

Overview of Italian verification

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This work has been done with the collaboration and the funds of Civil Protection Department. Furthermore thanks again to Civil Protection Department for making available the high resolution rain gauges dataset usefull for the verification tools.

Cosmo General Meeting 2014 – Eretria
(Greece)

The methodologies

Weather elements – standard verification

Using VERSUS (operative verification)

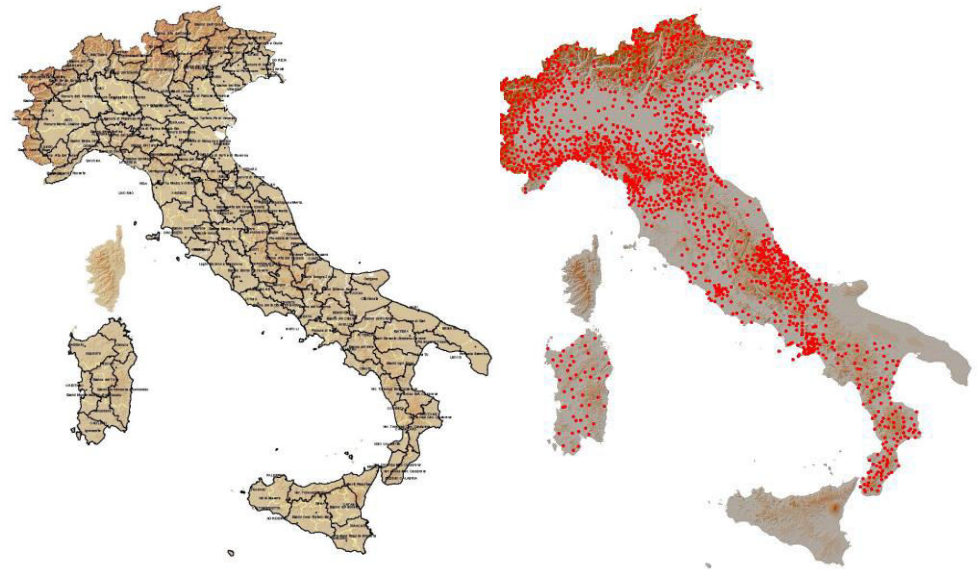
- Upper air
 - Surface Parameters
- Precipitation:

dataset → synop stations

Method → 6h/12h/24h averaged cumulated forecasted precipitation values over 15 km radius, 6h/12h/24h cumulated observed precipitation values over station point

Precipitation- high resolution network

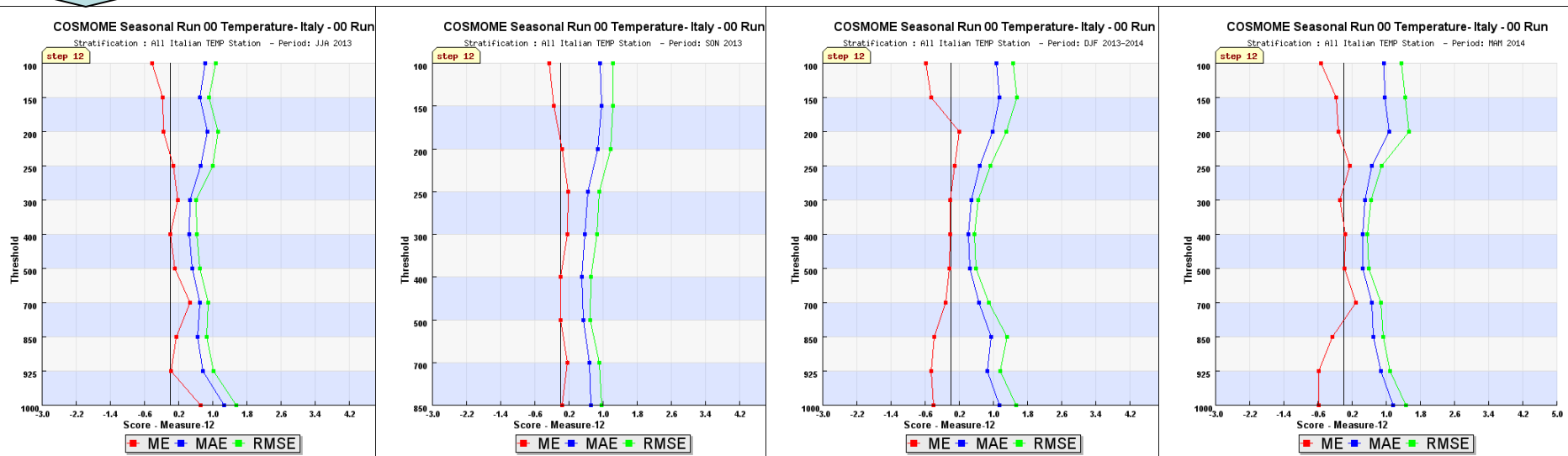
- Common area → Italy
- Dataset → high res raingauges
- Method → 24h/6h averaged cumulated precipitation or maximum values (both observed and forecasted) over 90 meteo-hydrological basins



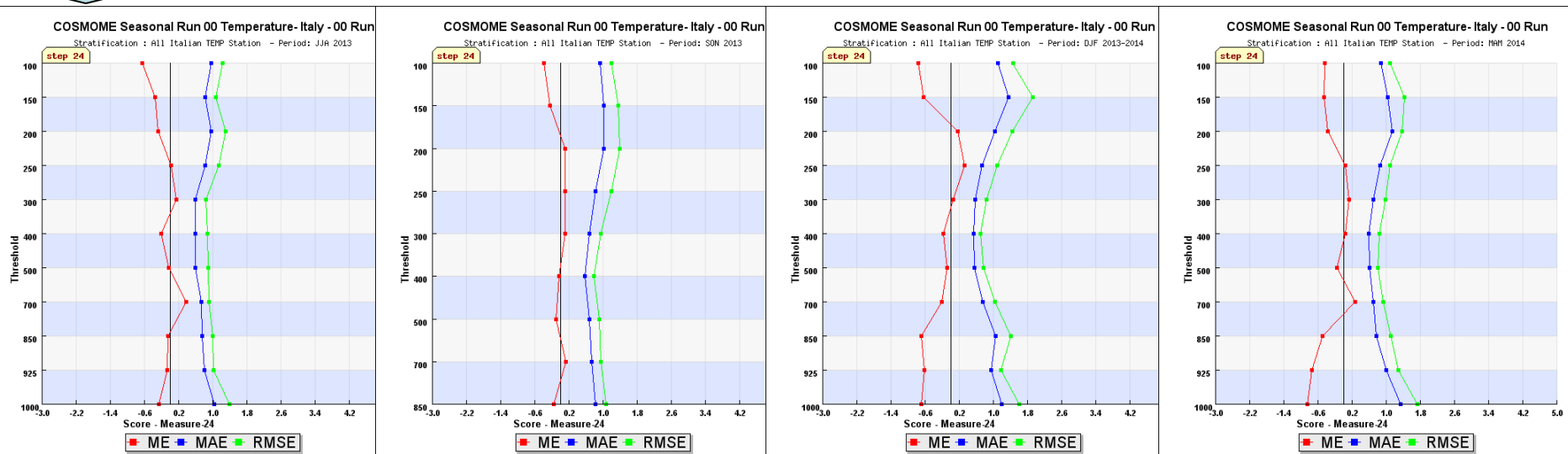
UPPER AIR: TEMPERATURE COSMOME

RUN00 UTC - FORECAST D+1

+ 12UTC



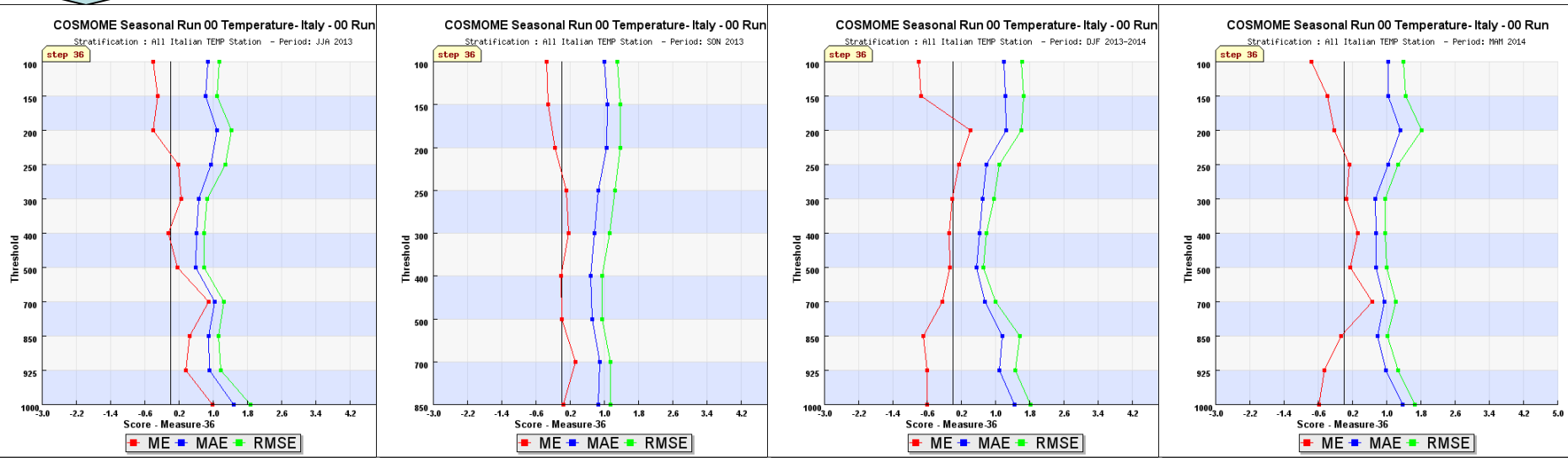
+ 24UTC



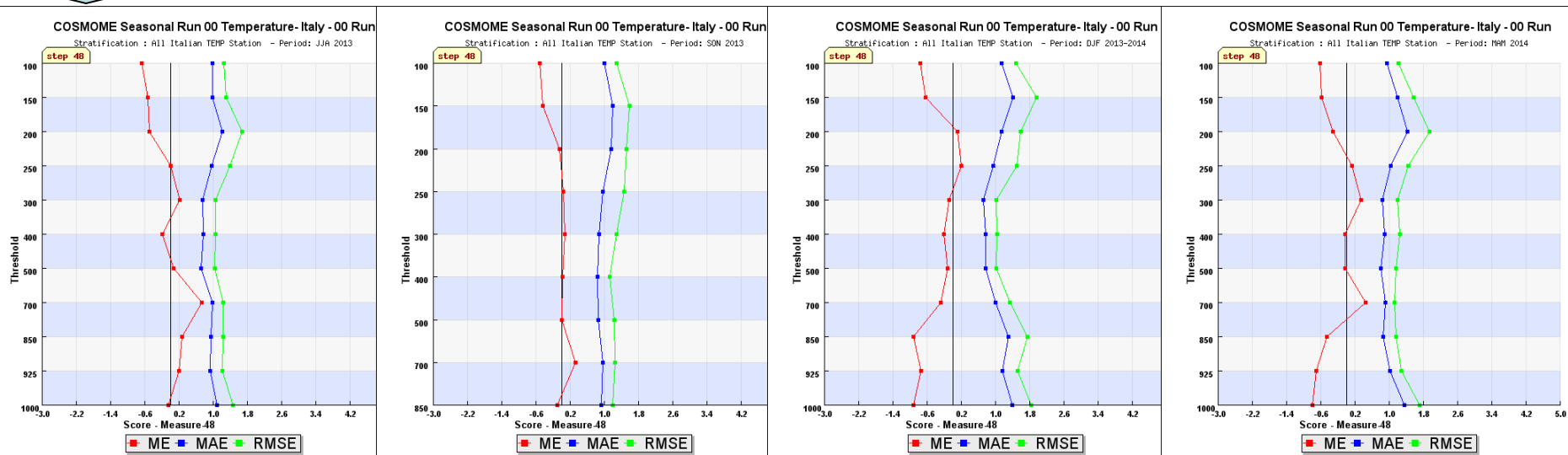
UPPER AIR: TEMPERATURE COSMOME

RUN00 UTC - FORECAST D+2

+ 36UTC



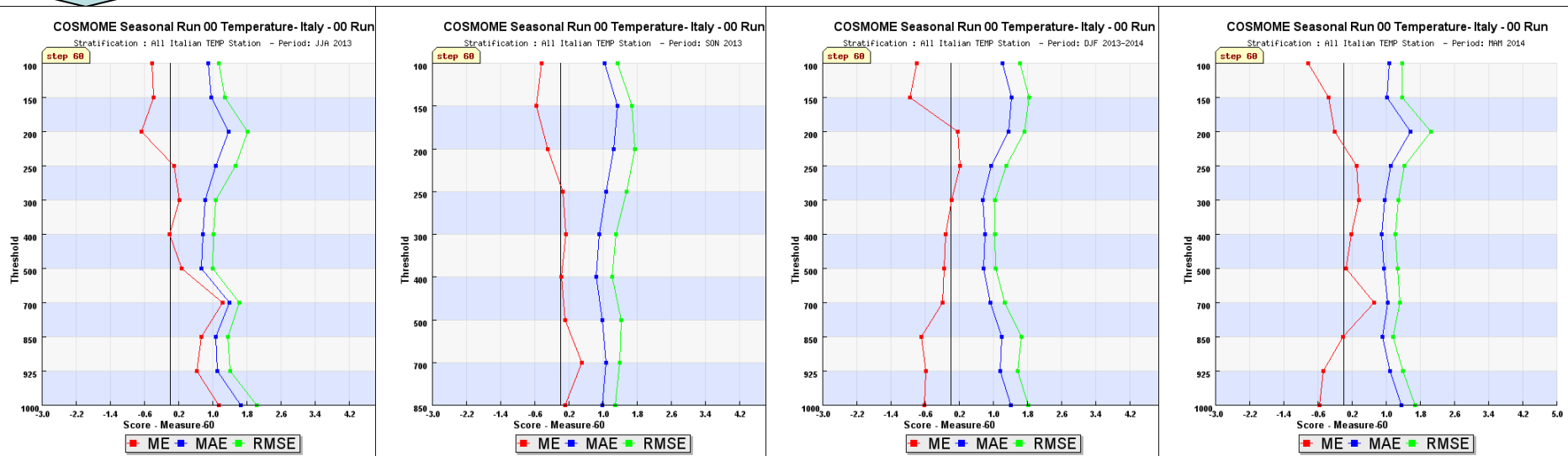
+ 48UTC



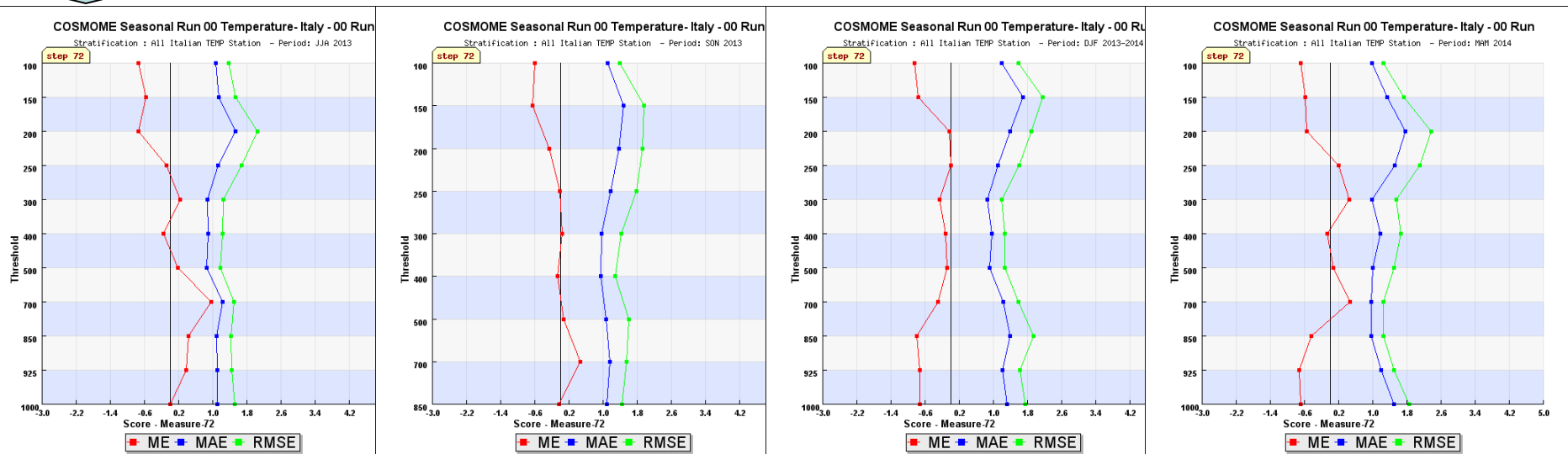
UPPER AIR: TEMPERATURE COSMOME

RUN00 UTC - FORECAST D+3

+ 60UTC



+ 72UTC



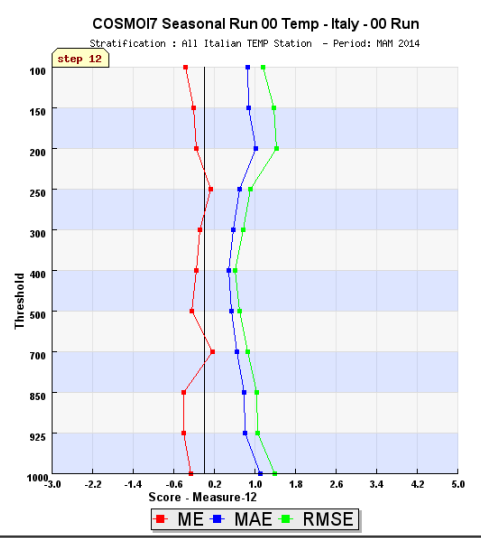
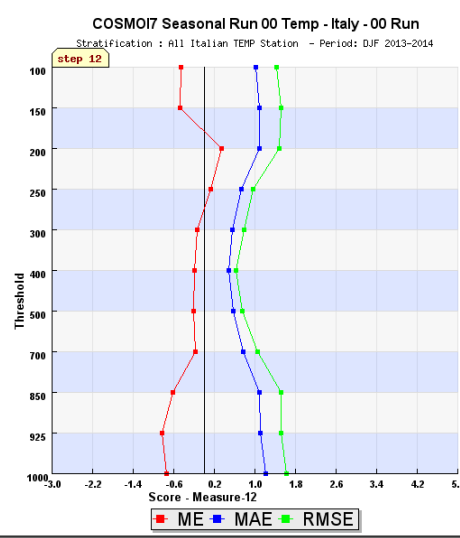
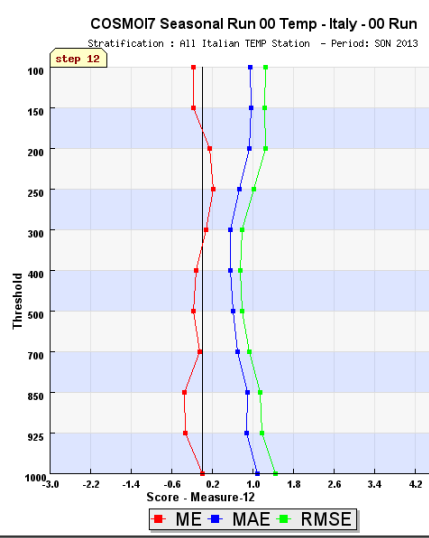
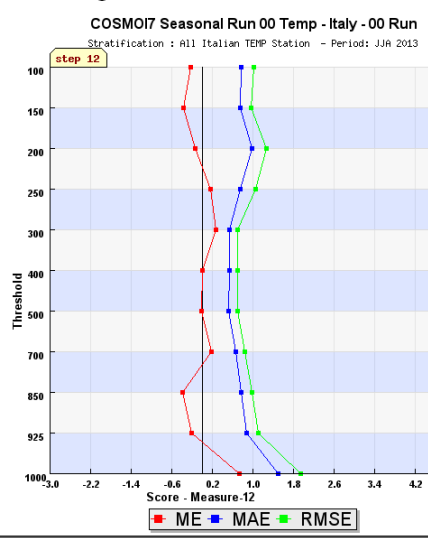
CONSIDERATIONS

- Systematic error (seasonally independent): the model is colder above 250hPa
- PBL systematic error during winter and spring: up to 850 hPa 0.5 °C colder

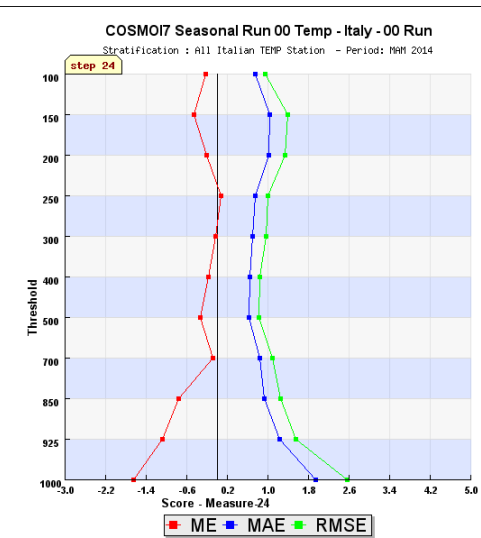
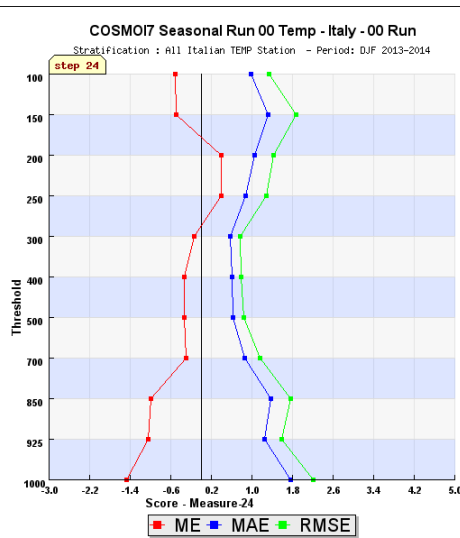
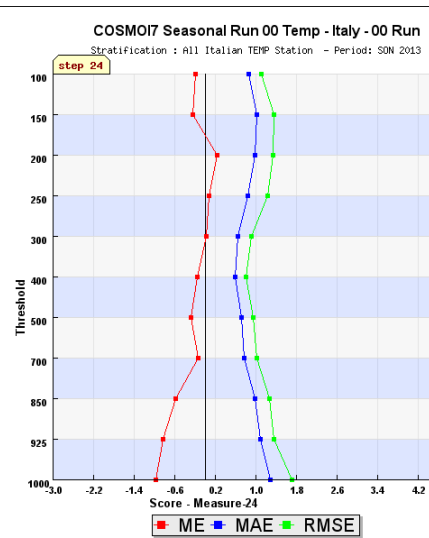
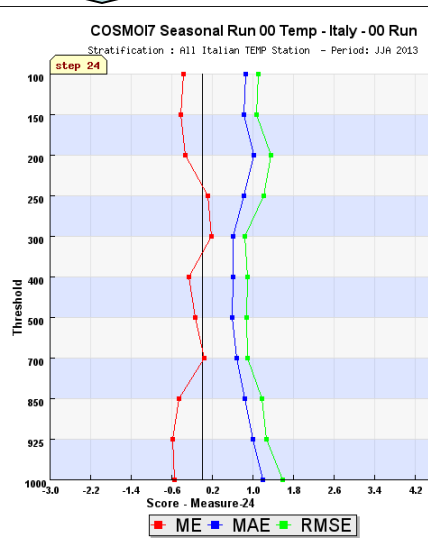
UPPER AIR: TEMPERATURE COSMOI7

RUN00 UTC - FORECAST D+1

+ 12UTC



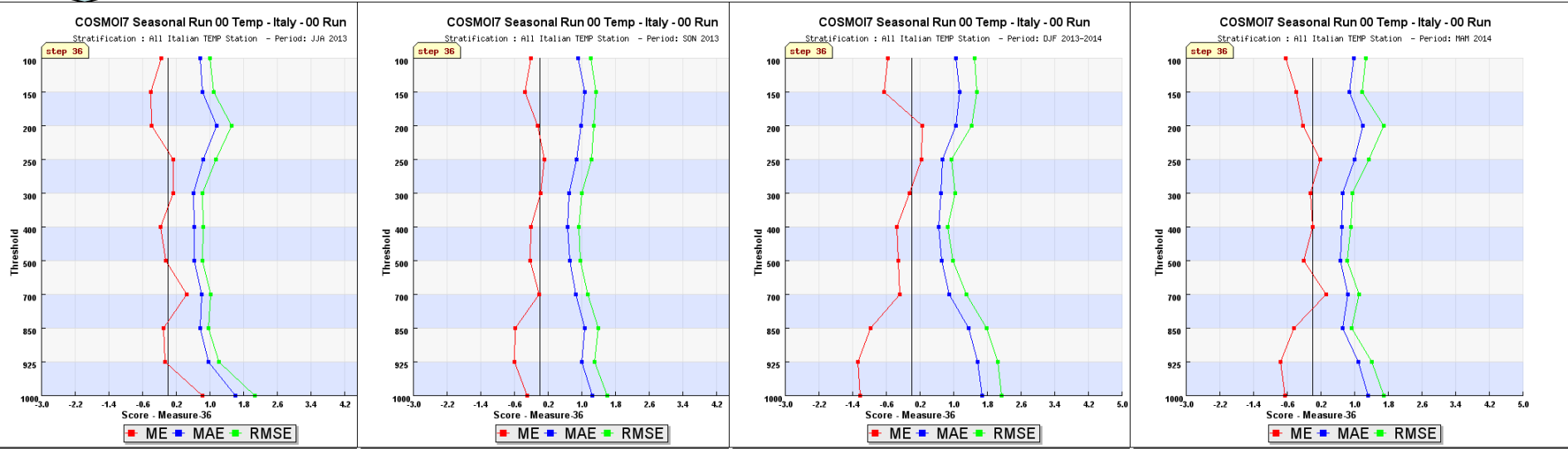
+ 24UTC



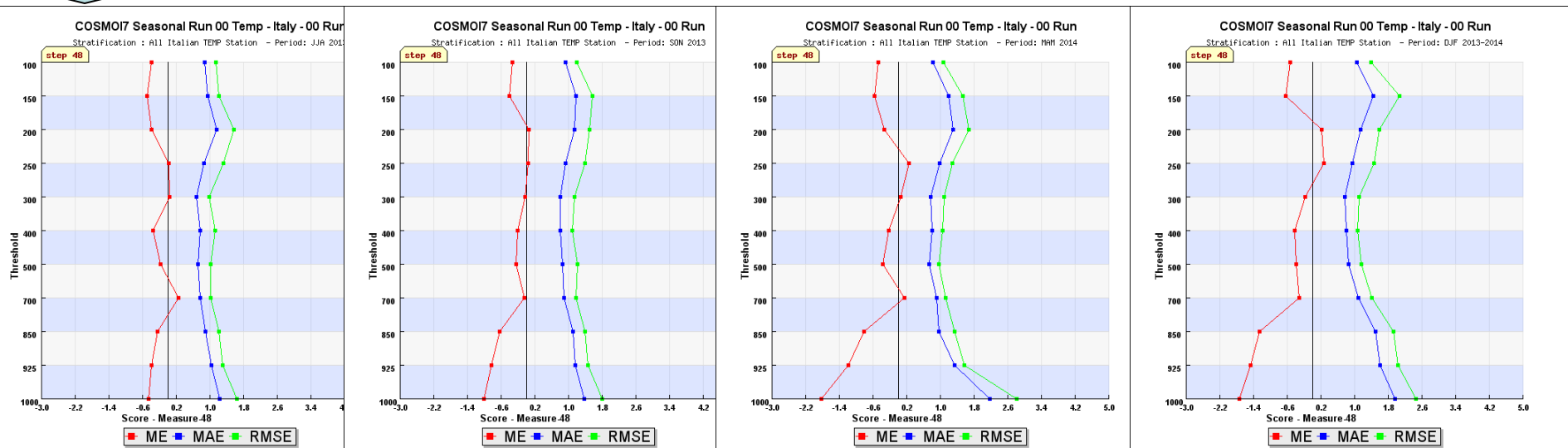
UPPER AIR: TEMPERATURE COSMOI7

RUN00 UTC - FORECAST D+2

+ 36UTC



+ 48UTC



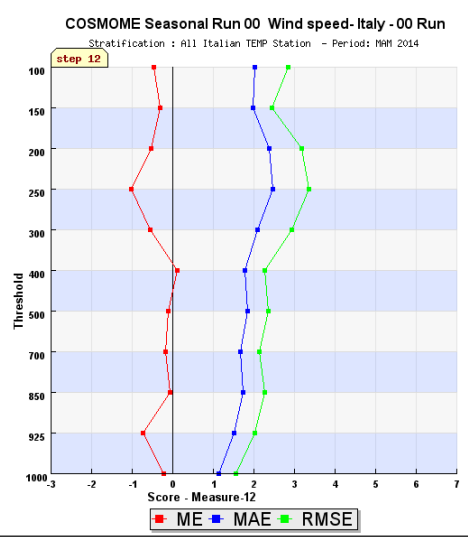
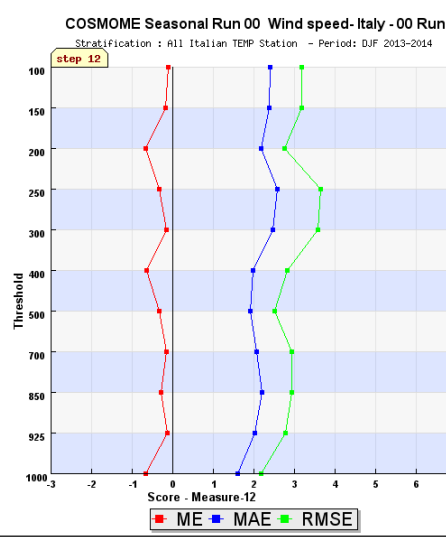
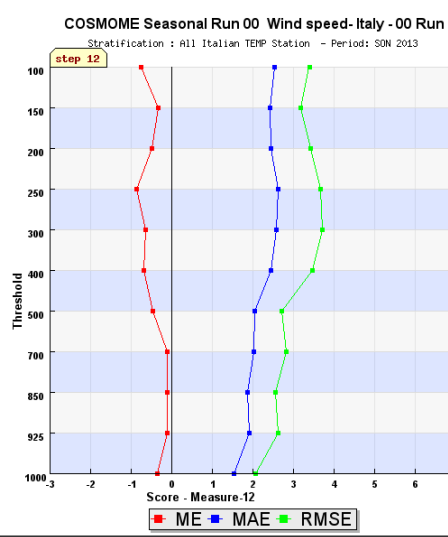
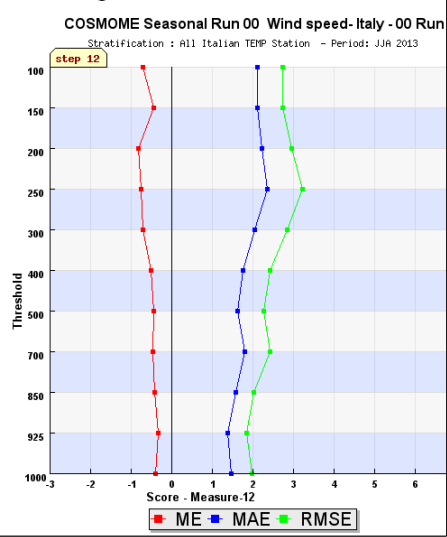
CONSIDERATIONS

- Systematic error (seasonally independent): the model is colder above 250hPa
- PBL up to 850 hPa:
 - Summer: warmer during midday (~ 0.5 °C), colder during night (~ 0.5 °C)
 - Fall, winter and spring: colder, >1.5 °C during night in winter and spring

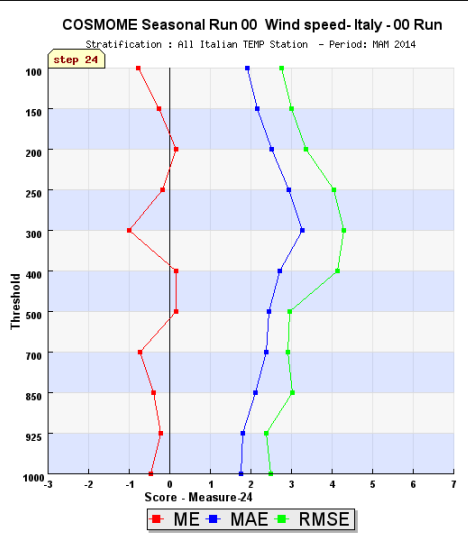
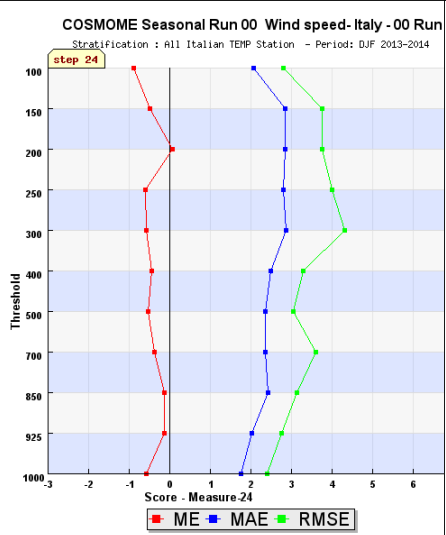
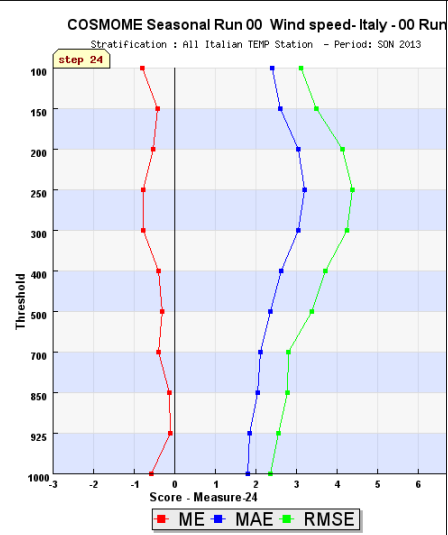
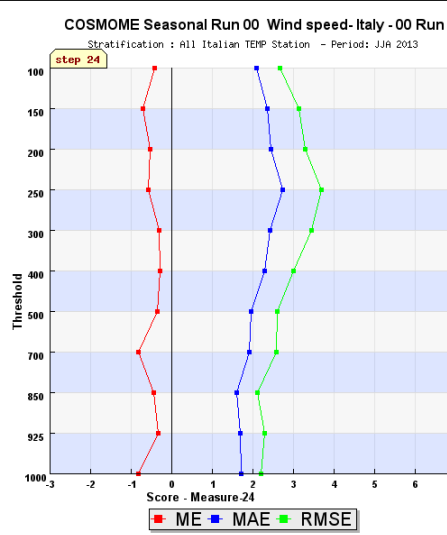
UPPER AIR: WIND SPEED COSMOME

RUN00 UTC - FORECAST D+1

+ 12UTC



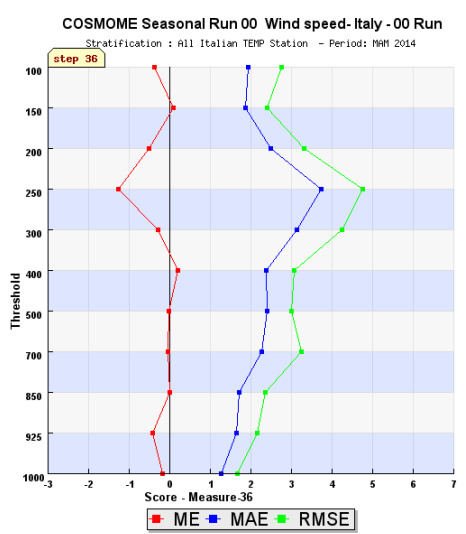
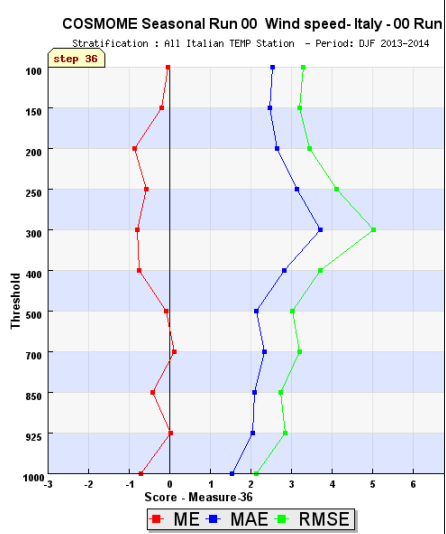
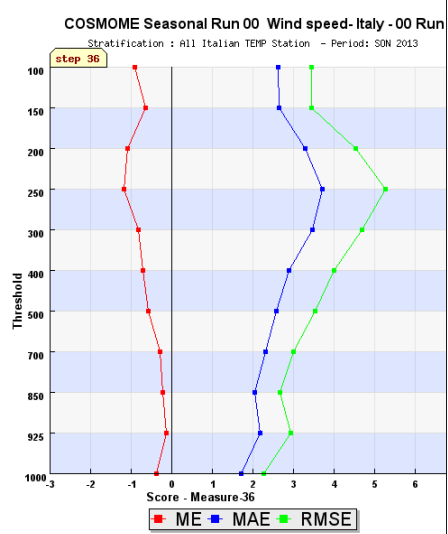
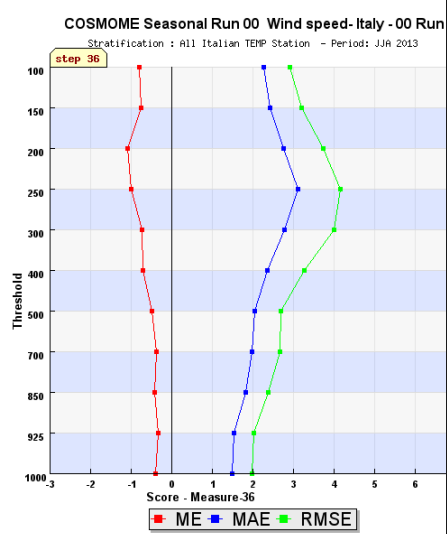
+ 24UTC



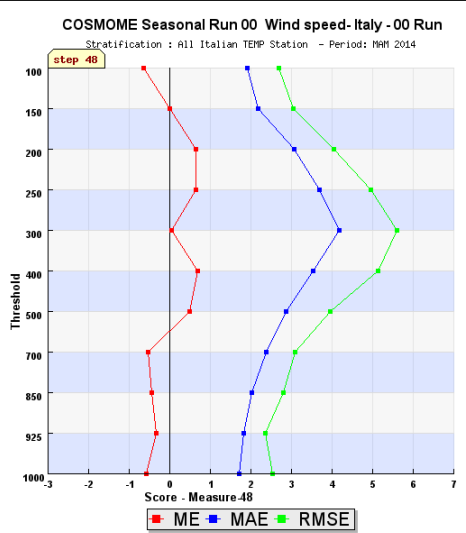
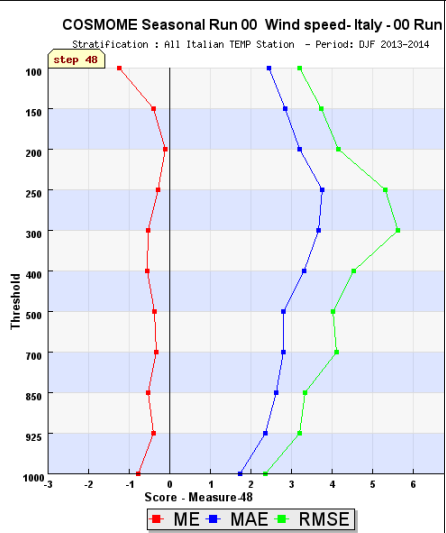
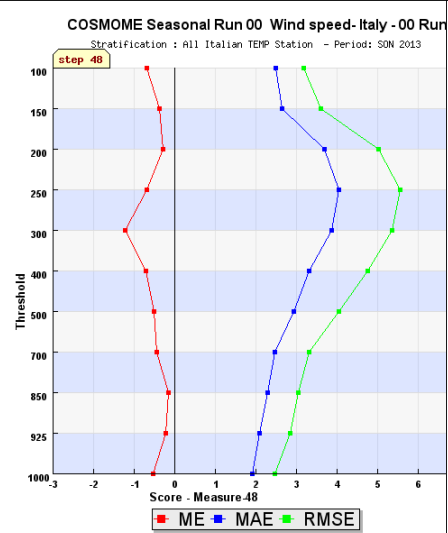
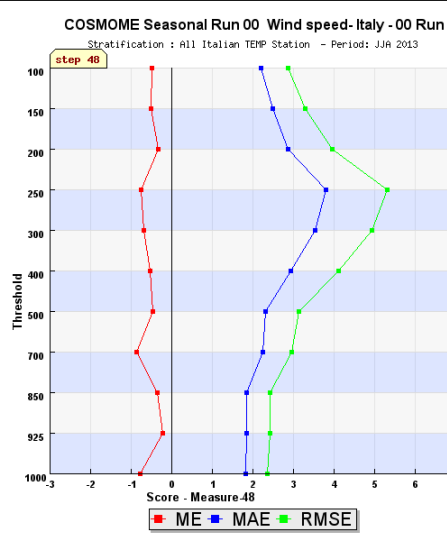
UPPER AIR: WIND SPEED COSMOME

RUN00 UTC - FORECAST D+2

+ 36UTC



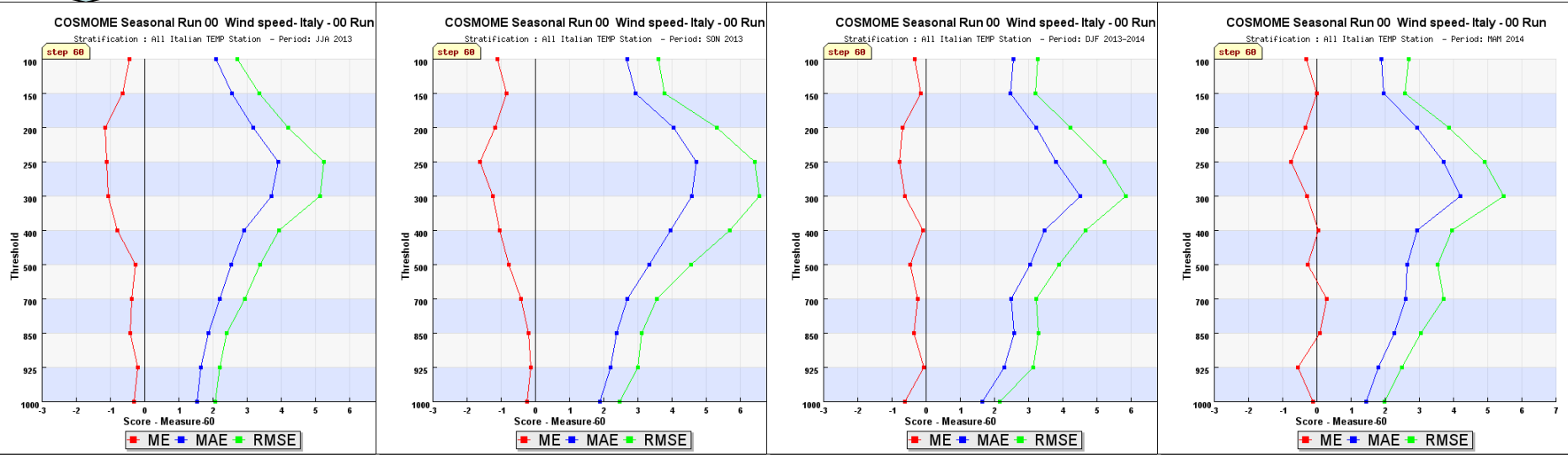
+ 48UTC



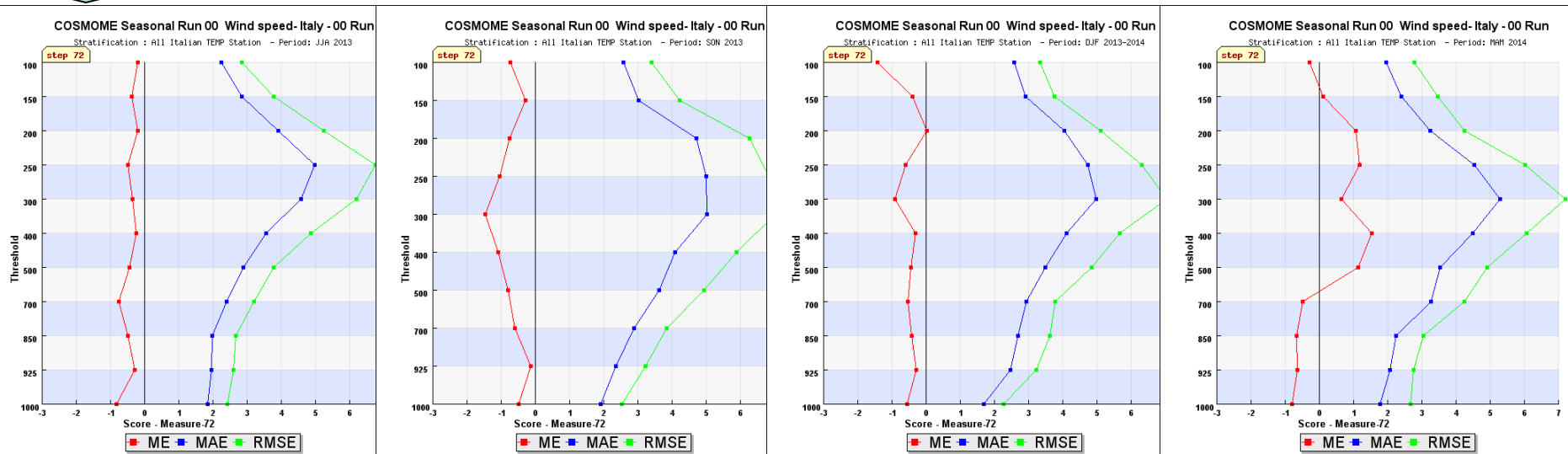
UPPER AIR: WIND SPEED COSMOME

RUN00 UTC - FORECAST D+3

+ 60UTC



+ 72UTC



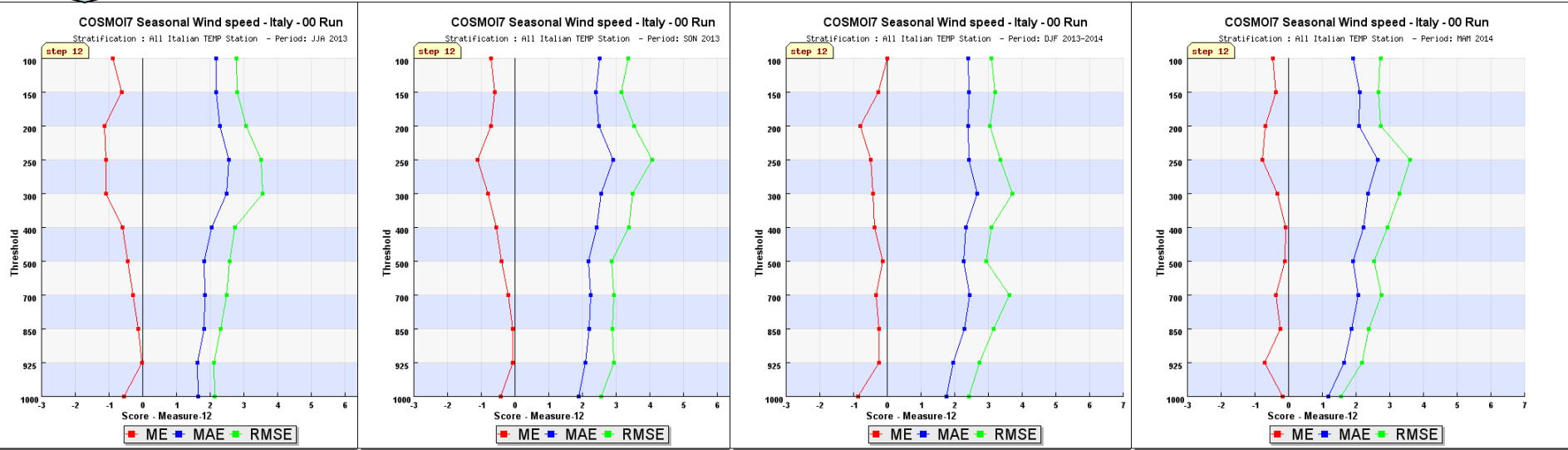
CONSIDERATIONS

- Error increasing vs forecast time for jet stream-tropopause (around 200/250 hPa): bigger wind underestimation
- In general: wind underestimation for all levels (except during spring)

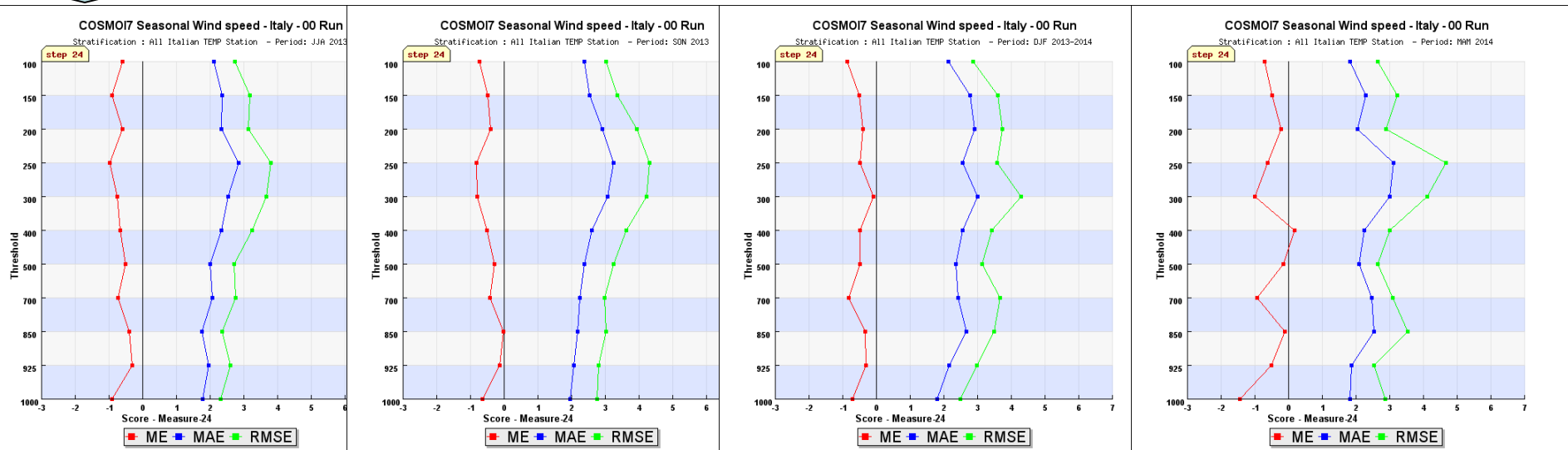
UPPER AIR: WIND SPEED COSMOI7

RUN00 UTC - FORECAST D+1

+ 12UTC



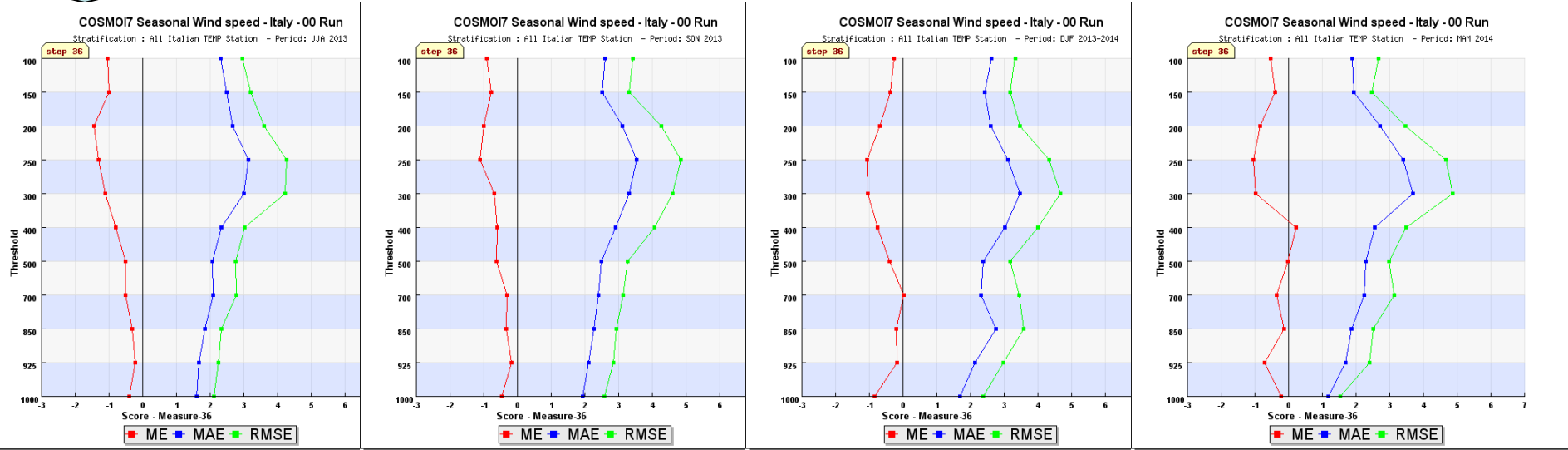
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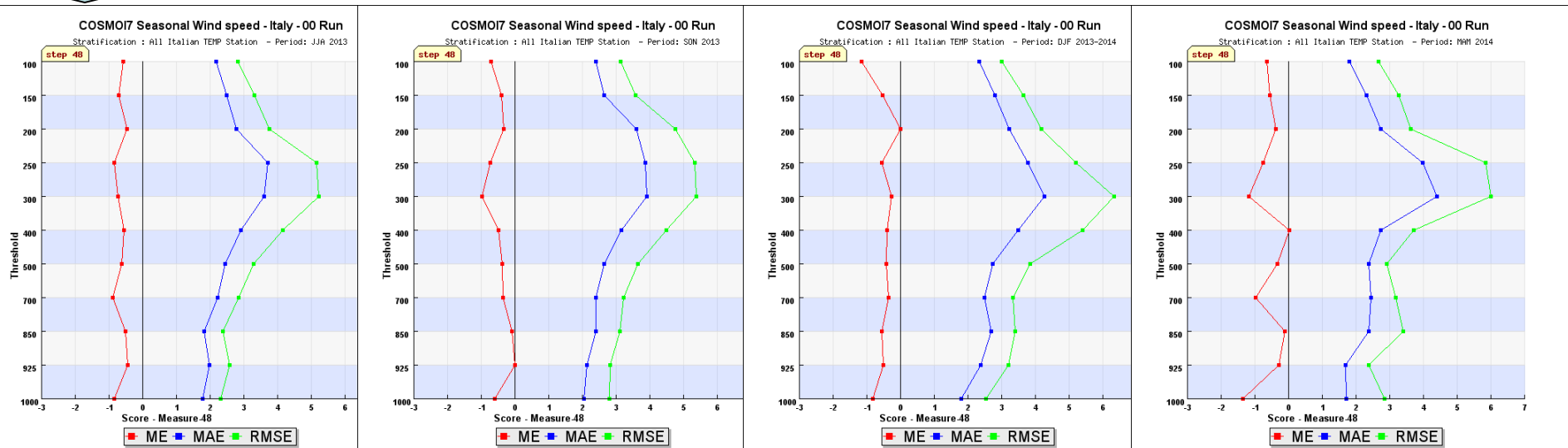
UPPER AIR: WIND SPEED COSMOI7

RUN00 UTC - FORECAST D+2

+ 36UTC



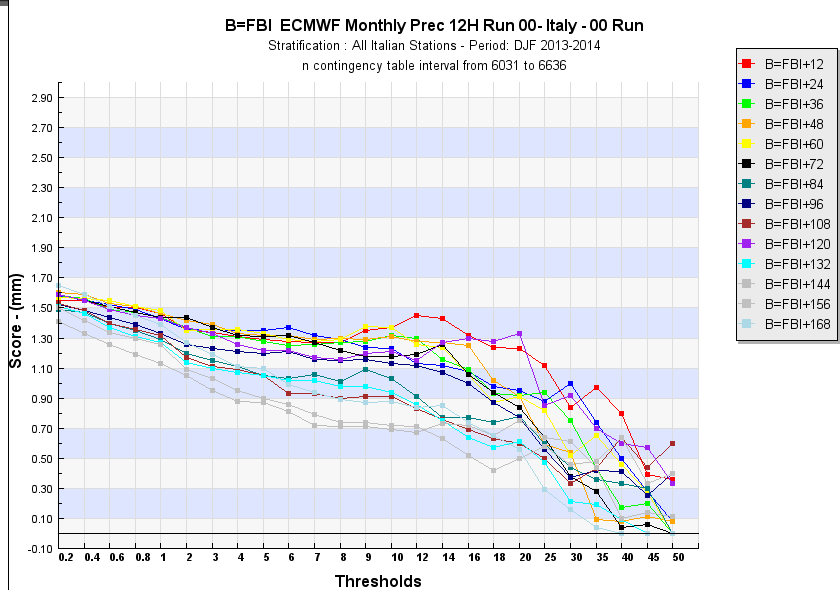
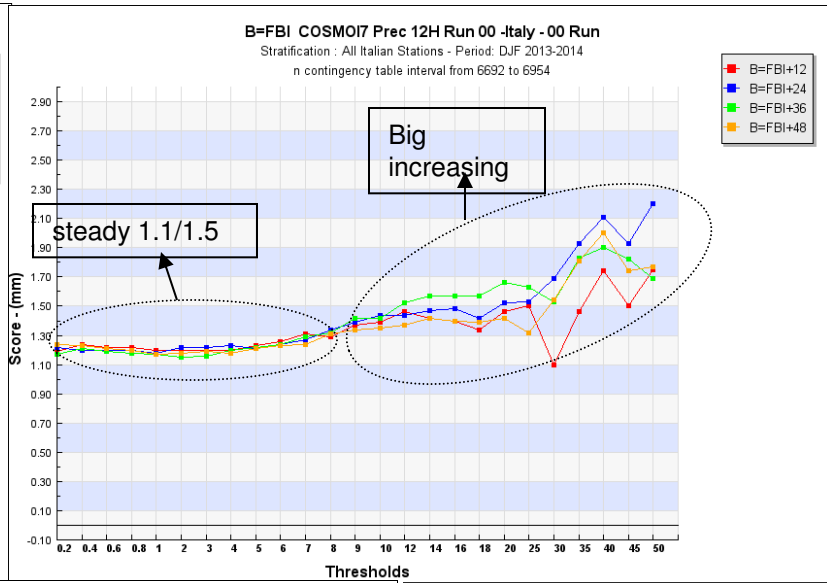
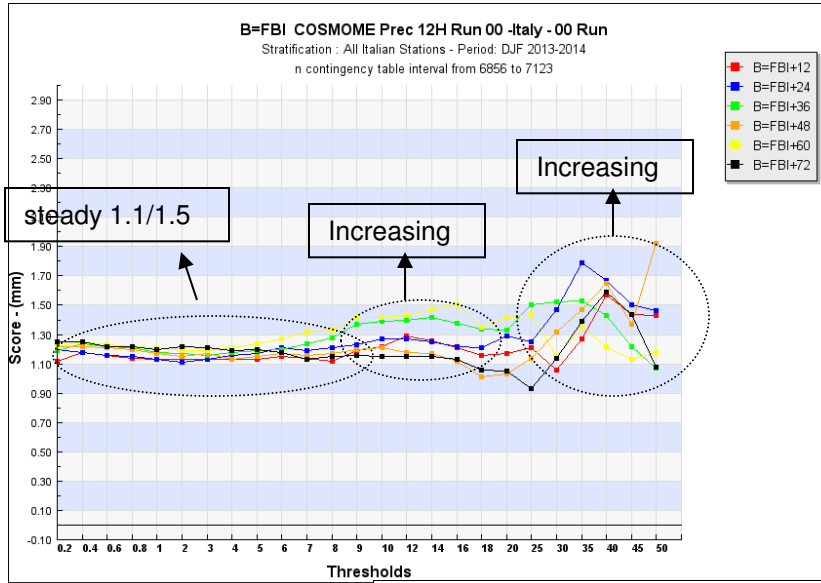
+ 48UTC



CONSIDERATIONS

- Error increasing vs forecast time for jet stream-tropopause (around 200/250 hPa): bigger wind underestimation
- In general: wind underestimation for all levels

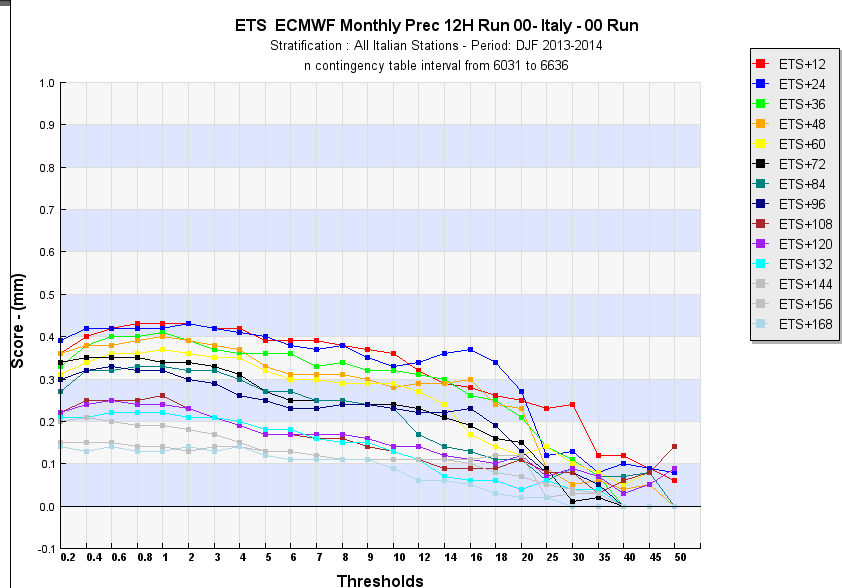
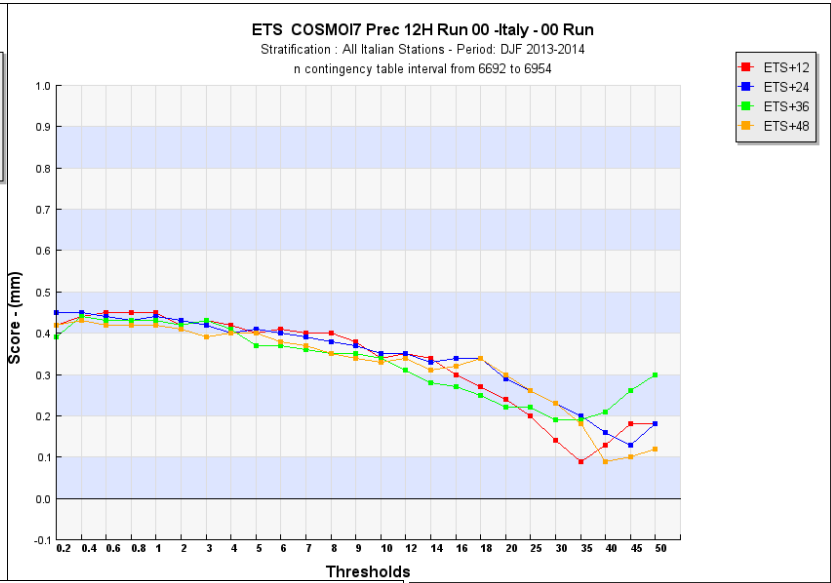
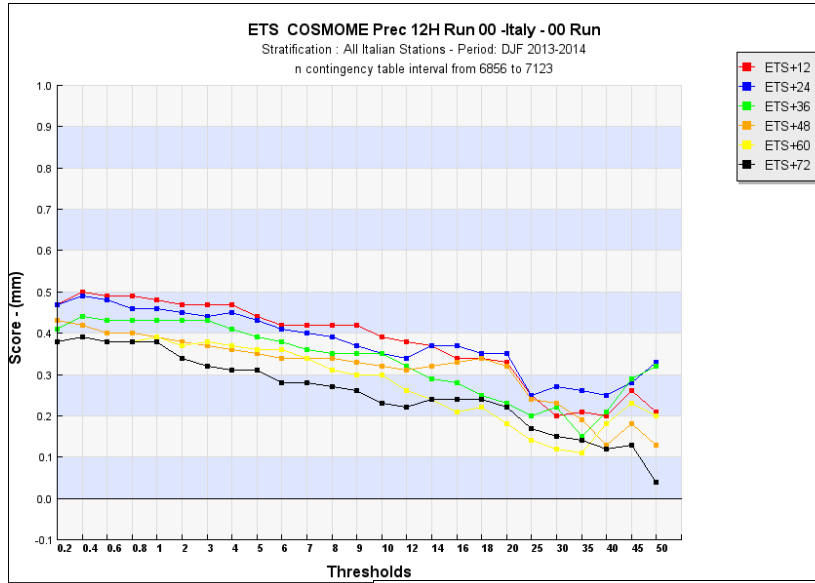
12H PRECIPITATION versus synop stations



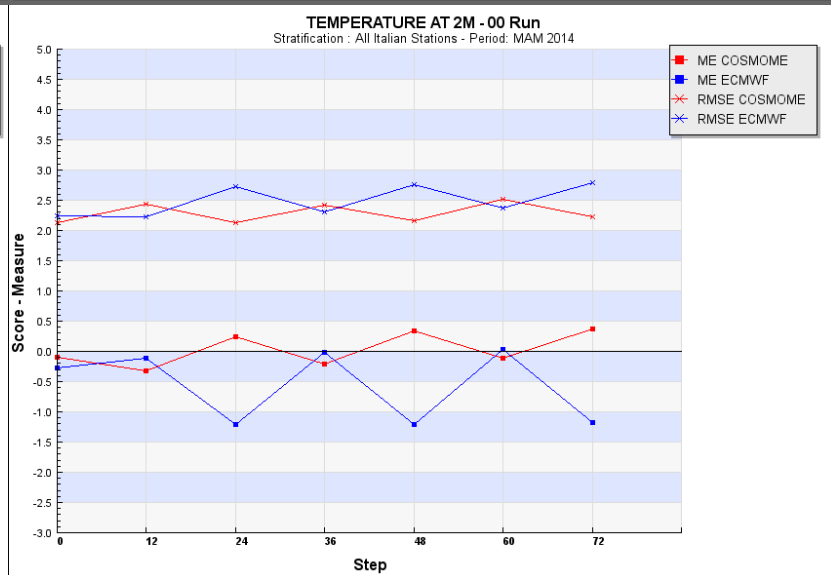
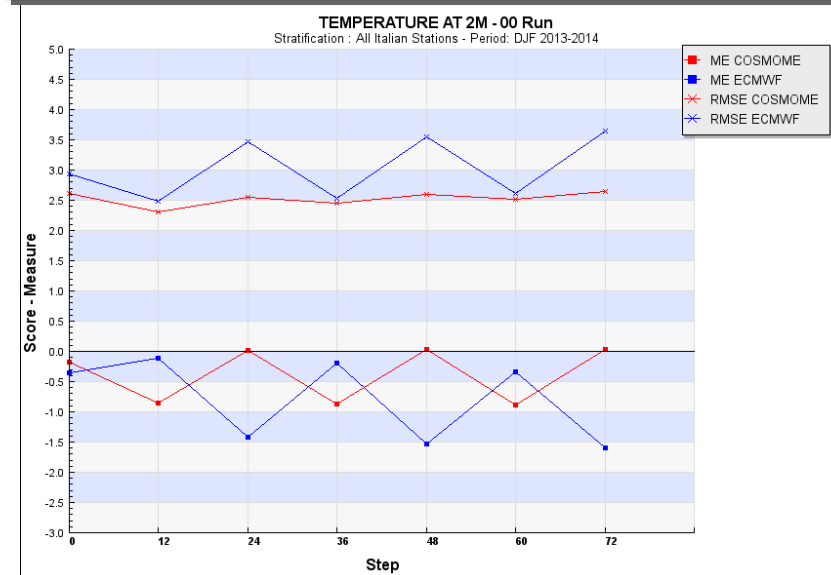
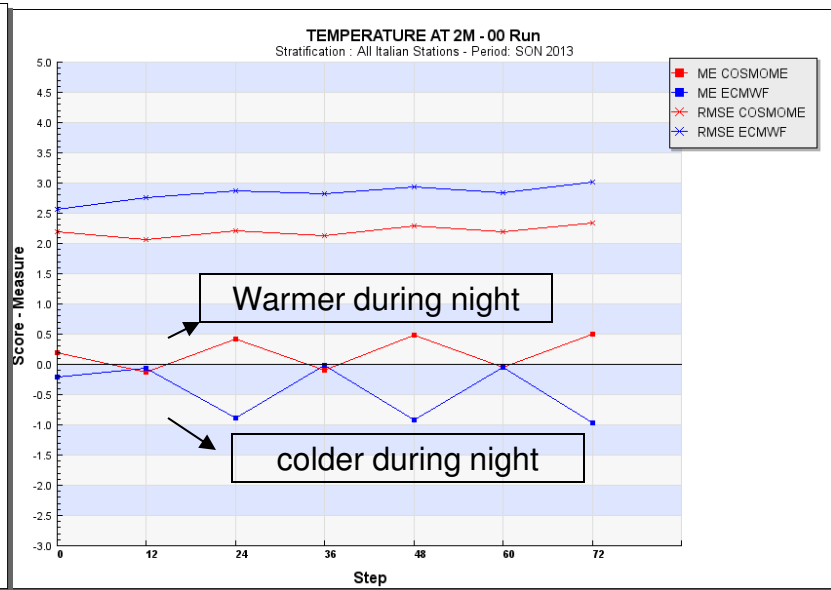
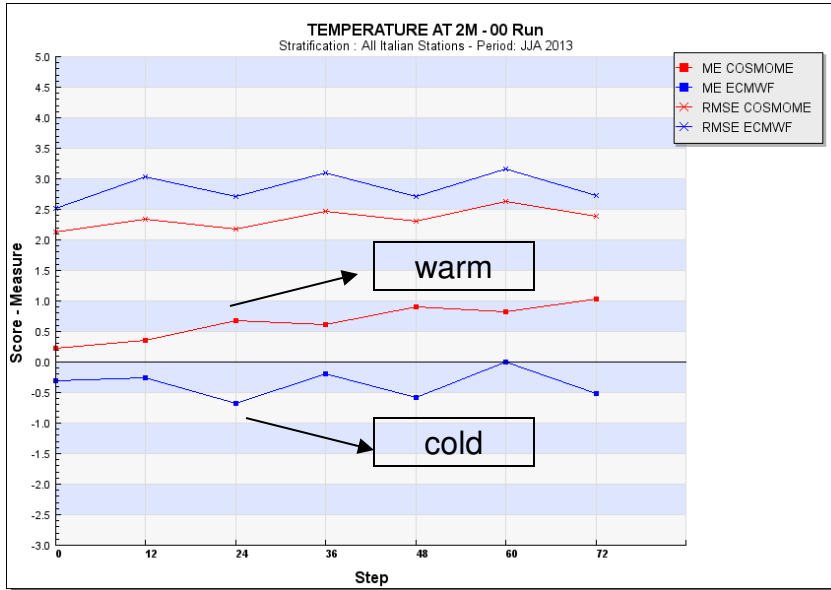
Overestimation for low thres

Big underestimation for high thres

12H PRECIPITATION versus synop stations

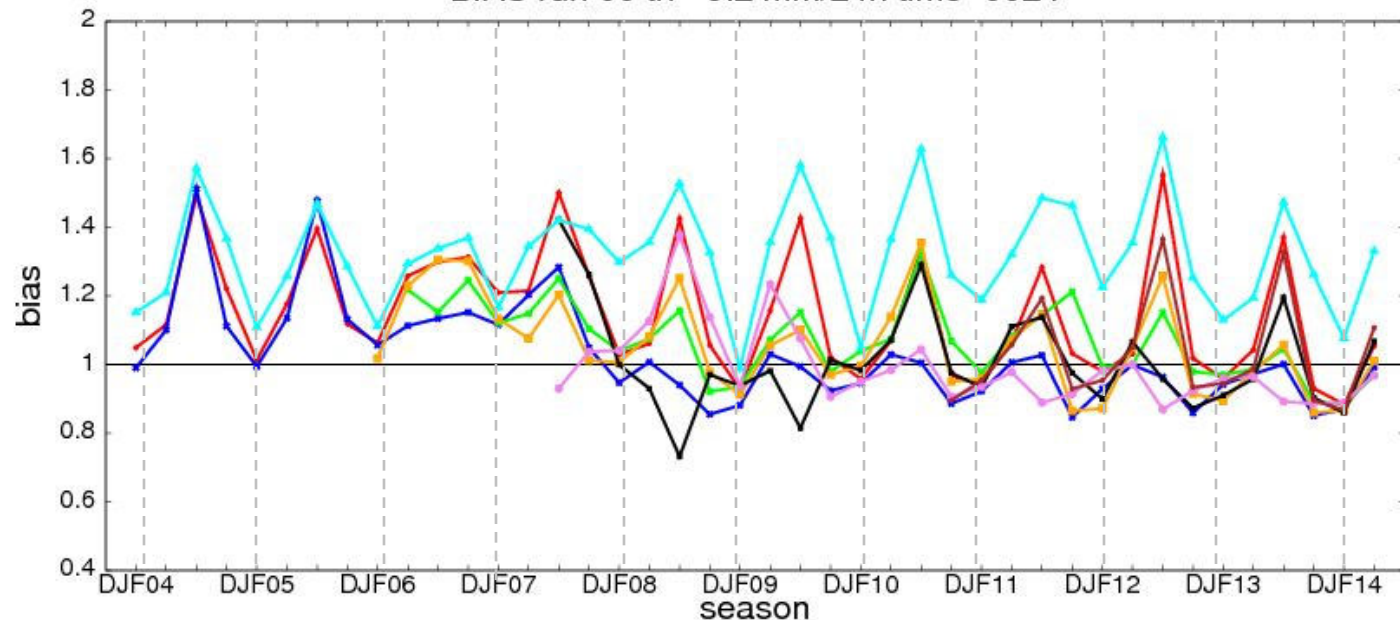


ECMWF/COSMOME: T2m versus synop stations



LONG TREND PRECIPITATION with high resolution stations

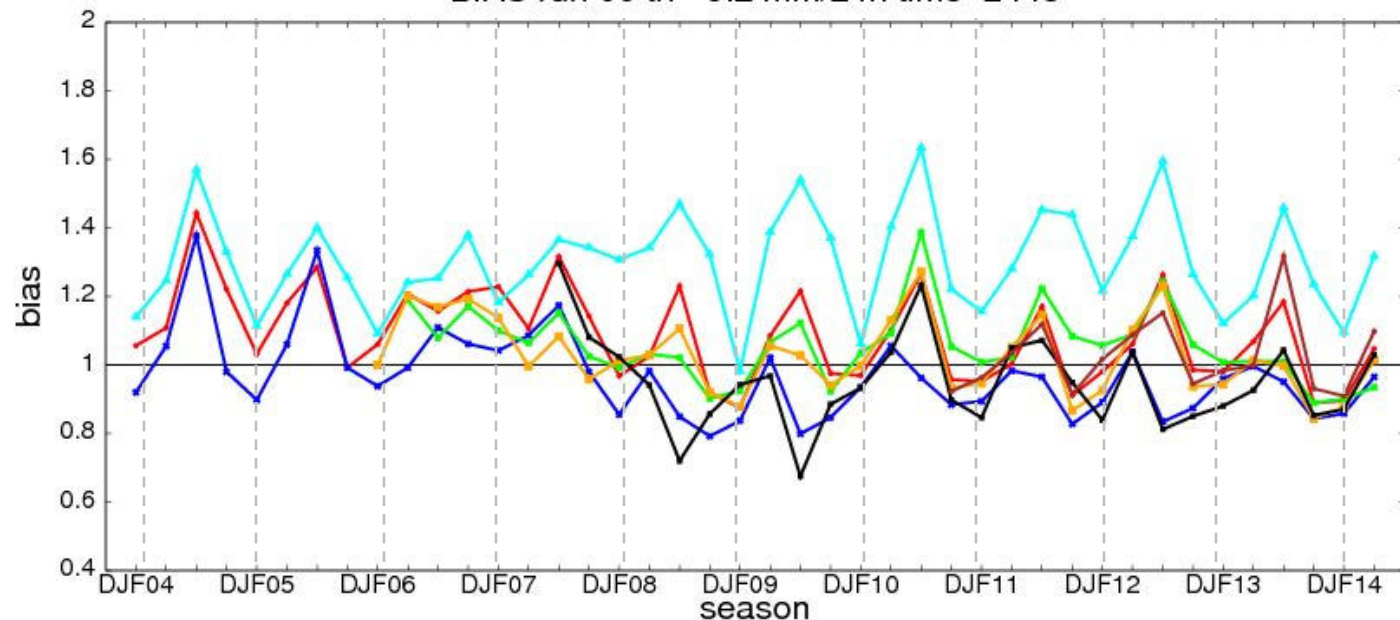
BIAS run 00 th= 0.2 mm/24h time=0024



LOW THRESHOLDS

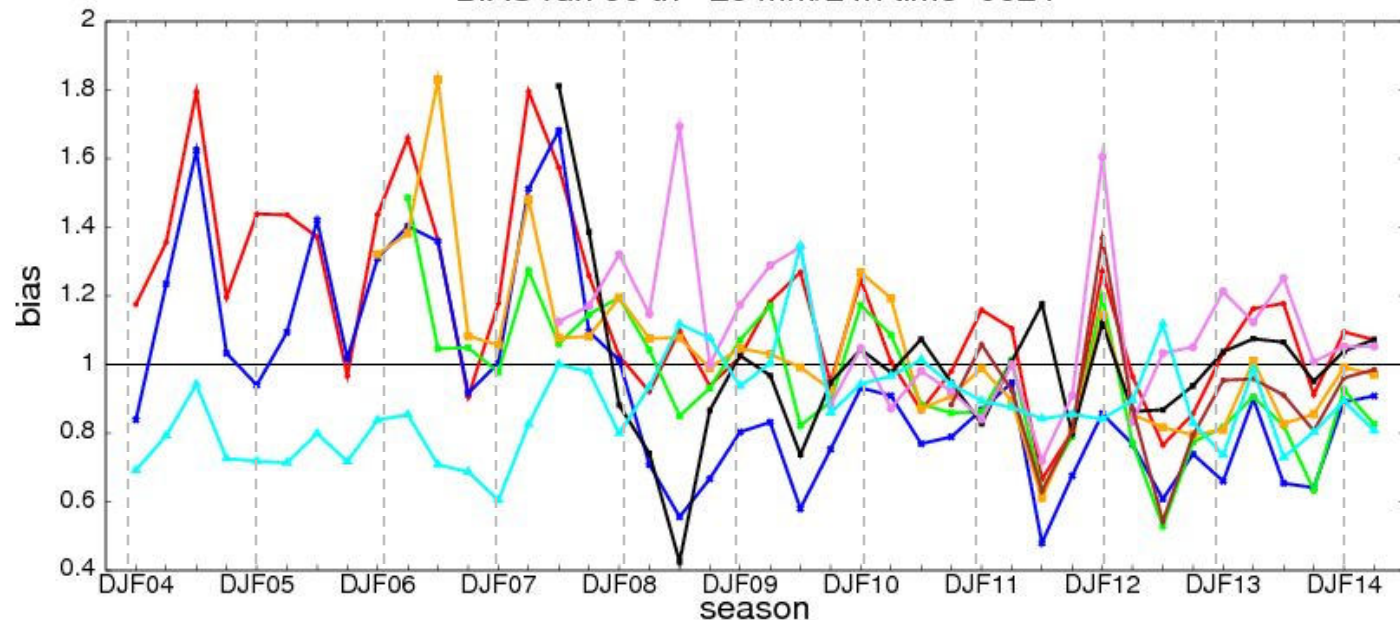
- Ecmwf overestimation
- Summer overestimation

BIAS run 00 th= 0.2 mm/24h time=2448



LONG TREND PRECIPITATION with high resolution stations

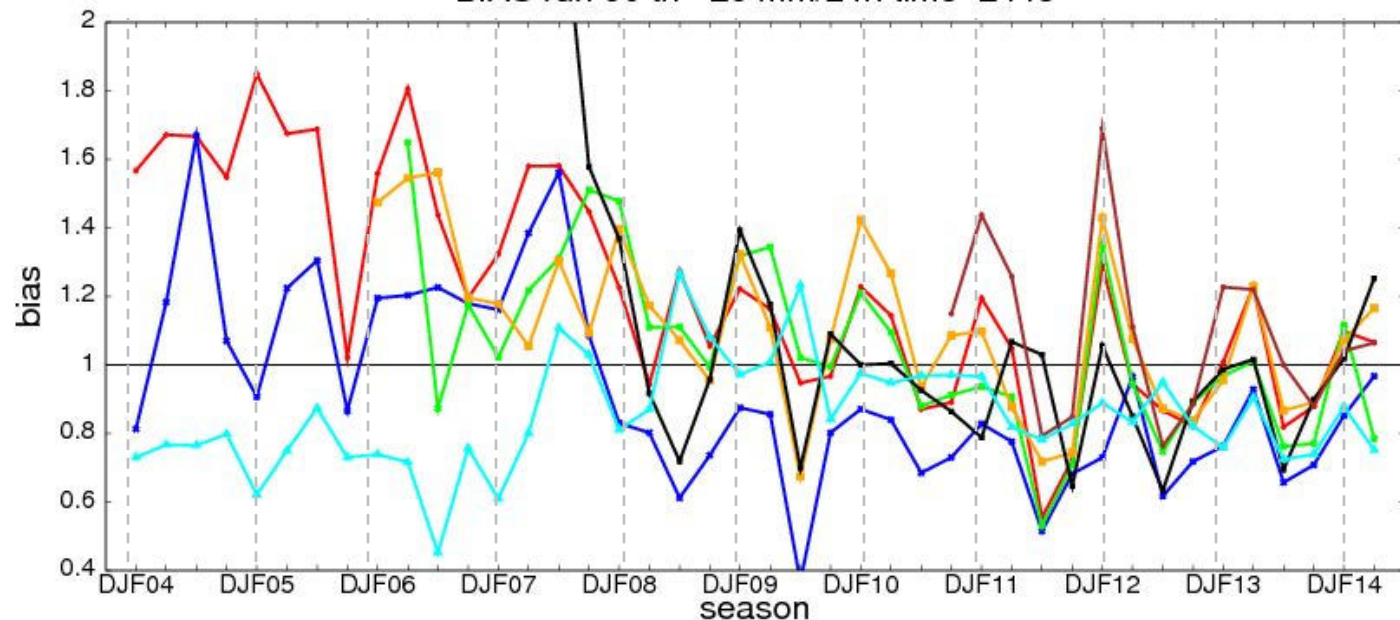
BIAS run 00 th= 20 mm/24h time=0024



HIGH THRESHOLDS

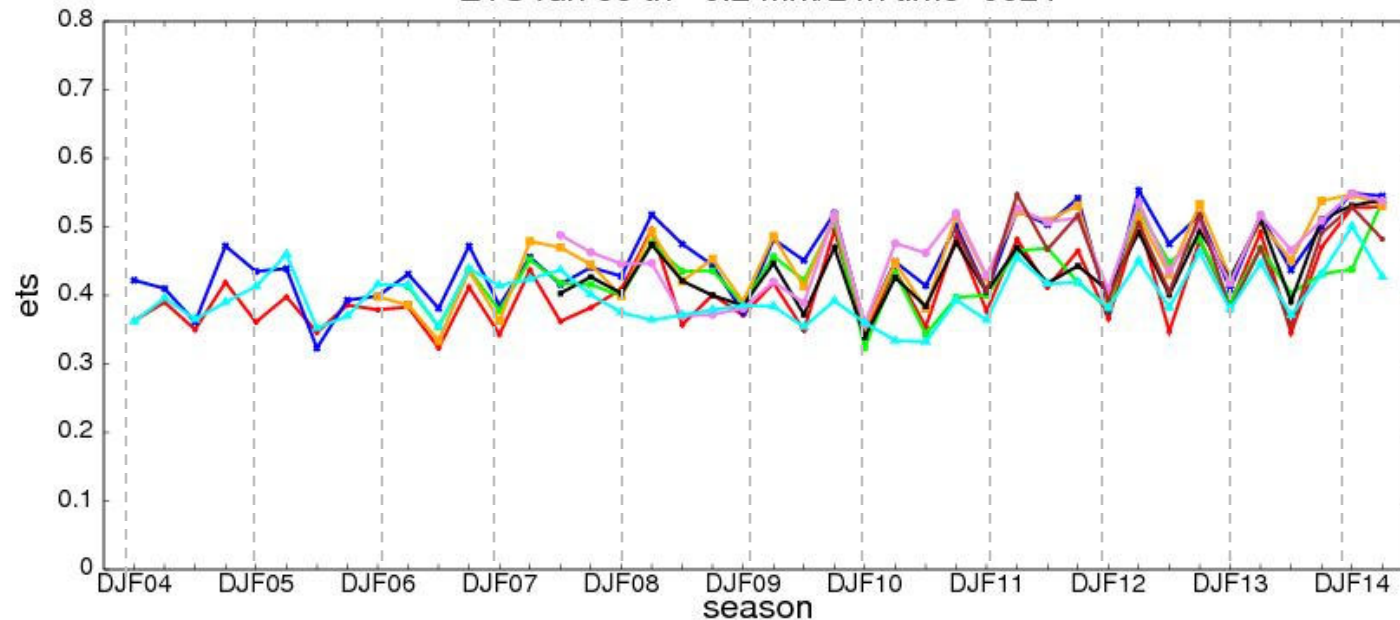
•General underestimation, especially 7, EU

BIAS run 00 th= 20 mm/24h time=2448



LONG TREND PRECIPITATION with high resolution stations

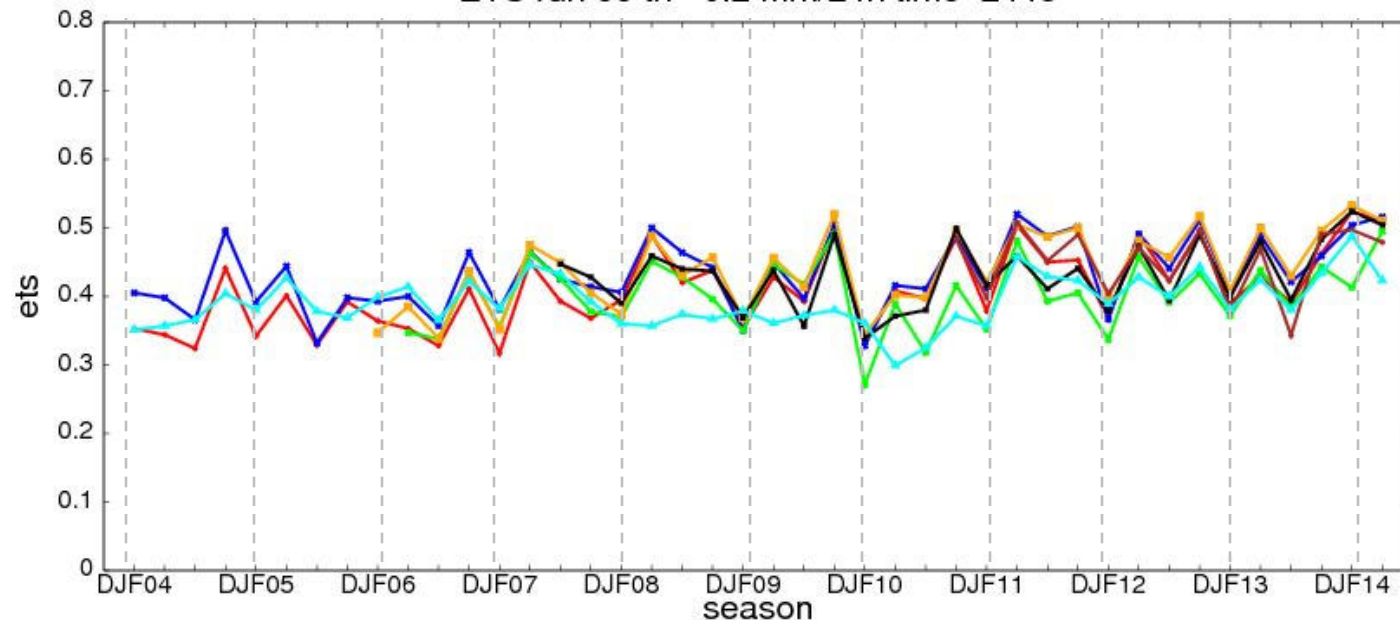
ETS run 00 th= 0.2 mm/24h time=0024



LOW THRESHOLDS

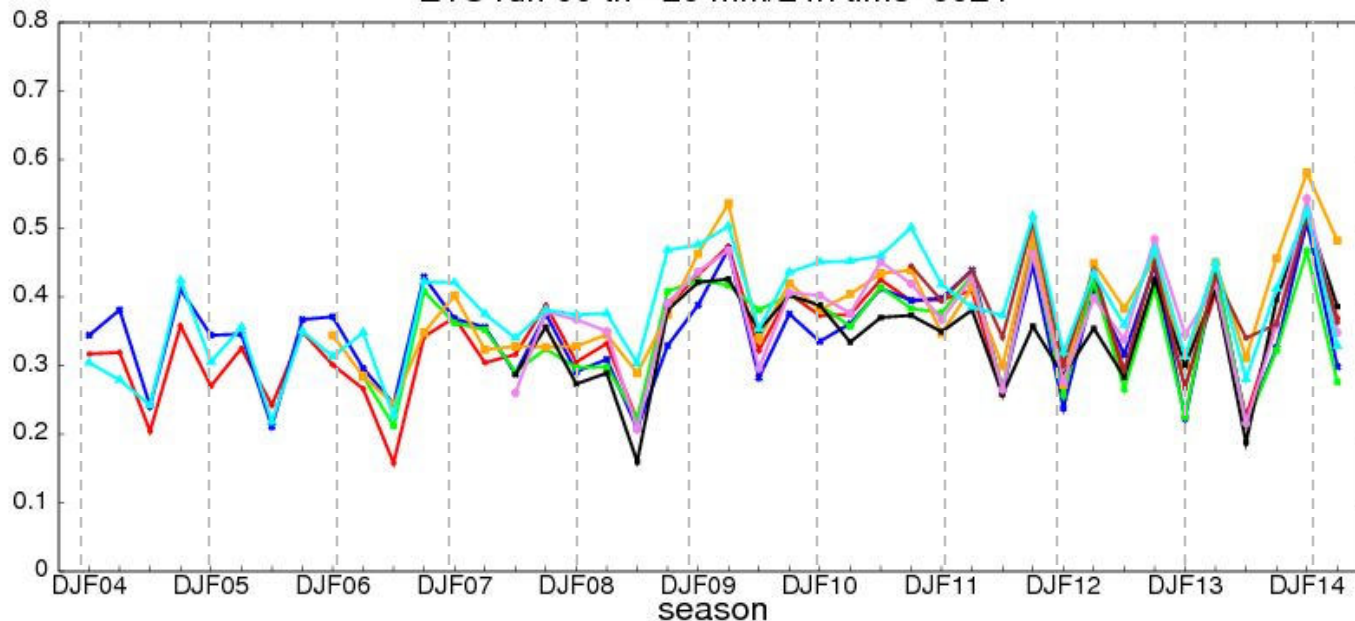
- Very slightly positive/steady trend
- Good ME,7
- Big seasonal oscillation

ETS run 00 th= 0.2 mm/24h time=2448



LONG TREND PRECIPITATION with high resolution stations

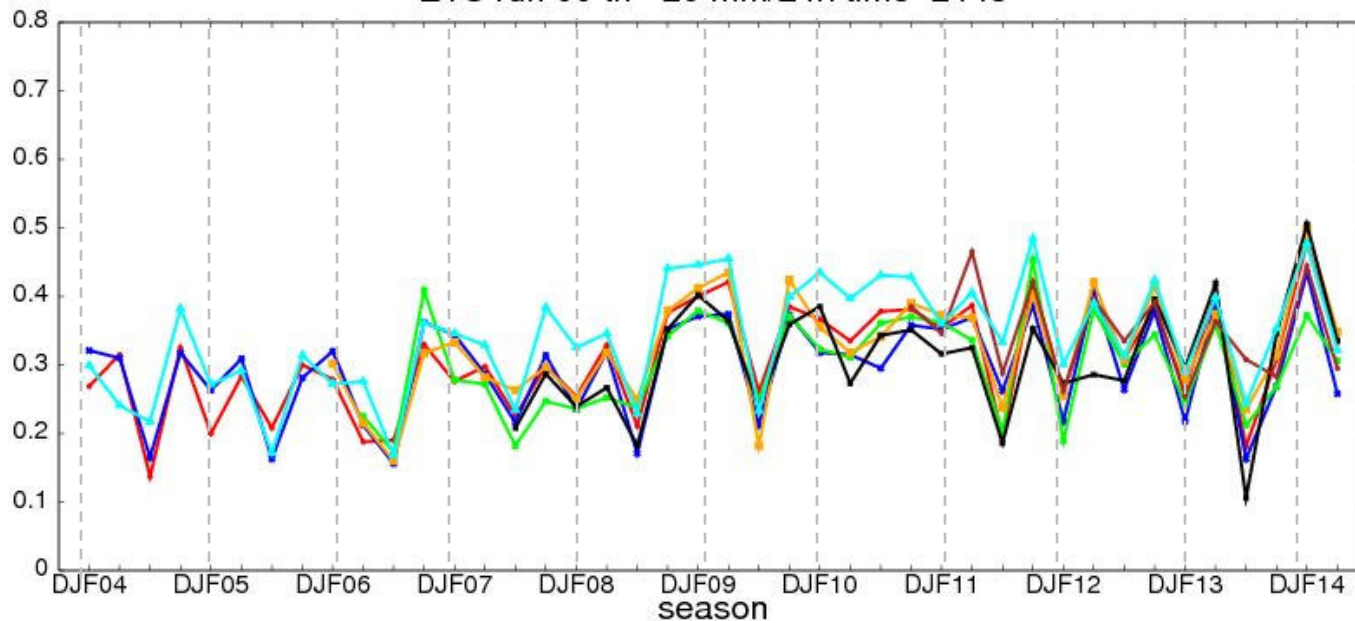
ETS run 00 th= 20 mm/24h time=0024



HIGH THRESHOLDS

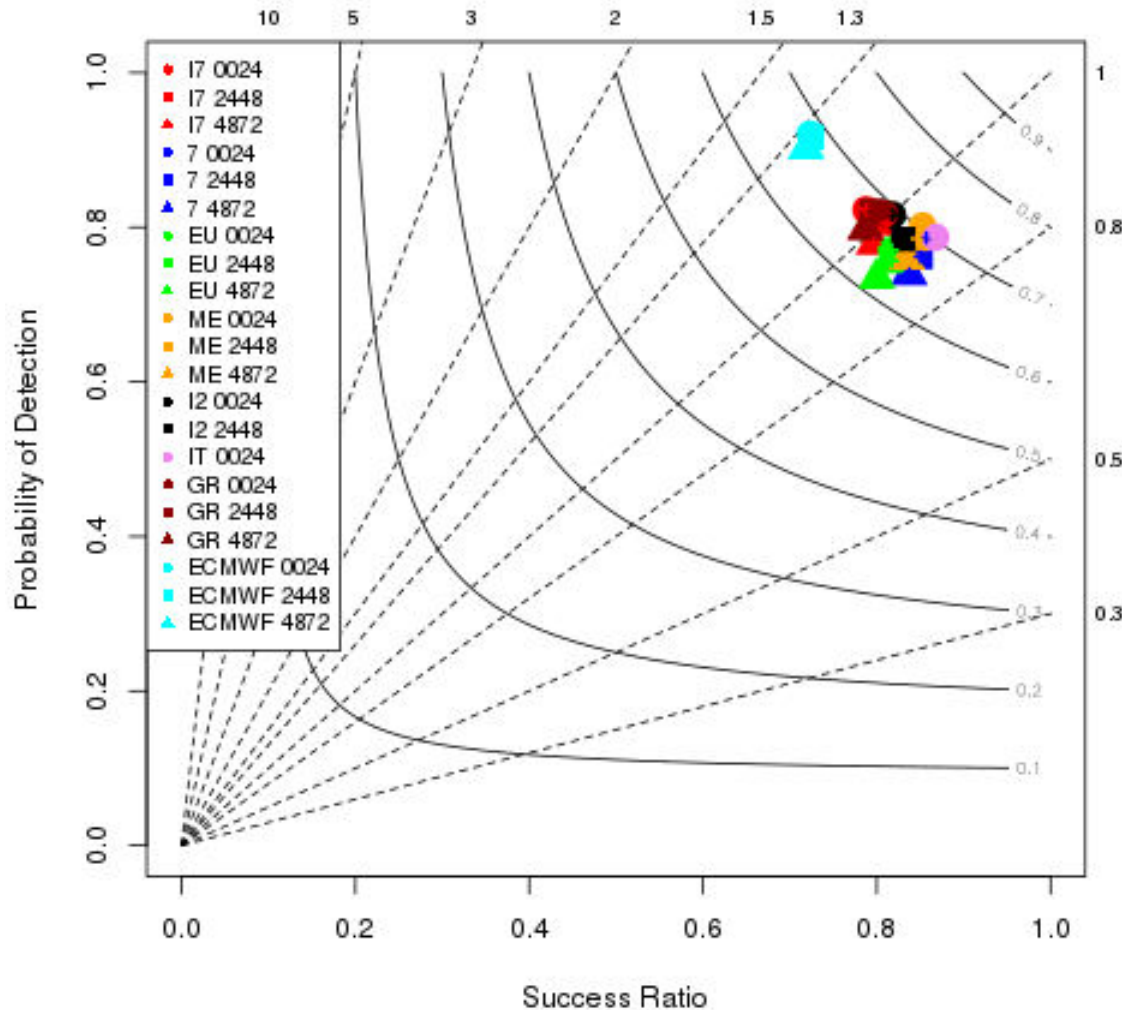
- Very slightly positive trend
- Big seasonal oscillation
- Good ets for ME
- Big worsening jja13

ETS run 00 th= 20 mm/24h time=2448



201306- 201406: Average over area > 0.2 mm/24h

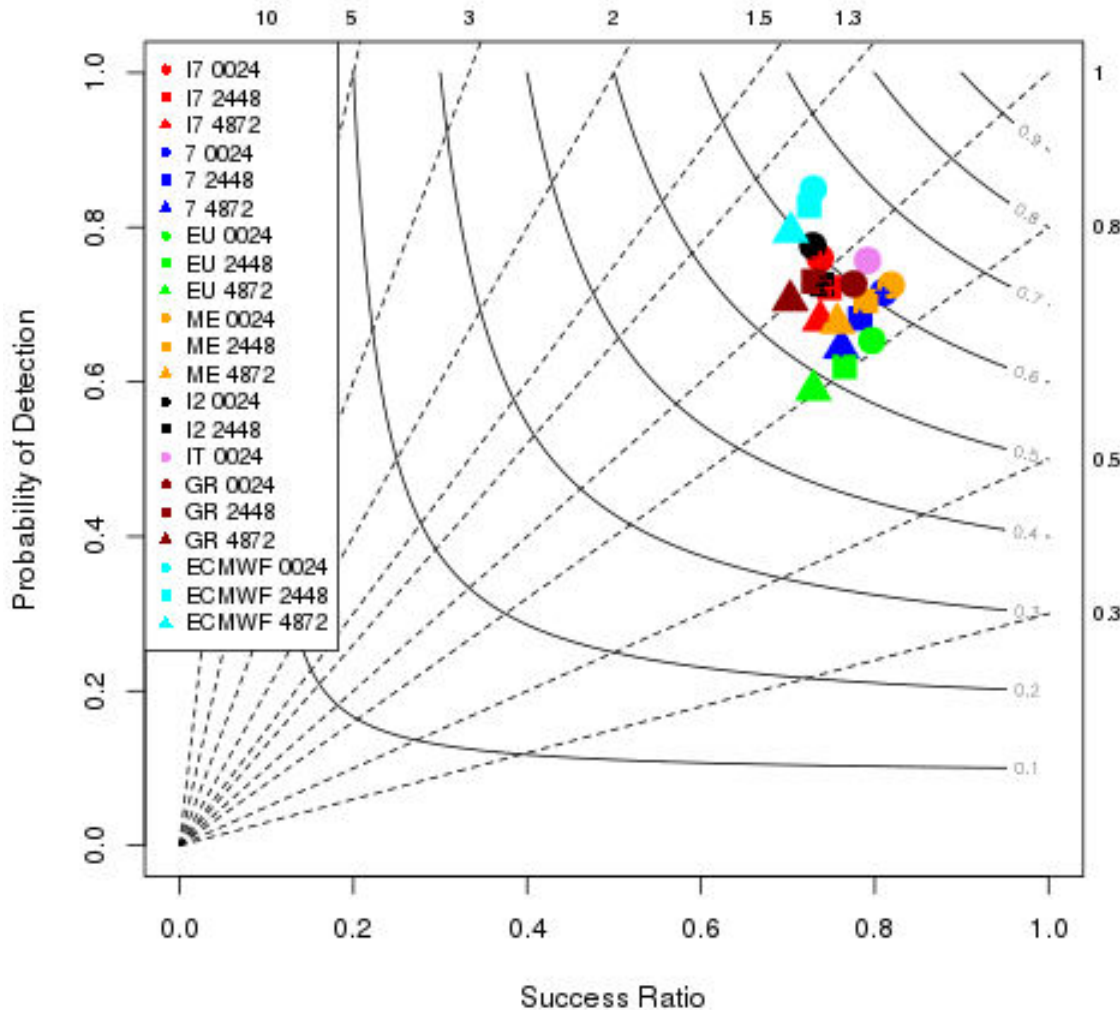
201306_201406: Precipitation in 24h (ave) - 0.2 mm threshold



Ecmwf →
overestimation

201306- 201406: Average over area > 2 mm/24h

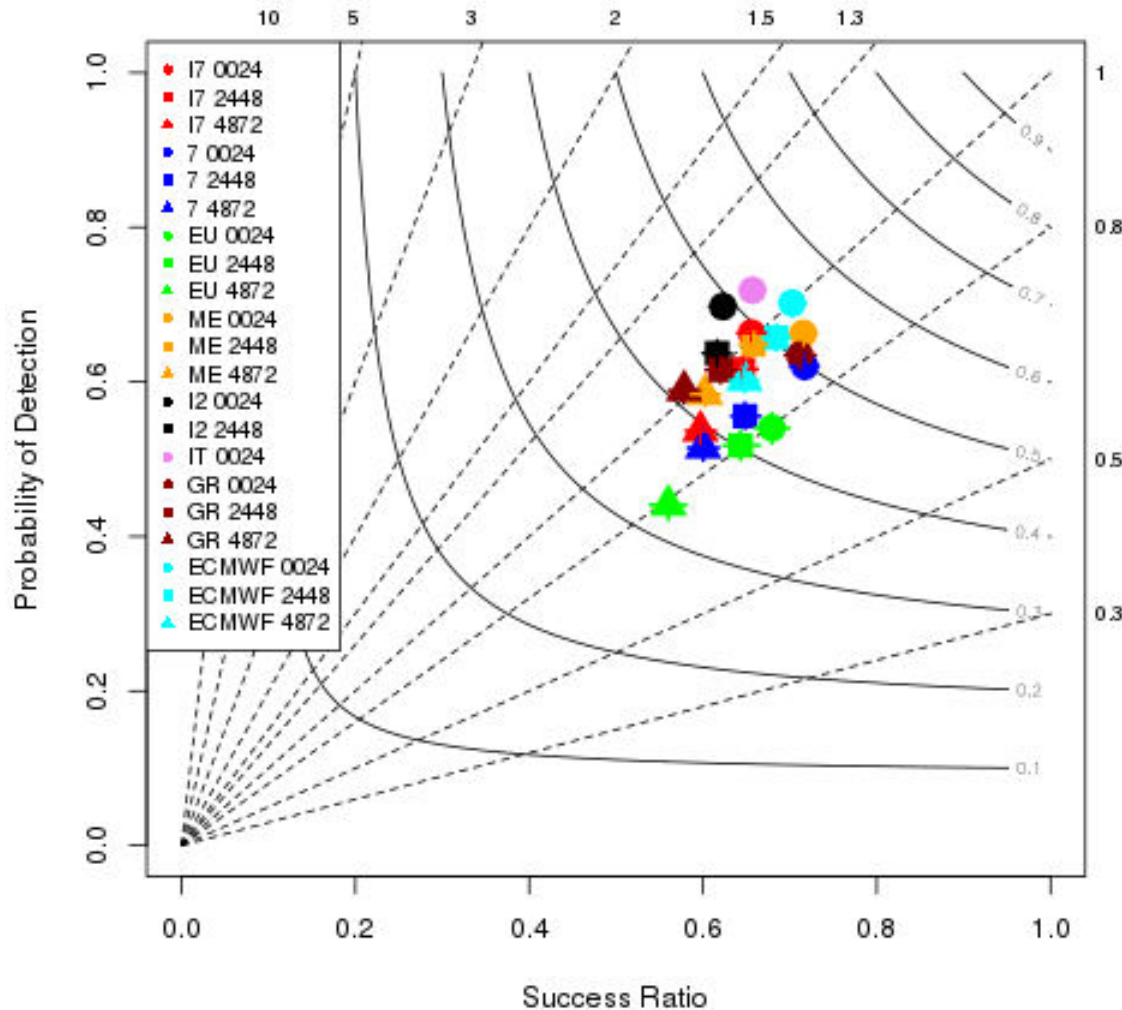
201306_201406: Precipitation in 24h (ave) - 2.0 mm threshold



Ecmwf → overestimation
IT, ME, I2, I7 → good

201306- 201406: Average over area > 10 mm/24h

201306_201406: Precipitation in 24h (ave) - 10.0 mm threshold



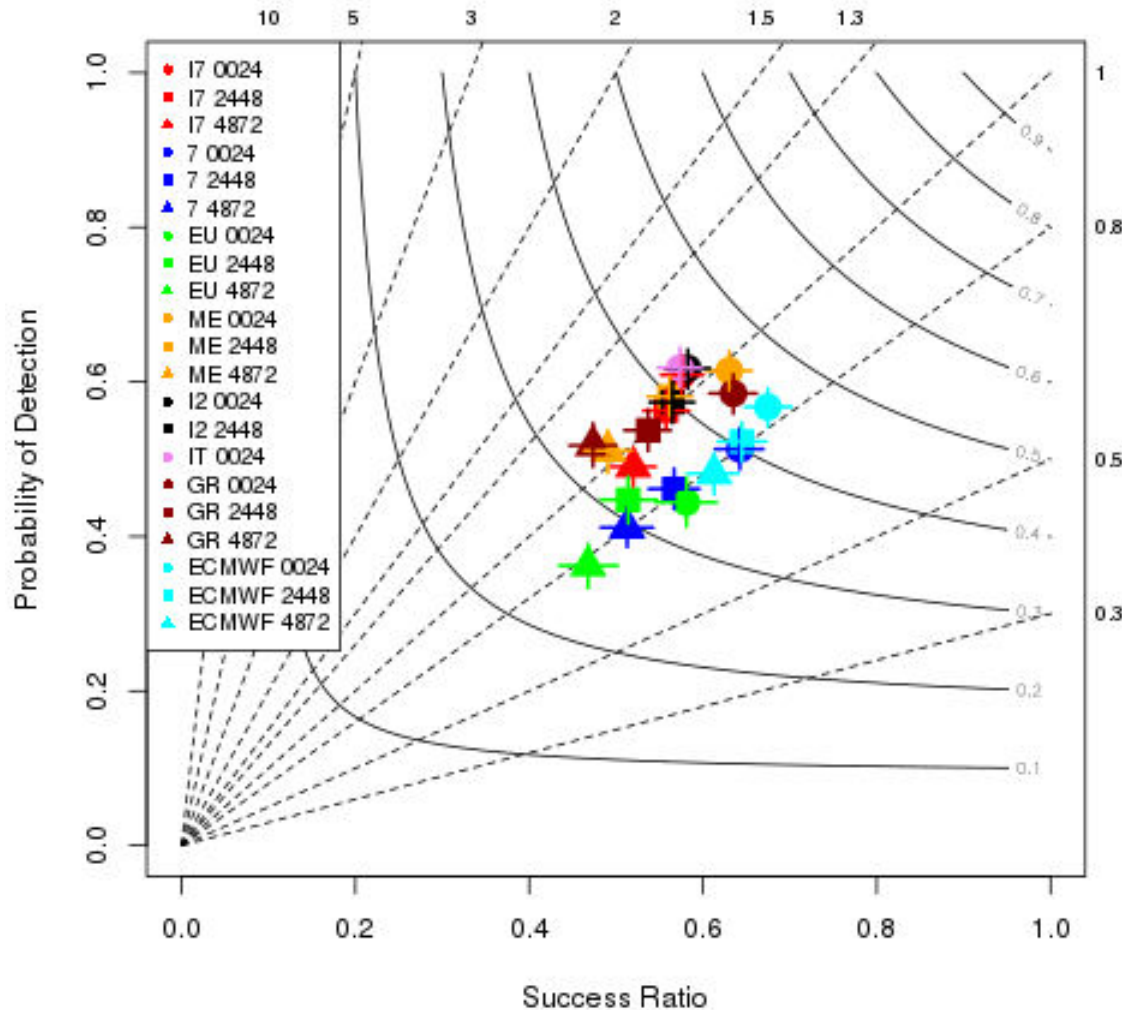
Ecmwf → the best

ME, I2, I7 → good

7, EU → low skills

201306- 201406: Average over area > 20 mm/24h

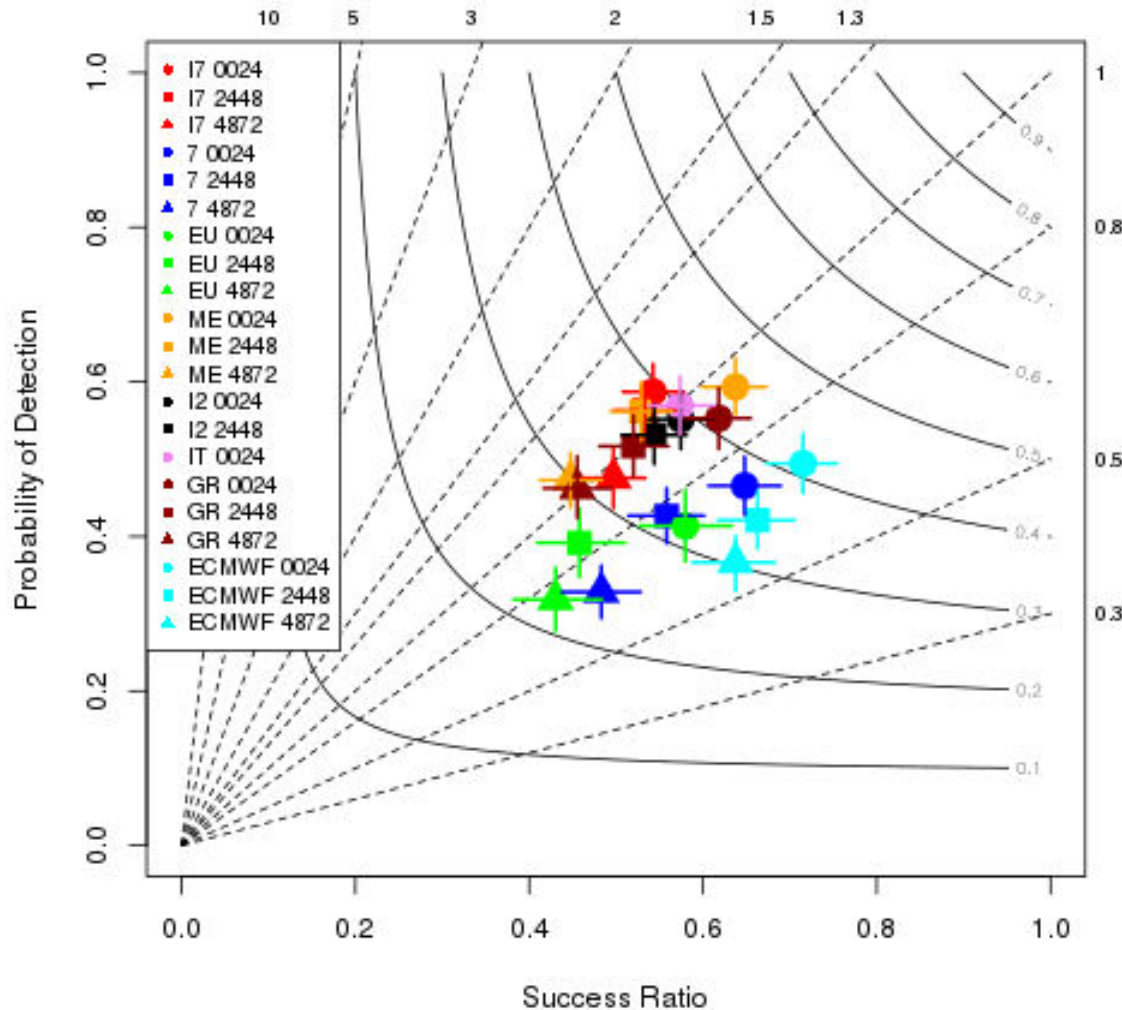
201306_201406: Precipitation in 24h (ave) - 20.0 mm threshold



ME, I2,
I7,GR,IT →
good
7, EU, ecmwf →
low
skills/underesti
mation

201306- 201406: Average over area > 30 mm/24h

201306_201406: Precipitation in 24h (ave) - 30.0 mm threshold

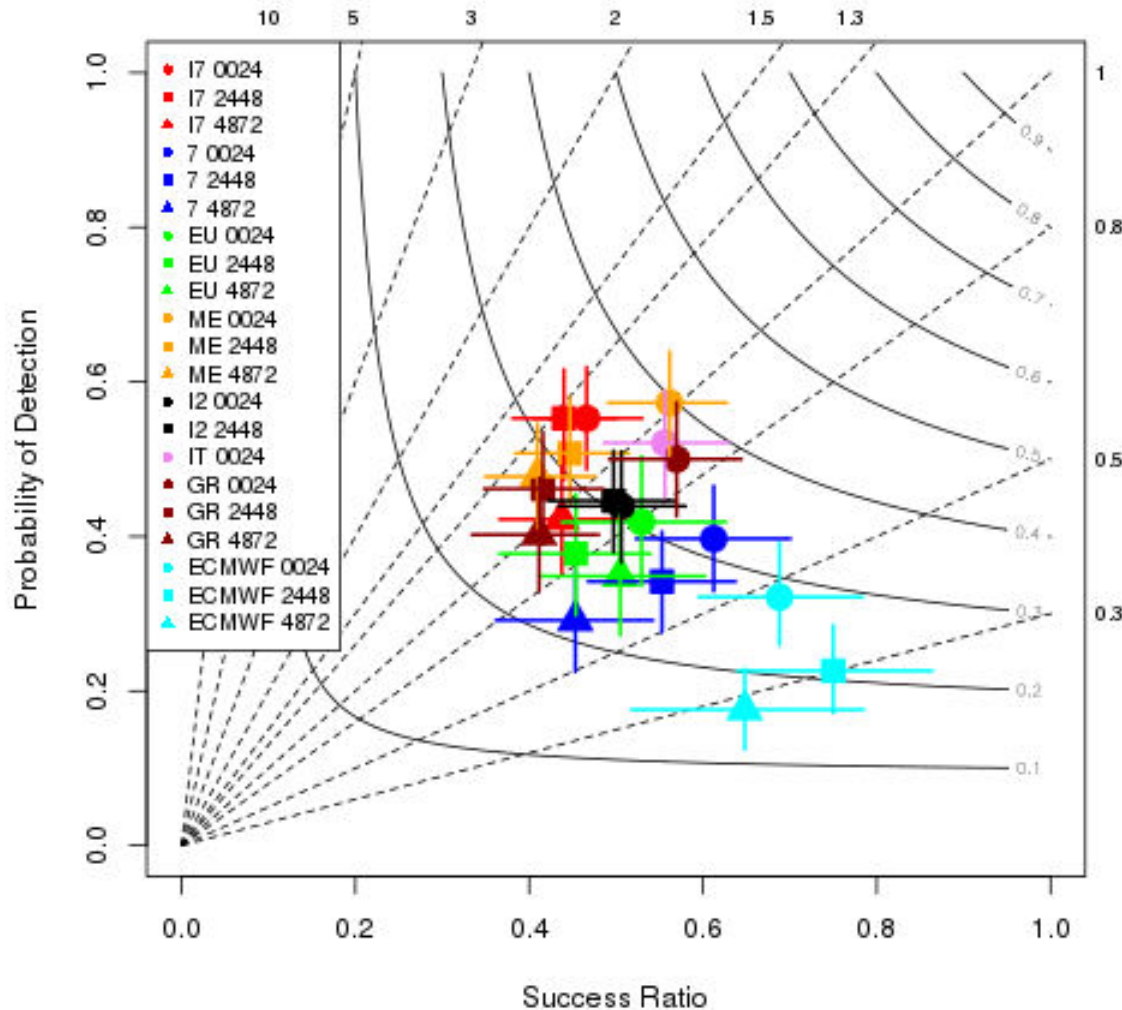


ME, I2,
I7,GR,IT →
good

7, EU, ecmwf →
low
skills/underesti
mation

201306- 201406: Average over area > 50 mm/24h

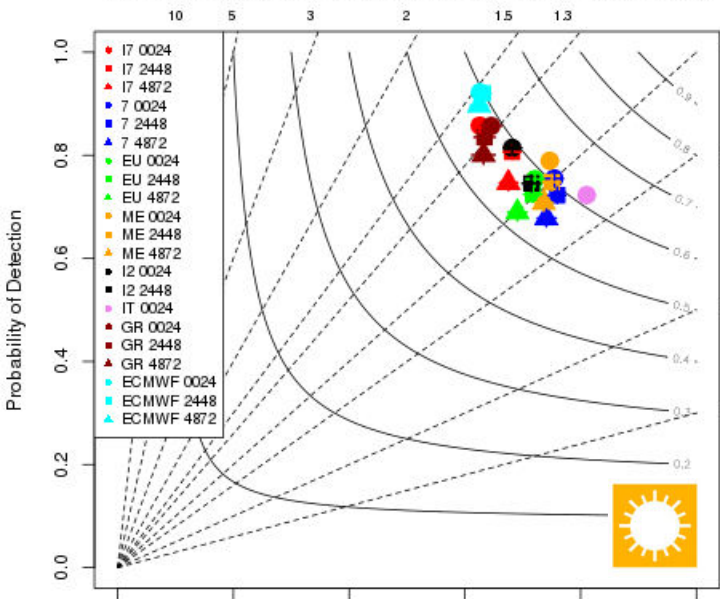
201306_201406: Precipitation in 24h (ave) - 50.0 mm threshold



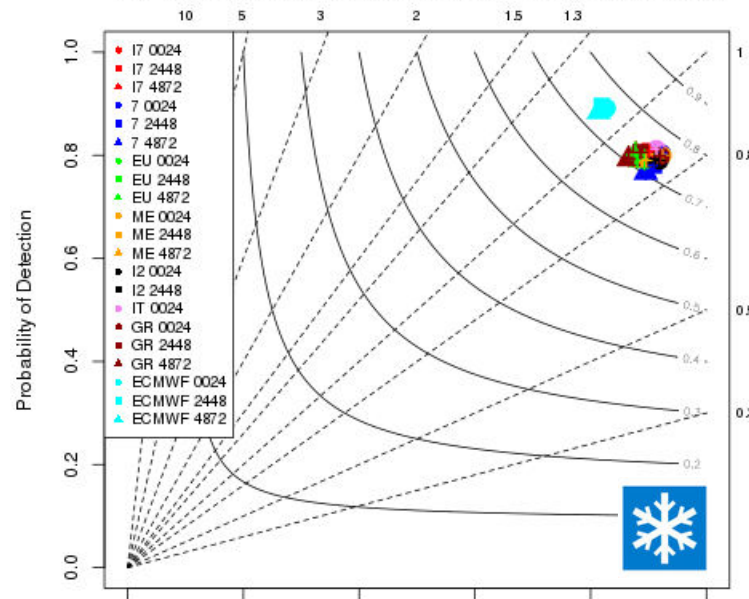
ME, I7, EU → good

7, ecmwf → low skills/underestimation

JJA 2013: Precipitation in 24h (ave) - 0.2 mm threshold



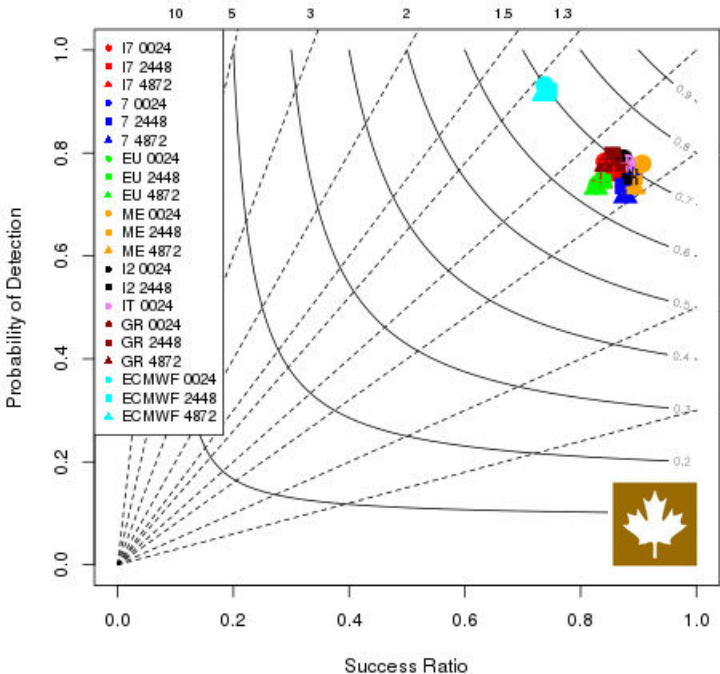
DJF 2014: Precipitation in 24h (ave) - 0.2 mm threshold



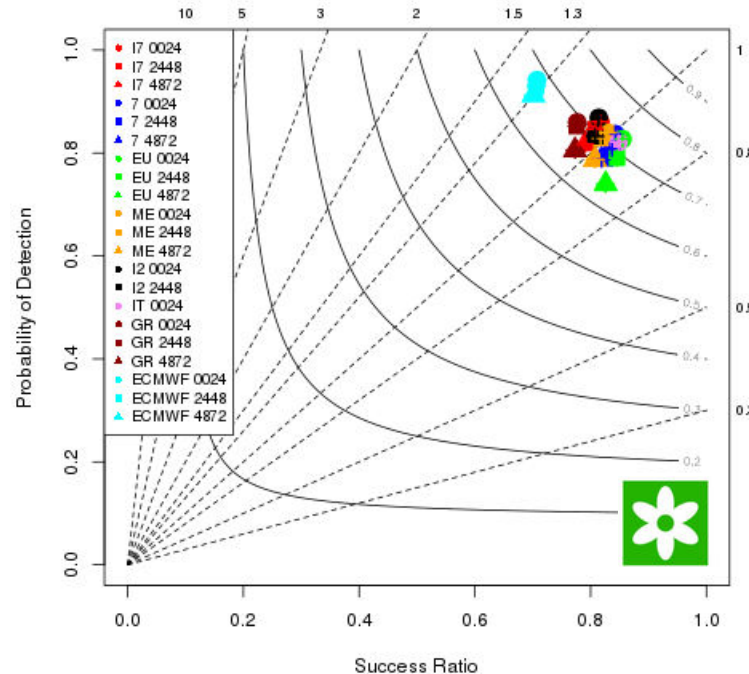
Average over area > 0.2 mm/24h

ecmwf → overestimation
 other → underestimation/low skill

SON 2013: Precipitation in 24h (ave) - 0.2 mm threshold

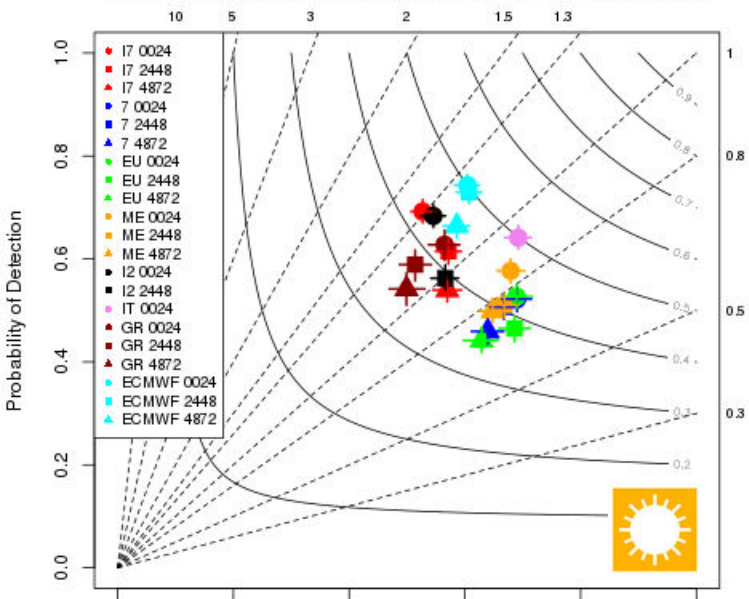


MAM 2014: Precipitation in 24h (ave) - 0.2 mm threshold

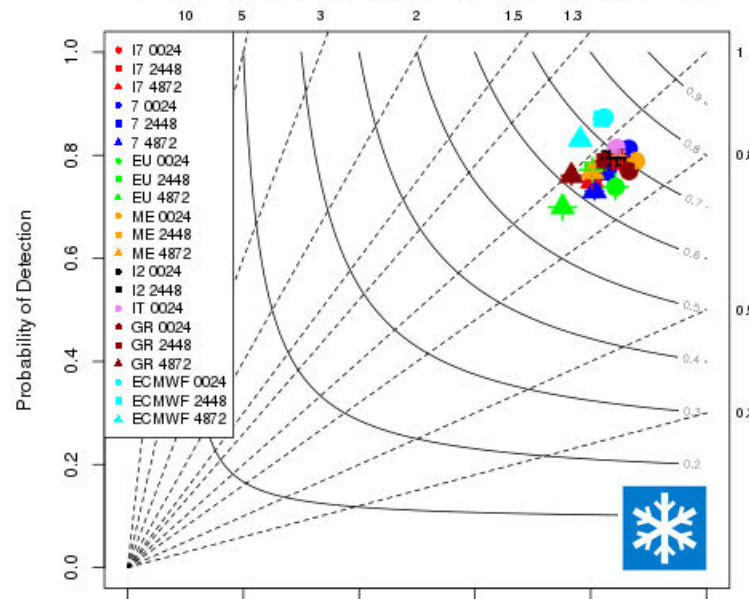


Jja13 → low skill

JJA 2013: Precipitation in 24h (ave) - 2.0 mm threshold



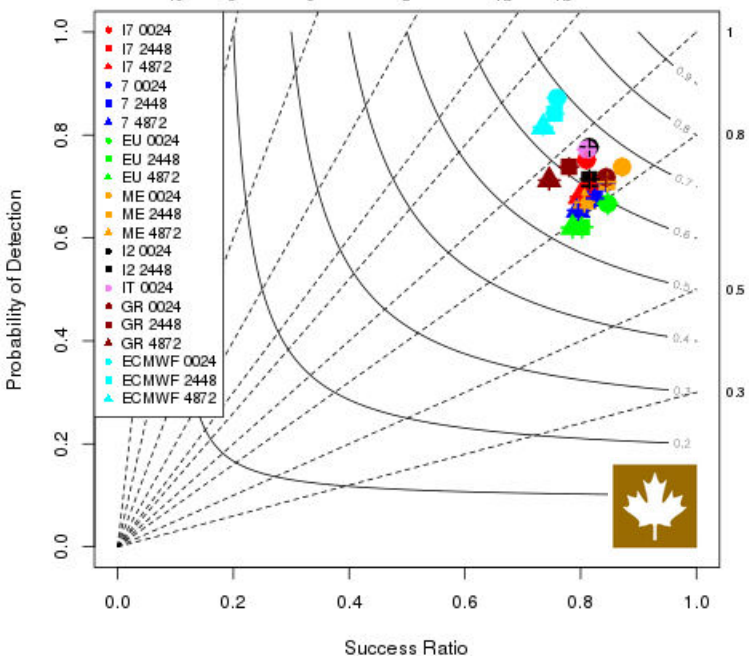
DJF 2014: Precipitation in 24h (ave) - 2.0 mm threshold



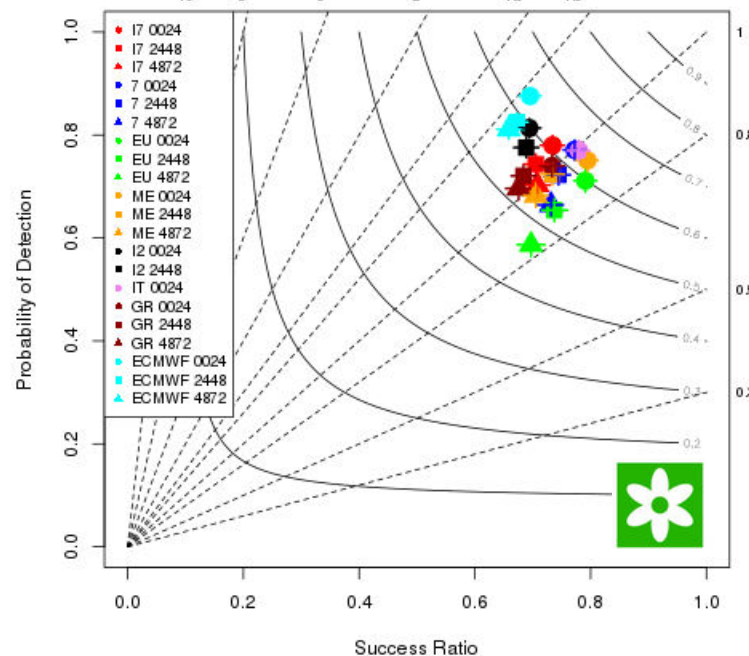
Average over area > 2 mm/24h

ecmwf → overestimation
 other → underestimation/low skill

SON 2013: Precipitation in 24h (ave) - 2.0 mm threshold

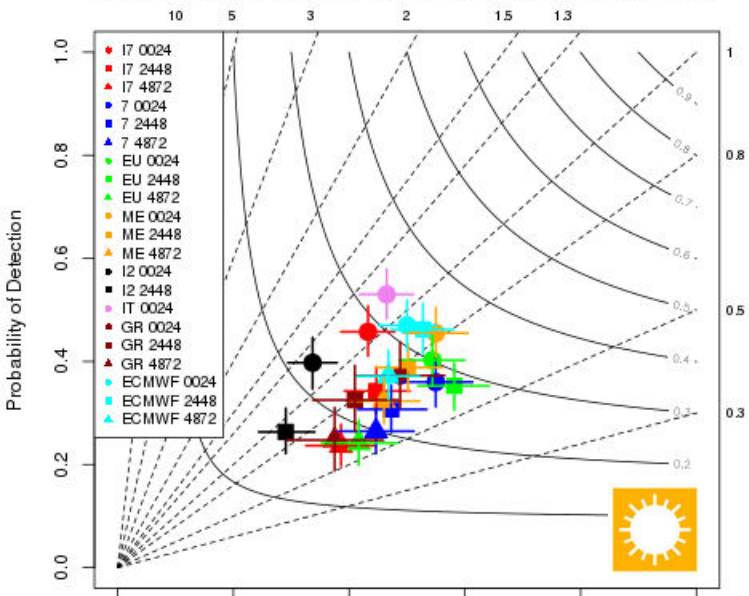


MAM 2014: Precipitation in 24h (ave) - 2.0 mm threshold

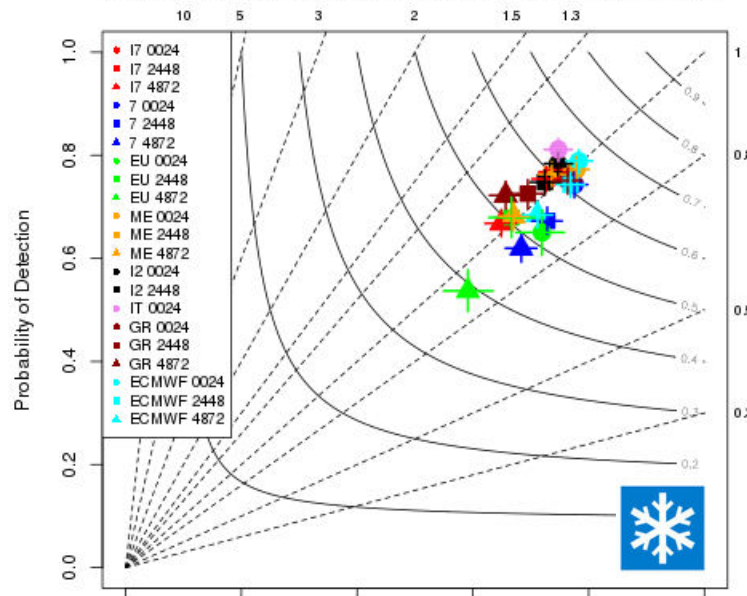


Jja13 → low skill

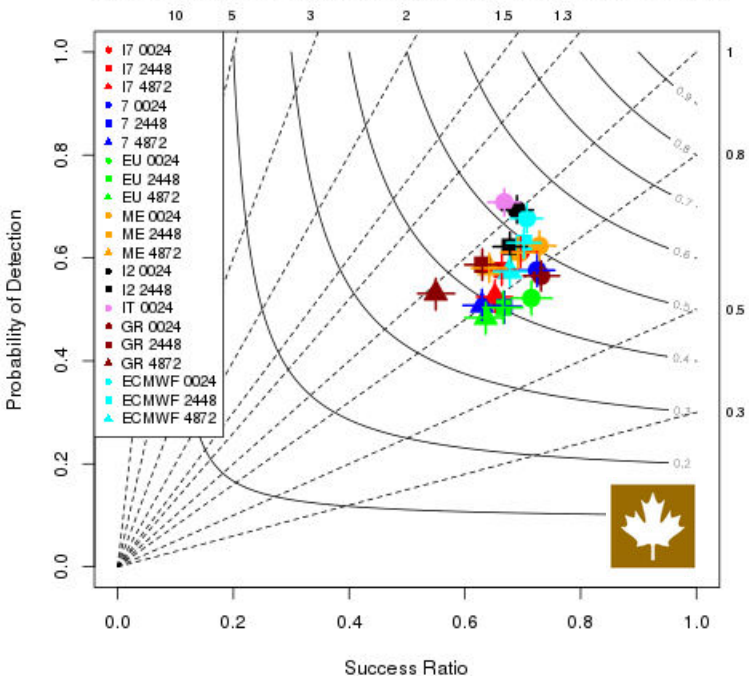
JJA 2013: Precipitation in 24h (ave) - 10.0 mm threshold



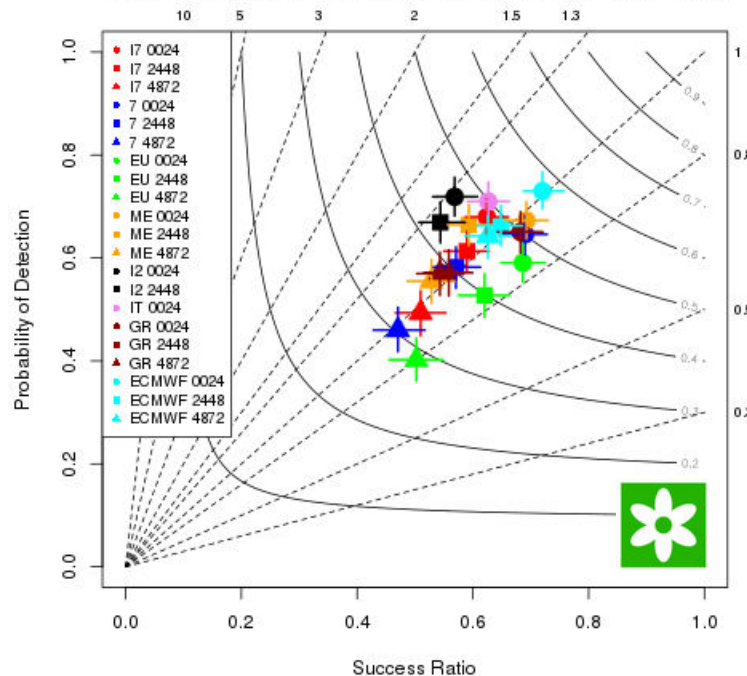
DJF 2014: Precipitation in 24h (ave) - 10.0 mm threshold



SON 2013: Precipitation in 24h (ave) - 10.0 mm threshold



MAM 2014: Precipitation in 24h (ave) - 10.0 mm threshold



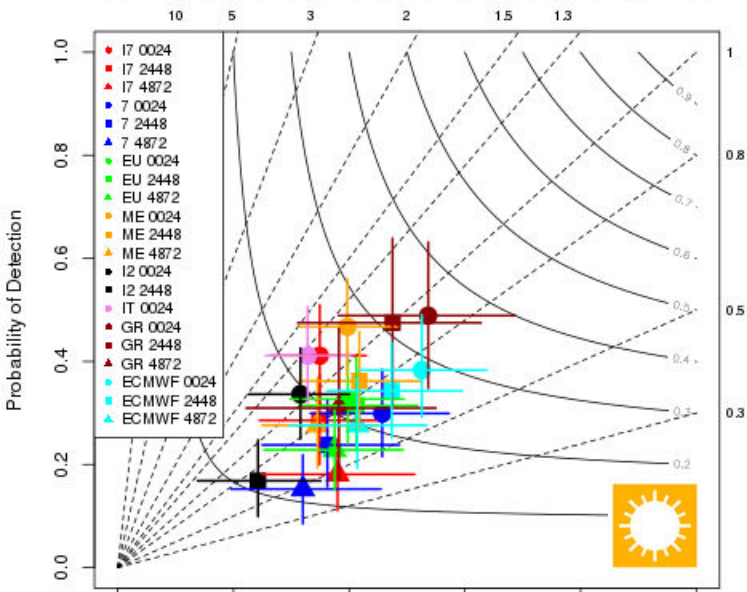
Average over area > 10 mm/24h

Good behaviour for all models, especially ECM

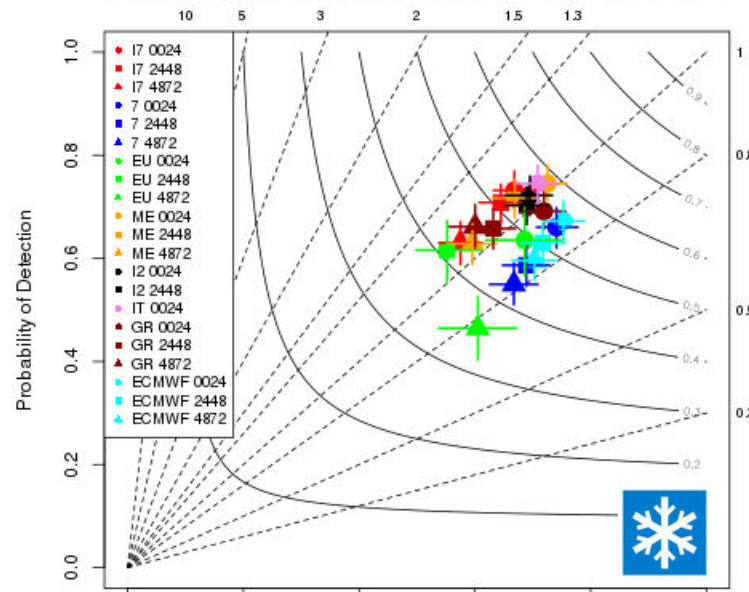
Jja13 -> low skill

Good performance during wintertime

JJA 2013: Precipitation in 24h (ave) - 20.0 mm threshold



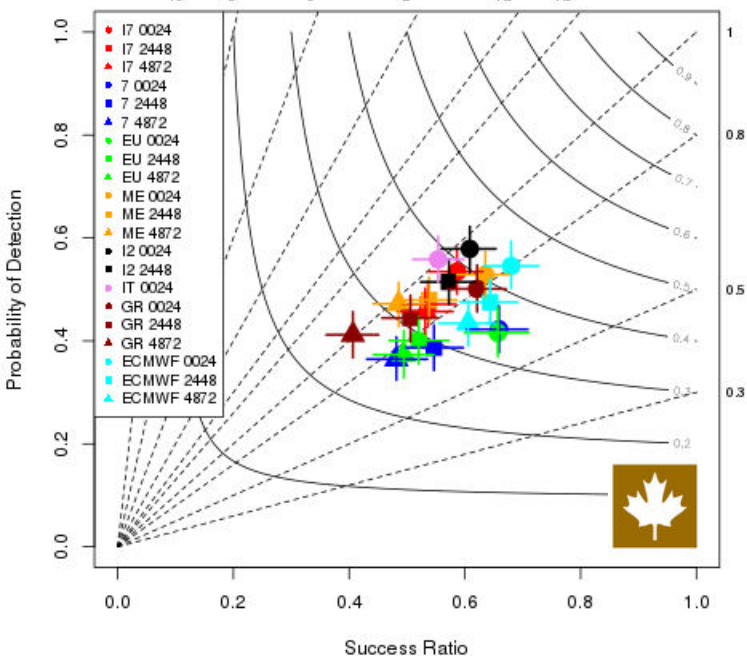
DJF 2014: Precipitation in 24h (ave) - 20.0 mm threshold



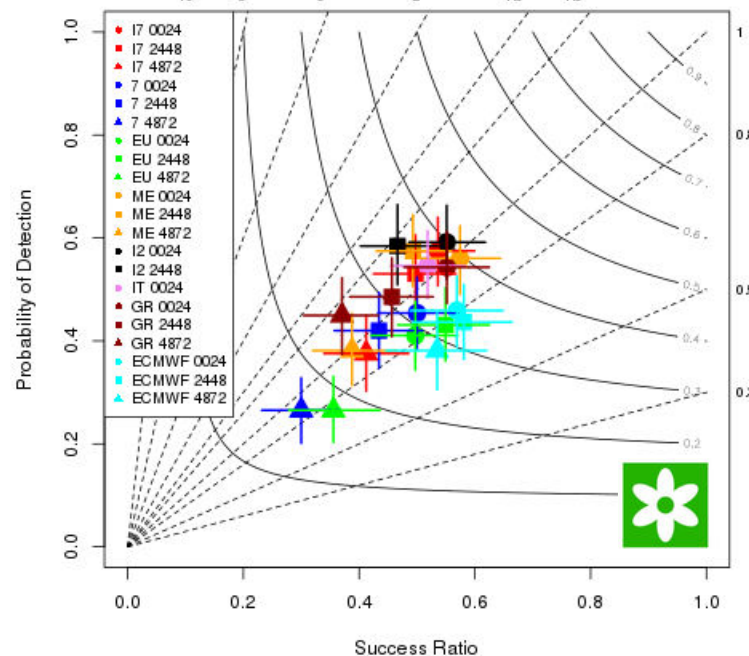
Average over area > 20 mm/24h

Good behaviour for all models
Jja13 -> low skill

SON 2013: Precipitation in 24h (ave) - 20.0 mm threshold

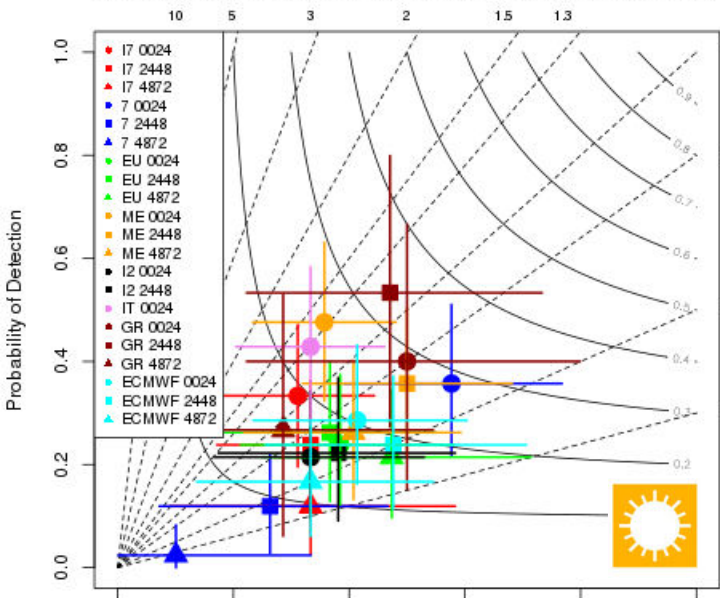


MAM 2014: Precipitation in 24h (ave) - 20.0 mm threshold

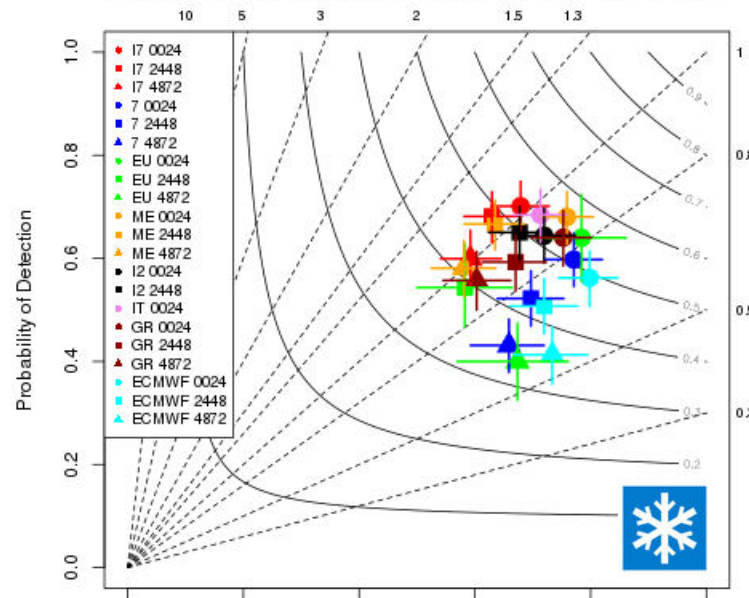


Good performance during wintertime

JJA 2013: Precipitation in 24h (ave) - 30.0 mm threshold



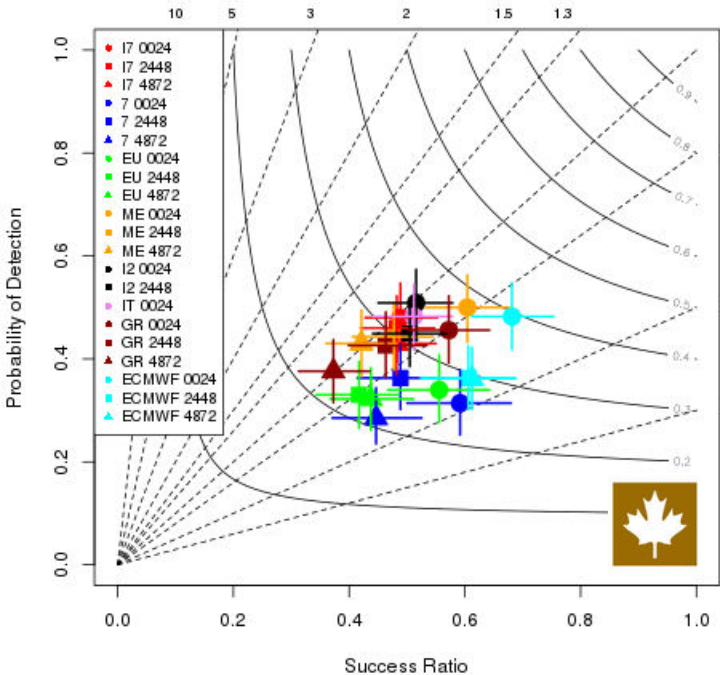
DJF 2014: Precipitation in 24h (ave) - 30.0 mm threshold



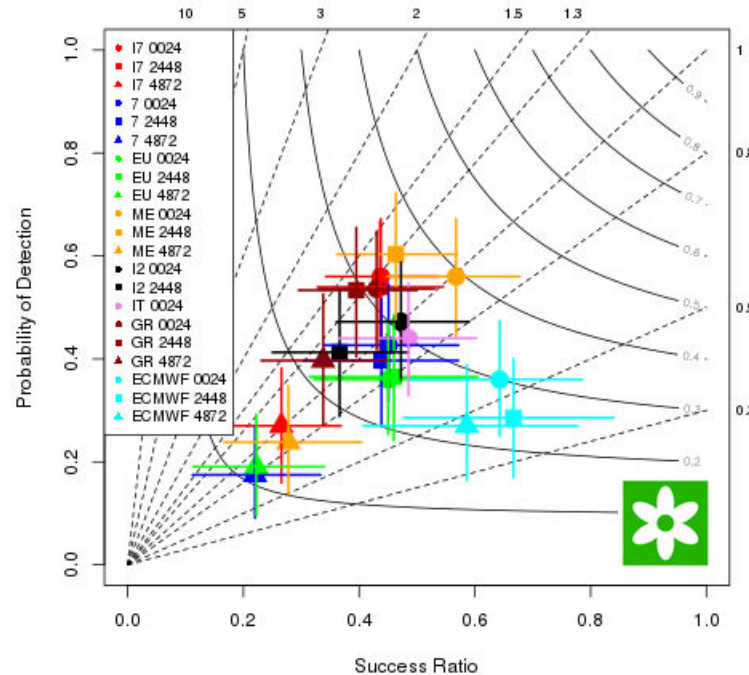
Average over area > 30 mm/24h

Jja13 and mam 14-> low skill

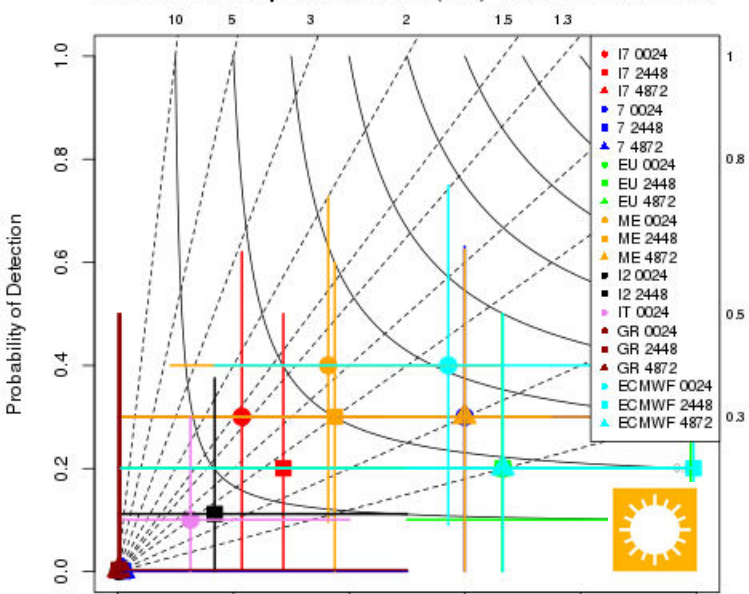
SON 2013: Precipitation in 24h (ave) - 30.0 mm threshold



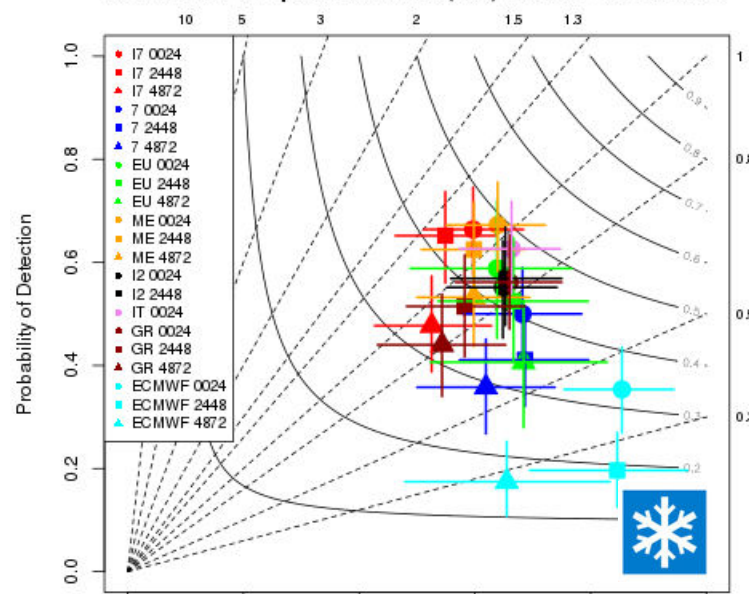
MAM 2014: Precipitation in 24h (ave) - 30.0 mm threshold



JJA 2013: Precipitation in 24h (ave) - 50.0 mm threshold

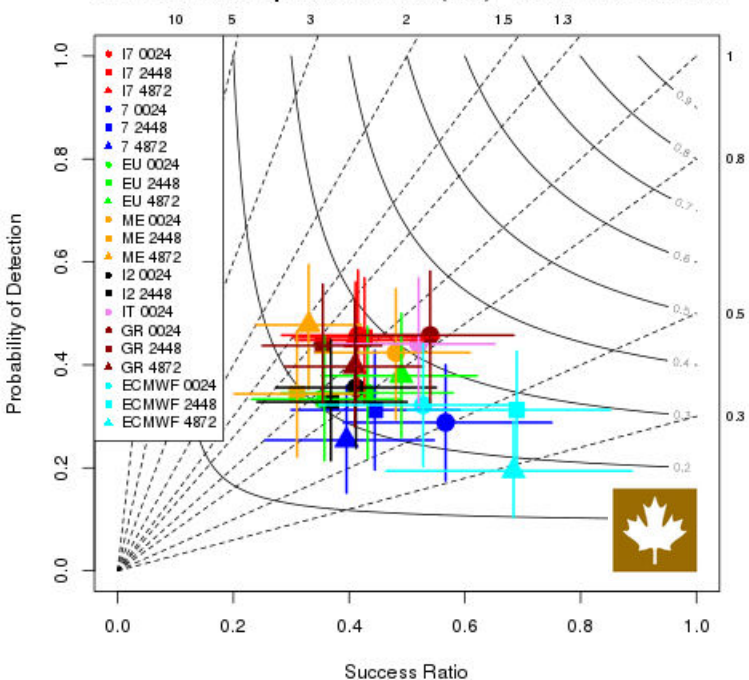


DJF 2014: Precipitation in 24h (ave) - 50.0 mm threshold

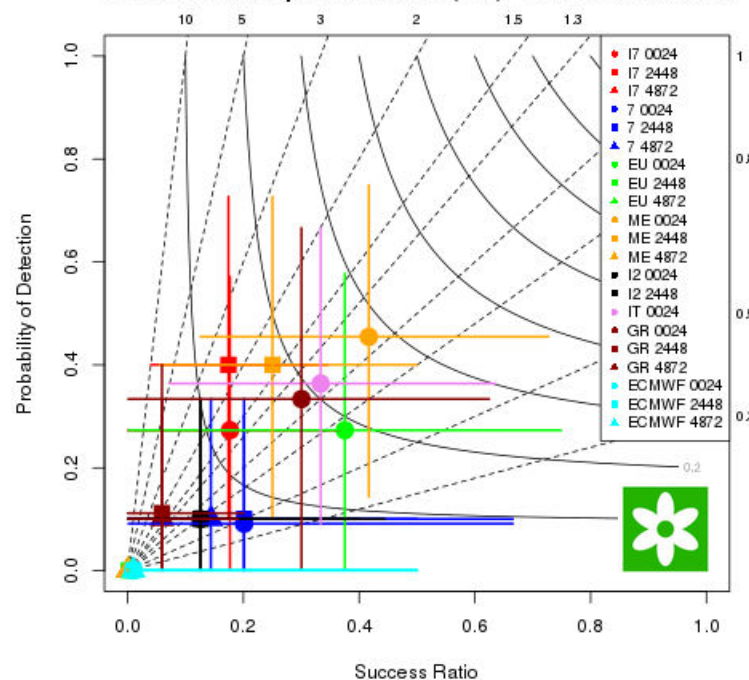


Average over area > 50 mm/24h

SON 2013: Precipitation in 24h (ave) - 50.0 mm threshold

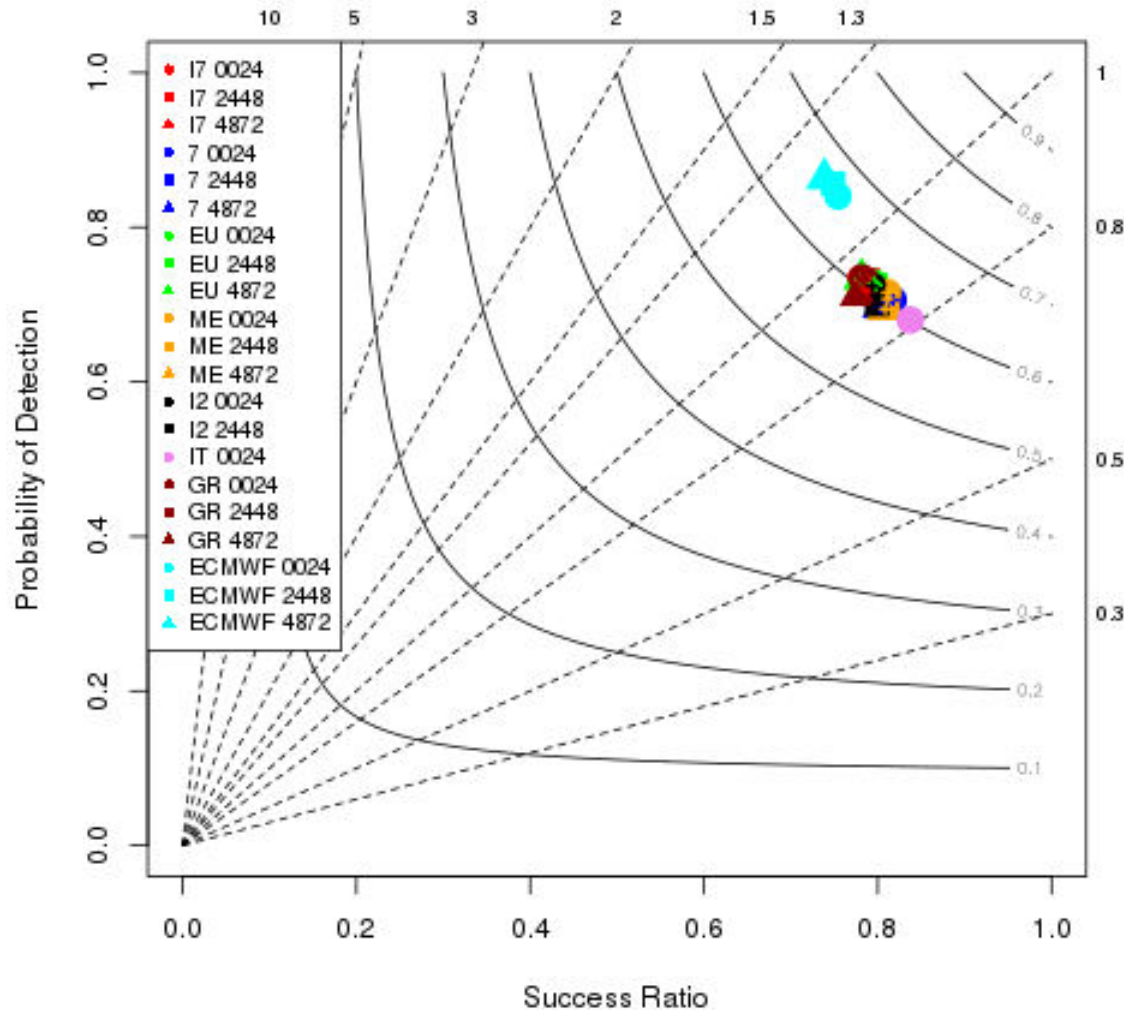


MAM 2014: Precipitation in 24h (ave) - 50.0 mm threshold



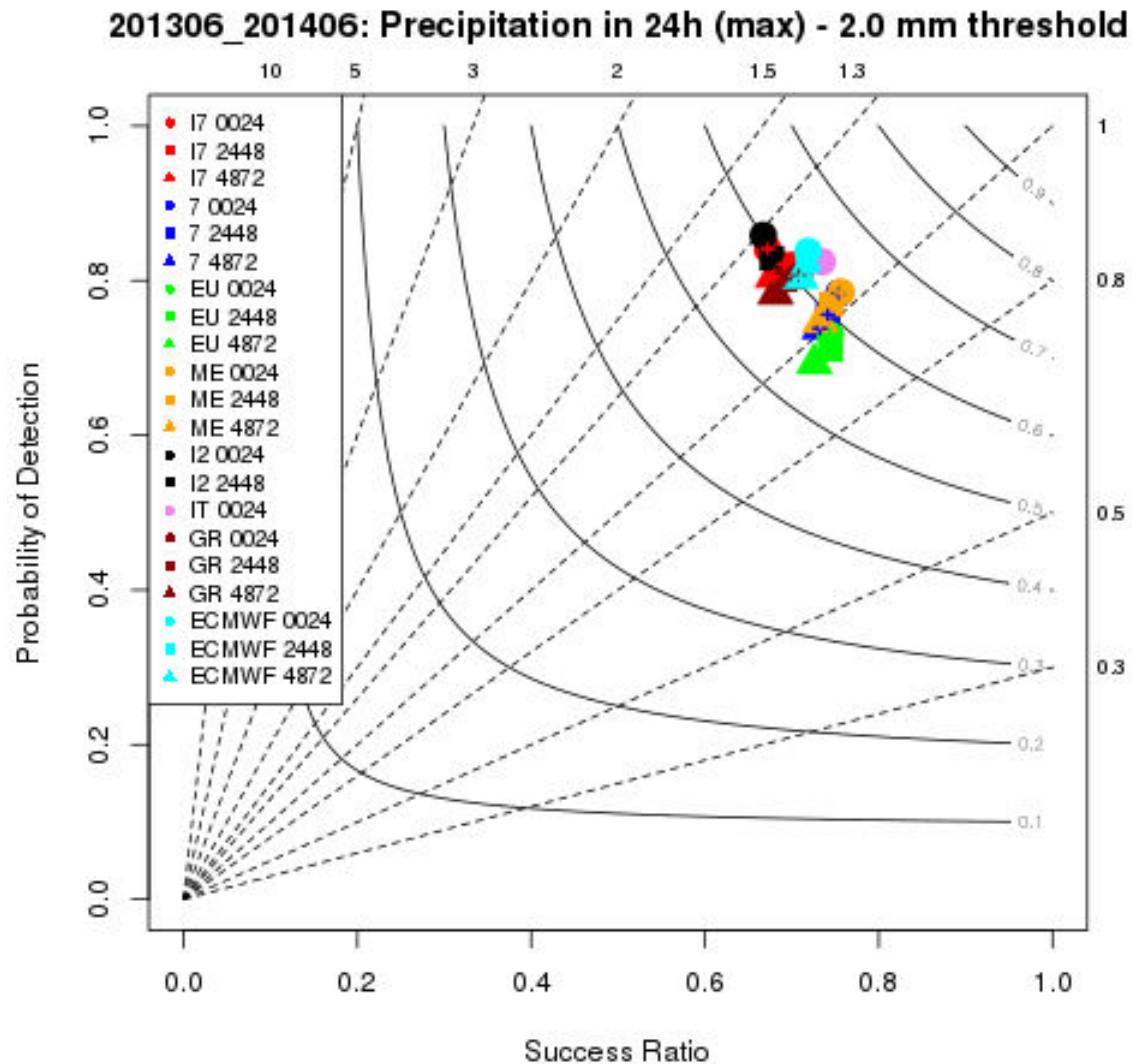
201306-201406: Maximum over area > 0.2 mm/24h

201306_201406: Precipitation in 24h (max) - 0.2 mm threshold



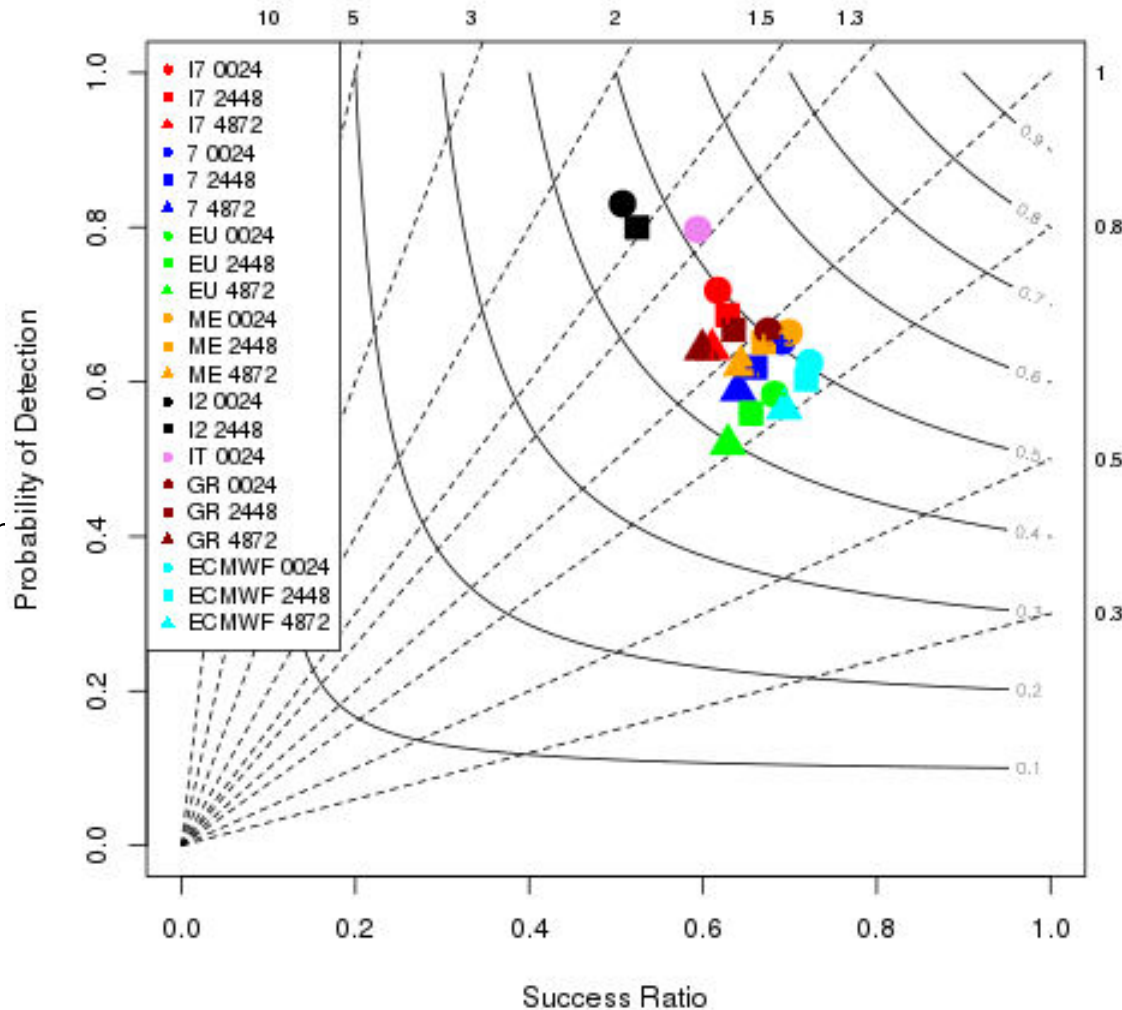
ecmwf→
overestimation
other→
underestimation/low skill

201306-201406: Maximum over area > 2 mm/24h



201306-201406: Maximum over area > 10 mm/24h

201306_201406: Precipitation in 24h (max) - 10.0 mm threshold

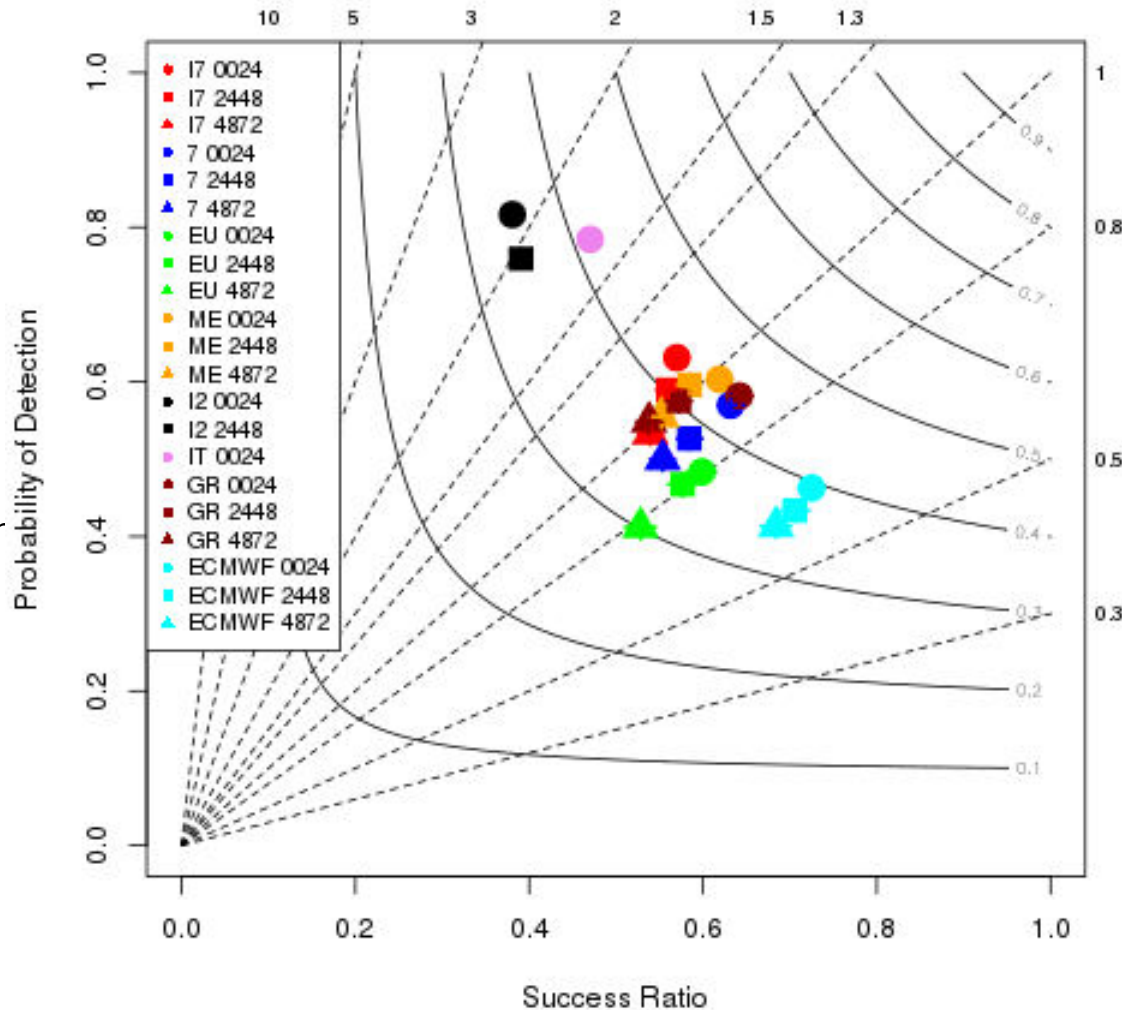


Split into 3 groups:

- 1) 2,8km overestimation
- 2) 7km around bisector
- 3) ecmwf underestimator

201306-201406: Maximum over area > 20 mm/24h

201306_201406: Precipitation in 24h (max) - 20.0 mm threshold



Split into 3 groups:

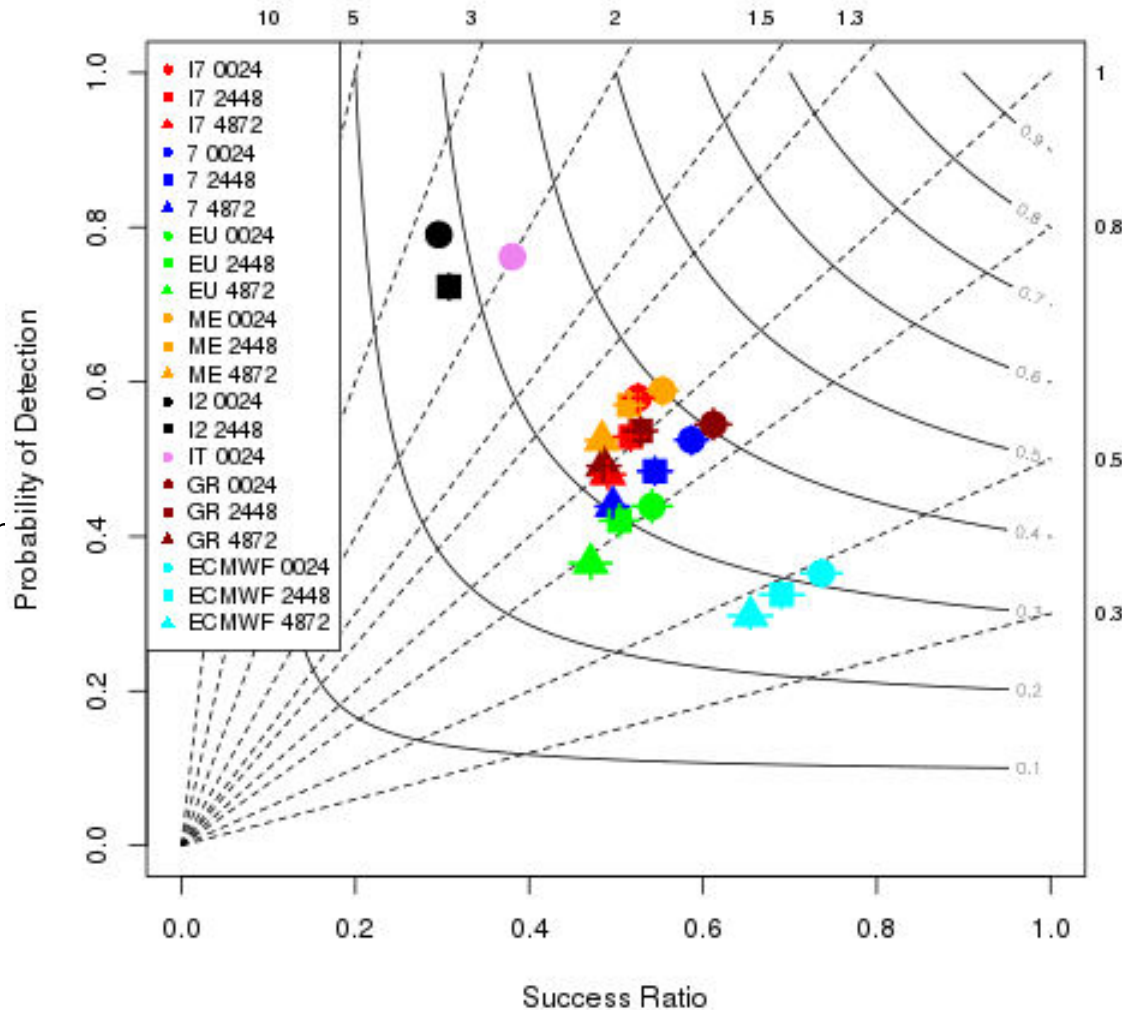
1) 2,8km overestimation

2) 7km around bisector

3) ecmwf underestimator

201306-201405: Maximum over area > 30 mm/24h

201306_201406: Precipitation in 24h (max) - 30.0 mm threshold

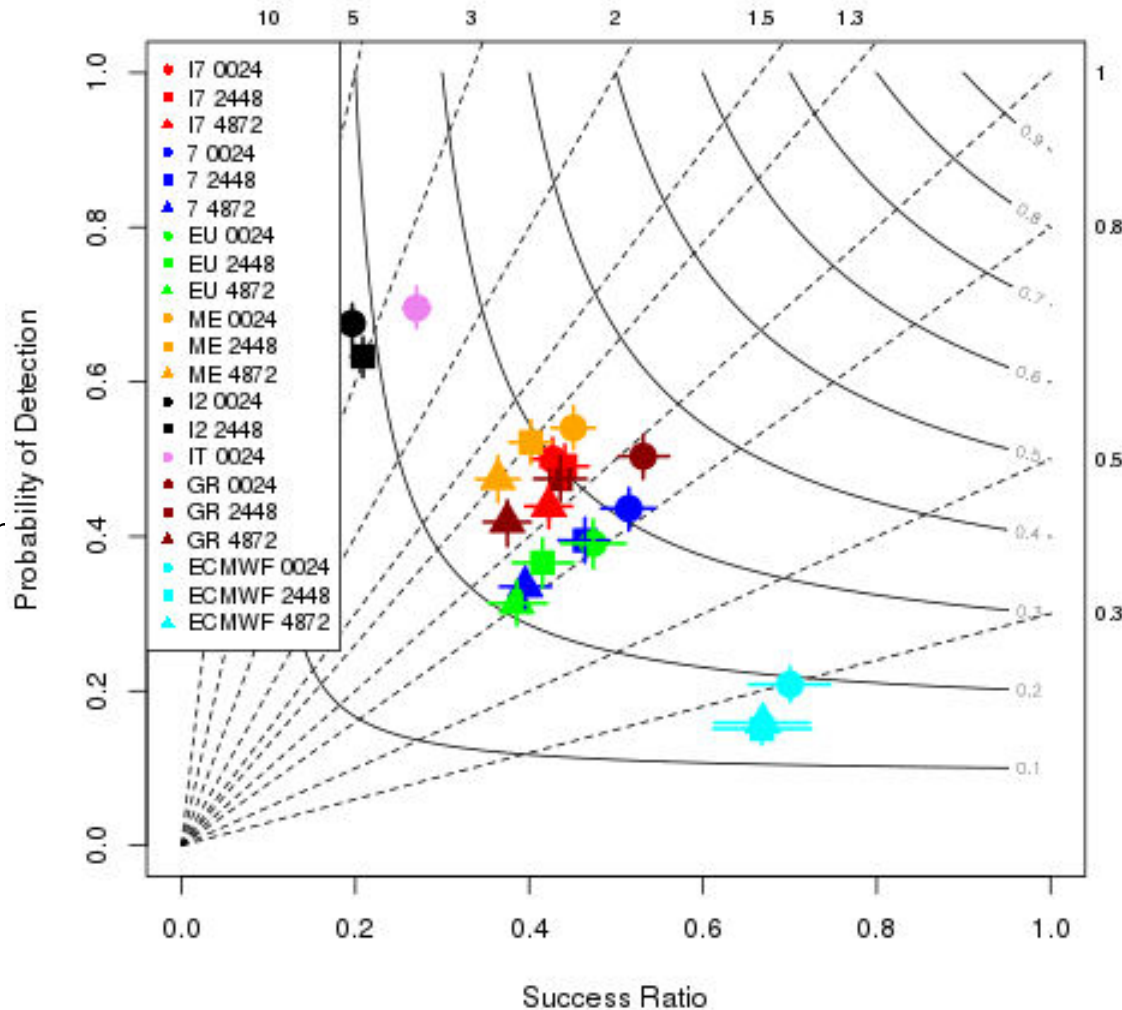


Split into 3 groups:

- 1) 2,8km overestimation
- 2) 7km around bisector
- 3) ecmwf underestimator

201306-201406: Maximum over area > 50 mm/24h

201306_201406: Precipitation in 24h (max) - 50.0 mm threshold



Splitted into 3 groups:
1) 2,8km overestimation
2) 7km around bisector
3) ecmwf underestimator

You are a decision maker

C/L ratio model (Richardson)



Expense matrix

	Event occurs	Event does not occur
Action taken	C	C
Action not taken	L	0

No forecast info

$$E_{\text{always}} = C$$

$$E_{\text{never}} = sL, s = \text{climatological base rate}$$

$E_{\text{always}} < E_{\text{never}} \rightarrow \text{action}$
 $E_{\text{always}} > E_{\text{never}} \rightarrow \text{no action}$

Optimal strategy = mean expense = minimise losses

Perfect forecast

$$E_{\text{perfect}} = sC$$

$$E_{\text{climate}} = \min(C, sL)$$

$$V \text{ of forecast system} = (E_{\text{climate}} - E_{\text{forecast}}) / (E_{\text{climate}} - E_{\text{perfect}})$$

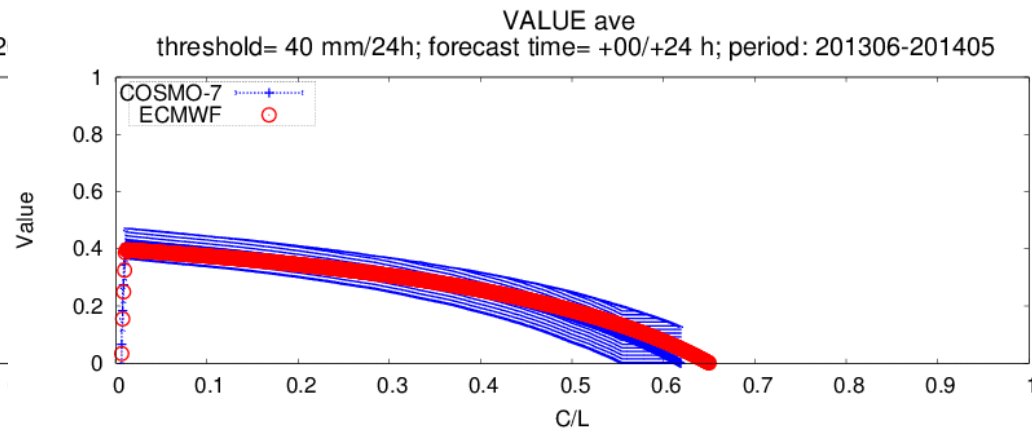
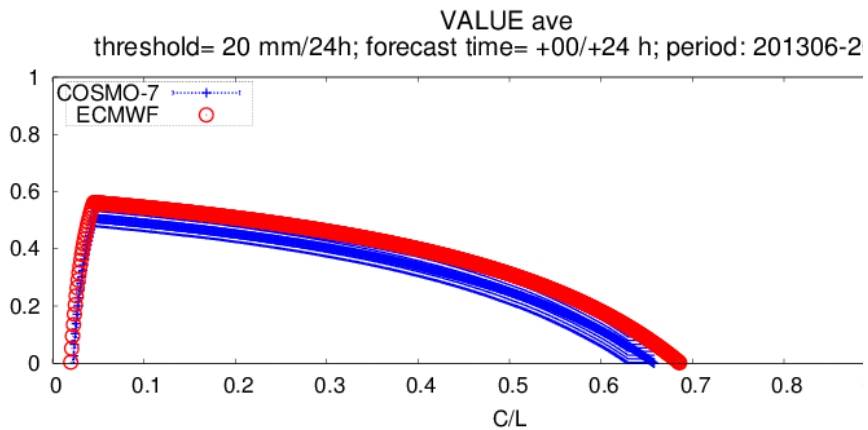
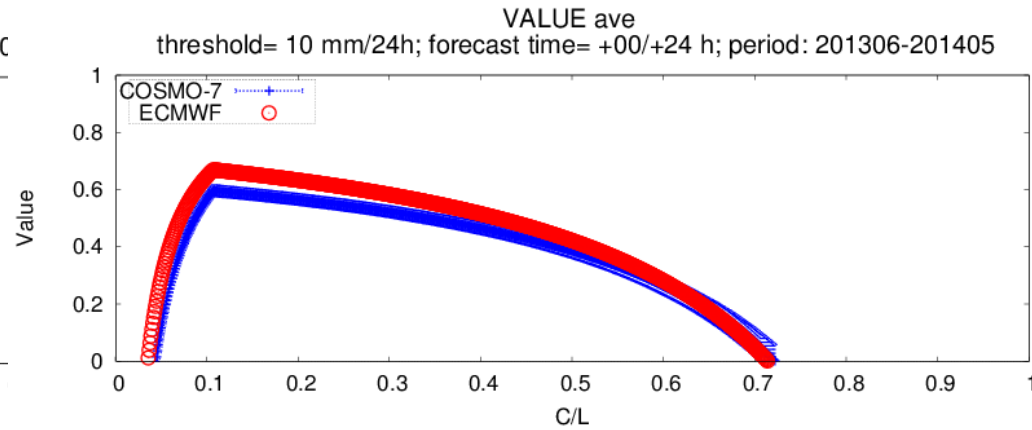
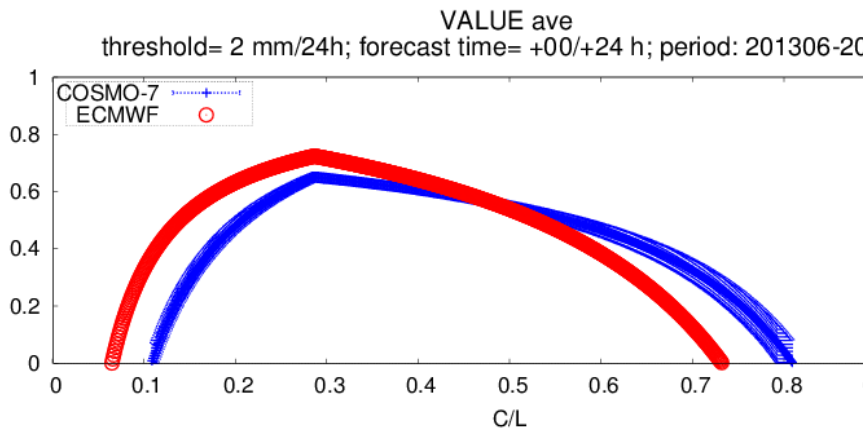
A maximum value is when the system perfectly forecasts the future. If $V > 0$ the decision maker will gain economic benefit by using forecast info in addition to climatology.

$$V_{\text{relative}} = [\min(C/L, s) - F(1-s)C/L + Hs(1 - C/L) - s] / [\min(C/L, s) - sC/L], s = a+c \text{ (base rate)}$$

V relative depends on quality of system, observed base rate and user's C/L

ECMWF/COSMO7

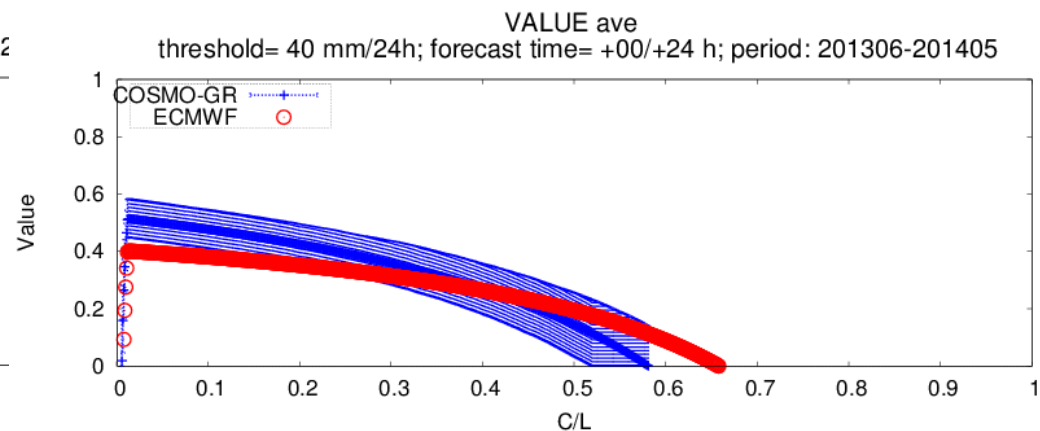
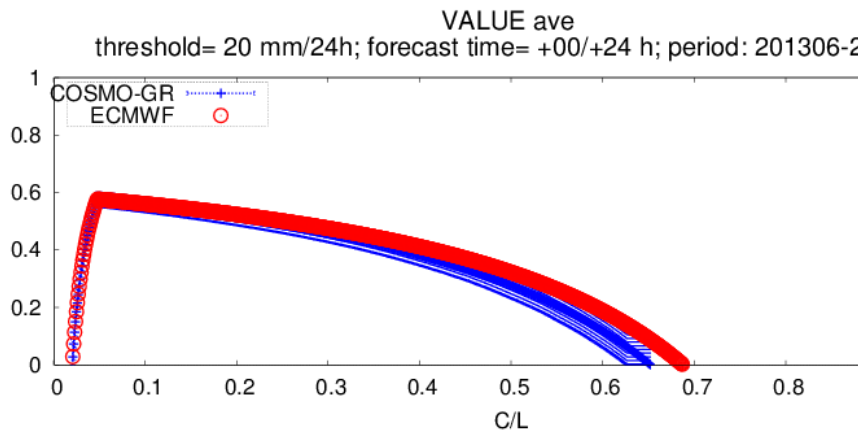
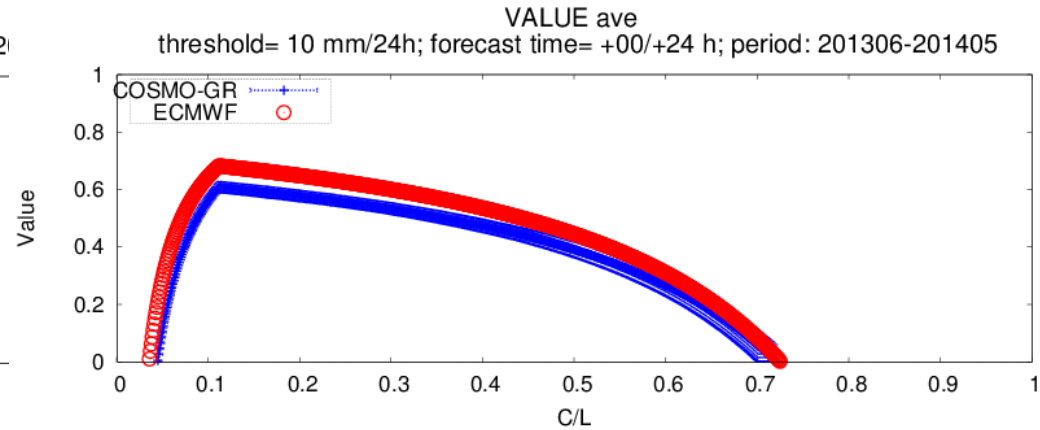
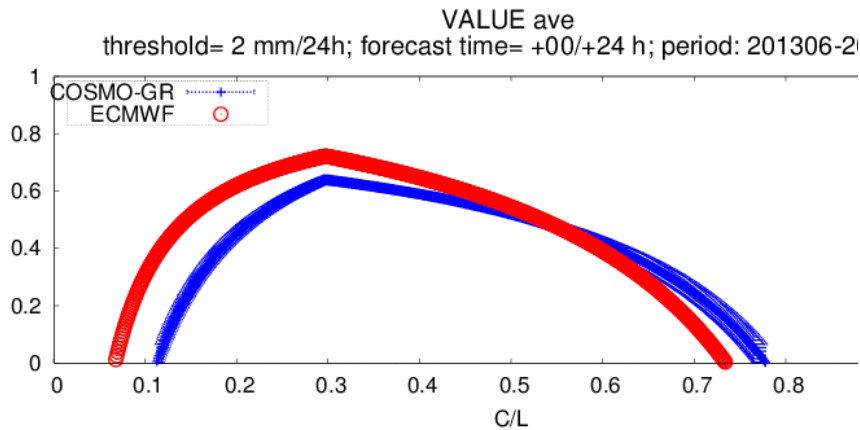
- For low thresholds → higher value for ecm for low C/L ratio, higher value COSMO7 for high C/L ratio
- For high thresholds → same value (or slightly better ecm)



Thanks to M.Milelli for the graphs

ECMWF/COSMOGR

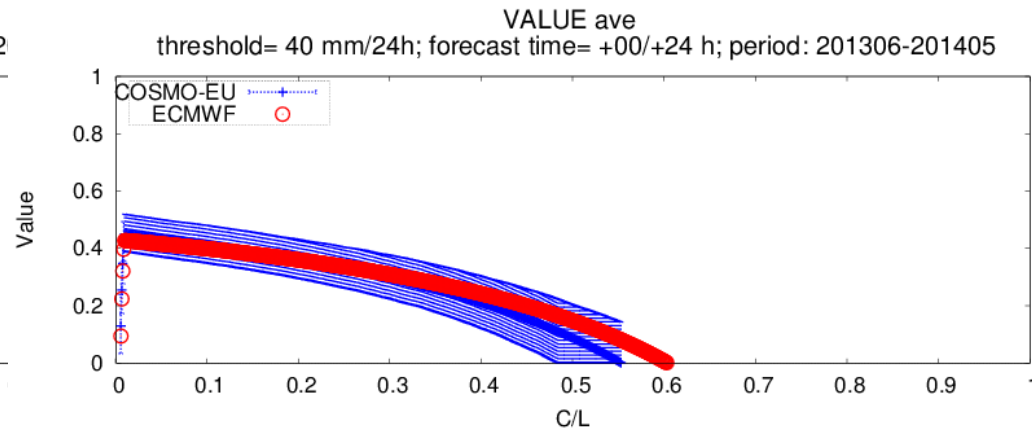
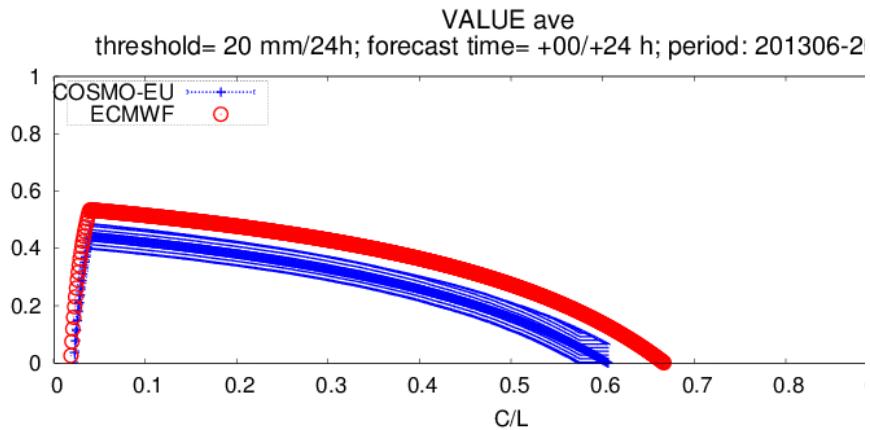
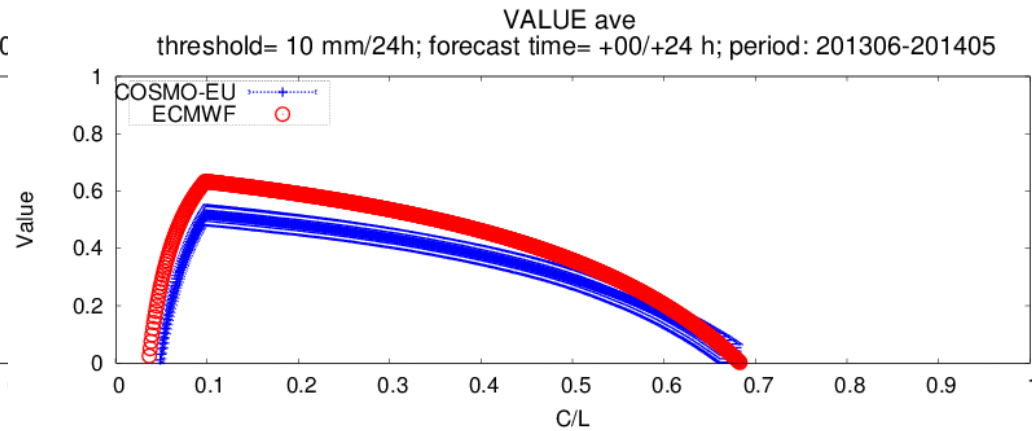
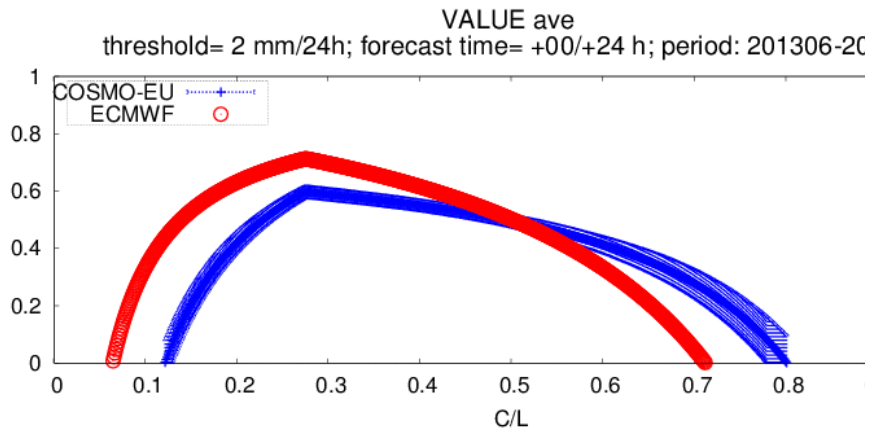
- For low thresholds → higher value for ecm for low C/L ratio, higher value COSMOGR for high C/L ratio
- For medium thresholds → higher value for ecm
- For high thresholds → equivalent or best COSMOGR



Thanks to M.Milelli for the graphs

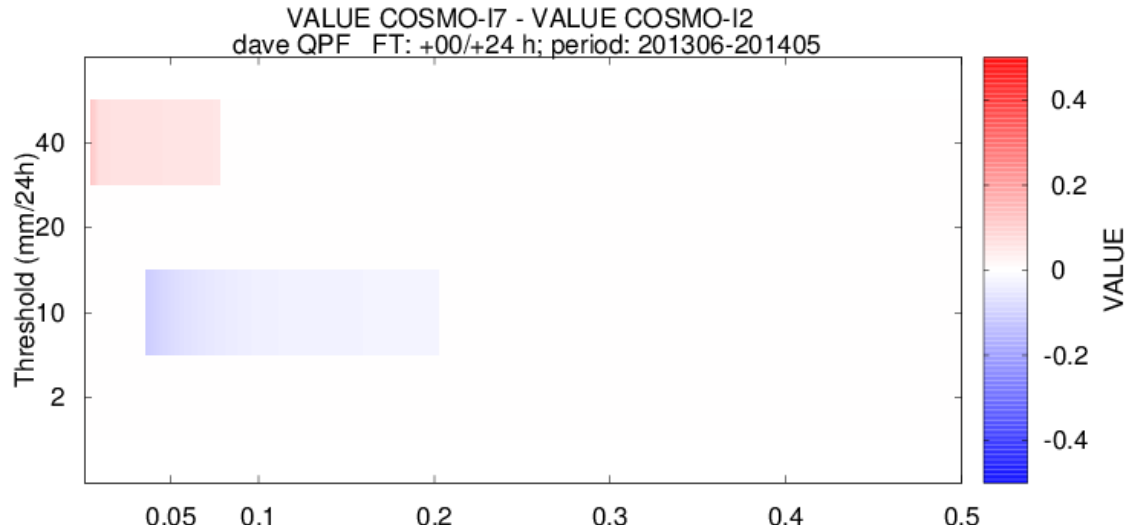
ECMWF/COSMOEU

- For low thresholds → higher value for ecm for low C/L ratio, higher value COSMOEU for high C/L ratio
- For medium thresholds → higher value for ecm
- For high thresholds → equivalent

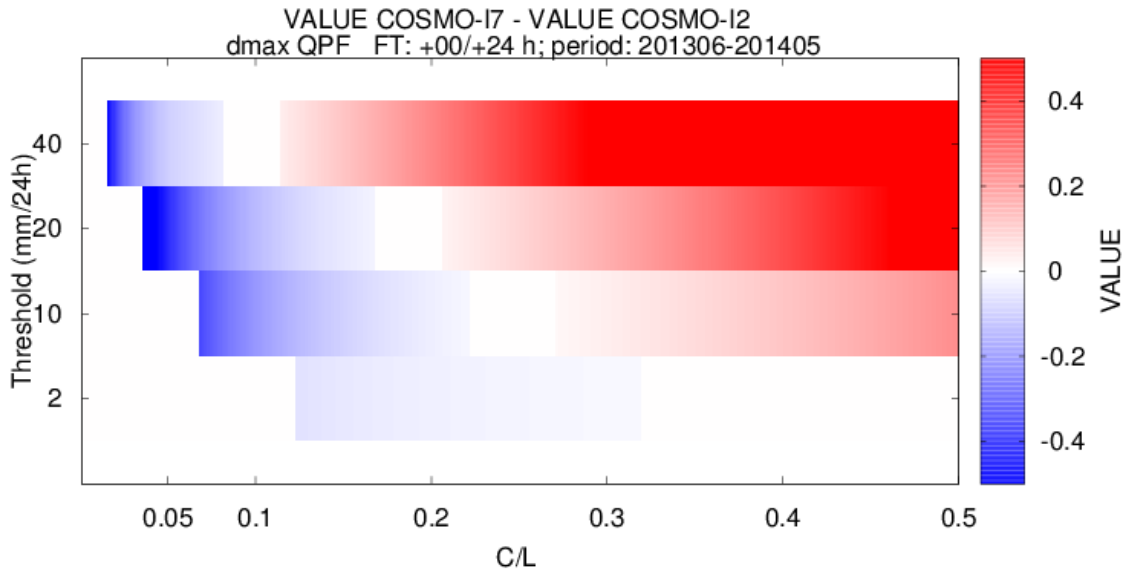


Thanks to M.Milelli for the graphs

COSMOI7/COSMOI2



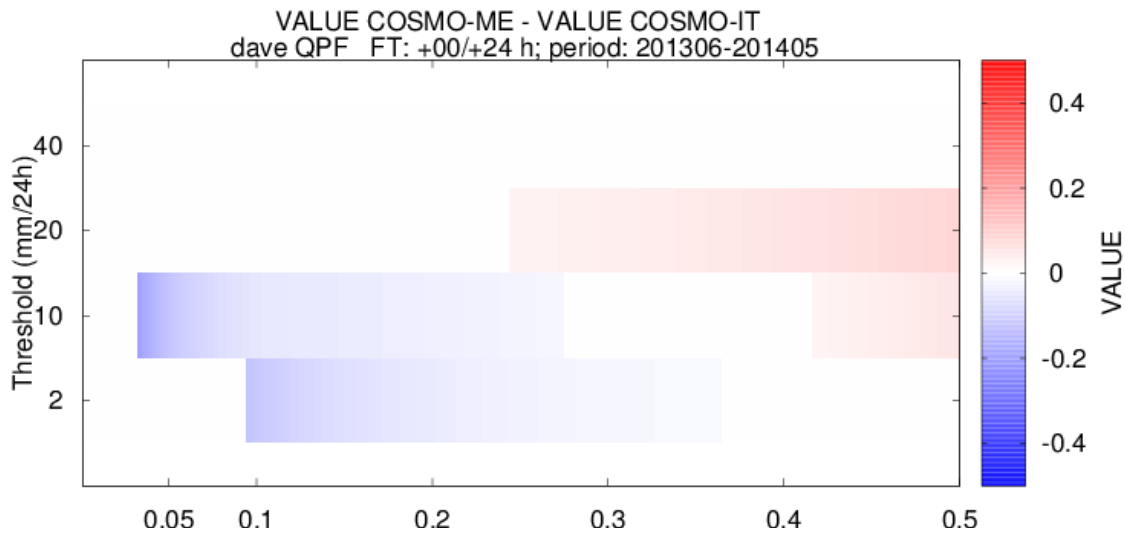
VALUE
difference
Mean
average over
areas



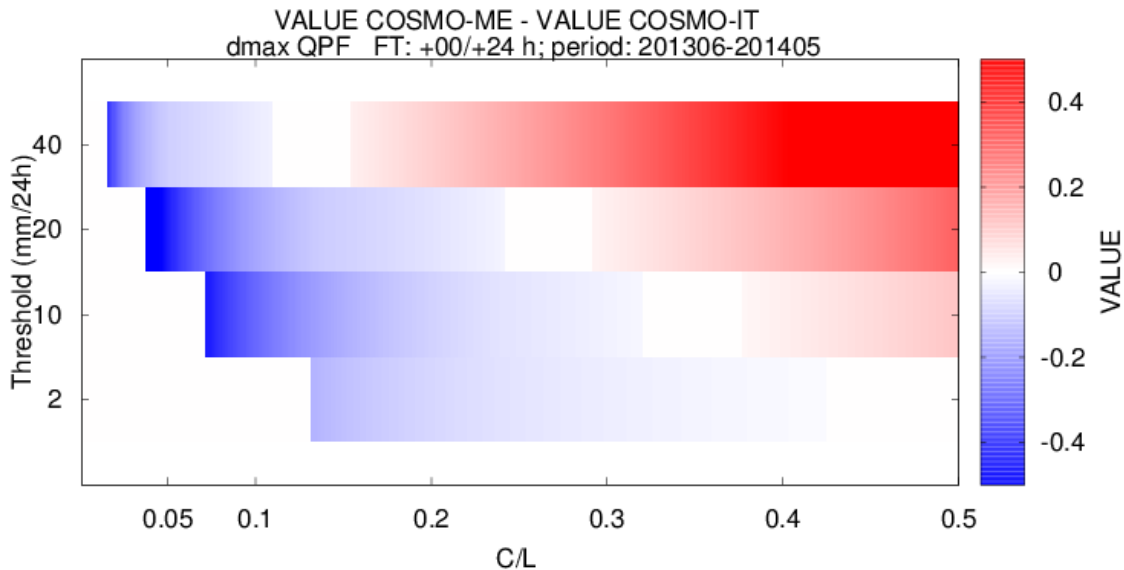
VALUE
difference
maximum
average over
areas

Thanks to M.Milelli for the graphs

COSMOME/COSMOIT



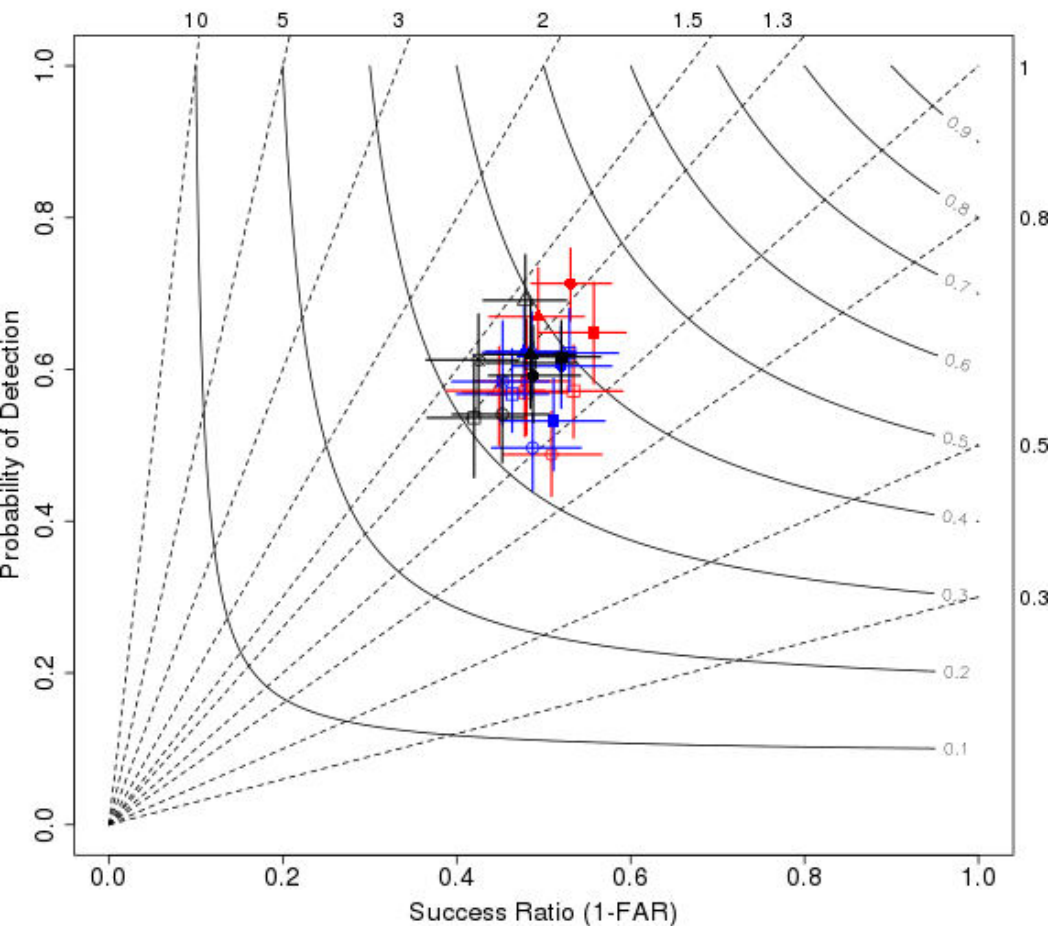
VALUE
difference
Mean
average over
areas



VALUE
difference
maximum
average over
areas

Thanks to M.Milelli for the graphs

med-max > 0.5-5 mm/24h



**3h verification over
North Italy- SON13**

**COSMO1CH-COSMOI7-
COSMOI2**

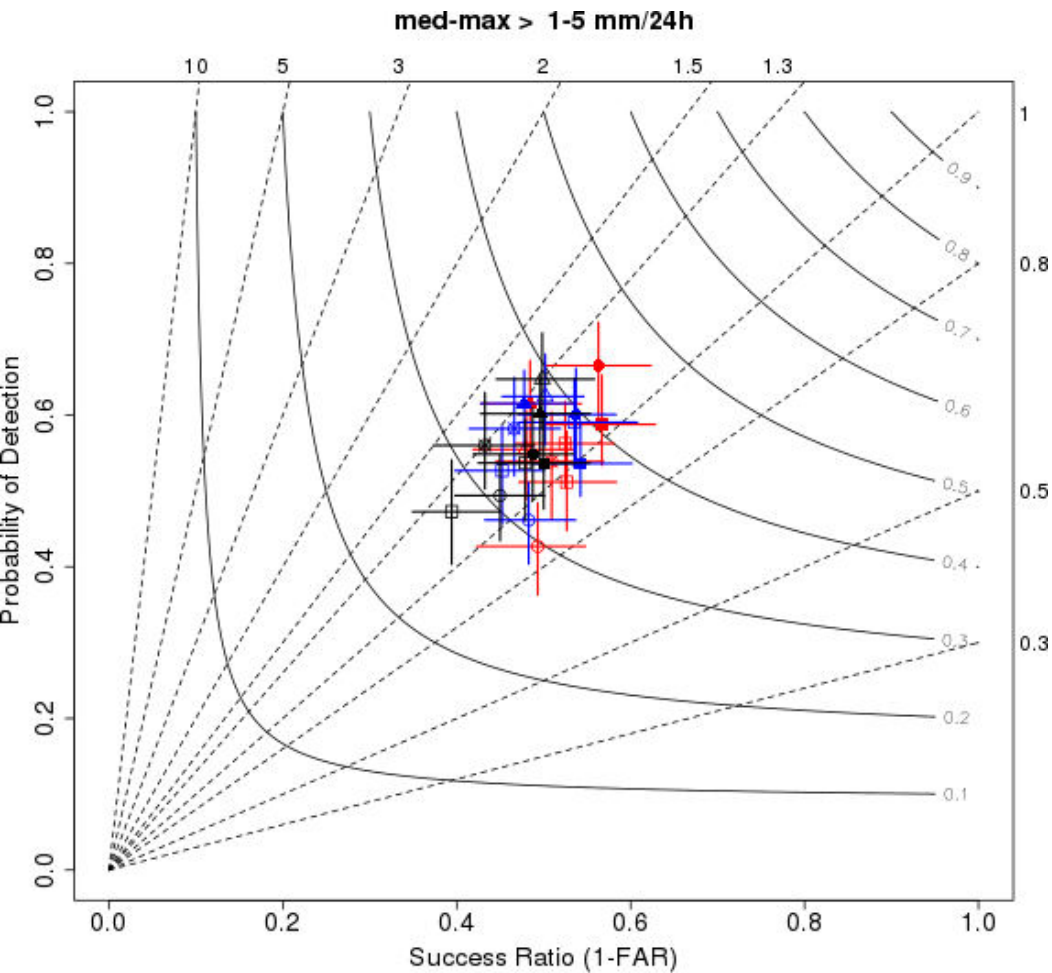
Median 0.5 mm/3h
Maximum 5 mm/3h

3h precipitation verification →
operative purpose

How the maximum values are
linked to the model resolution?

How is the model capability to
produce maximum peaks inside
a certain precipitation pattern?

- | | | |
|------------------------|-----------------------|-----------------------|
| ■ COSMO1CH_00 -fc + 3 | ■ COSMO17_00 -fc + 3 | ■ COSMO12_00 -fc + 3 |
| ■ COSMO1CH_00 -fc + 6 | ■ COSMO17_00 -fc + 6 | ■ COSMO12_00 -fc + 6 |
| ■ COSMO1CH_00 -fc + 9 | ■ COSMO17_00 -fc + 9 | ■ COSMO12_00 -fc + 9 |
| ■ COSMO1CH_00 -fc + 12 | ■ COSMO17_00 -fc + 12 | ■ COSMO12_00 -fc + 12 |
| ■ COSMO1CH_00 -fc + 15 | ■ COSMO17_00 -fc + 15 | ■ COSMO12_00 -fc + 15 |
| ■ COSMO1CH_00 -fc + 18 | ■ COSMO17_00 -fc + 18 | ■ COSMO12_00 -fc + 18 |
| ■ COSMO1CH_00 -fc + 21 | ■ COSMO17_00 -fc + 21 | ■ COSMO12_00 -fc + 21 |

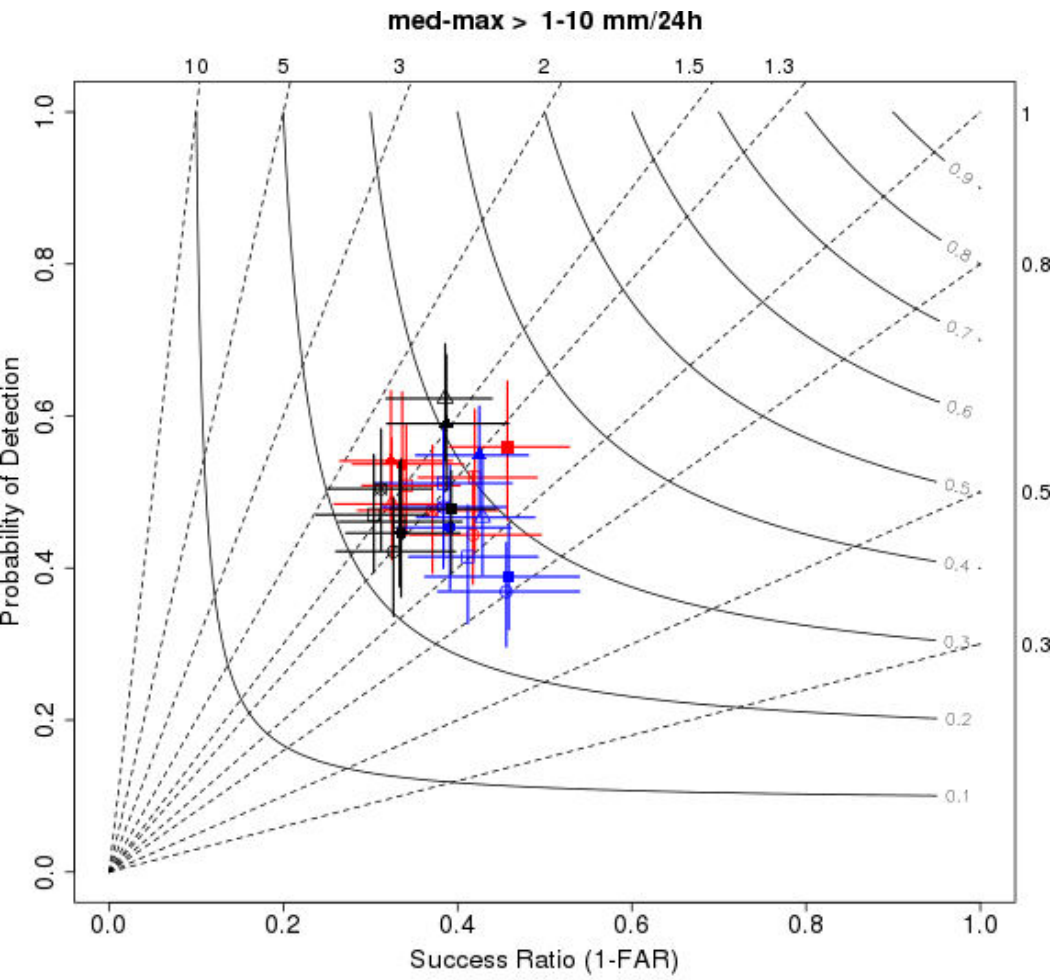


**3h verification over
North Italy- SON13**

**COSMO1CH-COSMOI7-
COSMOI2**

Median 1 mm/3h
Maximum 5 mm/3h

- | | | |
|------------------------|------------------------|------------------------|
| ■ COSMO1CH_00 -fc + 3 | ■ COSMO-I7_00 -fc + 3 | ■ COSMO-I2_00 -fc + 3 |
| ■ COSMO1CH_00 -fc + 6 | ■ COSMO-I7_00 -fc + 6 | ■ COSMO-I2_00 -fc + 6 |
| ■ COSMO1CH_00 -fc + 9 | ■ COSMO-I7_00 -fc + 9 | ■ COSMO-I2_00 -fc + 9 |
| ■ COSMO1CH_00 -fc + 12 | ■ COSMO-I7_00 -fc + 12 | ■ COSMO-I2_00 -fc + 12 |
| ■ COSMO1CH_00 -fc + 15 | ■ COSMO-I7_00 -fc + 15 | ■ COSMO-I2_00 -fc + 15 |
| ■ COSMO1CH_00 -fc + 18 | ■ COSMO-I7_00 -fc + 18 | ■ COSMO-I2_00 -fc + 18 |
| ■ COSMO1CH_00 -fc + 21 | ■ COSMO-I7_00 -fc + 21 | ■ COSMO-I2_00 -fc + 21 |



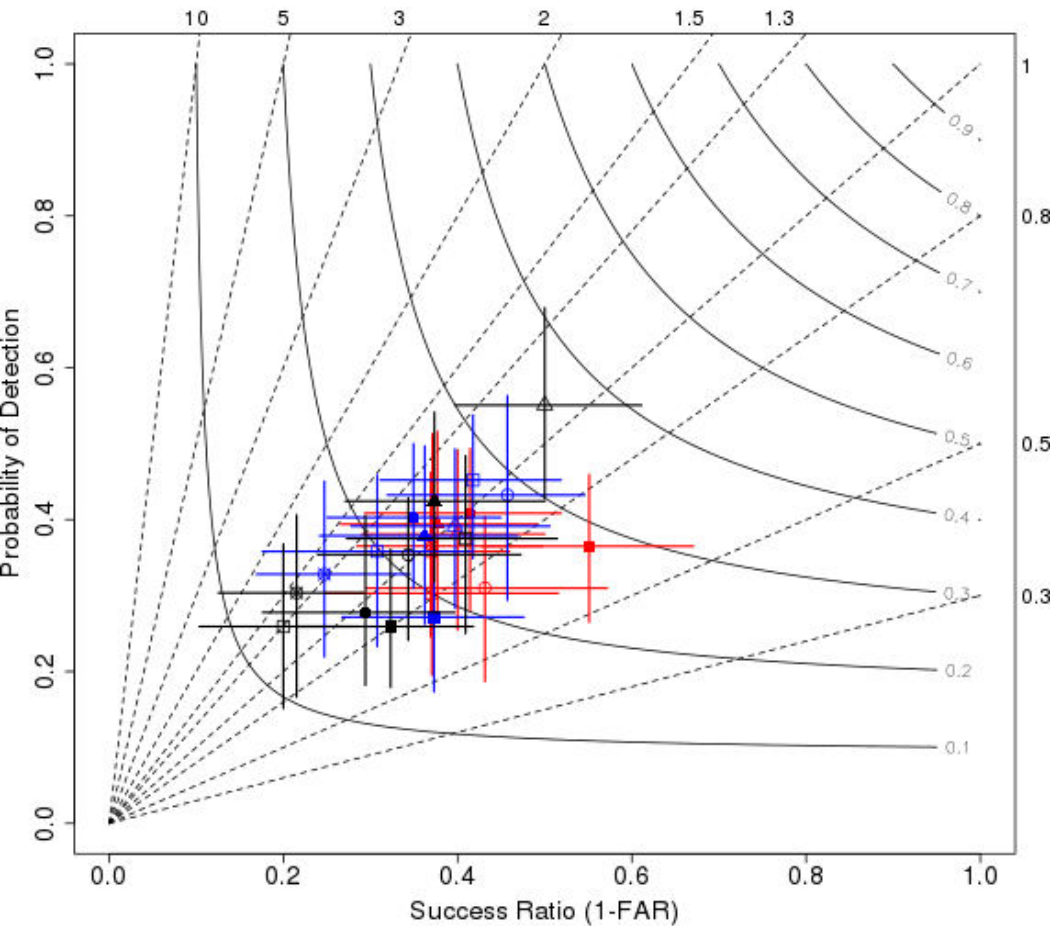
**3h verification over
North Italy- SON13**

**COSMO1CH-COSMOI7-
COSMOI2**

Median 1 mm/3h
Maximum 10 mm/3h

- | | | |
|------------------------|------------------------|------------------------|
| ■ COSMO1CH_00 -fc + 3 | ■ COSMO-17_00 -fc + 3 | ■ COSMO-12_00 -fc + 3 |
| ■ COSMO1CH_00 -fc + 6 | ■ COSMO-17_00 -fc + 6 | ■ COSMO-12_00 -fc + 6 |
| ▲ COSMO1CH_00 -fc + 9 | ▲ COSMO-17_00 -fc + 9 | ▲ COSMO-12_00 -fc + 9 |
| ■ COSMO1CH_00 -fc + 12 | ■ COSMO-17_00 -fc + 12 | ■ COSMO-12_00 -fc + 12 |
| □ COSMO1CH_00 -fc + 15 | □ COSMO-17_00 -fc + 15 | □ COSMO-12_00 -fc + 15 |
| ○ COSMO1CH_00 -fc + 18 | ○ COSMO-17_00 -fc + 18 | ○ COSMO-12_00 -fc + 18 |
| △ COSMO1CH_00 -fc + 21 | △ COSMO-17_00 -fc + 21 | △ COSMO-12_00 -fc + 21 |

med-max > 5-10 mm/24h



**3h verification over
North Italy- SON13**

**COSMO1CH-COSMO17-
COSMO12**

Median 5 mm/3h
Maximum 10 mm/3h

- | | | |
|------------------------|------------------------|------------------------|
| ■ COSMO1CH_00 -fc + 3 | ■ COSMO-17_00 -fc + 3 | ■ COSMO-12_00 -fc + 3 |
| ■ COSMO1CH_00 -fc + 6 | ■ COSMO-17_00 -fc + 6 | ■ COSMO-12_00 -fc + 6 |
| ■ COSMO1CH_00 -fc + 9 | ■ COSMO-17_00 -fc + 9 | ■ COSMO-12_00 -fc + 9 |
| ■ COSMO1CH_00 -fc + 12 | ■ COSMO-17_00 -fc + 12 | ■ COSMO-12_00 -fc + 12 |
| ■ COSMO1CH_00 -fc + 15 | ■ COSMO-17_00 -fc + 15 | ■ COSMO-12_00 -fc + 15 |
| ■ COSMO1CH_00 -fc + 18 | ■ COSMO-17_00 -fc + 18 | ■ COSMO-12_00 -fc + 18 |
| ■ COSMO1CH_00 -fc + 21 | ■ COSMO-17_00 -fc + 21 | ■ COSMO-12_00 -fc + 21 |