EPS-Case study of serious HIW event in Poland, August 11th, 2017. Increasing resolution approach ˘ from 7 km to 0.7km

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Abstract

The results from research on COSMO-EPS, carried out at IMWM, are presented. The operational EPS (Ensemble Prediction System) set-up is based on perturbations of soil surface-area index of the evaporating fraction of grid points over land. In this paper High Impact Weather event that occured on August 11th, 2017 in northwestern Poland is analyzed. This event resulted in two deaths, many people were injured, the final consequences are to be presented later on the basis of the prosecutor's investigation. The case was examined in both deterministic and EPS approaches, with a resolution increasing from 7 to 0.7 km.

1 Introduction

On August 27th, 2017, around 20:30 UTC, a very strong storm went over the Kujawsko-Pomorskie and Pomorskie voivodeships. The effects of this storm are being analyzed to this day. Two people were killed at the scout camp in Suszek, and many were wounded as a result of being crushed by breaking trees. Since then, the ongoing prosecutor's investigation led at its current stage to accusations against weather forecasters, claiming that they had not issued the highest level warning (red alarm), despite the fact that the wind speed exceeded 25 m/s, i.e. the threshold obliging such a warning. Measurements (not forecasts) at the nearest synoptic stations (Chojnice or Gdańsk) found wind gusts of up to 50 m/s, however, these measurements were made already during the period when the storm was passing through this area. This work attempts to answer the question whether numerical weather forecasts, in particular ensemble forecasts, predicted such wind speed, that is, whether there was a basis for prior announcement of warning of the highest degree. In this work, the ensemble prediction system (EPS) was used, which has been running in IMGW-PIB since 2013. A detailed description of the system can be found in the work (Duniec et al, 2016). In this approach, a cascading sequence of nested domains from a resolution of 7 km through 2.8 km to 0.7 km was used. The cascade of domains is shown in Figure 1, with the location of the town of Suszek marked.

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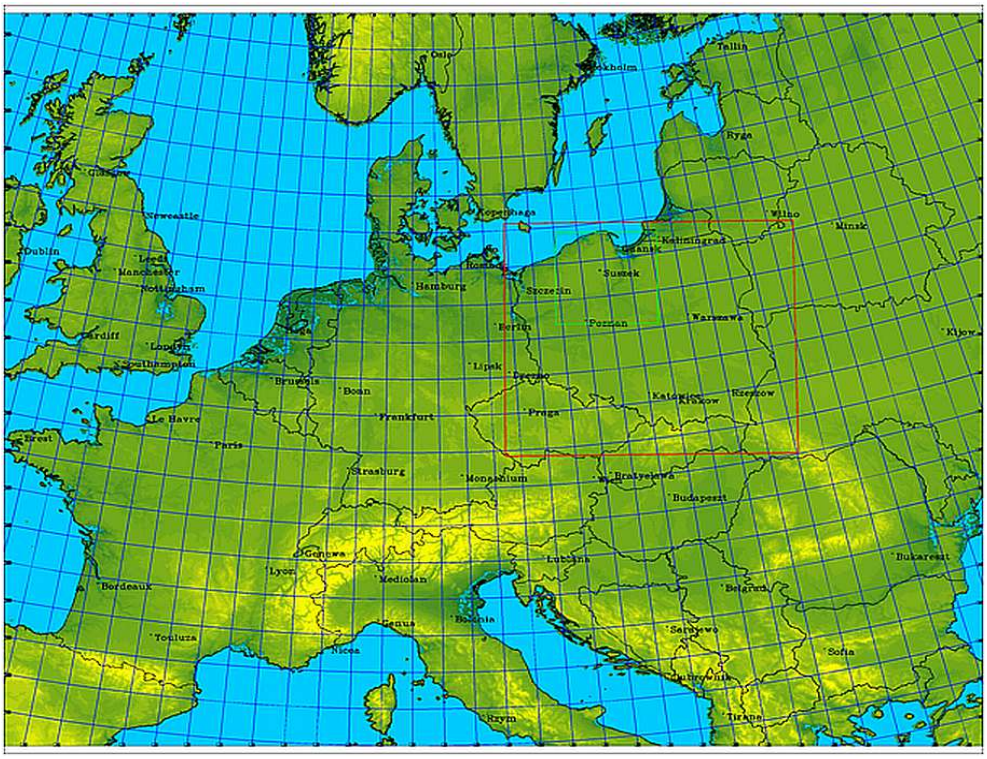

Figure 1: The basic computational domain of the COSMO model at a resolution of 7x7km, mesh size: 385x321 points. The red rectangle marked the nested domain 2.8x2.8km, (285x255 points), the green – nested domain 0.7x0.7km (400x400 points).

The basic input data to the cascade (EPS input data with a resolution of 7km) were obtained from the results of the ICON model (Zängl et al, 2015), calculations at a resolution of 2.8km were performed using the results of the model at 7km resolution as initial and boundary conditions. Finally, the 2.8km model results served as boundary and initial conditions for EPS at a resolution of 0.7km. The result of the model's work were the values (spatial distributions) of parameters related to the description of convective phenomena, including Total Precipitation, Windspeed at 10m agl., Maximum windspeed at 10m agl., CAPE_3KM, CAPE_ML, CAPE_MU, Derecho Composite Potential, Supercell Detection Index, Showalter Index, Lifted Index, Universal Tornadic Index (conf. Taszarek and Kolendowicz, 2013), Radar Reflectivity and Wind Shear up to 6 km. In this paper, however, only the results of the two basic parameters are presented: forecasts of maximum wind speed (VMAX) and radar reflectance (REFL).

2 Results

Figures 2-7 provide forecasts for the distribution of mentioned parameters (VMAX, REFL) for all resolutions, from 19:00 to 22:00 UTC. Forecasts are presented both as EPS results and as results of a deterministic approach. In the case of EPS, the distributions of the ensemble mean and the maximum predicted values are presented. Additionally, Figure 8 presents comparisons of radar reflection forecasts with real images obtained with the Polish radar network, hourly accumulated from 15:00 to 23:00 UTC (see also Taszarek et al, 2019). The exemplary areas and convective structures (with locations similar for ensemble mean/max/deterministic spatial distributions), that can be identified from reflections forecasts vs. the observations, are marked with arrows.

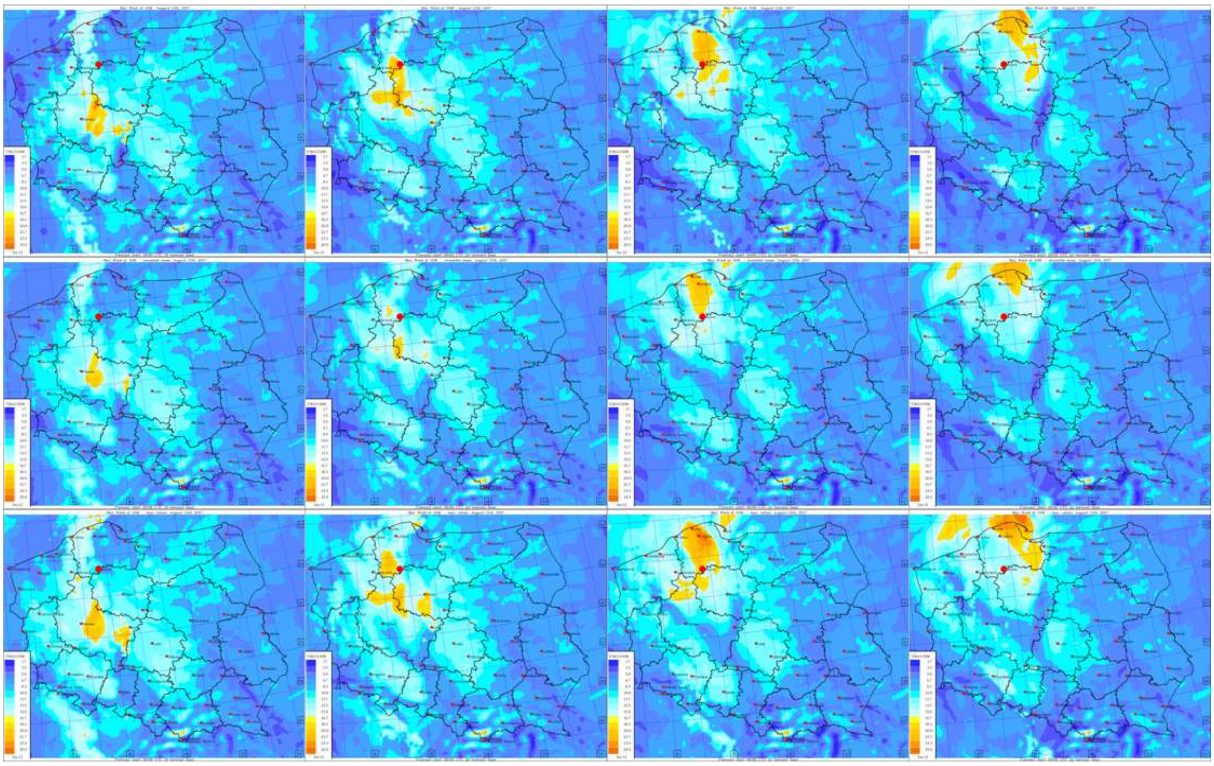

Figure 2: VMAX forecasts from 19:00 (leftmost) to 22:00 (rightmost) UTC. Top to bottom: deterministic forecast, ensemble mean, ensemble maximum values. Resolution 7km.

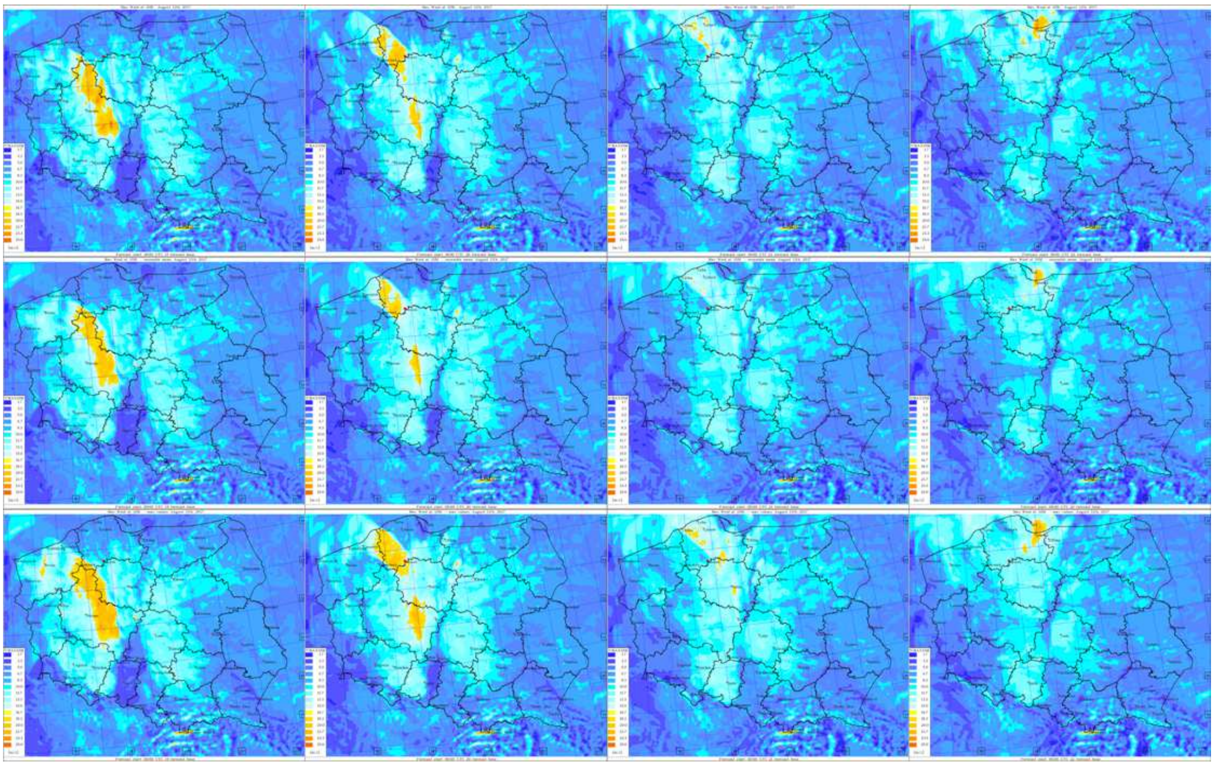

Figure 3: VMAX forecasts from 19:00 (leftmost) to 22:00 (rightmost) UTC. Top to bottom: deterministic forecast, ensemble mean, ensemble maximum values. Resolution 2.8km.

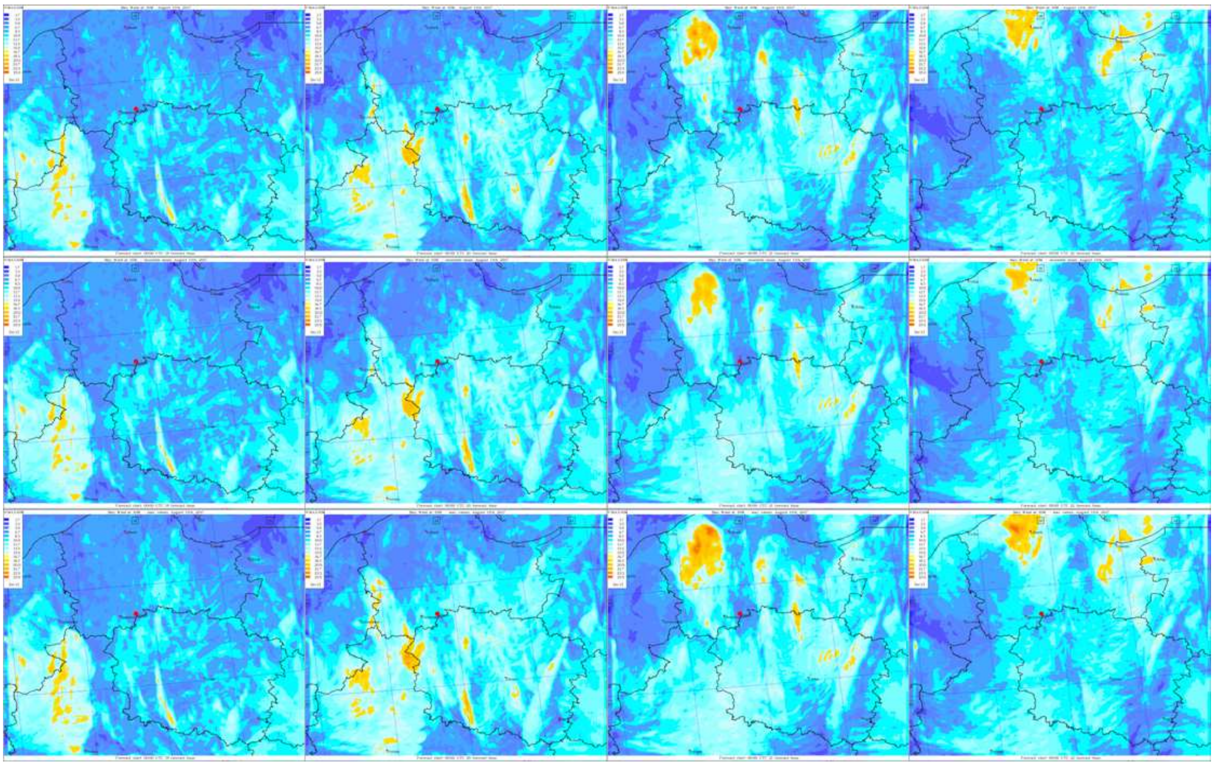

Figure 4: VMAX forecasts from 19:00 (leftmost) to 22:00 (rightmost) UTC. Top to bottom: deterministic forecast, ensemble mean, ensemble maximum values. Resolution 0.7km.

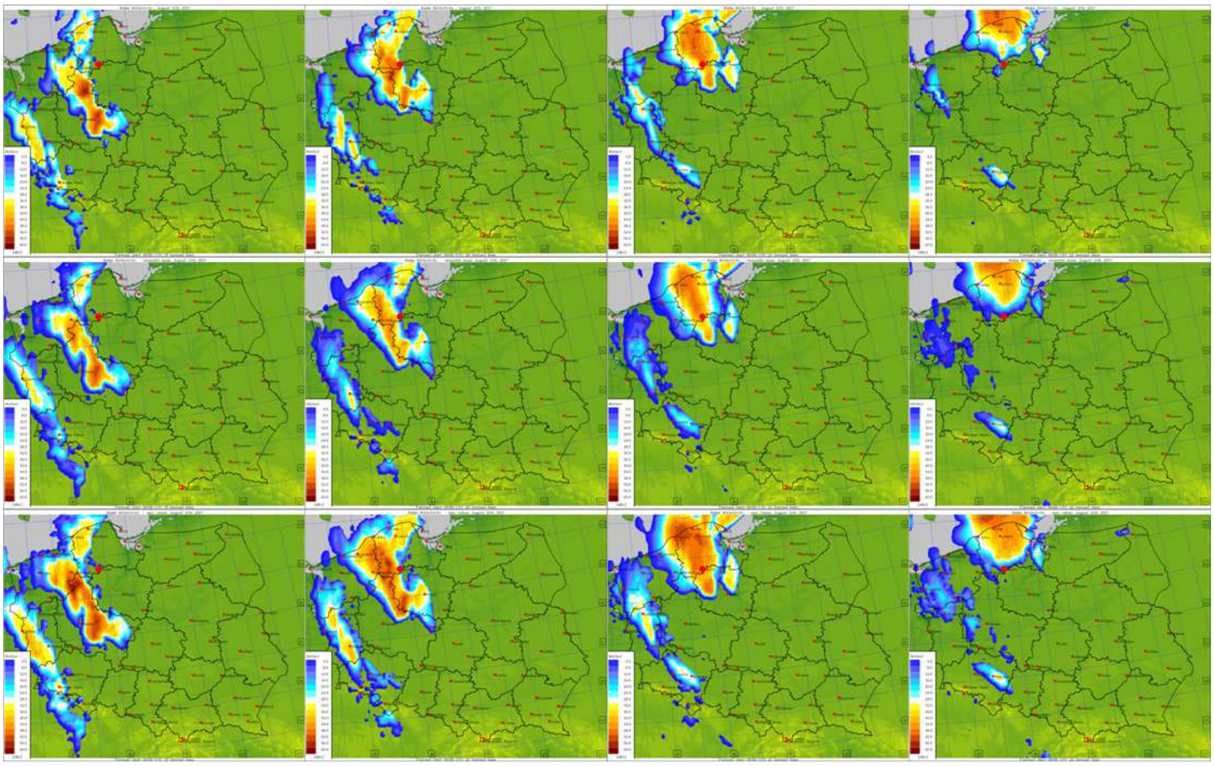

Figure 5: REFL forecasts from 19:00 (leftmost) to 22:00 (rightmost) UTC. Top to bottom: deterministic forecast, ensemble mean, ensemble maximum values. Resolution 7km.

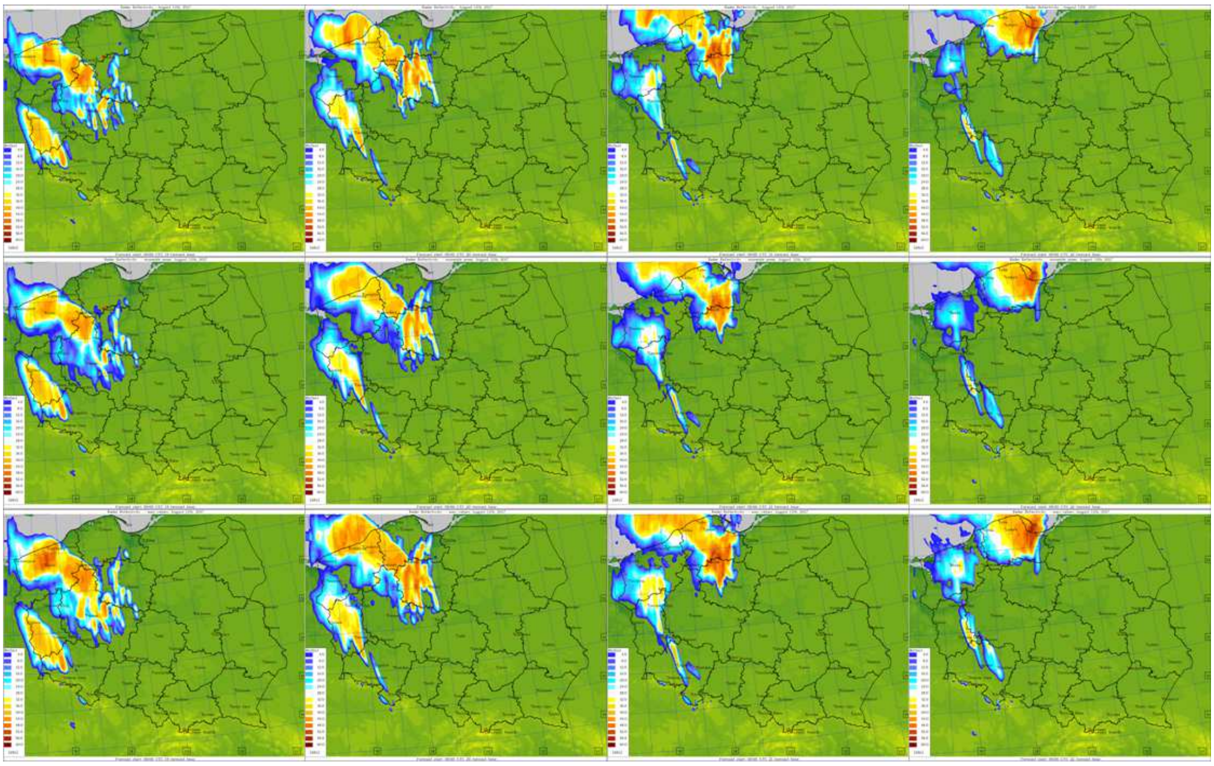

Figure 6: REFL forecasts from 19:00 (leftmost) to 22:00 (rightmost) UTC. Top to bottom: deterministic forecast, ensemble mean, ensemble maximum values. Resolution 2.8km.

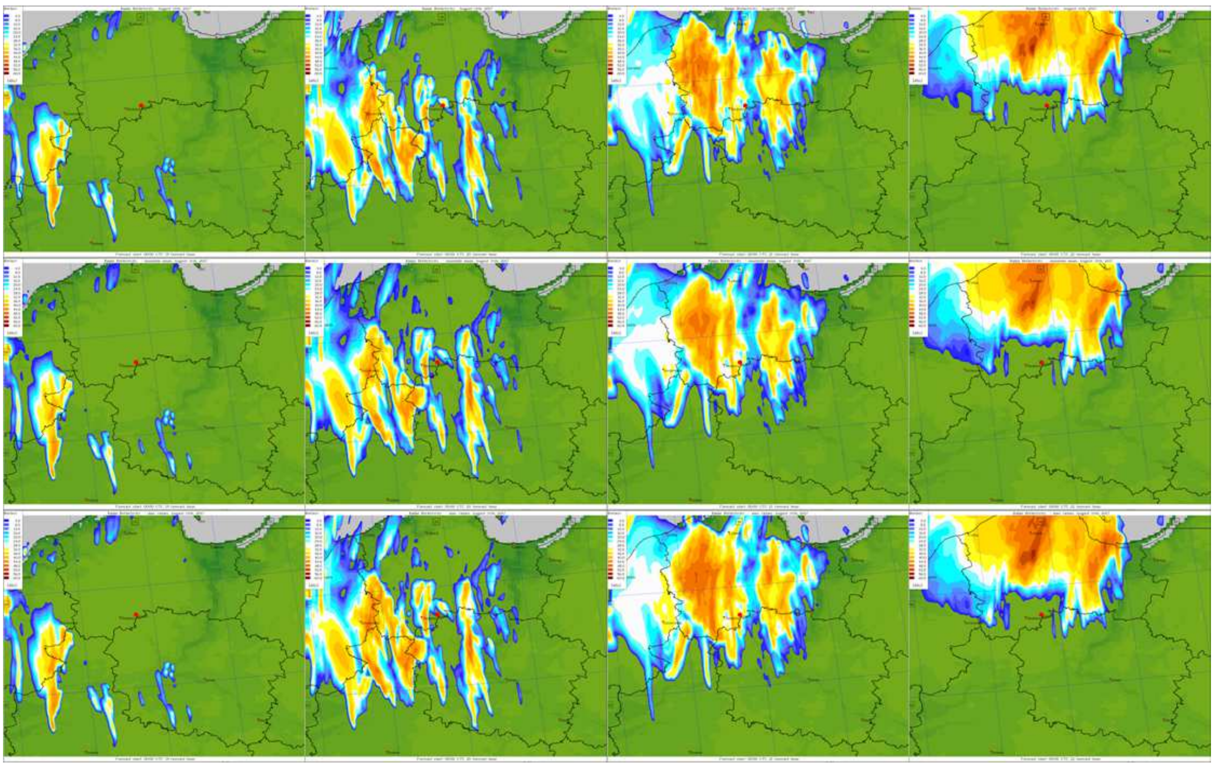

Figure 7: REFL forecasts from 19:00 (leftmost) to 22:00 (rightmost) UTC. Top to bottom: deterministic forecast, ensemble mean, ensemble maximum values. Resolution 0.7km.

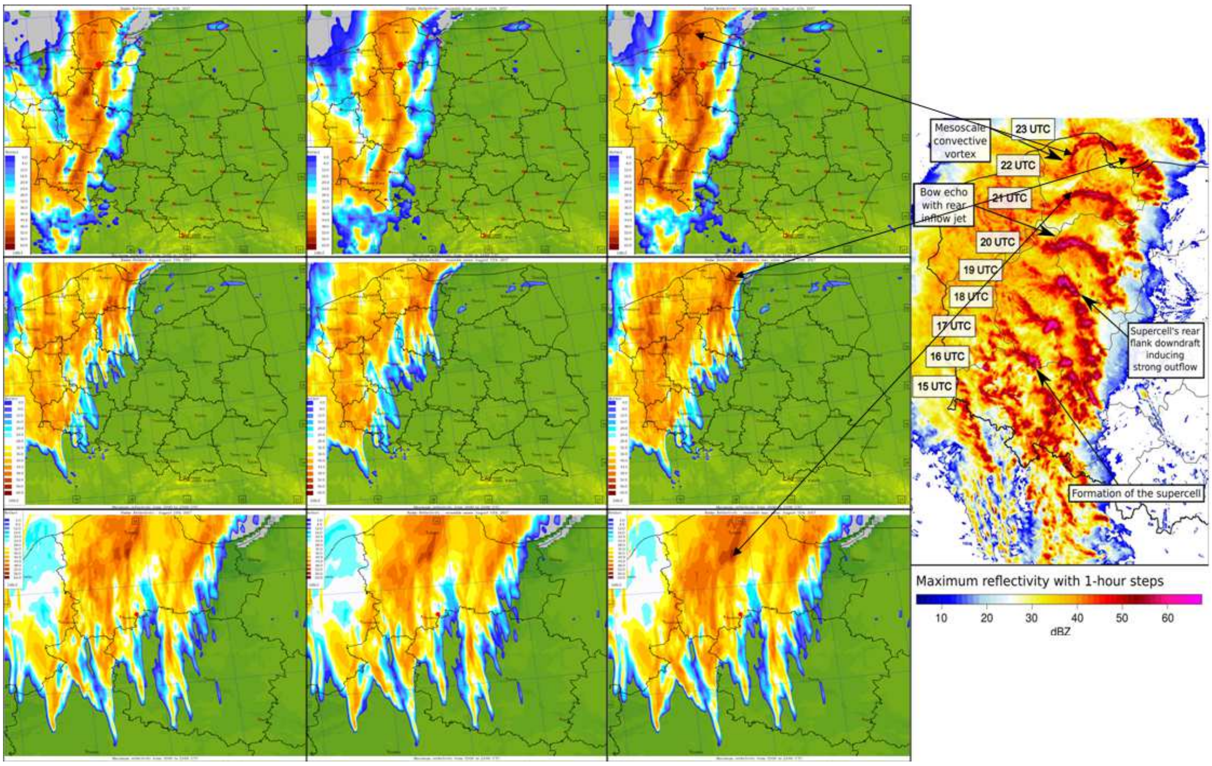

Figure 8: Radar reflectivity forecasts from 15:00 to 23:00 UTC. Top to bottom: resolution 7.0km, 2.8km, 0.7km. Left to right: deterministic forecast, ensemble mean and maximum values. Right-most: Maximum reflectivity as observed with Polish radar network.

3 Discussion

It should be stressed that most likely this event was cause by a supercell that rapidly moved north-northeast. Important information about the event was provided by VMAX forecasts(as DMO) and reflectivity forecasts, which could be verified in relation to measurements at SYNOP stations and the values in the Polish radar network (conf. Taszarek et al, ibid). The information on reflectivity forecasts may serve as the method to identify structures relevant to high impact weather events, especially an intensive convective phenomena. Results of verification are similar for both EPS-and deterministic forecasts for the case. Low wind speeds (below 5.0 m/s) are overestimated by all instances of EPS deterministic forecasts whilst larger wind speeds (above 5 m/s) are underestimated. The skill decreases with wind speed and smaller spatial scales. Wind gusts above 6 m/s are underestimated and the degree of underestimation is increasing with gust speed. The best skill was achieved for low wind gust speeds. A small variation in skill with spatial scale, with greater skill at larger scales, can be seen.

4 Summary

However, forecasts of the maximum wind gusts, both in statistical and deterministic approach, in all considered resolutions did not exceed 25 m/s. Hence, the maximum forecast wind was not strong enough to give substantial reason for the warning of the highest level. In the light of this study, the accusations against forecasters should be considered unfounded.

Thus, the answer the basic question asked in this article (whether there was a basis for issuing of warning of the highest degree) should read as follows: from all of the above it can be stated that no forecast, neither deterministic nor EPS, predicted winds faster than 25m/s (regardless, mean or gusts) that would be a basis for giving out the top-level – red – alert.

As it was already said, the transition from 7.0 km via 2.8 km to 0.7 km was not just the increasing the resolution. It was also the transition from parameterized to explicit convection, that changes the results with every change of resolution.

Finally, it should be stressed that at IMWM-NRI this work was the very first attempt of forecasting model with resolution higher than 1km. Further work on this topic is expected.

Acknowledgements

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References

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