Application and verification of ECMWF products 2018

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1. Summary of major highlights

ECMWF model output from both 12 and 00 UTC runs is used (plotted fields) mainly for the medium range forecasts. ECMWF data are also provided to a few physical adaptation schemes and as boundary conditions to some components of the Italian Air Force NWP system (COMET-LETKF, COSMO-ME, COSMO-ME-EPS). Objective verification with Italian SYNOP observations of HRES model is routinely carried out at COMET along with the comparison with COSMO-ME model. A few case studies are also presented by the COMET and CNMCA forecasting branches.

2. Use and application of products

2.1 Post-processing of ECMWF model output

2.1.1 Statistical adaptation

A statistical post-processing system, named SIBILLA (Statistical Integrated Bayesian Information from Large to Local Area), aiming at the refinement and downscaling of the ECMWF seasonal forecast model output through an artificial neural network adaptive approach is used. This system runs on a decade basis providing monthly and three-months outlooks of significant atmospheric variables over Italy.

2.1.2 Physical adaptation

Physical adaptation is being used within the meteograms generation application. Routines selecting for each geographical site the most likely point among nearest grid points, make use of land/sea mask and elevation comparisons. Correction at all is being performed once the grid point has been chosen on the base of geophysical properties of the site.
The Metview module FLEXTRA is being used to trace contaminant dispersion in case of nuclear, chemical or biological incident/accident.
Meteorological CBRN messages as well are generated and distributed according to NATO directives and other agreements.
The ECMWF model data are also used as boundary conditions in the following components of the operational short-range numerical forecasting system:

• Ensemble Kalman Filter (EnKF) Data Assimilation System based on the COMET-LETKF algorithm and the high-resolution non-hydrostatic model COSMO integrated over the Mediterranean-European region (40+1 members, 7 km, 49 vertical levels);
• COSMO-ME EPS short-range ensemble prediction system initialized by the COMET-LETKF ensemble analysis and running twice a day (00 and 12 UTC) up to 72 hours;
• COSMO-ME deterministic model integrated up to 72 hours over the Mediterranean-European region (5km, 45 vertical levels), four times a day.

In the COMET-LETKF assimilation cycle, both HRES and ENS ECMWF are used to generate the perturbed lateral boundary conditions. In particular, 40 randomly selected perturbations (ensemble member minus ensemble mean) from 12 hours older ECMWF-EPS run are added to the most recent HRES fields. The COSMO-ME EPS boundary conditions are instead given by 40 randomly selected members from the 6 hours older ECMWF-EPS run.

2.1.3 Derived fields

Thousands of meteograms are routinely produced over geographical sites within the 80°N-60°S area. At present meteograms are being produced in PNG graphical format and in text or XML mode every 6 hours for the range T+0H to T+168H stepping in time. Meteograms are produced targeting to a general purpose use and for this reason the weather parameters included are numerous; among them: 2m temperature, 2m humidity, mean sea level pressure, total-high-medium-low cloud cover, convective precipitation, grid scale precipitation and 10 m wind. Despite the static mass production a web based system offering dynamic generation services of the same meteograms as above to the registered users is operational since 2011.
Based on the ECMWF models output, several derived parameters are routinely calculated as well. Using the deterministic operational model forecasts, the derived fields produced are for example:

• freezing level;
• wet bulb potential temperature;
• KO and other stability indexes;
• liquid water content;
• accumulated precipitation over fixed time interval;

• heat index (Steadman);

• wind-chill;

• tropopause height and maximum wind;

• 2m relative humidity.

A deterministic post-processing package known as Automatic Weather Interpretation (AWI) is also applied to ECMWF HRES model output fields. A series of multi-parameter decisional tree allows the determination of weather phenomena (drizzle, rain, snow, thunderstorms, fog, etc.) as well as of the cloud type, the risk of icing, strong wind or heat waves. The AWI output are operationally used to establish weather impact over regions of interest.

Derived fields are also calculated using the ECMWF Wave Model output. The most important derived parameter is the sea state code, which is based on the primary wind wave height (Douglas Scale). Meteograms over sea geographical sites are being produced in PNG graphical format and in text or XML mode too. For each site primary sea swell height, wind wave height, 10 m wind and wave direction behaviours are described from T+0H up to T+96H at 6H time resolution. Most of the sites are chosen according to buoys and tide gauges deployment. Some of them do not correspond to any physical instrument deployed and for this reason they are named as "virtual buoys". As above a web based system offering dynamic generation services of the same meteograms to the registered users is operational since 2011.

The production of some graphical outputs from the EPS forecast system, is carried out directly from ECMWF Servers using "ad hoc" built applications and Metview batch procedures. In particular, the following maps are created on a daily basis:

• Epsgrams and Plumes for 40 main Italian cities

• Probability maps on Europe from t+ 48 to t+168 (precipitation, wind, 850 hPa Temp)

• Tubes on Europe t+96 and t+168

Both ECMWF Wave Model and ECMWF Atmospheric Model outputs are used and suitably cropped, re-gridded and distributed according to agreements with specific users.

2.2 ECMWF products

2.2.1 Use of Products

Air Force Met service uses ECMWF products from ecChart, ECMWF web-site and from our operational web-site, where most of the products are replotted for Italy area.

CNMCA mission is to to issue severe weather warnings and to support the National Civil Protection Department. Our main warnings usually are issued at 12.00UTC and not before 18-24 hours before the severe weather event begins.

At 10.00L the forecaster discuss his decisions about the warnings with the Civil Protection Department, unfortunately between end march to end October without using all the ENS products, because for example EFI are available after 10.00L. Anyway in this period, at 09.40, closed before the discussion we have short time only to see the total precipitation probability maps, which start to be available. Before issuing the warning at 12UTC we also look at EFI-SOT with model climate, CDF, ecChart, for example to have more detailed information (probe-window), the clickable charts at www.ecmwf.int, which are very useful to have together punctually ENS and HRES values in ENSgrams and maps.

We appreciate the ECMWF web-site cloud cover representation, which is the best way to show three cloud layer in a single map.

Finally extended forecasts are also used in the operational forecasting room to issue monthly forecasts available weekly on our public website www.meteoam.it.

2.2.2 Product requests

1. On www.ecmwf.int, EFI with more geographical domains and Quantile 100.
2. Clickable charts: Prob total precipitation in 6 hours step 6 hours with threshold >10mm, >15mm, >20mm
3. On ecchart Probe for EFI with hundredths (i.e. EFI=0,79)
4. On ecchart regional boundaries
5. On ecchart 500 hPa temperature Contour shade Interval 2
6. On ecchart not the same Meteogram window for every Product
7. On ecchart Shading without contours (-1/-0.5) for EFI 2m minimum Temp
8. On ecchart Shading without contours (0.5/1.0) for EFI with 0.3 red dashline
9. New GRIB parameter: maximum temperature at 2m in the last 24 hours

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both HRES and ENS)

Local weather parameters verified for locations

Objective scores are computed for ECMWF HRES 12 and 00 UTC run (d+1 to d+7) after collecting data retrieved from all available Italian SYNOP stations, using several stratifications. Plots have been produced for a number of parameters: 2m Temperature, 2m Dew Point Temperature, 10m Wind Speed, MSLP, Total Cloud Cover (ME, MAE).

Cumulated precipitation quarterly event scores (POD/FAR, FBI, KSS, ETS, ORSS, POD, FAR) with respect to fixed thresholds and for d+1 to d+7 ranges, are computed.

For this report, data covering the 1-year period from JJA 2017 to MAM 2018 have been used for the verification of these parameters and only some selected results are presented in the next pages (see Appendix A), for ECMWF HRES 00 UTC run only.

In order to compute the scores, no interpolation from grid point to observation location is performed. The “nearest point” method is used, optimized by the “smaller” difference in altitude combined with the horizontal distance between a station and the corresponding grid point. The reference software used for verification purposes is called VERSUS (VERification System Unified Survey), i.e. the official software used within COSMO model consortium as Common Verification Suite (CVS). The VERSUS system has been developed at Air Force Met service and it is based on DB architecture with a GUI. Through this tool, Conditional Verifications are also possible (cross conditions on different parameters).

A short note on the results is given below.

10m Wind Speed: a general small underestimation is shown in ME, less than 0.8 m/s in absolute value. MAE, around 1.4-1.7 m/s in summer 2017, 1.5-2 m/s in fall 2017 and spring 2018 , 1.7-2.4 m/s in winter 2018, with a tendency to slightly increase with forecast step.

2m Temperature: clear diurnal cycle in both ME and MAE especially in winter. A general underestimation is shown in ME, especially during the night. MAE increases with the forecast time and its values are mainly comprised between 1.4 and 2.5 K (reaching up to 2.9 K in winter).

12-h Cumulated Precipitation: regarding the bias (FBI) ECMWF model shows an overestimation for all the seasons for lower thresholds, while tends to underestimate the really higher ones. The discriminant threshold (i.e. FBI = 1) is around 06-18 mm/12h in fall 2017 and spring 2018, 01-14 mm/12h in summer 2017 and around 10-25 mm/12h in winter 2017-18. About the accuracy (ETS), all seasons exhibit the best results mainly for low thresholds and for the first 3-4 days of integration. For all thresholds there is a gradual decrease in accuracy with the integration time.

3.1.2 ECMWF model output compared to other NWP models

ECMWF HRES 00-UTC scores (ETS, FBI) for 12 hours cumulated precipitation have been calculated and graphically compared to those for the 00 UTC run of COSMO-ME model (5 Km resolution) for d+1 and d+2 over the Italian SYNOP stations. Results are shown in the Appendix A. COSMO-ME forecasts are ready before (a few hours) the ECMWF HRES forecasts, because of the use of old IFS BC fields (for example 18 UTC IFS for 00 UTC COSMO-ME run).

Respect to the FBI scores, COSMO-ME and ECMWF HRES show a similar tendency, with an overestimation for the lower thresholds and a general underestimation for the higher thresholds; COSMO-ME model shows better values that are lower and closer to 1 (around 1.0-2.0 in Summer 2017, 1.0-1.5 in Fall 2017) respect than the ECMWF model (around 1.5-3.0 in Summer 2017, 2.0 in Fall 2017) and more constant in function of the thresholds (at least up to 18-20 mm) . Accuracy, represented here through ETS score, tends to be similar, except for lower thresholds, for both models and for all seasons, showing a behaviour comparable to that recorded in previous years.

A further comparison between the two models has been done in terms of mean error and root mean square error (ME,RMSE) for 2m temperature and 10m wind speed.

Results show a tendency of COSMO-ME to overestimate the 2m Temperature in Summer and, for some time steps, in Fall 2017, opposite to the IFS behaviour; for Winter 2017-18 both models have an underestimation attitude, with a counter-phase trend, for the mean error; for Spring 2018 COSMO-ME has a ME close to zero, while it is present a negative bias for ECMWF. Looking at the 10m Wind Speed comparison COSMO-ME model seems to slightly outperform the IFS in terms of ME and RMSE, except for Winter 2017-18.

3.1.3 Post-processed products

3.1.4 End products delivered to users

Quarterly reports on model verification results are made available to Intranet and Internet users as well as Forecasts and Research division.

3.2 Subjective verification

3.2.1 Subjective scores

3.2.2 Case studies

Case Study (COMET): Liguria, Southern Piedmont, Emilia December 10th -11th 2017

Freezing rain may be easily under assessed within a forecasting approach process, sometimes without considering the remarkable effect of such incident, especially during winter season. Here is a case occurred on December 10th-11th 2017 when such type of rain has been well spotted by models and by forecaster on charge. As in fig. 1, 2 an anticyclone over northern Europe is keeping main flux and frontal systems concentrated between 45° and 50° determining a complex and really evolutionary scenery. Particularly a warm cold front sequence is affecting north western Italy convoying at first southerly warm air all through Ligurian Apennines. After that katabatic winds are generated across to Apennines northern side, down to southern Piedmont and Emilia, where a cold air cushion is already lying. Such irruption is followed by cold air due to the next cold branch of such frontal system determining a quite unstable atmospheric layer. Some rainfall are expected over this areas but the problem is to understand how probable may it be some of them were freezing rain like.

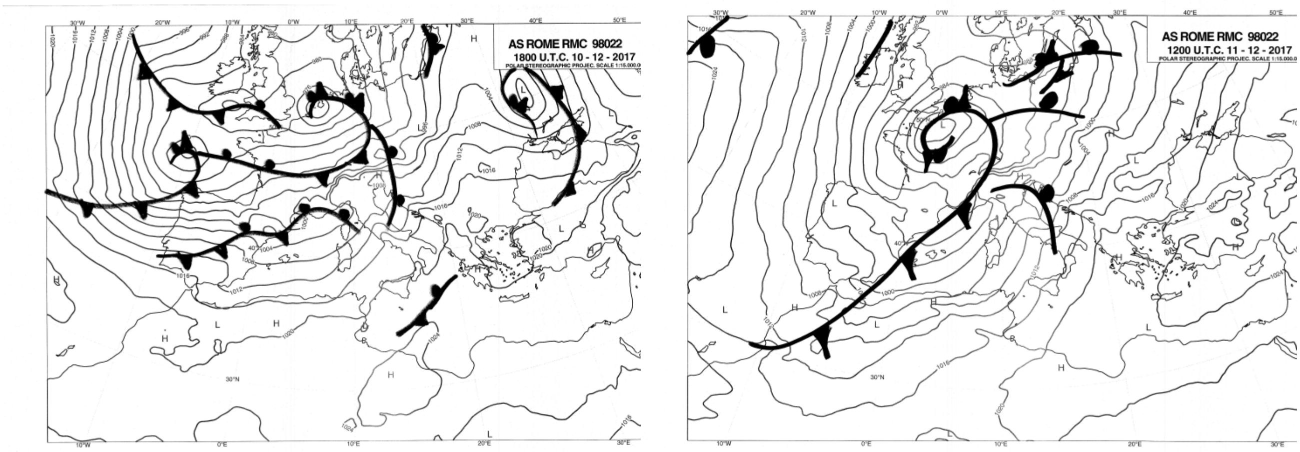


Fig. 1: Low level Analysis chart on December 10th-11th 2017. A well organized frontal system is producing a number of waves all through western and central Europe in fast evolution and northern Italy is affected as well by some rainfall due to the present conceptual model.

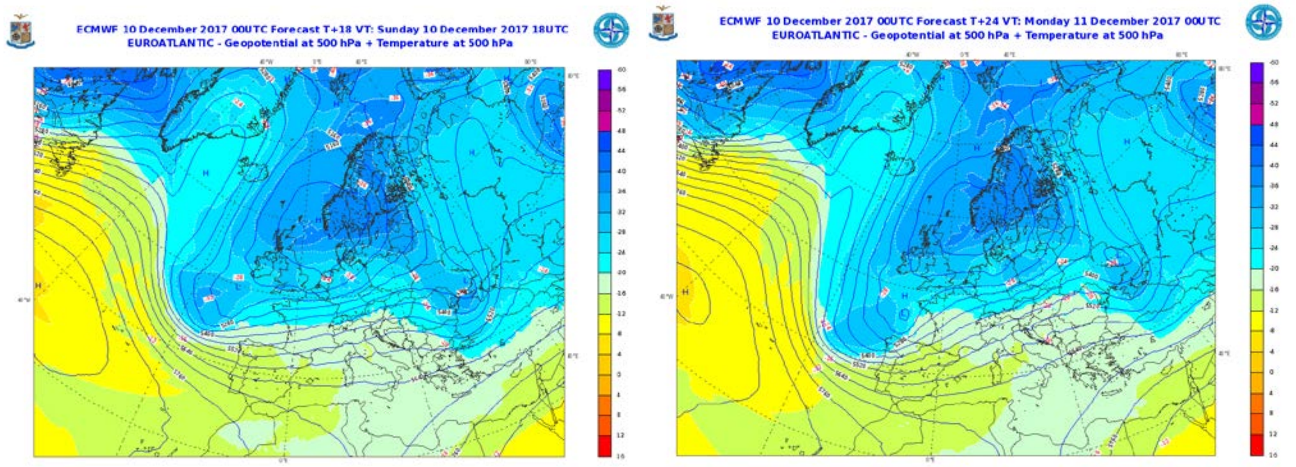


Fig. 2: Forecast charts (ECMWF global model, December 10th 2017, 00.00UTC, T+18, T+24 hours) for Geopotential and Temperature 500 hPa showing how Scandinavian anticyclone is producing a "bridge" structure convoying cold air masses down and all through Europe

Fig. 3, 4 show the Ecmwf product called "Precipitation Type" which spotted quite well an hypothetical freezing rain area occurrence already form December 10th 00.00UTC run as happening in the final part of the day, following night and morning. December 11th 00.00UTC run confirms exactly such expectation. So a coherence has been verified within model being consistent, at least up to 36 hours, at least in forecasting something. Verification are a difficult matter as they can come from reports or maybe from vertical sounding throughout atmospheric layer, as in fig. 5.

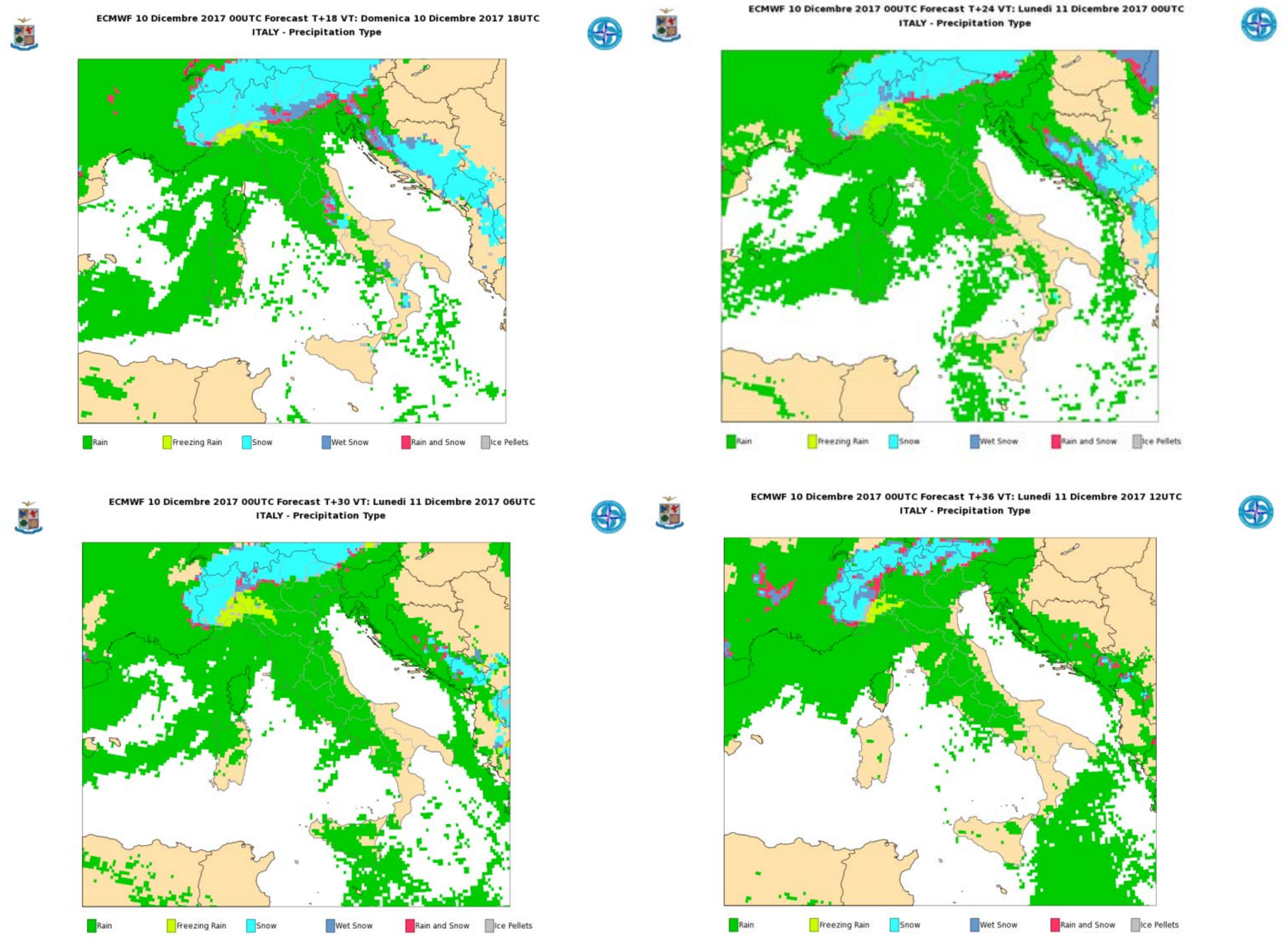


Fig. 3: Forecast charts (ECMWF global model, December 10th 2017, 00.00UTC, T+18, T+24, T+30, T+36 hours) for Precipitation Type, showing

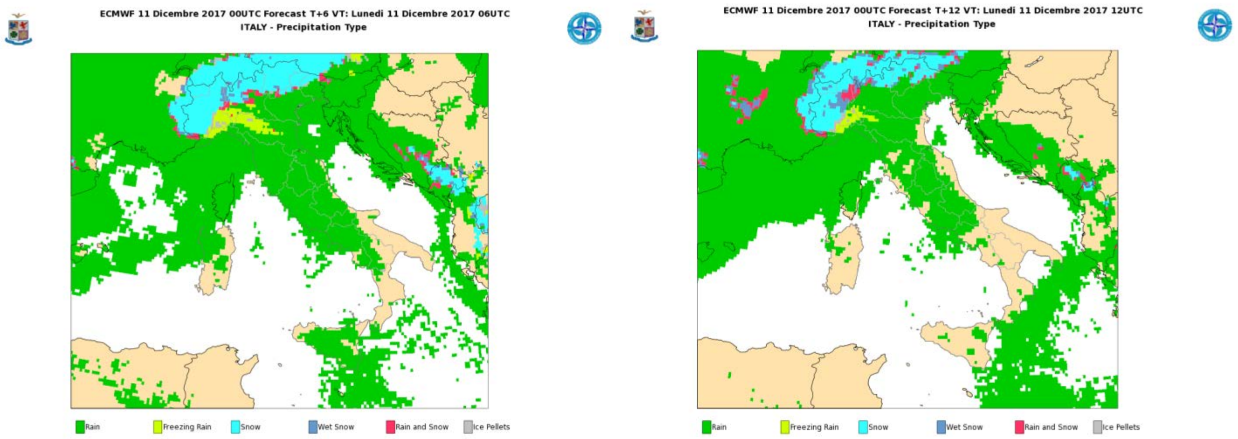


Fig. 4: Forecast charts (ECMWF global model, December 11th 2017, 00.00UTC, T+6, T+12) for Precipitation Type, showing

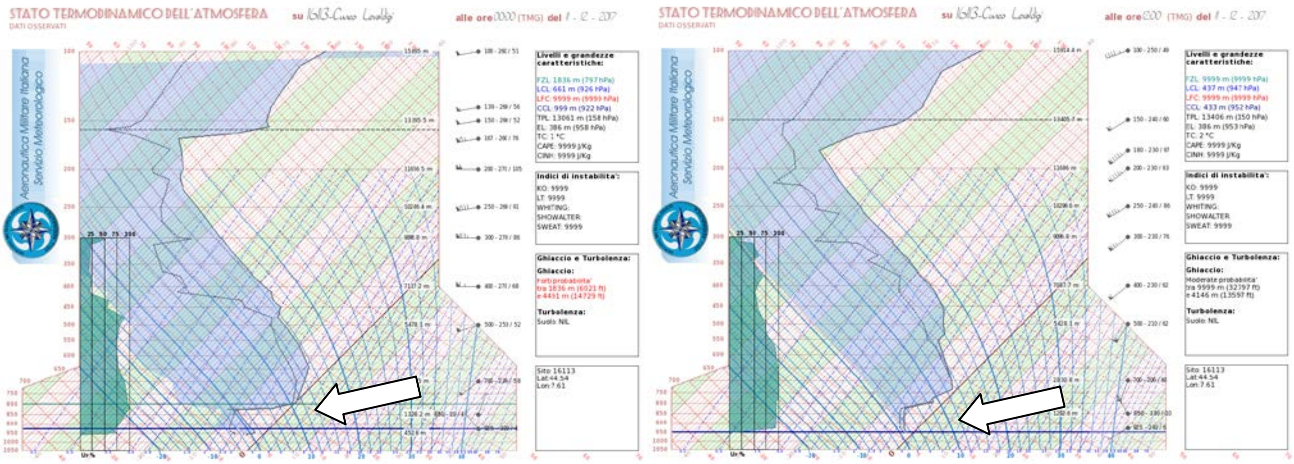
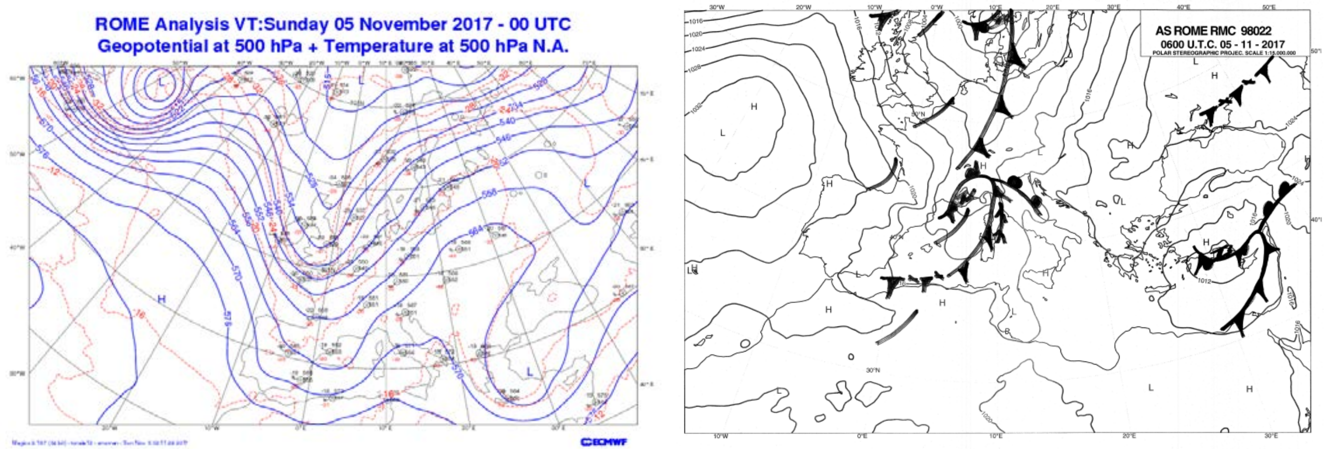


Fig. 5: Thermodynamic Sounding (COSMO-ME local model) December 11th 2017, 00.00UTC and 12.00UTC over Cuneo Levaldigi on Herloffson nomogram. No particular convective instability is showed but rather air column saturated since lower levels within negative temperature air and ice probability.

These Thermodynamic Soundings show a very saturated air column within negative temperature where warmer air is conveyed on top of a cold cushion (but always below the thermal zero). In fact supercooled water survives in such conditions of cloudy sky with ground temperature just smaller than air temperature (even a couple of °C).

Case Study (COMET): Northern Italy November 5th 2017

Sometimes any classic conceptual model can give birth to something else because of an orographic component or an air masses convergence line, and so on. Here is a case regarding consequences of a classic system centered over North Sea and Scandinavian area, progressing eastwards with a katabatic cold front associated coming down to Provence. As it results from fig. 1, such a configuration produces, during all day, on November 5th 2017, 00.00UTC, a secondary geopotential minimum and a consequent low centre over the Gulf of Lion, being separated by the main subject by a branch of jet stream, progressing eastwards because of a meridional circulation, involving mainly northern Italy but, more specifically, the whole of it, up to an activity maximum on November 6th 2017, 00.00UTC.



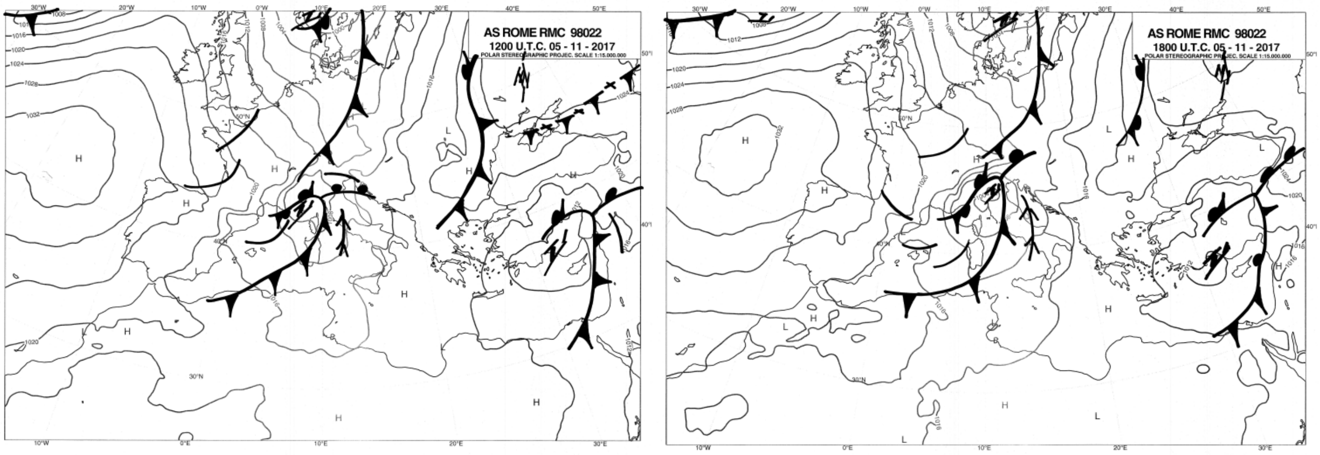


Fig. 1: Upper and Low level Analysis charts on November 5th 2017. A well organized frontal system is producing a secondary complex system in fast evolution and northern Italy is affected mainly, together with most of Italian peninsula.

As been correctly represented in Analysis charts, this system is not merely a cold front but an individual warm-cold front getting occluded, with prefrontal convergence line and postfrontal upper cold subjects (commas). All these subjects can give, in this season of the year, persistent and heavy thunderstorm like rainfall. Satellite observational verification in fig. 2. In fact it is there evident as WCB, normally associated to a moderate instability, because it is dry African air getting recalled up all through Mediterranean sea and getting enriched with humidity, looks this time enforced by convergence lines which usually provoke heavy thunderstorm phenomena in strips over the sea, continually fed by new air mass refuelment. At least a couple of commas follow the classic cold cyclogenesis. All the described structure approaches Ligurian sea and western sector of northern Italy first, the occlusion cover such an area and there persist as long as some energy is available, while the cold branch progress down to central Italy; all the warm sector instead is represented by WCB and convergence line which, November 6th 2017, 00.00UTC, involves almost the whole of Italy.

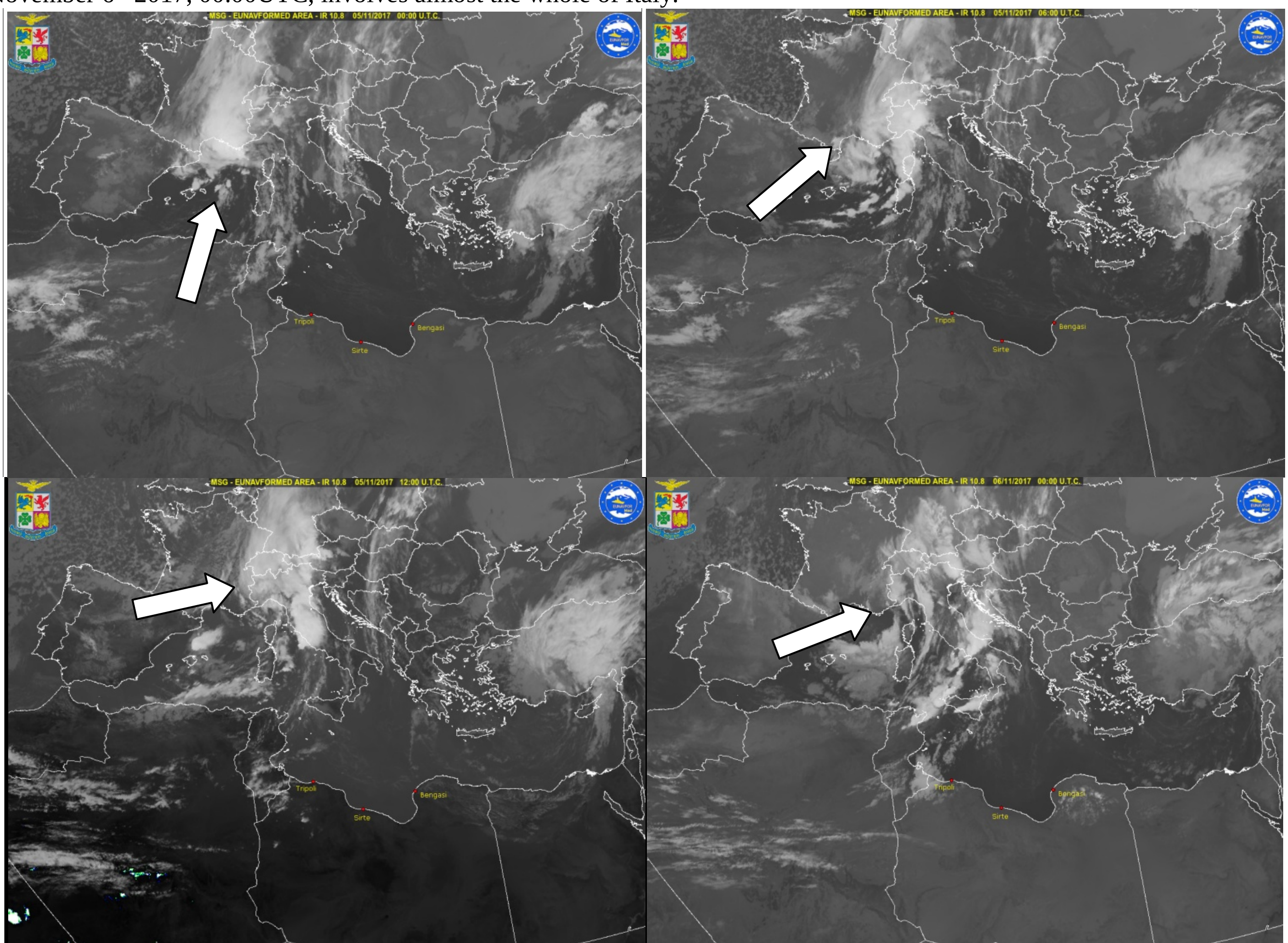


Fig. 2: Satellite IR cannel showing already on November 5th, 00.00 UTC, a prefrontal warm flow over Western Mediterranean region with un regular cloudiness. This means WCB is acting with a moderate instability. Even air masses collision are visible

in prefrontal position, giving cloudiness in strips: they are convergence lines. In the last chart orographic thermodynamic processes are in progress.

Let's now have a look to the way Ecmwf global model approaches. Fig. 3 shows dynamic Tropopause evolution since November 4th 00.00UTC run, being exactly confirmed the following day (November 5th, 00.00UTC run) being geopotential 500 hPA a very invariant field. It is noticeable the presence of a jet streak over southern France, which corresponds with unstable conceptual models at the lower levels. In fig 4, 5 is Wet Bulb Potential Temperature at 850 hPa evolution since November 4th 00.00UTC run, being confirmed rather well the following day (November 5th, 00.00UTC run), even considering that this parameter is not so invariant as geopotential 500 hPa being sensitive to seasonality. So we can say that predictionability is more than acceptable in front of this case which is a classic conceptual model but, as we said, is crowned by some different factors making it a less ordinary one. As a partial confirm of model evaluation a different model (Cosmome local) can be considered, as in fig.6, showing how winds 10m draw well the shape of frontal system and prefrontal convergence lines navigating within the WCB. The effect of such configuration over the sea is producing gales. So it is remarkable to notice that at T+12 convergenge lines over Thyrrenian sea produce a gale striped as in a line: it is because it is continually fed and thunderstorms being part of the gale itself look quite stationary. In the time progress all the gales having started from western basins next to southern France move into the Adriatic sea, where their effect is enlarged by the falling winds from Appennines (katabatic winds).

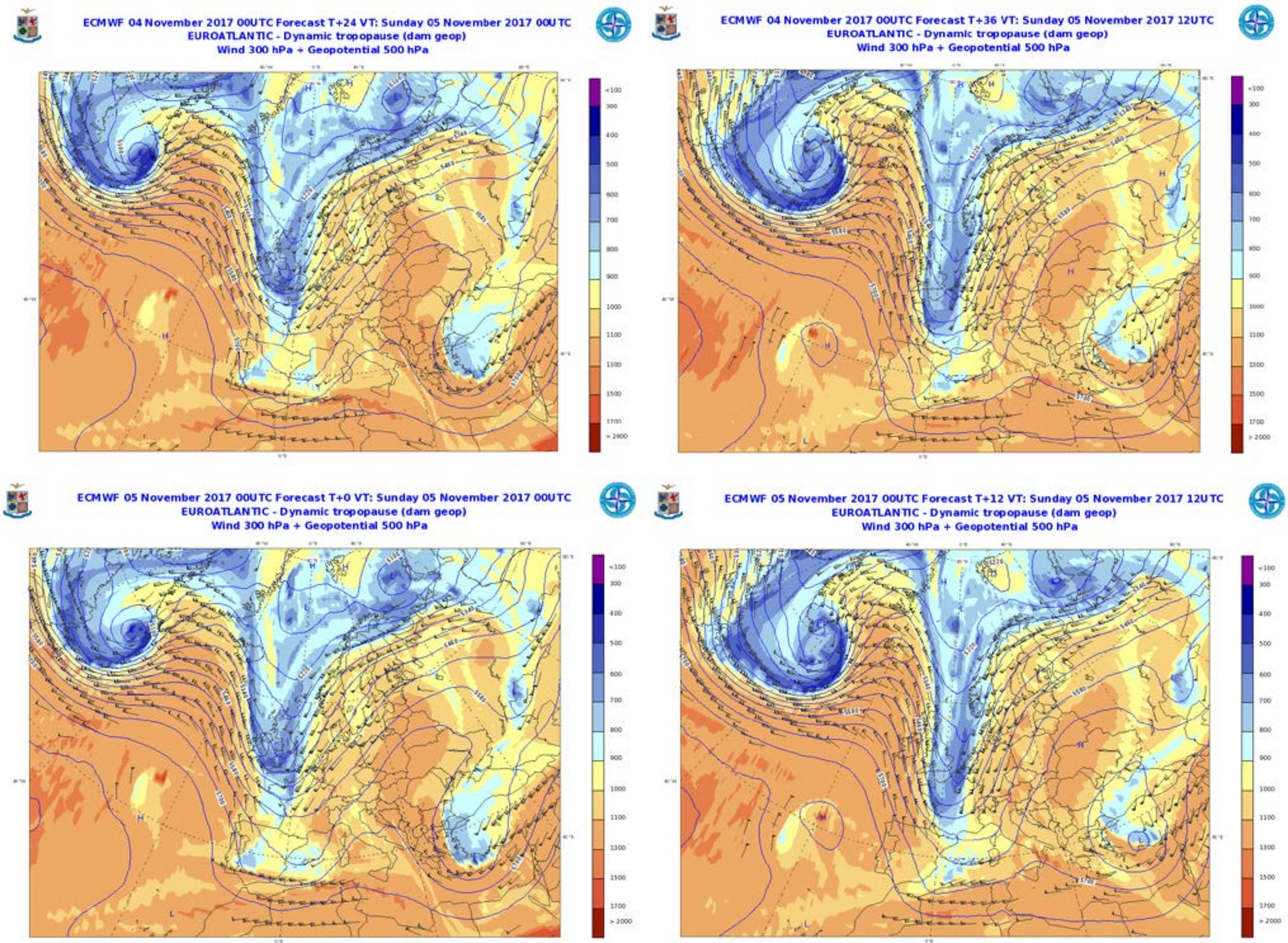


Fig. 3: Forecast charts (ECMWF global model, November 4th, 00.00UTC, T+24, T+36 and November 5th, 00.00UTC, T+0, T+12) for Dynamic Tropopause, showing jet stream different branches (300 hPa wind) and air mass movement being produced by upper level convergence/ divergence: Russian block anticyclone effect is noticeable, determining a tear off like configuration within the main part of tropopause anomaly assuring persistence of such synoptic subject influence

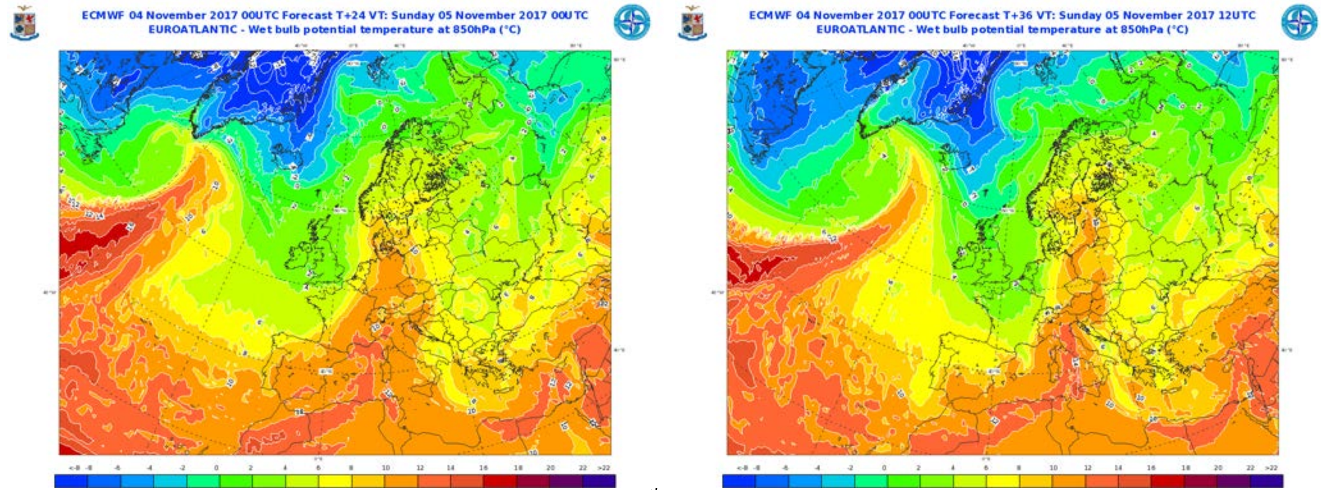


Fig. 4: Forecast charts (ECMWF global model, November 4th, 00.00UTC, T+24, T+36) for Wet Bulb Potential Temperature at 850 hPa, showing the different air masses circulation: warmer dry air coming up from Africa to Ligurian sea is a WCB, moderately unstable because of humidity in the sea.

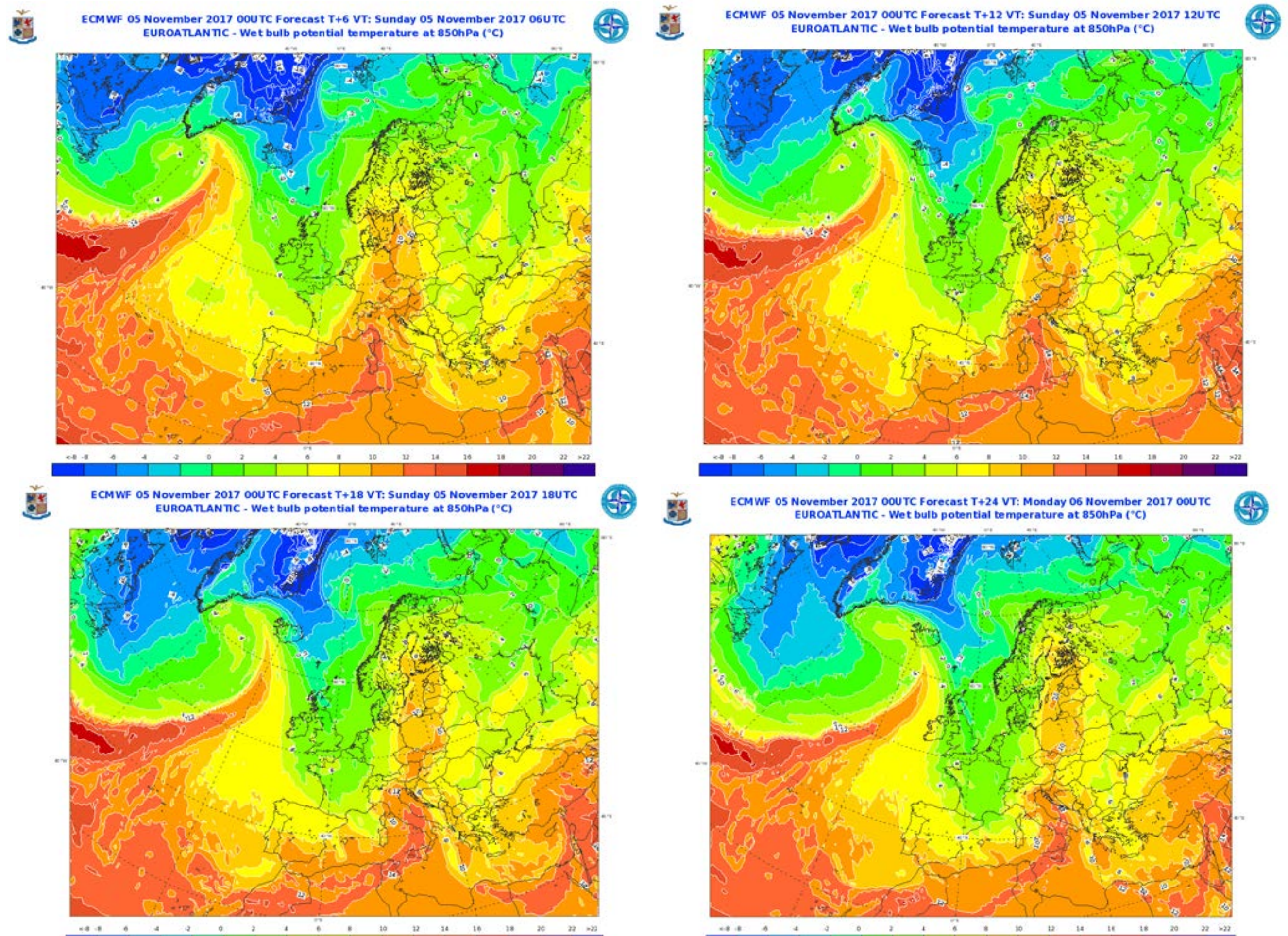


Fig. 5: Forecast charts (ECMWF global model, November 5th, 00.00UTC, T+0, T+12) for 850 hPa Potential Wet Bulb Temperature. Such parameter is a valid classic front and pseudofront tracker (even if its efficiency gets partially disabled during summer time over Mediterranean area). Different air masses and WCB branches are visible

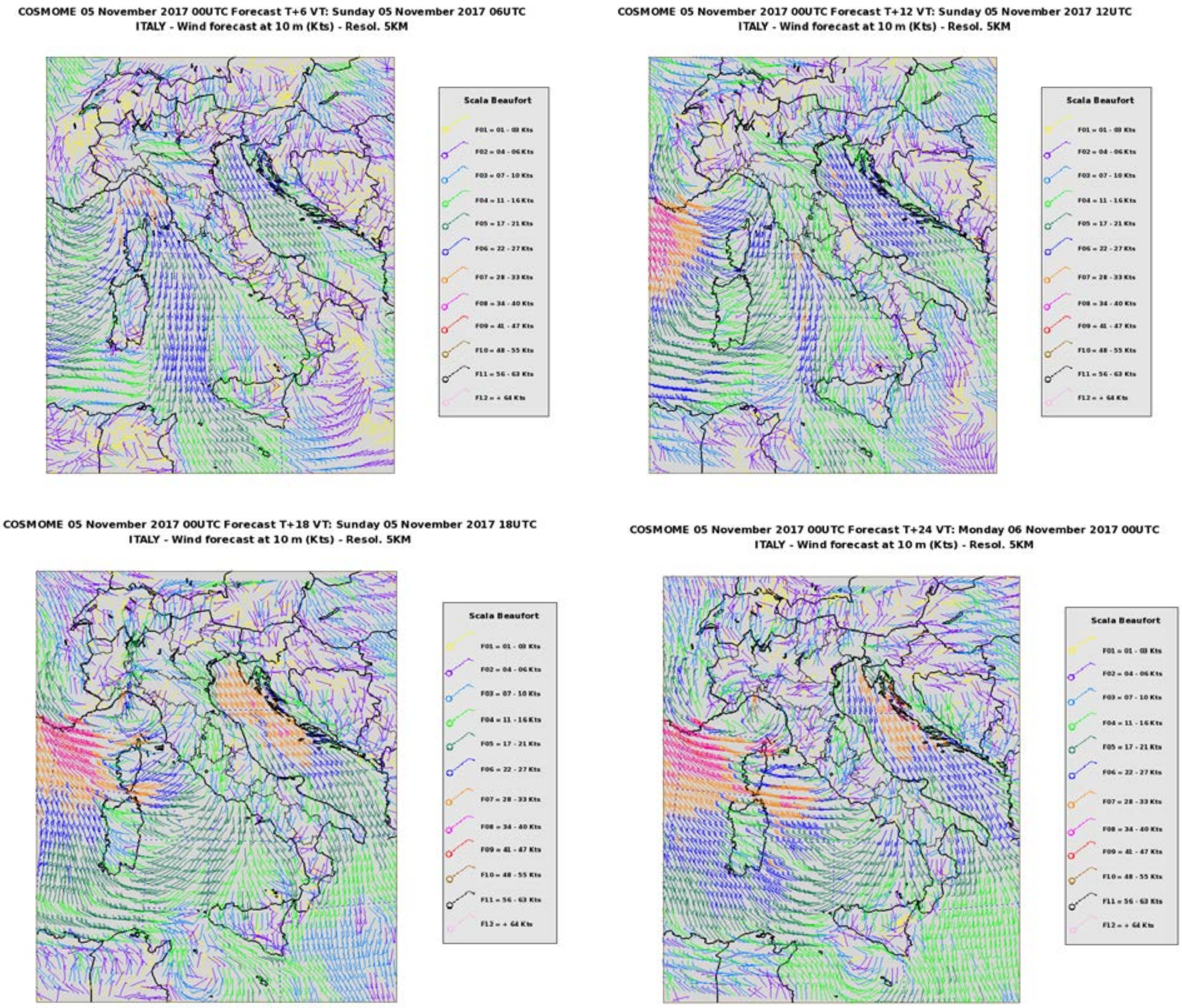


Fig. 6: Forecast charts (COSMO-ME local model, November 5th, 00.00UTC T+6, T+12, T+18, T+24) for 10m wind: prefrontal convergence initially over Liguria and Provence is noticeable, by ascending air masses from southern sector and falling down from Apennines with a cyclonic like rotation, progressing then towards Italian central regions.

Precipitation amount connected to all described conceptual models in charge is analysed in fig. 7, 8 as in Ecmwf global model product, which shows a slight reduction of amounts from November 4th 00.00UTC run to November 5th 00.00UTC run, although the parameter distribution plot look quite similar. A first conclusion may be suggested as in the fact model worked well. This may be true because most of phenomenology is related to winter classic subjects, which notoriously get well interpretated by this model, with medium thresholds. It is not the same when we are in presence of convective summer phenomena, when model sometimes looks “blind”.

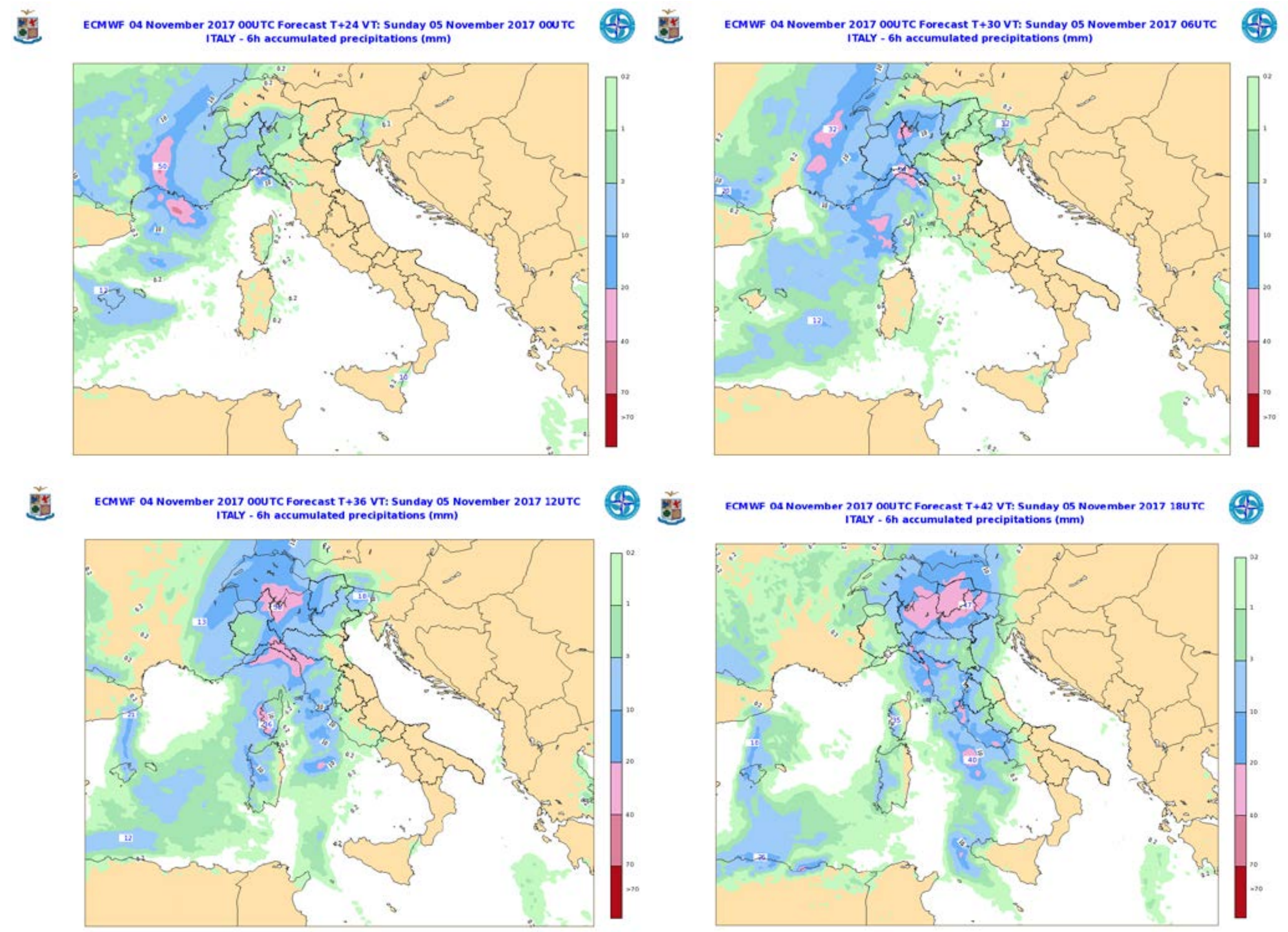
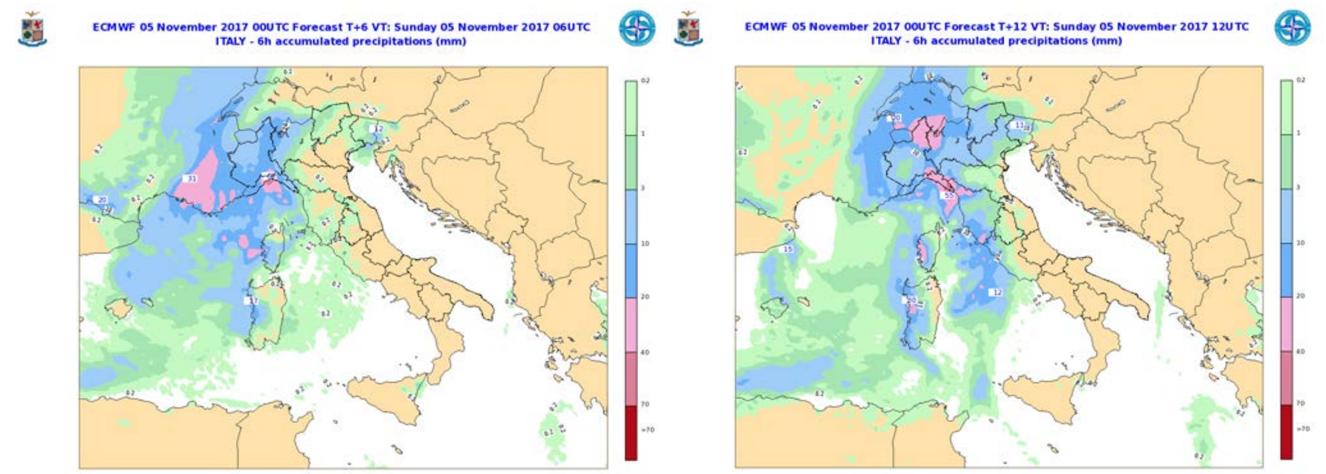


Fig. 7: ECMWF global model Forecast chart 6hours Accumulated Precipitation, November 4th, 00.00UTC, T+24, T+30, T+36, T+42: the shape of the cold front is evident, as well as orographic impact over Ligurian mountains and, further on, over western Alpine profile.



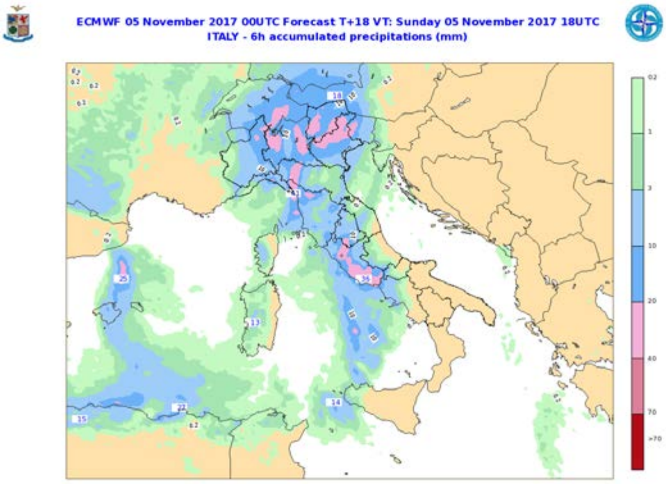


Fig. 8: ECMWF global model Forecast chart 6hours Accumulated Precipitation, November 5th, 00.00UTC, T+6, T+12, T+18: a comparation with November 4th 00.00UTC run shows a certain rain distribution similarity between the one another.

All what has been represented by Ecmwf global model, as in fig. 7, 8, may be compared with a different model results of which features are well known. In fig. 9 this is shown as in production from local model Cosmome, which is been verified drier than Ecmwf, showing a slower decaying process for cumulated precipitation on very high thresholds, as well as a better interpretation of minimum thresholds (0.2 for instance). Moreover this model usually circumscribes heavy thunderstorm like phenomena with a good precision. In fact fig. 9 shows how some areas get a more considerable impact than what proposed by global model. By a synoptic interpretation of all subjects involved within this configuration, as previously explained, it looks how such heavier impacts correspond with the presence of all factors enforcing normal air mass destabilisation, like mountains, as in T+12 and T+18. In the same way prefrontal convergence lines confirmed at T+12, where the heavy amount of rain is forecasted over sea. Both models show a resemblance in precipitation distribution, leading to the conclusion they are consistent.

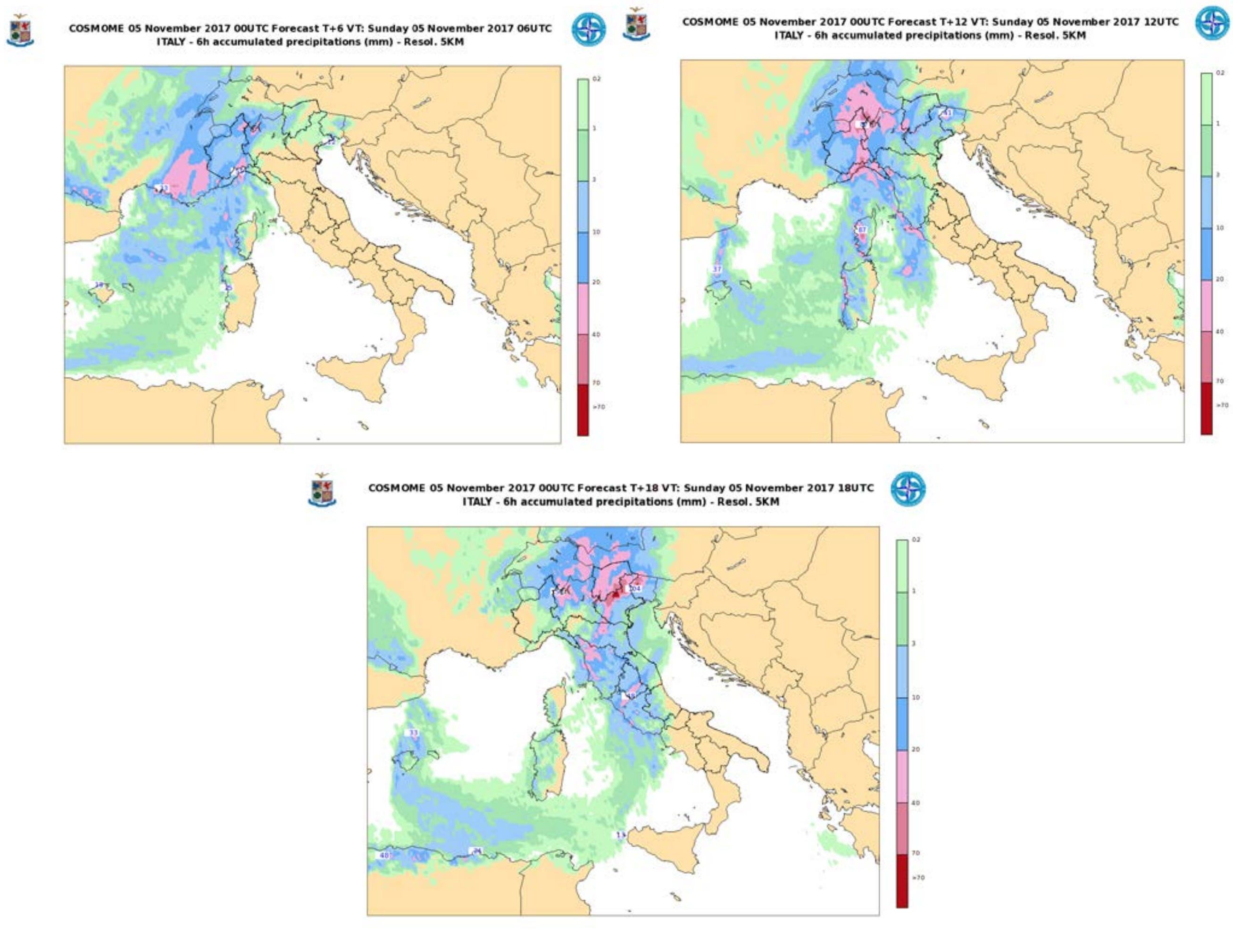


Fig. 9: COSMO-ME local model Forecast chart 6hours Accumulated Precipitation, November 5th, 00.00UTC, T+6, T+12, T+18: main phenomenology is confirmed to lie within the same strip west side of Genoa. Rainfall within WCB looks low or moderate as no forcing terms are present there.

Here is following a set of Synop reports extracts to verify the real type of phenomenology and rain amount over some affected areas on November 5th 2017 during previous 6 hours (in red relevant data about precipitation, in mm, and phenomenology): it is understandable that forecasts were realistic in precipitation amount, typology and distribution.

Capo Mele (Western Liguria)

2017-11-05 06:00:00	16153	5	NNE	12	12.1	Thunderstorm, Rain	1008.9	86	**25.8**
2017-11-05 12:00:00	16153	5	N	15	11.0	Rain, Fog	1006.3	85	**28.0**
2017-11-05 18:00:00	16153	5	NE	3	12.8		1005.0	90	**0.0**

Chiavari (eastern Liguria)

2017-11-05 12:00:00	16123	5	E	4	15.0	1005.7	81	**32.0**
2017-11-05 18:00:00	16123	5	NE	4	13.2	1003.3	89	**12.0**

Genoa

2017-11-05 00:00:00	16120	5	ESE	19	17.8	Thunderstorm, Rain	1014.5	83	**44.0**
2017-11-05 06:00:00	16120	5	NW	23	11.4	Thunderstorm, Rain	1008.9	90	**11.0**
2017-11-05 12:00:00	16120	5	NNE	4	12.5	Thunderstorm, Rain	1006.2	95	**52.0**
2017-11-05 18:00:00	16120	5	N	10	14.0	Rain	1005.2	62	**27.0**

Bergamo (Lombardia)

2017-11-05 12:00:00	16076	5	ESE	15	13.1	Rain	1007.9	92	**15.0**
2017-11-05 18:00:00	16076	5	N	6	10.8	Rain	1005.2	96	**20.0**

Milano Linate

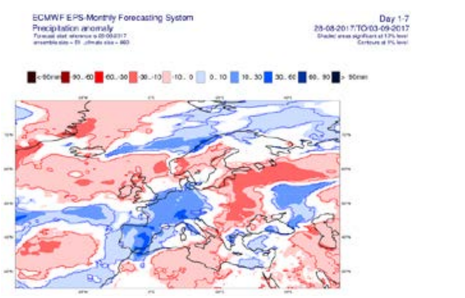
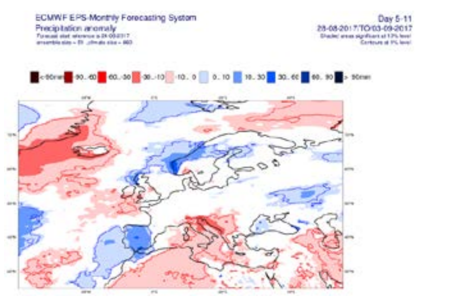
2017-11-05 12:00:00	16080	5	ESE	9	13.0	Rain	1007.2	91	**15.0**
2017-11-05 18:00:00	16080	5	NNW	8	9.7	Rain	1005.9	97	**33.0**

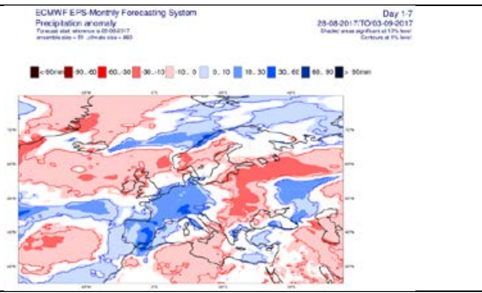
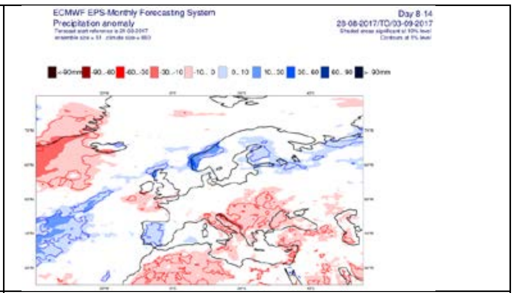
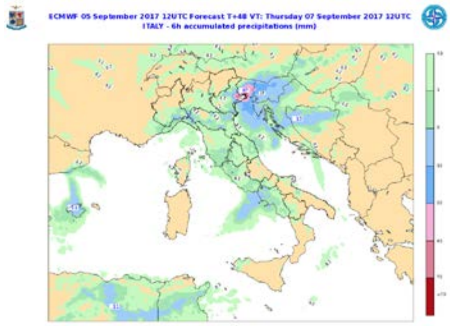
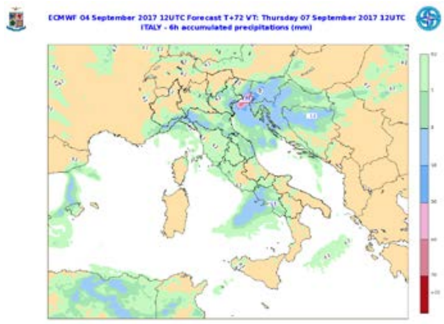
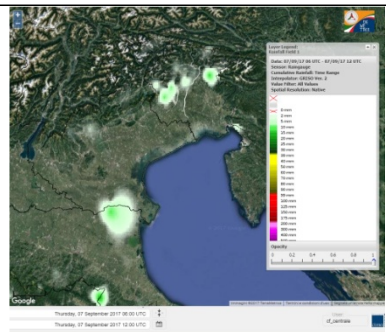
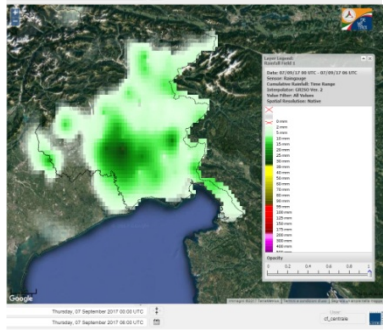
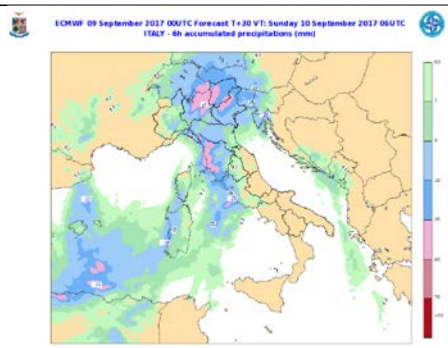
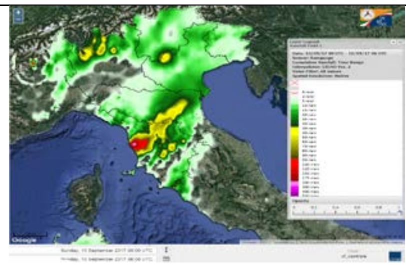
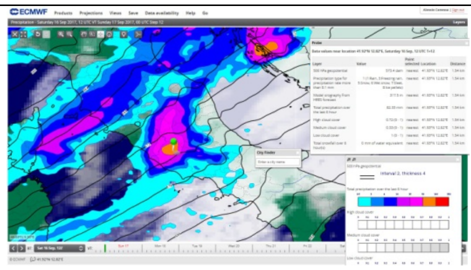
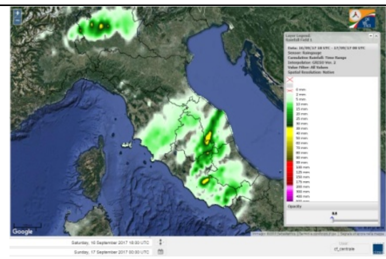
Milano Malpensa

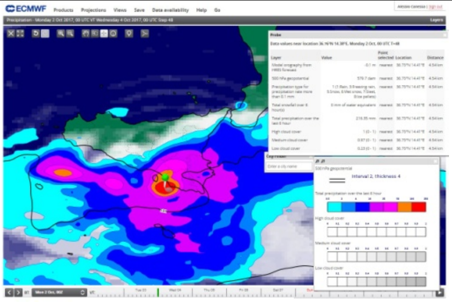
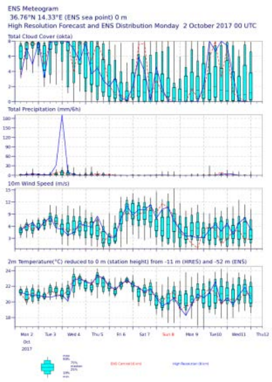
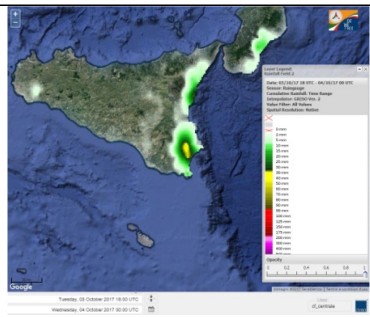
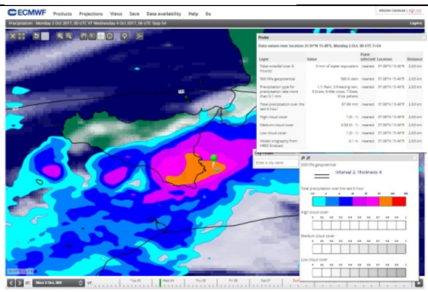
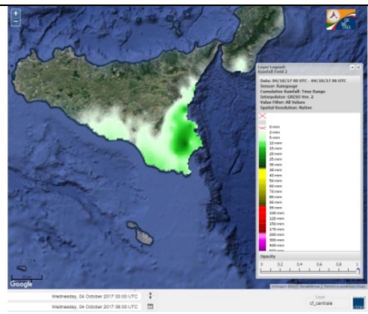
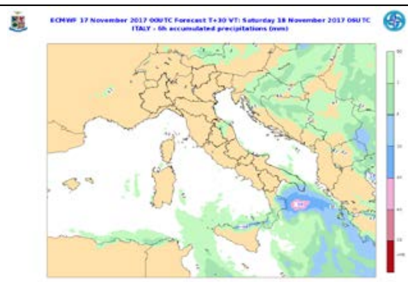
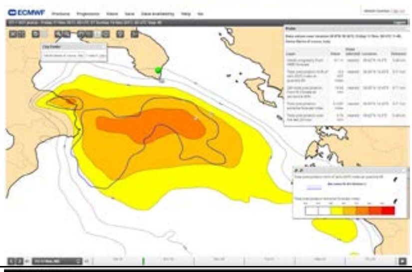
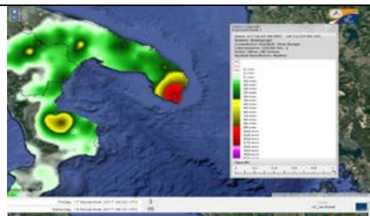
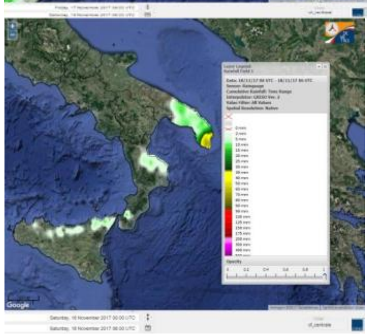
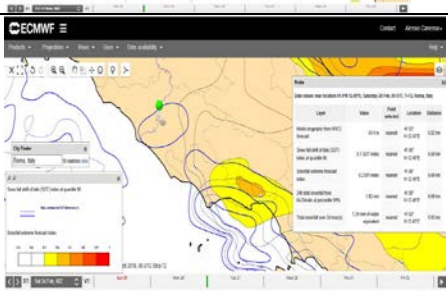
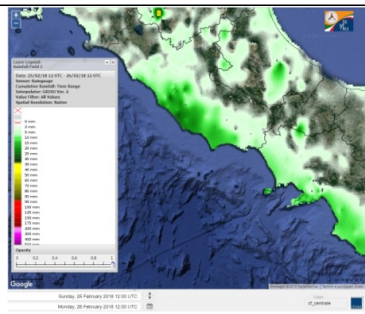
2017-11-05 06:00:00	16066	5	E	4	11.2	Rain	1011.9	97	**14.6**
2017-11-05 12:00:00	16066	5	SSE	4	12.3	Rain	1008.2	94	**20.0**
2017-11-05 18:00:00	16066	5	NNE	20	8.5	Rain	1008.1	85	**24.0**

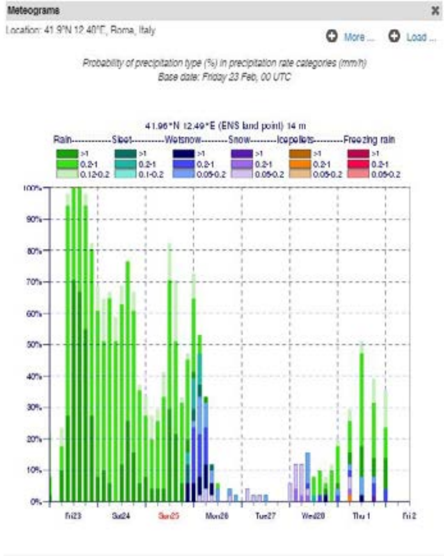
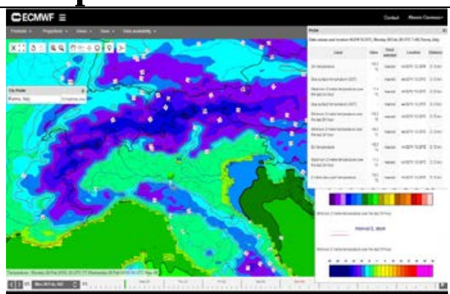
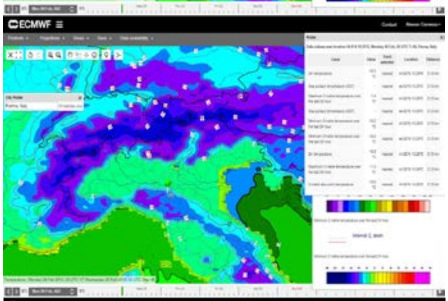
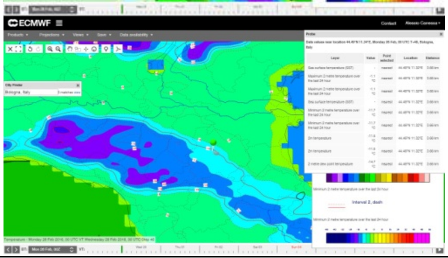
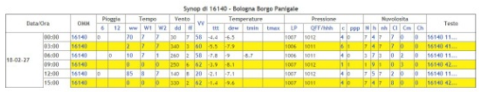
Other Case Studies (CNMCA)

We have noticed that the total precipitation's maxima per 6 hours are much bigger than in the past, with sometimes peaks close or even bigger to the observed precipitation maxima and to LAM models. Rainfall intensity in case of convective precipitation and in particular low-level convergence thunderstorms is underestimated by the HRES and ENS models. Unfortunately we continue to observe "jumpiness" in EFI and SOT.

Case studies		
The monthly forecast (Forecast start reference 24-08) for the second week Day 5-11 (28-08 to 03-09 2017) was wrong over northern and central Italy (precipitation anomaly).		

The monthly forecast (Forecast start reference 21-08) for the second week Day 8-14 (28-08 to 03-09 2017) was wrong over Italy (precipitation anomaly).		
	Precipitation forecast	**Observed precipitation**
7 september 2017 06-12UTC Friuli Venezia Giulia **Overestimation**: **HRES+48h max 87mm/6h forecast (05 12UTC)** **HRES+60h max >40 mm/6h forecast (05 00UTC)** **HRES+72h max 139mm/6h forecast (04 12UTC)** 0mm/6h observed Max 40mm/6h observed in the 6 hours before (00-06UTC)	 	 
10 september 2017 00-06 UTC **Livorno Flash flood (8 deaths)** **Underestimation** **HRES+30h** **max 35,51mm/6h forecast** **ENS+30h** **10%>25mm,6%>30mm, 12%>35mm,<5%>40mm** EFI 0,8 SOT 2 **max 242,78mm/6h observed**		
16 september 2017 18-24 UTC Lazio **Overestimation** **HRES+72h** **max 82,33mm/6h forecast** **HRES+48h** **max 68mm/6h forecast** max 40mm/6h observed		

3 october 2017 18-24 UTC Sicily **Overestimation** **HRES+54h** **max 88mm/6h forecast** **HRES+48h** **max 216,35mm/6h forecast** **HRES+36h** **max 151mm/6h forecast** ENS low probability max 40mm/6h observed	 	
4 october 2017 00-06 UTC Sicily **Overestimation** **HRES+36h** **max 108mm/6h forecast** **HRES+54h** **max 88mm/6h forecast** **HRES+60h max 251mm/24h** ENS low prob max 30-40mm/6h observed		
17-18 november 2017 18-06 UTC **Medicane "Numa"** – Puglia (Salento) **Underestimation due to wrong Numa's position** **HRES+30h** **max 3-10mm/6h forecast** max >70mm/6h observed **EFI+48h big forecast error**	 	 
26 february 2018 00-06UTC **HRES Underestimation** **Snow in Rom** (sea effect snow) **HRES+84h 0,49mm/24h** **HRES+60h 2,73mm/24h** **HRES+48h 2,75mm/24h**		

EFI SOT+120h 0.3 1.7 EFI SOT+108h 0.5 6.7 **EFI SOT+96h 0.4 5.2** EFI SOT+84h 0.5 2.1 **EFI SOT+72h 0.2 0.1** **EFI SOT+60h 0.3 1.5** EFI SOT+48h 0.7 7.1 **EFI SOT+36h 1.0 10** 27 february 2018 00-06UTC **Snow in Napoli** (sea effect snow) EFI SOT+48h 0.5 6 In both cases high uncertainty (low EFI) but extreme snowfall was likely (high SOT)		Snow observed: 10-15 cm More snow on the beach (Lido di Ostia) then in Rom. 
	Temperature forecast	**Observed temperature**
27-28 february 2018 Parma **HRES+48 too cold** **Minimum 2m temp forecast over the last 24h=-16.2°C &-17.1°C** Minimum 2m temp observed over the last 24h=-9°C 27february 2018 Bologna **HRES+48 too cold** **Minimum 2m temp forecast over the last 24h=-11,7°C** Minimum 2m temp observed over the last 24h=-9°C		2018-02-28 h06 >> SPECI LIMP 280600Z 08005KT CAVOK M09/M13 Q1016= 2018-02-27 h06 >> SPECI LIMP 270600Z 22002KT 3000 BR FEW060 M09/M10 Q1010=  The temperatures are observed at the airports and are not infuenced by the urban heat island effect, so this big difference is not to part of the known IFS forecasting issues.

4. Feedback on ECMWF "forecast user" initiatives

As last year we invite comment on whether you use the following, on how useful you find them, and on any changes you would like to see:

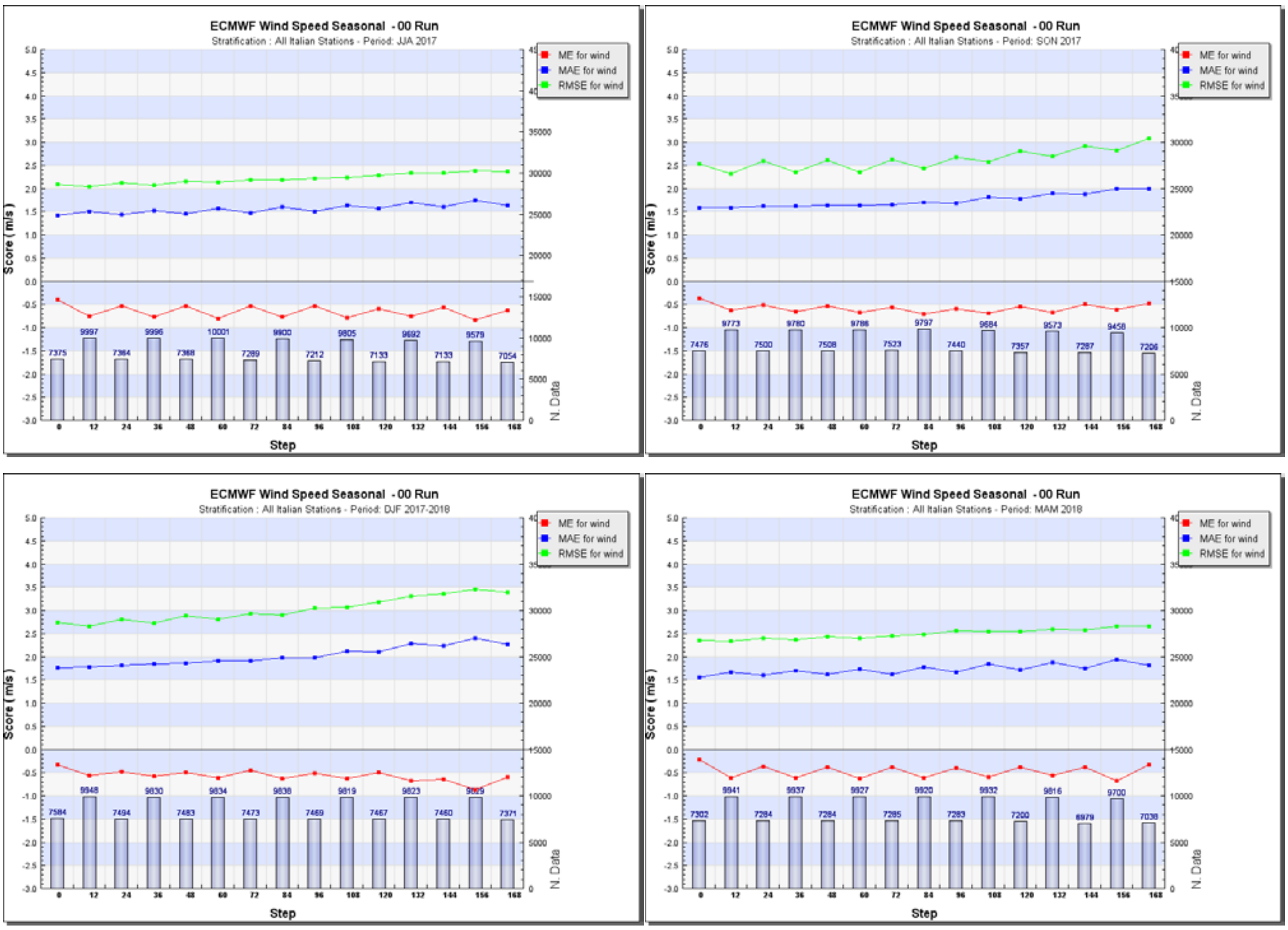
- "Known IFS forecast issues" page – (https://software.ecmwf.int/wiki/display/FCST/Known+IFS+forecasting+issues)
- "Severe event catalogue" (https://software.ecmwf.int/wiki/display/FCST/Severe+Event+Catalogue).

Both pages are very interesting and useful, but hard to find from the webpage www.ecmwf.int.

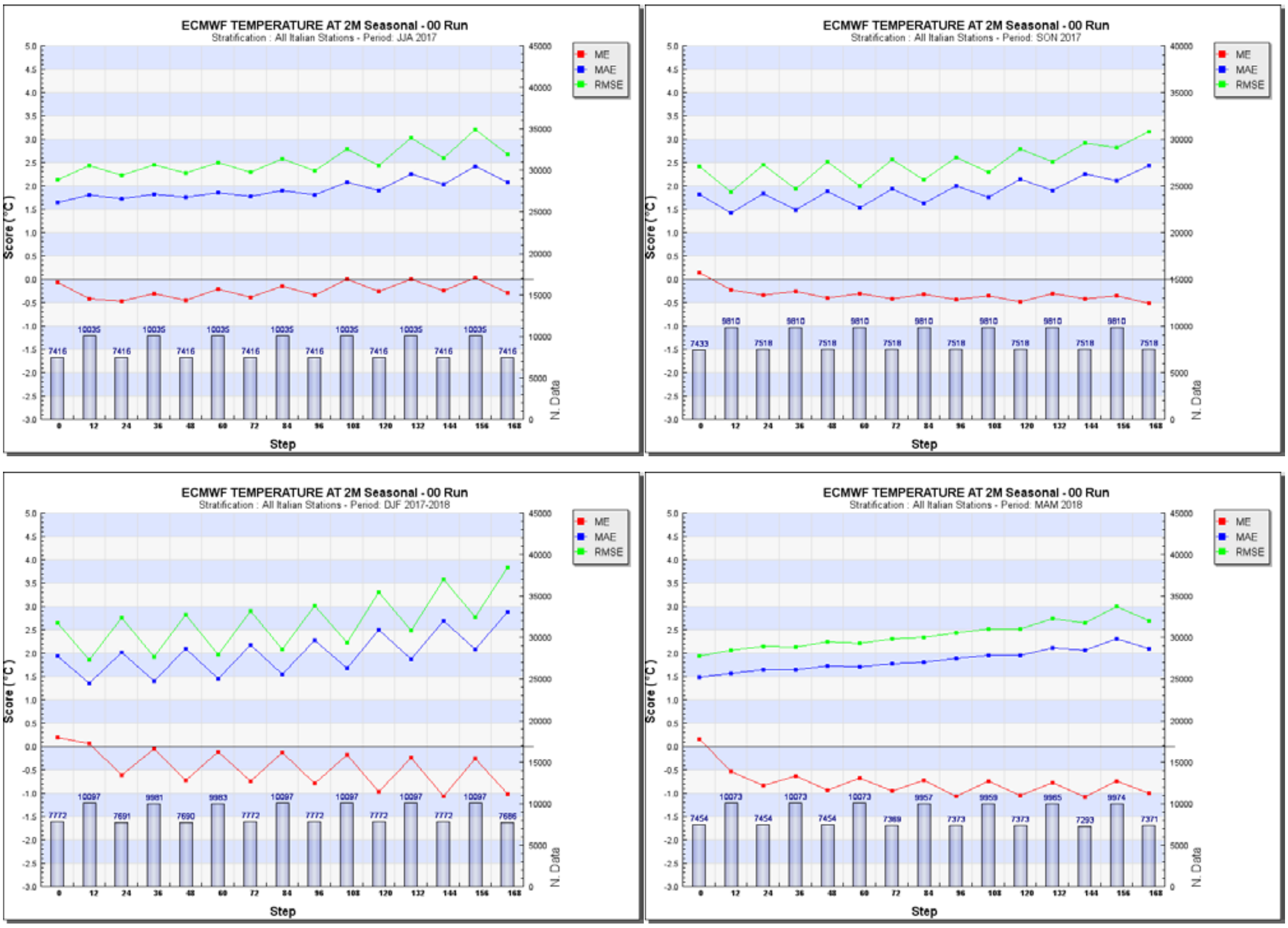
5. References to relevant publications

Appendix A of Report ECMWF 2018 -- ITALY

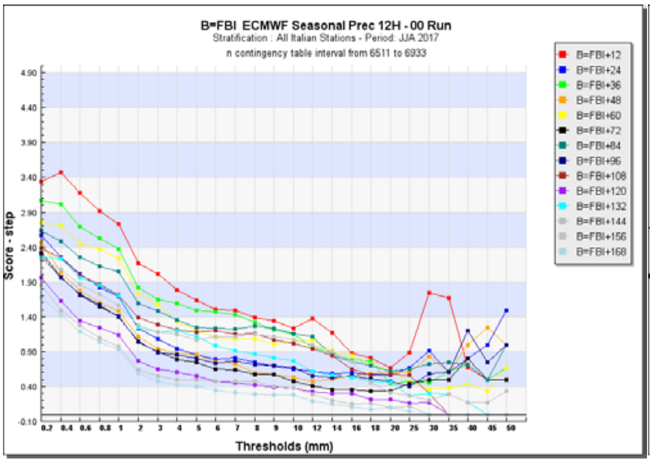
IFS 10m Wind Speed (Mean Absolute Error, Mean Error and Root MSE)

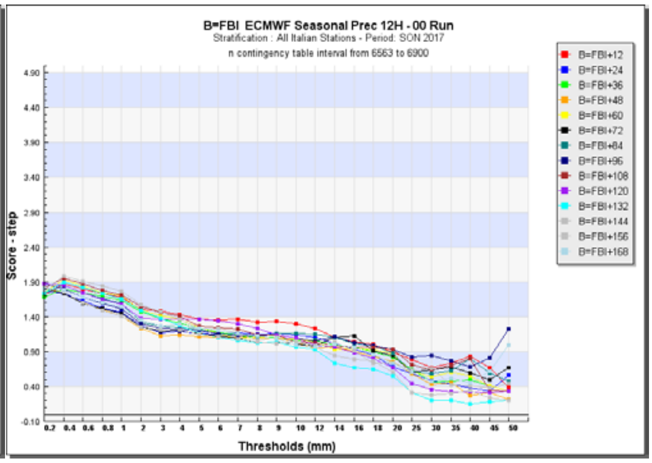


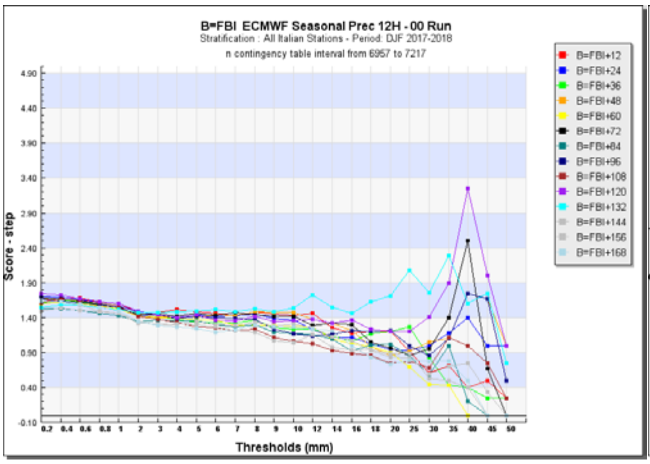
IFS 2m Temperature (Mean Absolute Error, Mean Error and Root MSE)

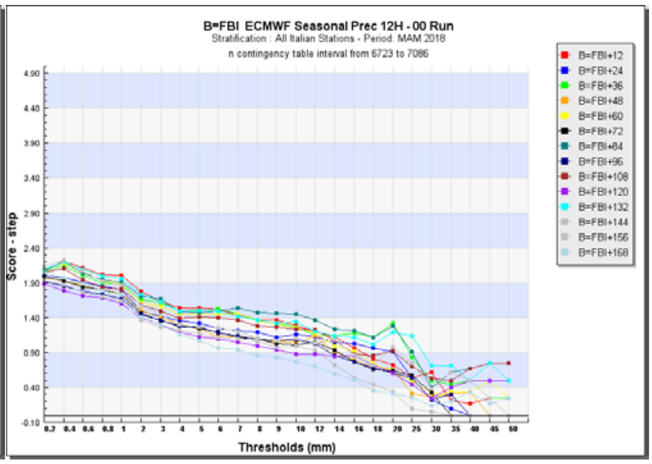


IFS Precipitation in 12 hours - FBI score

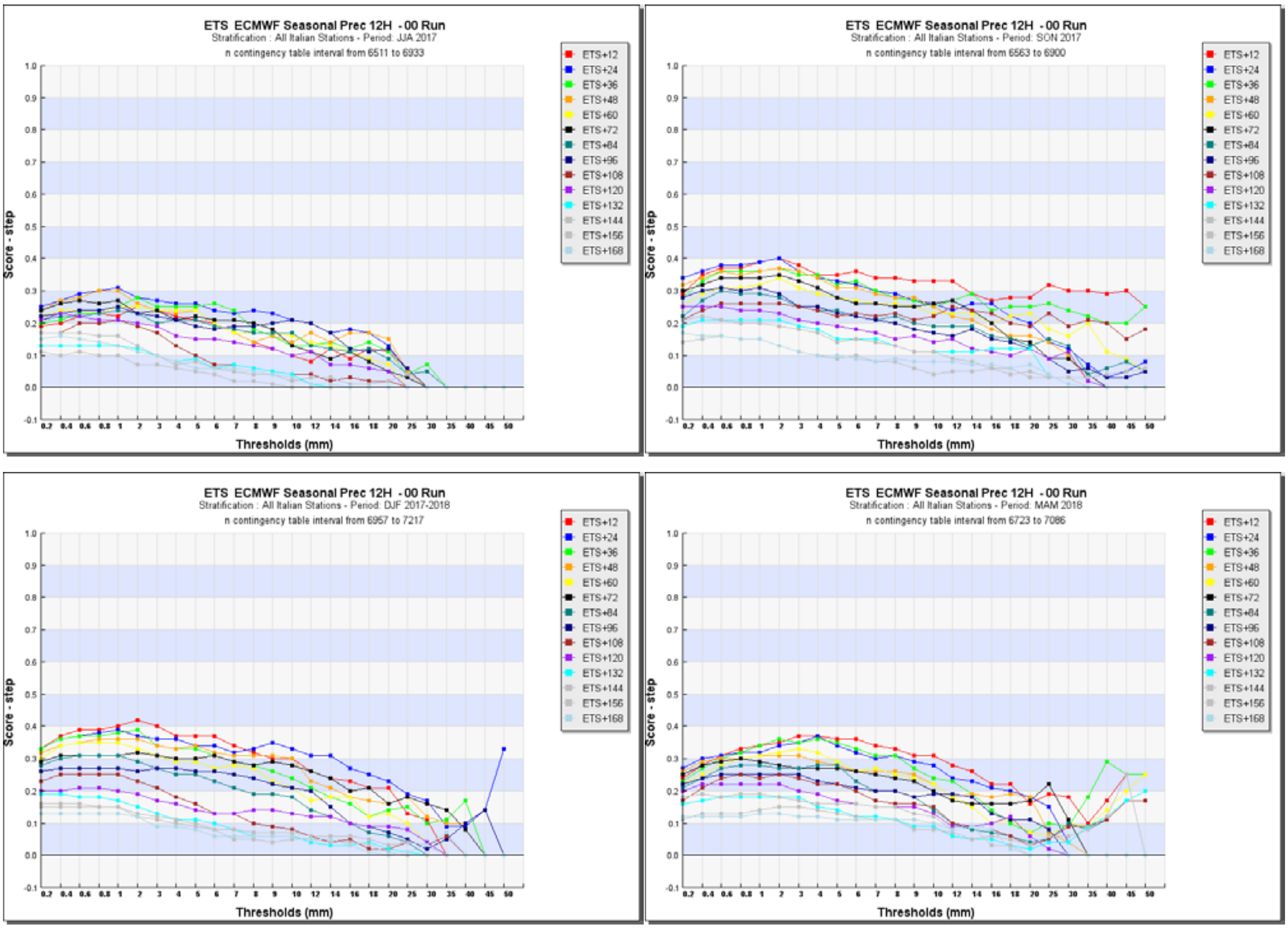




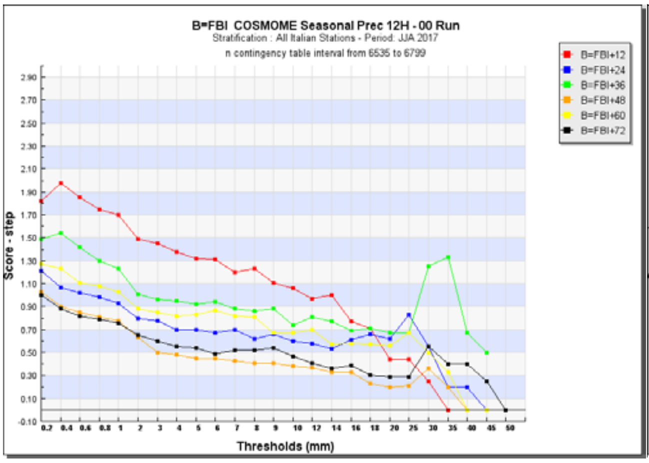


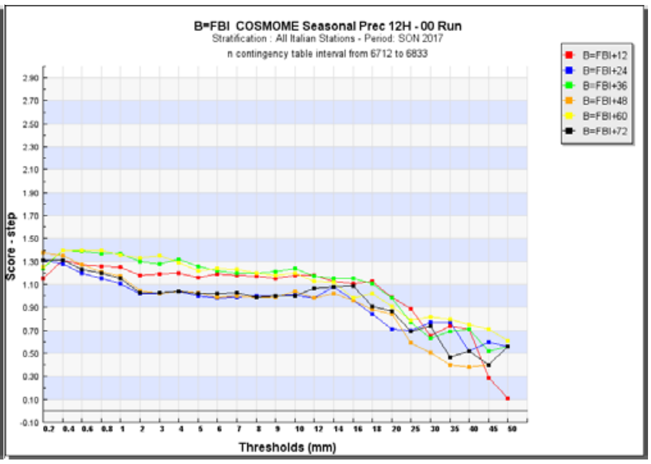


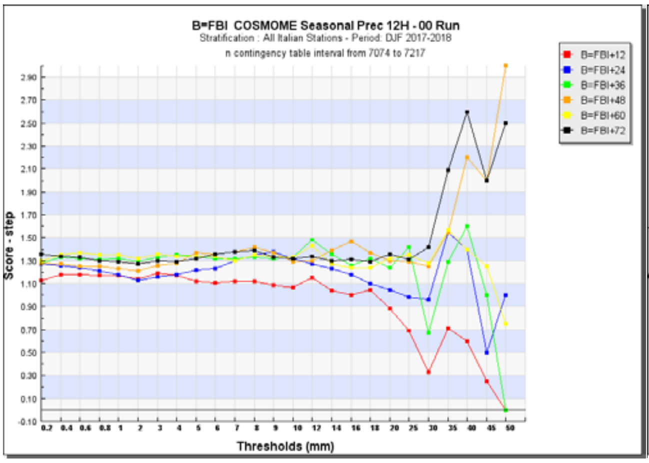
IFS Precipitation in 12 hours - ETS score

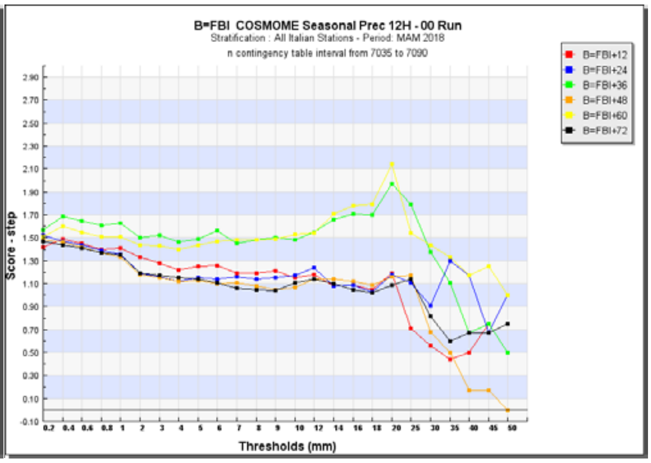


COSMO-ME Precipitation in 12 hours - FBI score

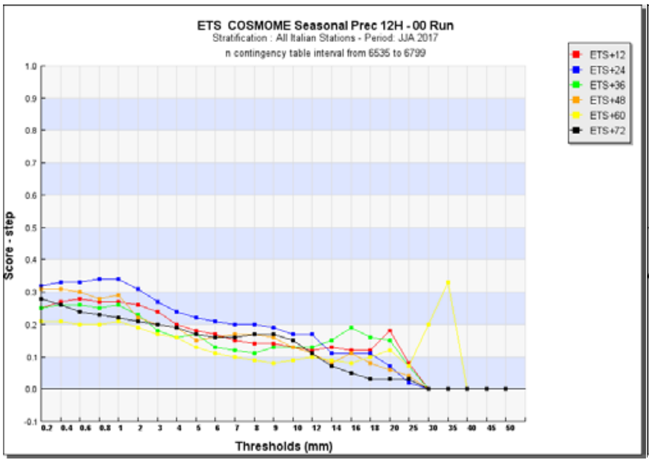


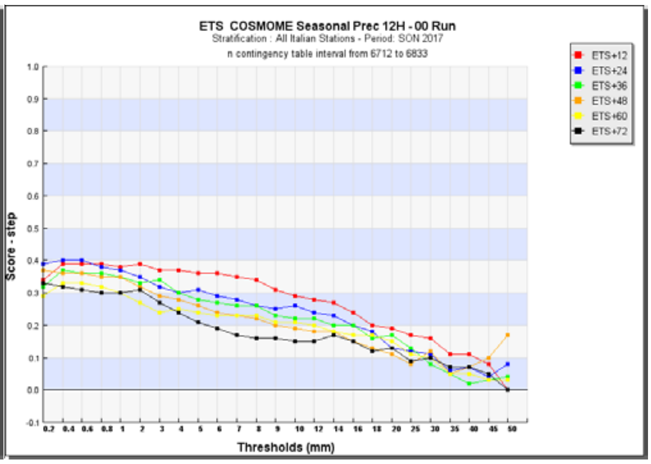


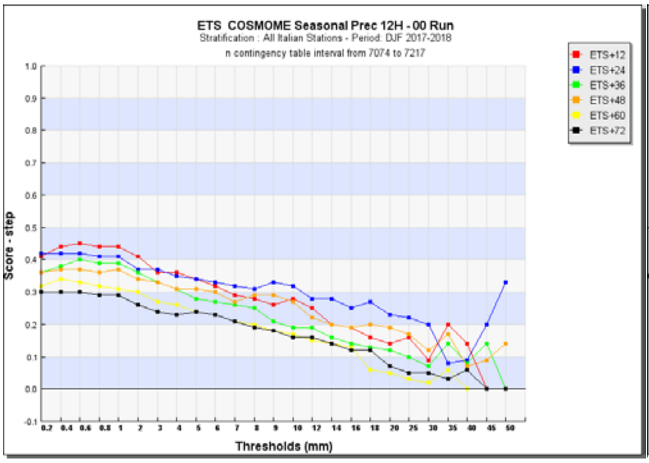


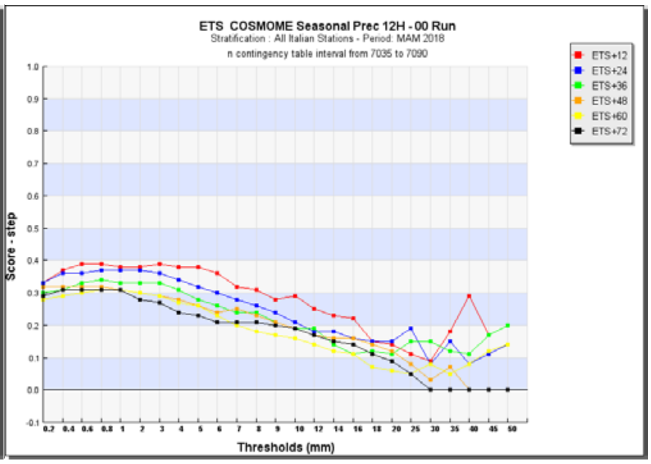


COSMO-ME Precipitation in 12 hours - ETS score

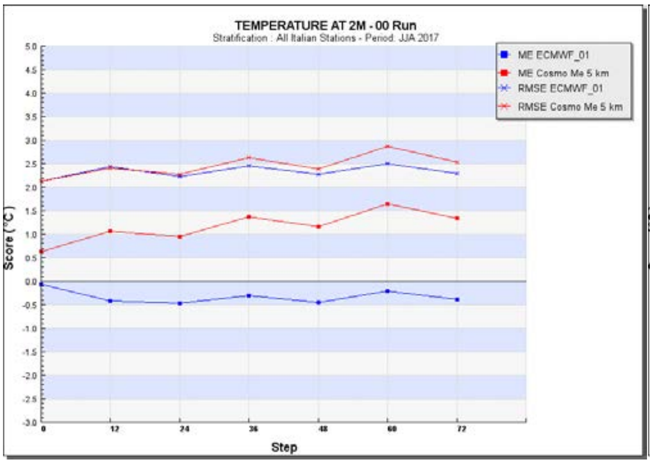


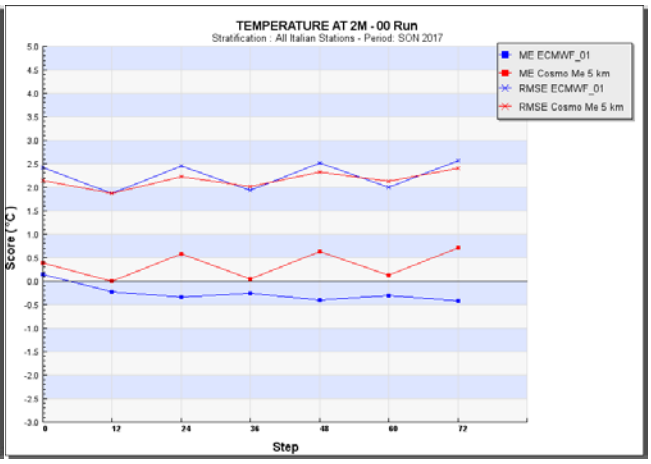


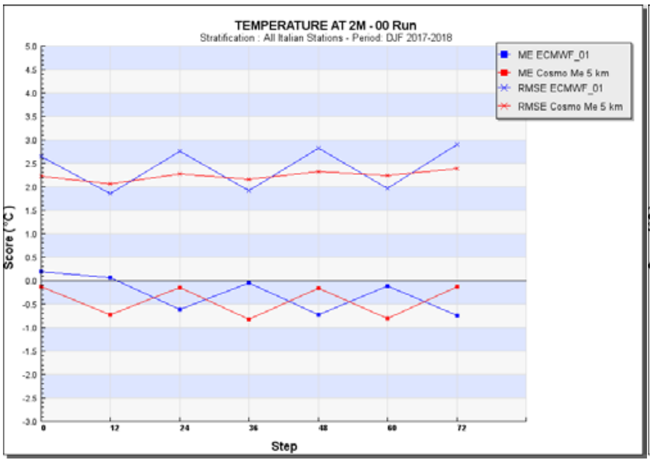


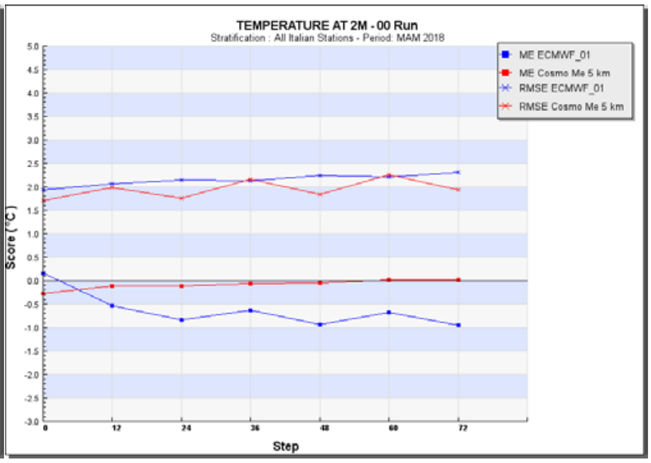


IFS – COSMO-ME comparison: 2m Temperature









IFS – COSMO-ME comparison: 10m Wind Speed