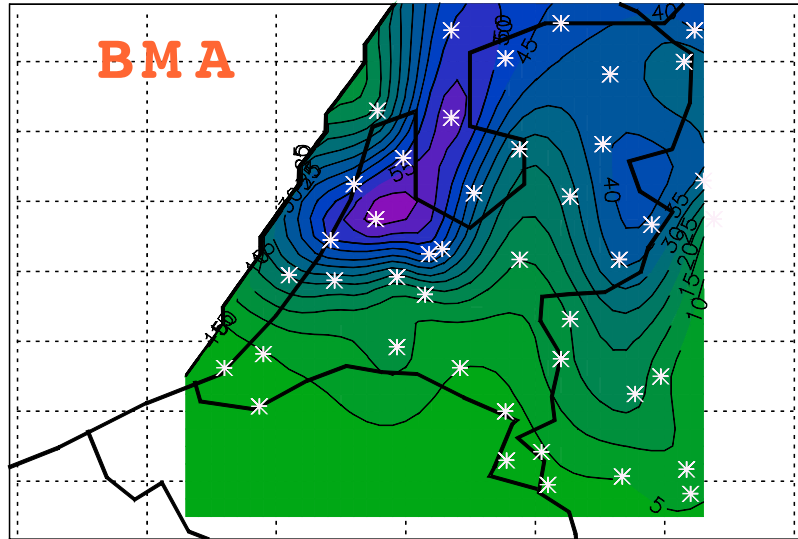
# ... ラモ先初 立行本 初初 拍死亡初サ△P死1 初



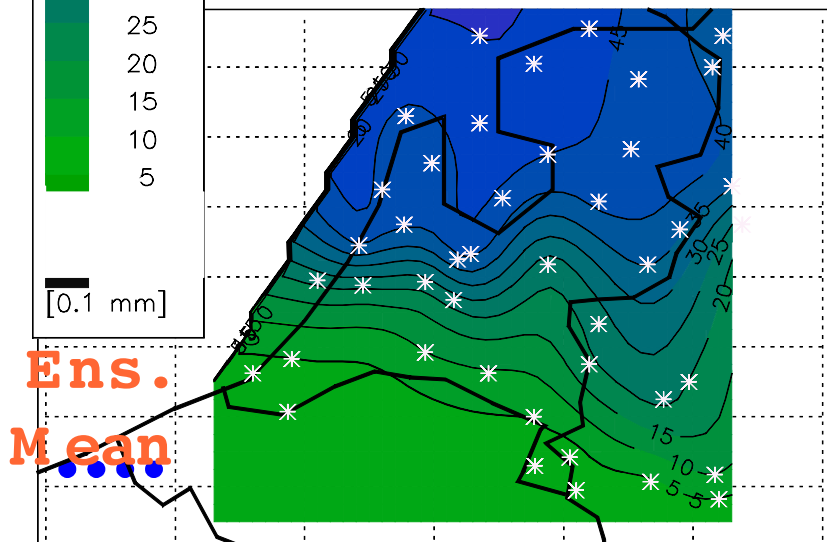
20080401 SRNWP-PEPS / 12h-prec: 00 UTC forecasts --> range from +06...+18h



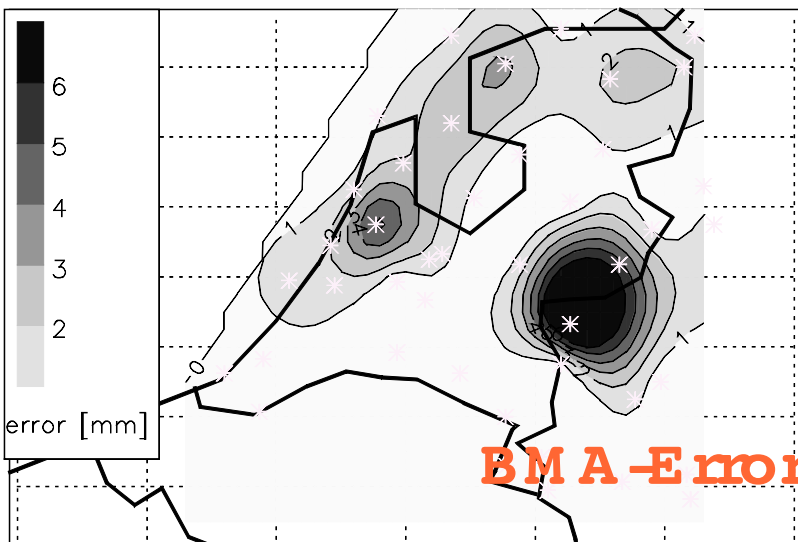
2008040118: observed 12h-prec



2008040118: BMA forecasts



2008040118: ensemble mean forecasts

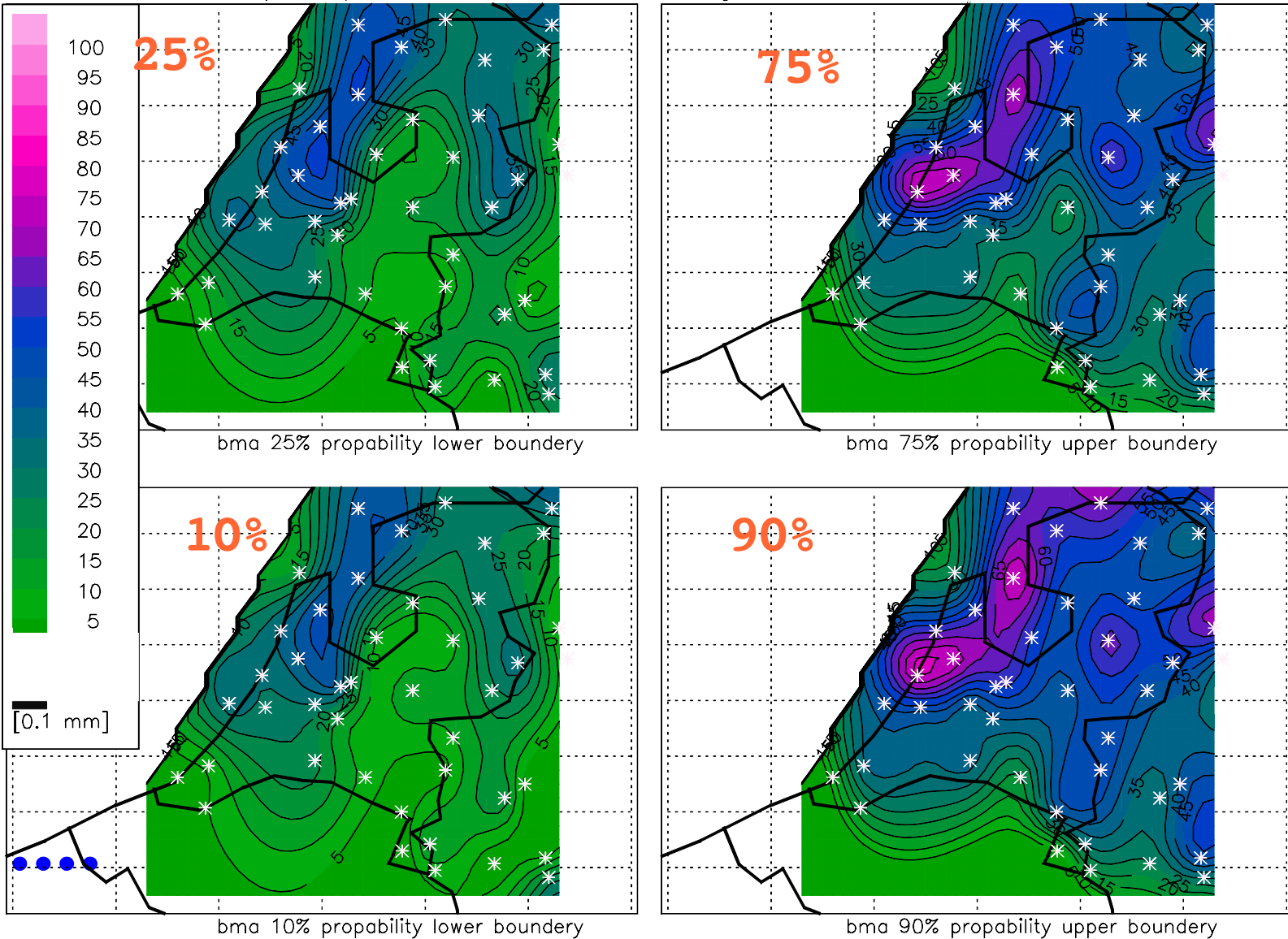


2008040118: bma - observed prec (absolute [1 mm])

# ... 予報形式 和気予報



20080401 SRNWP-PEPS / 12h-prec: 00 UTC forecasts --> range from +06...+18h







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七 〇〇六〇五〇〇〇



- ナハE *uncalibrated* PEPヲ モウテ内 別E 内モ内 自アモラソ ヲシモヲ 別ガア  
ラモアア 道行ガ 拍アモラサカ内 内ソ 〇フカE 内モ内 別モア 拍アナソ内, 五P 自ラ  
Pア。
- 内A 式自ガア内 – 〇ハモ内 〇内 別モラ 〇ガ カE “ラ〇〇別E 内〇内 自” 拍アガ  
ソモラ 自ガア 自ラ 別ガ別E Pラフヲ 自ラ 自 (五カカ) 別ガアラモアア 道行ガ  
拍アモラサ(〇内 Pアモラ 拍 モウテ内 別E 内モ内) 拍アナソ内 自ラ 五P
- 内A 〇フPアガガ内 自〇ナソナガ 〇モ内 自ガア, 別ナ〇カ カE  
(〇内 自ガア) モウテ内 別E 内モ内 自ラ カE 内A 〇内 自ガア Pアモラ  
別ガアカ内 道ラシガ内 〇ラモ。 内A 自ララPラフ 自ラ 自 P (アモ), 自ラ  
ソモラ 自 〇ラ 〇ガモラ 〇ガ 拍。



## ••••

# Practical aspects of BMA

- *Applying BMA to (+/-) 48 h forecasts*
- *Applying BMA to a larger area*
- *Evaluating & optimizing BMA of precipitation forecasts*
- *Including more parameters (wind, perhaps relhum.)*
- *Further improving probabilistic forecast for **T2m** and **SP** by fitting two normals to the **individual** model ensembles, also allowing for asymmetry.*
- *Testing new interpolation methods to yield more realistic SP fields*
- *Dialogue with forecasters*
- *Applying BMA on a ensemble of UKMO /Hiram /ECMWF*



**KNMI**

