

Application and Verification of ECMWF Products 2008

Centro Nazionale di Meteorologia e Climatologia Aeronautica (CNMCA)

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1. Summary of major highlights

IFS deterministic model output from both 12 and 00 UTC runs are used at CNMCA as plotted fields in the forecasting department mainly for medium range, also as input to statistical (PPM type) and physical adaptation schemes, and at last as initial and/or boundary conditions for CNMCA Local Area Models (Euro-HRM, 7km COSMO-ME and very high resolution 2.8km COSMO-IT). Verification of ECMWF products are carried out at CNMCA for operational model T799. Surface parameters and forecast ranges mainly used by weather forecasters are considered.

2. Use and application of products

2.1 Post-processing of model output.

2.1.1 Statistical adaptation.

Statistical adaptation is involved in a Perfect Prog application currently being used named ARGO. The model is used to infer surface weather parameters such as precipitation, 2T, humidity, cloudiness, wind etc. over about one hundred geographical sites corresponding to the locations where the Italian network of weather stations are deployed and observations are available.

2.1.2 Physical adaptation.

No 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. No correction at all is being performed once the grid point has been chosen.

2.1.3 Post-processing products and 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 mode for medium range meteograms up to T+72H stepping in time every 6 hours and long range meteograms up to T+168H stepping every 12 hours. Meteograms are intended as a general purpose product and for this reason the weather parameters included are 2m temperature, 2m humidity, mean sea level pressure, total-high-medium-low cloud cover, convective precipitation, grid scale precipitation and 10 m wind.

Basing on the ECMWF models output, several derived parameters are routinely calculated as well. For the atmospheric operational model the derived fields are:

- 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.

Derived fields are also calculated for the ECMWF Wave Model. The most important derived parameter is the sea state code according to primary and wind wave height (Beaufort Scale). Metgrams over sea geographical sites are being produced too. For each site primary sea swell height, wind wave height, 10 m wind and wave direction behaviours are described from T+12H up to T+96H. The sites are chosen correspondingly to buoys and tide gauges deployment.

Some outputs from EPS system are carried out directly from ECMWF Ecgate server using "ad hoc" built applications and Metview batch procedures. In particular the following maps are created:

- 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

2.2 Use of products

The ECMWF products are classified in two main typologies: primary and secondary. In the first ones parameter fields, identified as synoptic tracers, are considered, like Potential Vorticity at 300 Hpa and equivalent temperature at 850 hPa as well; they allow to localize and define the path of synoptic configurations, especially in cases where they are not well defined at 500 hPa maps.

In the second ones, all the maps regarding parameters which better summarize the related meteorological conditions are analyzed (high, medium and low cloudiness, temperature, wind etc.) The fields are generally overlapped among them, including satellite images; many combinations are used using proper tools. In this way the forecaster is able to detect the subjects of interest, like Conceptual Models.

Besides these maps, products from EPS and EFI are used for severe weather warnings detection.

Every months, according with the ECMWF production, maps from System 3 Seasonal FC, (ensemble mean, probability and climagrams) are subjectively analyzed to obtain an outlook for the next quarterly period. Along with a concise comment, these maps are shown on the internal intranet website (available on request also for external users).

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output

(i) in the free atmosphere

Some basic (MA, MAE or RMSE) verifications for free atmosphere parameters (e.g wind, Temp, RH and geopotential at standard pressure level) compared with CNMCA COSMO-ME, are produced.

(ii) of local weather parameters verified for locations

Objective scores are computed for ECMWF 12 and 00 utc run (d+1 to d+7) after collecting data, retrieved from all available Italian Synop stations, in several stratifications. Graphical visualizations have been elaborated for a number parameters: 2m Temperature, 2m dew point, 10m Wind Speed, MSLP, Tot Cloud Cover (ME, MAE).

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

For the present document, data covering the period from DJF 2006/07 to SON 2007 have been used for the verification of these parameters and only some selected results are showed in the next pages, for ECMWF 00 UTC run, only.

To compute the score no interpolation from grid point to observation location is performed and the "nearest point" method is used. The software used for verification products is called Common Verification Suite (CVS) developed at CNMCA and used as a common tool inside COSMO community. A new verification tool, named VERSUS based on DB architecture with a GUI, is under development and will replace CVS at the end of the year. Through this tool Conditional Verifications will be also possible.

Here a short note on results.

24 h Cumulated Precipitations: Model shows an overestimation for all the seasons for lower threshold, while tends to underestimate the higher ones. In winter, FBI score is around 1 for thresholds between 5 mm and 20 mm. It is worthwhile to note that for 10 mm threshold FBI is around 1 for all the seasons, as it was a sort of "limit". About the accuracy (ETS), winter and autumn show the best results (precipitation due mainly to synoptic perturbations), mainly for lower thresholds. All the thresholds show a decrease in accuracy with integration time.

2m Temperature: clear diurnal cycle in both ME and MAE. In winter and in spring it is clear a general underestimation; in autumn Temp ME is around 0°C. In summer a more evident overestimation increasing with higher steps can be found. MAE is mainly between 2 and 2,5 °C with a decrease in accuracy (higher MAE values) with integration time.

10m Wind Speed: Clear diurnal cycle for all the seasons for ME and MAE. A general underestimation is shown especially in spring and summer. MAE, around 1,5-2 m/s, tends to increase with forecast time.

3.1.2 ECMWF model output compared with CNMCA COSMO-ME limited area model.

ECMWF 00-UTC scores for 12 hours cumulated precipitation (ETS, FBI) have been calculated and graphically compared to those evaluated for Italian 00-UTC run non-hydrostatic LAM named COSMO-ME, 7 km of resolution for d+1 and d+2. These scores are shown in the next pages on Italian global area.

Accuracies of the two models are comparable, with better performances for lower thresholds (but no up-scaling is performed on COSMO-ME model, that could be in this case penalised).

About FBI scores, COSMO-ME shows a better distribution and representation than ECMWF especially for lower thresholds for all the seasons. IFS 10mm threshold tends to have often FBI around value 1, while there is none of this kind tendency for COSMO-ME. In general higher threshold are underestimated for IFS, while COSMO-ME clearly underestimates higher thresholds in summer only.

3.1.3 Post processed products.

Metgrams, Automatic Weather Interpretation (AWI), Trajectories, Sounding Forecast

3.1.4 End products delivered to users.

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

3.2 Subjective verification.

3.2.1 Subjective scores: none

3.2.2 Synoptic studies (T. La Rocca)

During the period 26-30 May 2008 western alpine area was affected by persistent and abundant precipitation with damage to people and things; large quantities were measured up to 300mm in 60 hours

Synoptic Description

The day 27 (Fig.1), a broad Upper Level Low on the Iberian Peninsula destabilised a derivative flow on North Africa, producing a subtropical ridge on Italy with 5820 mgp values of 500 Hpa

In this first phase, intense southerly currents carried subtropical continental air on Central Mediterranean; the first persistent rains with high quantities had been recorded, but only in a very limited mountainous area, between Piedmont and Valle D'Aosta; their orographical origin was clearly due to the interaction between a wet and cool eastern flow at low levels with a southern current at high altitudes.

The day 28 (Fig.2) the Upper Level Low was transforming into a V-Shaped Trough and the initialization of an Induce Wave cyclogenesis on Algerian Sahara took place; considerable intensification of flow in all the atmosphere produced increasing precipitation, although still locally and in the limited area.

The D-Day 29 (Fig.3) started the second phase: the V shaped Trough and cyclone rotating in anticlockwise sense, involved the entry of maritime mid-latitudes air in Warm Conveyor Belt which injected additional and significant contribution in humidity in entire air column; as consequence, considerable intensification of precipitation was registered not only in the North West Alps area, but also extended on the western part of Po Valley.

The northern part of Italy was hit (Fig.4) in sequence by a Warm Conveyor Belt type rearward at first, by the Occlusion, followed by the Low and finally by the Back Occlusion, as leading part of maritime polar air front.

The abundant rains affected the entire North, with several notable maximum of precipitation especially over Alps; the Day 30 the bad weather was gradually transferred to the eastern sector.

The sequence is recognized as " typical rainfall floods configuration" on the western Alps: a V-shaped Trough with meridian jet and intense but very stable Warm Conveyor Belt, which bring basic persistent rainfall, an "Induced Wave Cyclogenesis) that involves additional precipitation

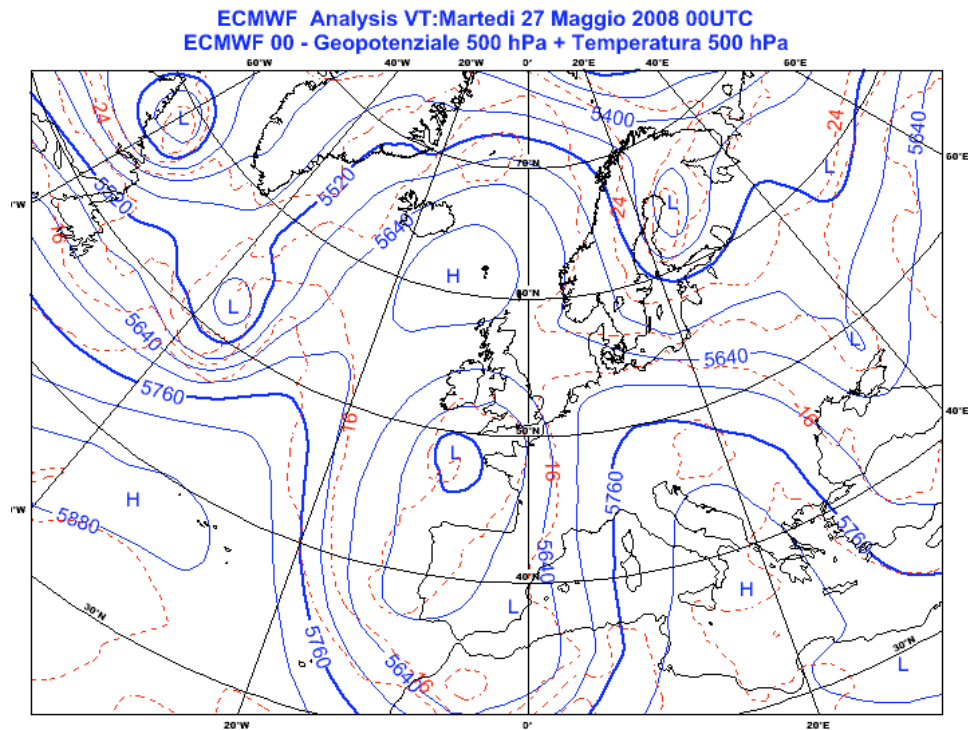


Fig. 1 The Upper Level Low is evolving into V-Shaped Trough

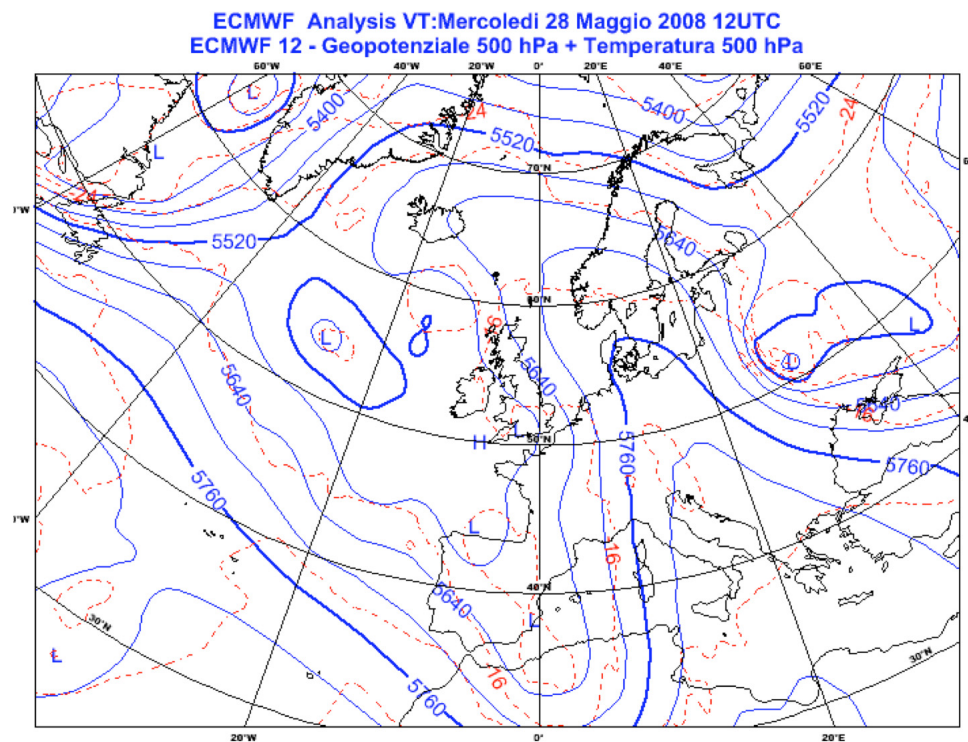


Fig. 2 the V-Shaped Trough is evolved and rotating anticlockwise; cyclogenesis is setting

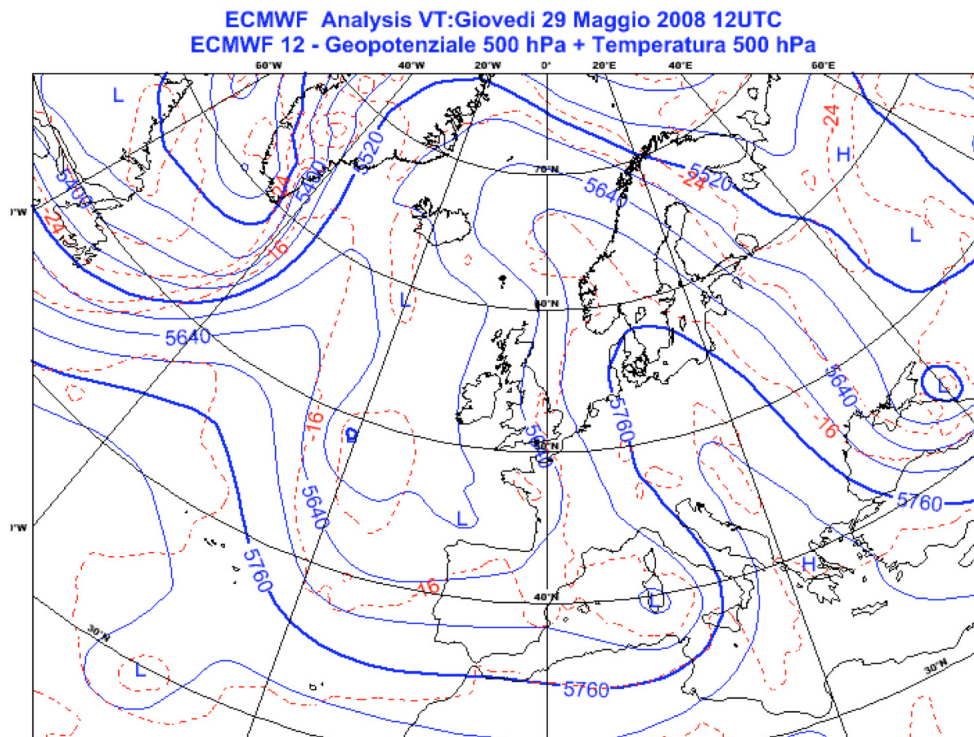


Fig. 3 The Induced Wave cyclogenesis is formed and identifiable over Sardinia

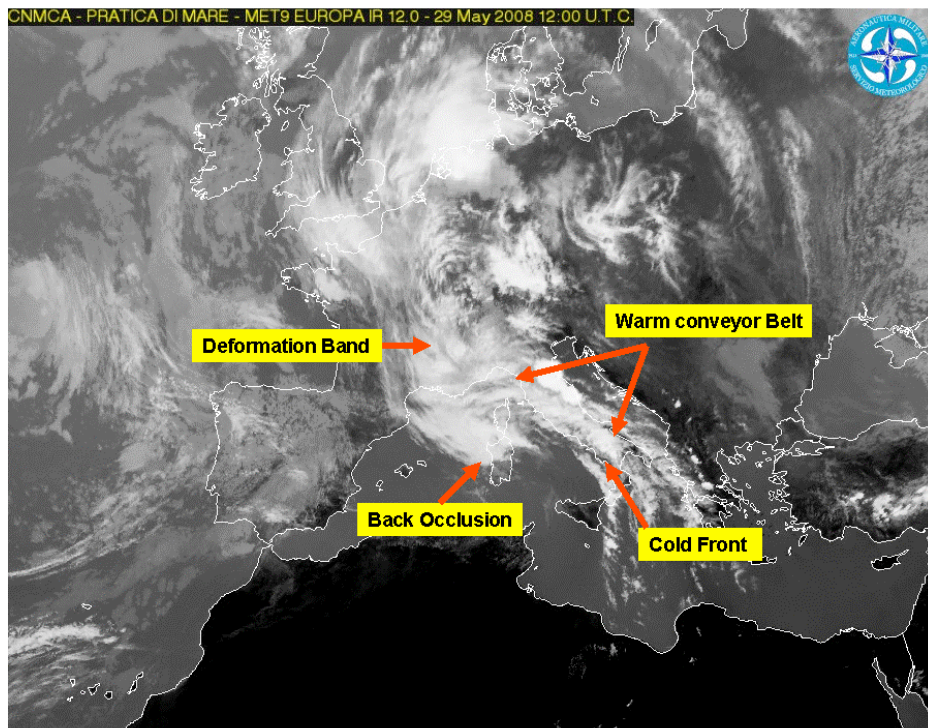


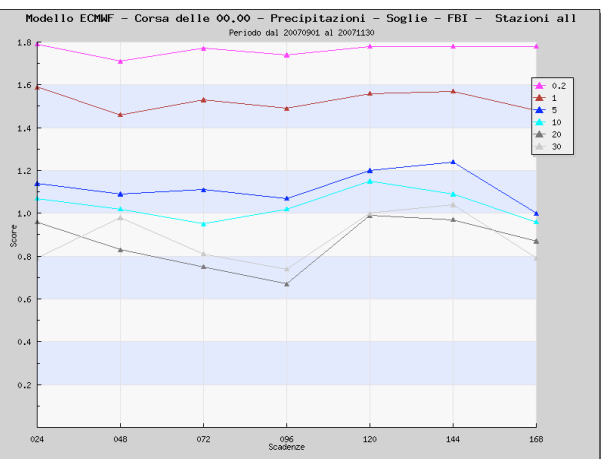
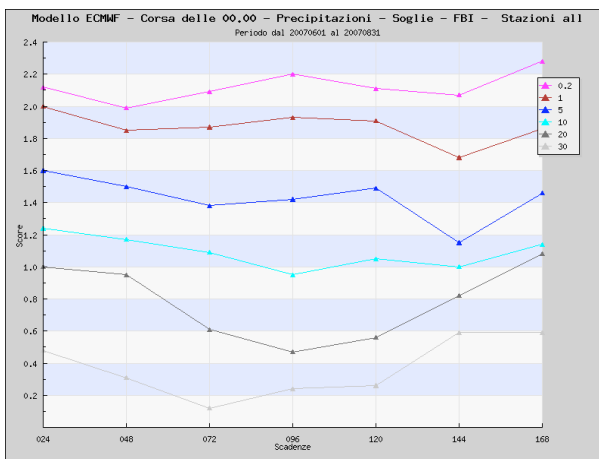
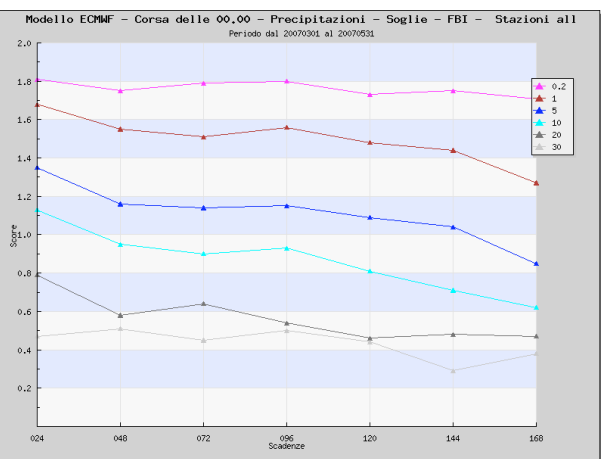
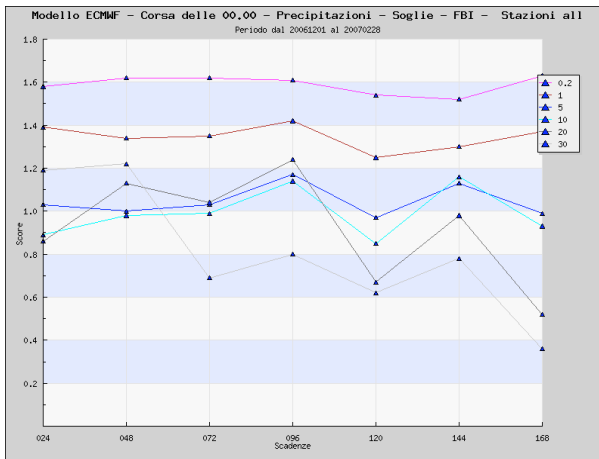
Fig. 4 then northern part of Italy is affected by the Warm Conveyor Belt and Occlusion

4. References

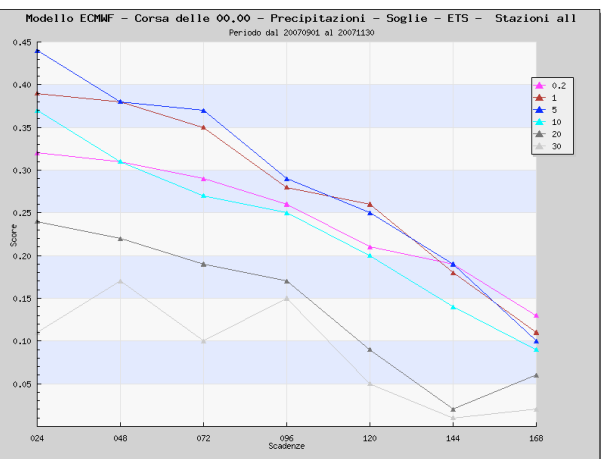
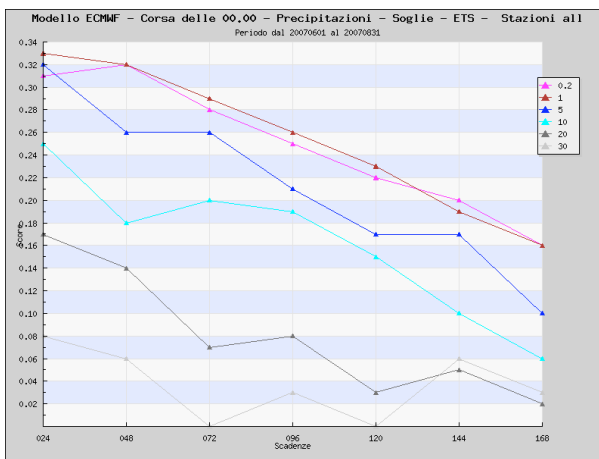
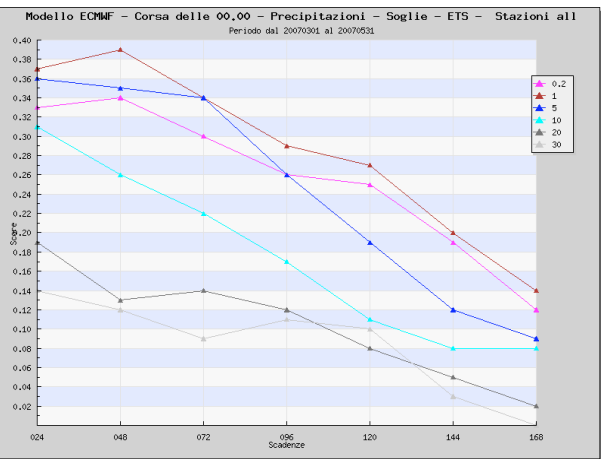
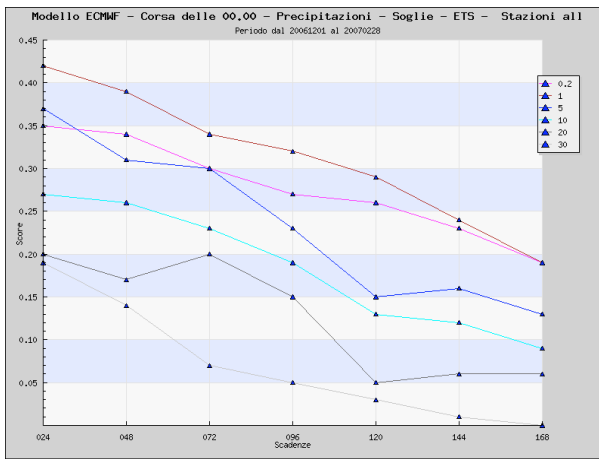
Mc Lennan and Neil (1988), Type of cyclogenesis, Depression in Mid Latitude, Images in weather forecasting, Bader et al. Cambridge university Press, 1995

Conceptual Models on Mediterranean, Synoptical Meteorology Manual, Italian Met Service, CNMCA, 2006

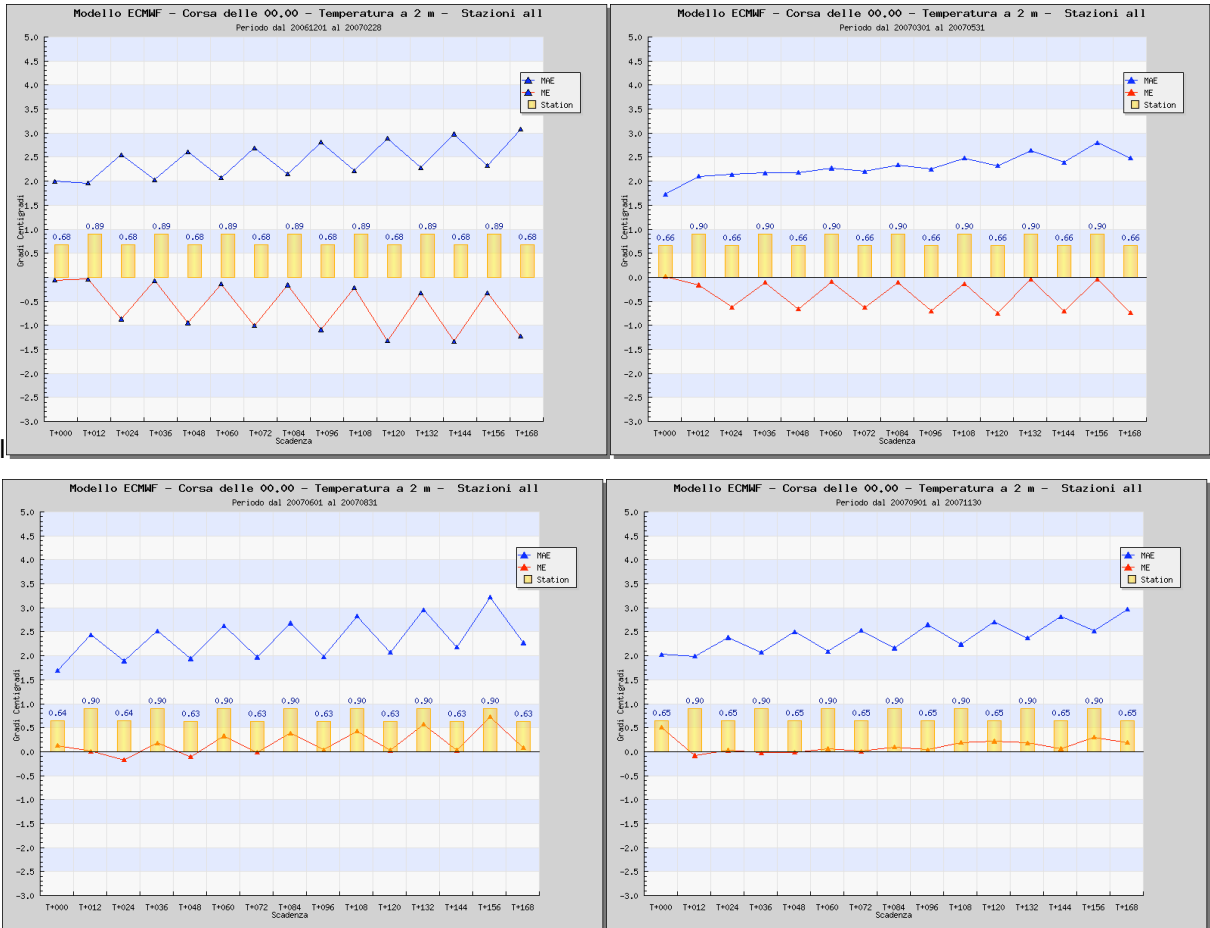
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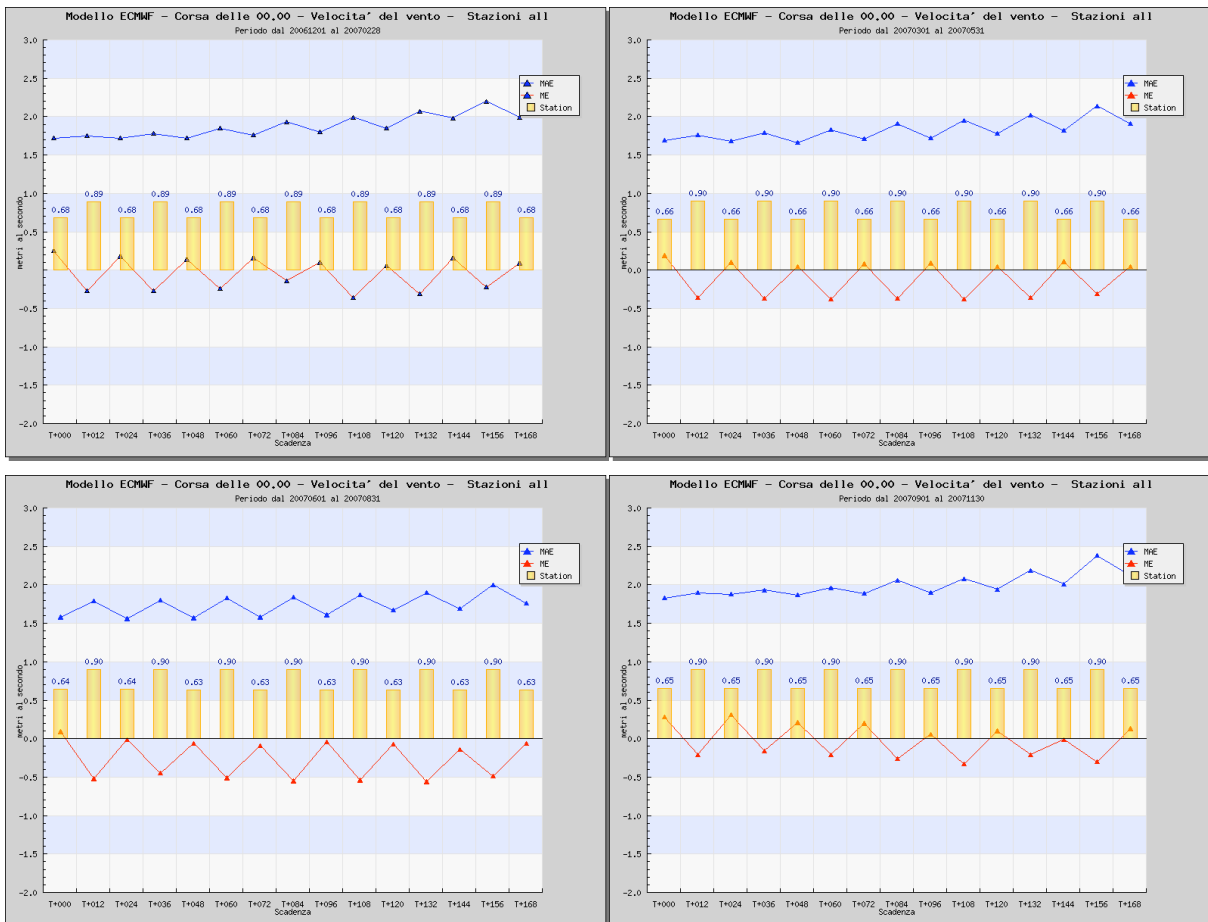
IFS Precipitation in 24 hours - FBI score for 0,2 - 1 - 5 - 10 - 20 - 30 thresholds



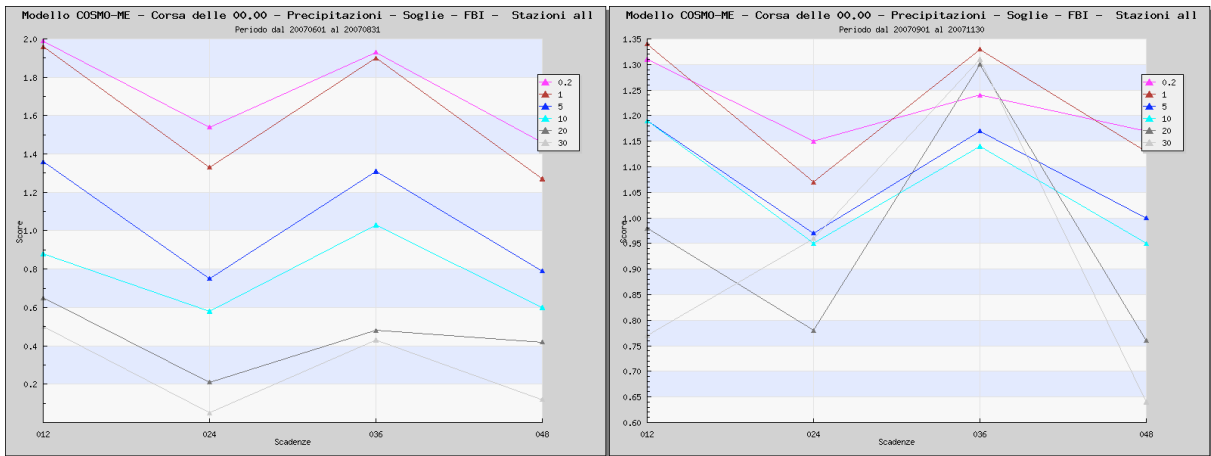
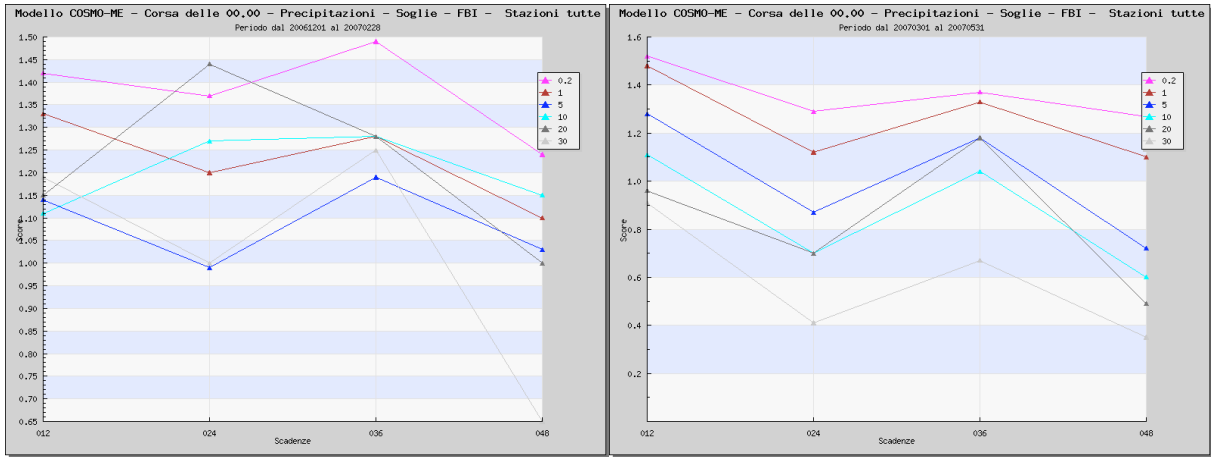
IFS Precipitation in 24 hours - ETS score for 0,2 - 1 - 5 - 10 - 20 - 30 thresholds



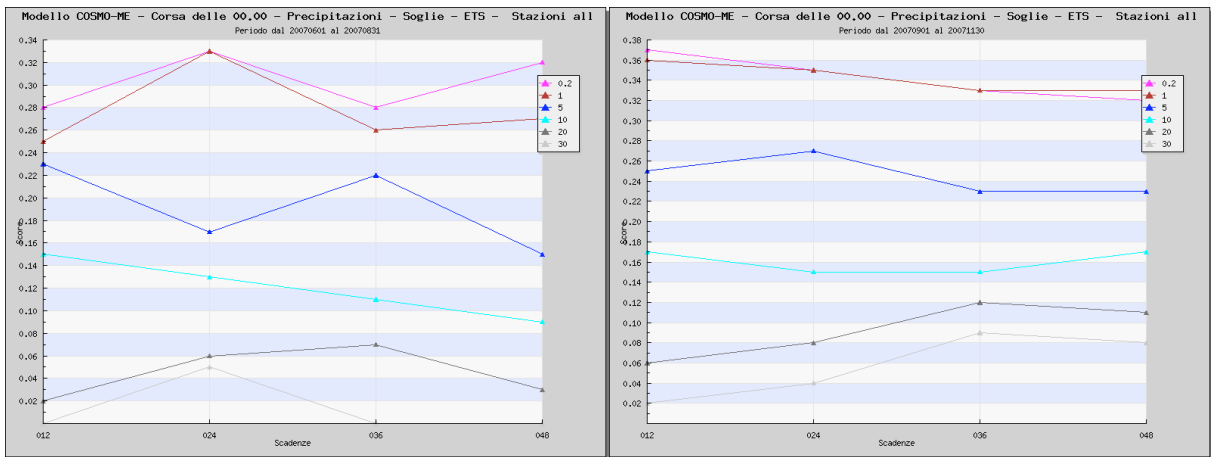
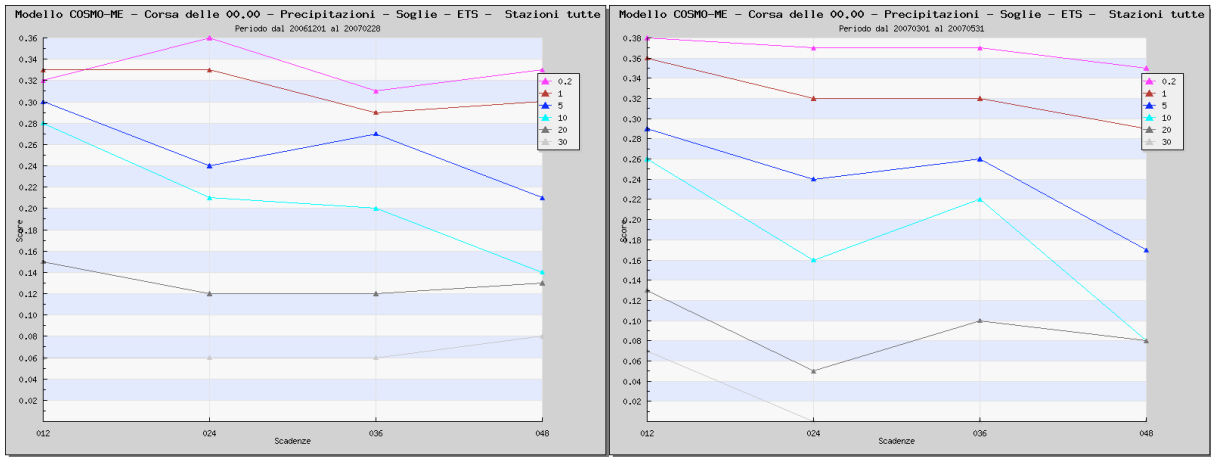
FS T2m temperature (Mean Absolute Error and Mean Error)



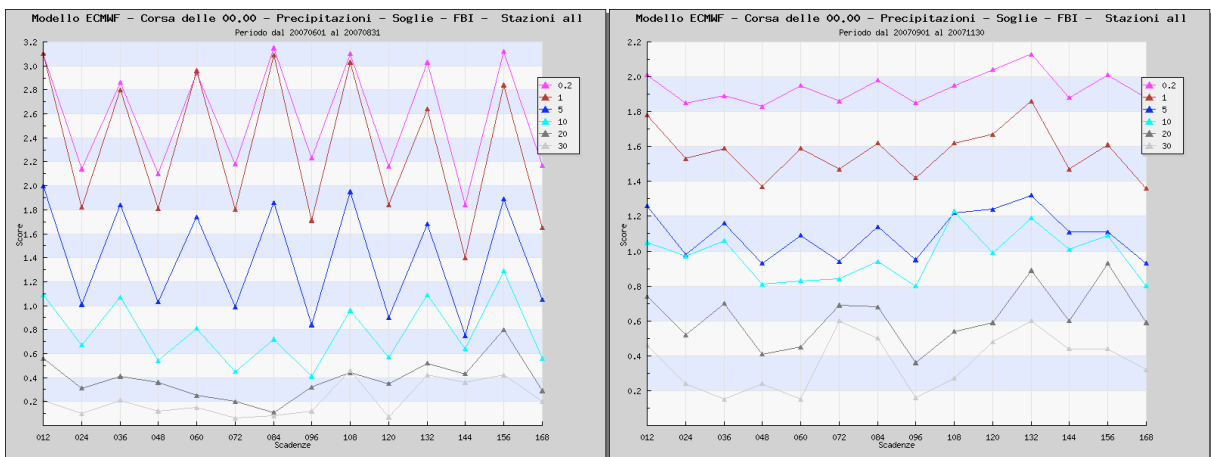
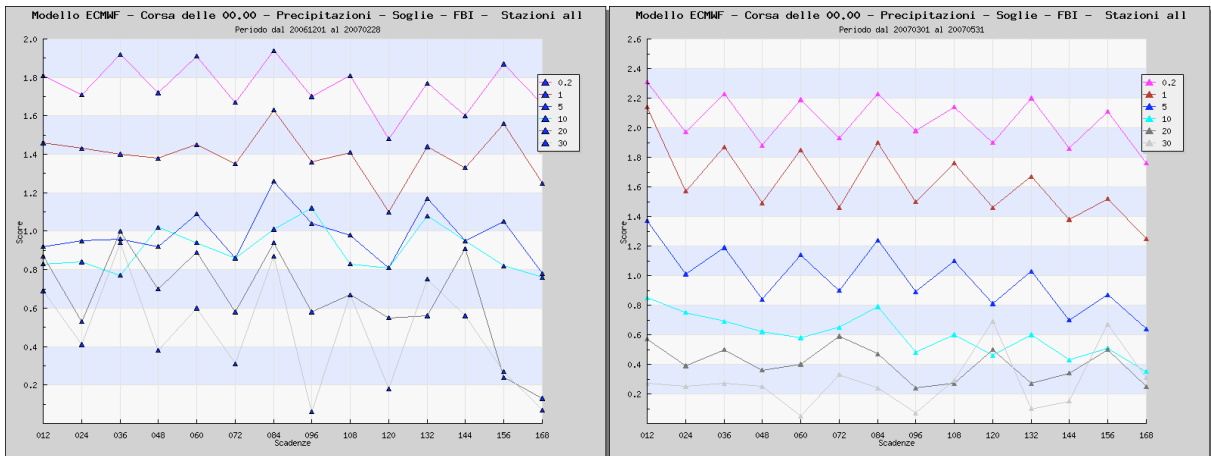
IFS Wind Speed (Mean Absolute Error and Mean Error)



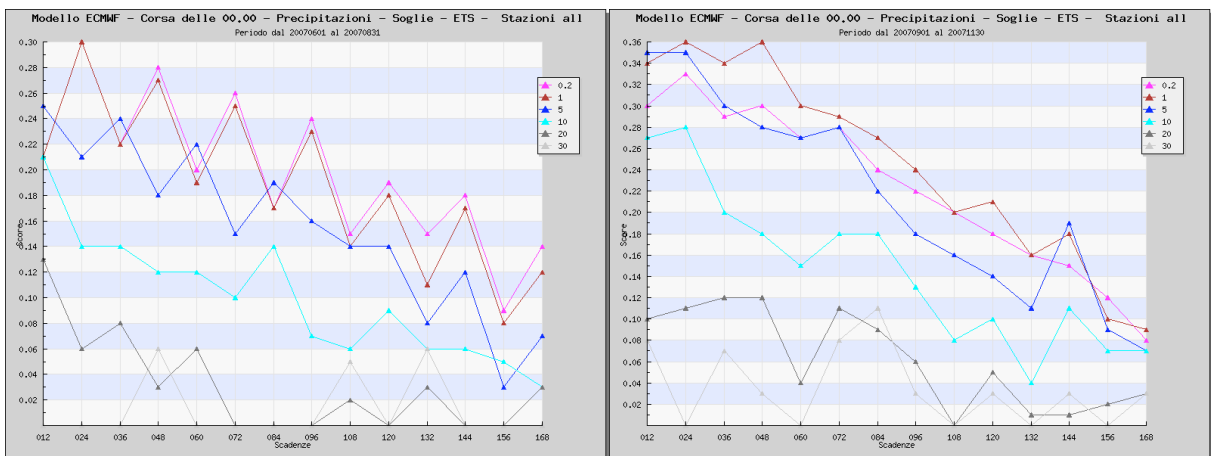
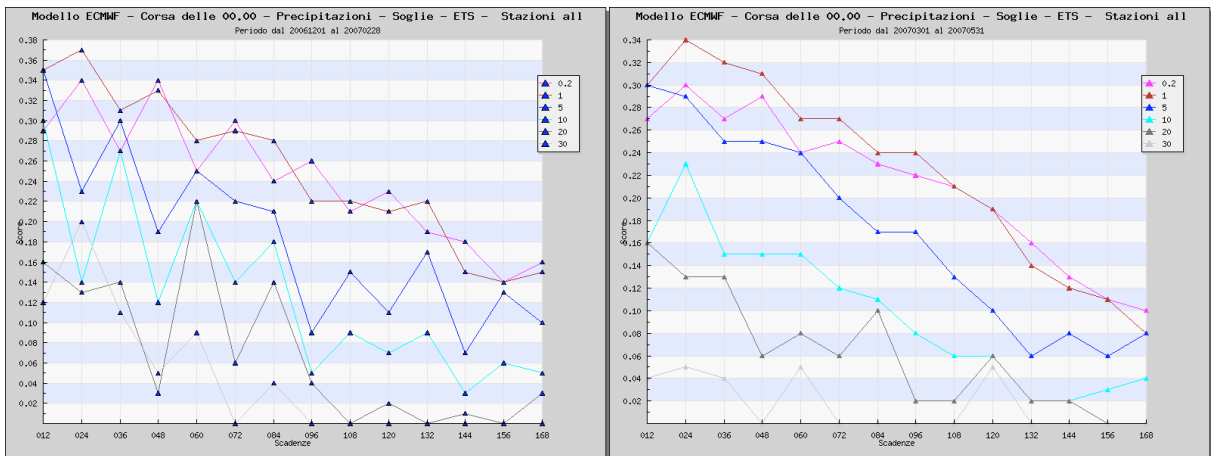
COSMO-ME Precipitation in 12 hours - FBI score for 0,2 - 1 - 5 - 10 - 20 - 30 thresholds



COSMO-ME Precipitation in 12 hours - ETS score for 0,2 - 1 - 5 - 10 - 20 - 30 thresholds



IFS Precipitation in 12 hours - FBI score for 0,2 - 1 - 5 - 10 - 20 - 30 threshold



IFS Precipitation in 12 hours - ETS score for 0,2 - 1 - 5 - 10 - 20 - 30 threshold