Operational verification in Italy

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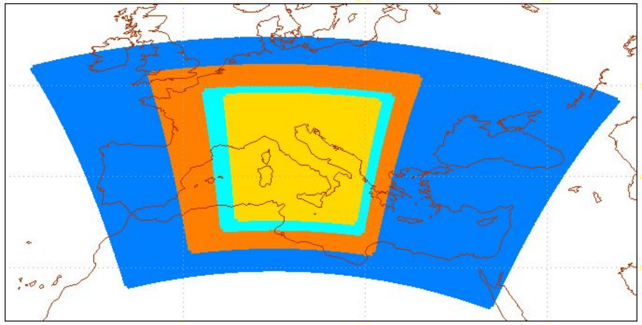
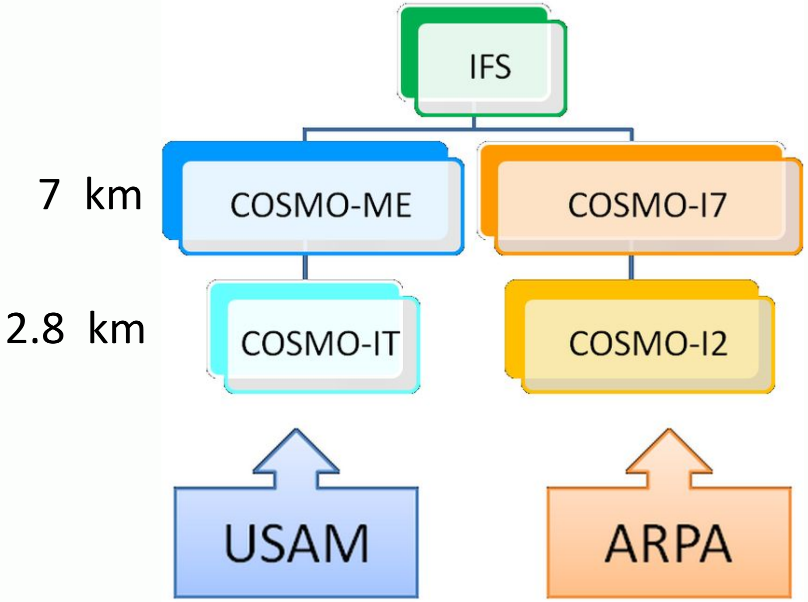
Overview

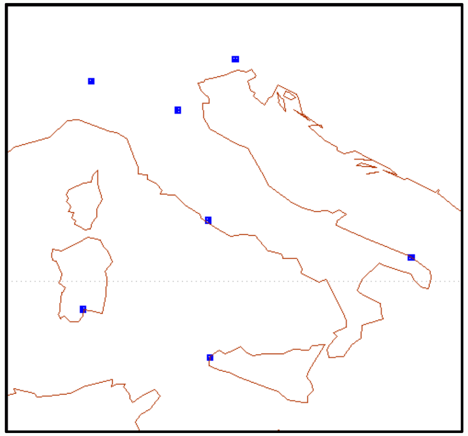




- **Verification using VERSUS (CNMCA & *ARPA-ER*)**
  - Standard : T 2m, Td 2m, MSLP, WIND 10m, TCC
  - Upper air : T , WIND
  - Conditional:
    T & TCC (obs) & Wind Speed
    Td & WIND speed
- **Precipitation using High-Res Rain-gauges (ARPA-P)**
  - Comparison of COSMO models over Italian territory

Summary

- Upper Air verification: Temperature, Wind Speed
  - COSMO-I7 , COSMO-ME
- Total Cloud Cover:
  - COSMO-I7 , COSMO-I7 / ECMWF,
    (COSMO-I7 / ECMWF /COSMO-I2 for MAM2012)
  - COSMO-ME ,COSMO-ME / ECMWF , COSMO-ME / COSMO-IT
- Mean Sea Level pressure and 10 m Wind:
  - COSMO-I7 , COSMO-I7 / ECMWF
  - COSMO-ME ,COSMO-ME / ECMWF , COSMO-ME / COSMO-IT
- 2m Temperature and Dew Point Temperature:
  - COSMO-I7 , COSMO-I7 / ECMWF
  - COSMO-ME ,COSMO-ME / ECMWF , COSMO-ME / COSMO-IT
  - COSMO-ME conditional verification
- Precipitation:
  - Long trend
  - Cosmo models inter-comparison



Italian radio-sounding stations

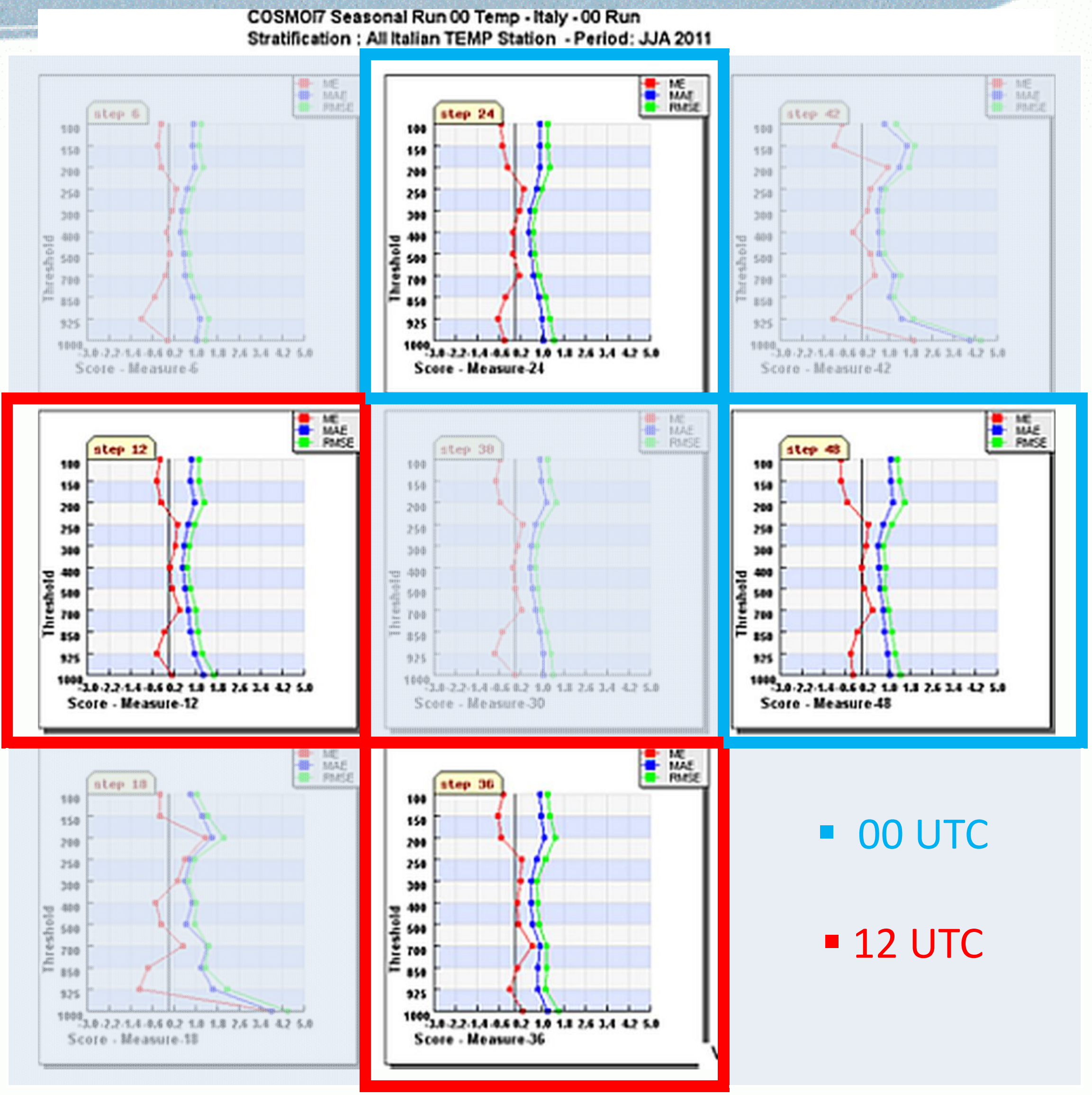
Upper air

TEMPERATURE

only few of them do soundings at 6 and 18 UTC
so we focus on verification of mainly 00 and 12 UTC

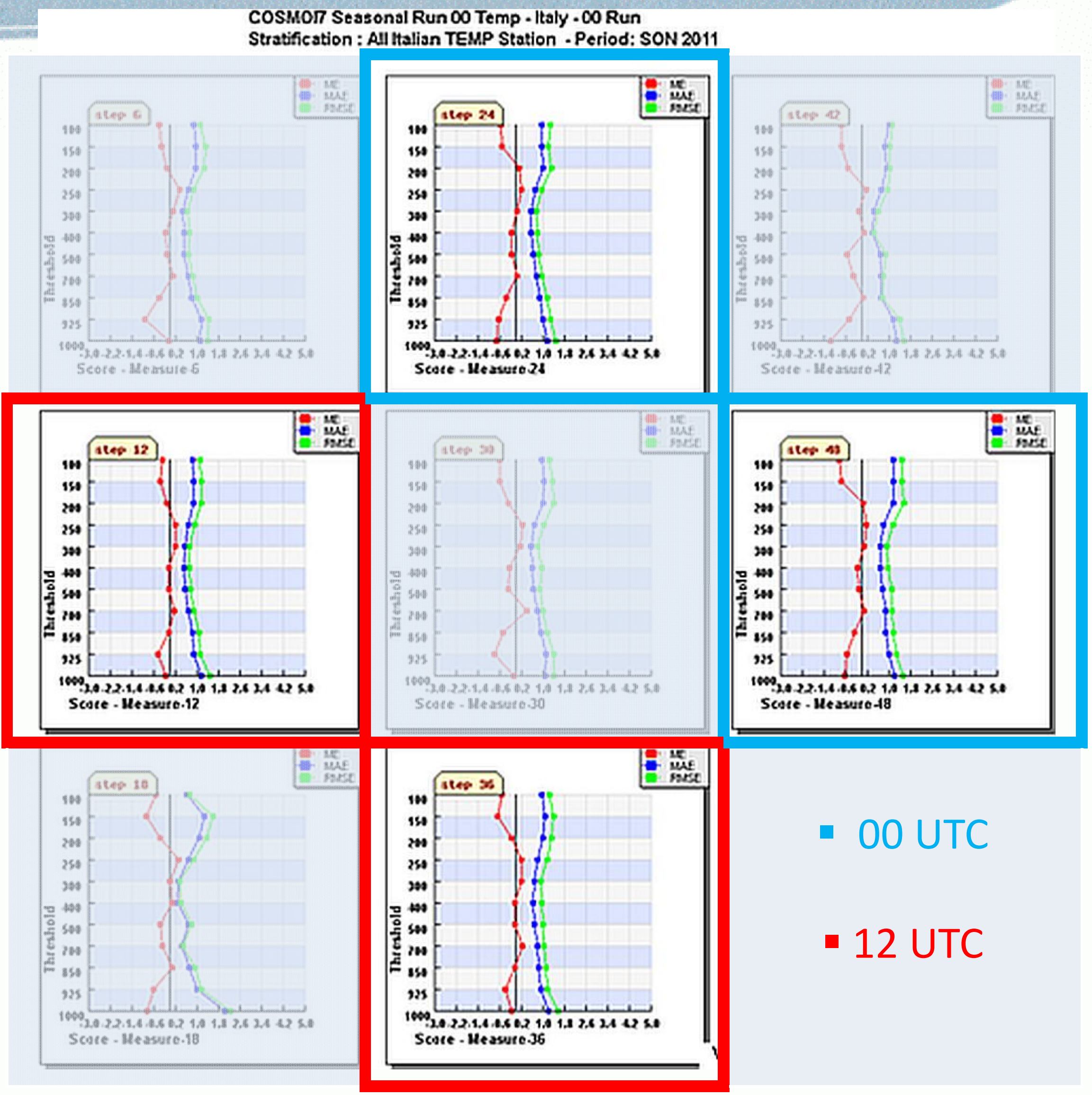
Upper Air Temperature
COSMO-I7
JJA 2011

- *underestimation above 250 hPa*
- *nearly no bias from 250 hPa to 700 hPa with lower MAE & RMSE*
- *overestimation at 700 hPa increasing with the forecast time*
- *underestimation under 700 hPa in particular at 00 UTC*



Upper Air Temperature
COSMO-I7
SON 2011

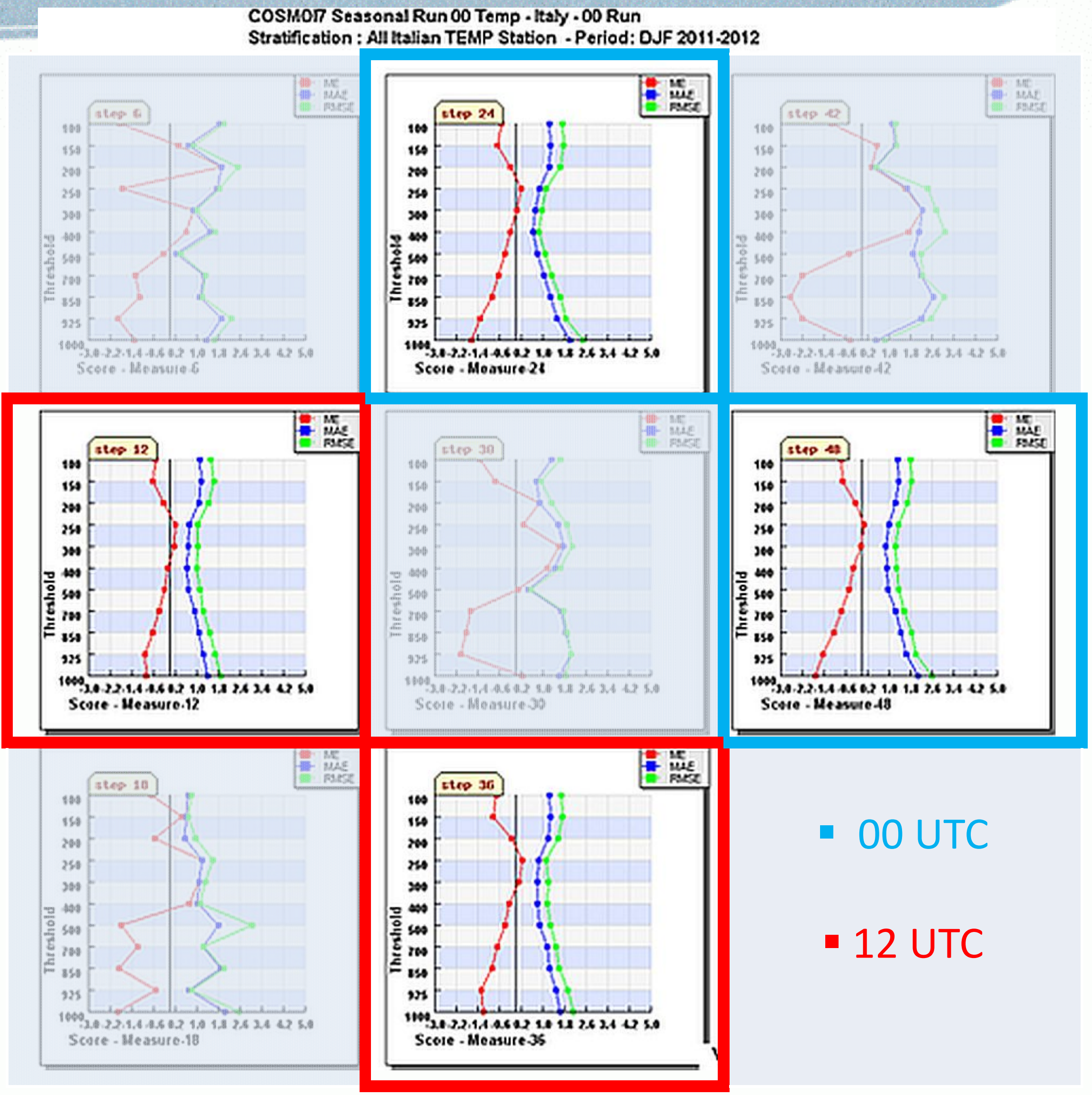
- similar to JJA but at the lower level the underestimation is bigger at 00 UTC



- 00 UTC
- 12 UTC

Upper Air Temperature
COSMO-I7
DJF 2011-12

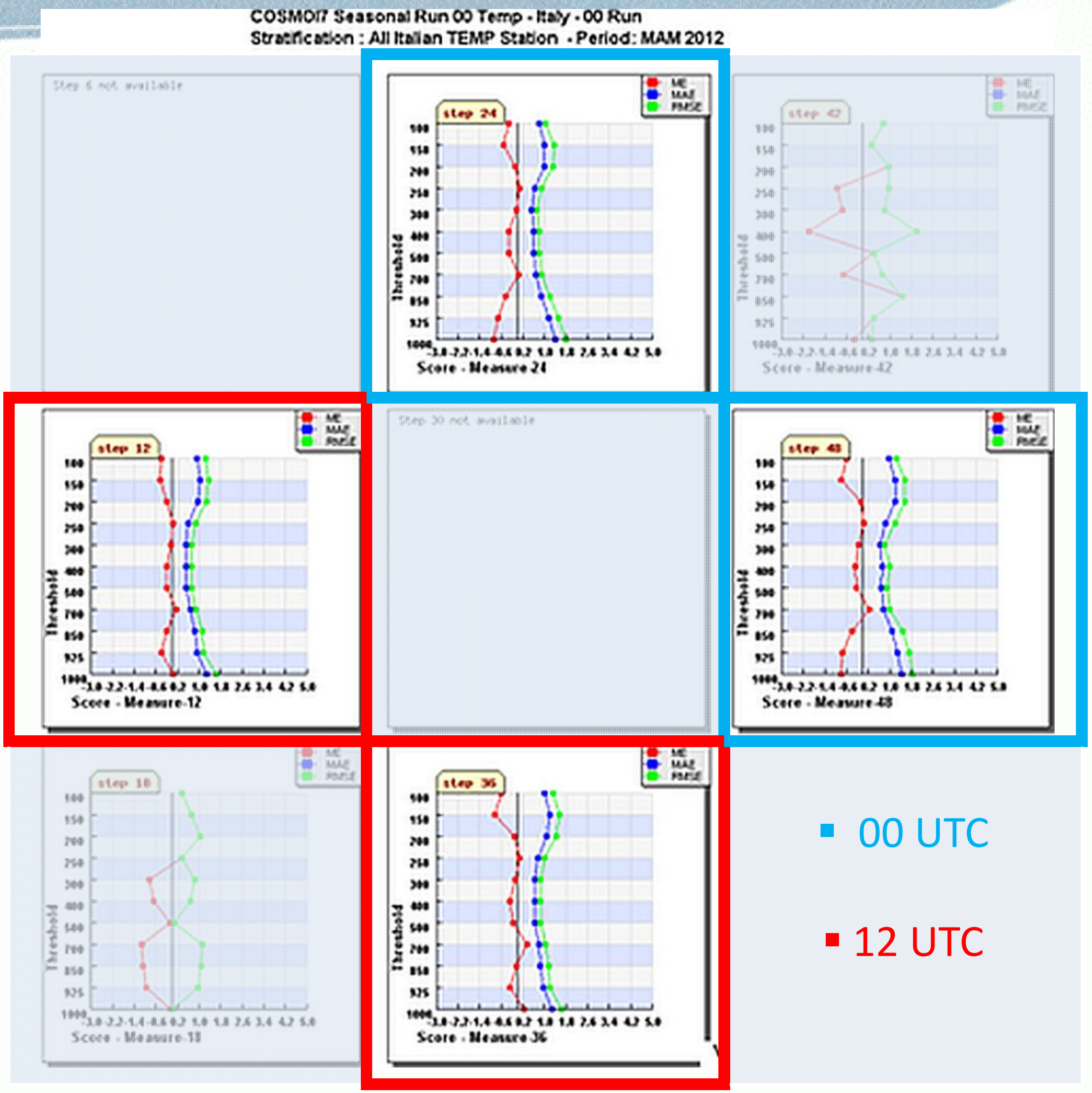
- same underestimation at higher levels as in the other seasons
- the underestimation start at 300 hPa and increases moving to lower layer
- at midnight the errors sees to be mainly due to bias



- 00 UTC
- 12 UTC

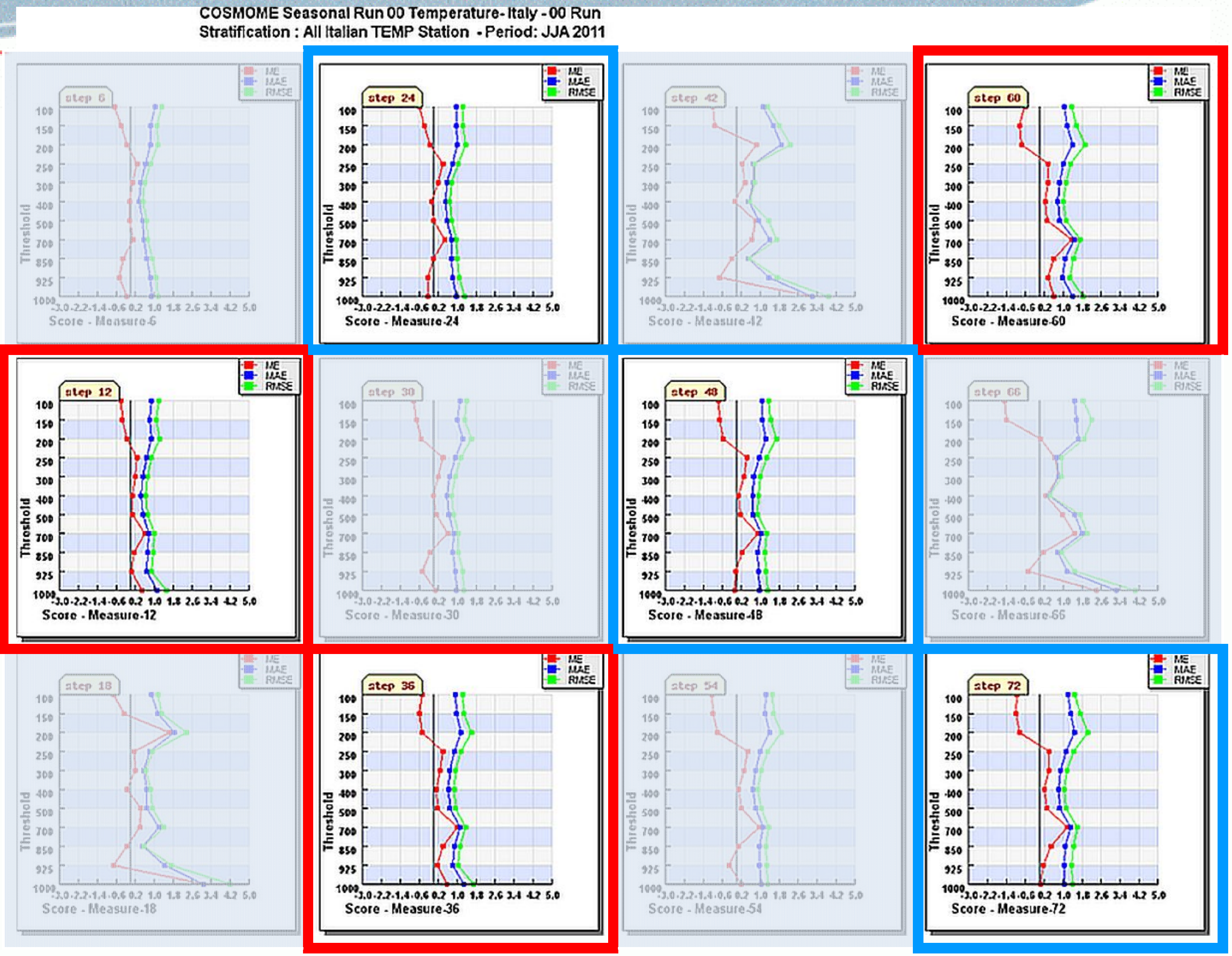
Upper Air Temperature
COSMO-I7
MAM 2012

- similar to JJA and SON



Upper Air Temperature COSMO-ME JJA 2011

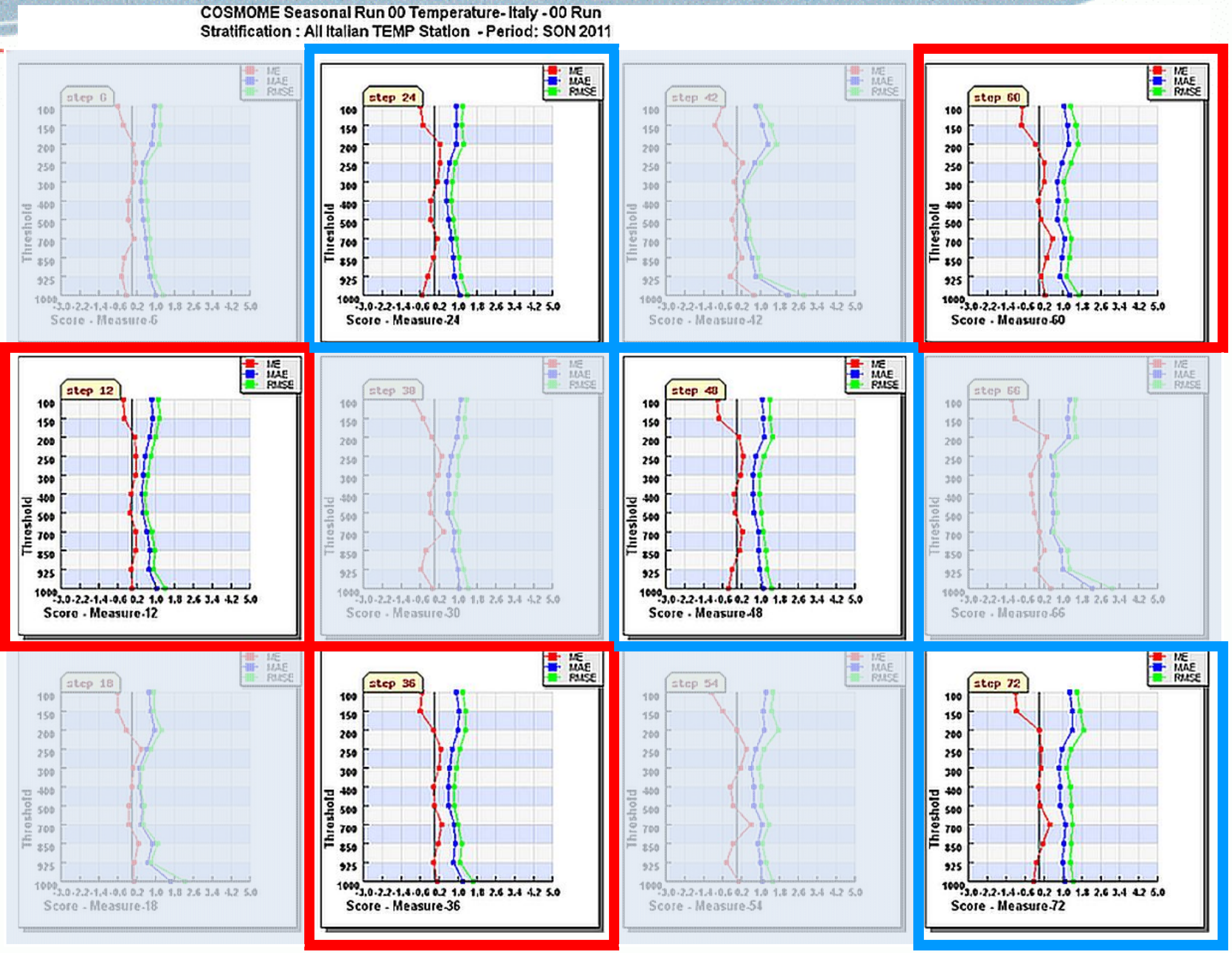
- underestimation above 250 Hpa
- overestimation at 250 hPa and 700 hPa increasing with forecast time
- ME increases with forecast time *("the model seems to warm")*
- Compared to COSMO-I7 seems warmer in particular from 700 hPa and 1000 hPa



- 00 UTC
- 12 UTC

Upper Air Temperature COSMO-ME SON 2011

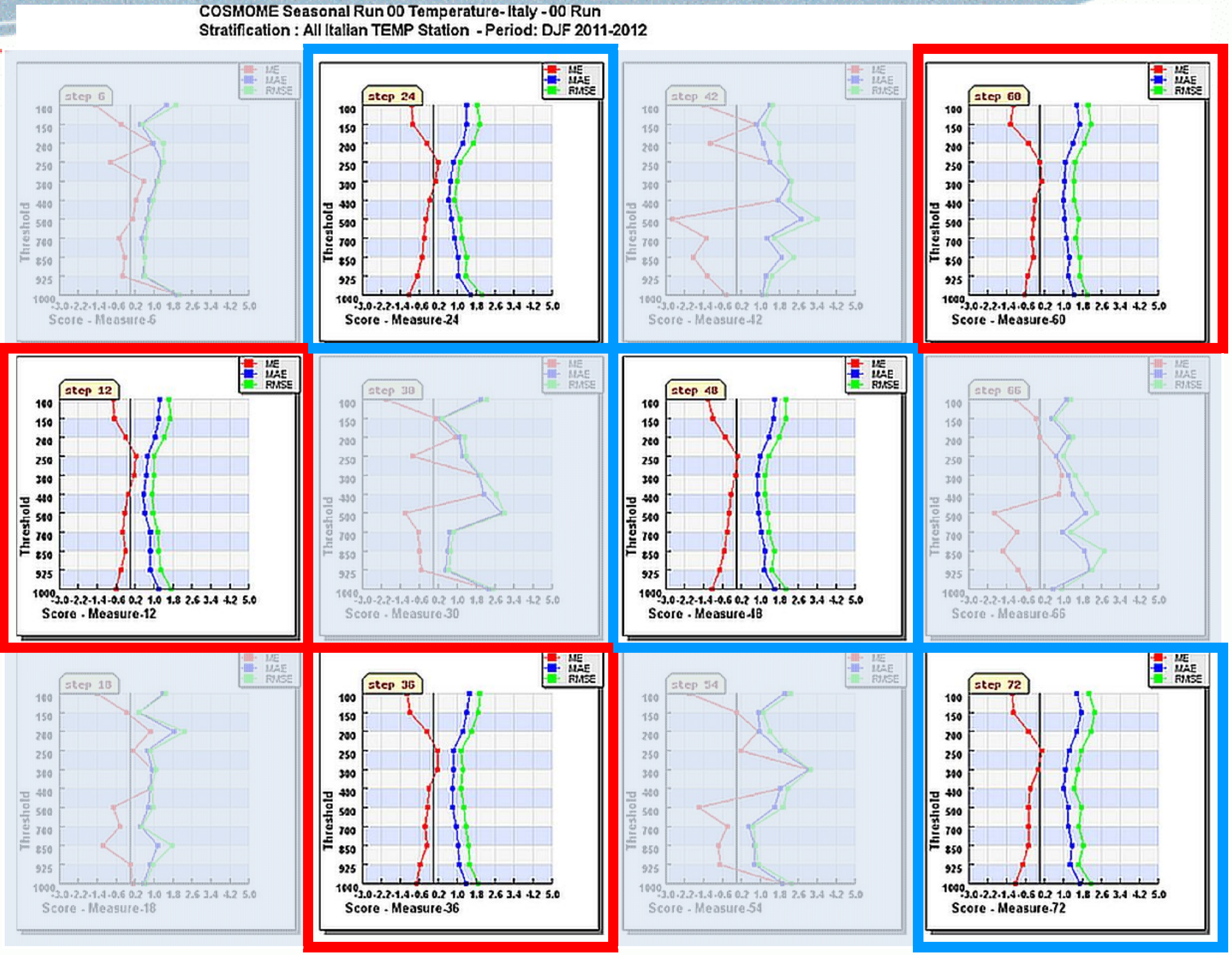
- similar behavior above 250 hPa
- little overestimation at 700 hPa increasing with forecast time
- at midnight negative bias under 850 hPa, reducing with forecast time



- 00 UTC
- 12 UTC

Upper Air Temperature COSMO-ME DJF 2011-12

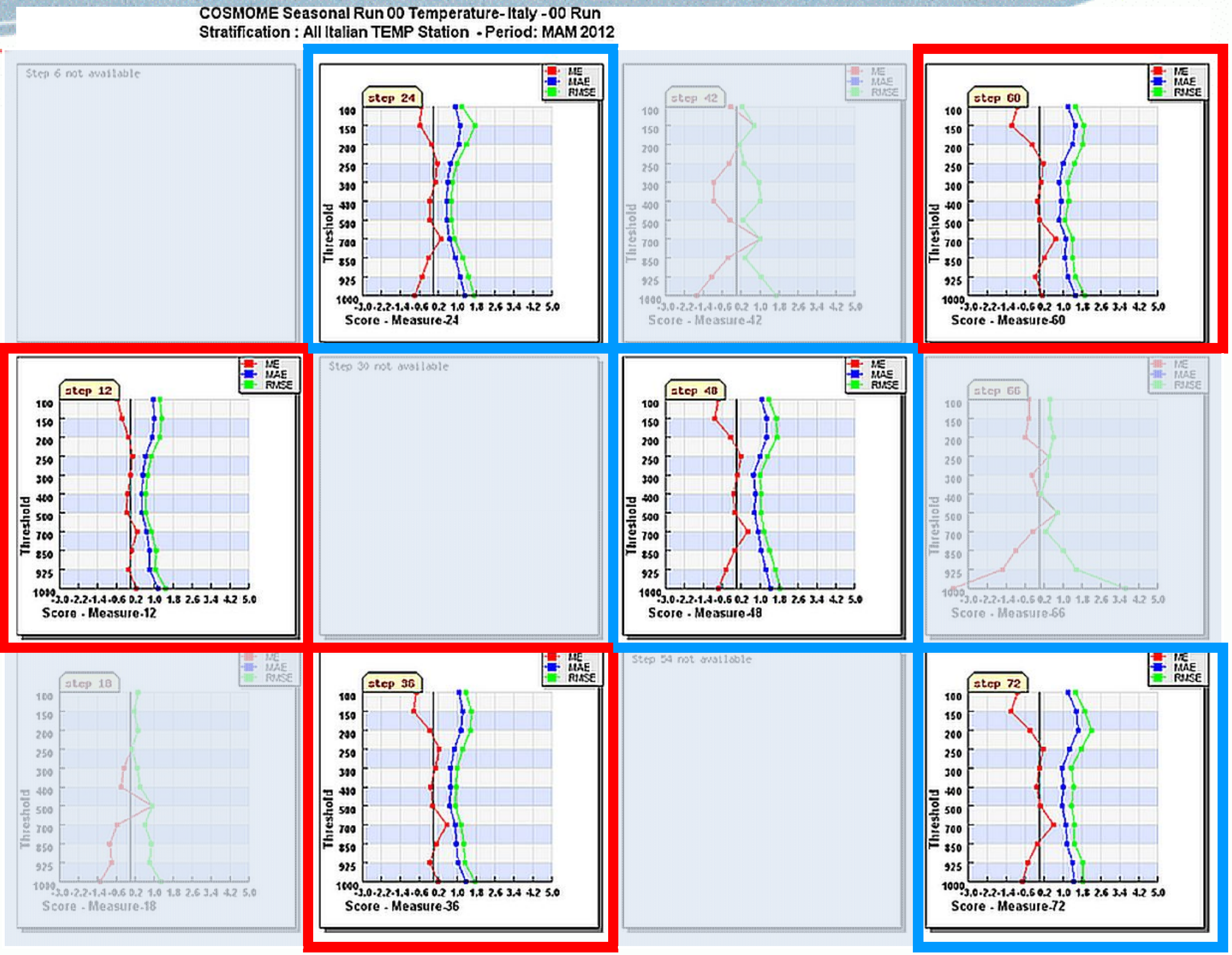
- very similar to COSMO-I7 even if the errors are a little smaller



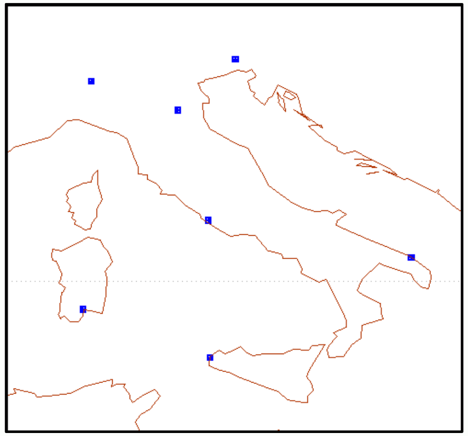
- 00 UTC
- 12 UTC

Upper Air Temperature COSMO-ME MAM 2012

- underestimation under 700 hPa only at 00 UTC
- overestimation at 700 hPa increasing with forecast time
- nearly no bias at 12 UTC (except 700 hPa)
- “usual” overestimation at higher levels



- 00 UTC
- 12 UTC



Italian radio-sounding stations

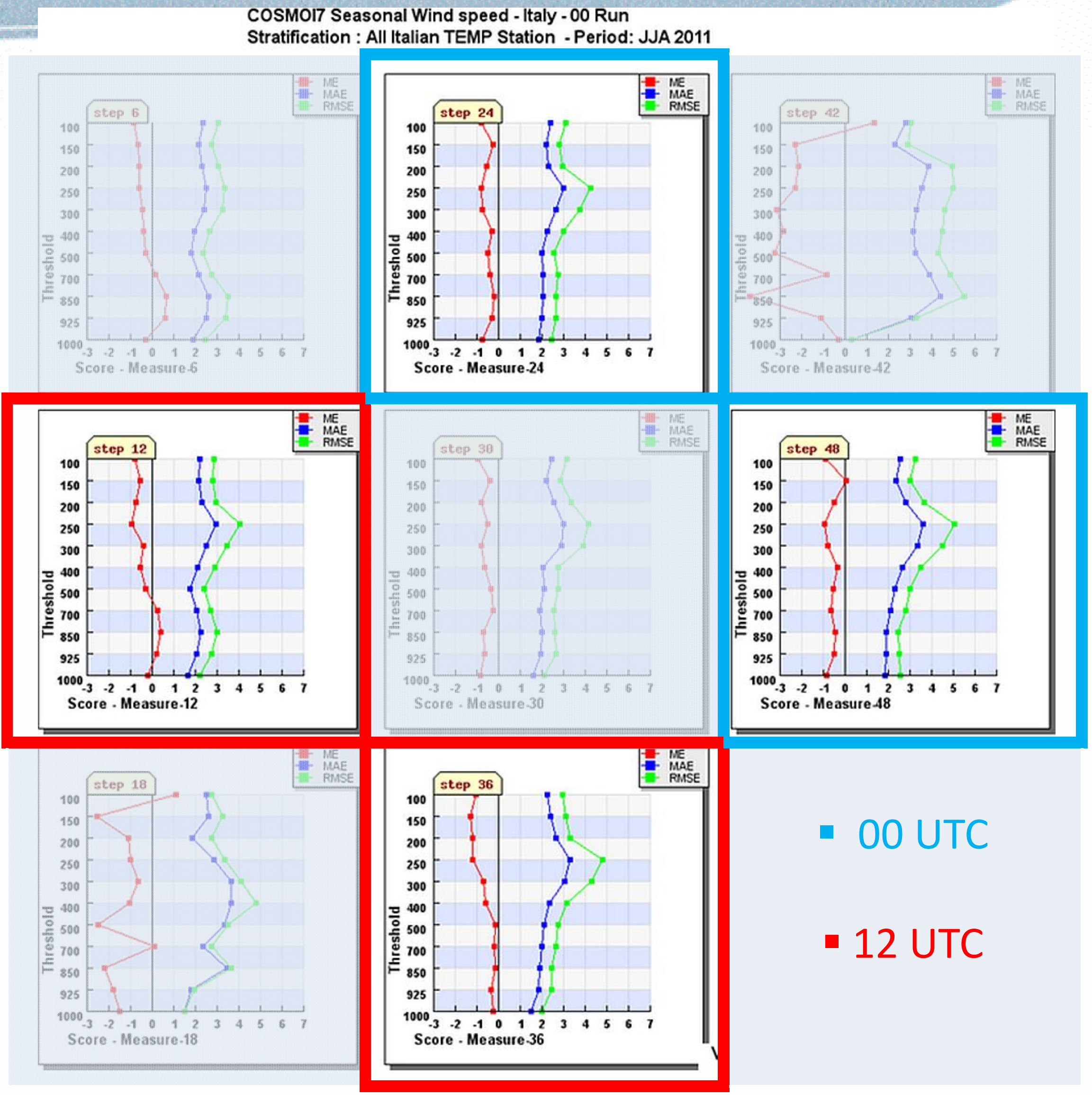
Upper air

WIND SPEED

only few of them do soundings at 6 and 18 UTC
so we focus on verification of mainly 00 and 12 UTC

Upper Air Wind Speed
COSMO-I7
JJA 2011

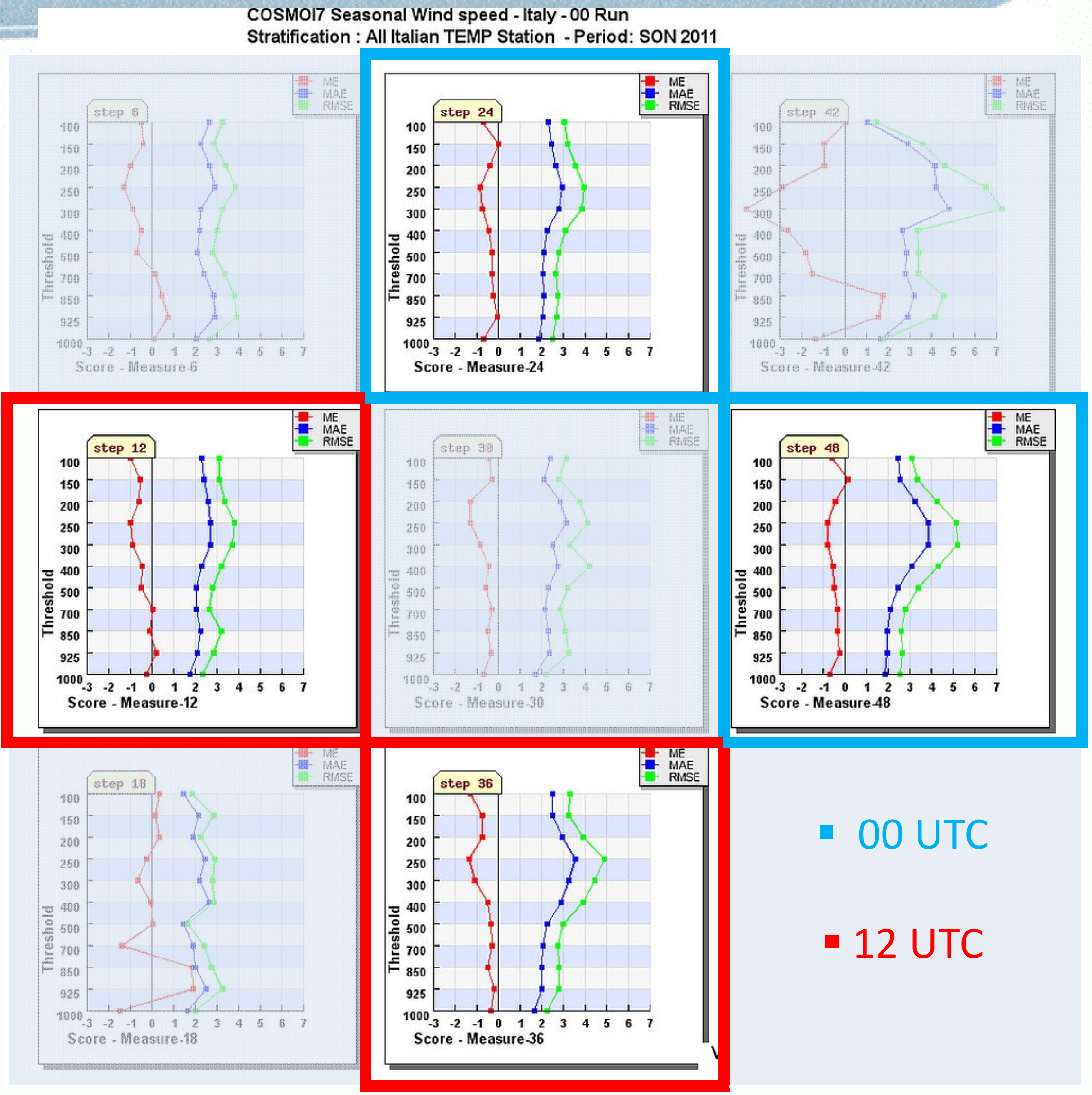
- •MAE near 2 m/s, RMSE a bit bigger (but < 4m/s)
- •Largest error at about 250 hPa (but relative to Jet stream speed is small)
- •Tendency to increase negative bias in particular in the lower layers and during night with forecast step



- 00 UTC
- 12 UTC

Upper Air Wind Speed
COSMO-I7
SON 2011

• more or less as JJA

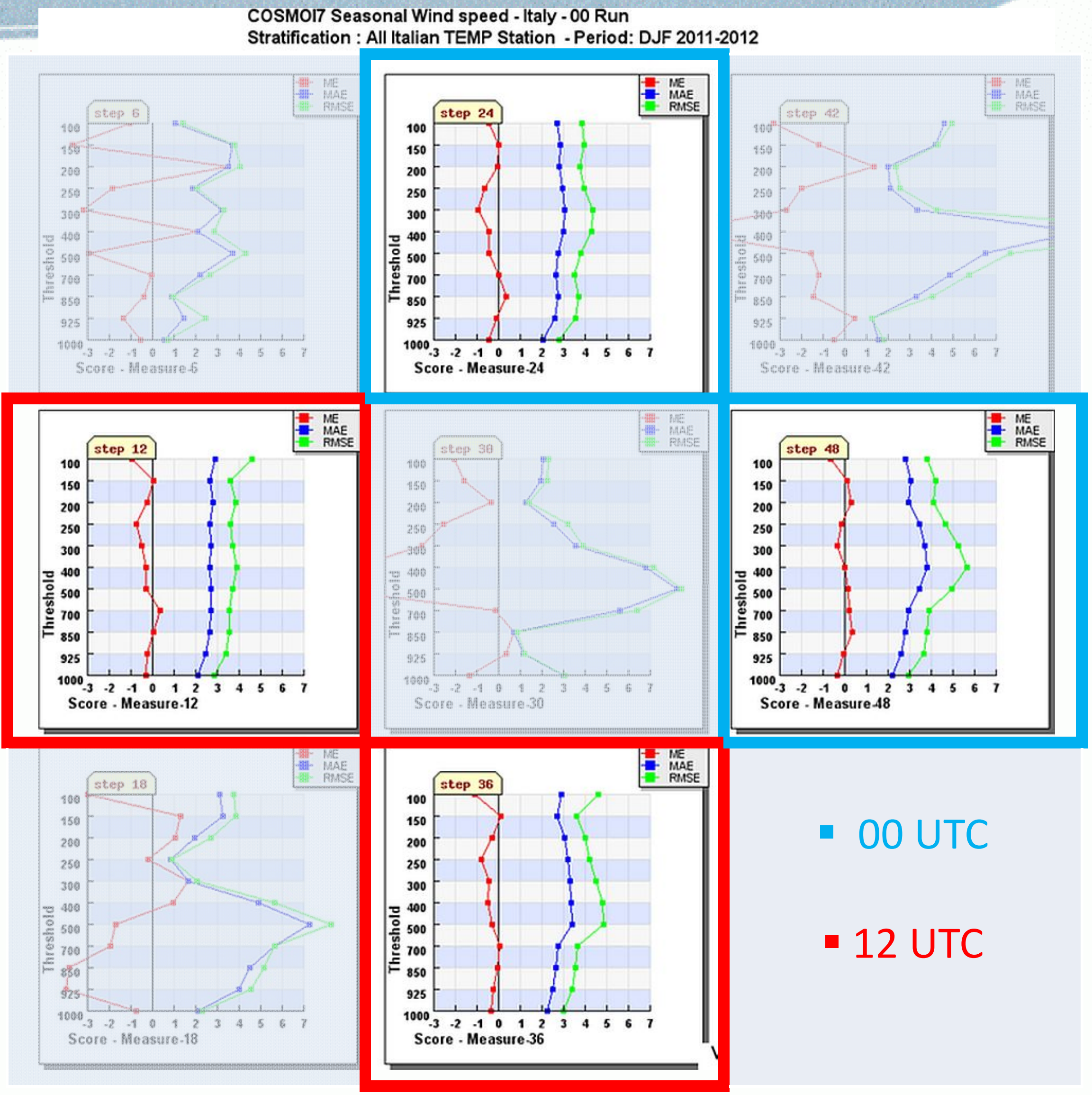


▪ 00 UTC

▪ 12 UTC

Upper Air Wind Speed
COSMO-I7
DJF 2011-12

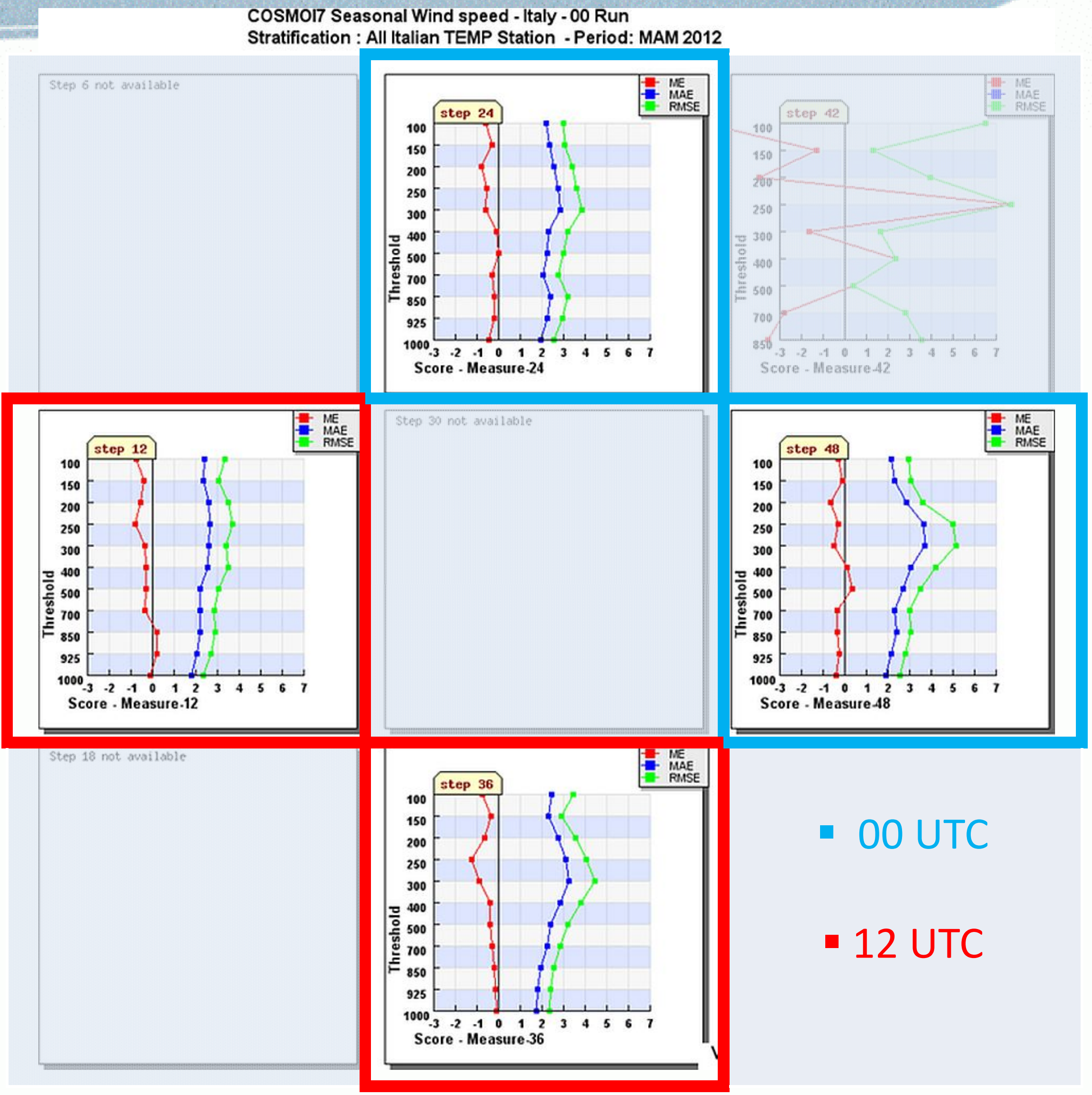
- bias nearly 0 but little increase with forecast time of MAE and RMSE especially at 400-500 hPa



- 00 UTC
- 12 UTC

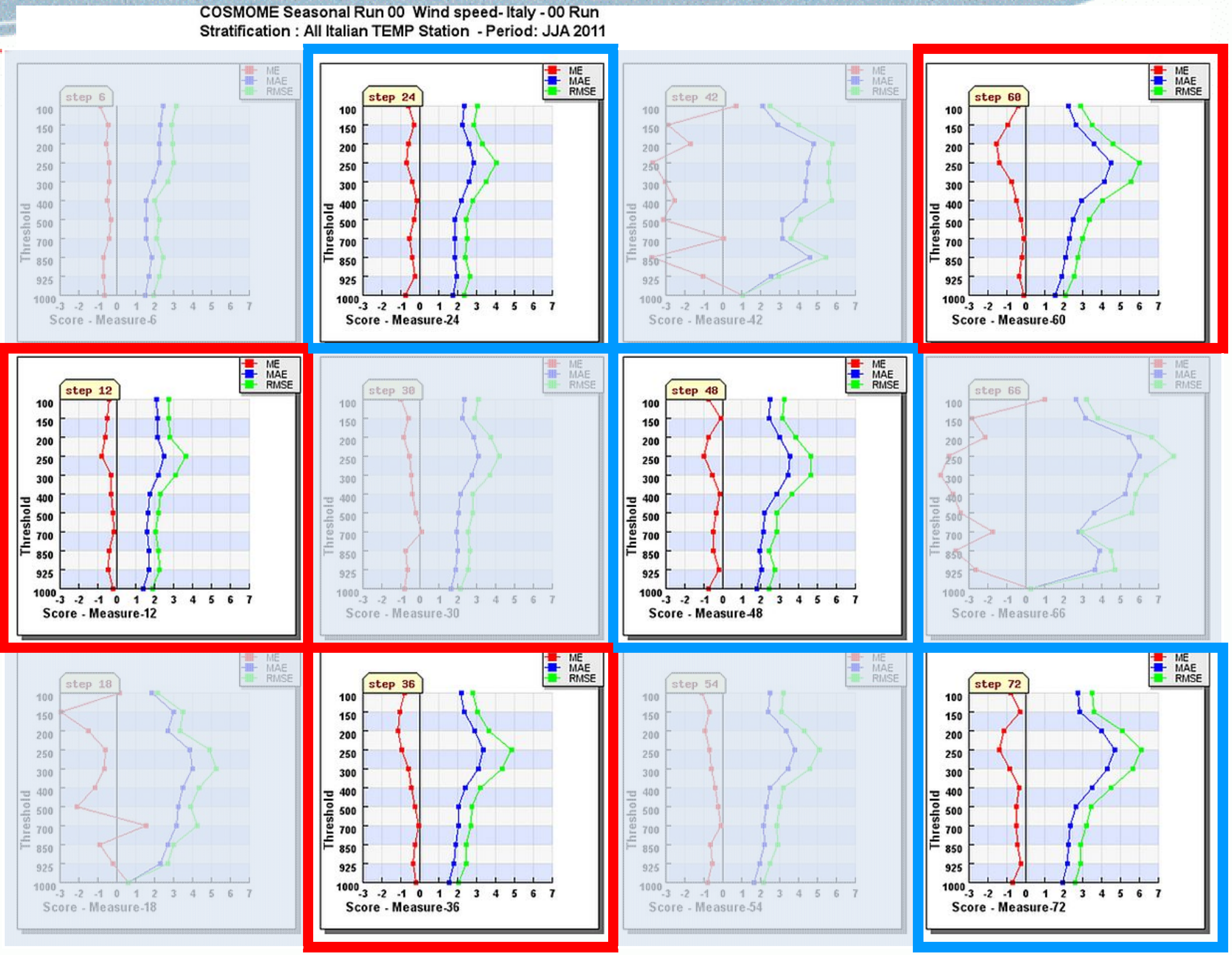
Upper Air Wind Speed
COSMO-I7
MAM 2012

- MAE &RMSE are smaller than DJF
- similar to JJA and SON

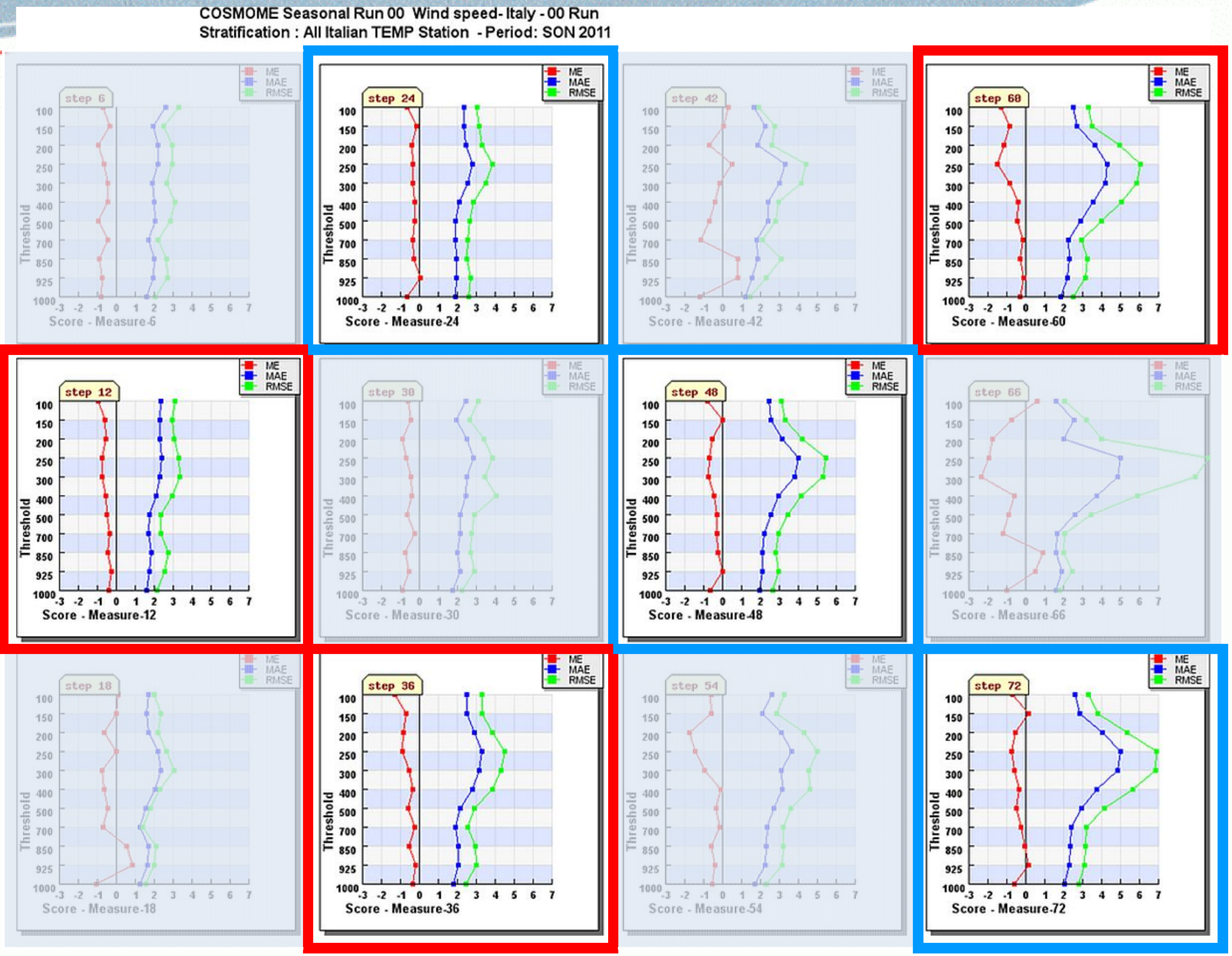


Upper Air Wind Speed COSMO-ME JJA 2011

Negative ME , in particular at “Jet stream height” where errors are bigger and grow with forecast steps



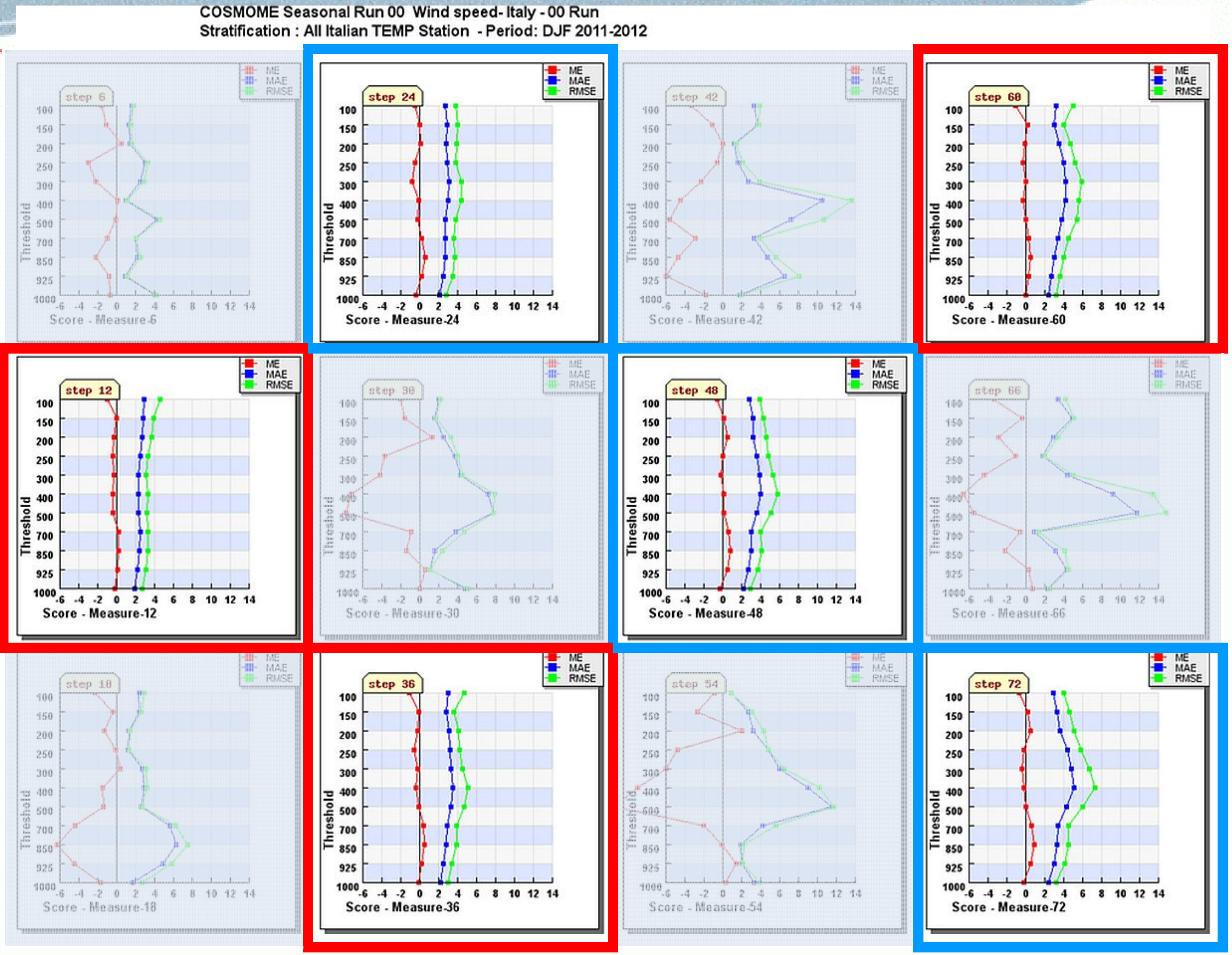
Upper Air Wind Speed COSMO-ME SON 2011



- Errors at about 250 hPa increase with forecast step
- small negative bias, especially at 12 UTC and below 925 hPa also during night

Upper Air Wind Speed COSMO-ME DJF 2011-12

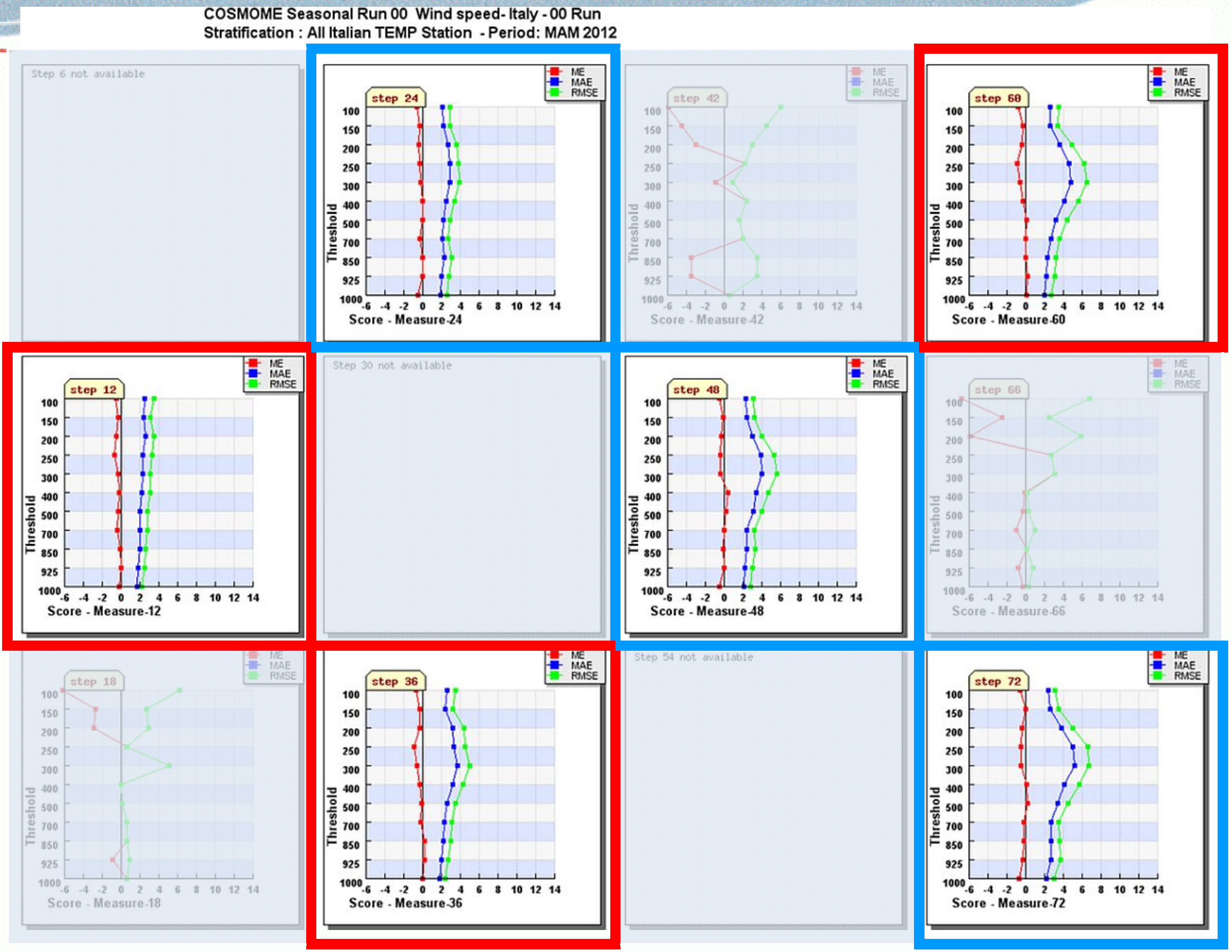
- Errors at about 400-500 hPa grow with forecast step (seasonal feature as for COSMO-I7)



Scale is different!

Upper Air Wind Speed COSMO-ME MAM 2012

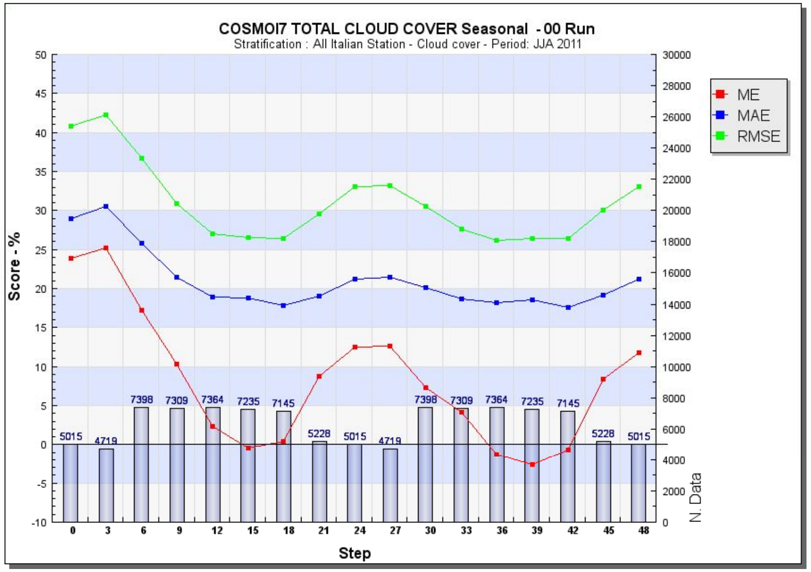
• same as JJA and SON

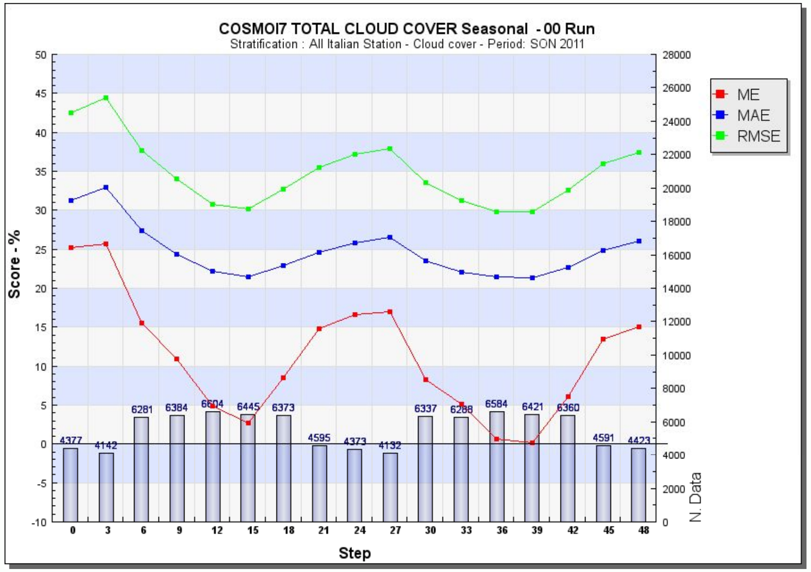


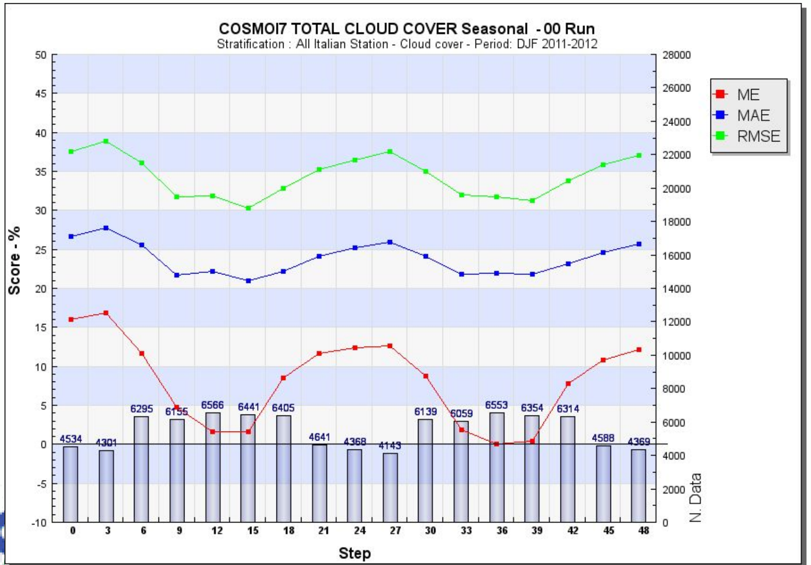
Scale is different!

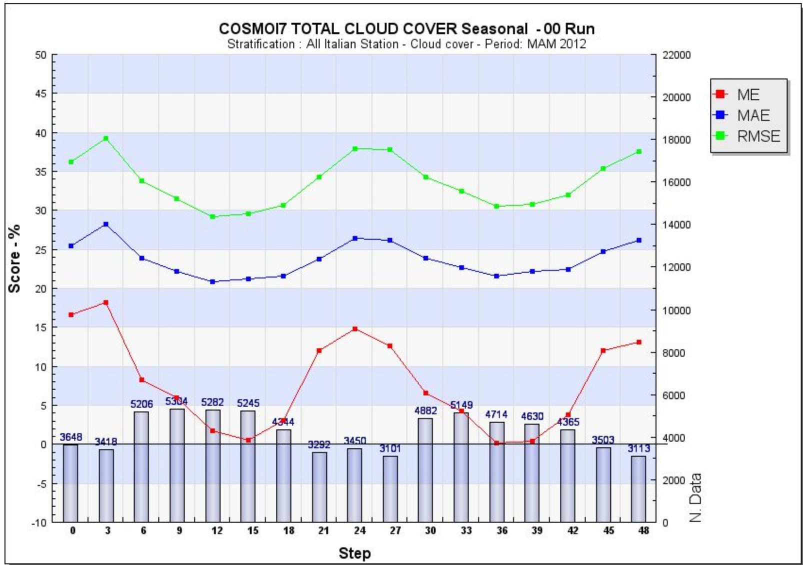
TOTAL CLOUD COVER

COSMO-I7
Total Cloud Cover (step 3h)

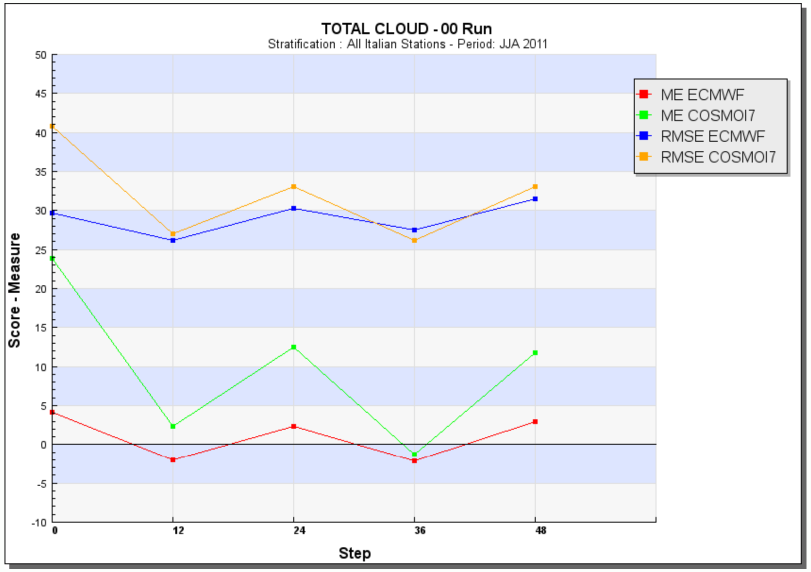


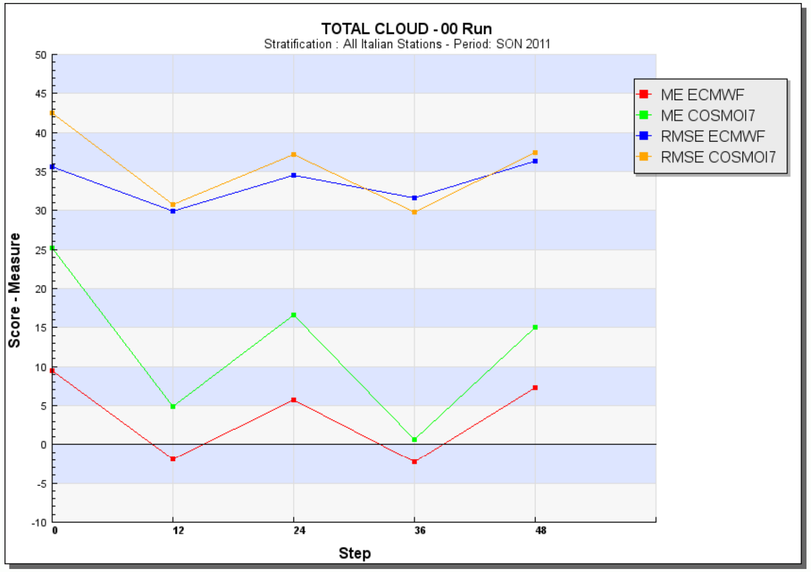


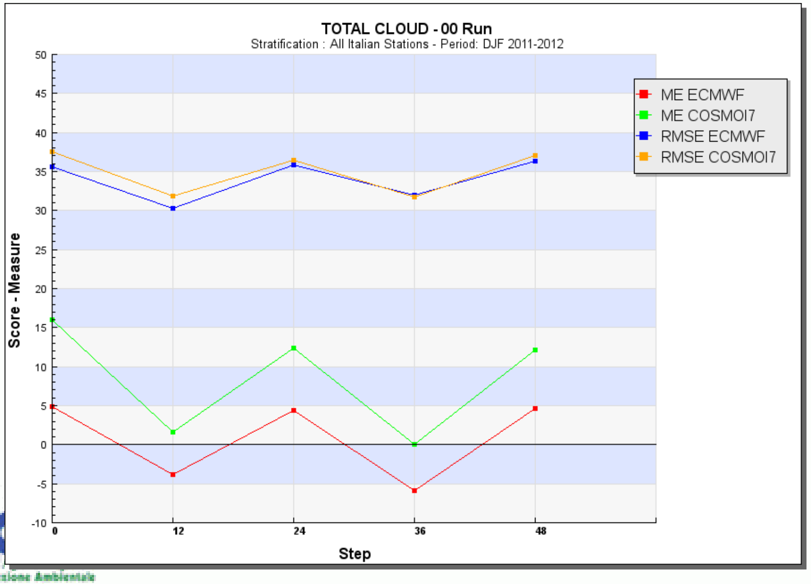


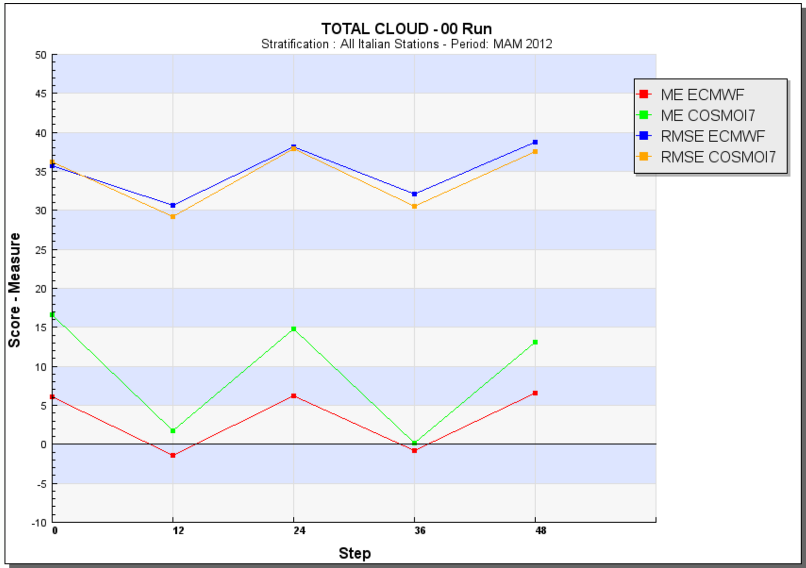


COSMO-I7 vs ECMWF Total Cloud Cover (step 12 h)





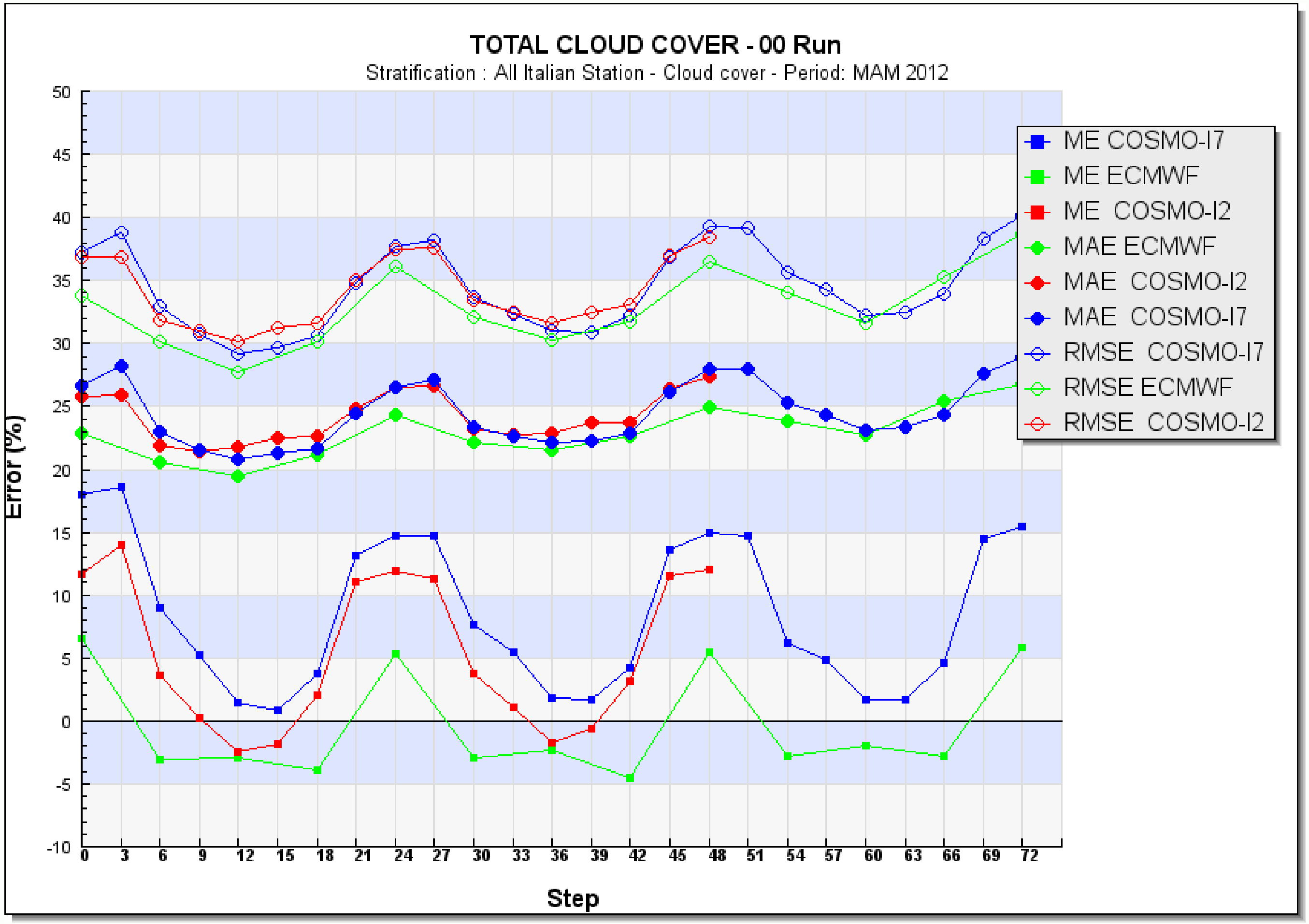




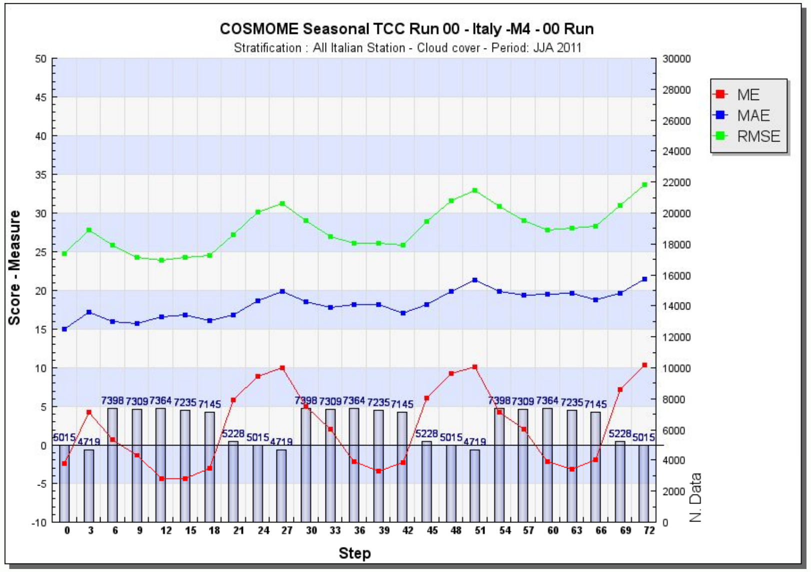
TCC :COSMO-I7,COSMO-I2,ECMWF

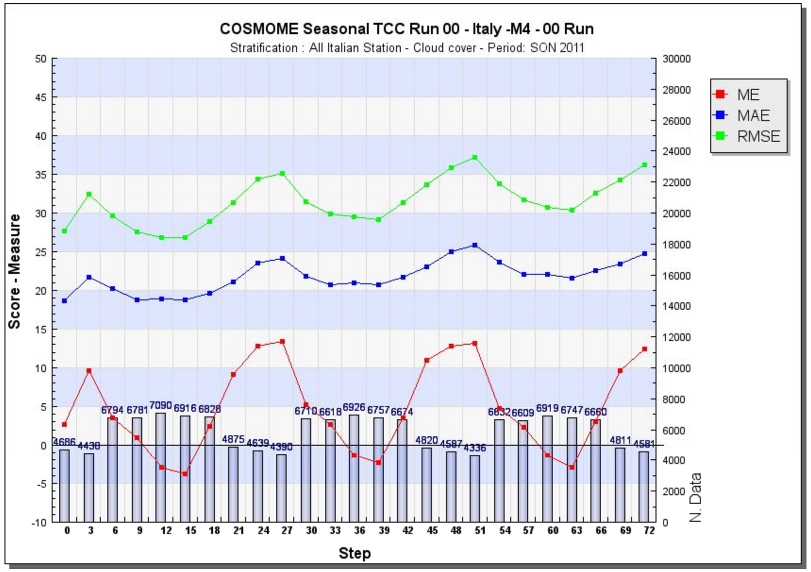
Arpa-ER started to use Versus!

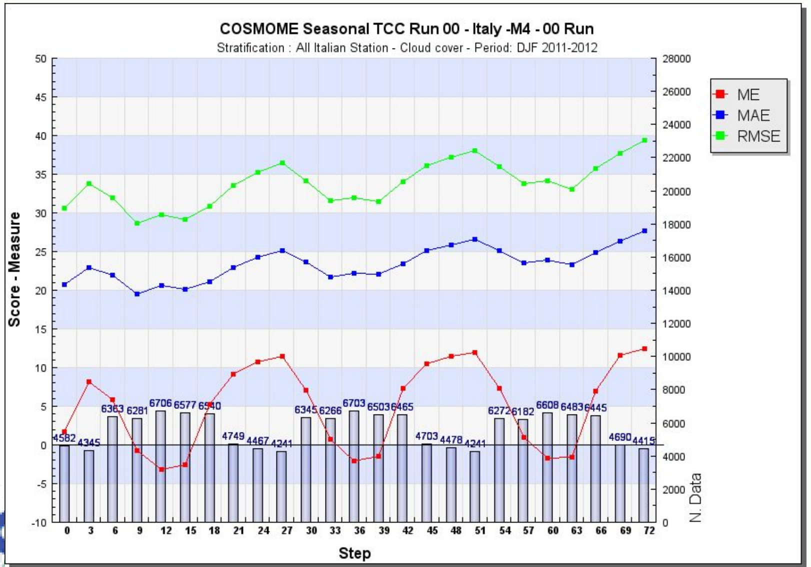
MAM 2012

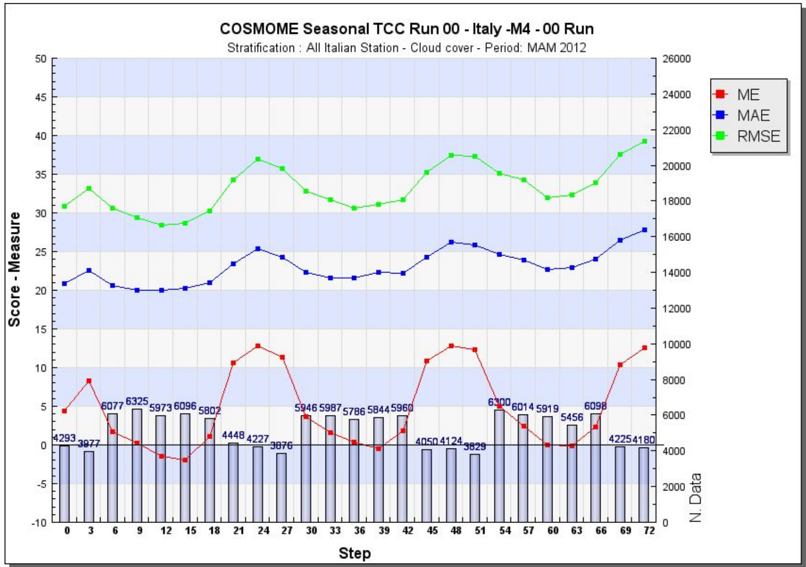


COSMO-ME
Total Cloud Cover (step 3h)

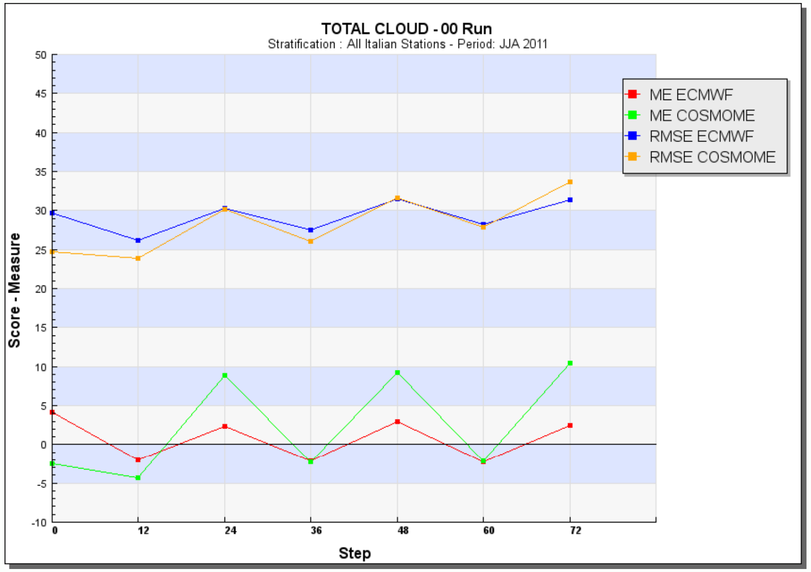


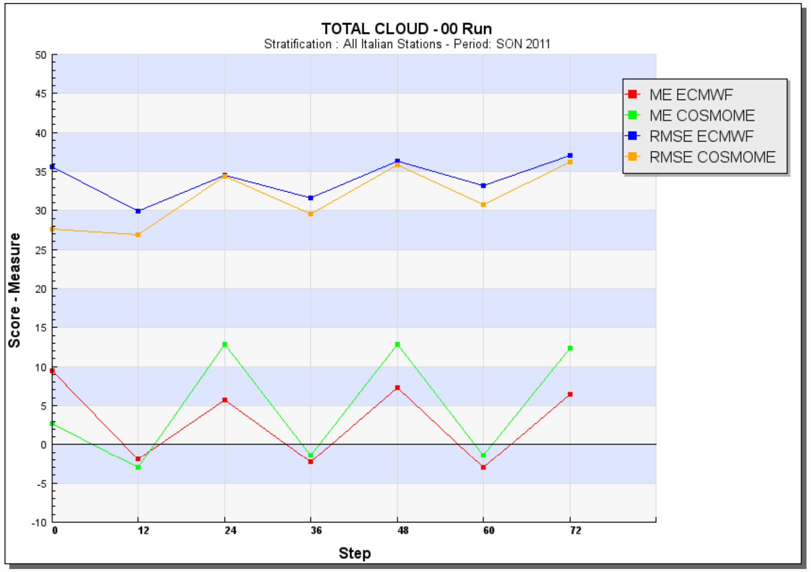


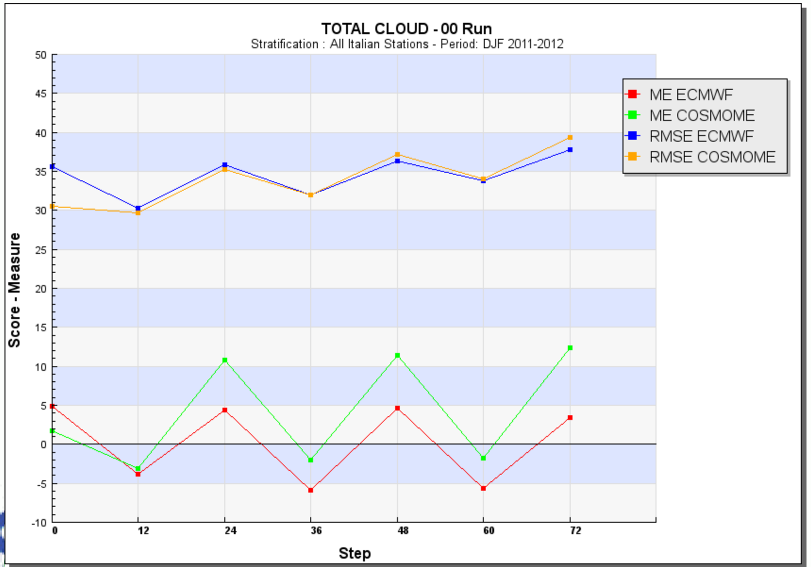


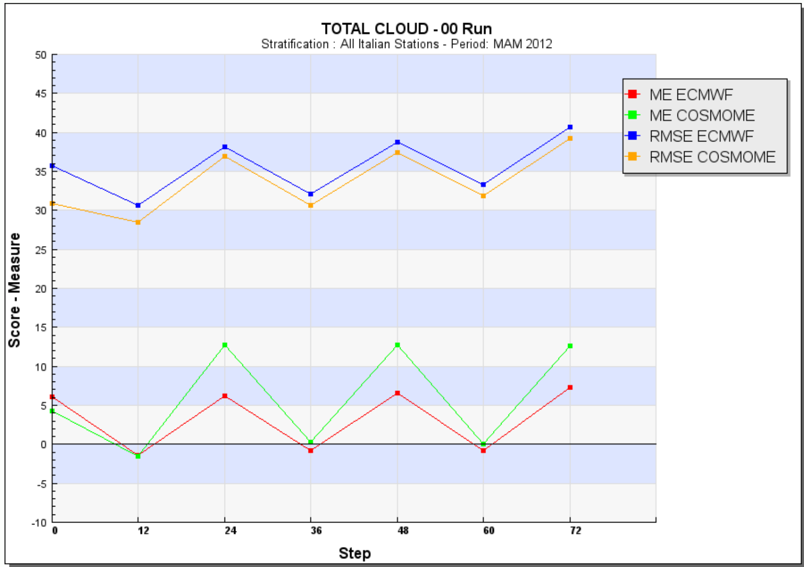


COSMO-ME vs ECMWF
Total Cloud Cover (step 12 h)

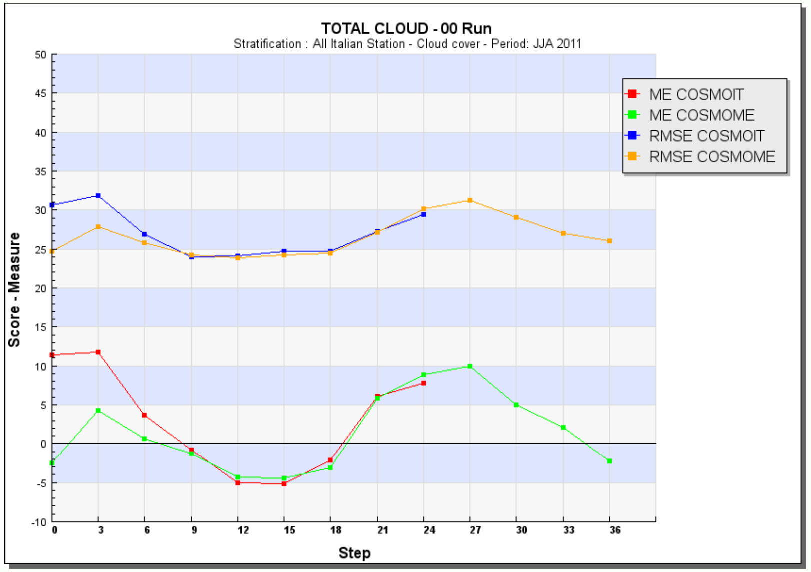


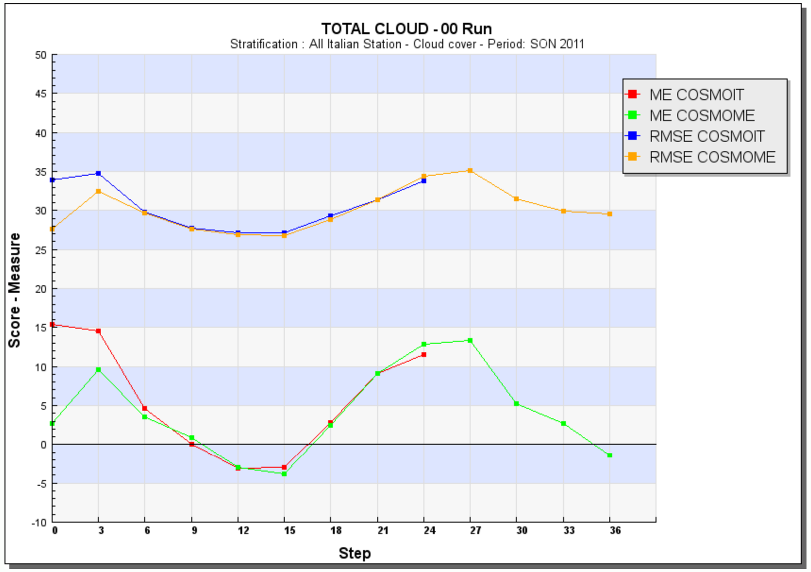


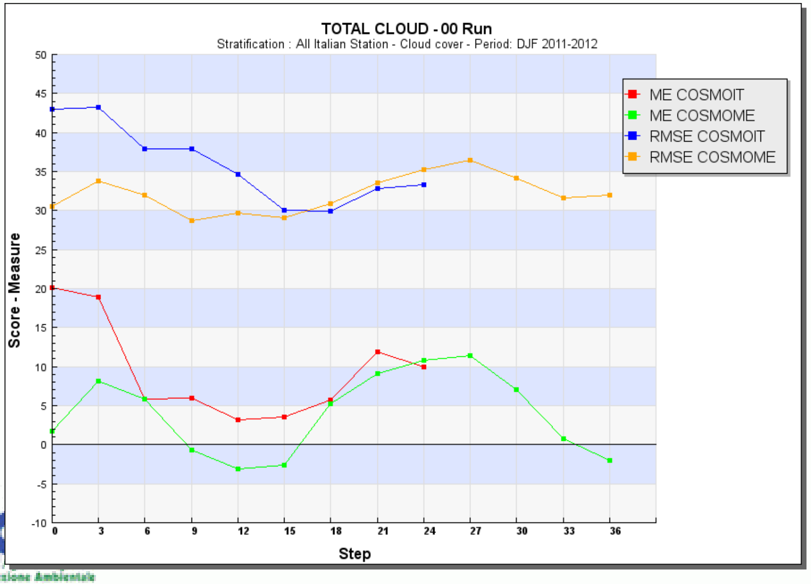


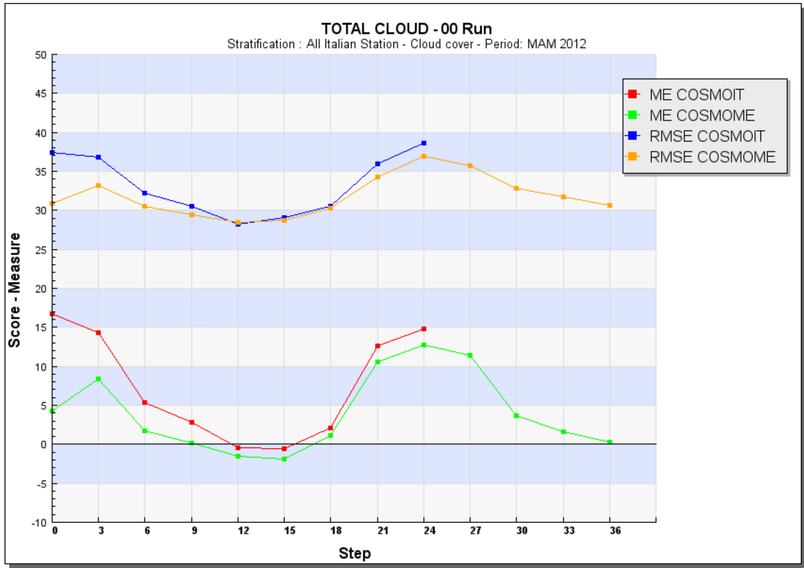


COSMO-ME vs COSMO-IT
Total Cloud Cover (step 3 h)







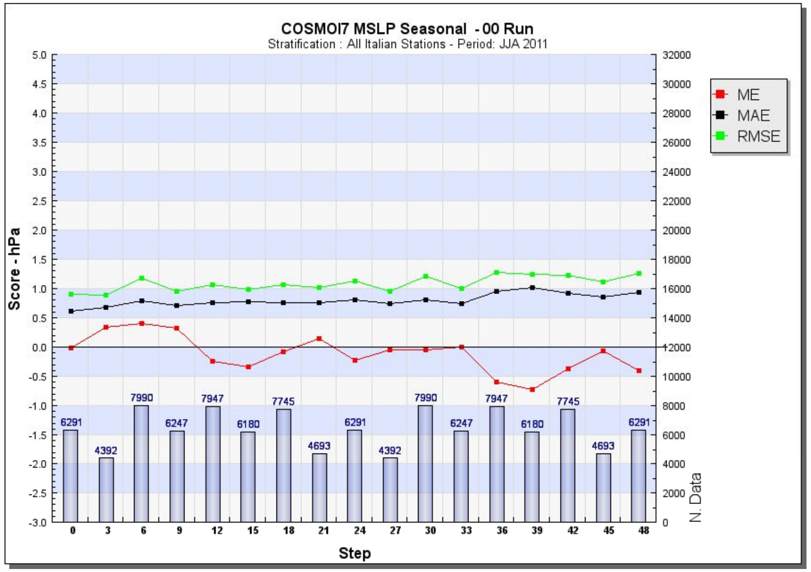


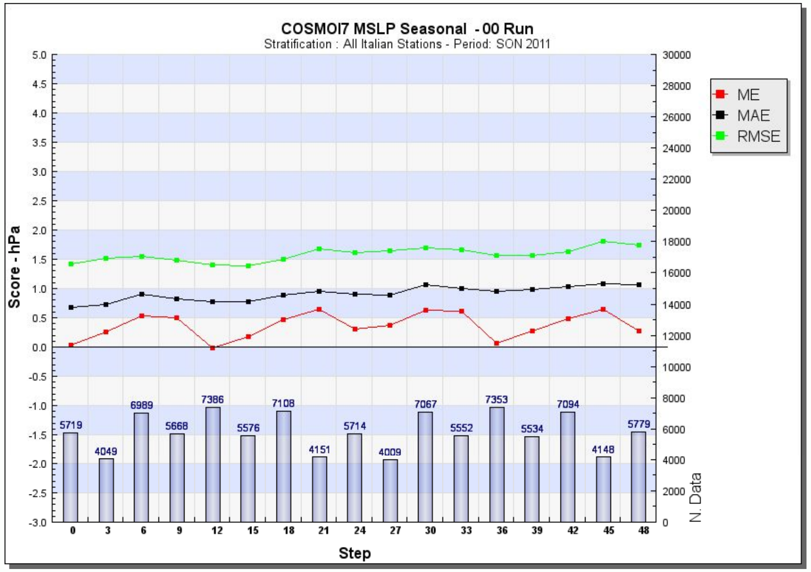
TCC considerations

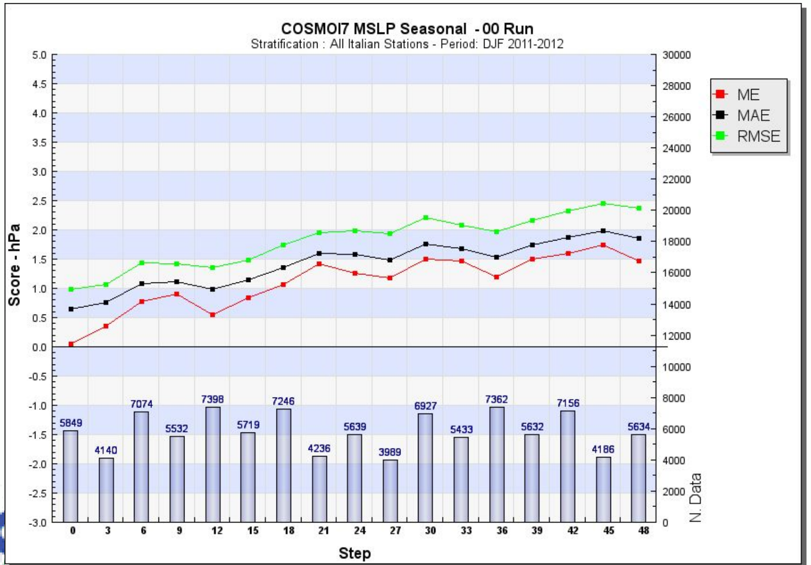
- COSMO-I7 tends to overestimate cloud cover with a bigger bias during the night
  - Errors in the early hours of integration are bigger then in the following steps
  - For MAM2012 COSMO-I2 reduces the overestimation during night but also underestimate during the day, but no significant differences in MAE and RMSE
  - ECMW has a bias oscillating around zero and errors are a little smaller than COSMO-I7
- COSMO-ME has a positive bias during night and a bit negative during day
  - Night overestimation is more pronounced than ECMWF but RMSE are nearly the same in JJA and DJF slightly better in SON and MAM
  - COSMO-IT has bigger errors in the first 6 hours of integration respect to COSMO-ME

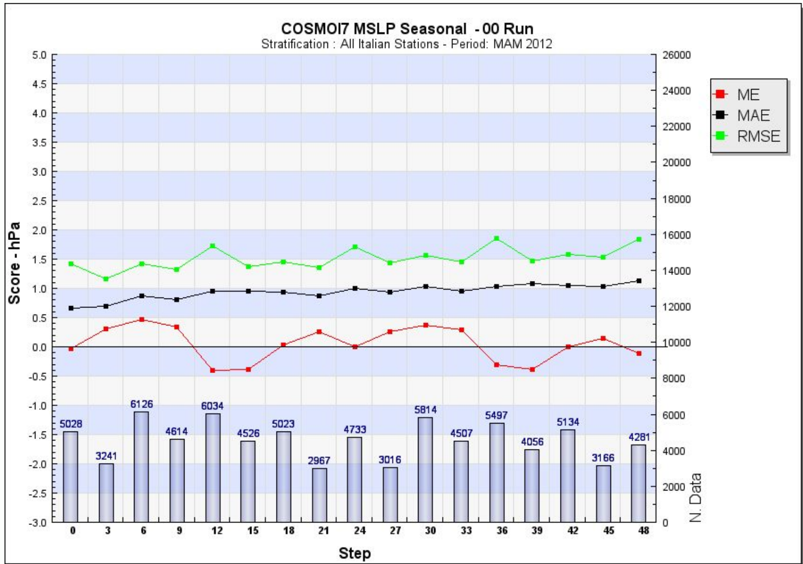
MEAN SEA LEVEL PRESSURE

COSMO-I7
MSL Pressure (step 3h)





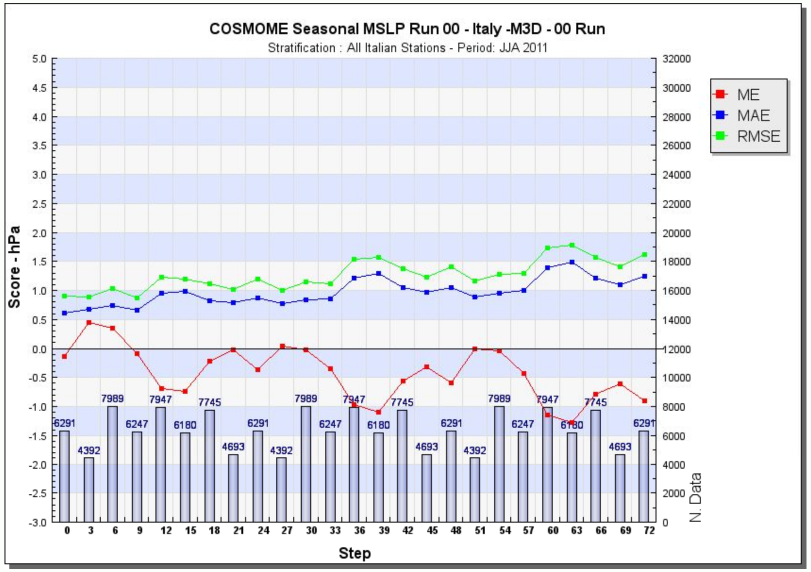


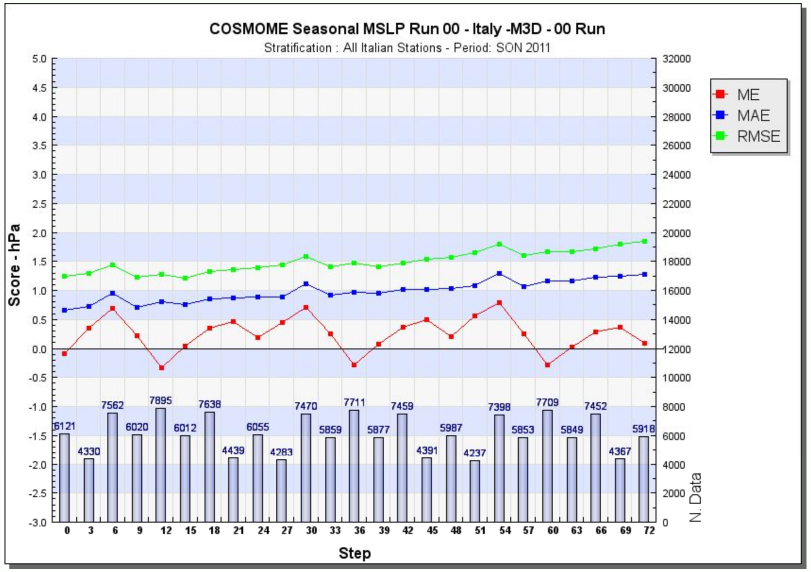


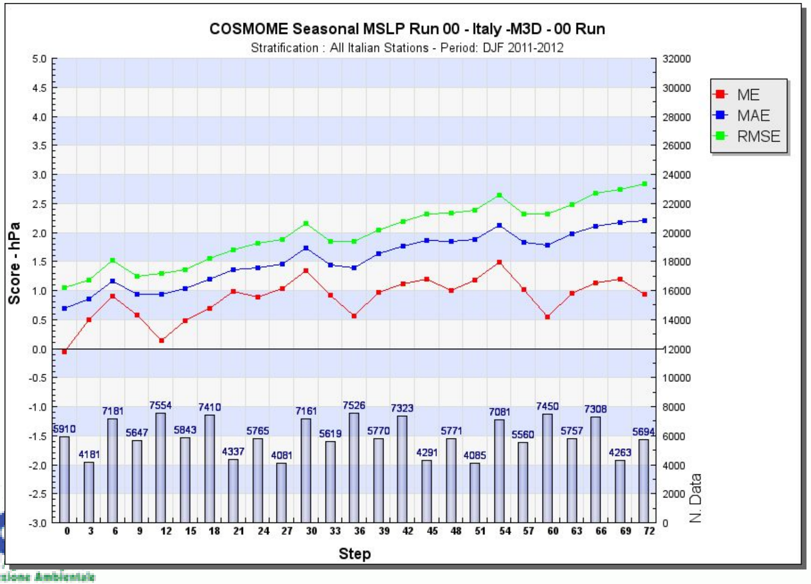
per la Protezione Ambientale

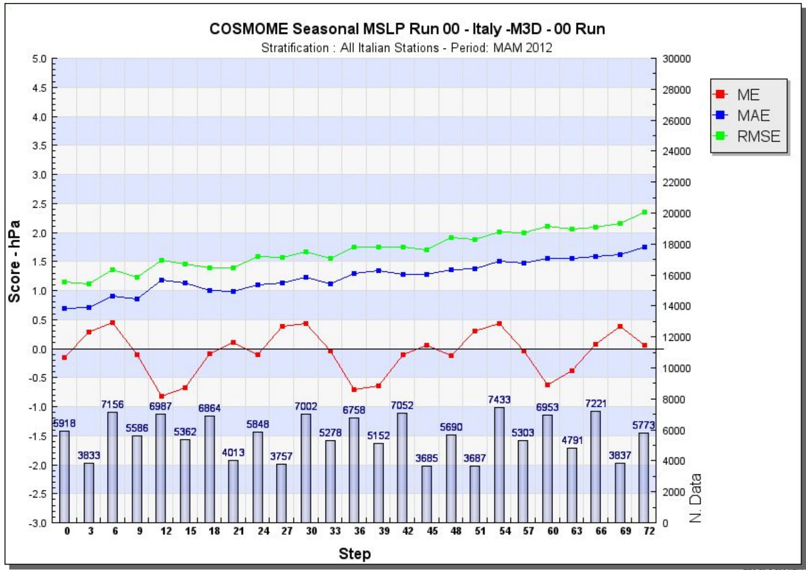
ambiente dell'emilia-romagna

COSMO-ME
MSL Pressure(step 3h)

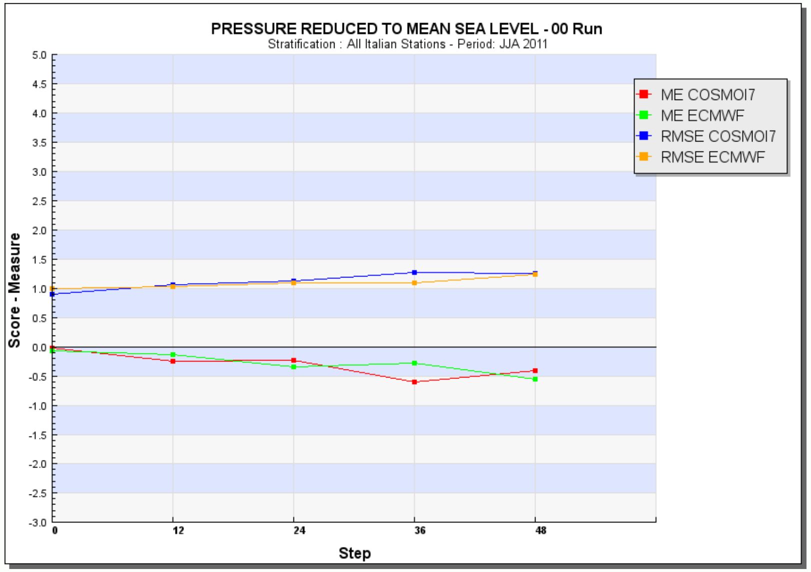


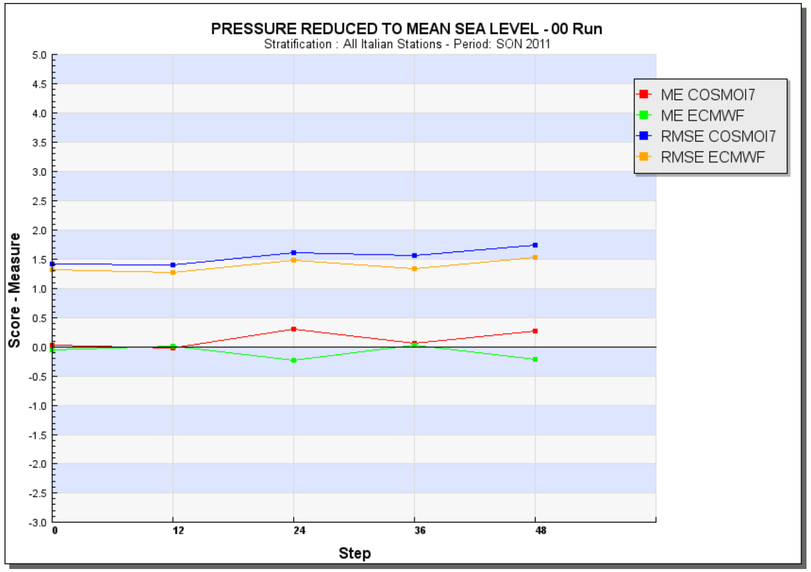


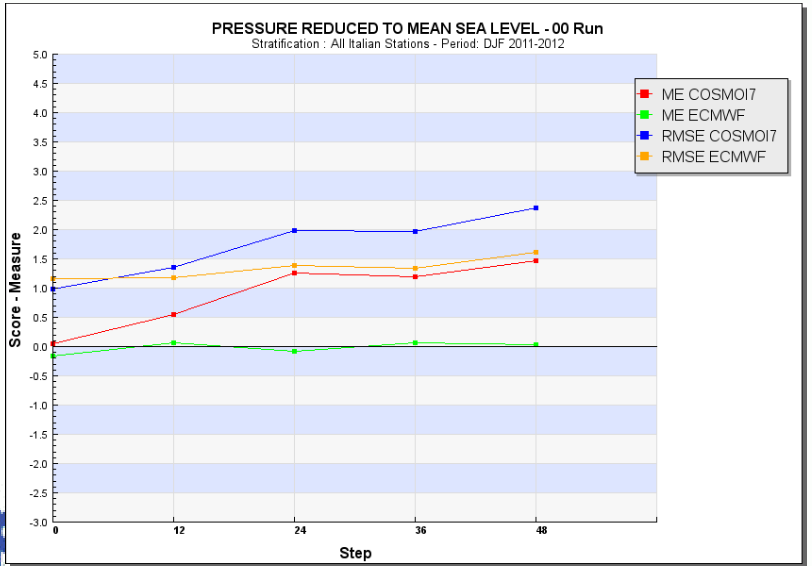


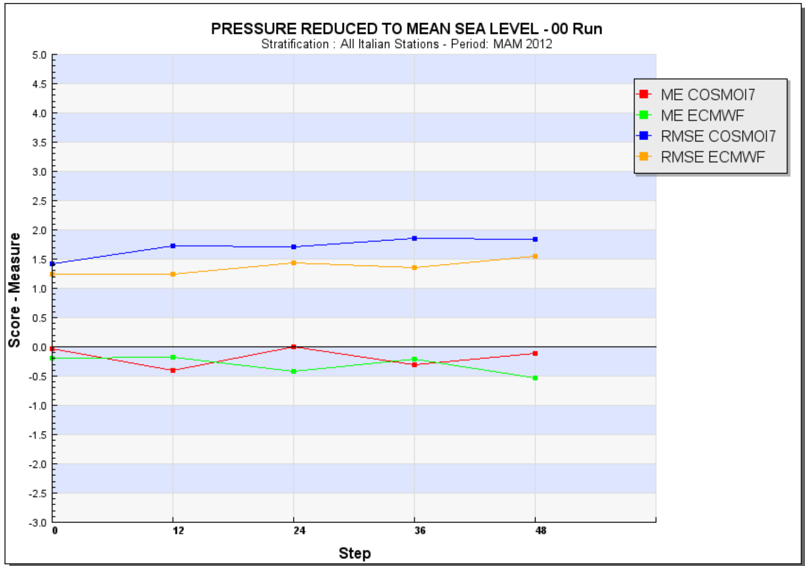


COSMO-I7 vs ECMWF
MSL Pressure (step 12 h)





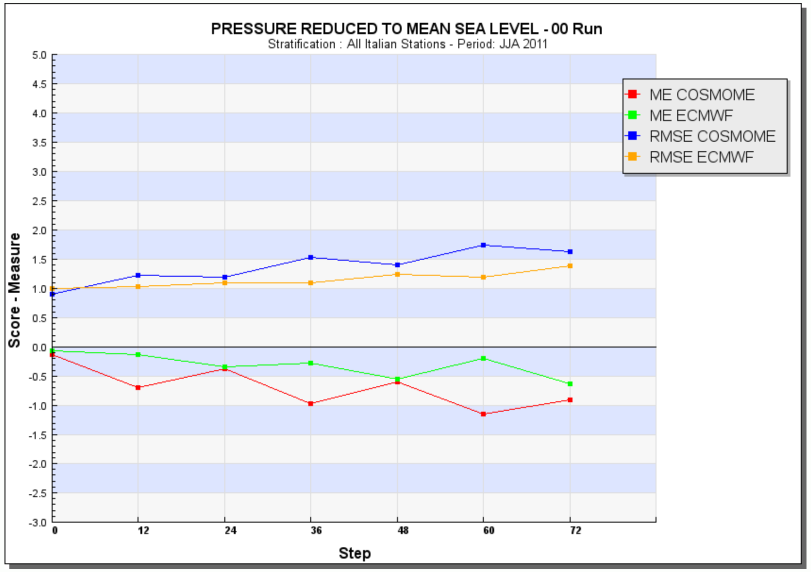


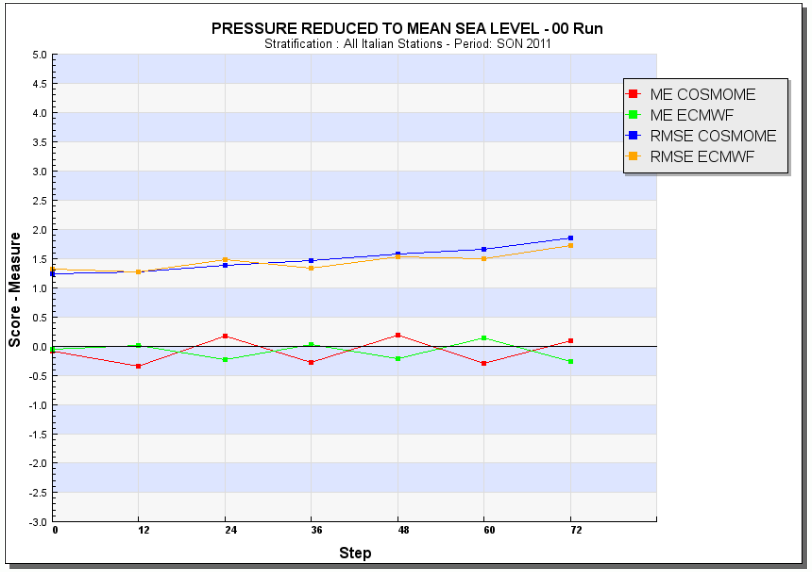


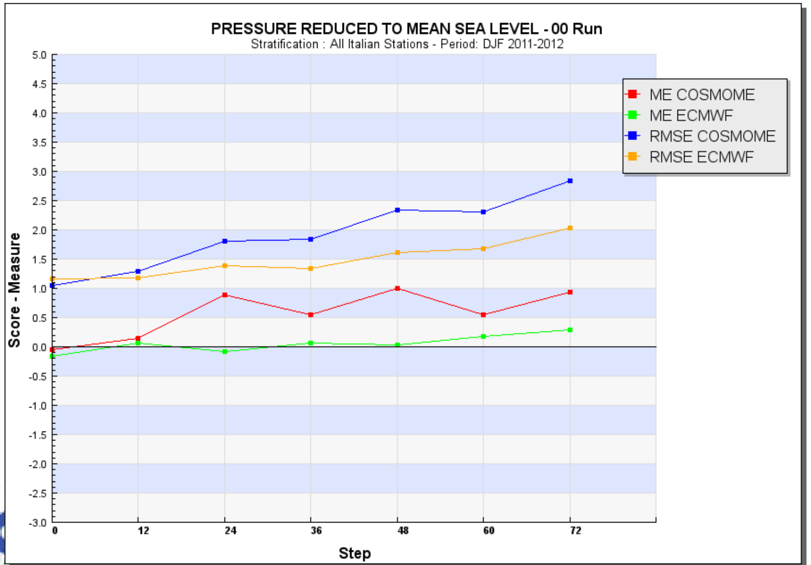
Arpa per la Protezione Ambientale

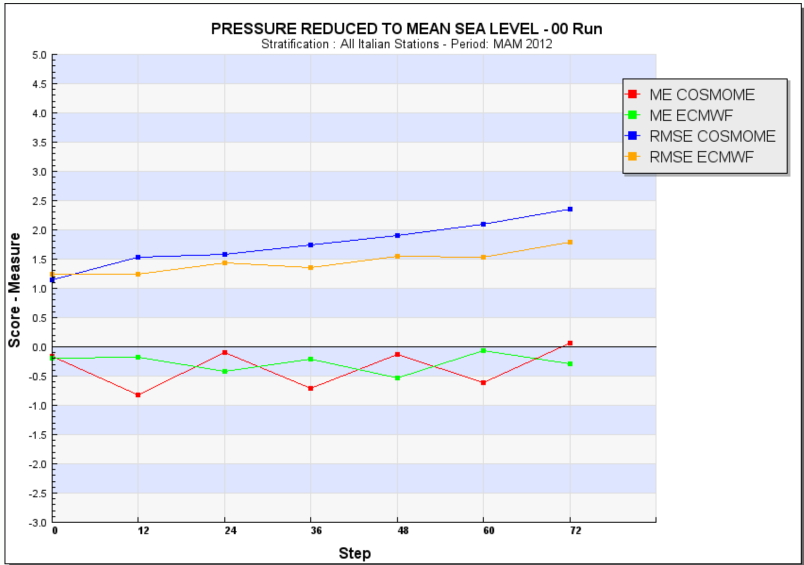
Arpa prevenzione e ambiente dell'emilia-romagna

COSMO-ME vs ECMWF
MSL Pressure (step 12 h)

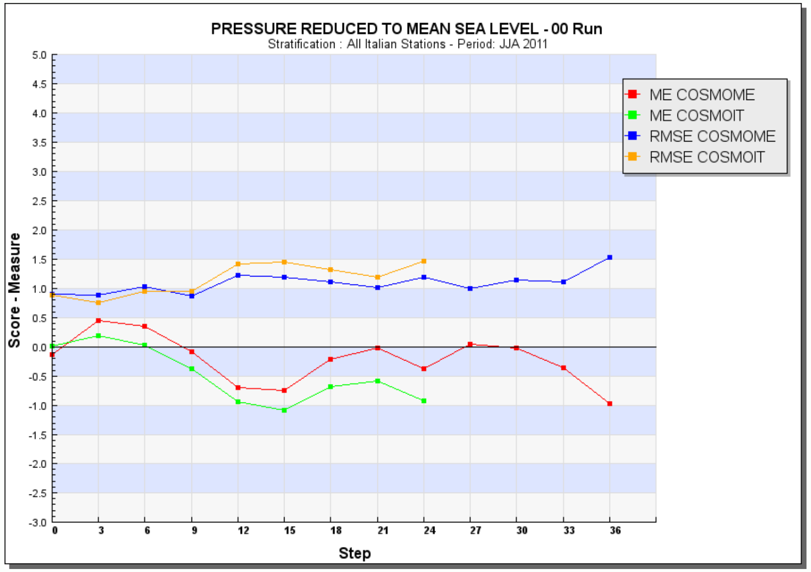


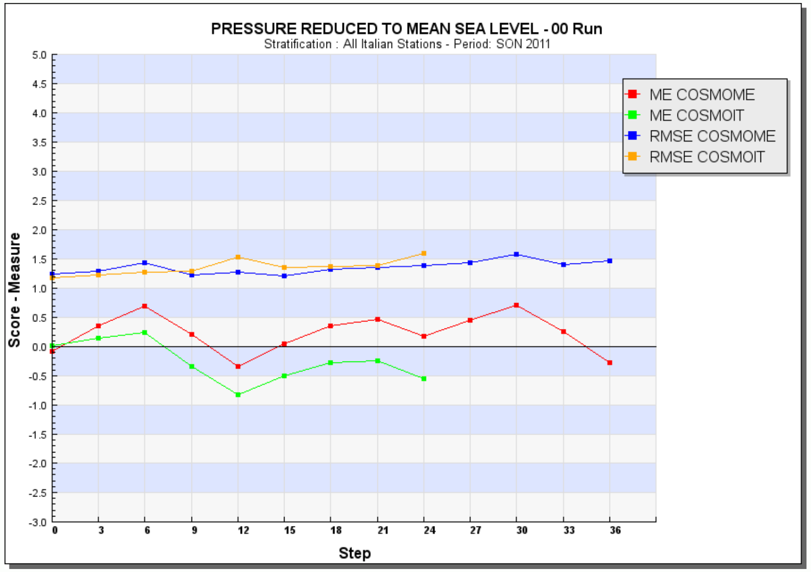


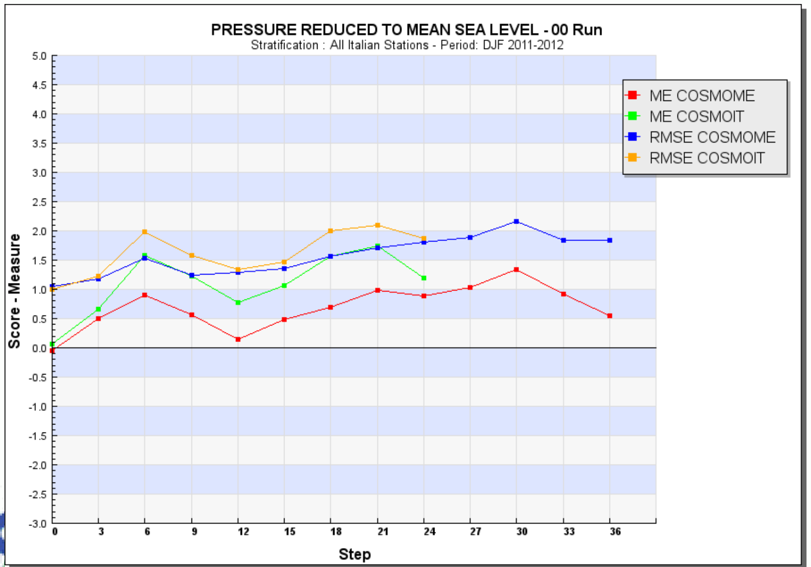


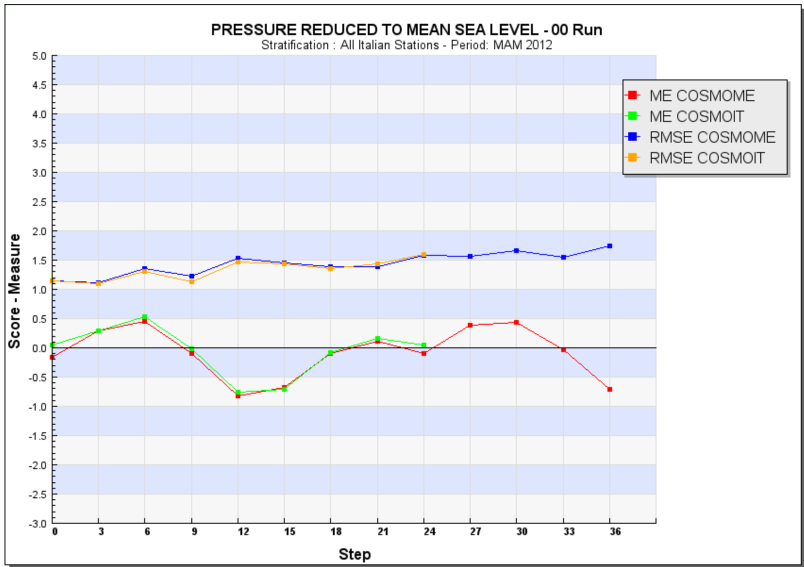


COSMO-ME vs COSMO-IT
MSL Pressure (step 3 h)









MSPL considerations

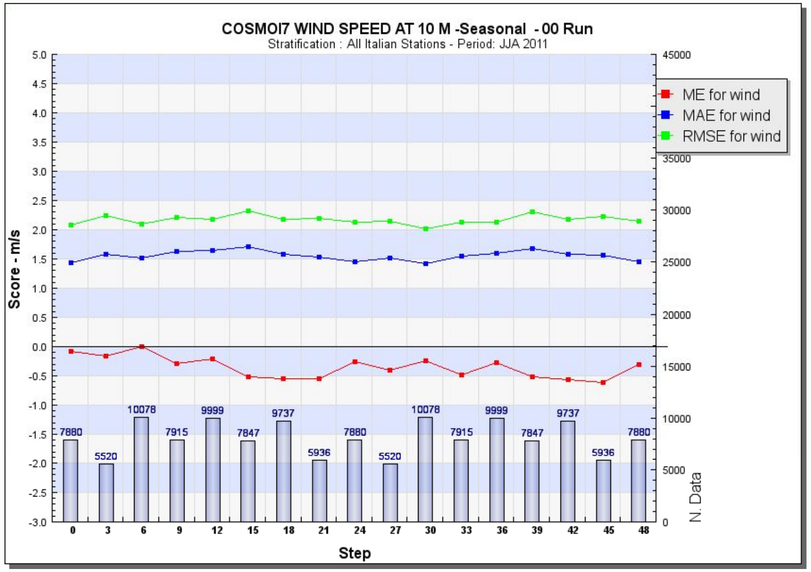
- COSMO-I7 and COSMO-ME
  - different bias depending on season
  - MAE and RMSE have similar trend in all the season except in winter when the errors grow with forecast step

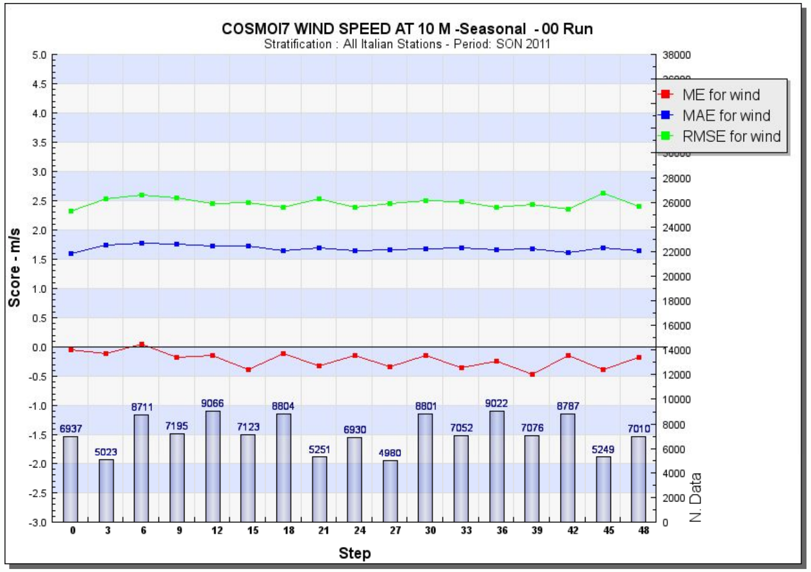
  - respect to ECMWF
    - COSMO models have bigger errors in DJF and MAM, but the difference are less than 1 hPa

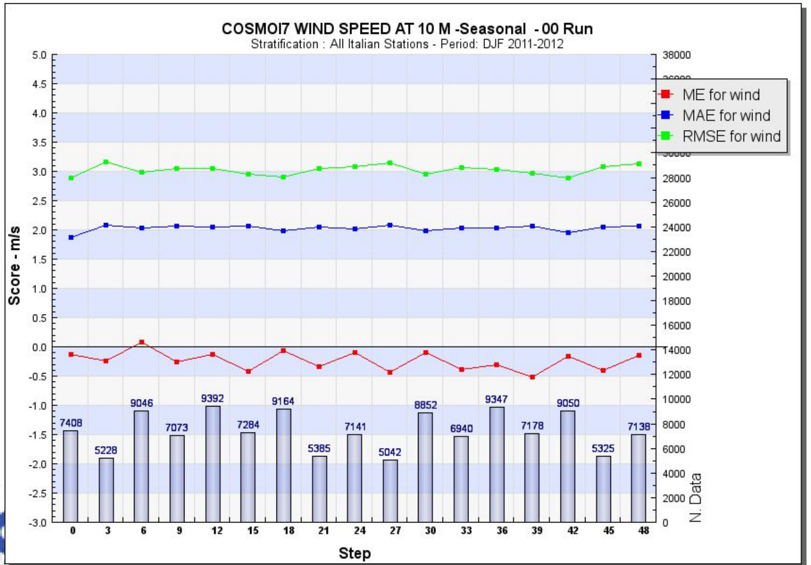
- COSMO-ME vs COSMO-IT
  - very similar in MAM2012
  - COSMO-IT a little worst in RMSE, especially in DJF
  - difference (except MAM2012) in bias

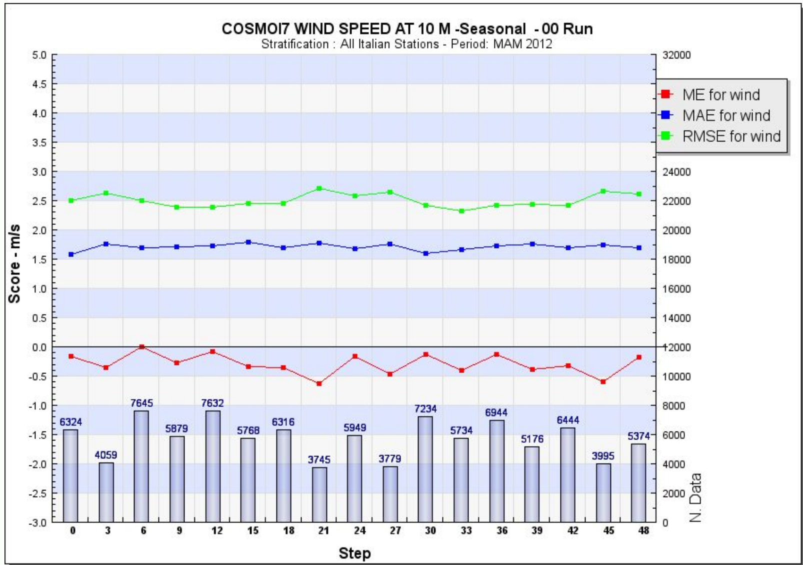
10 M WIND

COSMO-I7
10m Wind speed (step 3h)

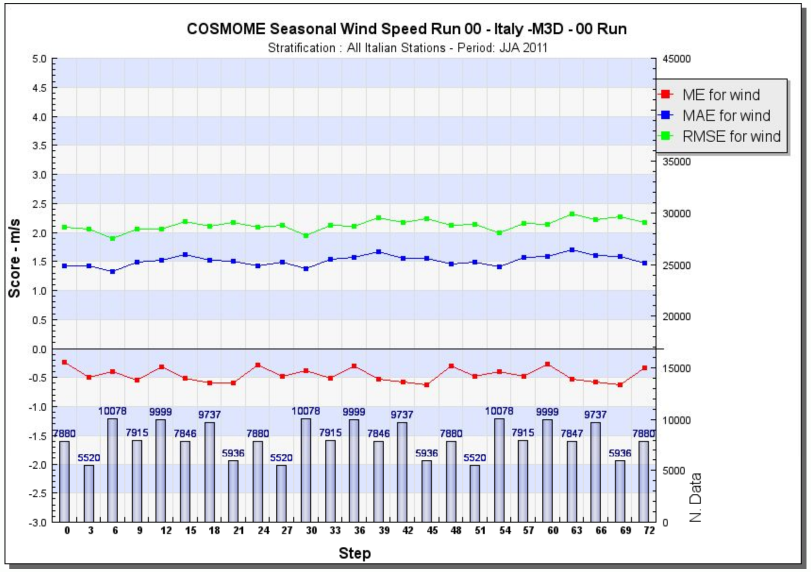


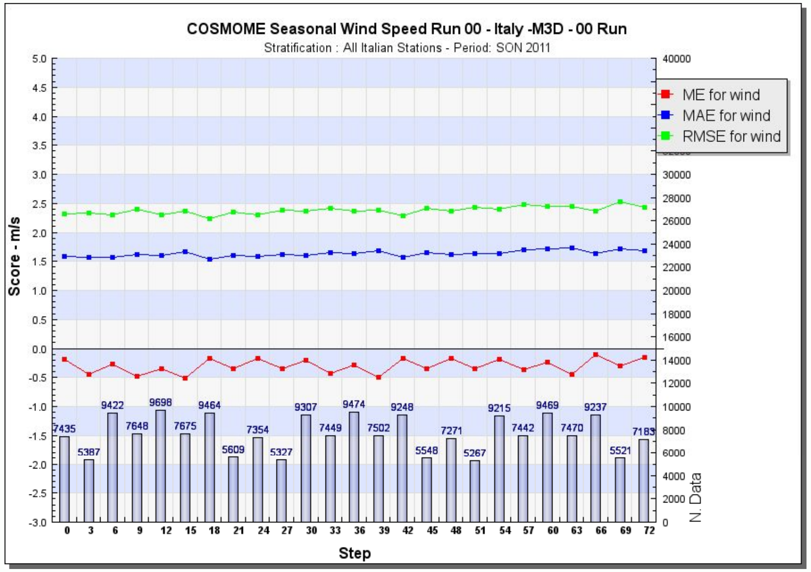


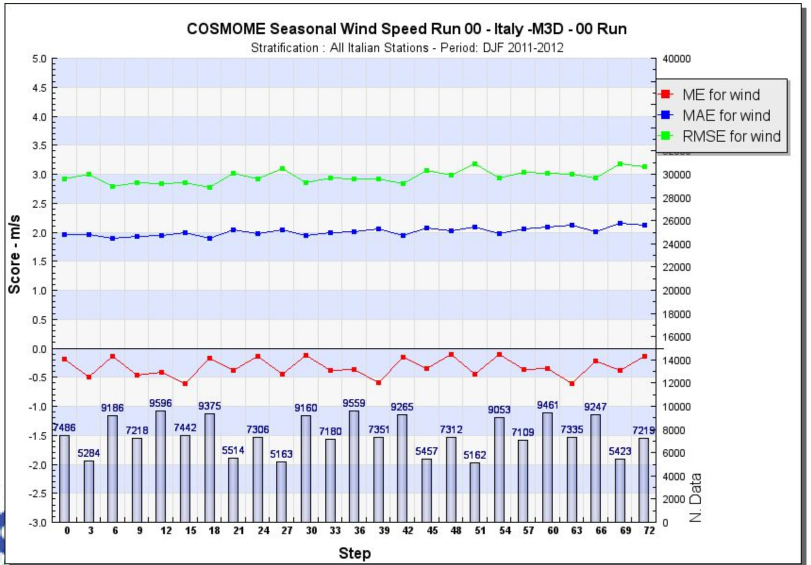


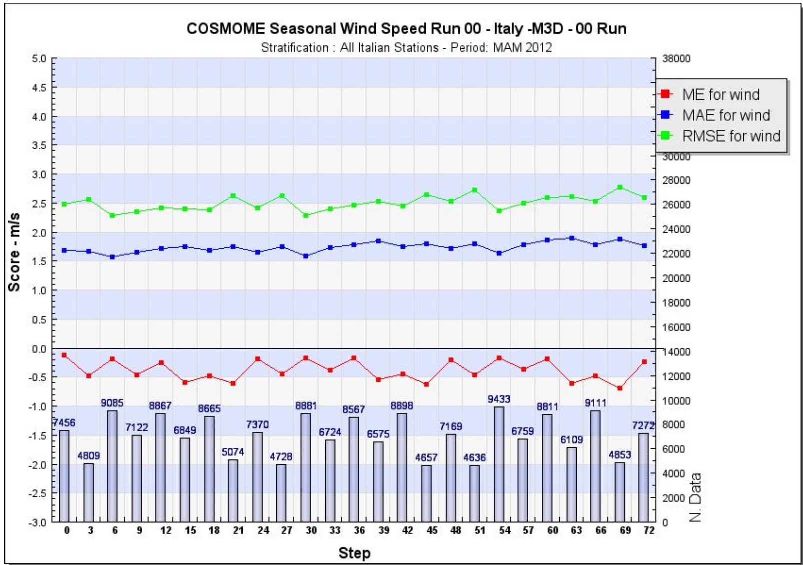


COSMO-ME
10m Wind speed (step 3h)

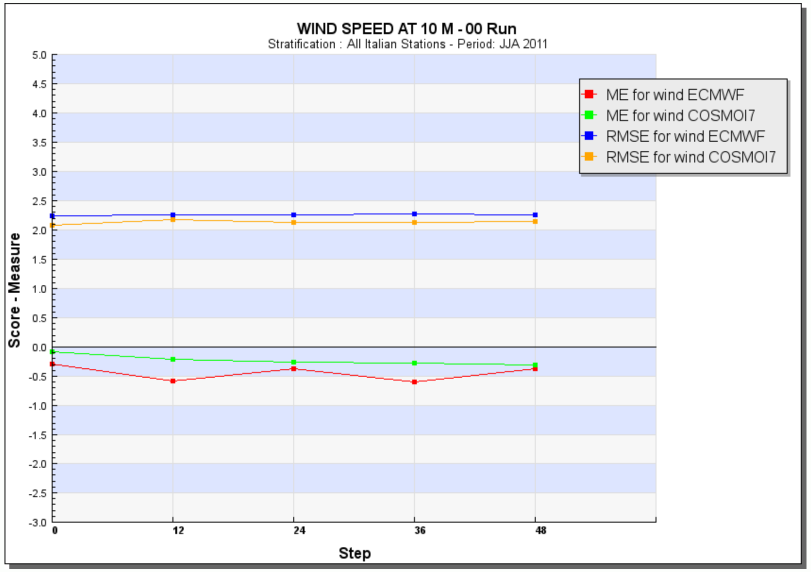


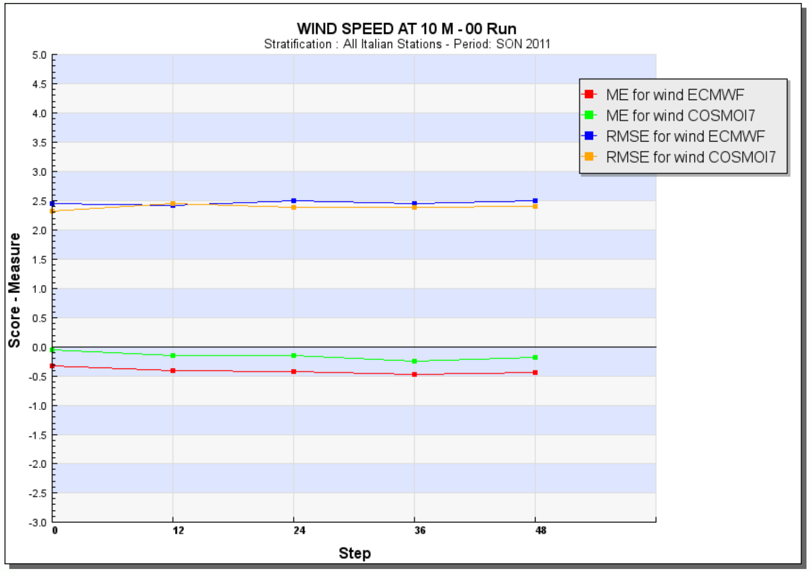


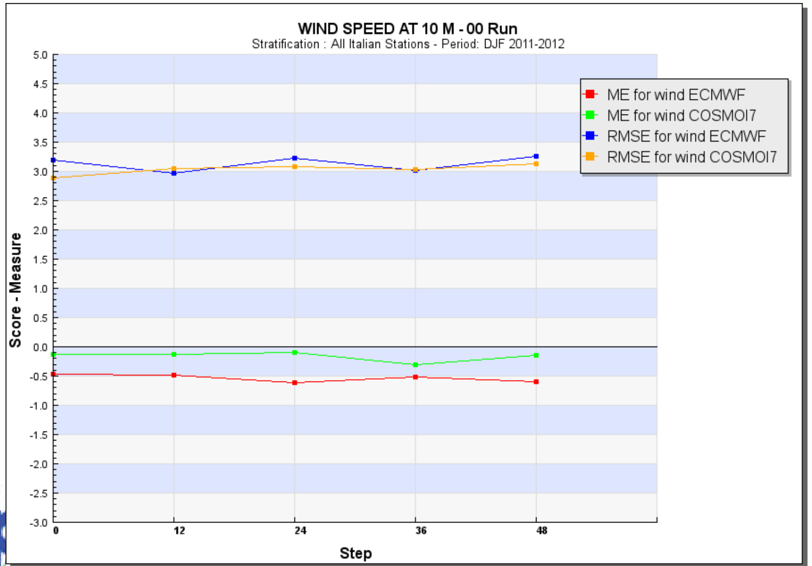


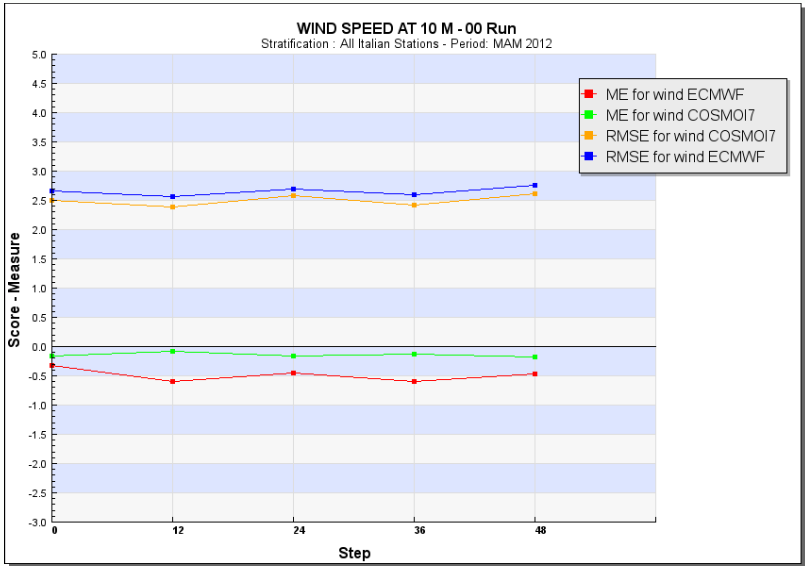


COSMO-I7 vs ECMWF
10m Wind speed (step 12 h)





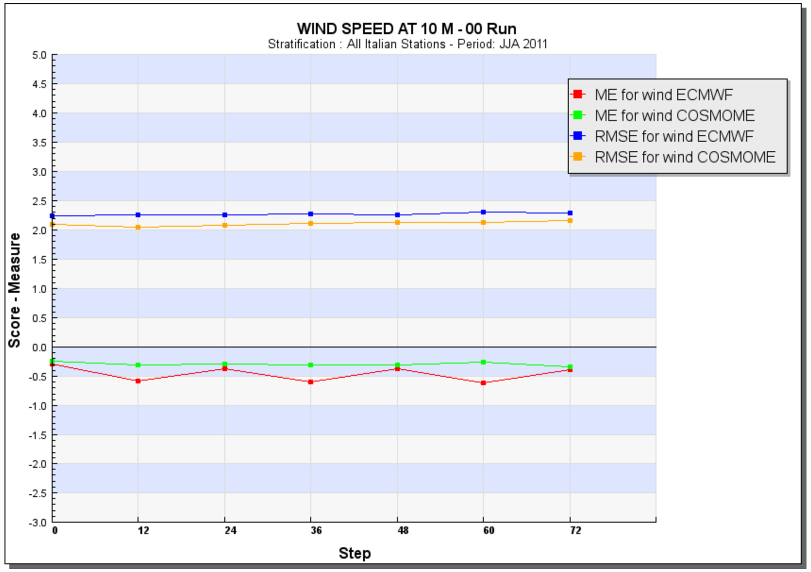


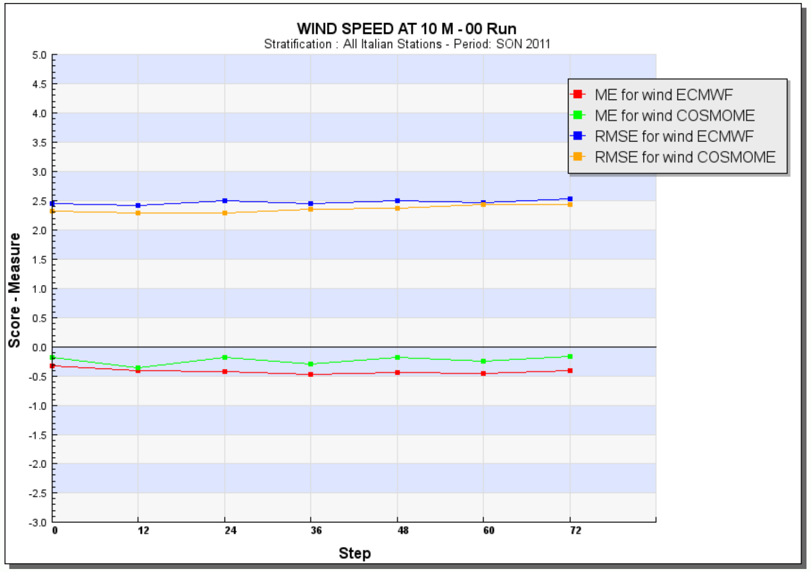


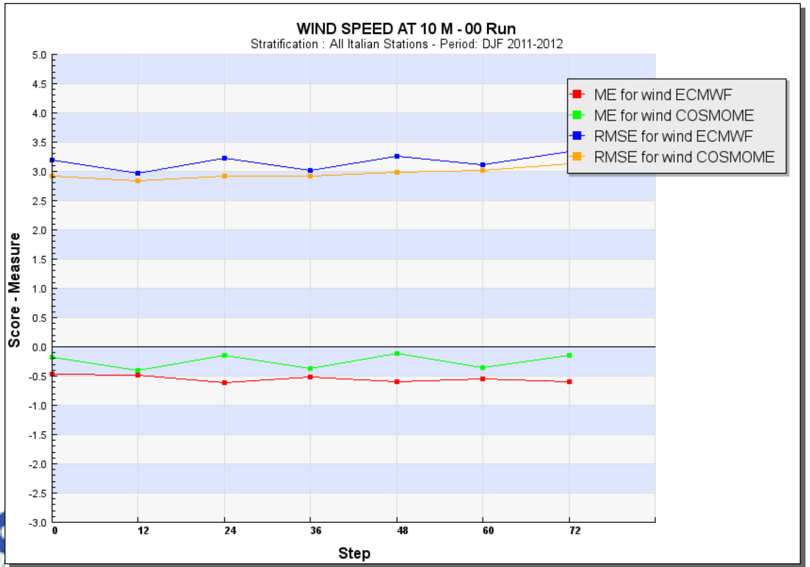
Arpa per la Protezione Ambientale

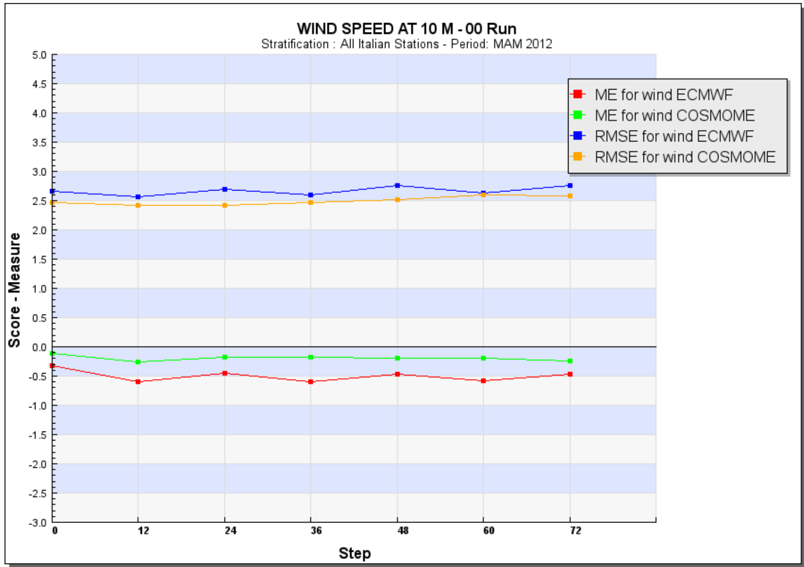
Arpa prevenzione e ambiente dell'emilia-romagna

COSMO-ME vs ECMWF
10m Wind speed (step 12 h)

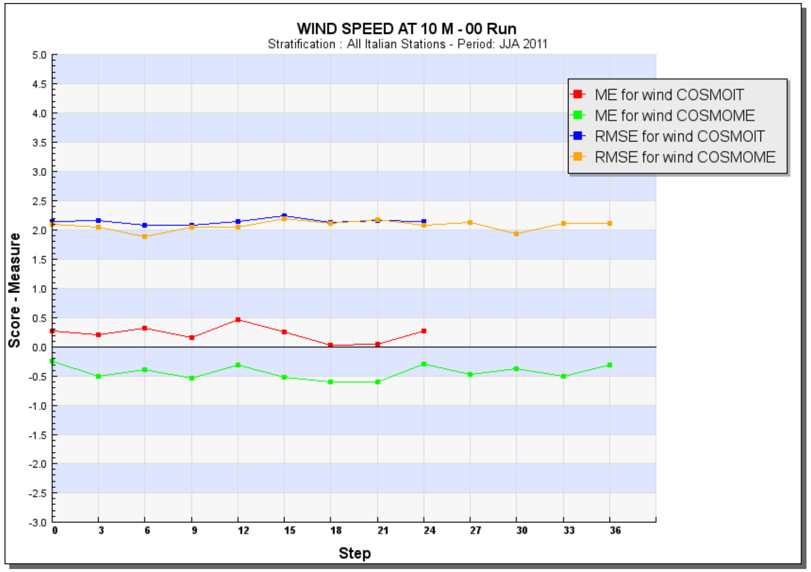


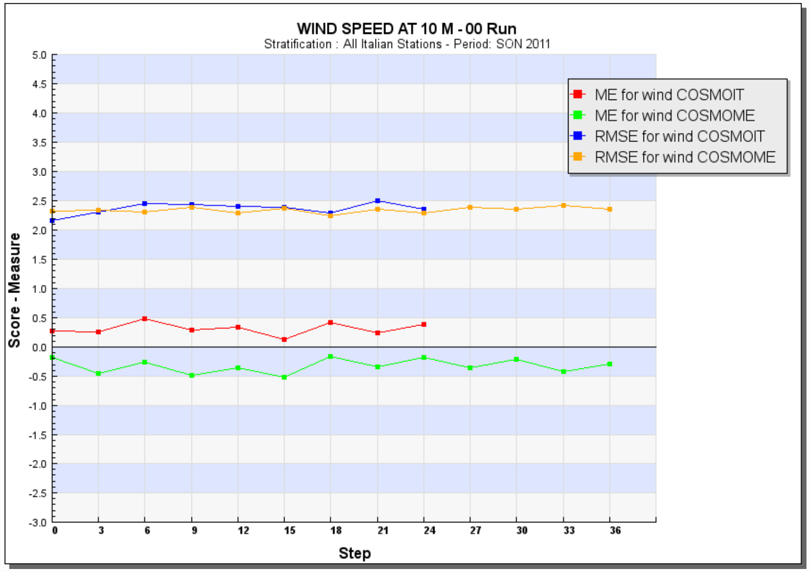


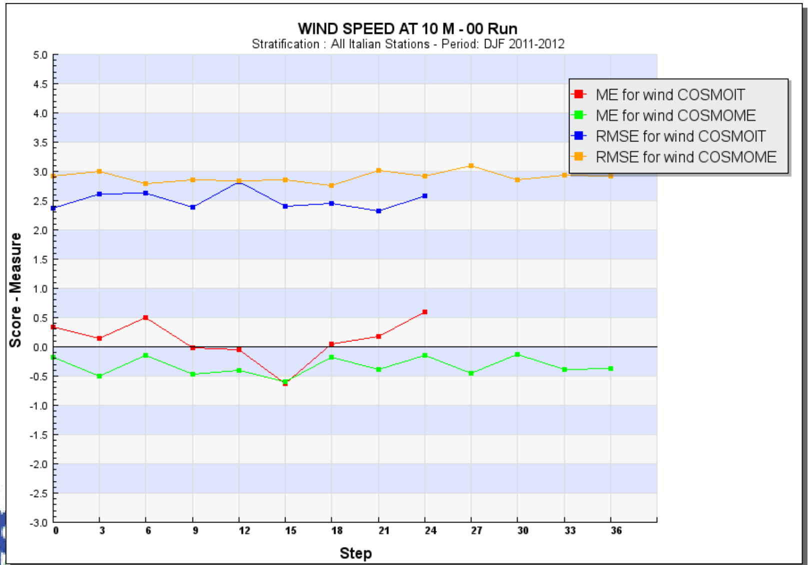


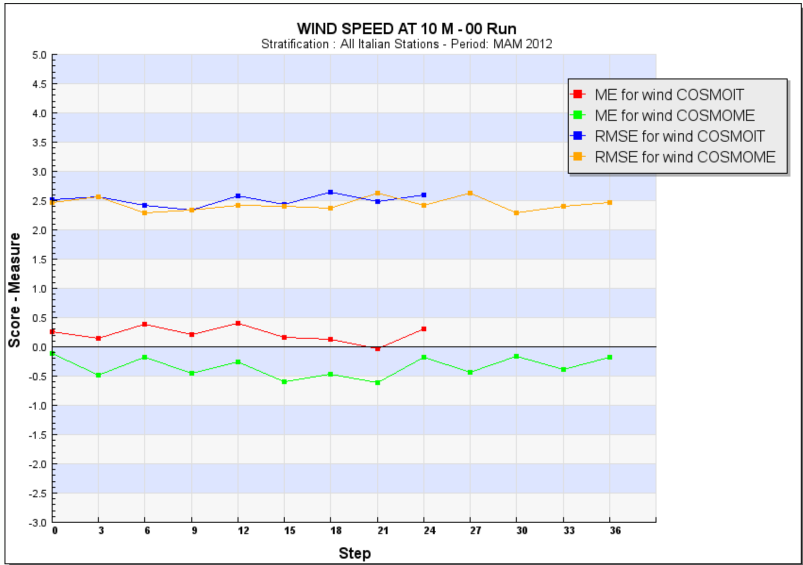


COSMO-ME vs COSMO-IT
10m Wind speed (step 3 h)









per la Protezione Ambientale

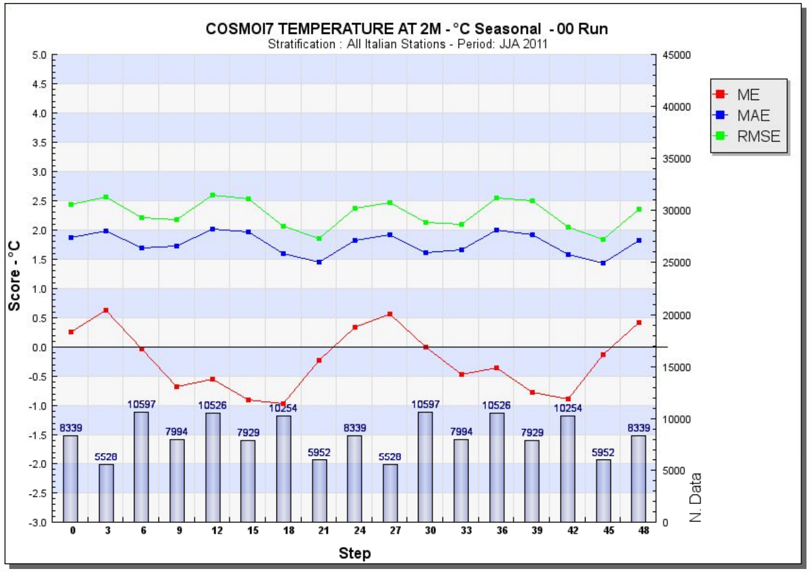
prevenzione e ambiente dell'emilia-romagna

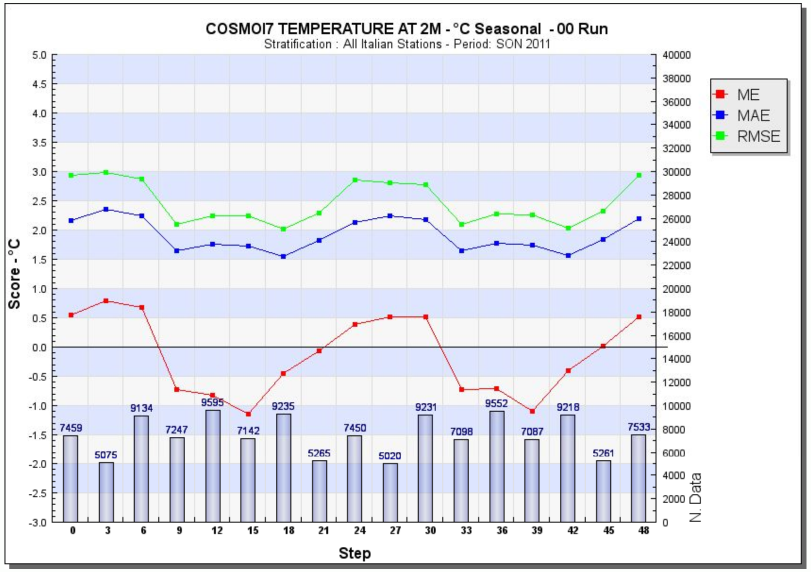
Wind speed considerations

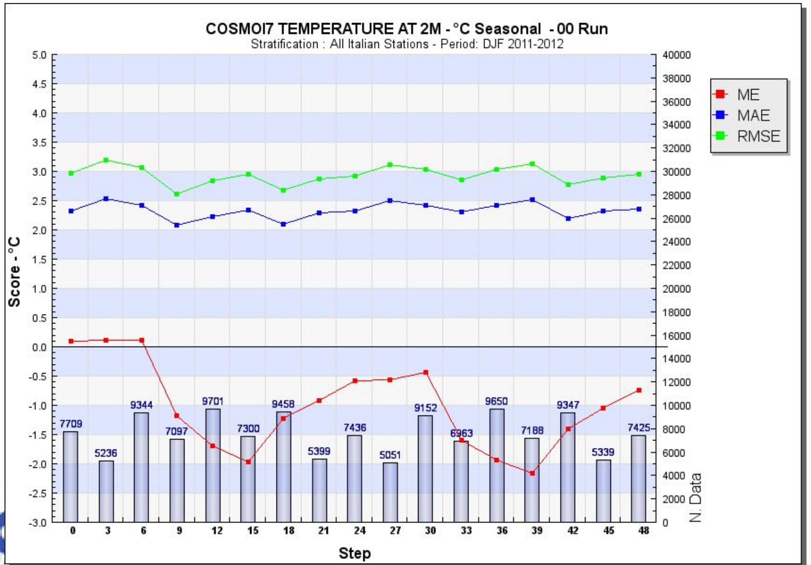
- COSMO-I7 and COSMO-ME
  - negative bias, a little bigger for COSMO-ME (ECMWF has bigger bias)
  - MAE and RMSE constant during the forecast step
    - MAE around 1.5 m/s (2 m/s in DJF)
    - RMSE around 2.5 m/s (3 m/s in DJF)
    - Non significant differences respect to ECMWF (COSMO-ME slightly better)
  - COSMO-ME vs COSMO-IT
    - COSMO-IT has positive bias in JJA, SON and MAM (DJF has negative value for ME at 15 UTC)
    - RMSE similar except for DJF when COSMO-IT is better

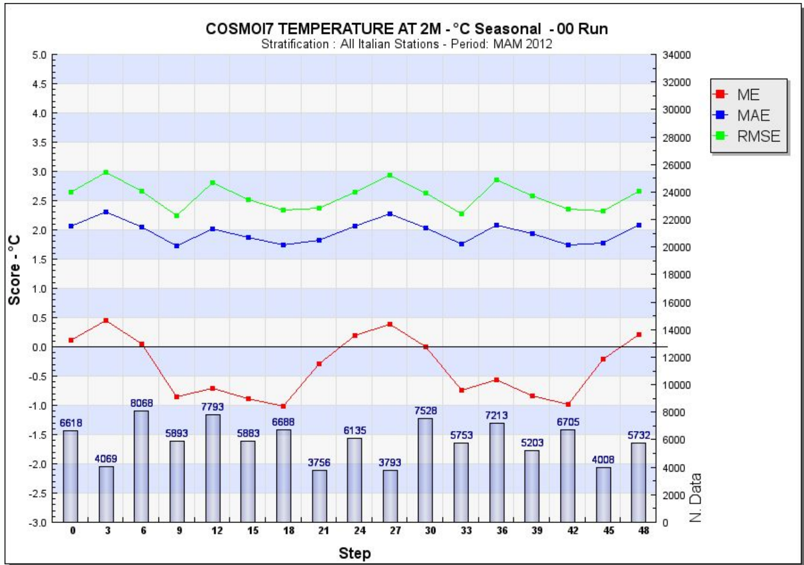
2M TEMPERATURE

COSMO-I7
2m Temperature (step 3h)



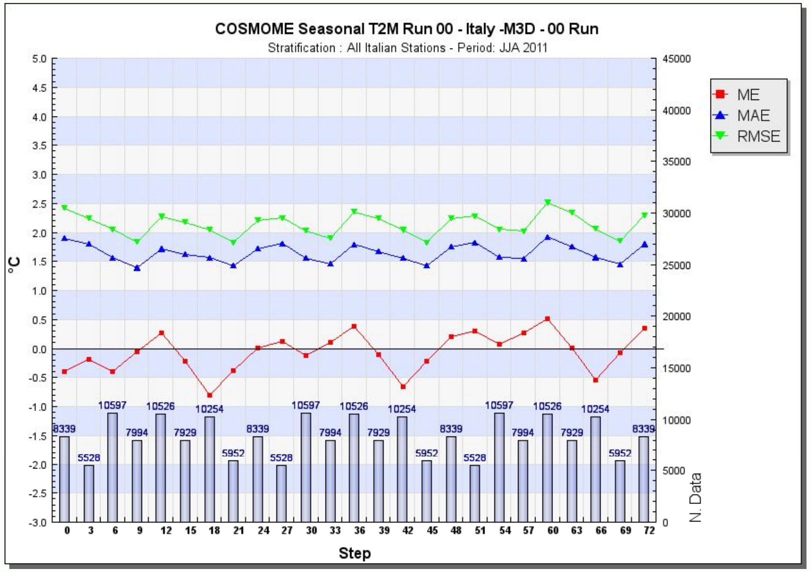


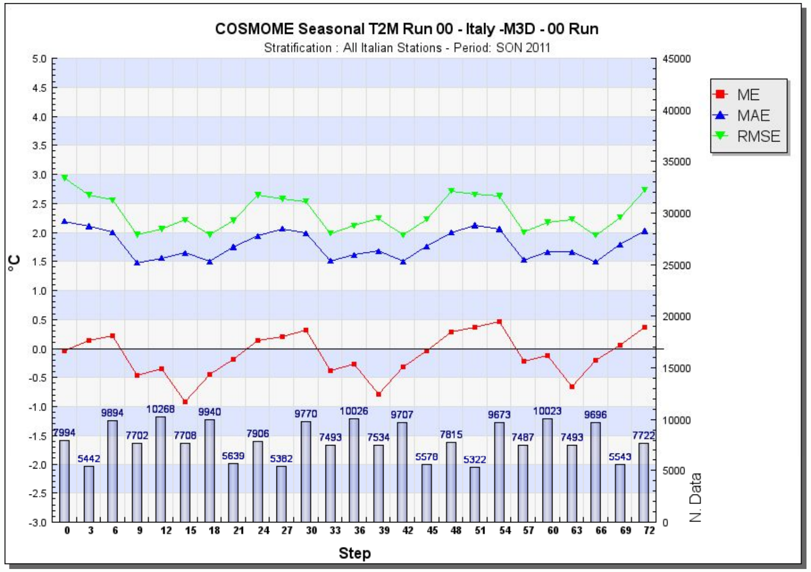


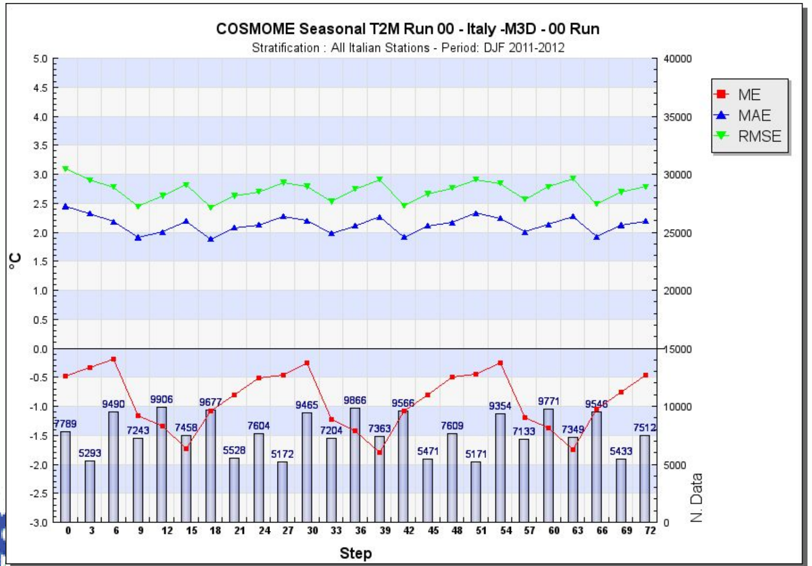


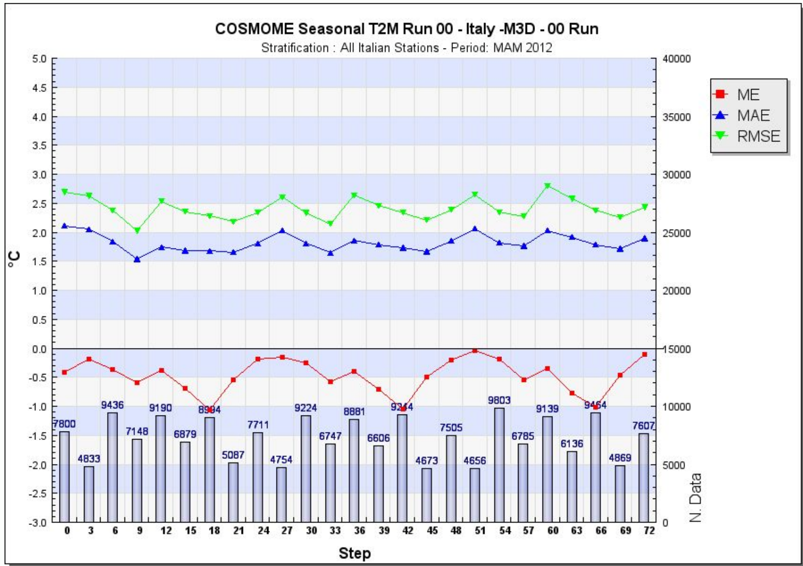
COSMO-ME

2m Temperature (step 3h)

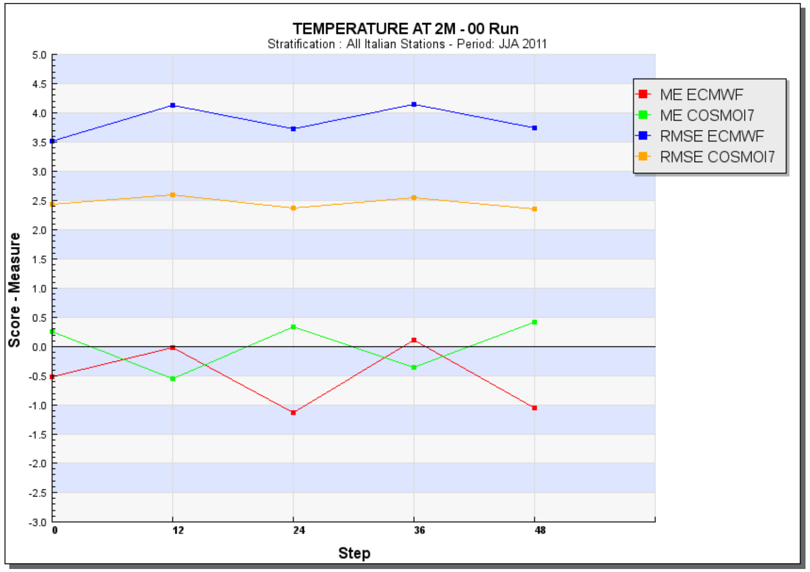


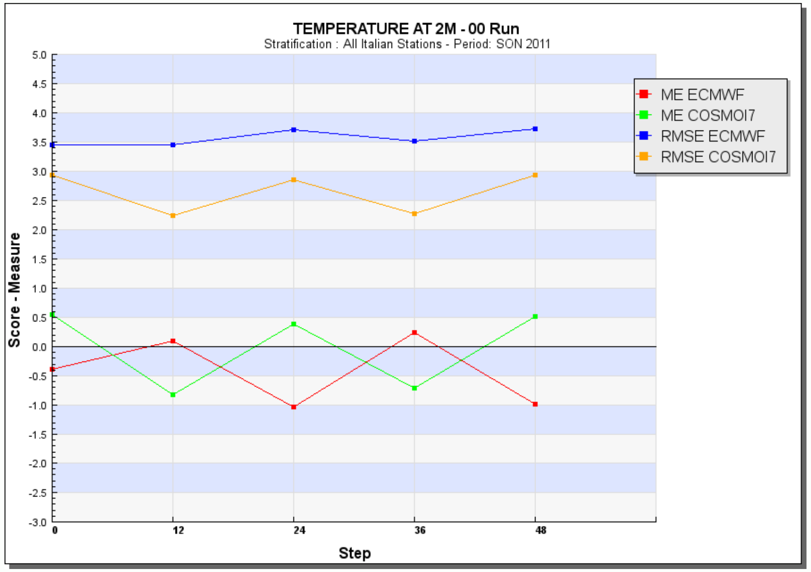


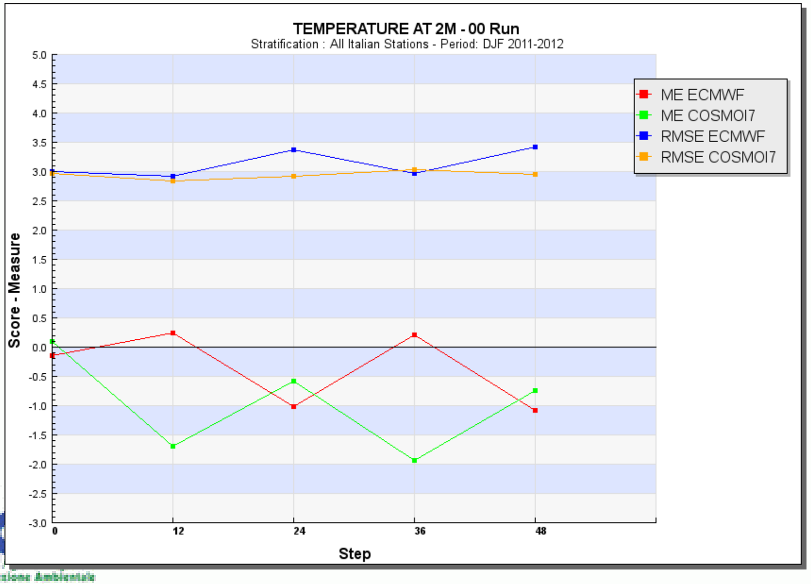


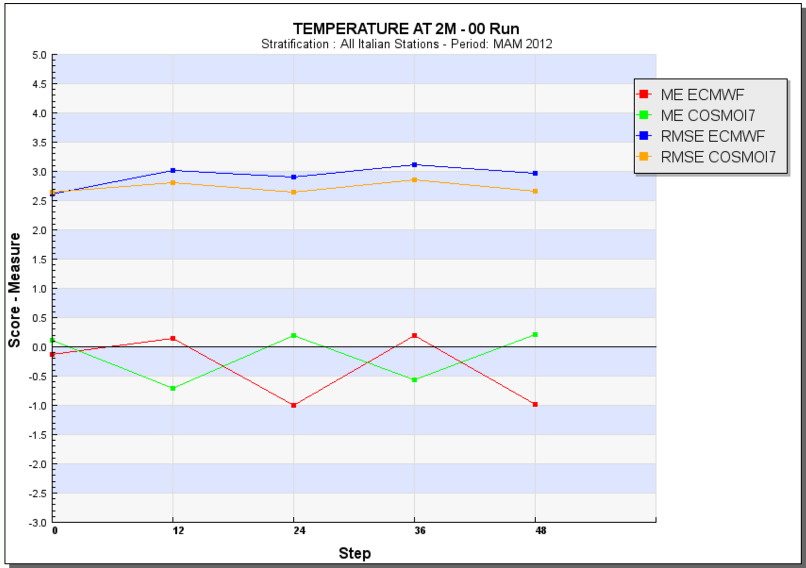


COSMO-I7 vs ECMWF
2m Temperature (step 12 h)









per la Protezione Ambientale

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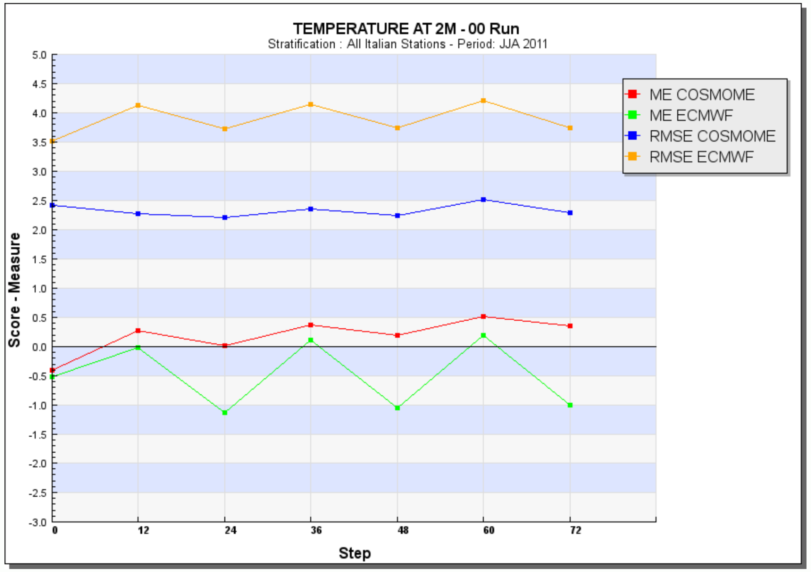
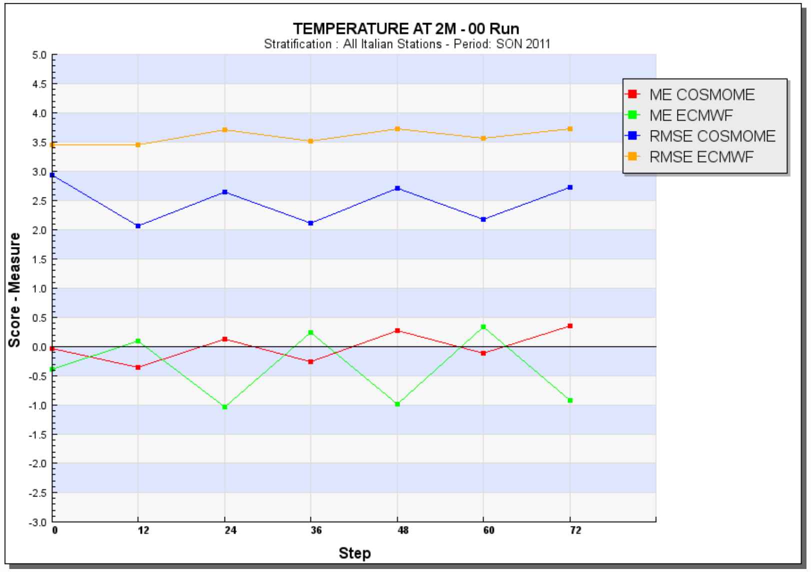
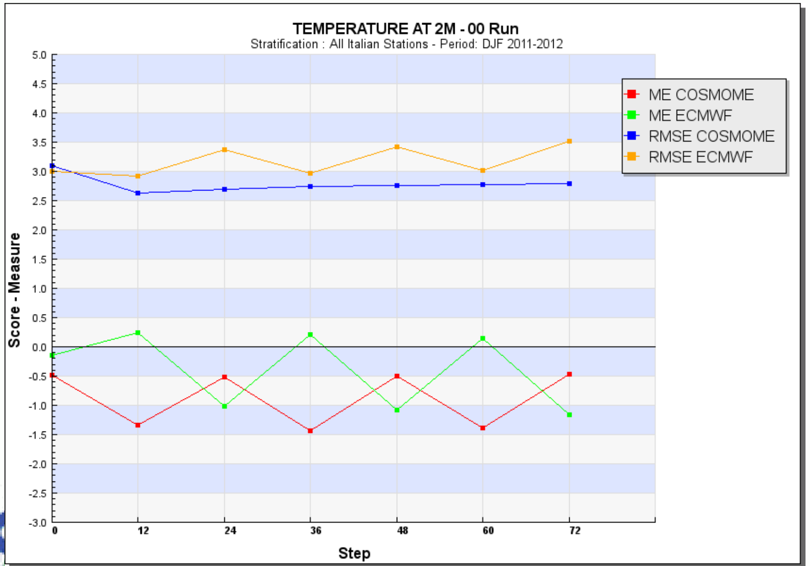
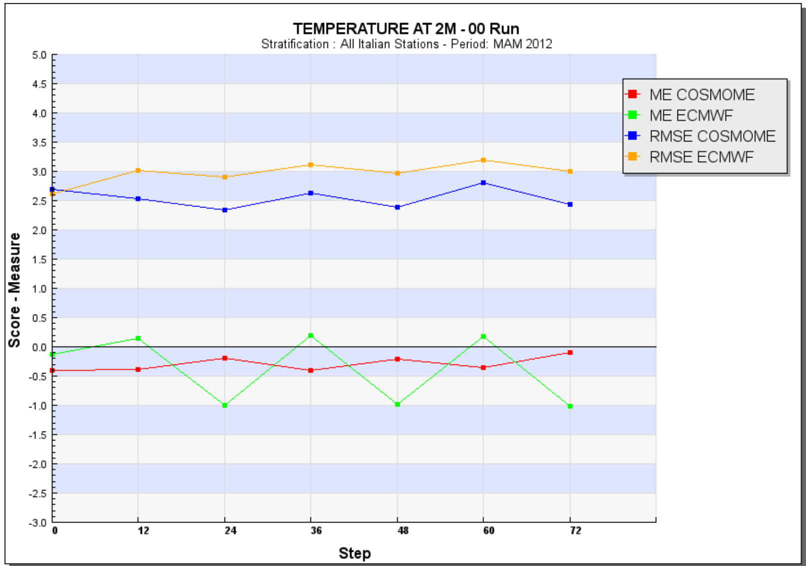
COSMO-ME vs ECMWF
2m Temperature (step 12 h)

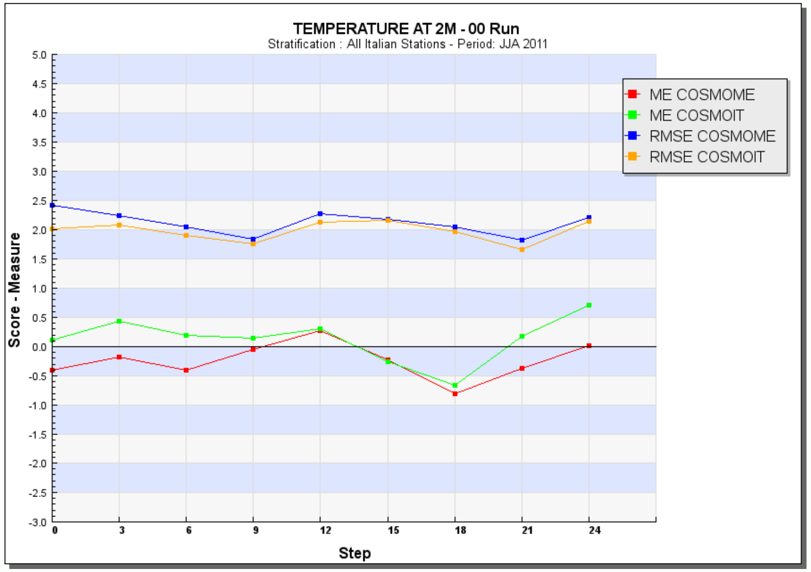


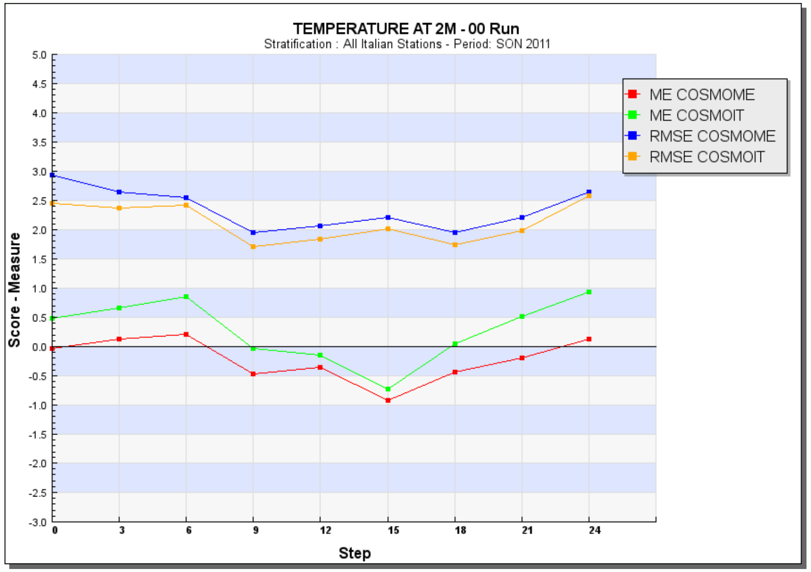


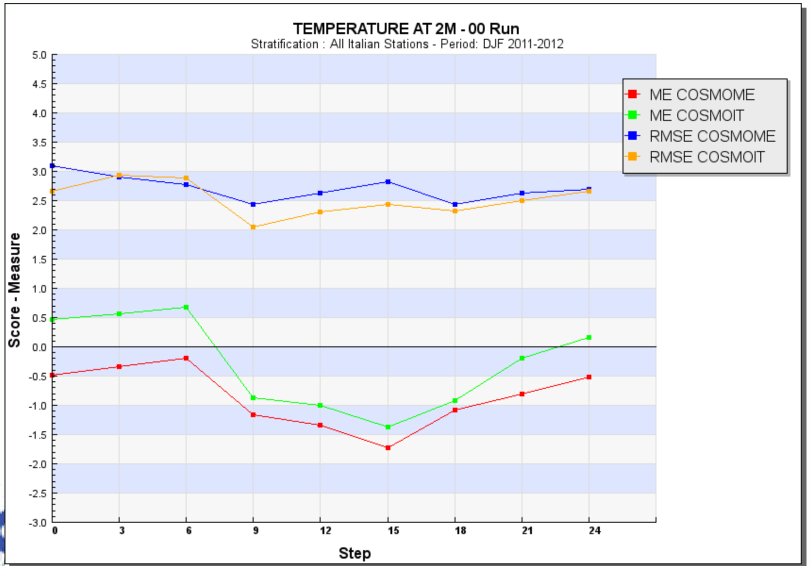


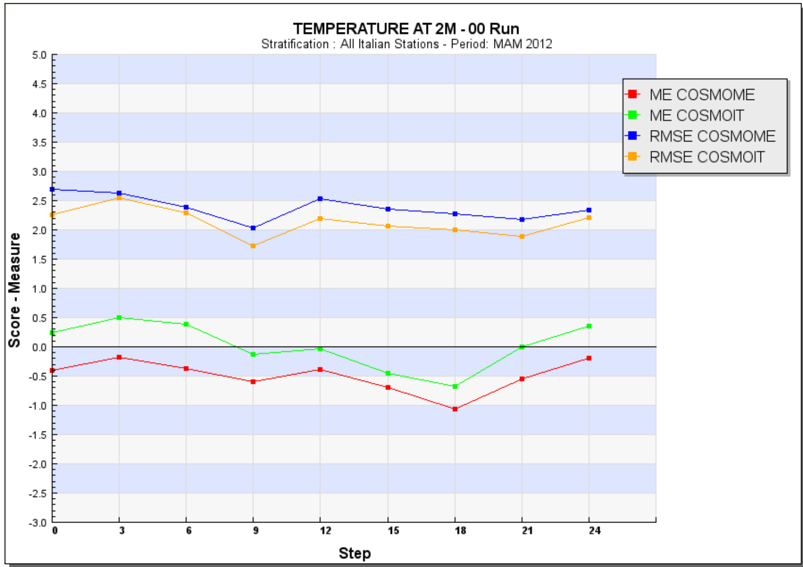


COSMO-ME vs COSMO-IT 2m Temperature (step 3 h)









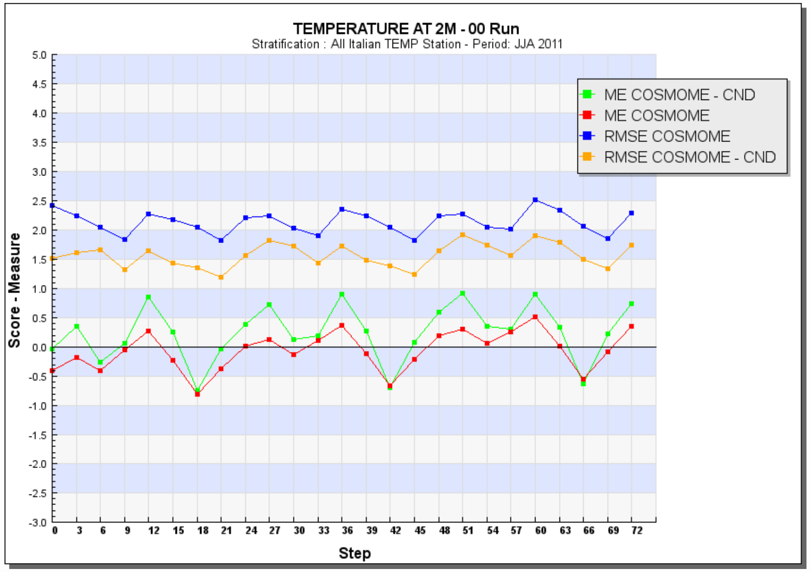
T2m considerations

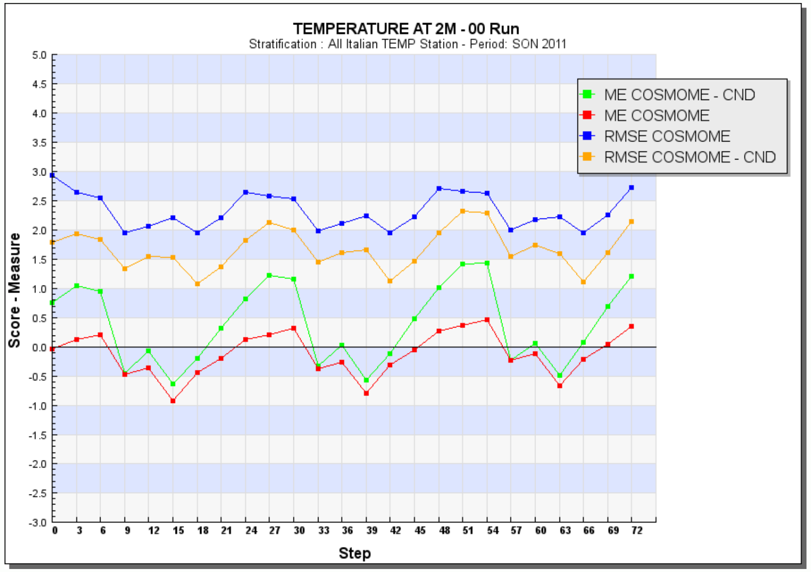
- ME with a “typical” diurnal cycle: overestimation during night and underestimation during day
- This behavior is masked during DJF for both 7 Km-COSMO and MAM for COSMO-ME because model temperature is generally too low
- ECMWF has opposite diurnal cycle of ME respect to COSMO models

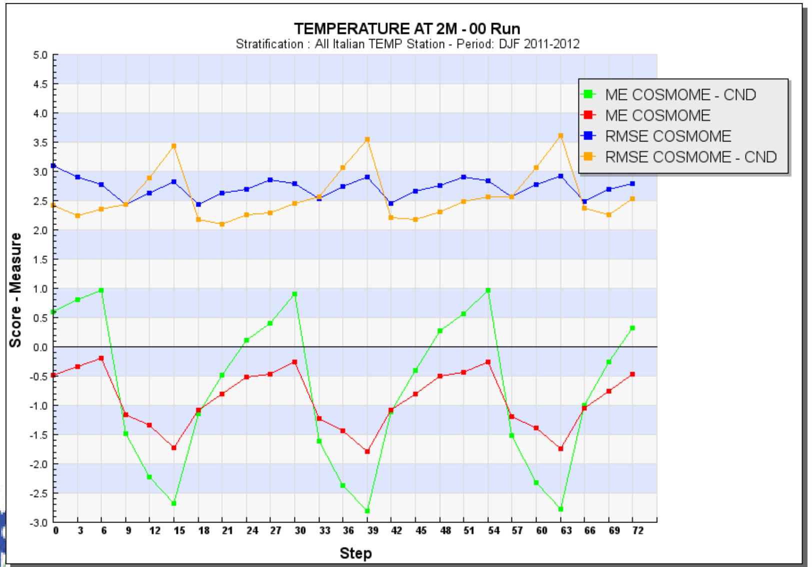
  MAE varies between 1.5 and 2.5 degrees (COSMO-ME slightly better) and RMSE between 2.5 and 3 degrees. Errors over all Italian stations are smaller than ECMWF
- COSMO-IT is a little better than COSMO-ME, the ME is less negative but the cycle of the error is the same

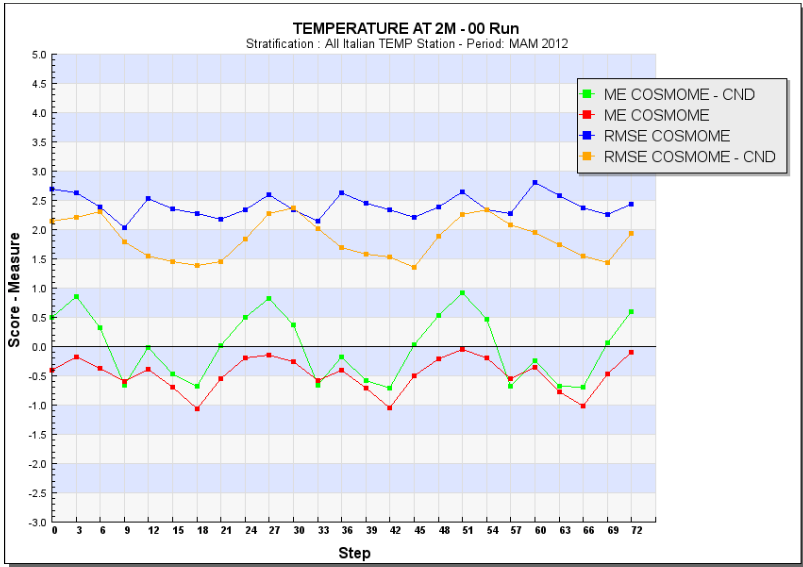
COSMO-ME Conditional Verification

T2m when observed TCC ≤ 25%



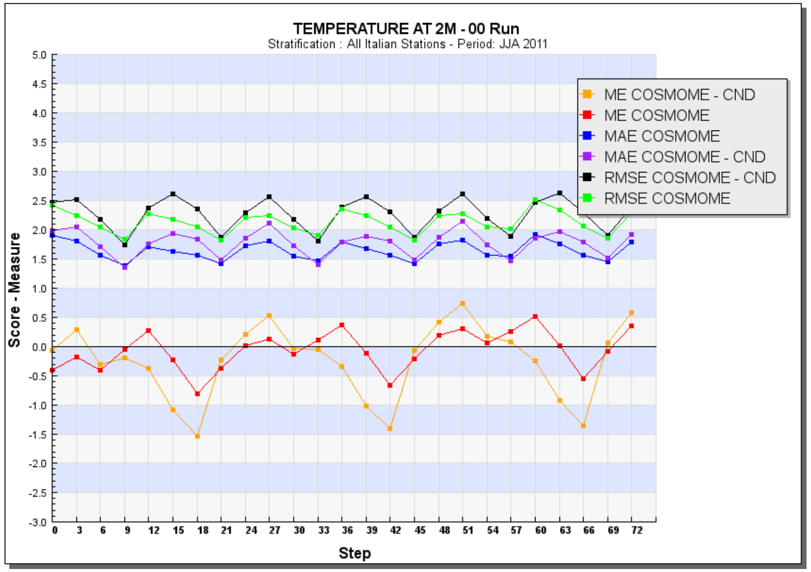


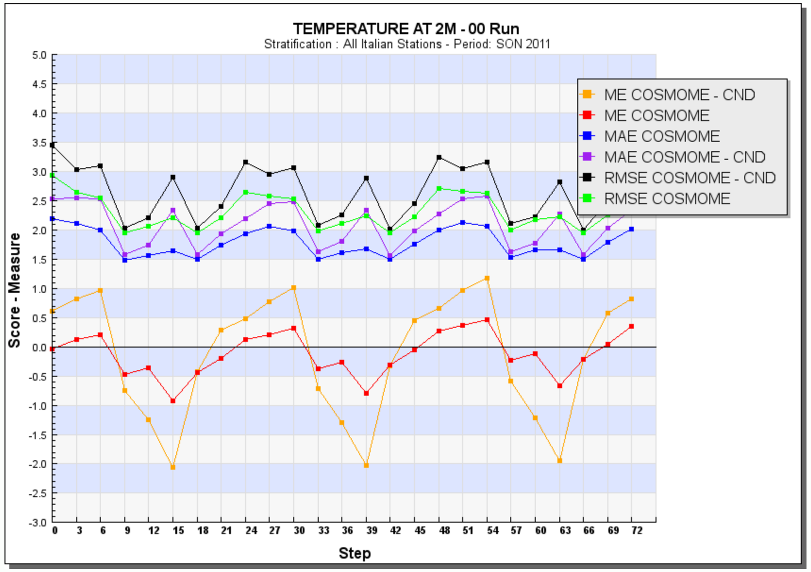


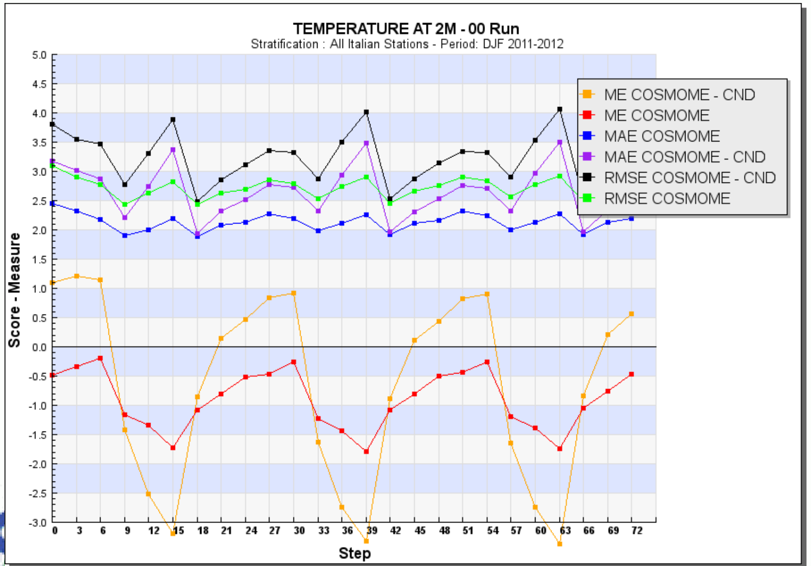


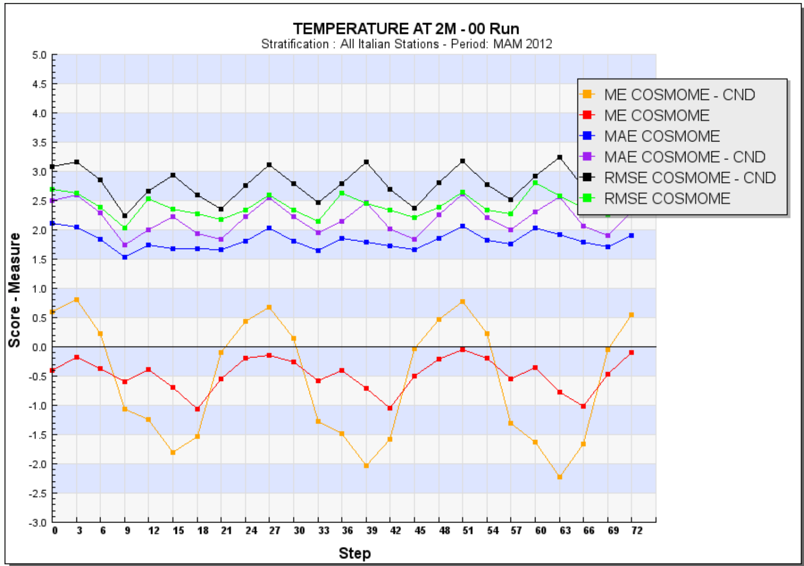
COSMO-ME Conditional Verification

T2m when observed TCC ≤ 25% & wind speed ≤ 2 m/s







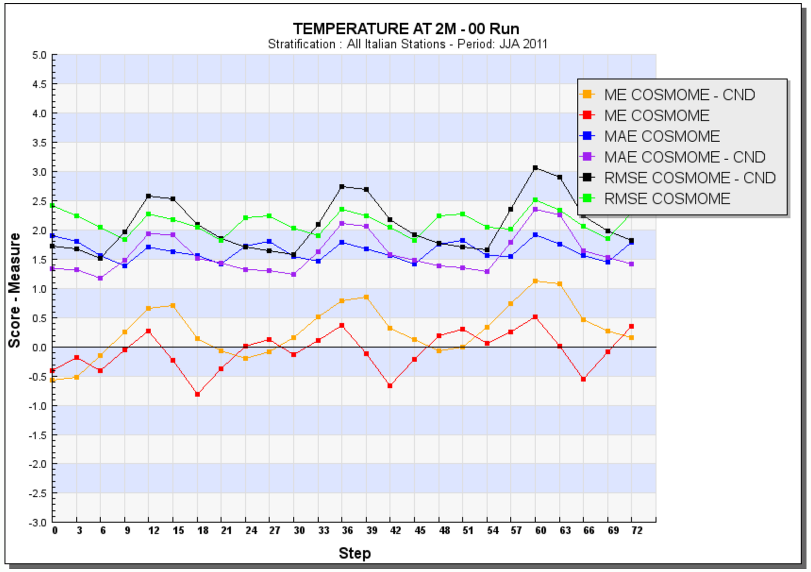


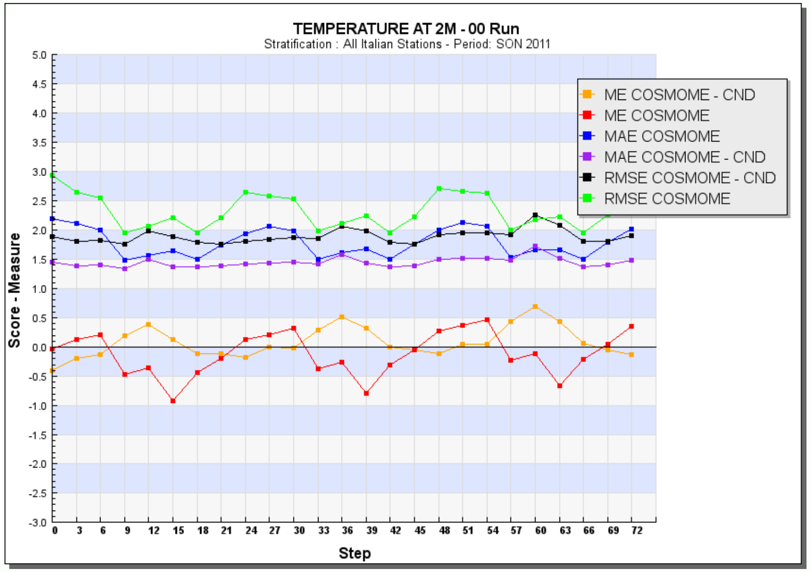
per la Protezione Ambientale

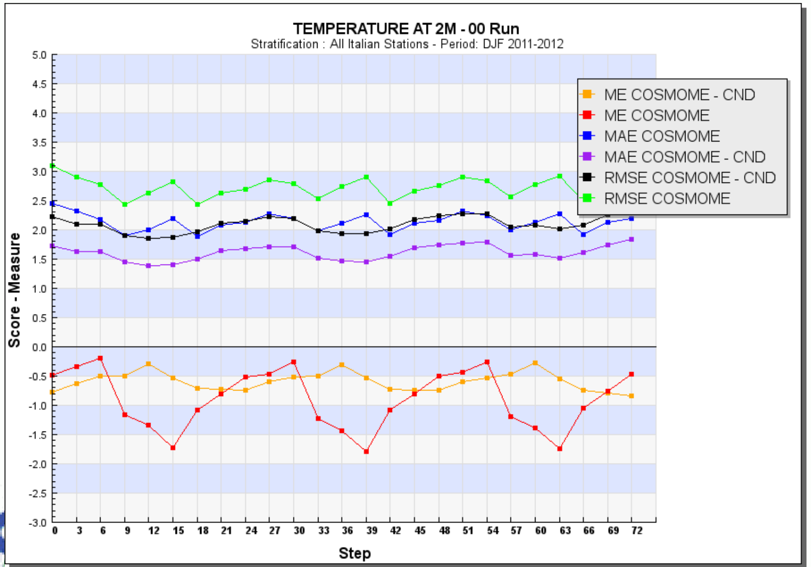
prevenzione e ambiente dell'emilia-romagna

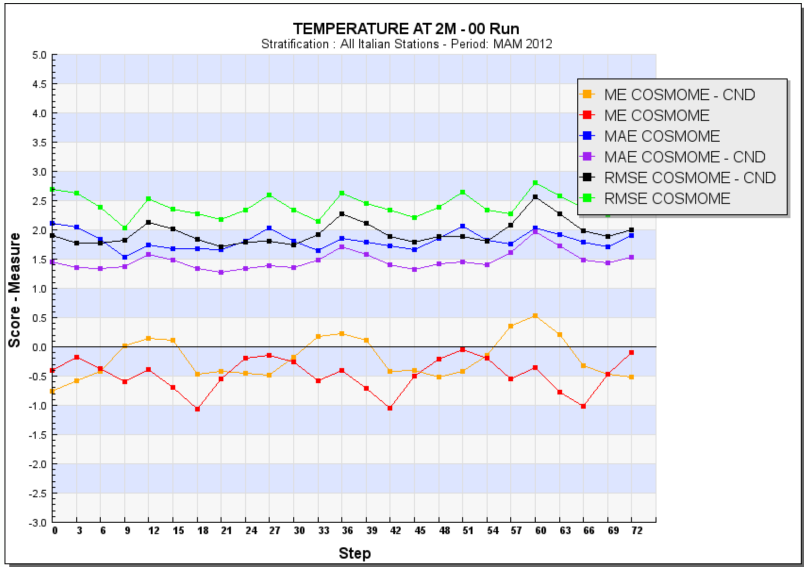
COSMO-ME Conditional Verification

T2m when observed TCC ≥75%









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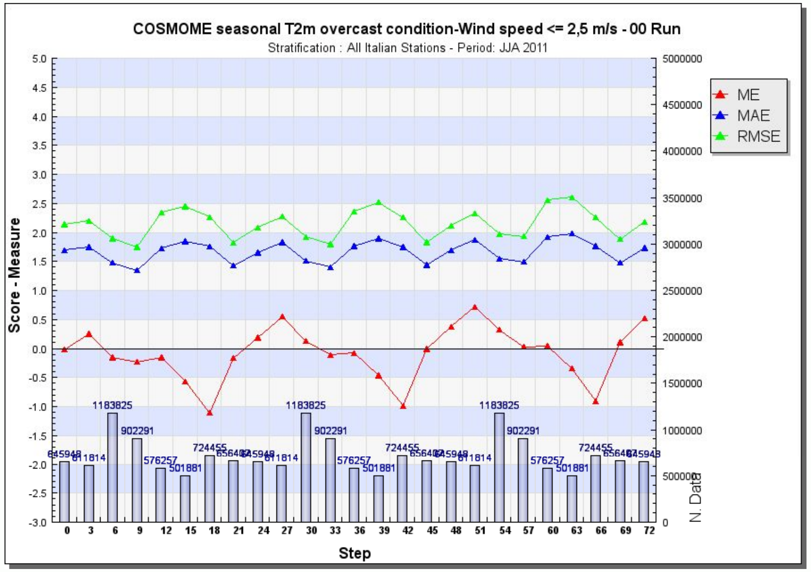
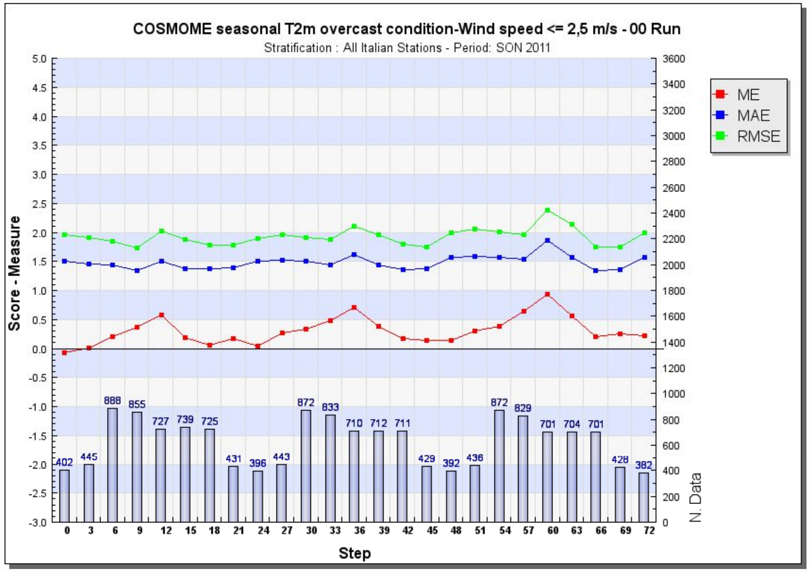
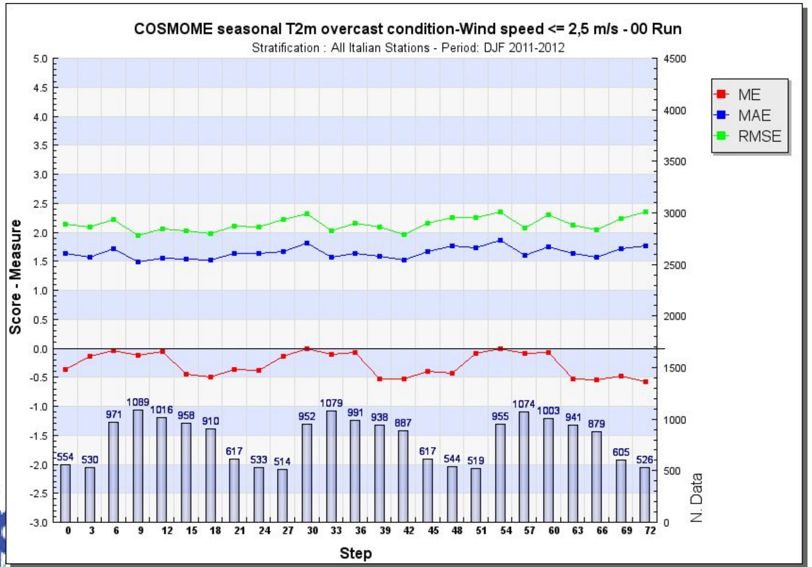
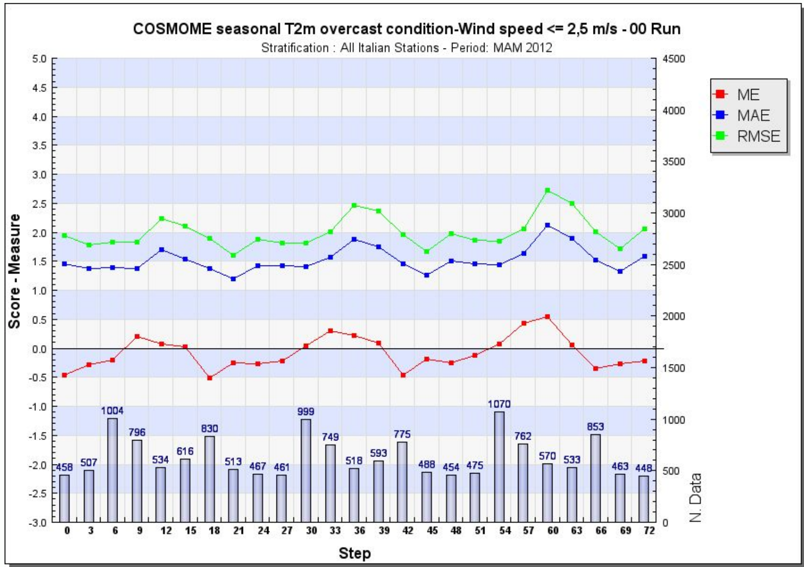
COSMO-ME Conditional Verification

T2m when observed TCC ≥75% & wind speed ≤ 2 m/s









T2m CV considerations

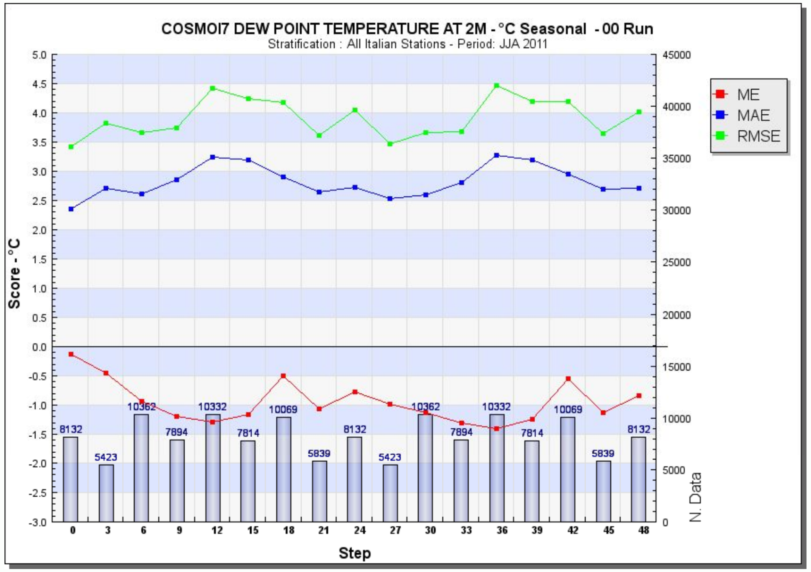
COSMO-ME:

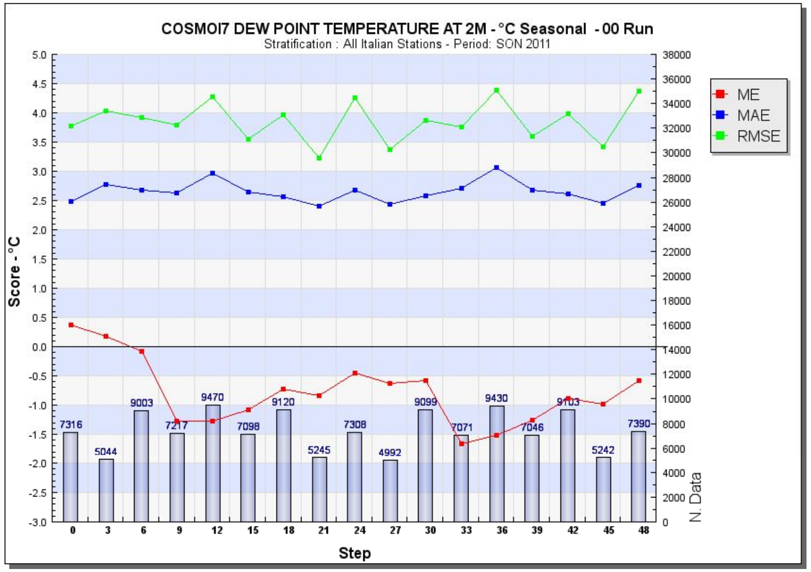
- In clear sky conditions (observed) the amplitude of the diurnal cycle of bias increases
  - In very low wind conditions the amplitude of the diurnal cycle of the bias further increase. Bias during the night hours becomes positive, bias in the central hours of the day becomes more negative
  - MAE and RMSE increase in clear sky condition and the error lines show several peaks during nighttime and at 15 UTC when the underestimation is bigger.
  - Windless condition amplify these features
- In cloudy condition the errors has a lesser amplitude, the mean bias is shifted toward higher temperature and the diurnal cycle is a bit different
  - This cause an increase in the error in JJA during daytime and a general decrease of errors in the other season.
  - Windless condition has no clear effects
- Further conditional verification studies have been done at ARPA-ER on COSMO-I7 (shown in the web conference of August 27^{th}) – results are in the same direction!

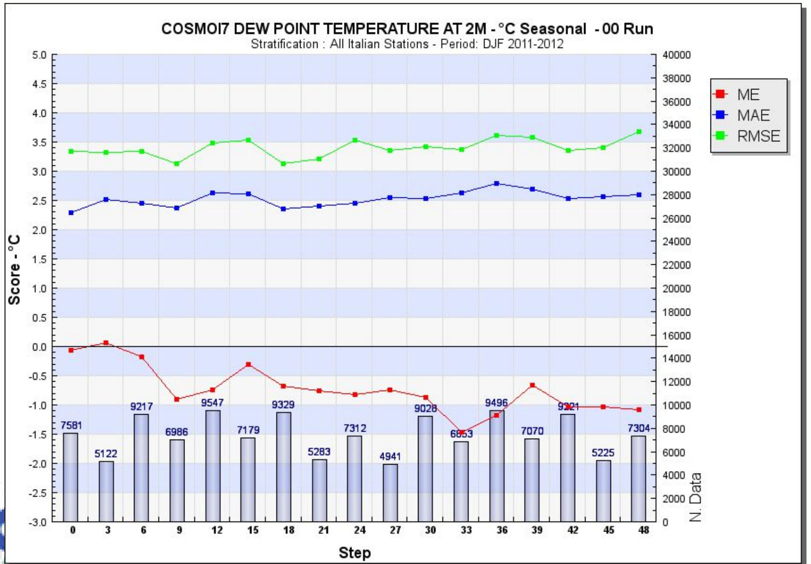
2M DEW POINT TEMPERATURE

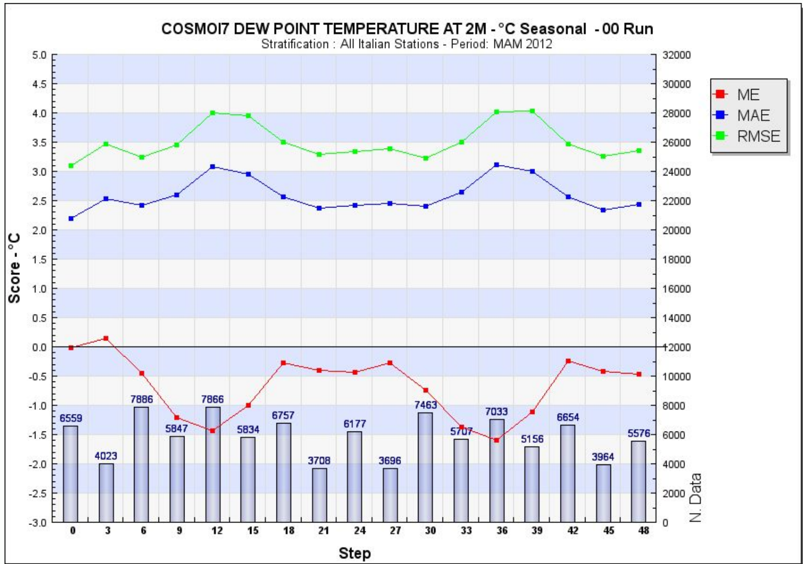
COSMO-I7

2m Dew Point Temperature (step 3h)





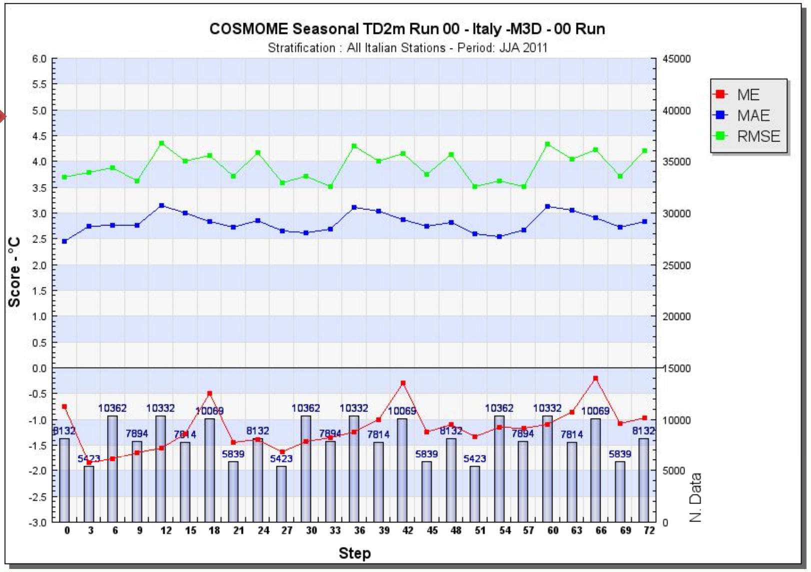


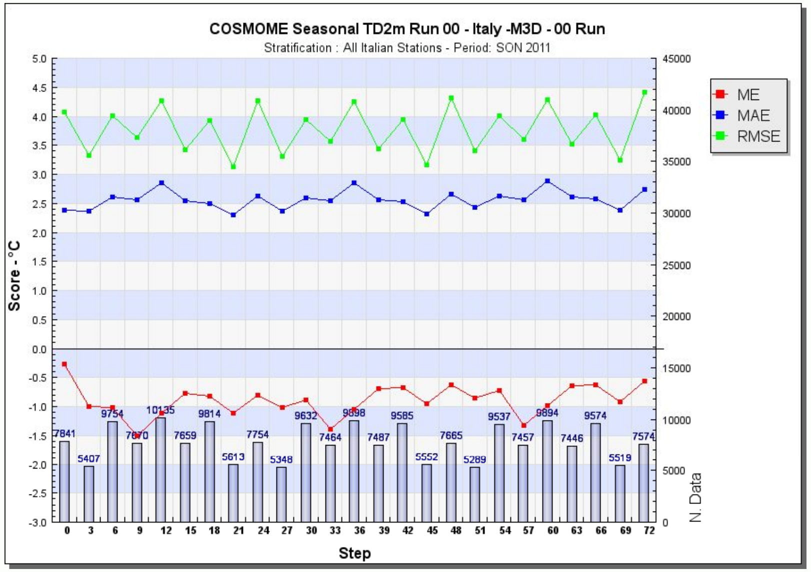


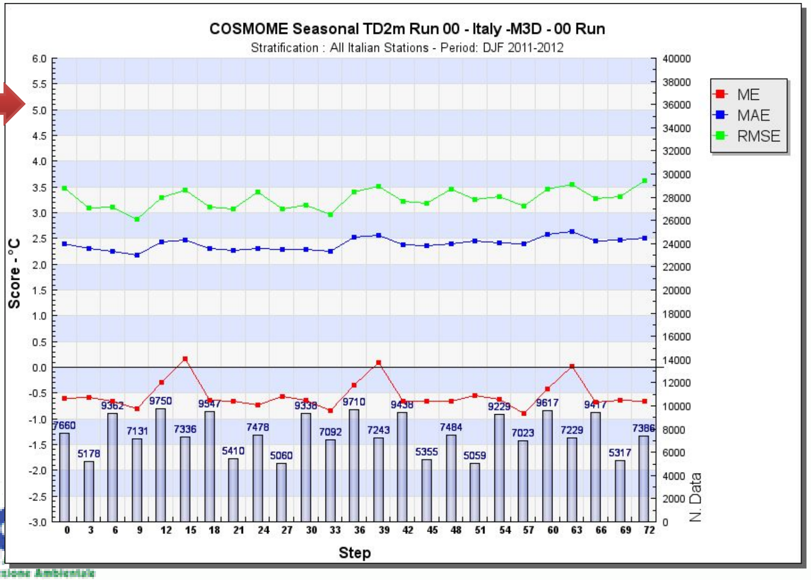
COSMO-ME

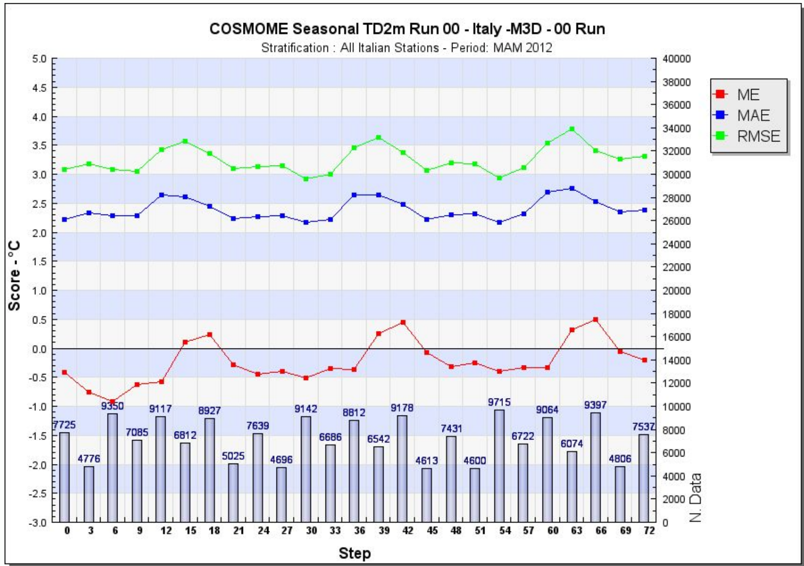
2m Dew Point Temperature (step 3h)

Different scale!

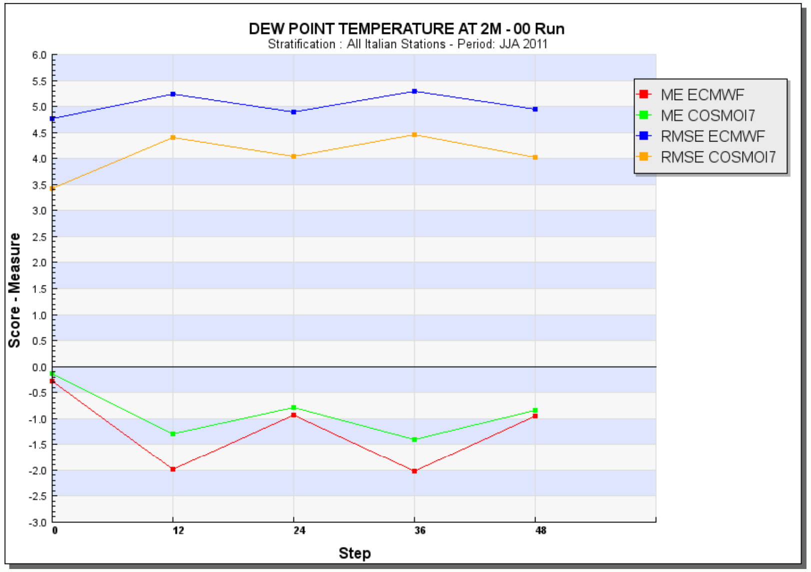


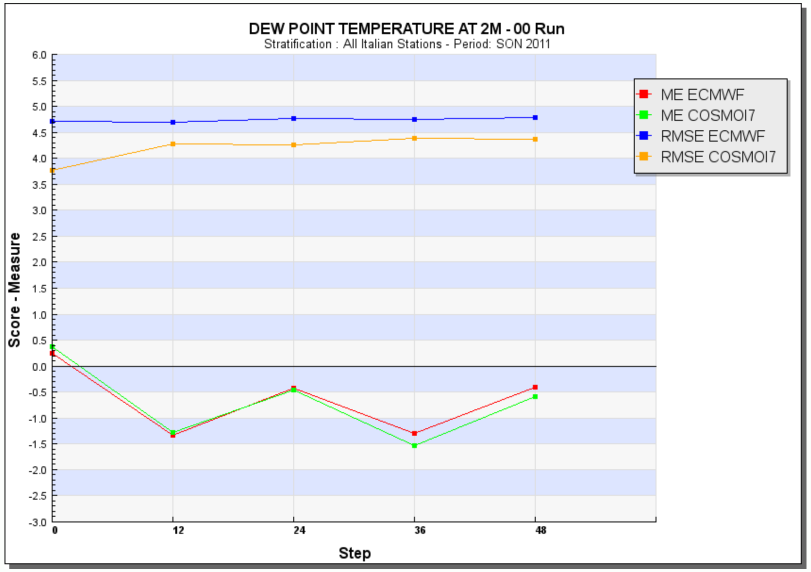


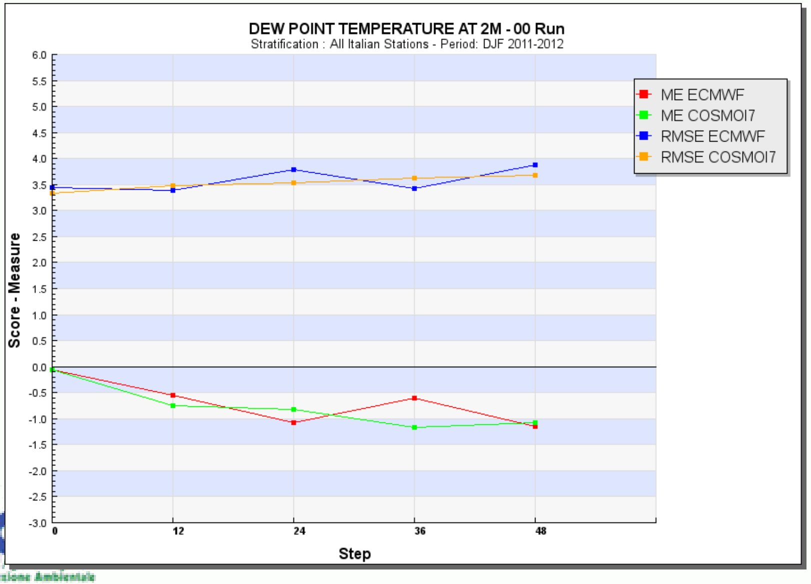


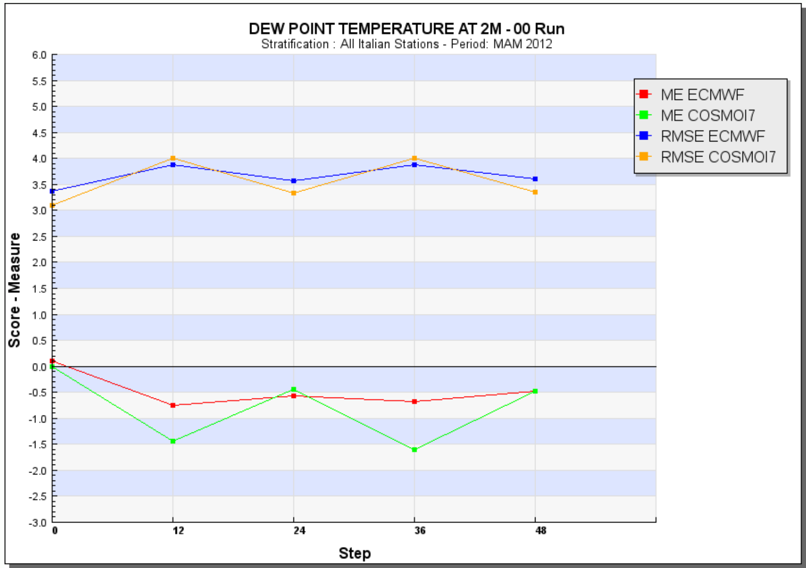


COSMO-I7 vs ECMWF
2m Dew Point Temperature (step 3h)

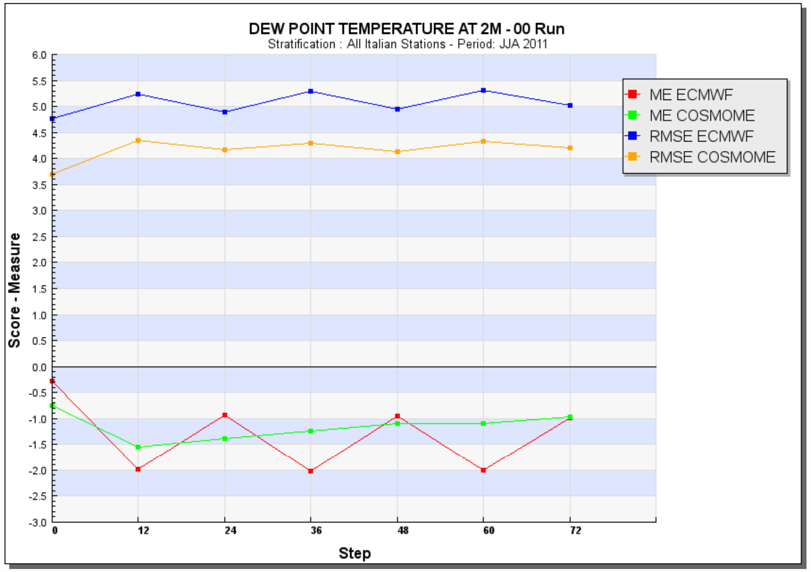


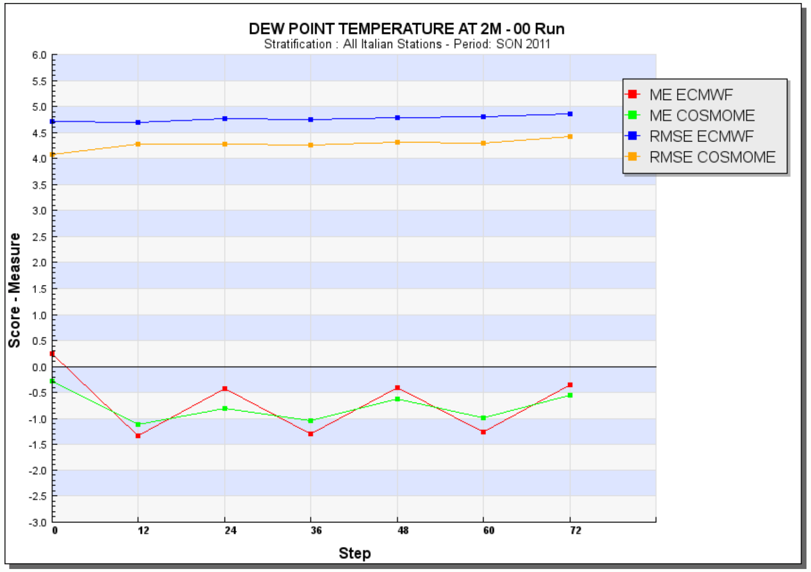


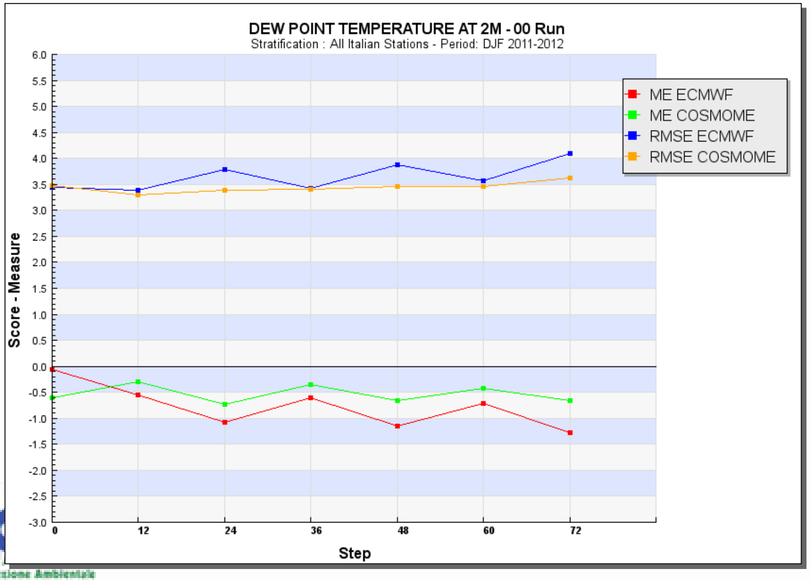


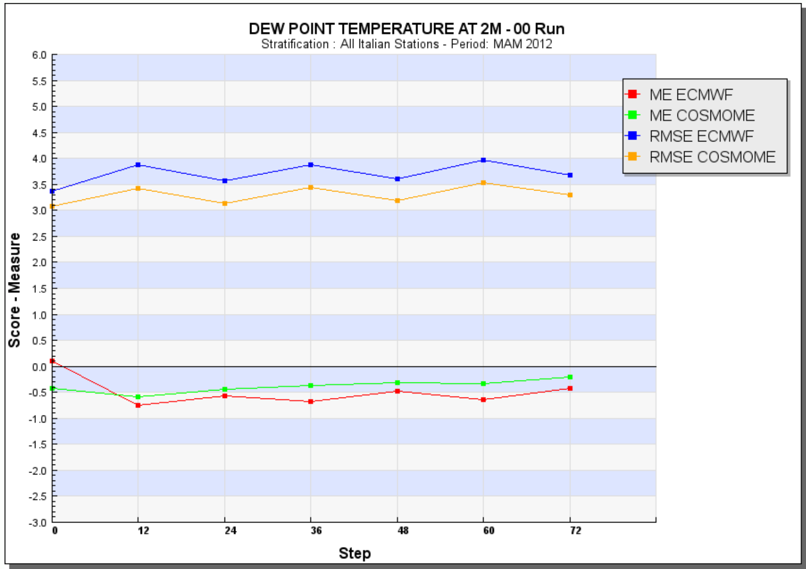


COSMO-ME vs ECMWF
2m Dew Point Temperature (step 3h)

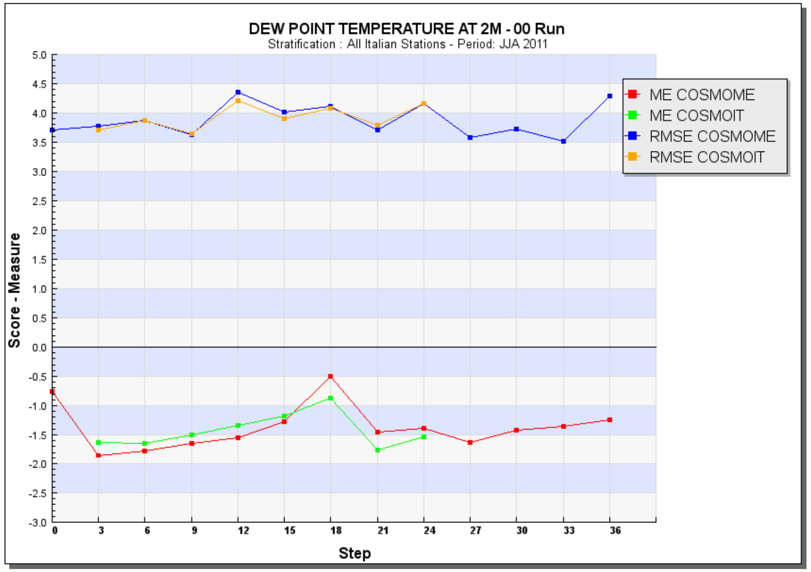


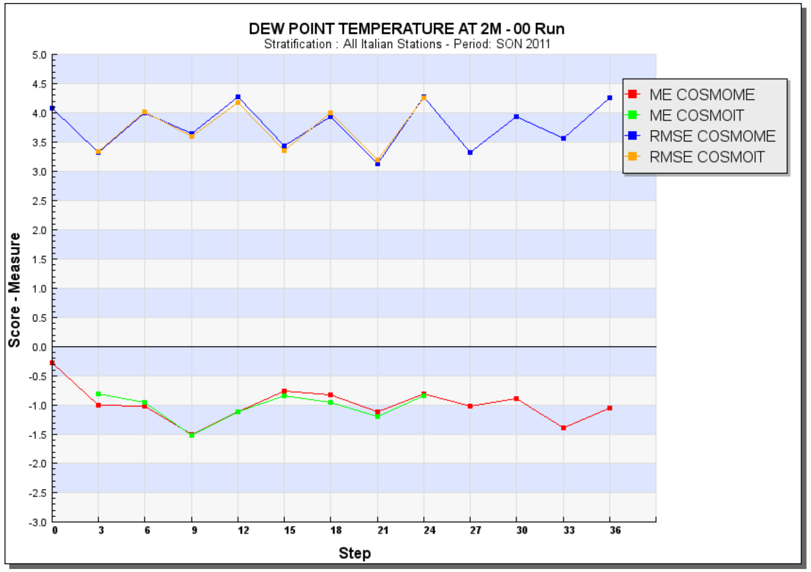


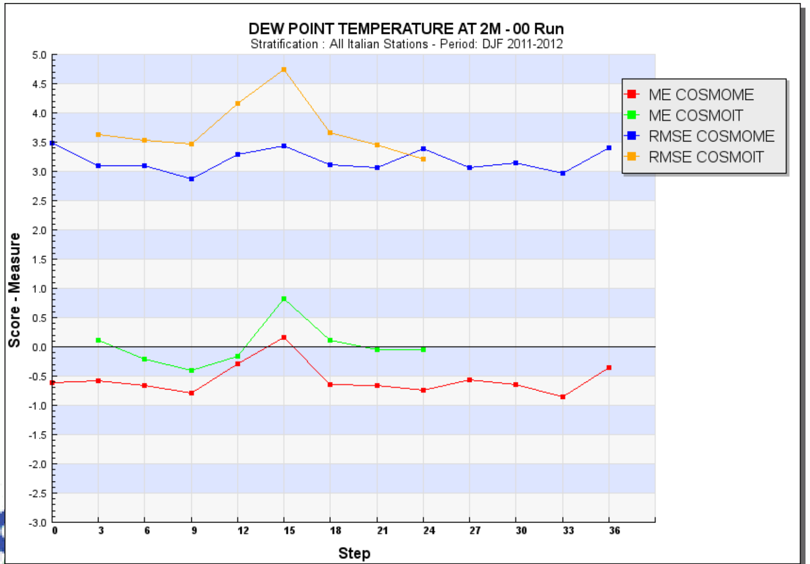


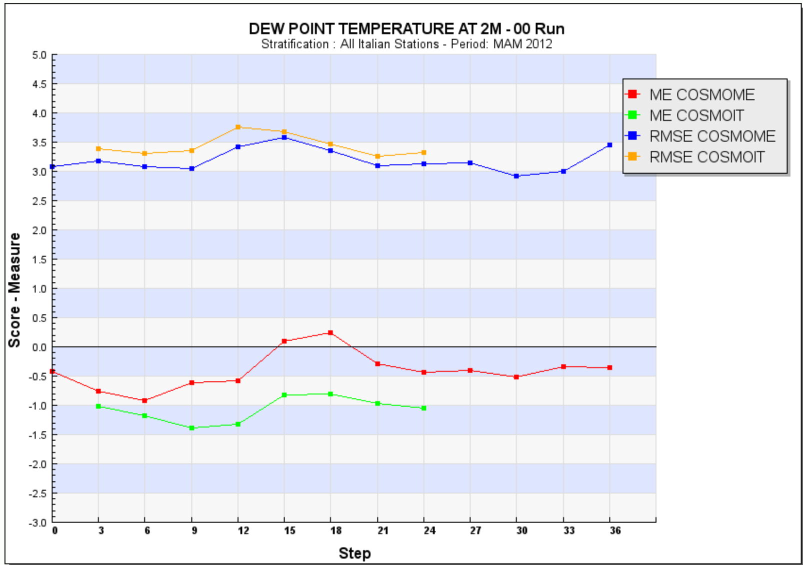


COSMO-ME vs COSMO-IT
2m Dew Point Temperature (step 3h)









per la Protezione Ambientale

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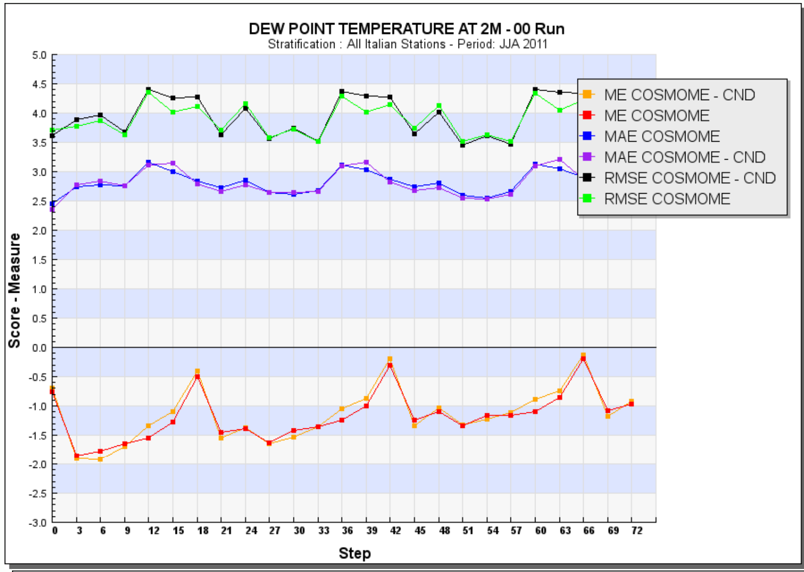
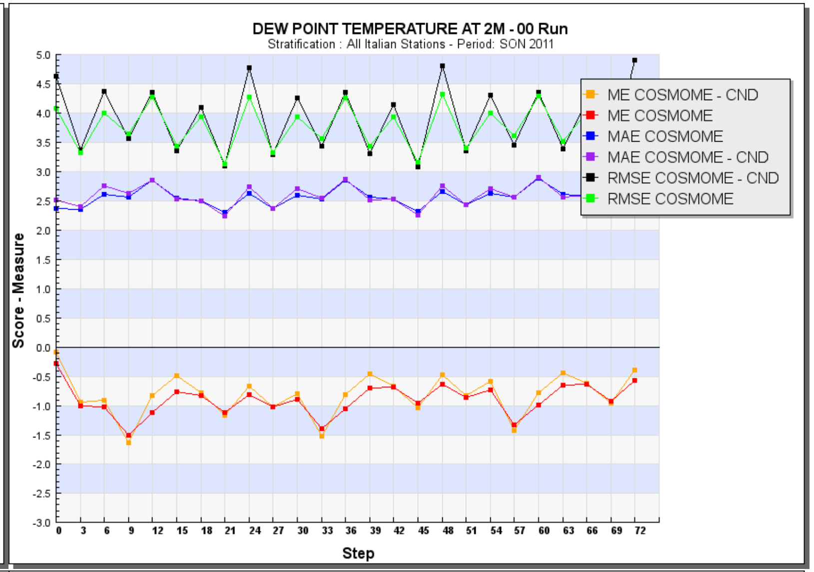
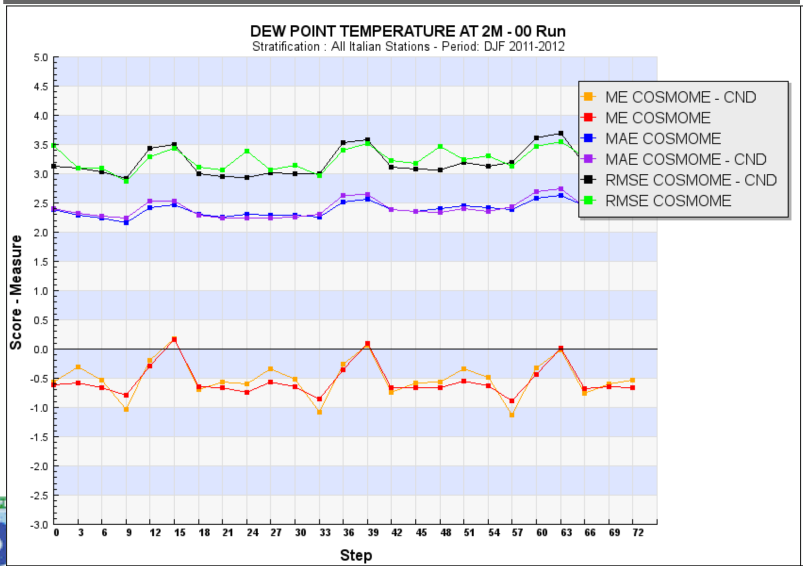
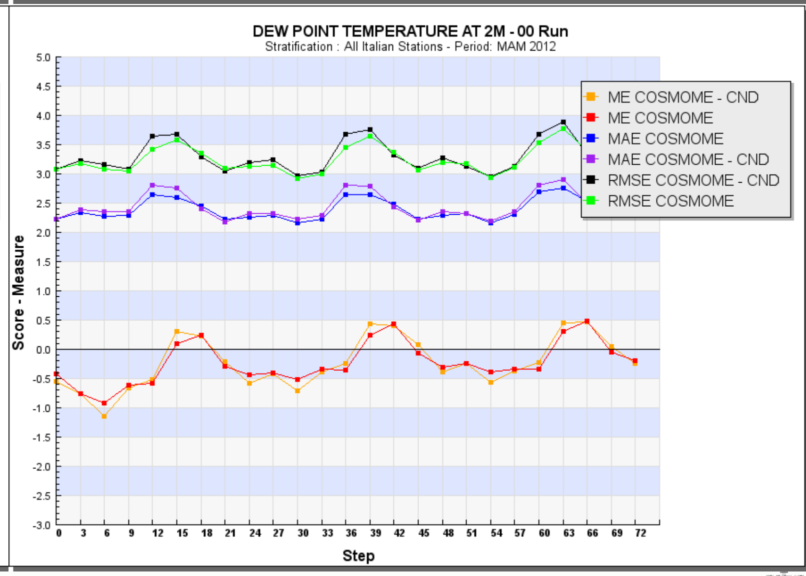
COSMO-ME Conditional Verification

TD 2m when observed wind speed ≤ 2 m/s









TD 2m considerations

- COSMO-I7
  - MAE from 2.5 to 3 °C, RMSE from 3.5 to 4 °C – bigger errors at 12-15 UTC
  - Different diurnal cycle of bias error depending on season but generally the dew point is under-predicted
- COSMO-ME
  - Smaller RMSE than COSMO-I7 but very similar behavior
  - Negative bias error except MAM at 15 and 18 UTC (up to 0.5 °C overestimation for the 3 day of forecast)
  - Conditional verification in windless situations does not show significant differences
- Respect to ECMWF
  - COSMO-I7 better in JJA and SON, equal in the other seasons
  - COSMO-ME better in all seasons
- COSMO-IT
  - Equal to COSMO-I7 in JJA and SON
  - Better RMSE in DJF and MAM, but the bias error in these seasons differs

PRECIPITATION

extreme dependency score

→ investigate the performance of an NWP model for rare events

Stephenson et al. Introduce the extreme dependency score (EDS) as a good alternative to standard scores for verification of rare events.

	Event observed yes	Event observed no	Total
Forecast yes	A	b	*a + b*
Forecast no	c	d	*c + d*
Total	*a +c*	*b+d*	*n= a + b + c + d*

frequency bias index	*FBI = (a + b)/(a + c)*	[0,∞] best 1	The frequency bias index indicates whether the forecasting system under or over-forecasts the number of events.
hit rate (POD)	*H = a/(a + c)*	[0,1] best 1	The hit rate represents the probability that the event is forecast when it occurs
false alarm rate (POFD)	*F = b/(b + d)*	[0,1] best 0	The false alarm rate represents the probability of forecasting the event when it did not occur. % not events obs. Not correctly forecasted. fraction of the observed "no" events were incorrectly forecast as "yes“.
true skill score	*T SS = H −F*	[-1,1] best 1	The true skill score gives information on how the forecasting system distinguishes between occurrences and not occurrences.
base rate	*BR = (a + c)/n*	[0,1]	The base rate represents the probability that the event occurs. By definition, 1-BR plotted versus increasing thresholds represents the probability that precipitation amount does not exceed a certain threshold.
extreme dependency score	*EDS= 2[ln((a+c)/n)/ln(a/n)] -1*	[-1,1] best 1	What is the association between forecast and observed rare events? Converges to 2η-1 as event frequency approaches 0, where η is a parameter describing how fast the hit rate converges to zero for rarer events. EDS is independent of bias, so should be presented together with the frequency bias

- To get clear information about how the forecasting system detects the extreme events, it would be fair if the EDS is compared for events having the same base rate. One has to investigate if better value of the EDS are related to an improvement in the quality of the forecasting system or if they are due to the event variability over the years.
- The equation defining the EDS uses the left hand side of a contingency table and the total number of cases (sample size). This results in an increased freedom for false alarms and correct negatives, which can freely vary with the only restriction that their sum has to be constant. Therefore, it is paramount to use the EDS in combination with other scores that include the right hand side of the contingency table, as the F and/or the FBI to show that improvements are not due to an increase of false alarms. (Ghelli&Primo,2009)

The affect of the base rate on the extreme dependency score (Ghelli&Primo,2009)

The Extreme Dependency Score (EDS) has been introduced as an alternative measure to verify the performance of numerical weather prediction models for rare events, taking advantage of the non-vanishing property of the score when the event probability tends to zero.

This score varies from 1 (best value) to −1 (worst value).

The EDS is written as a function of BR:

EDS =[ln(BR) – ln(HR)]/[ln(BR) + ln(HR)]

Equation presents the EDS as a function of the base rate and the hit rate. when HR = 1, the EDS = 1 and when BR = 1, the EDS = −1.

On the other hand, when the base rate is equal to one, the event happens all the time and so the EDS is not an appropriate score since it is focused on verification of extreme events (low probability of occurrence). Therefore, if different data samples need to be compared, it is imperative to have similar base rate.

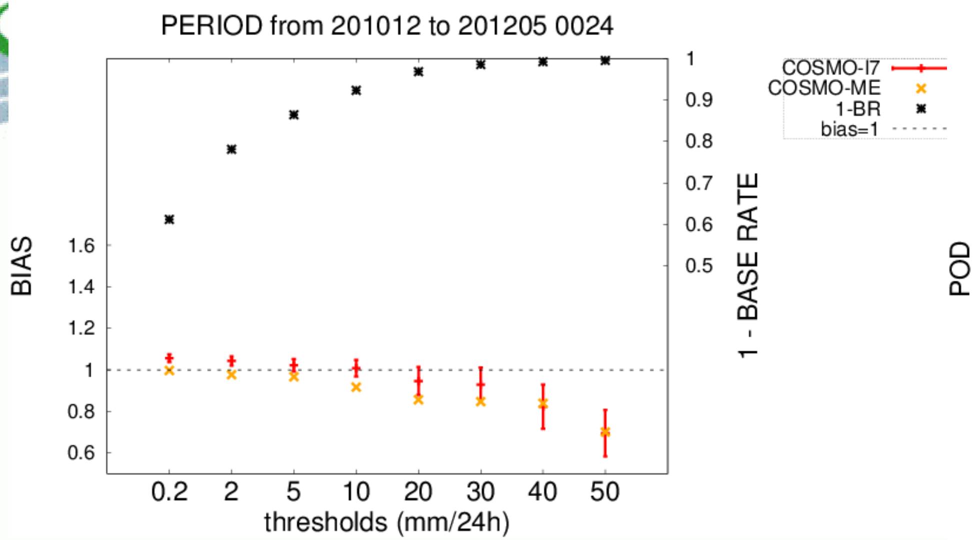
- Thus, even if there are no misses and the EDS value is maximum, the forecasting system might have a high number of false alarms. Therefore, an EDS = 1 does not imply a skilful system. If values of the EDS for different periods need to be compared, then the base rate must be constant in time to avoid changes in the EDS to be just a reflection of changes in the BR.
- If the base rate is constant, an increase of the EDS implies a better probability of detection (hit rate), i.e. a more skilful system. If only the hit rate is constant, then an increase of the EDS is only due to a higher event probability. If neither the base rate nor the hit rate is constant, then the improvement of the EDS could be due to any of the previous reasons.

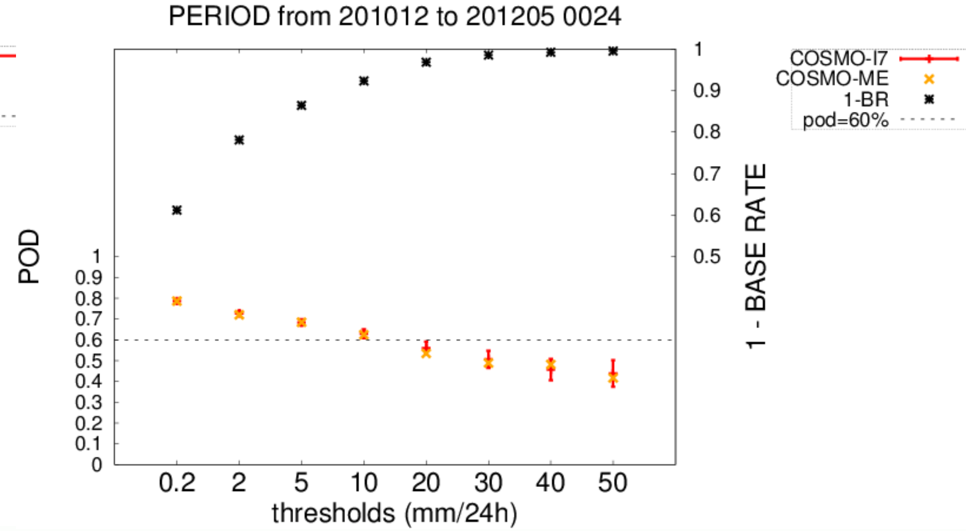
The extreme dependency score: a non-vanishing measure for forecasts of rare events (Stephenson et al.)

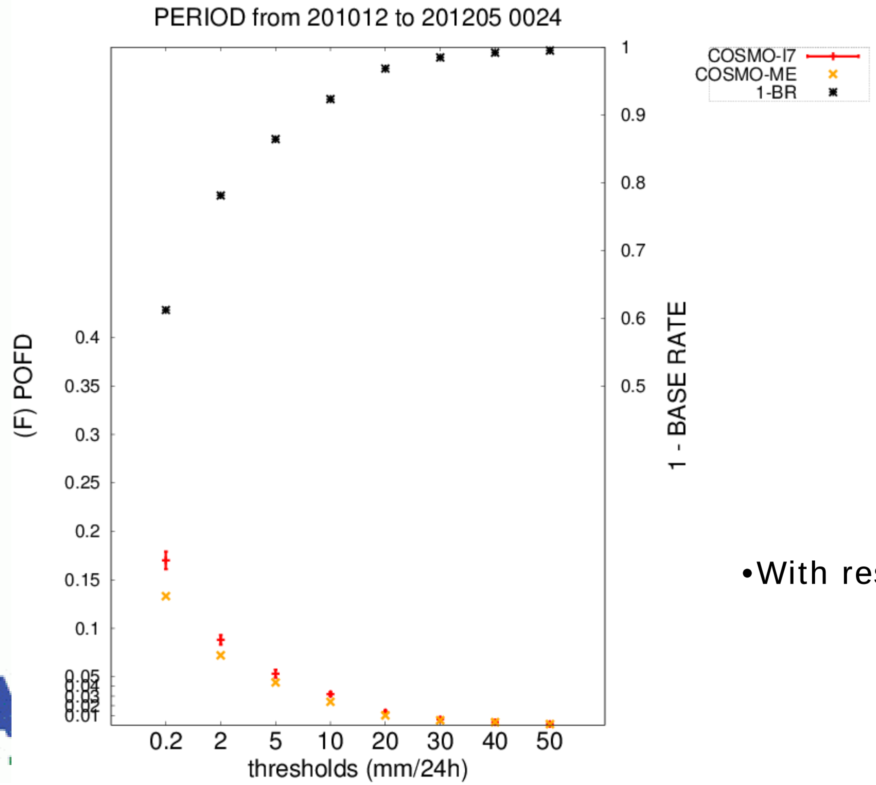
EDS takes the value of 1 for perfect forecasts and 0 for random forecasts, and is greater than zero for forecasts that have hit rates that converge slower than those of random forecasts

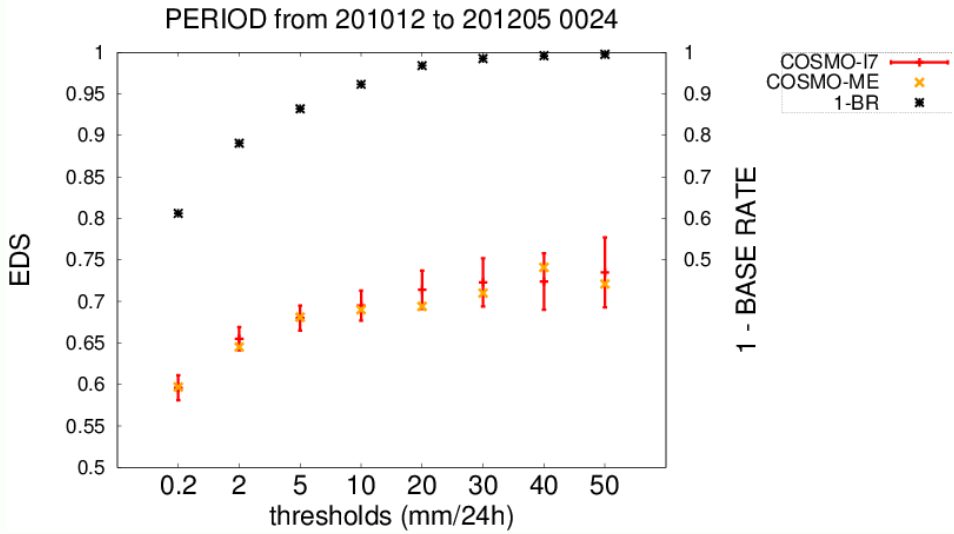
EDS has demonstrated here that there is dependency between the forecasts and the observations for more rare events, which is masked by the traditional skill scores that converge to zero as the base rate vanishes. EDS does not explicitly depend on the bias in the system for vanishing base rate and so is less prone to improvement by hedging the forecasts. EDS has the disadvantage that it is based only on the numbers of hits and misses, and so ignores information about false alarms and correct rejections. Therefore, EDS is non-informative about forecast bias, and a forecasting system with a good EDS could be very biased. Therefore, one should present EDS together with the frequency bias as a function of threshold in order to provide a complete summary of forecast performance.

Intercomparison COSMO-ME/COSMO-I7, FIRST 24H



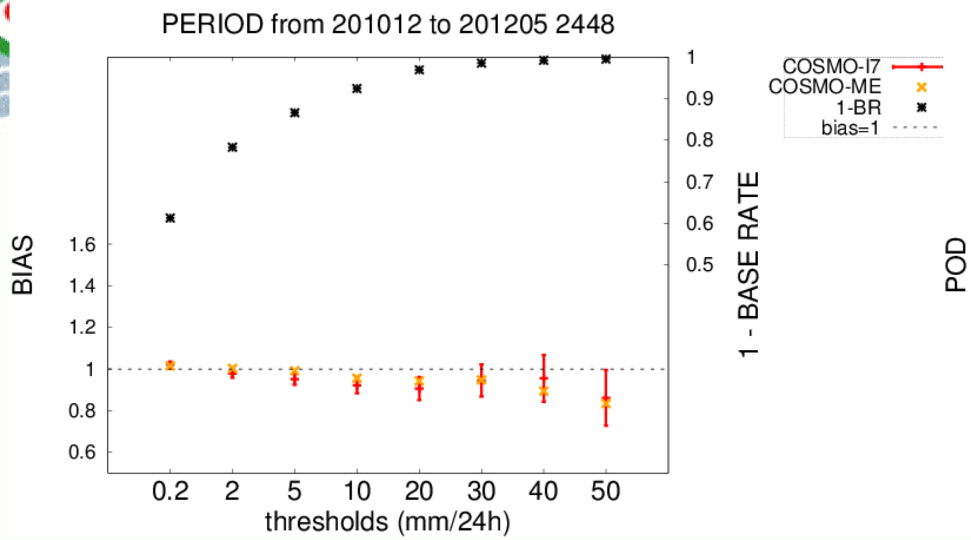


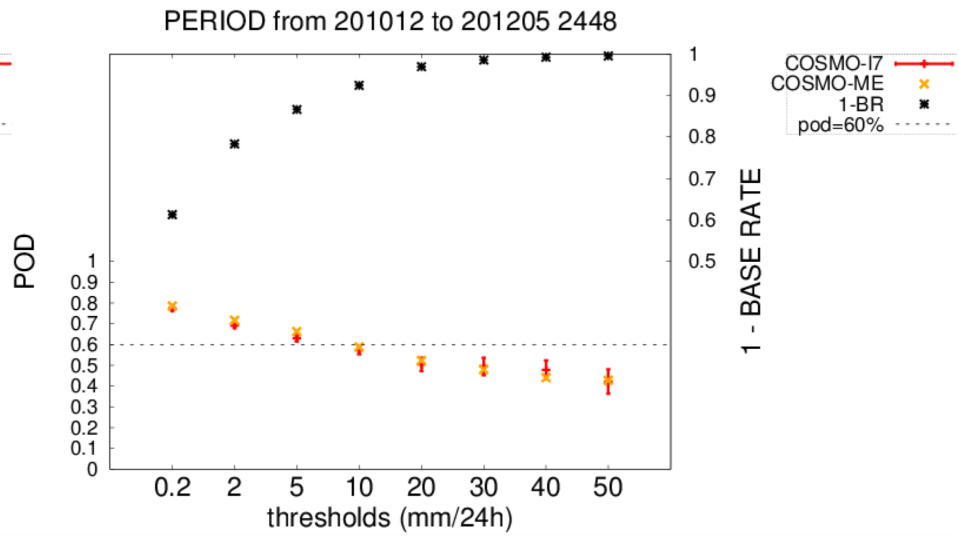


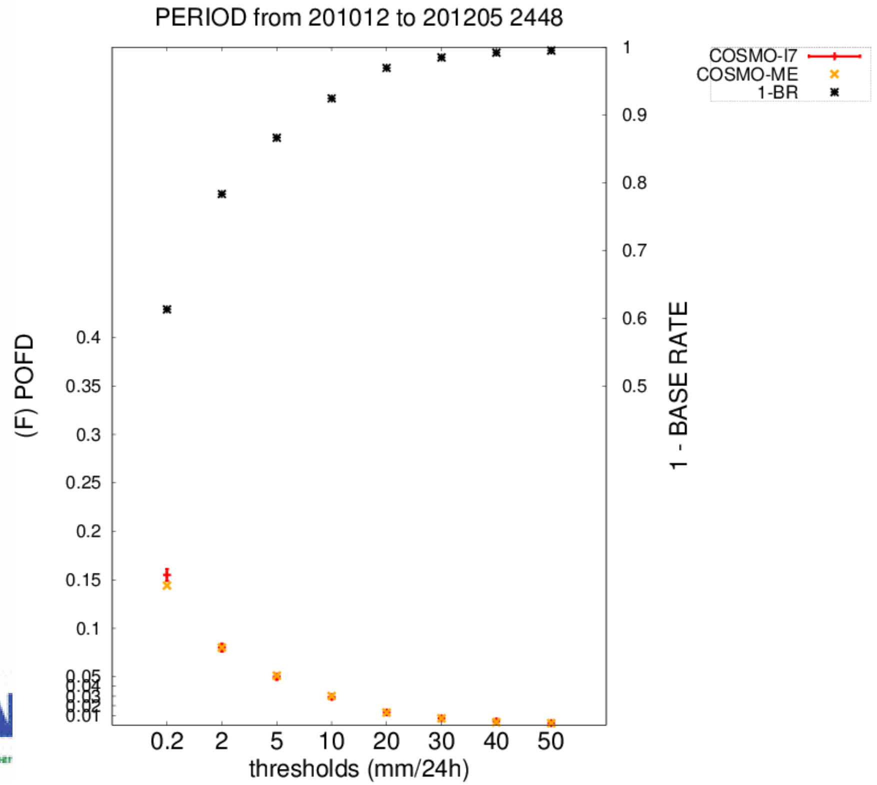


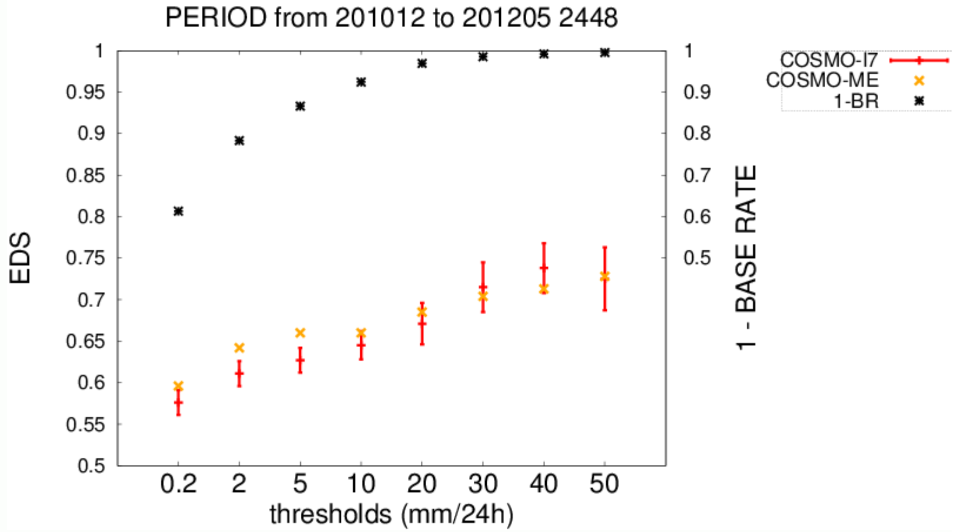
- With respect to the previuos year: less F and greater (1-BR)=>less rain
- Similar skill, ME better for low thresholds

Intercomparison COSMO-ME/COSMO-I7, SECOND 24H









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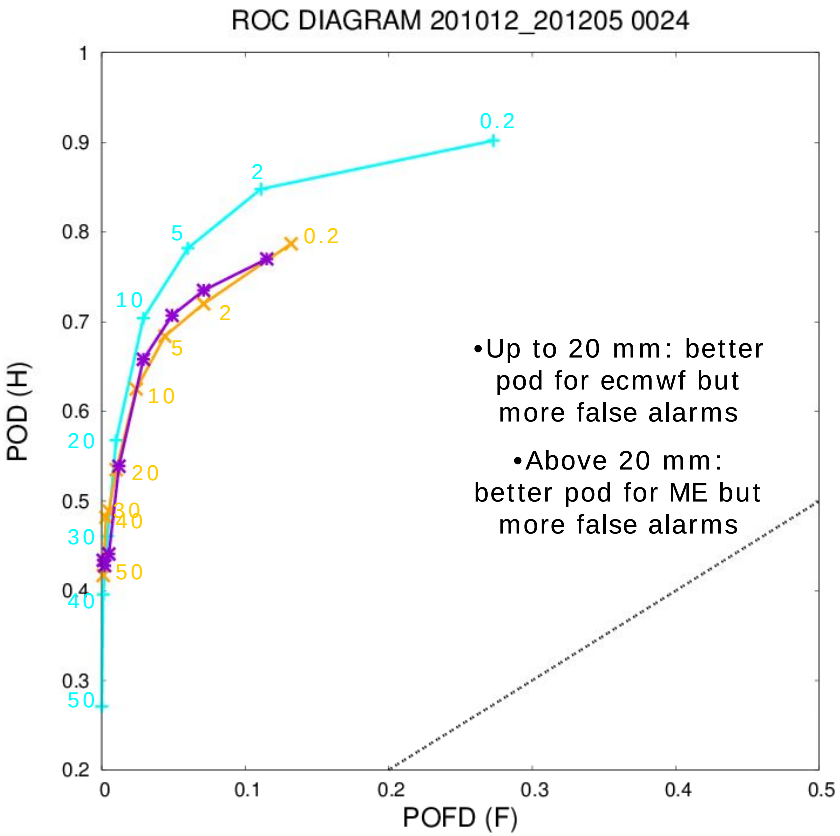
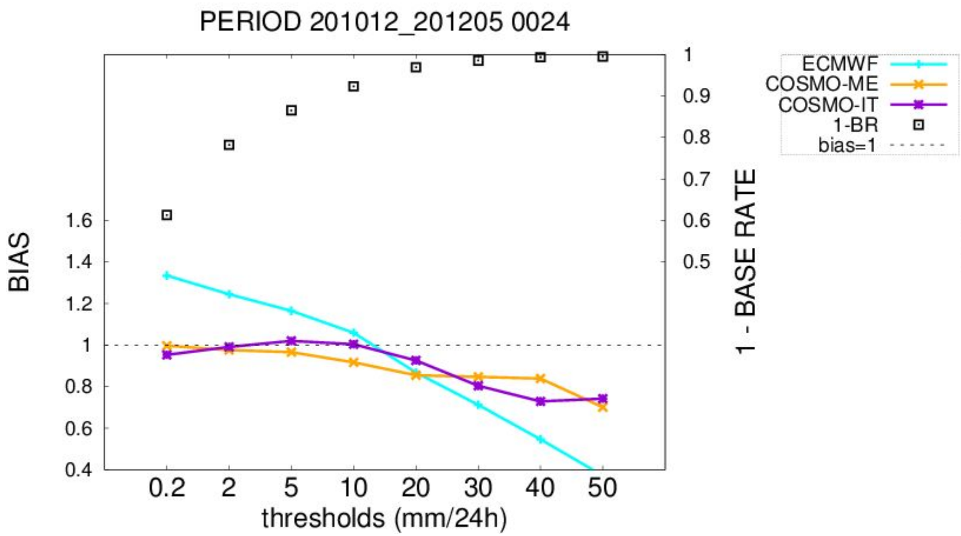
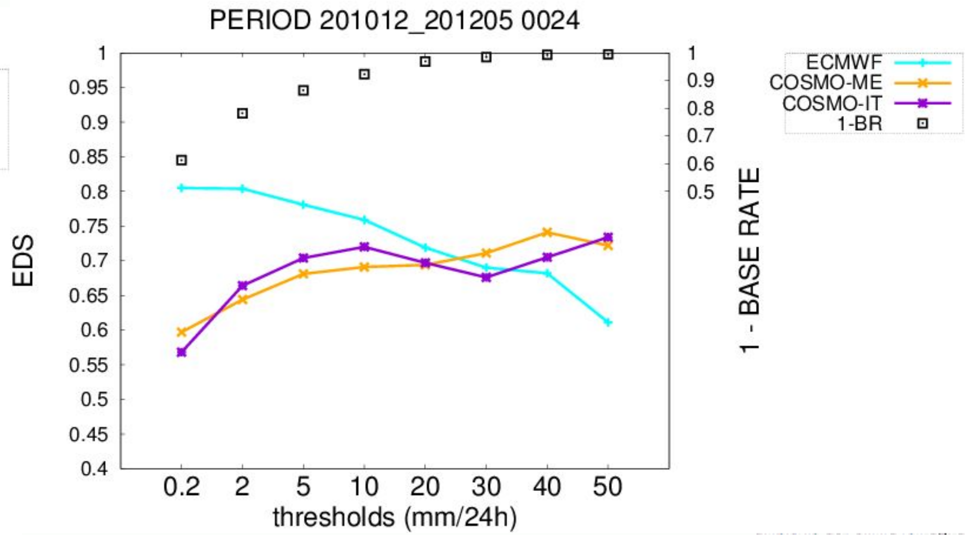


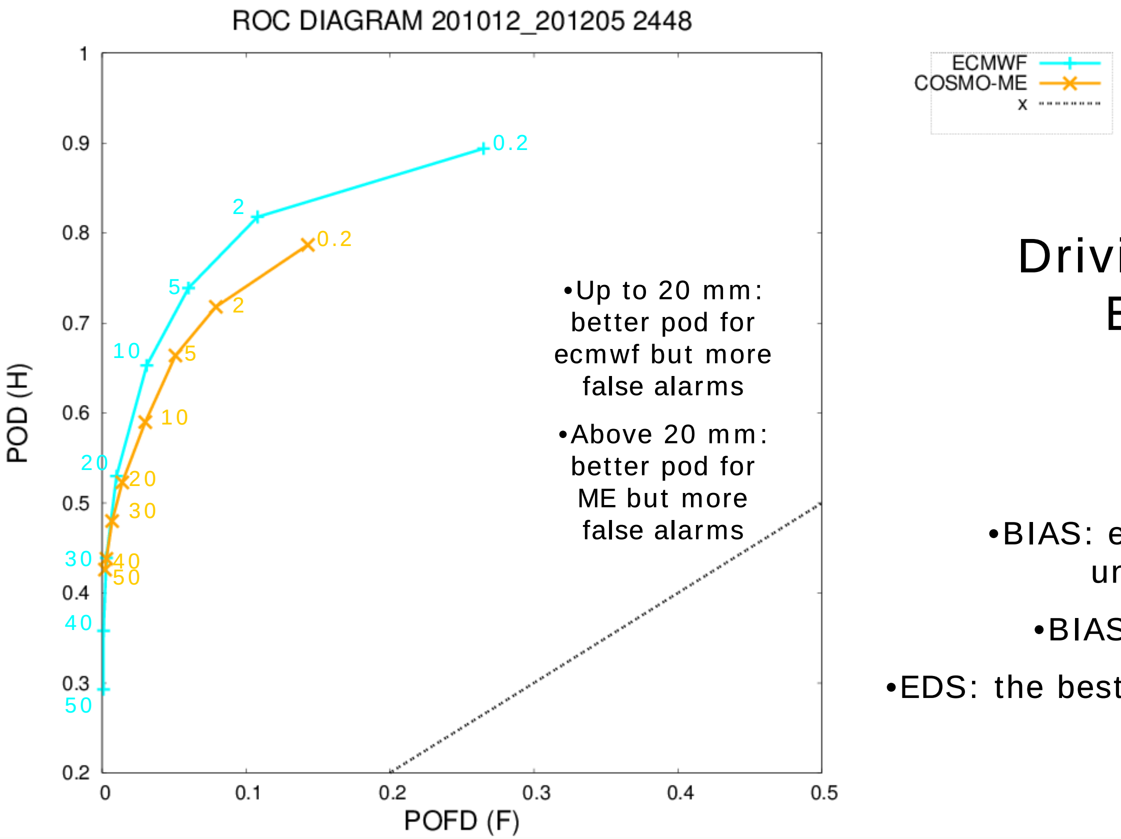
Driving model comparison: ECMWF/COSMO-ME/COSMO-IT

FIRST 24H

- BIAS: ecmwf overestimates for low thres., underestimates for high thres.
- BIAS: ME underest. above 5mm; IT good performance (up to 20 mm)
- EDS: the best is ecmwf up to 20mm. Above the best is COSMO-ME. IT perf. better than ME (from 2) up to 20 mm







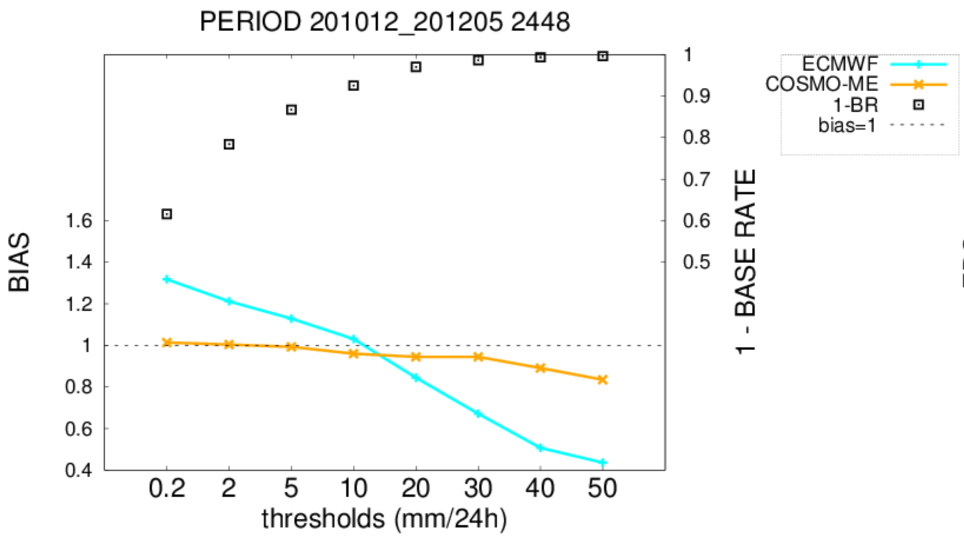
Driving model comparison: ECMWF/COSMO-ME

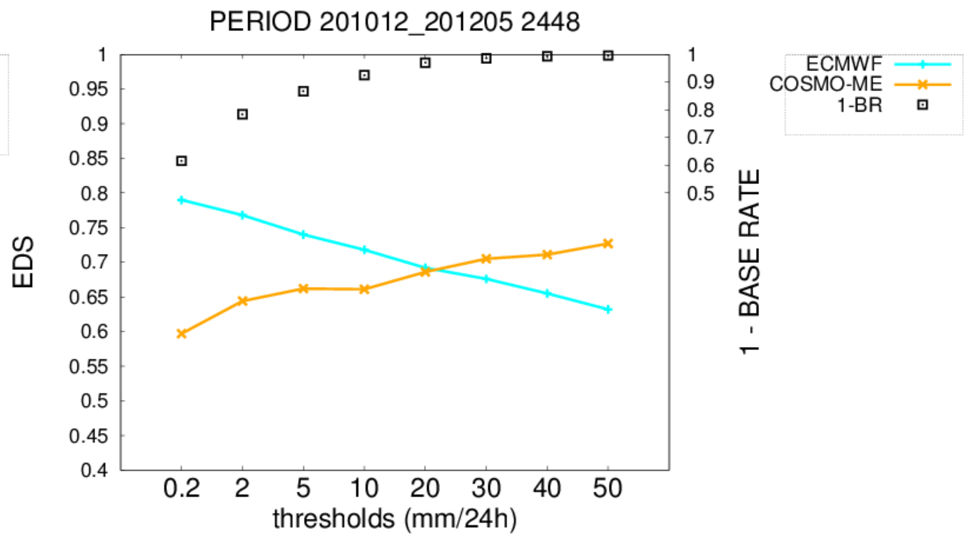
SECOND 24H

•BIAS: ecmwf overestimates for low thres., underestimates for high thres.

•BIAS: good skill for ME up to 30 mm

•EDS: the best is ecmwf up to 20mm. Above the best is COSMO-ME

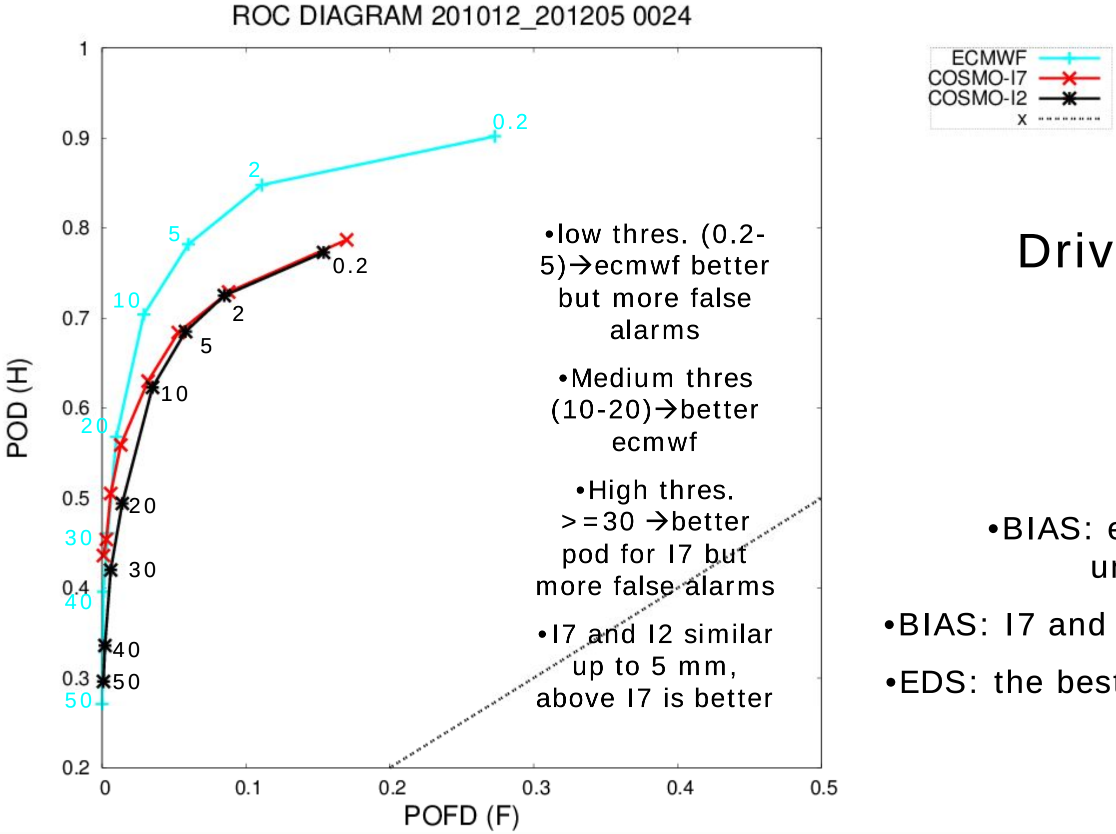




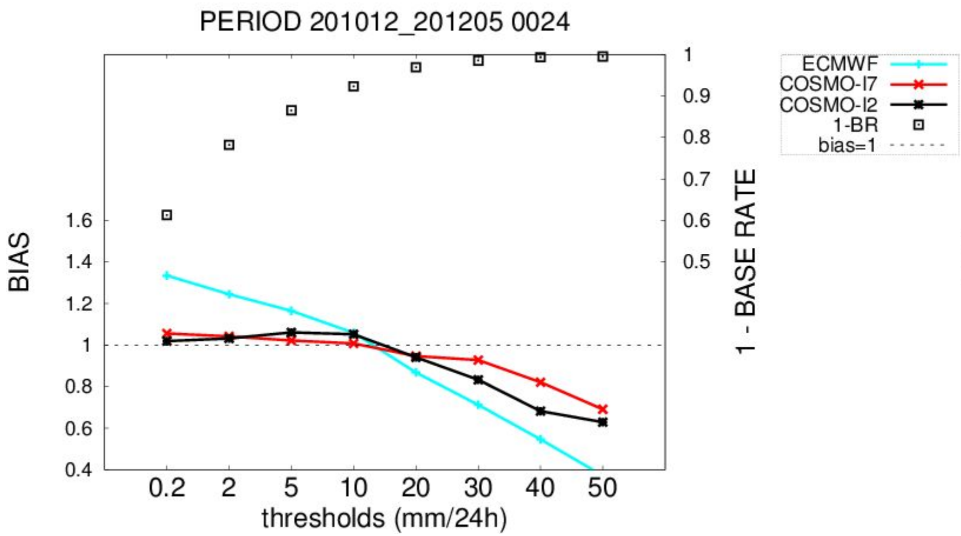
Driving model comparison: ECMWF/COSMO-I7/COSMO-I2

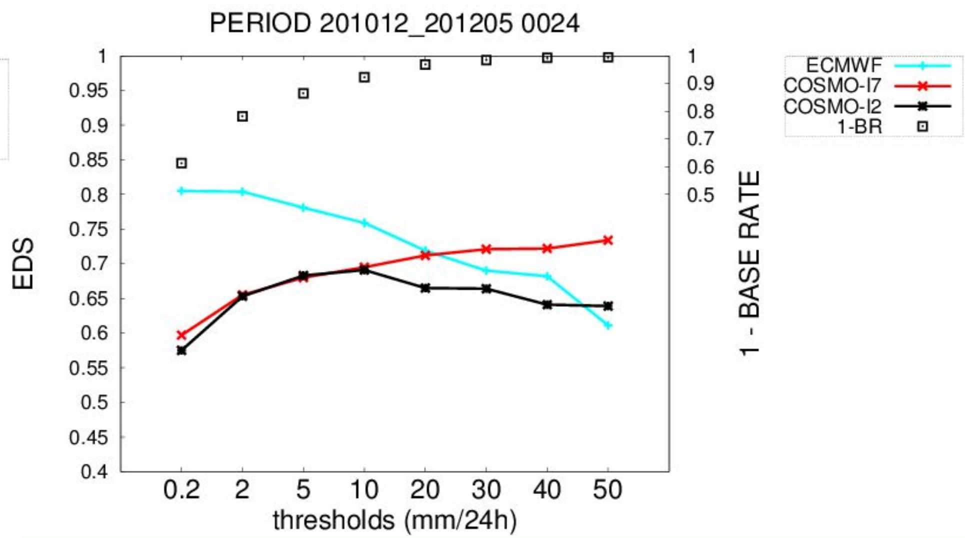
FIRST 24H

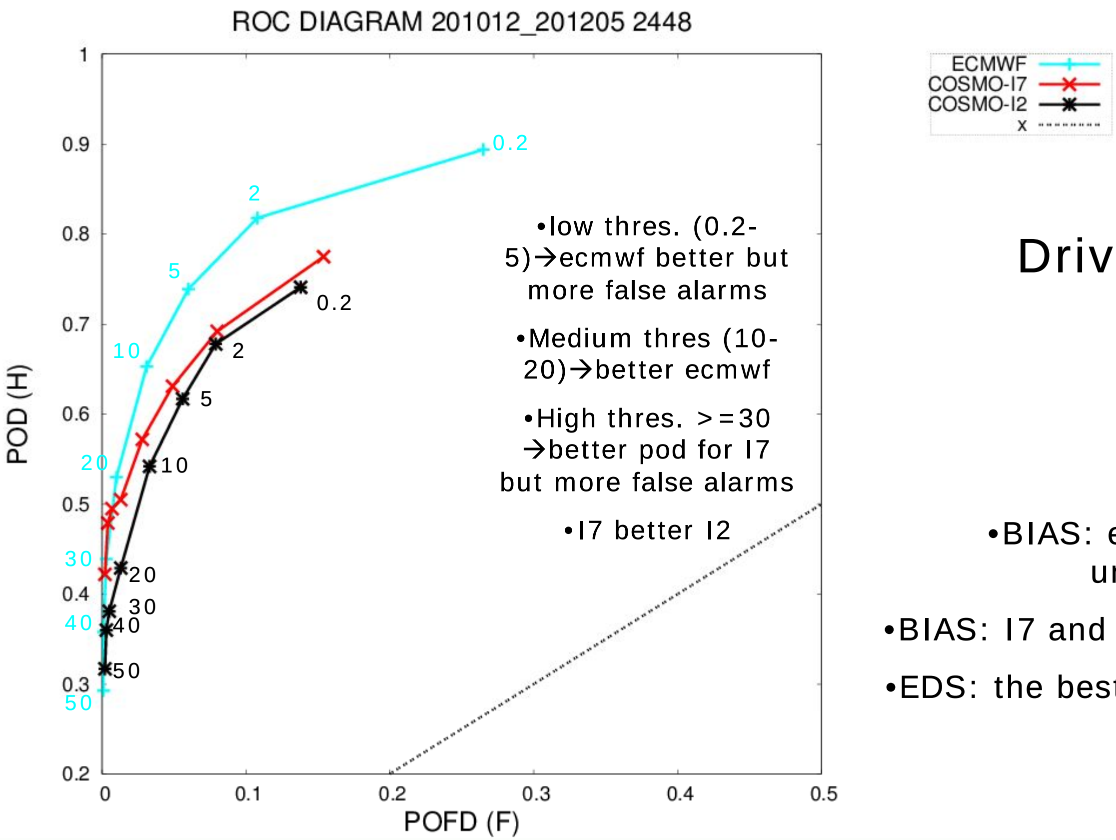
- BIAS: ecmwf overestimates for low thres., underestimates for high thres.
- BIAS: I7 and I2 similar up to 10mm, above I7 is better
- EDS: the best is ecmwf up to 20mm. Above the best is cosmo-I7



- low thres. (0.2-5)→ecmwf better but more false alarms
- Medium thres (10-20)→better ecmwf
- High thres. >=30 →better pod for I7 but more false alarms
- I7 and I2 similar up to 5 mm, above I7 is better







•low thres. (0.2-5)→ecmwf better but more false alarms

•Medium thres (10-20)→better ecmwf

•High thres. >=30 →better pod for I7 but more false alarms

•I7 better I2

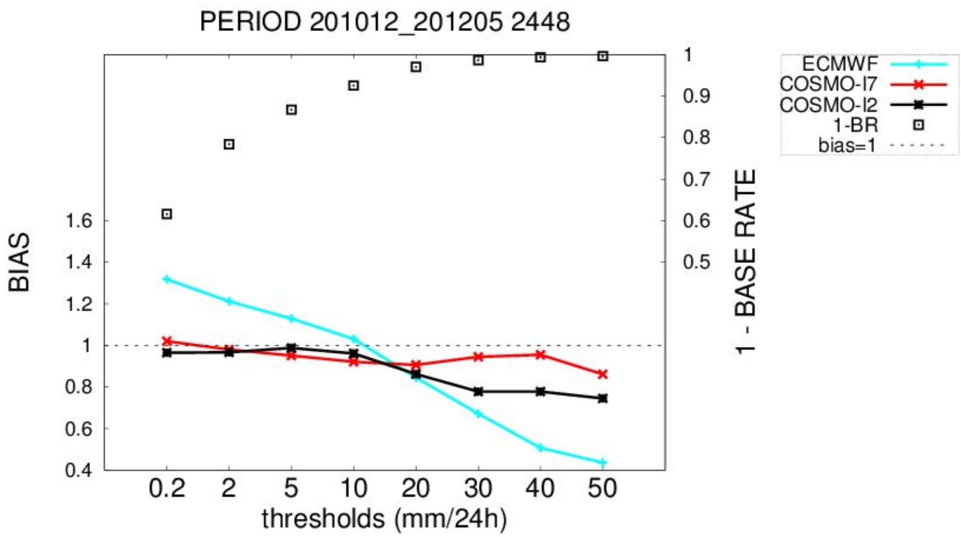
Driving model comparison: ECMWF/COSMO-I7/COSMO-I2

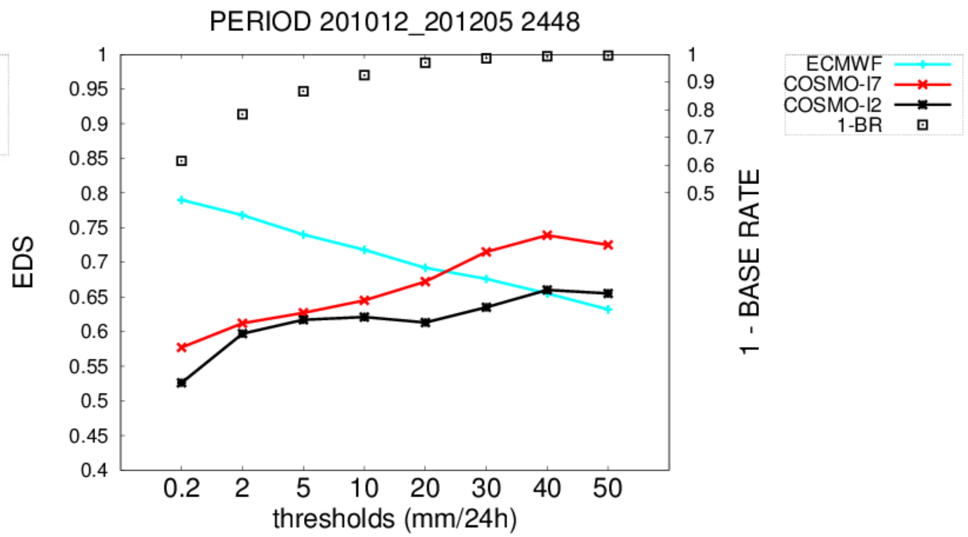
SECOND 24H

•BIAS: ecmwf overestimates for low thres., underestimates for high thres.

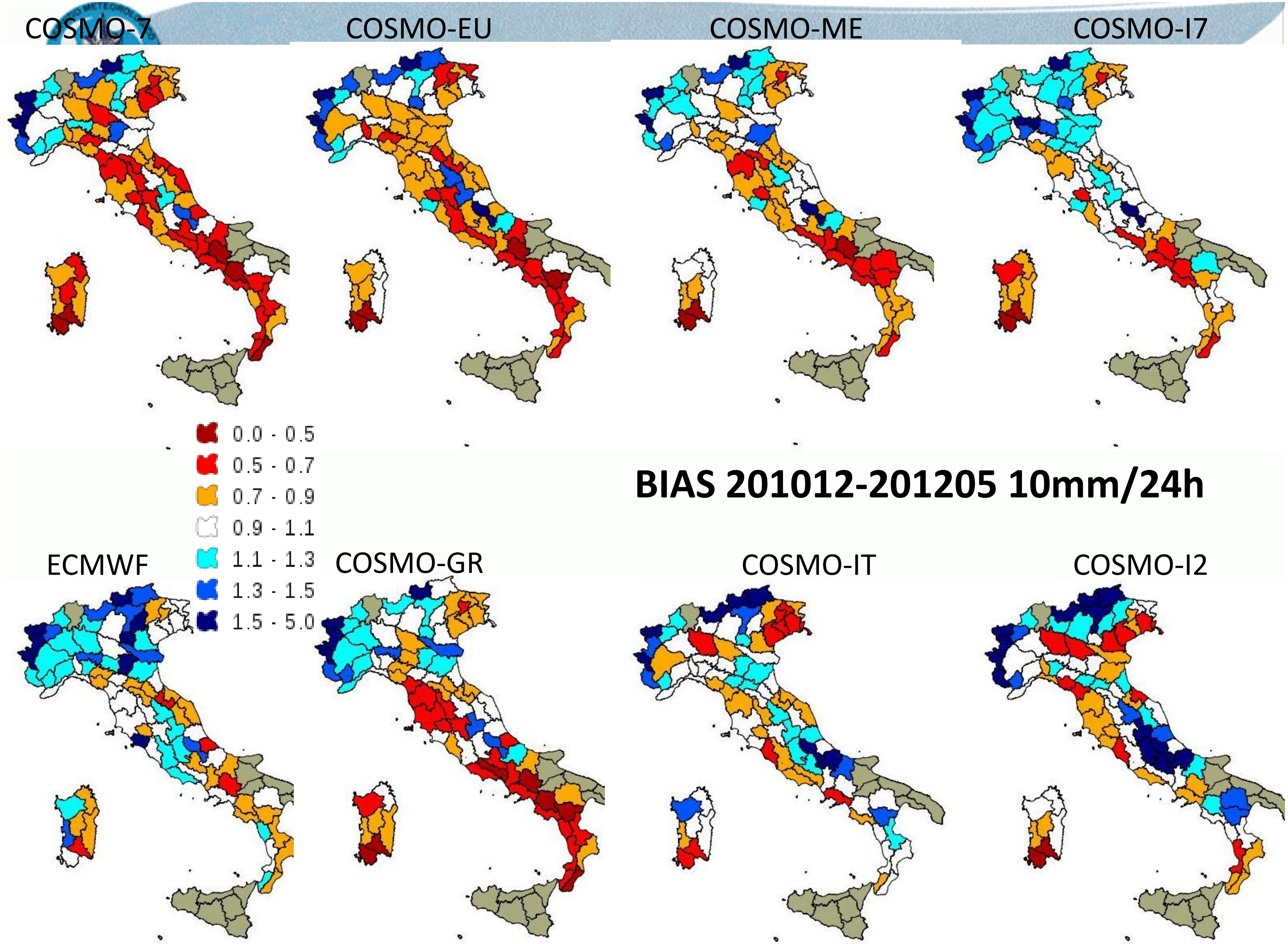
•BIAS: I7 and I2 similar up to 10mm, above I7 is better

•EDS: the best is ecmwf up to 20mm. Above the best is cosmo-I7

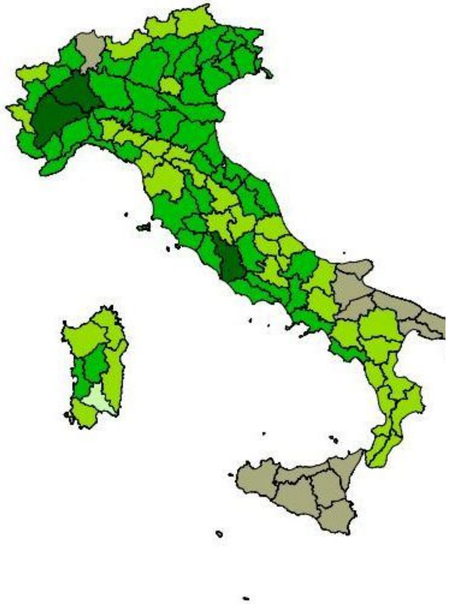




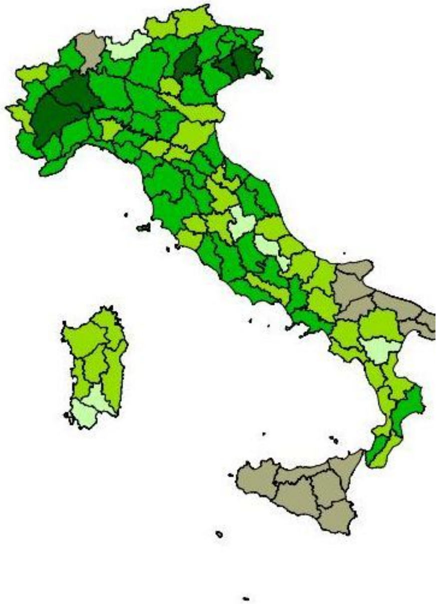
BIAS 201012-201205 10mm/24h



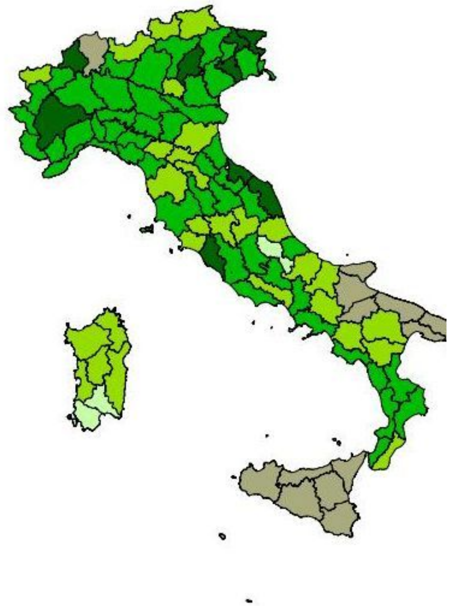
COSMO-7



COSMO-EU



COSMO-ME

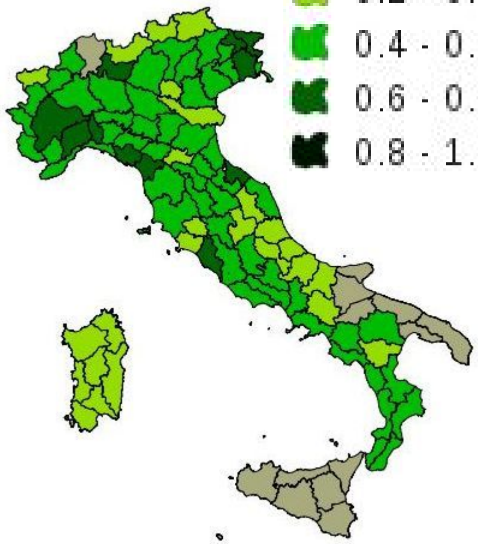


COSMO-I7

ETS 201012-201205 10mm/24h

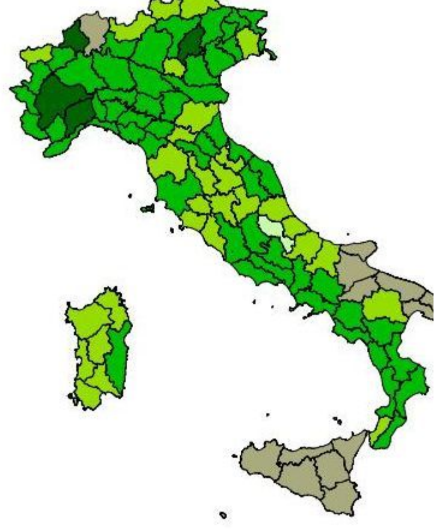
0.0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0

ECMWF

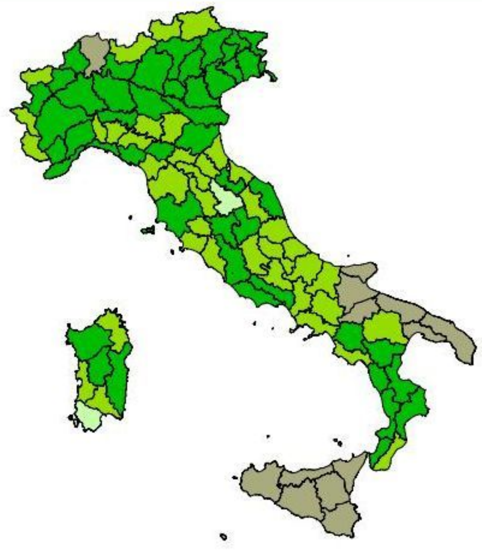


COSMO-GR

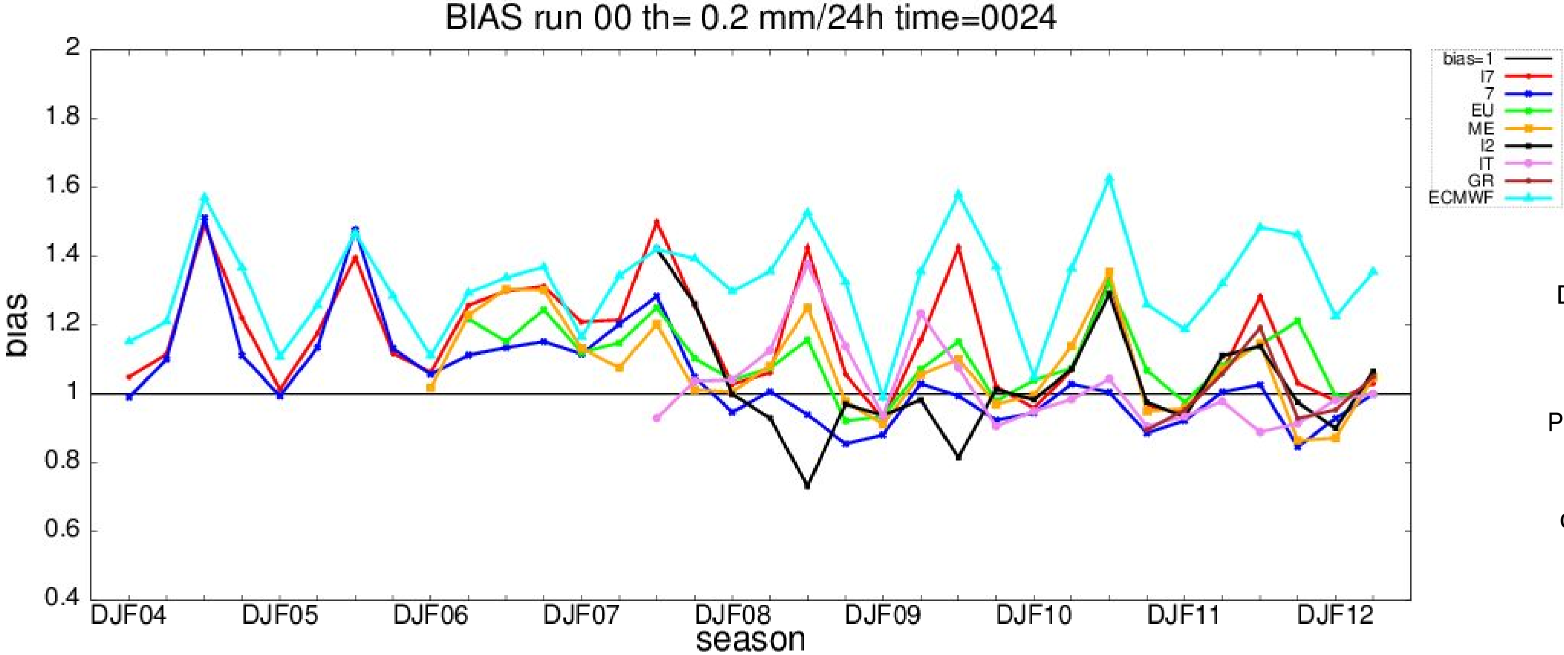
COSMO-IT



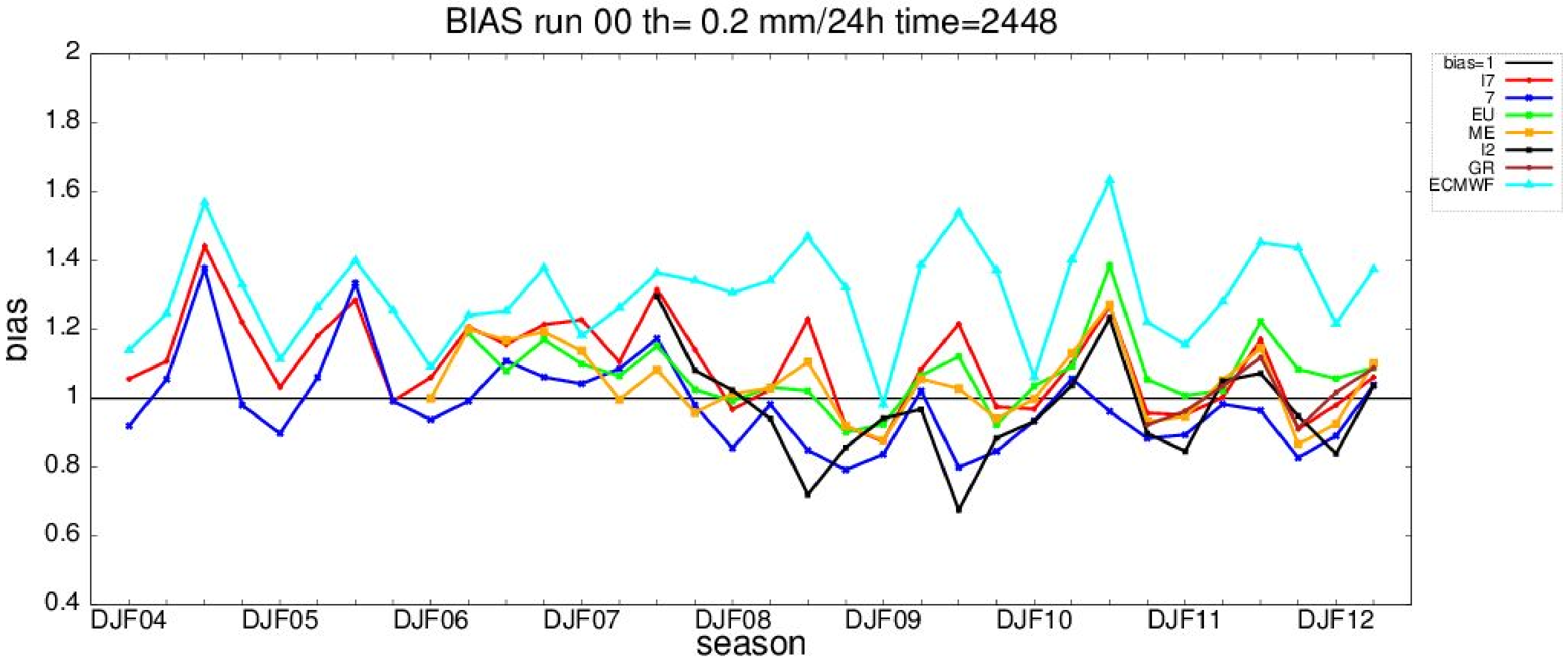
COSMO-I2



Seasonal trend 0.2mm/24h + ECMWF



Dataset: high resolution network of rain gauges coming from COSMO dataset and Civil Protection Department → 1300 stations
Method: 24h averaged cumulated precipitation value over 90 meteo-hydrological basins



All the versions present a seasonal cycle with an overestimation during summertime (except COSMO-7 and IT)
COSMO-7 and IT underestimate
Overestimation error decreases in D+2 (spin-up effect vanished)
Big overestimation for ECMWF (and EU)

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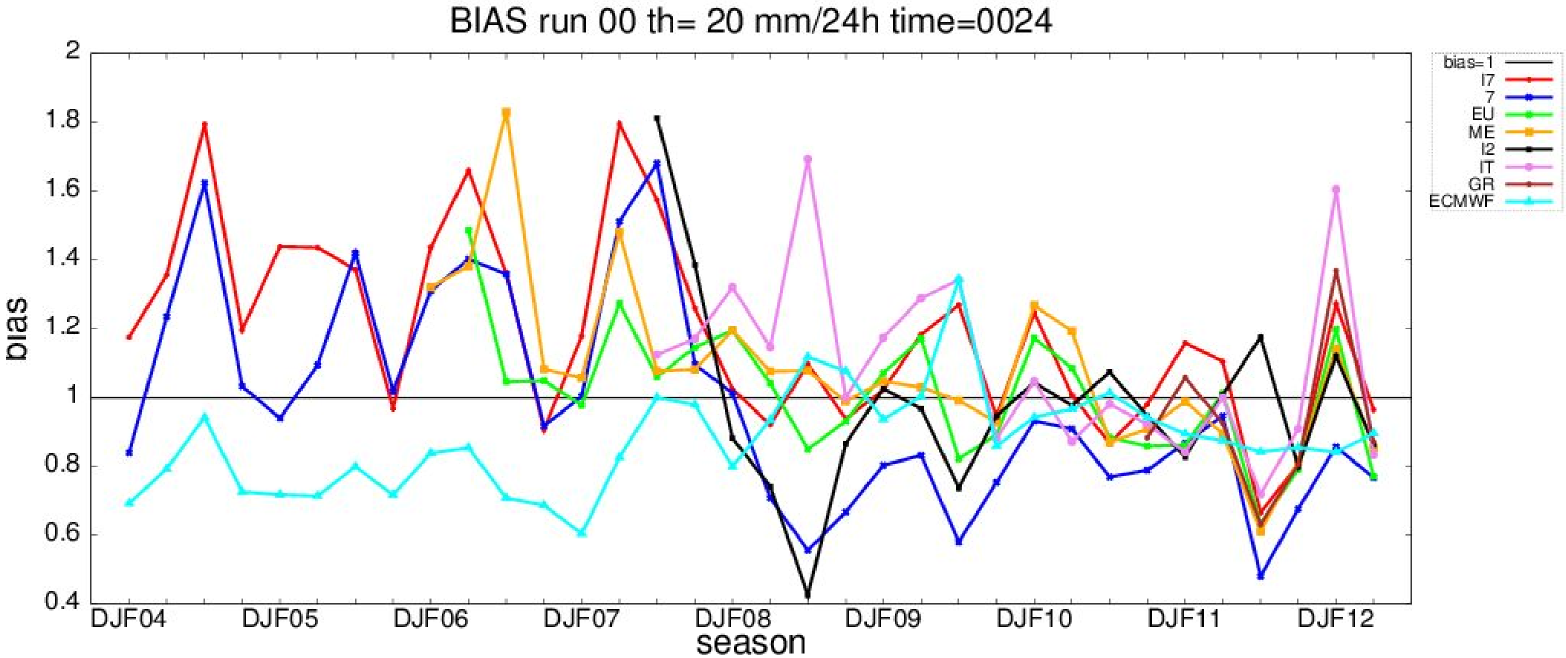
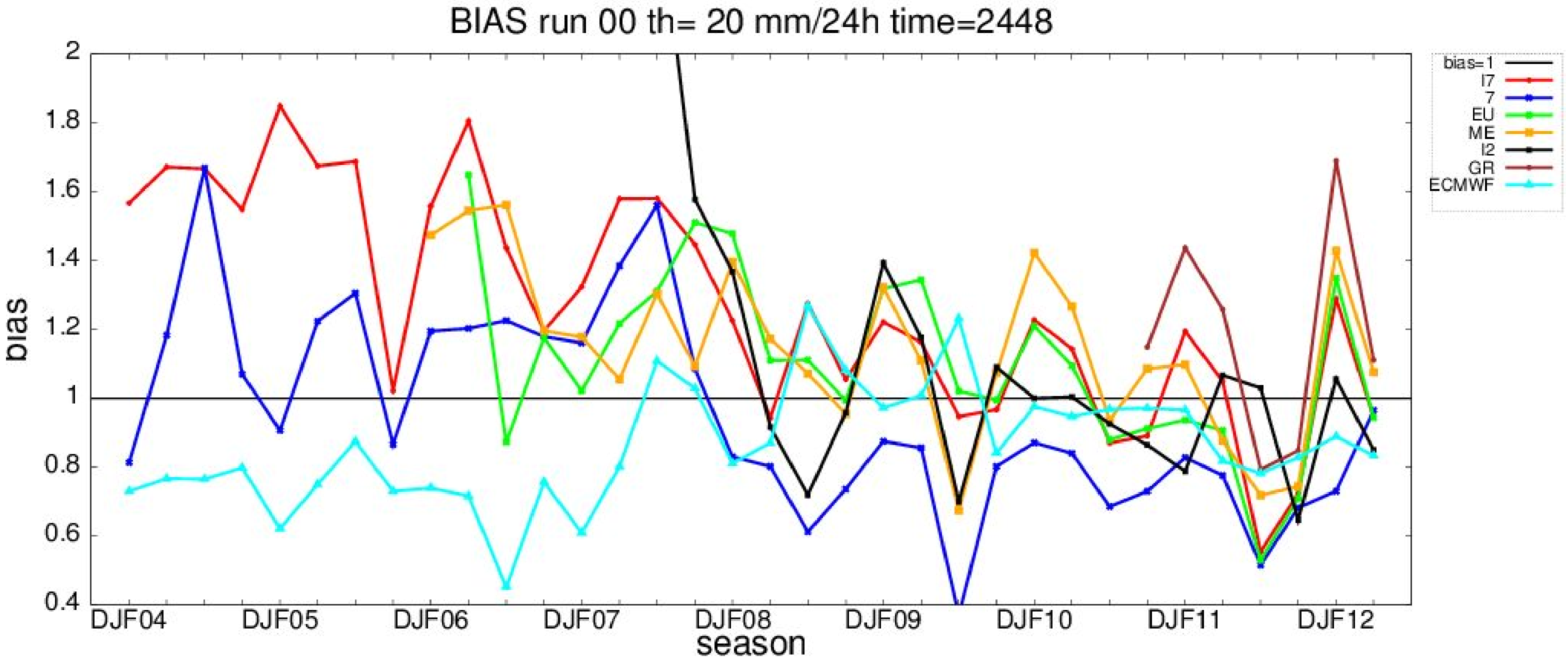
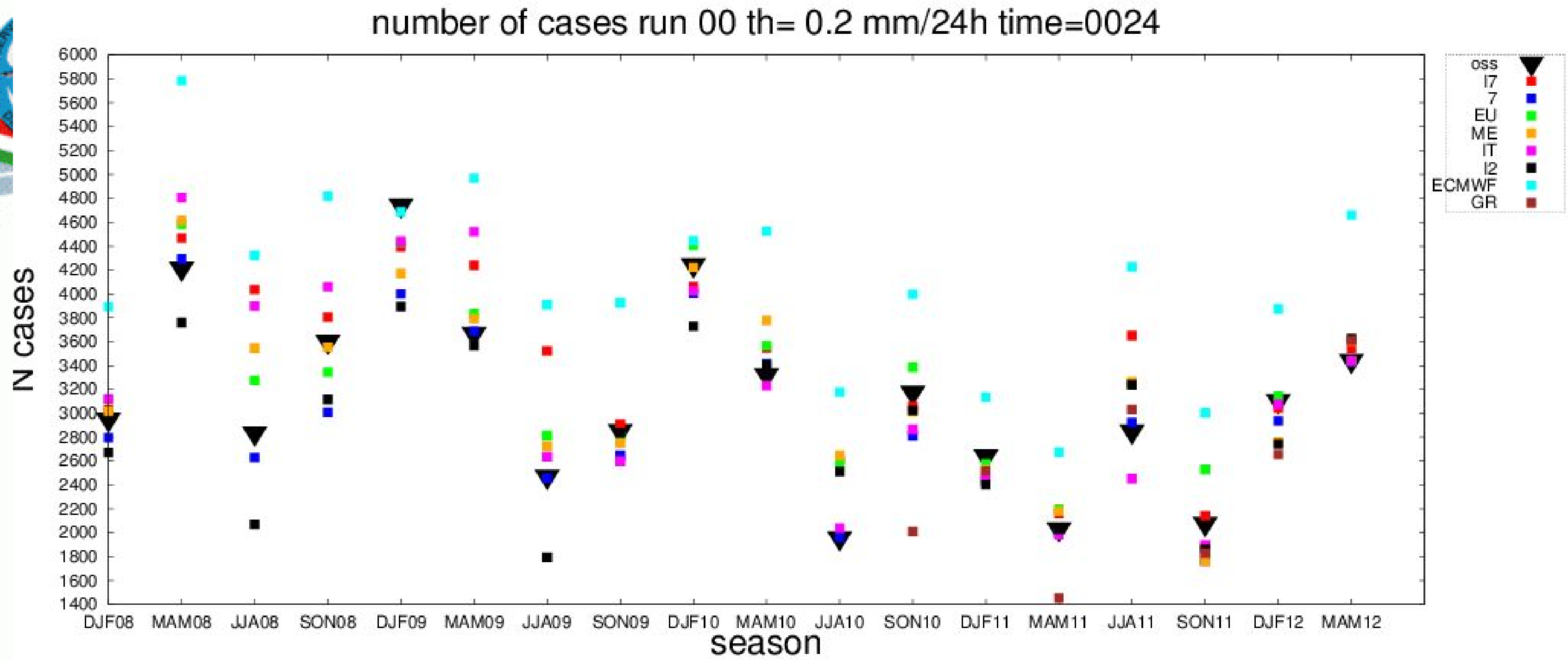
Seasonal trend 20mm/24h + ECMWF





- Slight bias reduction during latest seasons (except for latest winter!)
- winter 2012: all the versions overestimate (due to lack of representativeness of the rain gauges over the plain during snowfall??)
- Strong COSMO-7 underestimation
- ECMWF underestimates around 10%


number of cases run 00 th= 0.2 mm/24h time=0024
N cases
season
oss
I7
7
EU
ME
IT
I2
ECMWF
GR
DJF08
MAM08
JJA08
SON08
DJF09
MAM09
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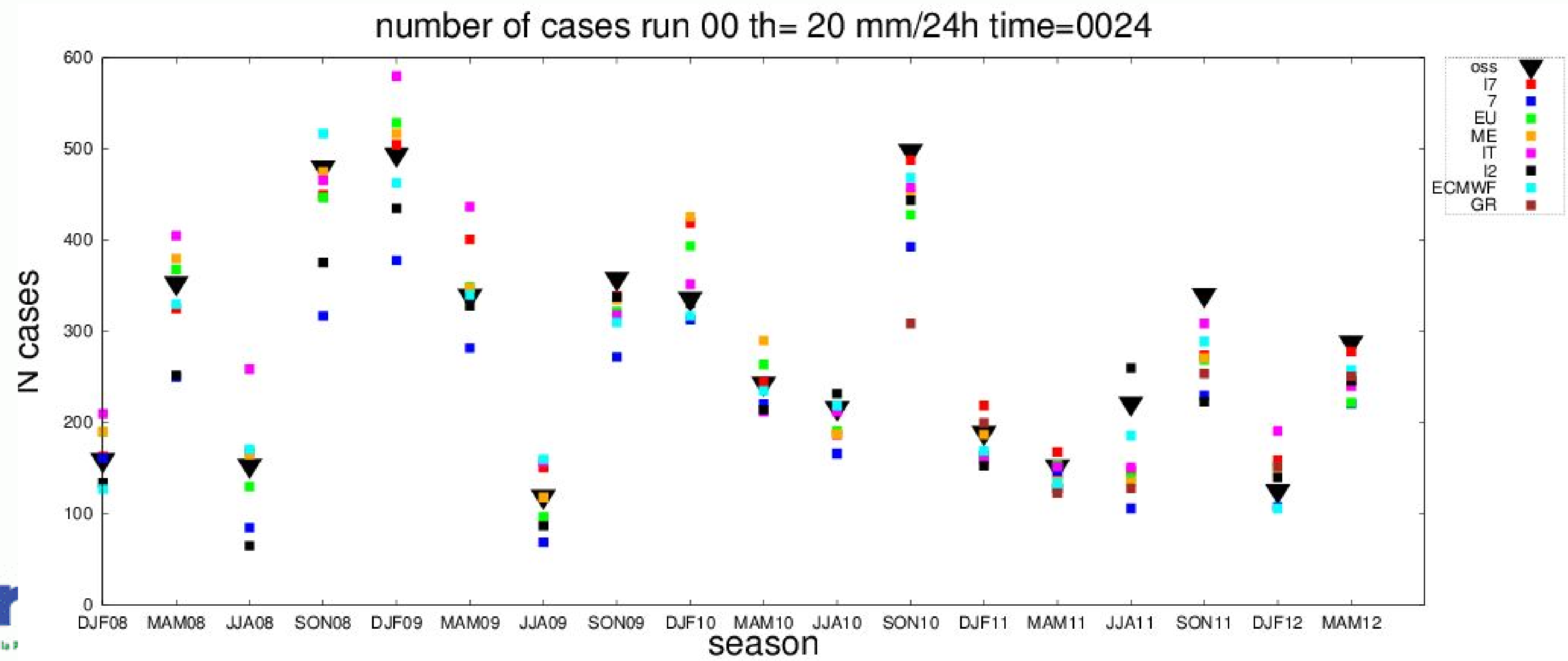
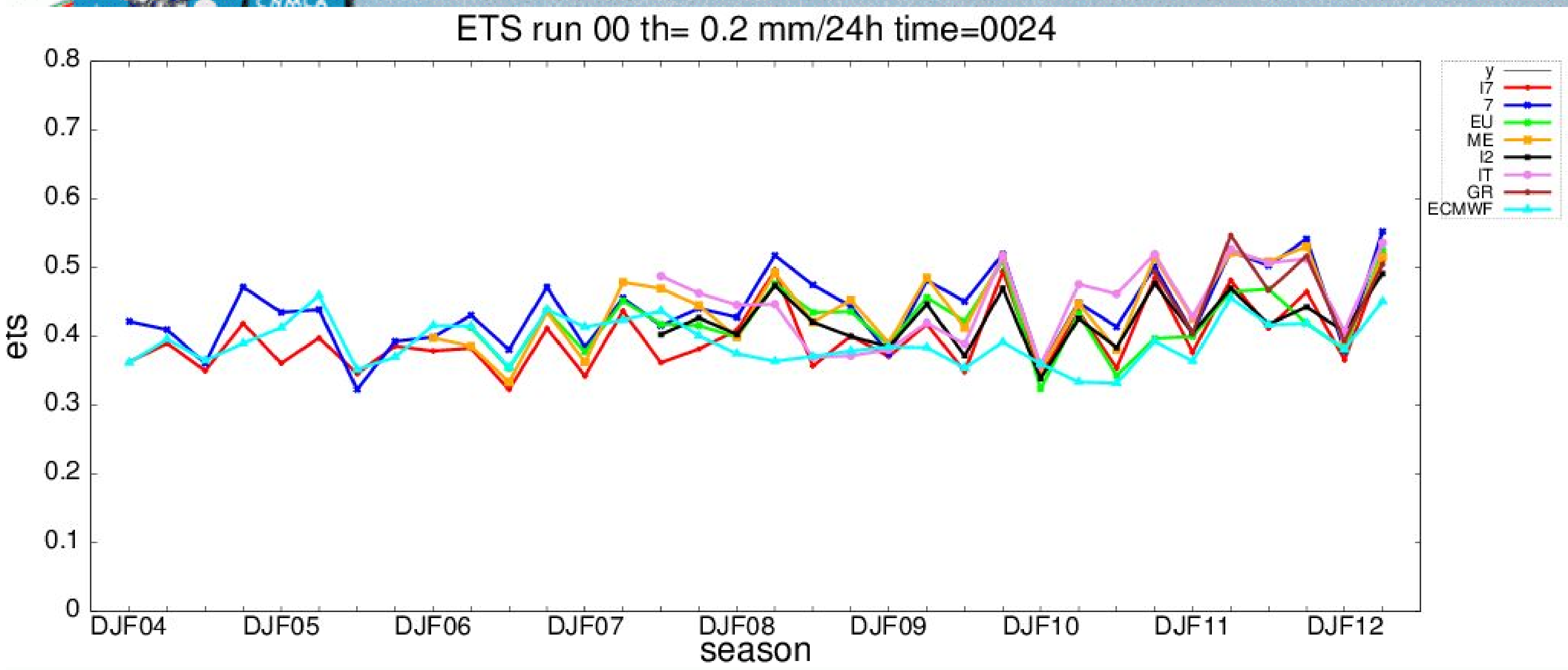
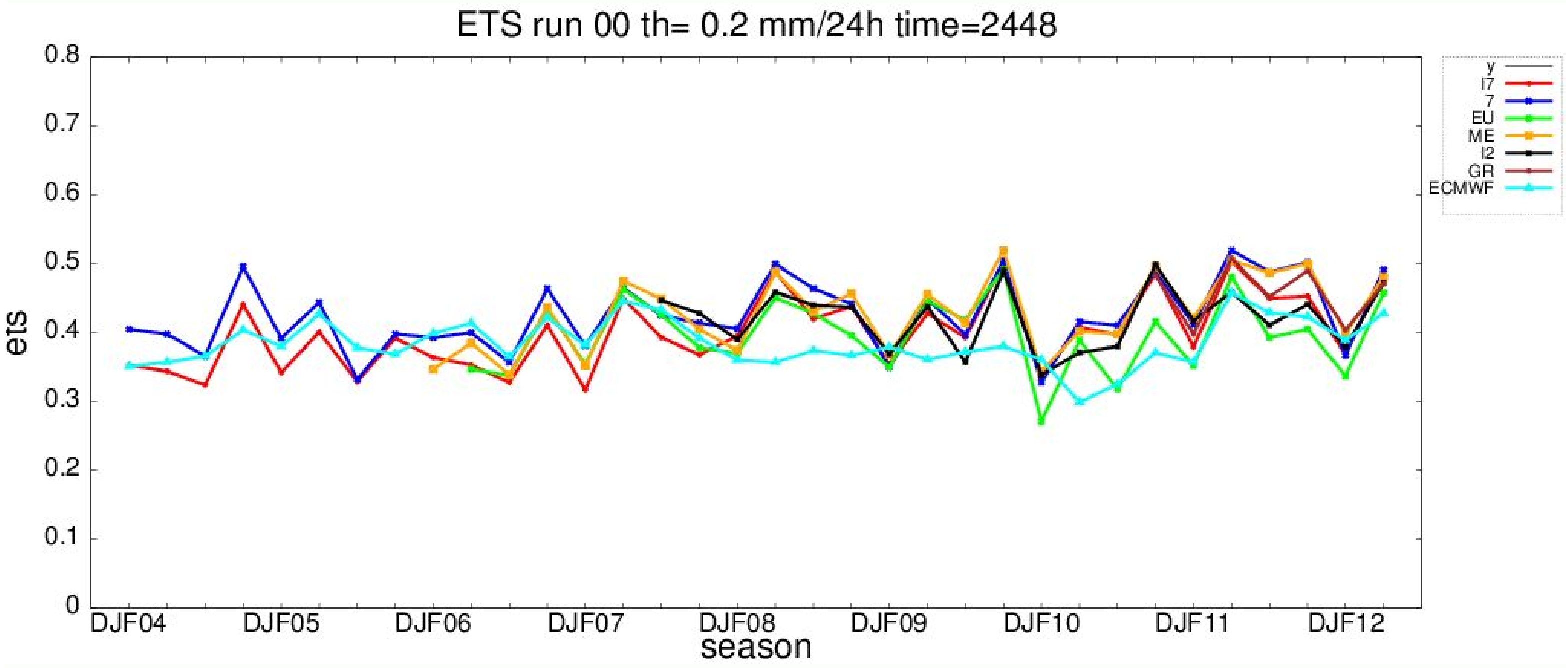
MAM12


number of cases run 00 th= 20 mm/24h time=0024
N cases
season
oss
I7
7
EU
ME
IT
I2
ECMWF
GR
DJF08
MAM08
JJA08
SON08
DJF09
MAM09
JJA09
SON09
DJF10
MAM10
JJA10
SON10
DJF11
MAM11
JJA11
SON11
DJF12
MAM12

Seasonal trend 0.2mm/24h + ECMWF





- Stationary improvement trend
- Big “negative” peaks during wintertime
- Seasonal error cycle: lower ets during winter and summertime
- Low ets for ECMWF and EU
- no significant differences between D+1 and D+2
- winter 2010 (very snowy particularly in Northern Italy)/winter 2011/winter 2012: low ets value (D+1 and D+2)→ model error or lack of representativeness of the rain gauges over the plain during snowfall ?

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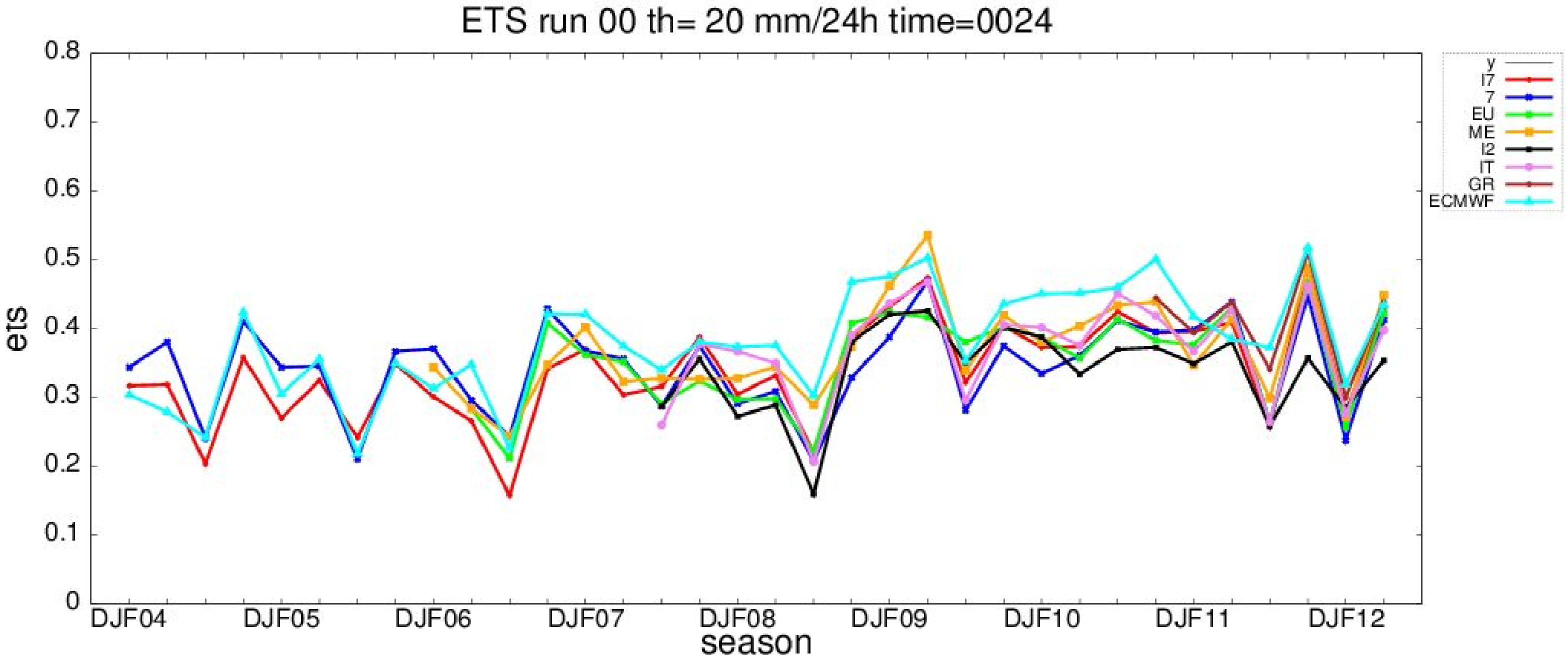
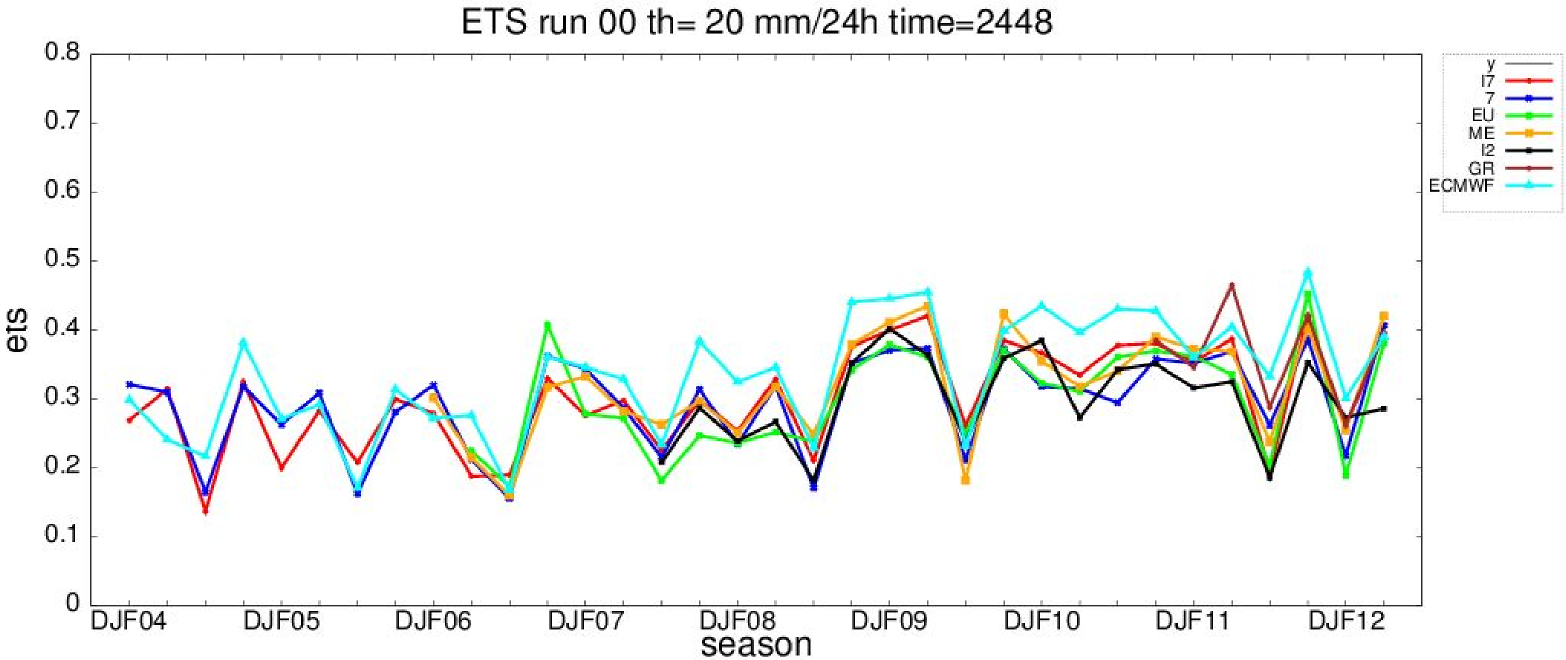
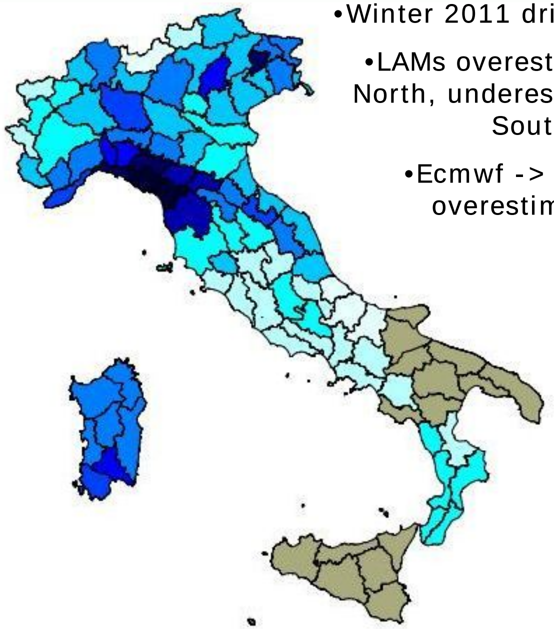
Seasonal trend 20mm/24h + ECMWF





- Big variability during latest year
- Good skill for ecmwf!!!
- Very low values during JJA12 and DJF12
- All the versions present two “big jump” at jja08 and jja09, after the values increase and become quite stationary
- Skill decreases with forecast time

Cumulated obs. Prec.



Cumulated seasonal precipitation (mm)

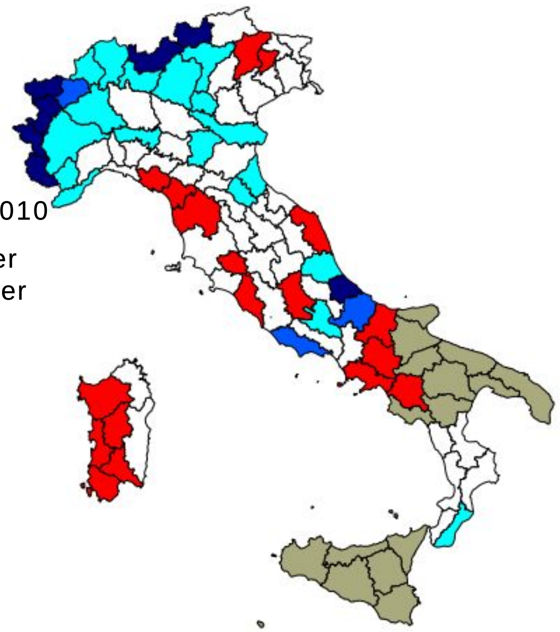
- Dato mancante
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 500
- >500

•Winter 2011 drier than 2010

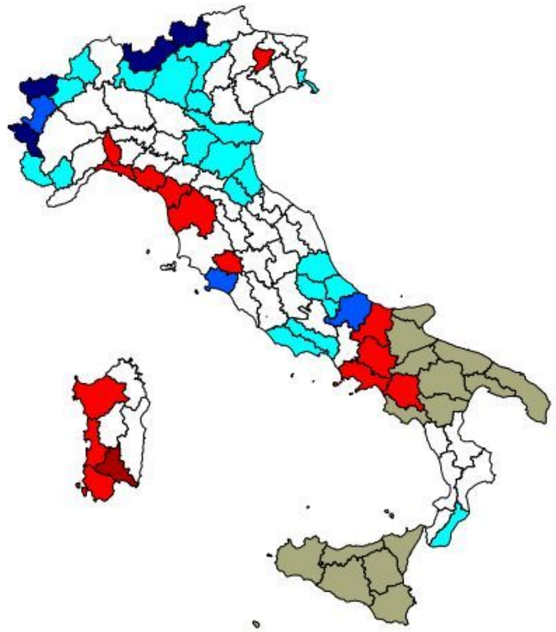
•LAMs overestimate over North, underestimate over South

•Ecmwf -> little bit overestimation

Cosmo-I7



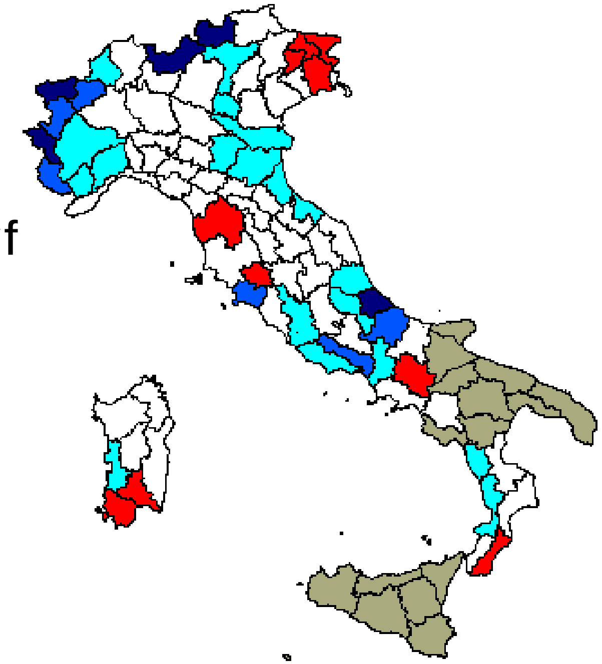
Cosmo-ME



Rel Err= (for-obs)/obs %

- -100 - -60
- -60 - -20
- -20 - 20
- 20 - 60
- 60 - 100
- > 100

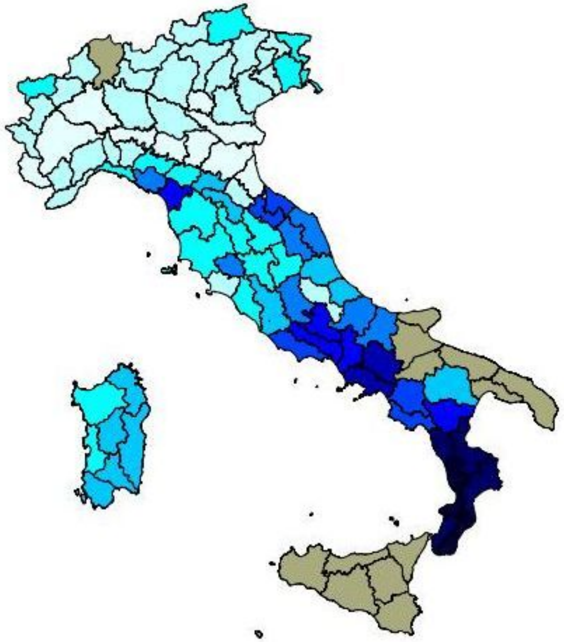
Ecmwf



RELATIVE ERROR winter 2011

RELATIVE ERROR winter 2012

Cumulated obs. Prec.



Cumulated seasonal precipitation (mm)

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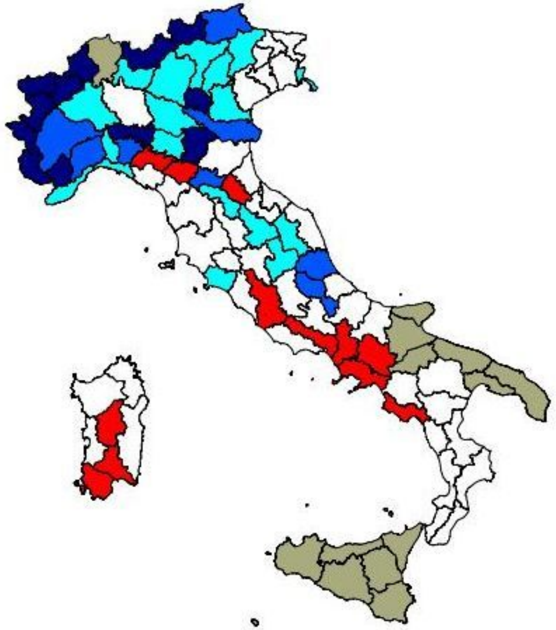
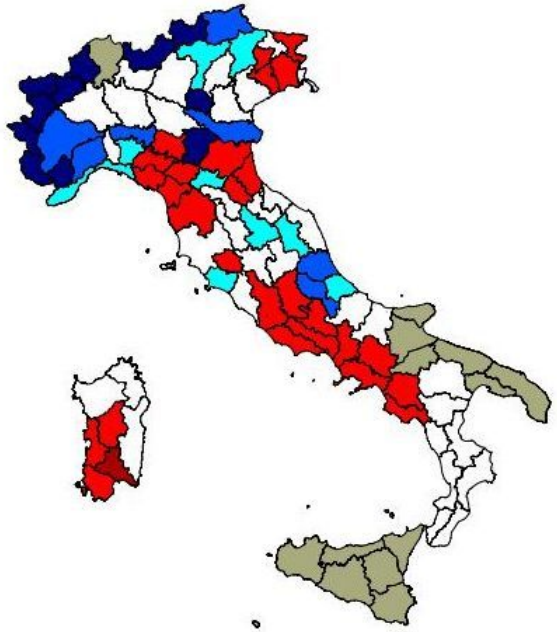
- >500

- Winter 2012 -> different weather regime -> drier in North (N-NW flow=> snow on mountains, few precipitation episodes over padania plain, all of these were snowy), wetter in Centre and South
- Models strongly overestimate over North, underestimate over South

Cosmo-I7



Cosmo-ME



Rel Err= (for-obs)/obs %

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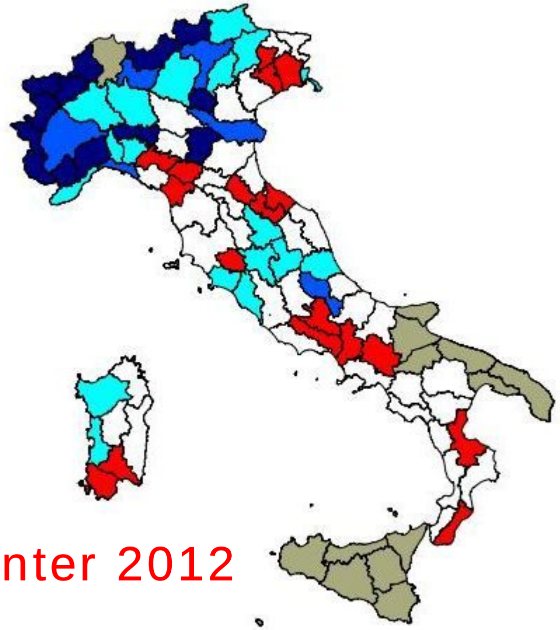
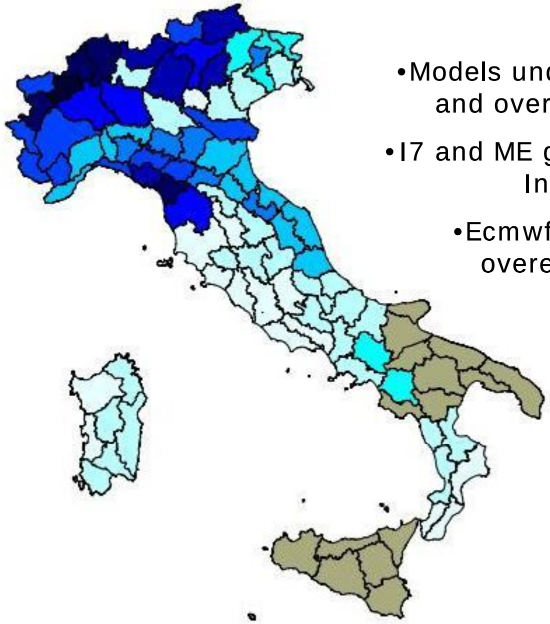
Ecmwf



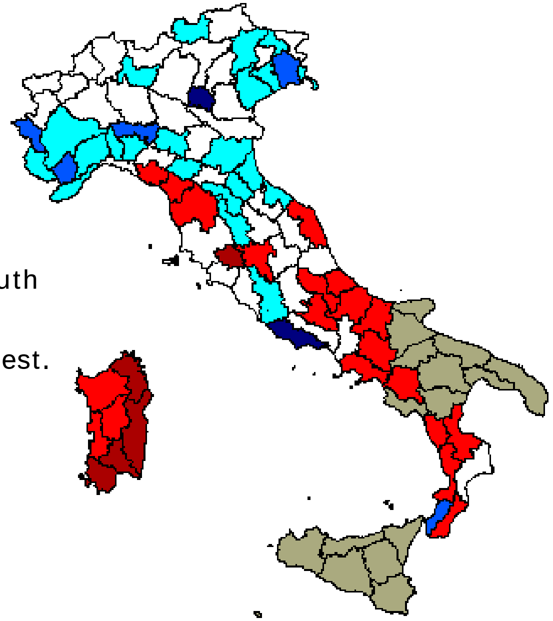
Cosmo-I7

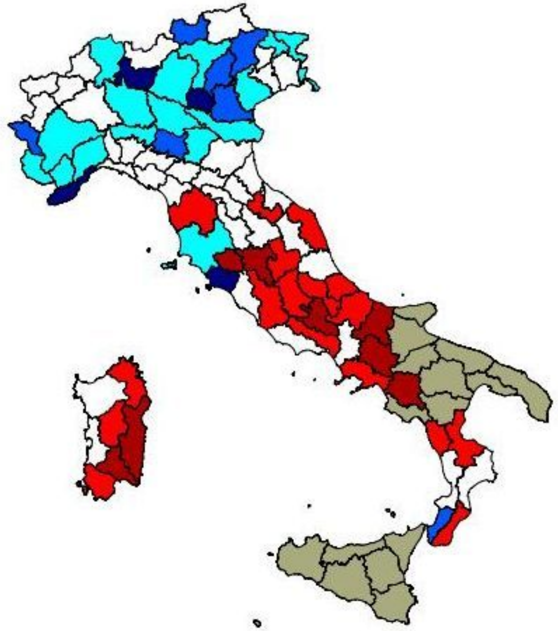
Cosmo-ME

Cumulated obs. Prec.



- Models underest. In South and overest. In North
- I7 and ME greater underest. In South
- Ecmwf -> little bit overestimation





Rel Err= (for-obs)/obs %

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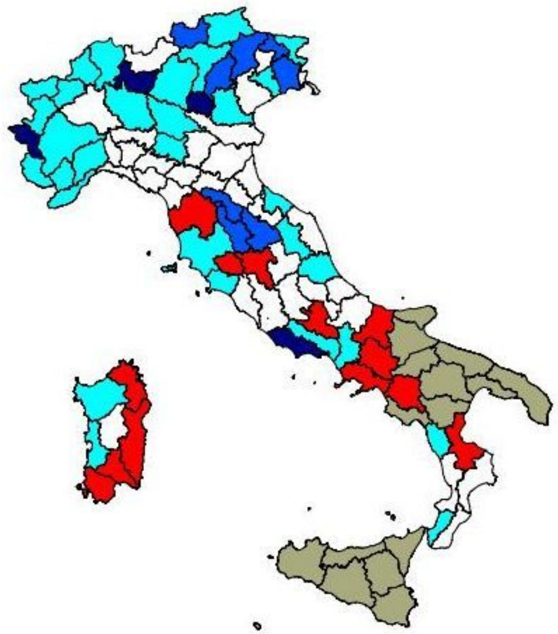
- -60 - -20
- -20 - 20
- 20 - 60
- 60 - 100
- > 100

Ecmwf



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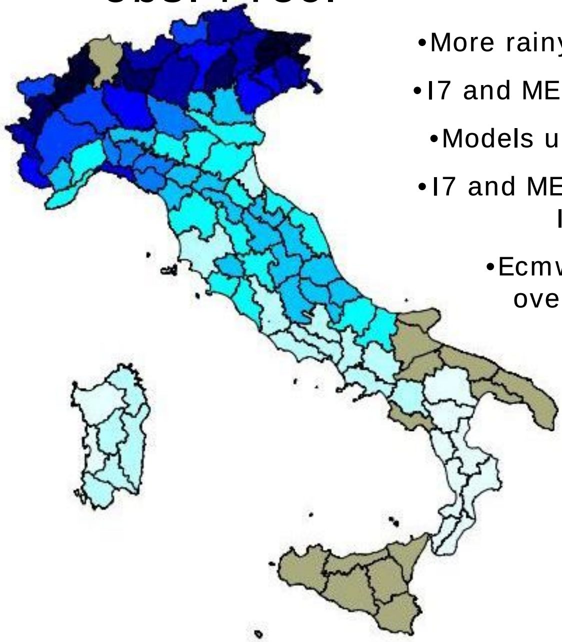
RELATIVE ERROR summer 2010

RELATIVE ERROR summer 2011

Cumulated obs. Prec.



Cumulated seasonal precipitation (mm)

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- 0 - 50
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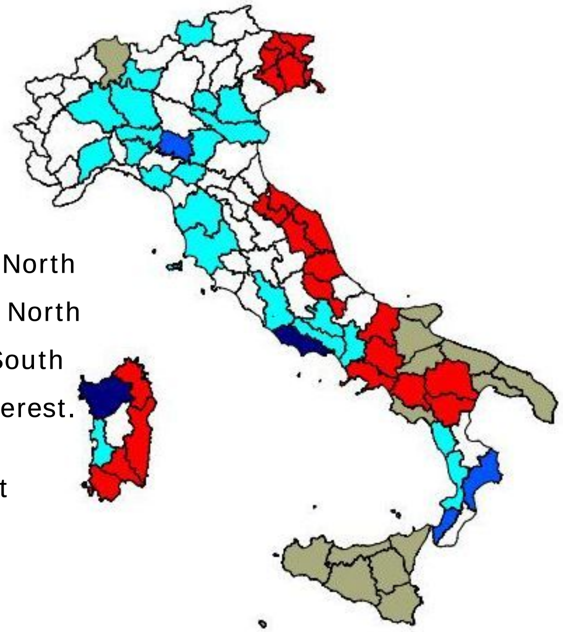
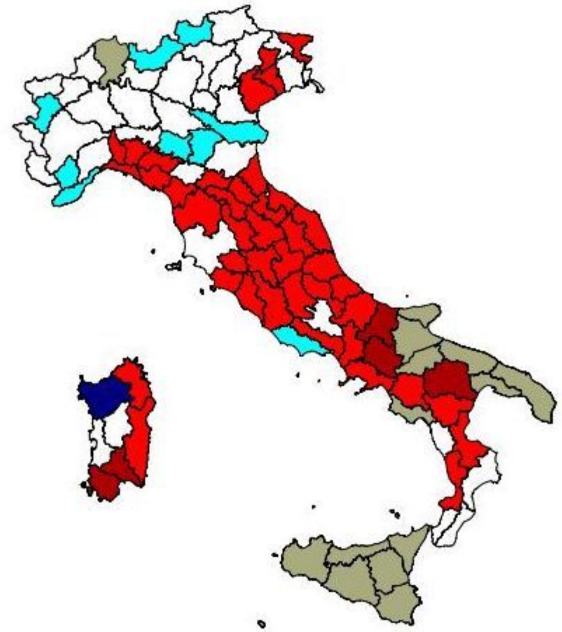
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 500
- >500

- More rainy summer in North
- I7 and ME good skill in North
- Models underest. In South
- I7 and ME greater underest. In South
- Ecmwf -> little bit overestimation

Cosmo-I7



Cosmo-ME



Rel Err= (for-obs)/obs %

- -100 - -60
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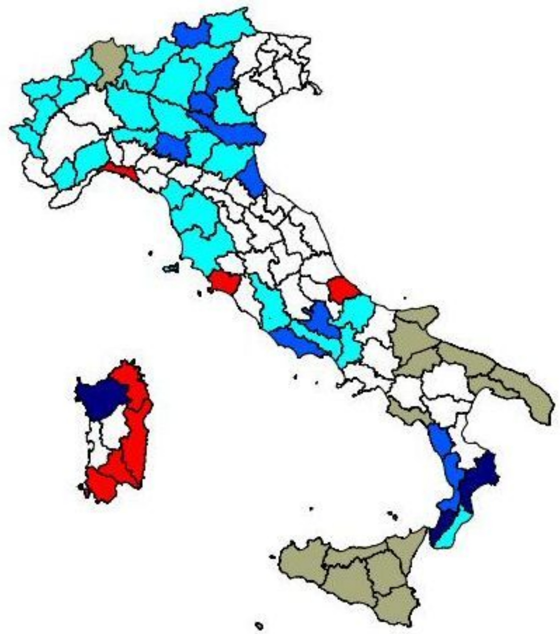
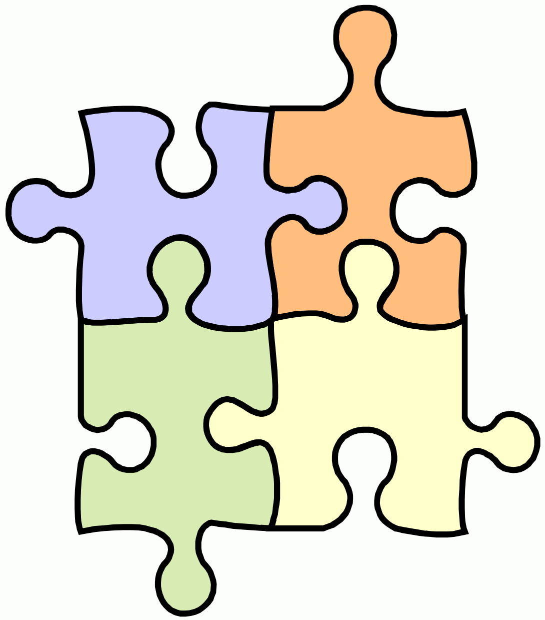
Ecmwf



Conclusion

- Very difficult to summarize the results



Thanks for your attention!