Using ECMWF's Forecasts (UEF2016)

The Ensemble Forecasts of ECMWF – the main tool for high impact weather and for medium range forecasts in NIMH, Bulgaria

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The Numerical models are getting better

The improvement of forecast systems in the last decades is an indisputable fact which gives forecasters the freedom to predict the weather more easily and more accurately. The medium range forecasts are unthinkable without the ensemble forecast systems of the advanced models. The ECMWF ensemble system is the main tool for issuing medium range forecasts in the National Institute of Meteorology and Hydrology in Sofia, Bulgaria. This work shows two different situations in which the ECMWF's model is the helpful advisor for issuing forecasts.

Predicting the extreme high temperatures in February 2016 in Bulgaria

The high temperatures during February 2016 in Bulgaria, reaching and exceeding the highest temperature for the entire period of observations and prediction of these unusual conditions, were a challenge for the forecasters. The extreme temperature conditions on 15th and 23rd February 2016 were predicted excellently and relatively easy by using the Extreme Forecast Index (EFI) for the temperatures at 2 m and ensemble cumulative distribution function (CDF).

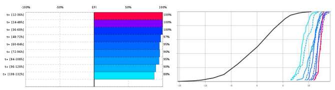

Figure 1. EFI (left) and ENS CDF for 2 m temperature (right) in Ruse, Bulgaria (43.86°N 25.97°E). Valid for: 23 Feb, 12 UTC, adjusted to 27m height

Figure 1 represents the EFI and CDF for a point with high 2 m temperatures and the model results were similar for many other places in Bulgaria. The highest percent of certainty (100%) for 12-36 h, 24-48h, and 48-60 h model forecasts for extreme temperature at 2m, and very high certainty (88%) for 108-132 h model forecast provide to the forecasters extremely high confidence.

The daily average temperatures for some synoptic stations in Bulgaria are shown on Figure 2. The peaks on the days with extreme high temperatures for February are distinctive. The temperatures in 83% of the February's days are higher than the climatic norms for examined stations.

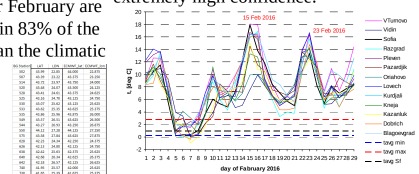

Figure 2. Daily average temperatures in some BG SYNOP stations in February 2016

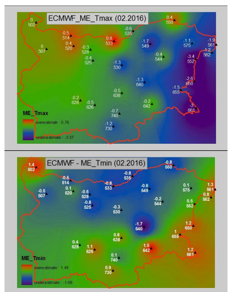

Figure 3. Min and max temperature's mean errors for some BG SYNOP stations (altitude differences in the model grid points and given location ≤ 100 m) in February 2016

How the model's temperatures differ from the observed ones in February 2016 is presented on Fig. 4. Underestimation of the temperatures during the extremely warm days is well seen and it is expected because of very complex topography.

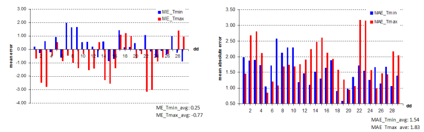

Figure 4. Min and max temperature's errors (ME - left plot; MAE - right plot) on the days in February 2016 for SYNOP stations in Bulgaria

Ensemble help for forecasters: "a disappearing cyclone" over Mediterranean in April 2016

To illustrate the role and the benefits of the ensemble forecast uncertainty about the appearance and the development of meteorological objects versus the deterministic forecast, we chose an example with a cyclone at level 500 hPa in Central Mediterranean and Balkan Peninsula, from 2nd to 4th April 2016 (Figure 5).The great impact of ensemble forecasts over medium range forecasts process can be recognized from forecasters who are issuing medium range forecasts.

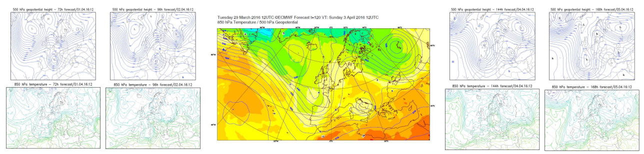

Figure 5. Deterministic forecasts, ECMWF 500 hPa Geopot. and 850 hPa Temp., 29.04.2016 12 UTC, +72, +96, +120, +144, +168h

The well developed low, passing over The Balkans (Figure 5), suggested convection development, rain (Figure 6), probability for thunders in Bulgaria. This deterministic forecast was sustained for several consecutive runs of the model. But the ensemble forecasts showed very high uncertainty about the development of this cyclonic circulation (Figure 7) and guide the forecasters to be cautious and to issue some probabilities about the wet weather.

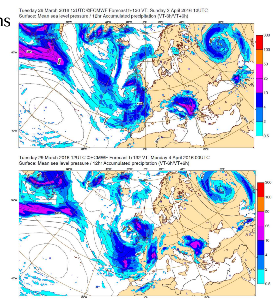

Figure 6. Deterministic forecasts for MSLP and 12h Accumulated precipitation, ECMWF, 29.04.2016 12 UTC, +120h, +132h

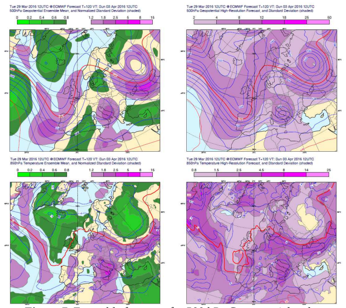

Figure 7. Ensemble forecasts for 500 hPa Geopotential and 850 hPa Temperature, ECMWF, 29.04.2016 12 UTC, +120h

What happened?

Only small areas with showers in the mountainous regions with total amount of precipitation up to 1-5 mm/24h were observed; almost no rain for the most part of the country (Figure 8). So, taking into account the ensemble forecast for the evolution of the synoptic situation was very helpful and important for making a good medium range forecast, although the statements in the forecast are still based on the deterministic forecast. Finally, the medium range forecasters have to make important decisions by using deterministic and mainly ensemble forecasts.

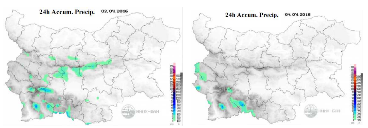

Figure 8. 24h Accumulated Precipitation, 3 and 4 April 2016, Bulgarian rain analysis. Left scale – Accum. Precip. [mm]; right scale – altitude [m]

Improvement of snow analysis over Bulgaria

Following the Finnish 6th National Seminar on Snow "On the Day of Pyry" (November 2015, Helsinki, with the support of Harmosnow COST ES1404) the following action took place during the winter season 2015/16. Dr. Ilian Gospodinov (NIMH, Bulgaria) assured the provision of additional snow data from Bulgaria in the dedicated snow BUFR format. Ioannis Mallas (Production section, ECMWF) assured the upload of the additional snow data to their database. Dr. Patricia de Rosnay (Coupled Assimilation Team Leader, ECMWF) carried out a one month experiment of snow analysis over Bulgaria with and without additional snow data. Figure 9 illustrates an improvement of the snow cover representation in the Upper Thracian Valley thanks to the assimilation of the additional snow data. The example is from the only big snow event last winter in Bulgaria, 16-19 January 2016. Figure 10 shows for comparison the national snow analysis for the same date where all available snow data was used (about 310 climate stations). Improved snow analysis over Bulgaria is directly linked to improved weather forecast in general and for the country in particular.

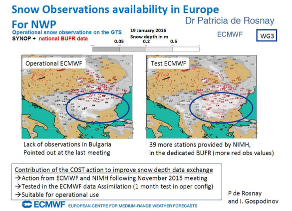

Figure 9. Improved snow analysis in the Upper Thracian Valley (South-central Bulgaria) thanks to increased number of snow data available for assimilation: result from 1 month experiment carried out by Dr Patrica de Rosnay (ECMWF)

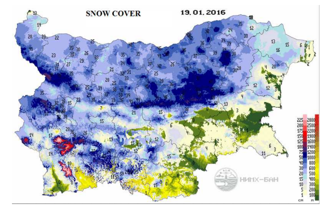

Figure 10. Bulgarian snow analysis, 19 Jan 2016. Left scale – snow depth [cm]; right scale – altitude [m] for the places without snow; black numbers – available snow data for the date

Wave forecasts for the Black Sea using ECMWF wind fields as forcing data

Wave forecasts for the Black Sea are made at the NIMH-BAS two times a day, 72h ahead using wind fields from the Limited Area NWP model ALADIN as forcing data. Alternatively wind fields have to be taken from ECMWF HRES atmospheric model (Figure 11). The comparison of the wave forecasts runs with forcing wind fields from NIMH-BAS and ECMWF atmospheric models shows that the differences between the forecasts are quite small (Figure 12).

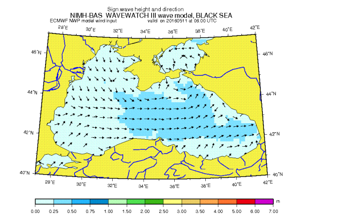

Figure 11. Sign wave height and direction, NIMH-BAS WAVEWATCH III Black Sea (ECMWF model input), 11 May 2016 06 UTC

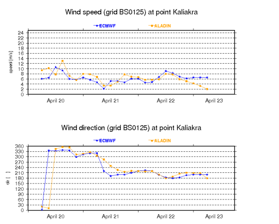

Figure 12. Wind speed [m/s] and wind direction [deg] at Kaliakra, 20-23 April 2016 12 UTC from ECMWF (blue) and from ALADIN (orange)