Application of ECMWF products in winter weather situations at OMSZ

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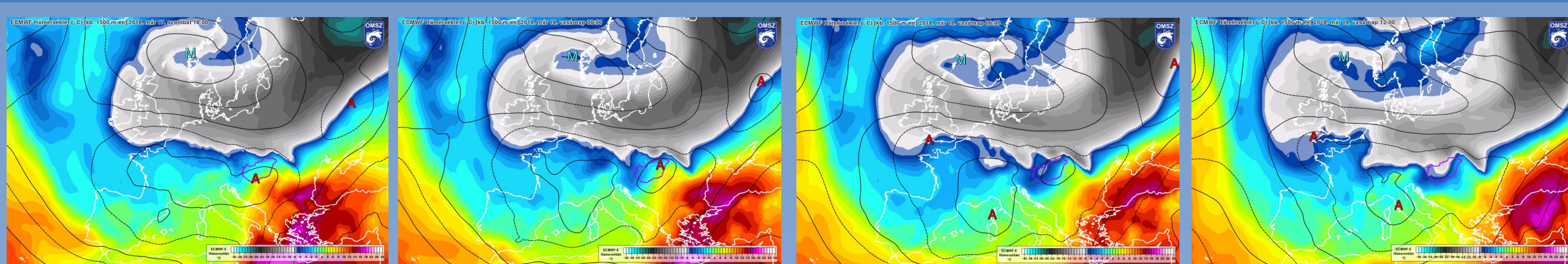
To forecast weather situations in winter - especially concerning the precipitation type around 0 °C - is one of the most difficult tasks in meteorology. This is the case in the Carpathian Basin, and in Hungary as well. There is a very big difference in the expected weather character and impact depending on snow, freezing rain or rain. In the Hungarian Meteorological Service (OMSZ), a number of products based mainly on the ECMWF model have been developed and introduced to operational work in the recent years, hence these weather situations can be better identified by public and our customers as well. These new developments will primarily help to predict the precipitation type, and to specify the areas affected by snowdrift with higher precision.

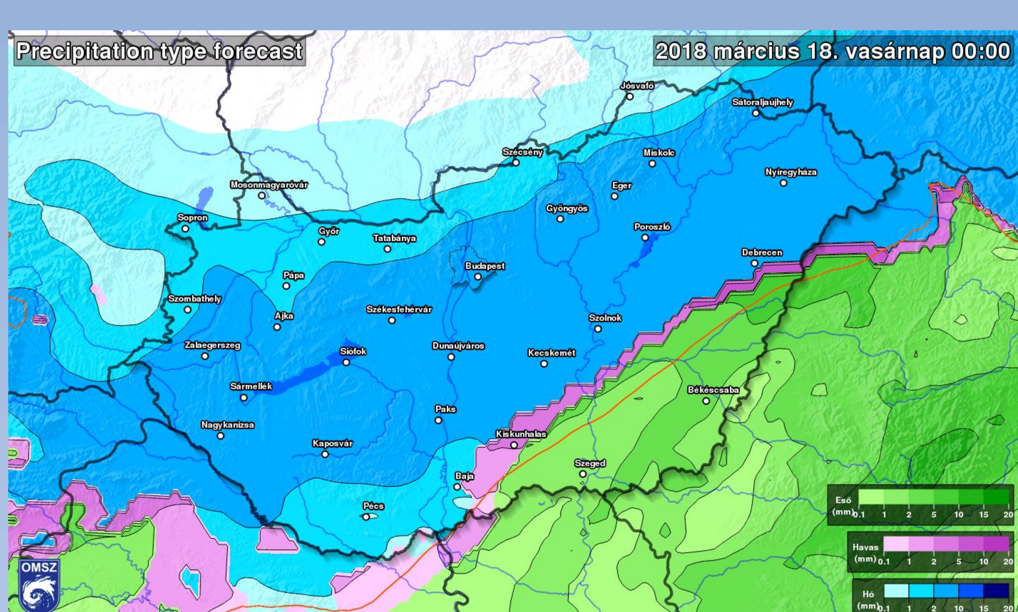
These new developments will be presented through a case study. On March 17-18, 2018 airmass of arctic origin flooded the Carpathian Basin from the north, northeast. The cold air flowed into the basin in the lower air layers and was mixed with the moist air mass of a Mediterranean cyclone, causing extensive precipitation. At first at the afternoon and evening of 17th March the precipitation type was rain almost everywhere in the country, but at the late evening, especially near midnight, the precipitation type was changing fast. Snowfall, blowing snow occurred on a larger area, but in this special weather situation, even freezing rain formed in several places.

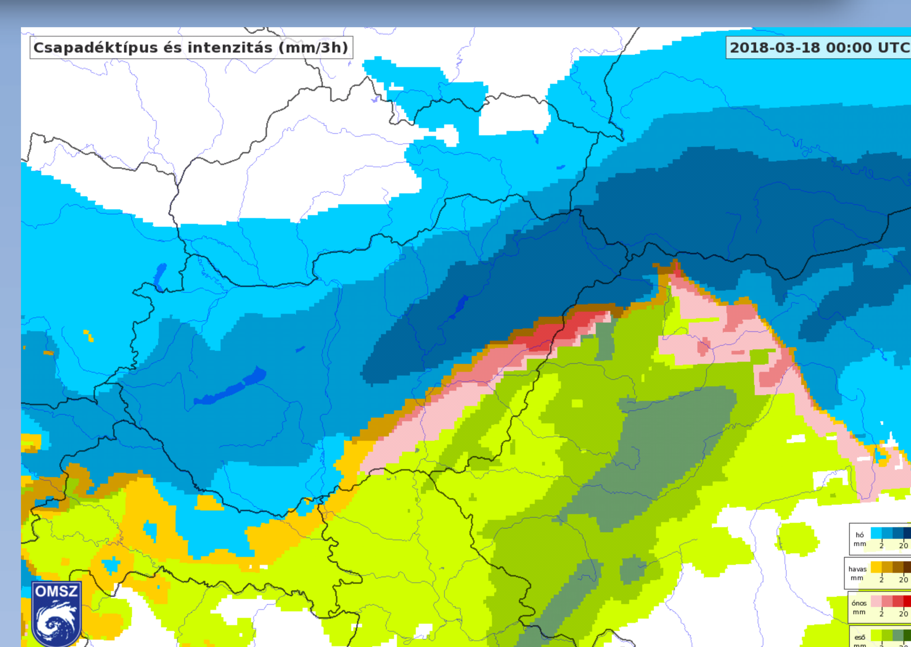


ECMWF forecasts of 850 hPa temperature between March 17, 2018, 18 UTC and March 18, 2018, 12 UTC

Precipitation type products

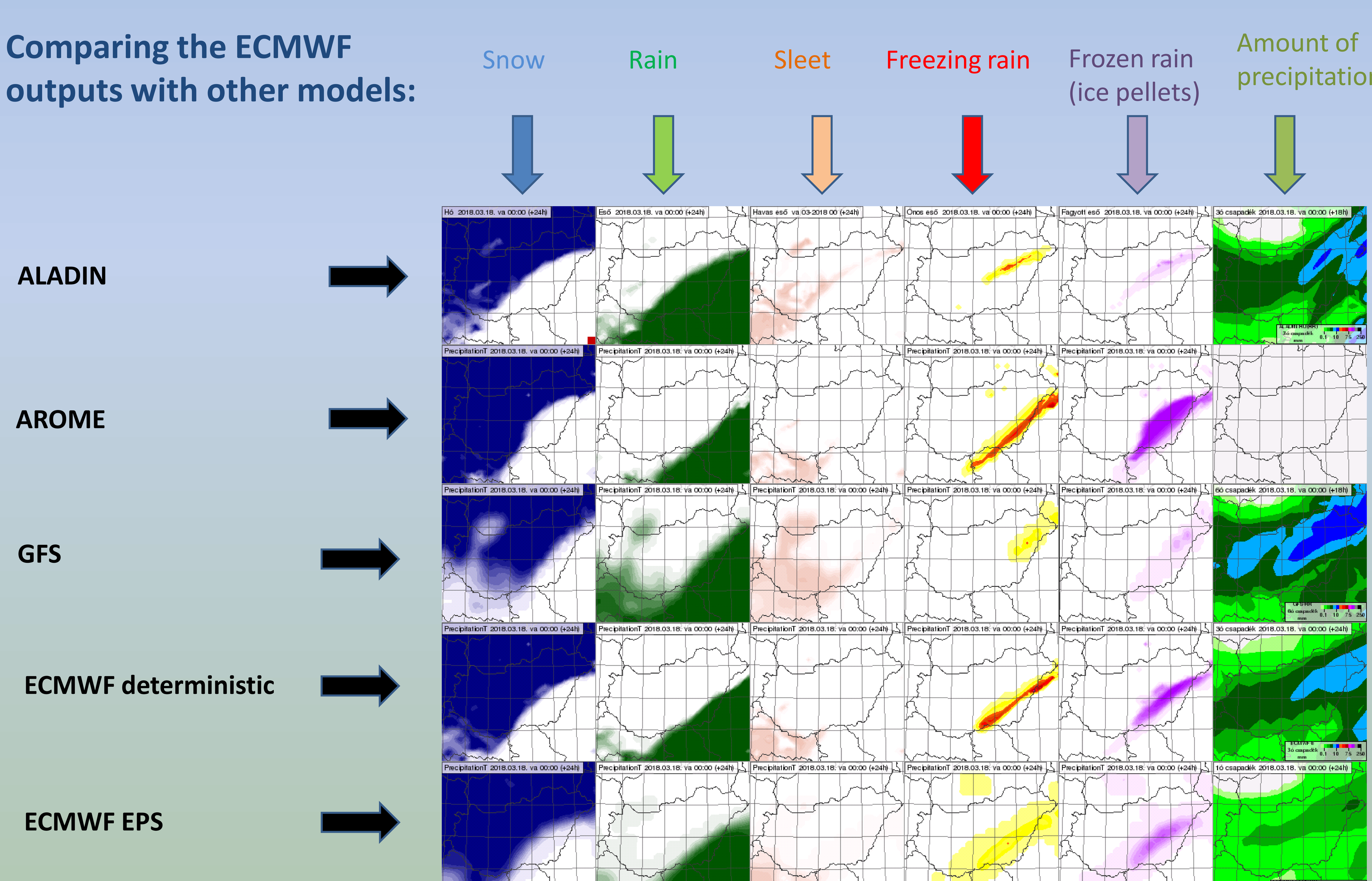
Different visualization methods for the ECMWF model:





Legends:
Blue - Snow
Green - Rain
Pink/Red/Yellow – Rain and snow/Freezing rain

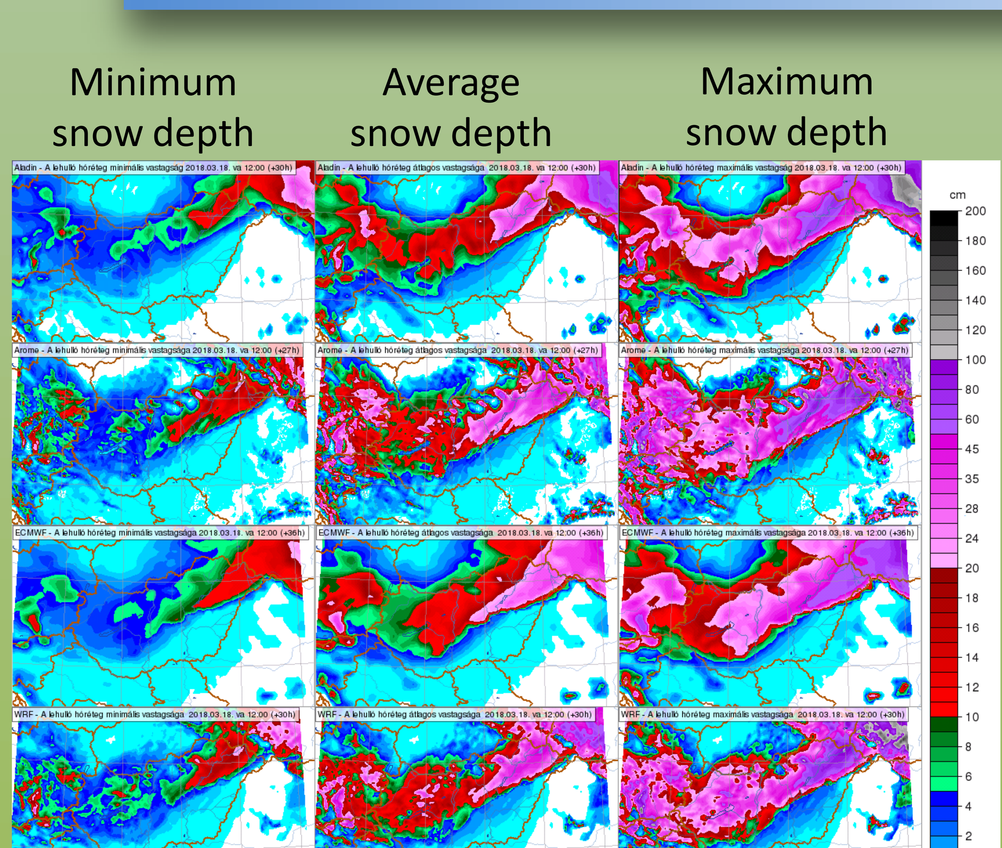
Comparing the ECMWF outputs with other models:



ECMWF and other model (ALADIN, AROME, GFS) 24 h forecasts of precipitation type. Valid for March 18, 2018, 00 UTC

Conclusion: ECMWF forecast was successful at the southeastern part of Hungary. AROME – which uses ECMWF boundary conditions - was also realistic. But the GFS – which wasn't quite good in Southeastern-Hungary - forecasted better that the precipitation type at this point will be still mixed in West-Hungary.

Snow depth forecast



In the last winter a new empirical method based on long-term (1980-2015, 3078 cases) observations was developed (by Attila Fövényi, OMSZ) to predict the depth of the fresh snow layer.
Minimum and maximum snow depth are the average of the 15 % of the lowest and highest data.

ALADIN, AROME, ECMWF and WRF (from top to bottom) snow depth forecasts. Valid for March 18, 2018, 12 UTC

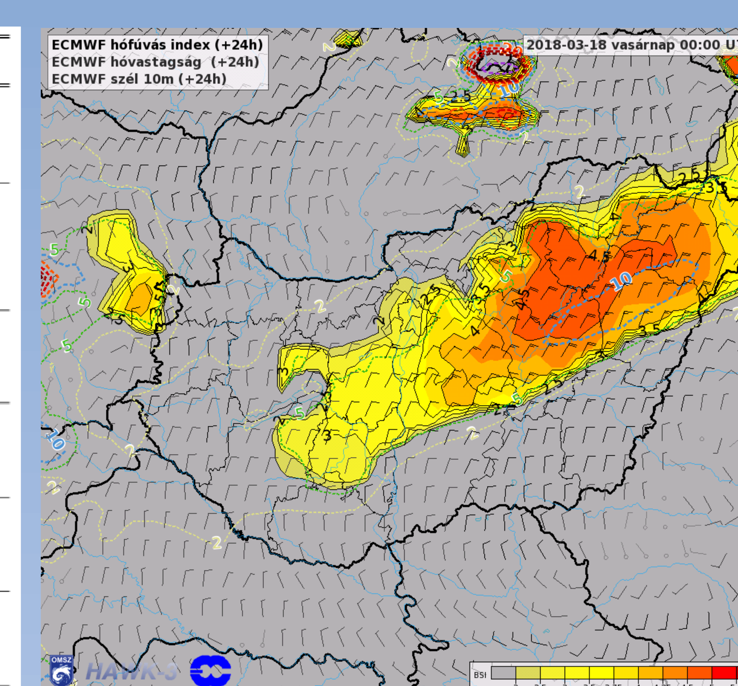
Blowing Snow Index

BSI = $f(T) + f(T_s) + f(U) + f(G) + f(H) + f(\rho_H)$, where

$f(T)$ - temperature at 2m, $f(T_s)$ - surface temperature, $f(U)$ - wind speed at 10m, $f(G)$ - wind gust at 10m, $f(H)$ - snow depth, $f(\rho_H)$ - snow density (Tordai, 2012).

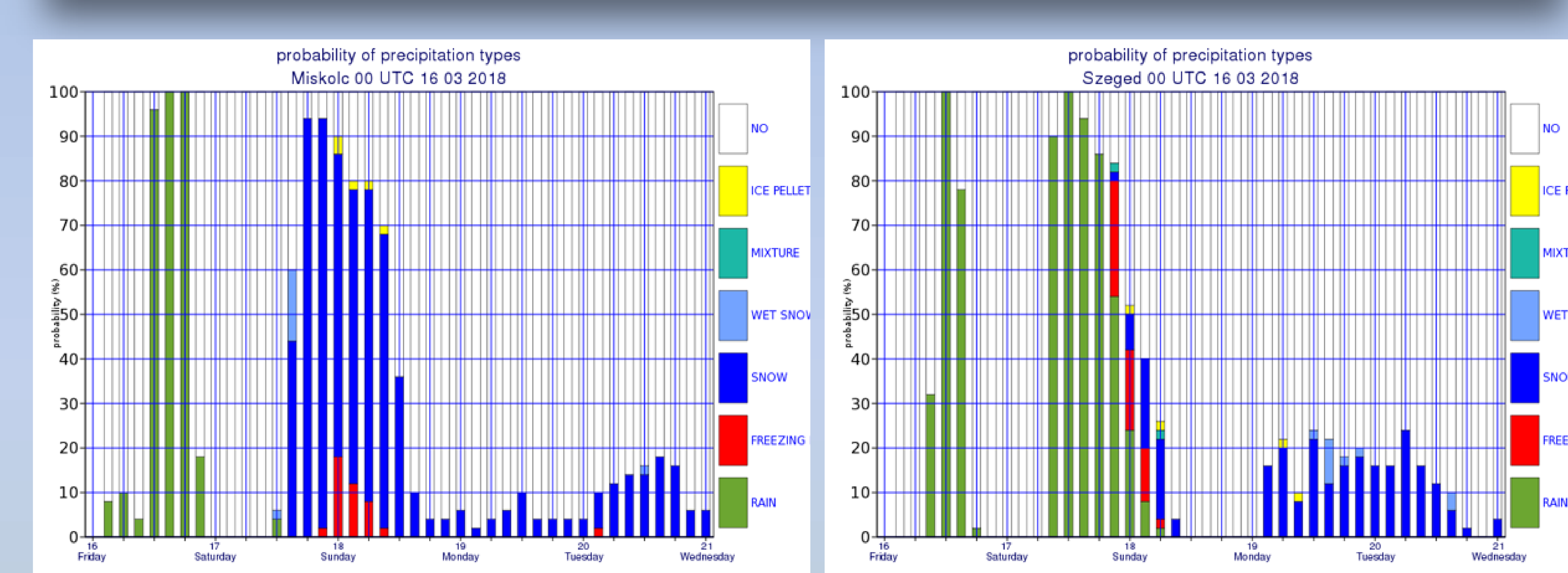
Maximum possible value is 6. Blowing snow is probable when BSI ≥ 2, and when BSI ≥ 3,5, it is recommended to issue first level (yellow) warning on blowing snow.

State determinating parameter	Interval	Weight function
T [°C] (2 m temperature)	$T \le -6.5$	$f(T)=1$
	$-6.5 < T \le 0.5$	$f(T)=-0.0087T^2-0.1727T+0.2447$
	$T > 0.5$	$f(T)=-(0.0181T)^2-0.139T+0.2257$
T_s [°C] (Surface temperature)	$T_S \le -3.0$	$f(T_S)=1$
	$-3.0 < T_S \le -0.5$	$f(T_s)=-0.0406T_s^2-0.2436T_s+0.6342$
	$-0.5 < T_S \le 2.0$	$f(T_S)=0.3397\exp(-1.5717\,T_S)$
	$T_S > 2.0$	$f(T_s)=-0.1264T_s^2+0.5056T_s-0.4915$
U [m/s] (10m wind)	$U < 4.0$	$f(U)=1.014U-4.014$
	$4.0 \le U < 15.0$	$f(U)=-0.0076U^2+0.2314U-0.7616$
	$U \ge 15.0$	$f(U)=1$
G [m/s] (10m wind gust)	$G < 6.0$	$f(G)=-0.075G^2+1.1192G-3.9657$
	$6.0 \le G \le 21.0$	$f(G)=-0.0029G^2+0.1416G-0.6952$
	$G > 21.0$	$f(G)=1$
H [cm] (snow depth)	$H < 5.0$	$f(H)=0.0732H^2+0.6711H-4.9321$
	$5.0 \le H < 31.0$	$f(H)=-0.0007H^2+0.0538H+0.0022$
	$H \ge 31.0$	$f(H)=1$
ρ_H [kg/m³] (snow density)	$\rho_H < 100.0$	$f(\rho_H)=1$
	$100.0 \le \rho_H < 240.0$	$f(\rho_H)=-1.83\times10^{-5}\rho_H^2+0.0019\rho_H+0.9912$
	$\rho_H \ge 240.0$	$f(\rho_H)=-0.0534\rho_H+13.207$



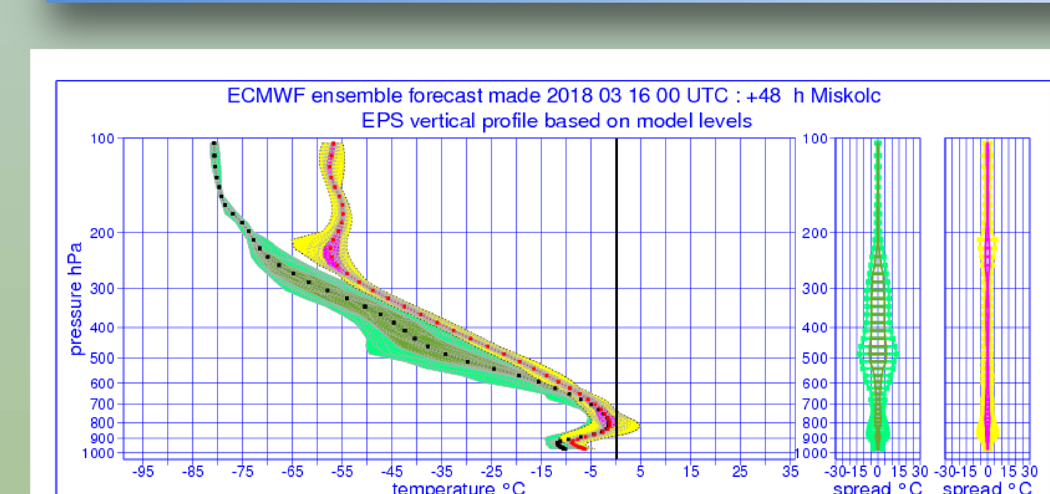
ECMWF 24 h forecasts of BSI and 10m wind. Valid for March 18, 2018, 00 UTC

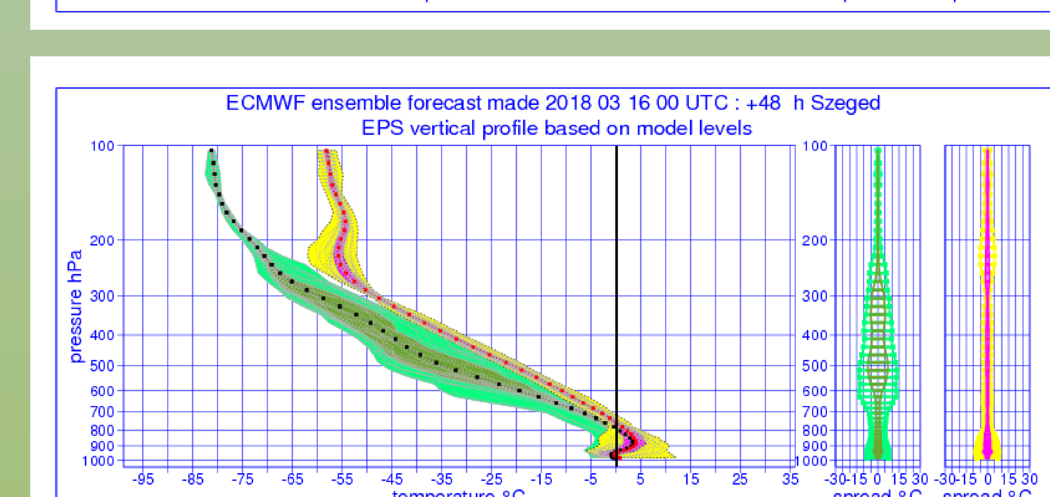
Ensemble products: meteogram



In 2015 a new meteogram product was developed at OMSZ, showing the evolution of the precipitation type for a selected city. In this case we can see that the precipitation type in Miskolc (Northeastern-Hungary) will be mostly snow, but in Szeged (South-Hungary) will be mostly rain and freezing rain at March 18, 2018, 00 UTC.
2 years later this product inspired the ECMWF to create two new products in ecCharts; a meteogram and a map product.

Ensemble products: probability charts





The meteograms matches well the EPS vertical profile in Miskolc and in Szeged as well.

References:
Gascón, E., Hewson, T., Sahin, C., 2018: New meteogram and map ecCharts products for precipitation type probabilities. ECMWF Newsletter, 154, 2-3.
Tordai, J., 2012: *A hófúvás előrejelzése Magyarország térségére*. MSc thesis, ELTE, Budapest. (In Hungarian)
Somfalvi-Tóth, K., Tordai J, Simon A., Kolláth K., Dezső Zs., 2015: Forecasting of wet- and blowing snow in Hungary, *Időjárás*, **119**, 277-306.