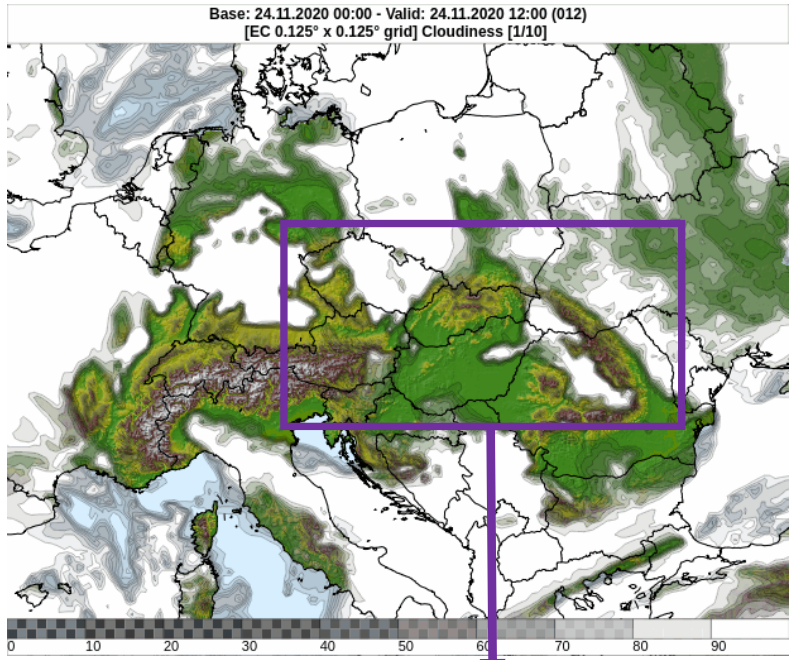
Forecasting fog and low cloudiness on 24/11/2020

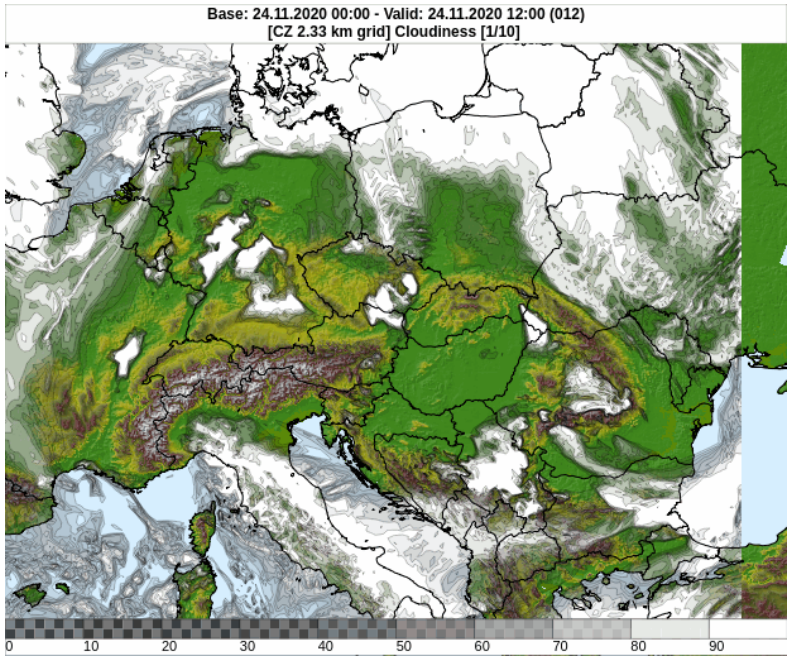
NWP Team SHMÚ

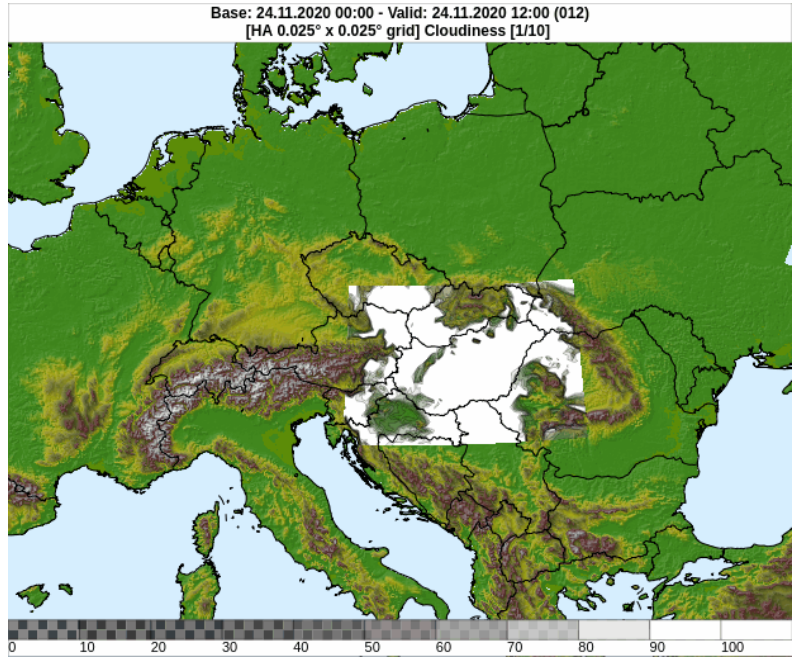
Short situation description

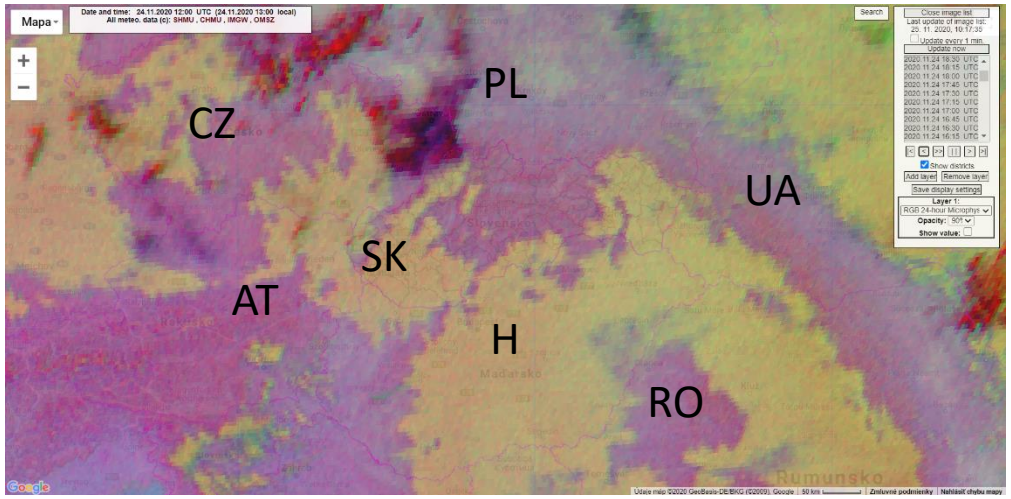
- On 24/11/2020 there was an anticyclone over the central Europe. Fog was present over large territories and remained during the whole day over lowlands. The visibility dropped to 100m or even less at some places (which is relatively rare in Slovakia). Previously, there was temporal cold advection at mid-tropospheric levels (e.g. 850 hPa) but this was soon replaced by advection of warmer air from the southwest.
- Several NWP models and even EPS systems (ECMWF) predicted sunny/relatively warm weather for the noon hours (there should have been a break in the foggy character of previous and later days) and as high temperatures as +5 , +6 °C but in the reality, the temperature remained somewhat over 0°C for many stations (e.g. southwest of Slovakia)

Cloudiness 12h forecasts for 24/11/2020 12 UTC (rclace.eu) vs satellite imagery (EUMETSAT)





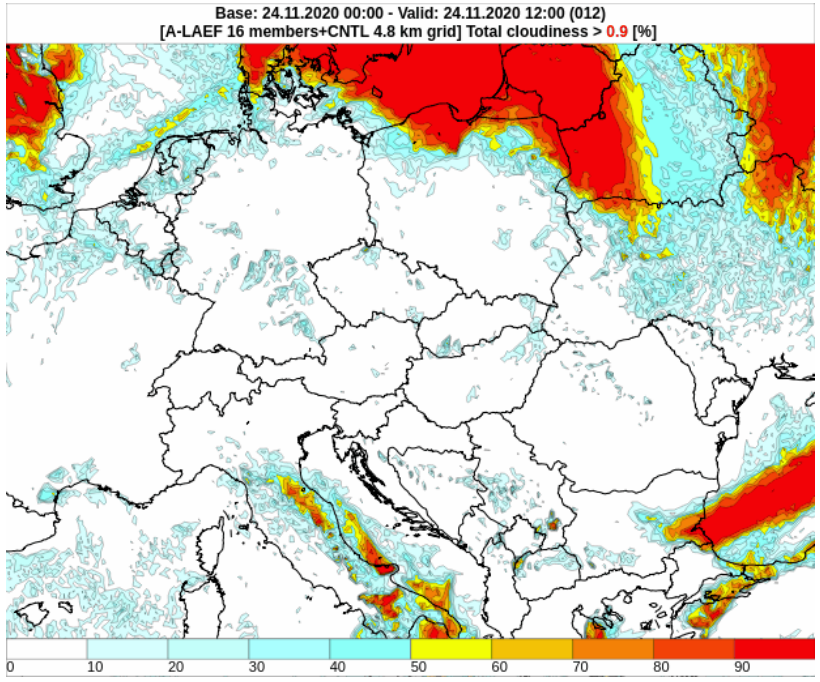


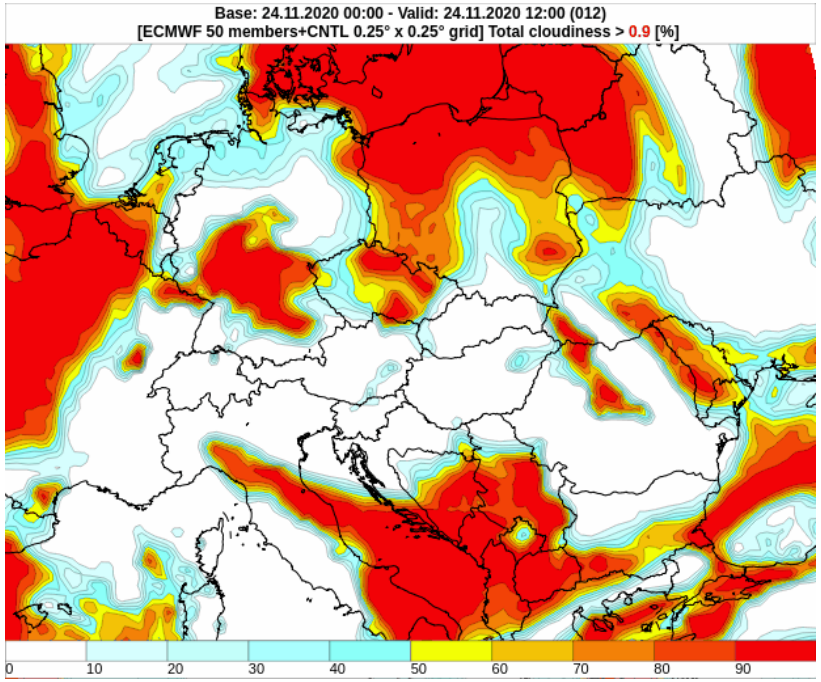


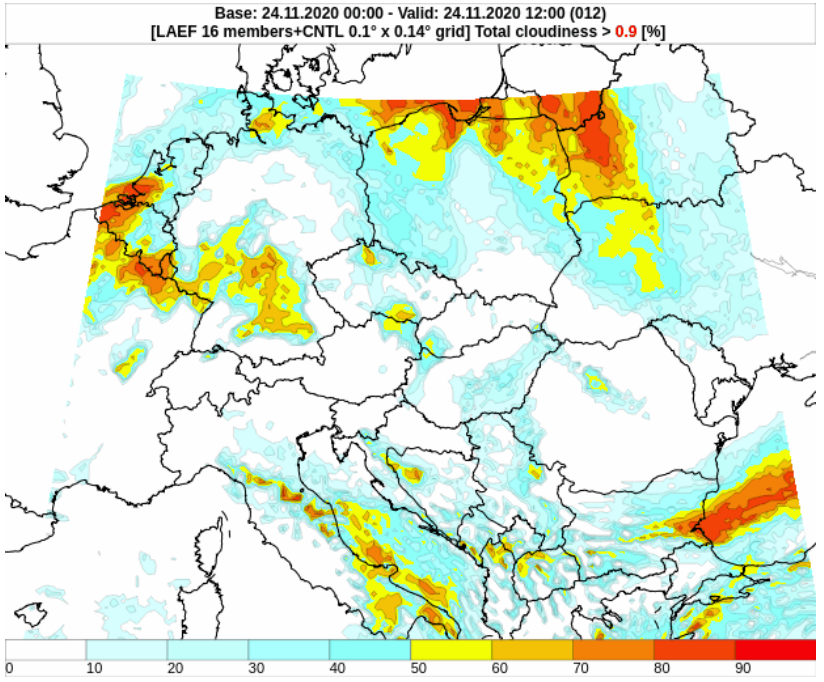
In general, deterministic global models (mostly GFS, ECMWF) underestimated cloudiness, also certain LAM models (CHMI, SHMÚ). Some LAM models even overestimated the size of the territory covered by low clouds (AROME)

Various EPS comparisons: total cloudiness

- The 90% threshold is too big for the EPS-s, somewhere there is hardly any probability for the cloud cover in the CE area. This is because for physics-perturbed EPS-s there are several runs/clusters, which have problems with forecasting low clouds and the cover rarely attains 90-100% in such situations (unless there are mid- or high clouds) .

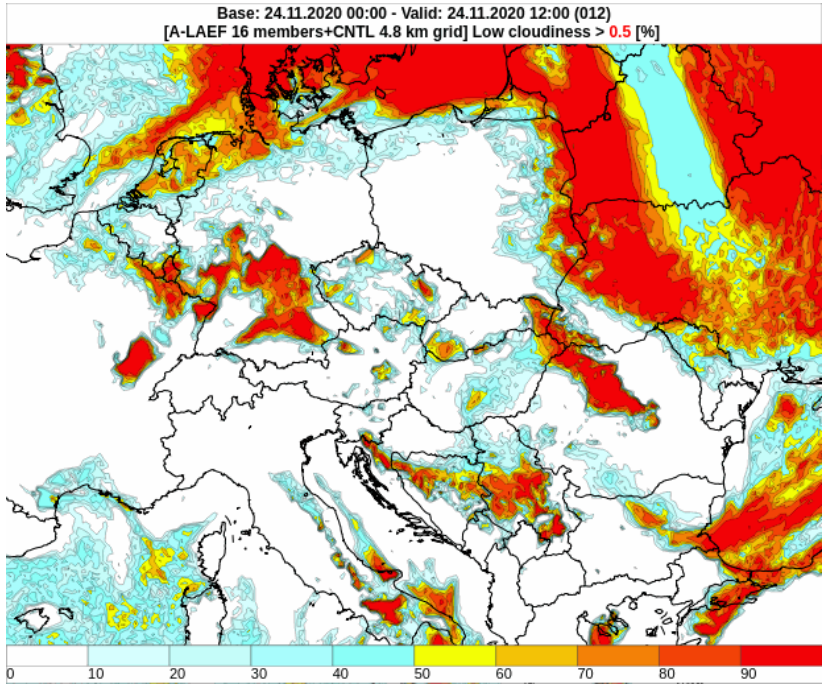


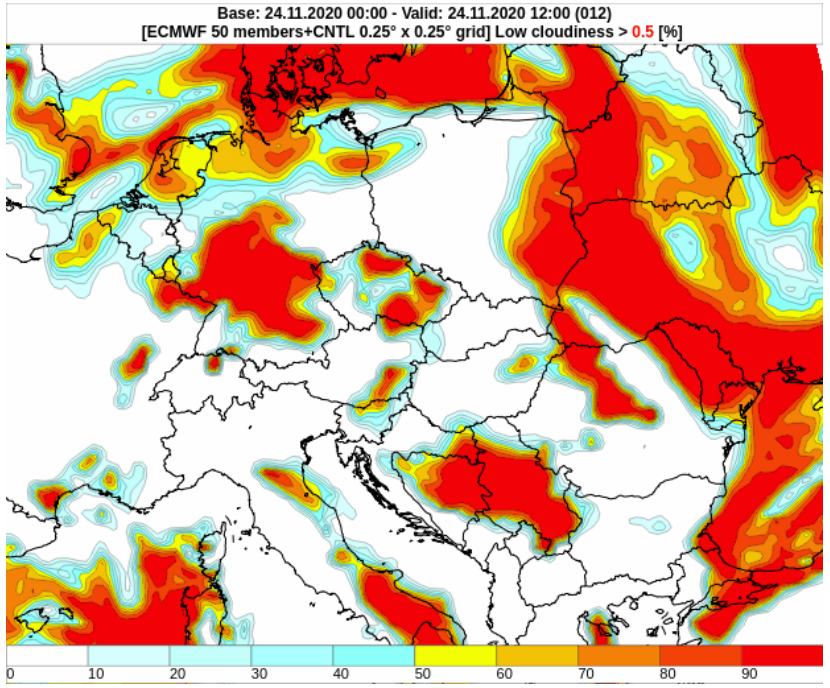


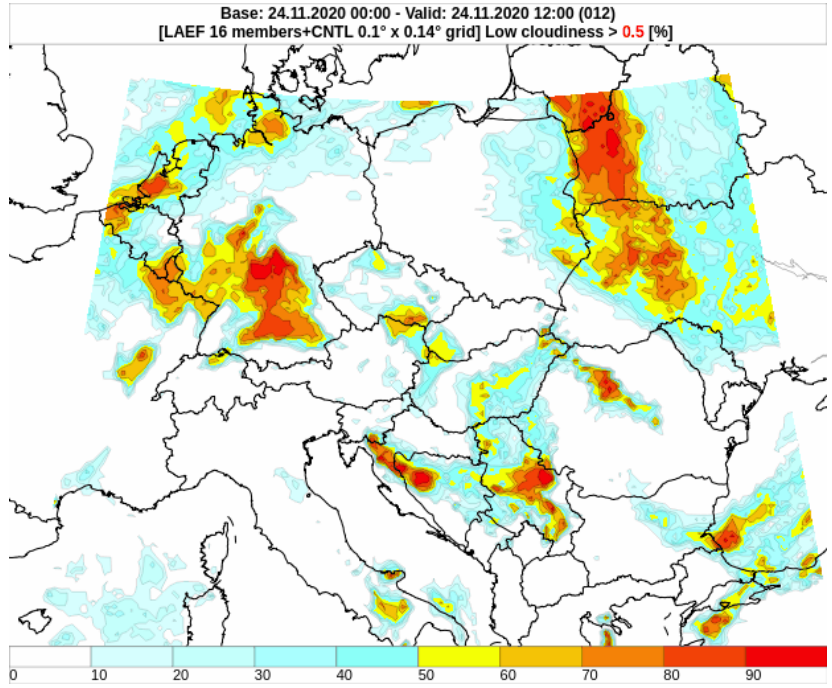


Various EPS comparisons: low-based clouds

- For low-based clouds with lower threshold (~5/10 cover) the situation is different and low clouds already occur over the SW Slovakia (in A-LAEF).

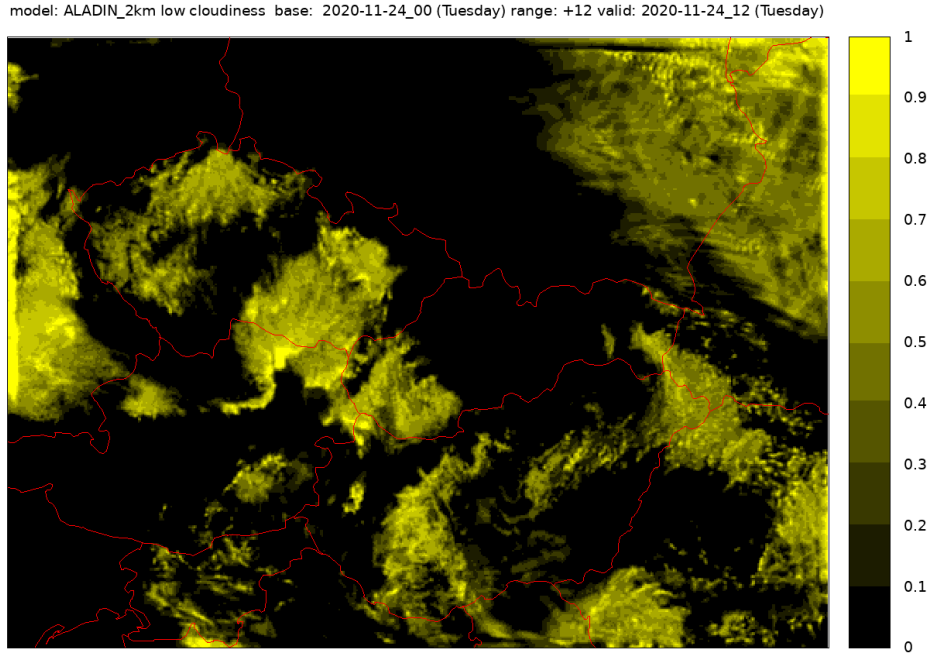


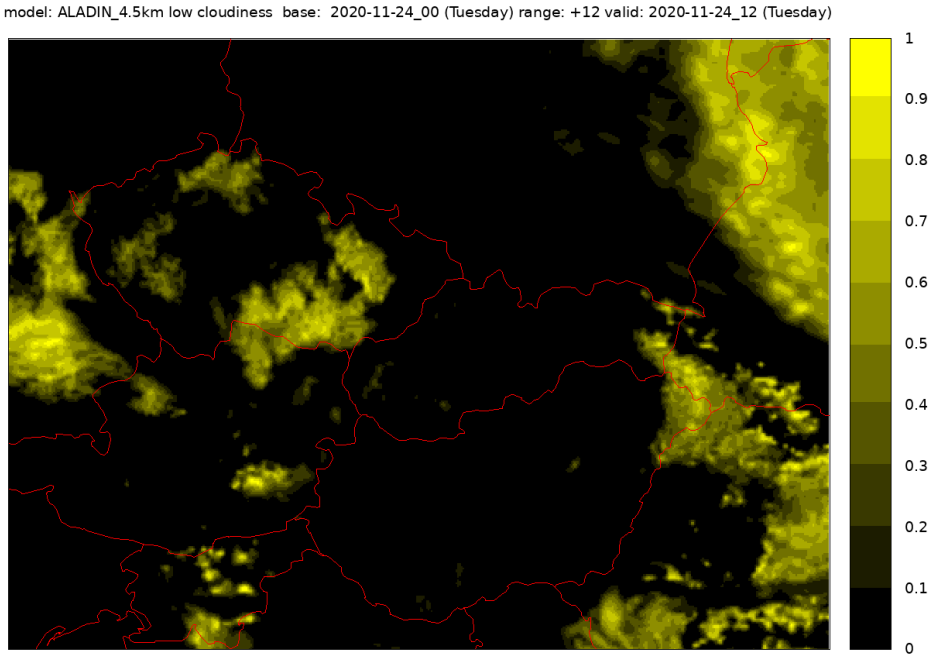




ALARO-1: SHMU vs experimental 2 km resolution model

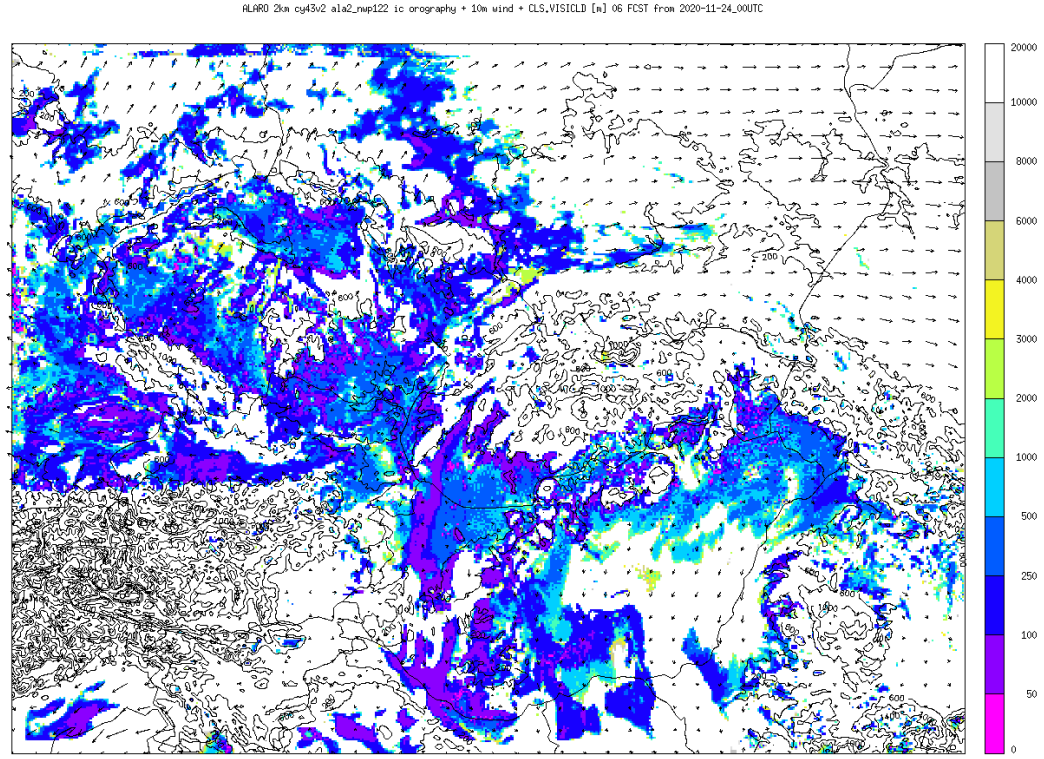
- Despite using similar cycle and settings than ALARO CHMI, the 2 km model predicted more low clouds, although there was a strong decreasing tendency at noon and afternoon hours
- A positive feature is the low cloudiness forecast of the 2 km model over Hungary, which is less influenced by orography, although the cloud cover was underestimated in its central and southeastern part.

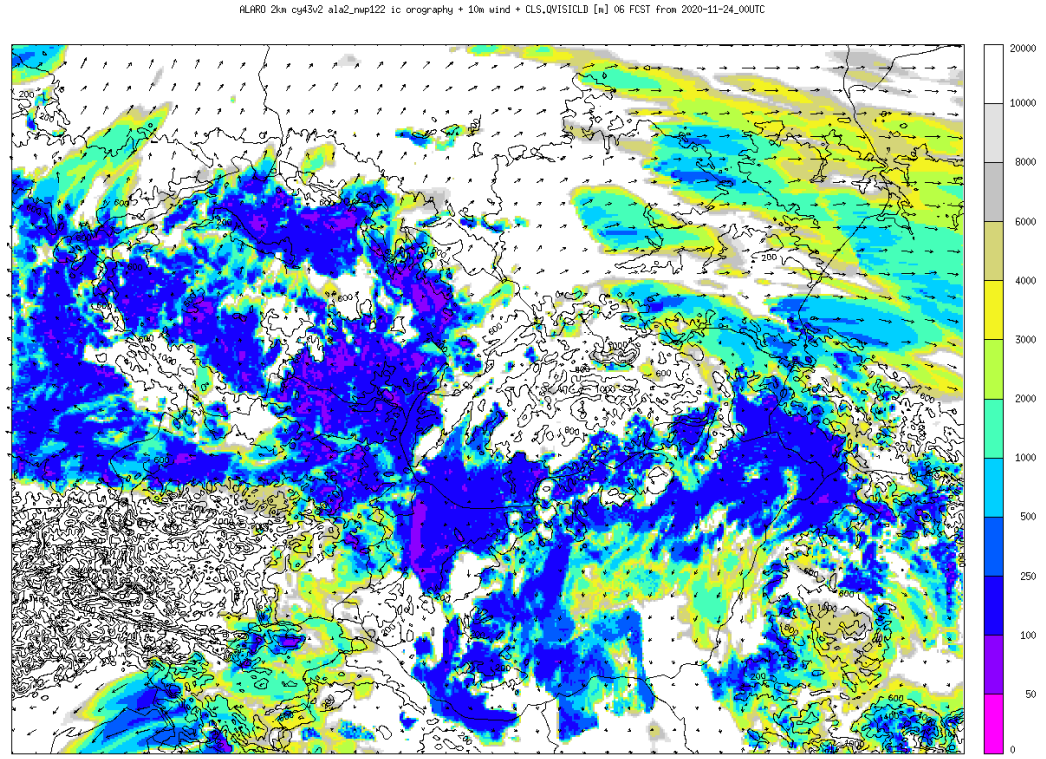




Visibility forecast (ALARO 2 km) – 24/11/2020 06 UTC

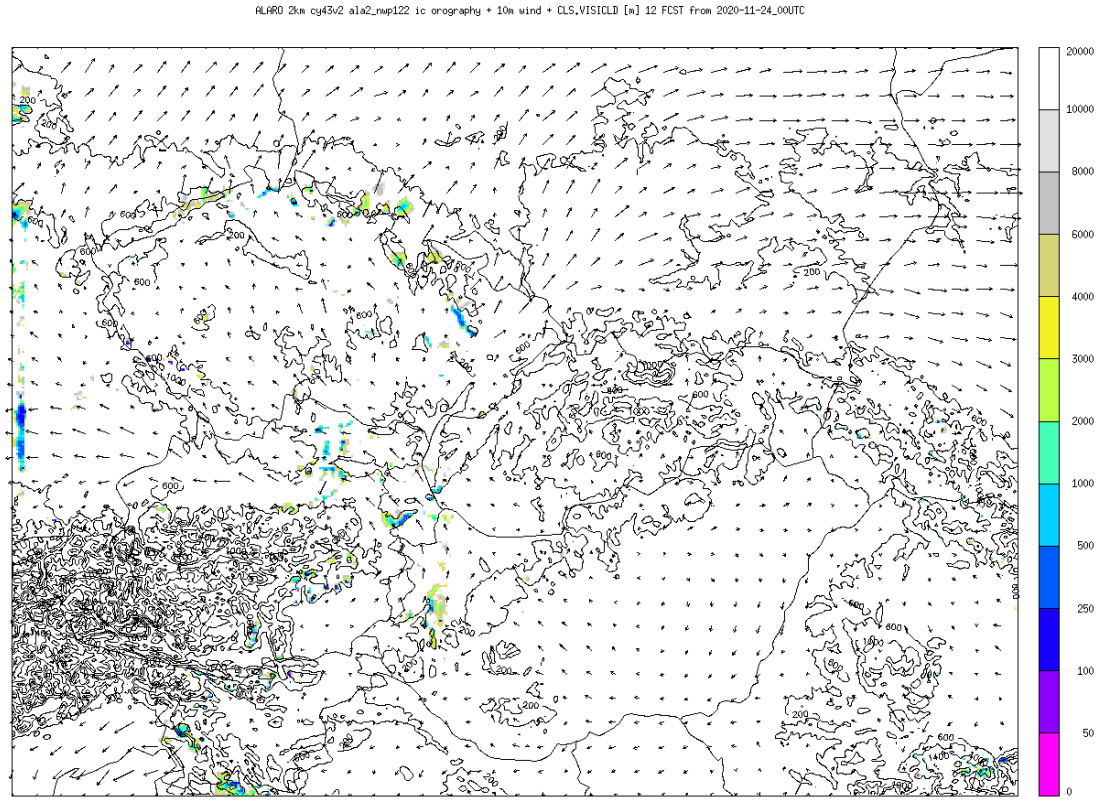
- The CLS.VISICLD (left) represents the previous 1h minimum visibility (in m) calculated upon the radiation scheme. CLS.QVISICLD (right) is derived from the model microphysics. Both +6h forecasts predict visibility as low as 100m, which was also observed

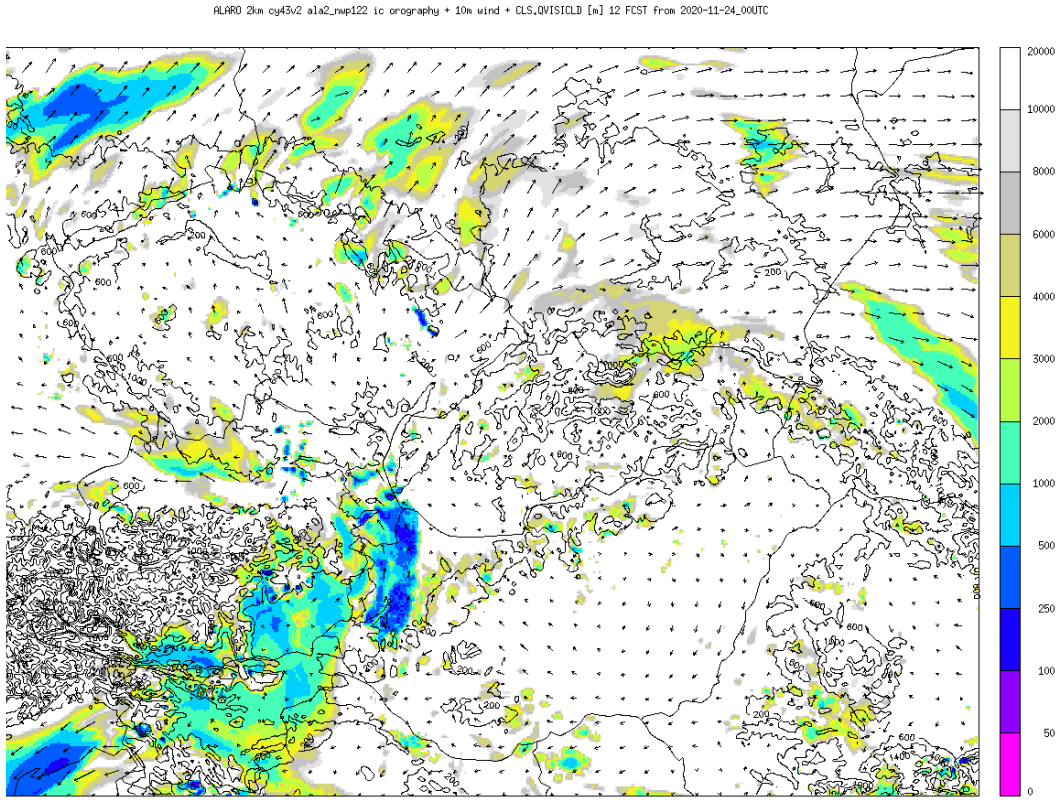




Visibility forecast (ALARO 2 km) – 24/11/2020 12 UTC

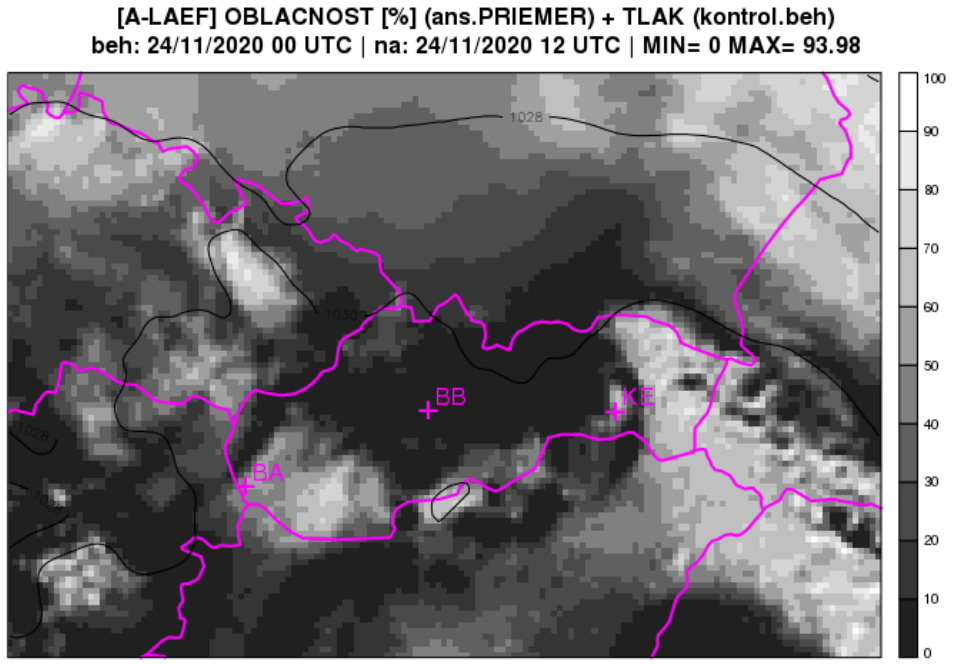
- Despite of some fractional low cloudiness in the 2km model, there is almost no low visibility at noon at the surface. Interestingly, there is still some decreased visibility in the microphysics product (e.g. haze in the Poprad valley). Thus, the products are almost useless for forecasting fog at noon hours, since the cloud water mostly evaporated or moved upwards.

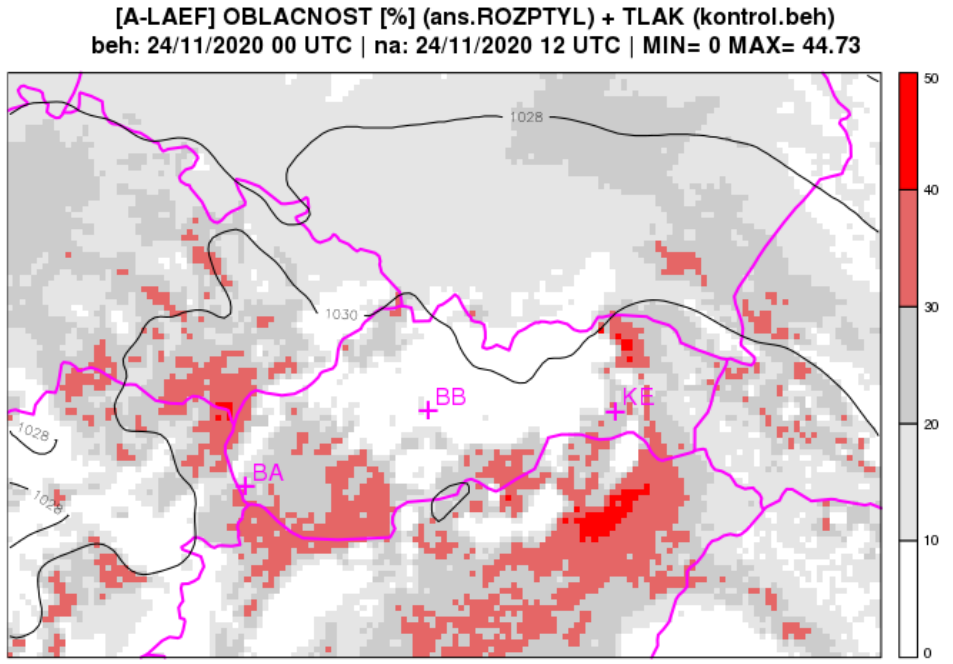


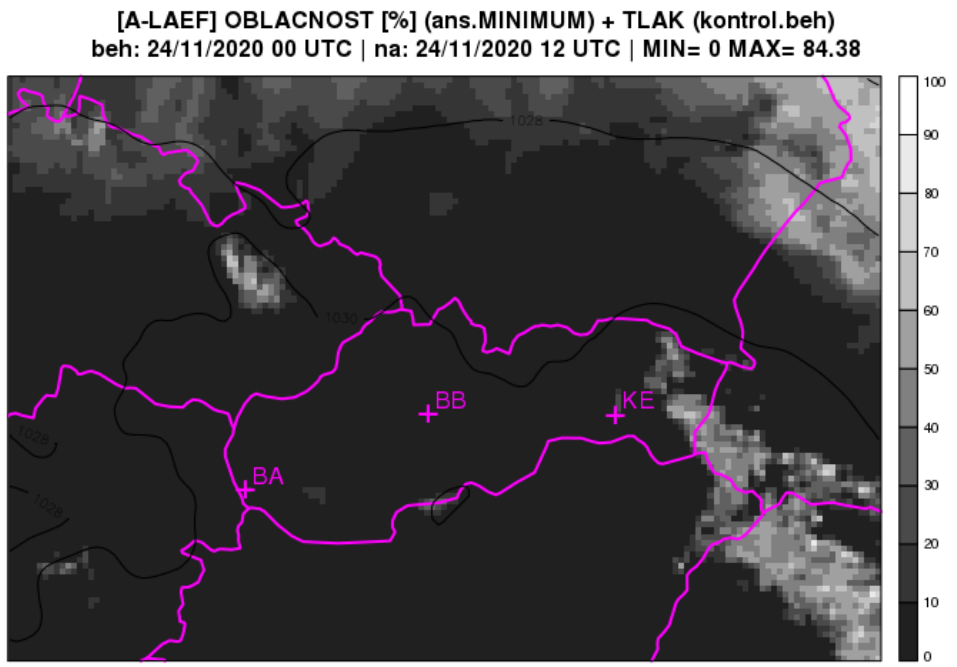


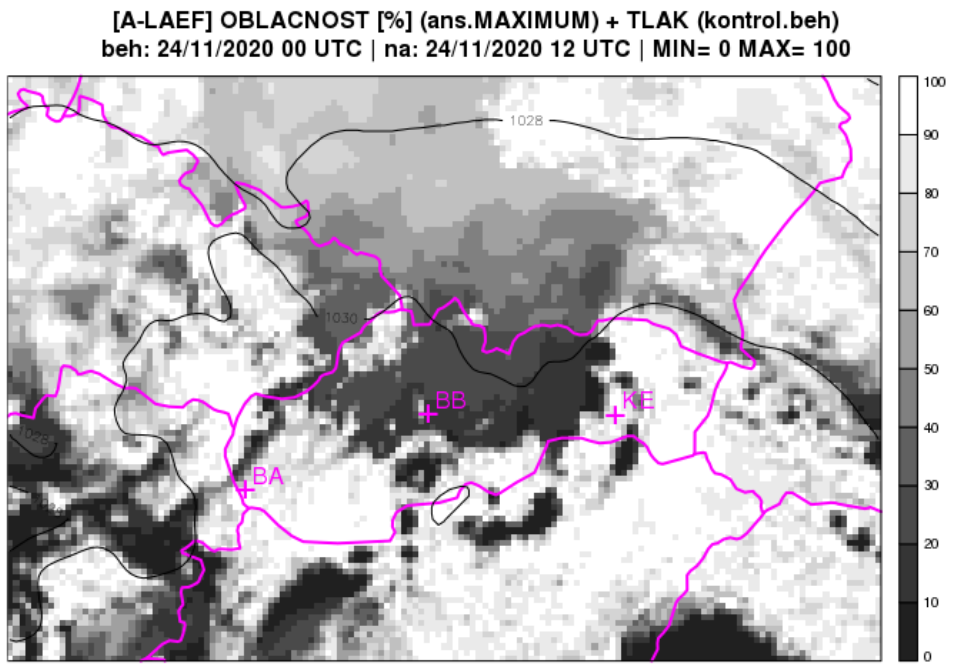
A-LAEF forecast

- Several members of A-LAEF also predicted that the cloudiness will vanish, somewhere completely (see the minimum) but low cloudiness was still present in many members, as can be deduced from the mean and maximum cover forecast. This is better represented in products shown on following slides.



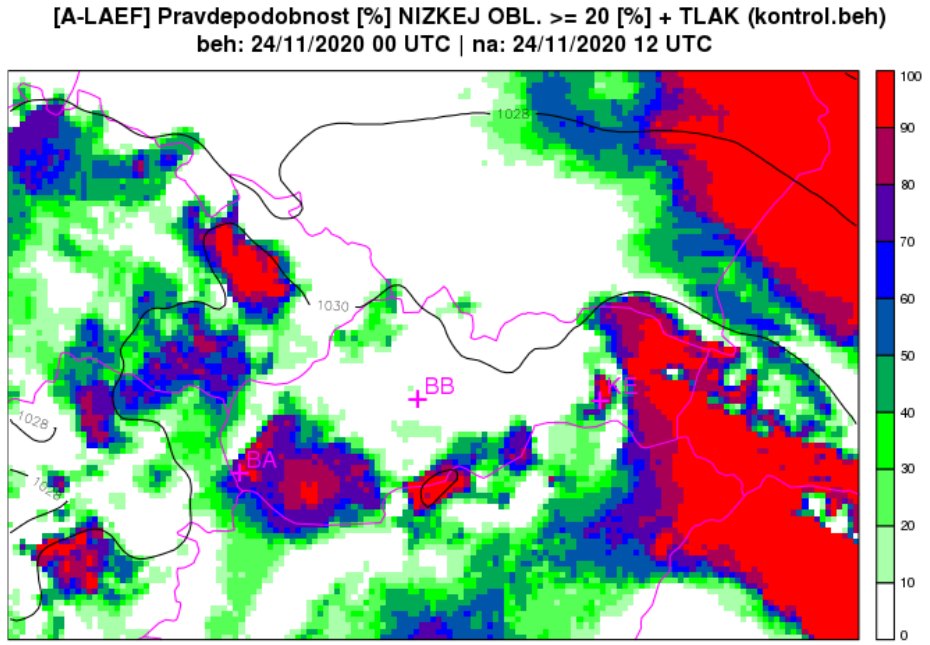


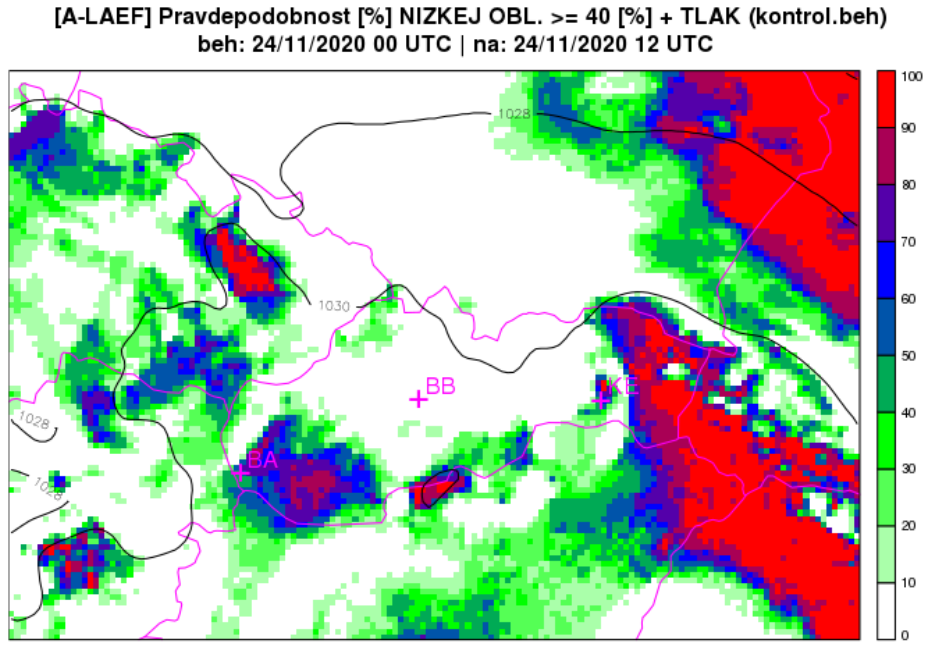


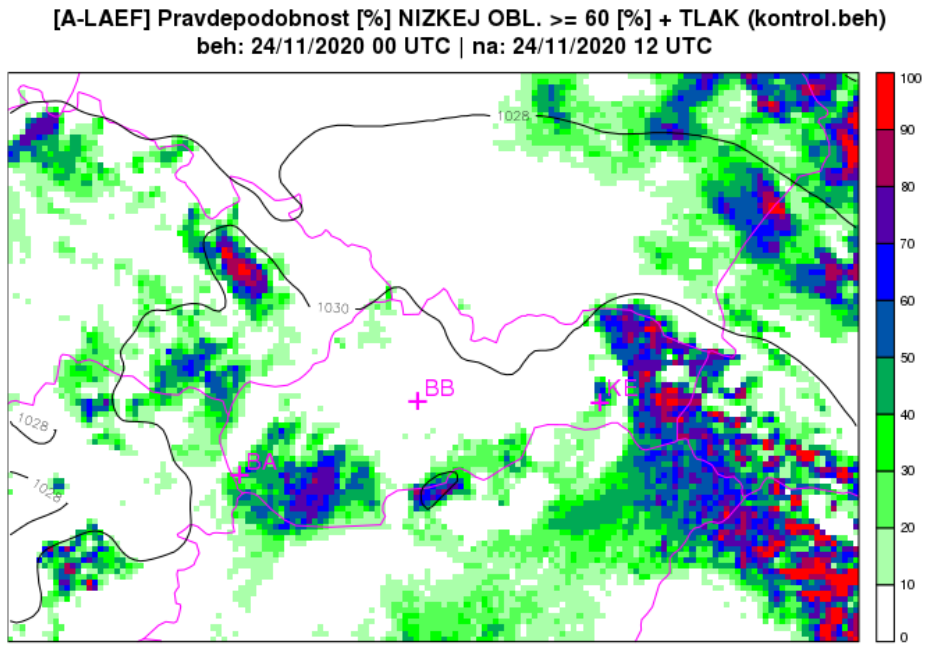


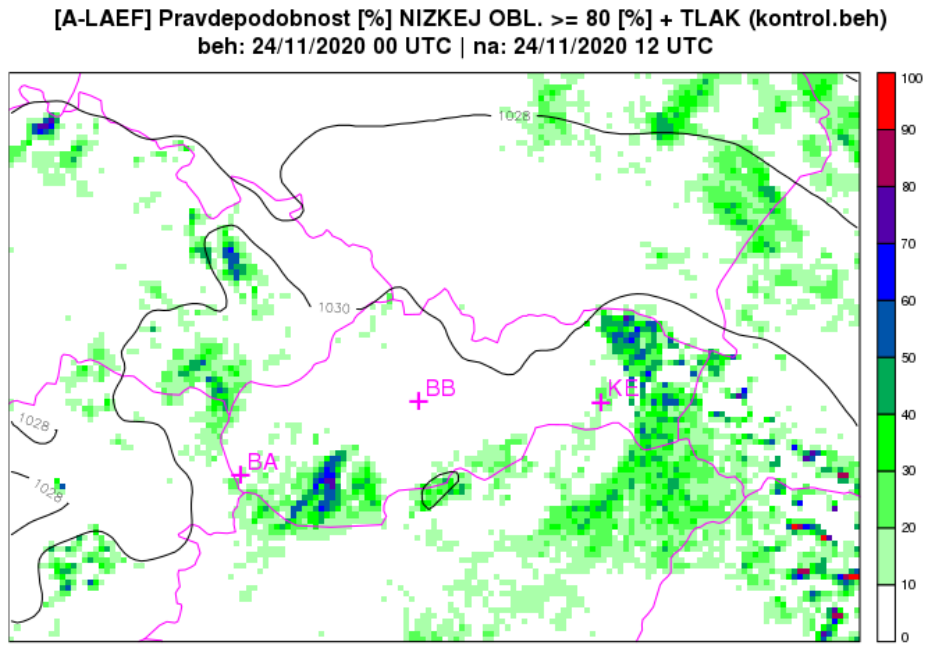
A-LAEF forecast

- The probability of at least 6/10 cover of low clouds over SW Slovakia was still high even at noon. Although the cloud cover was mostly 10/10 in the reality in lowlands.



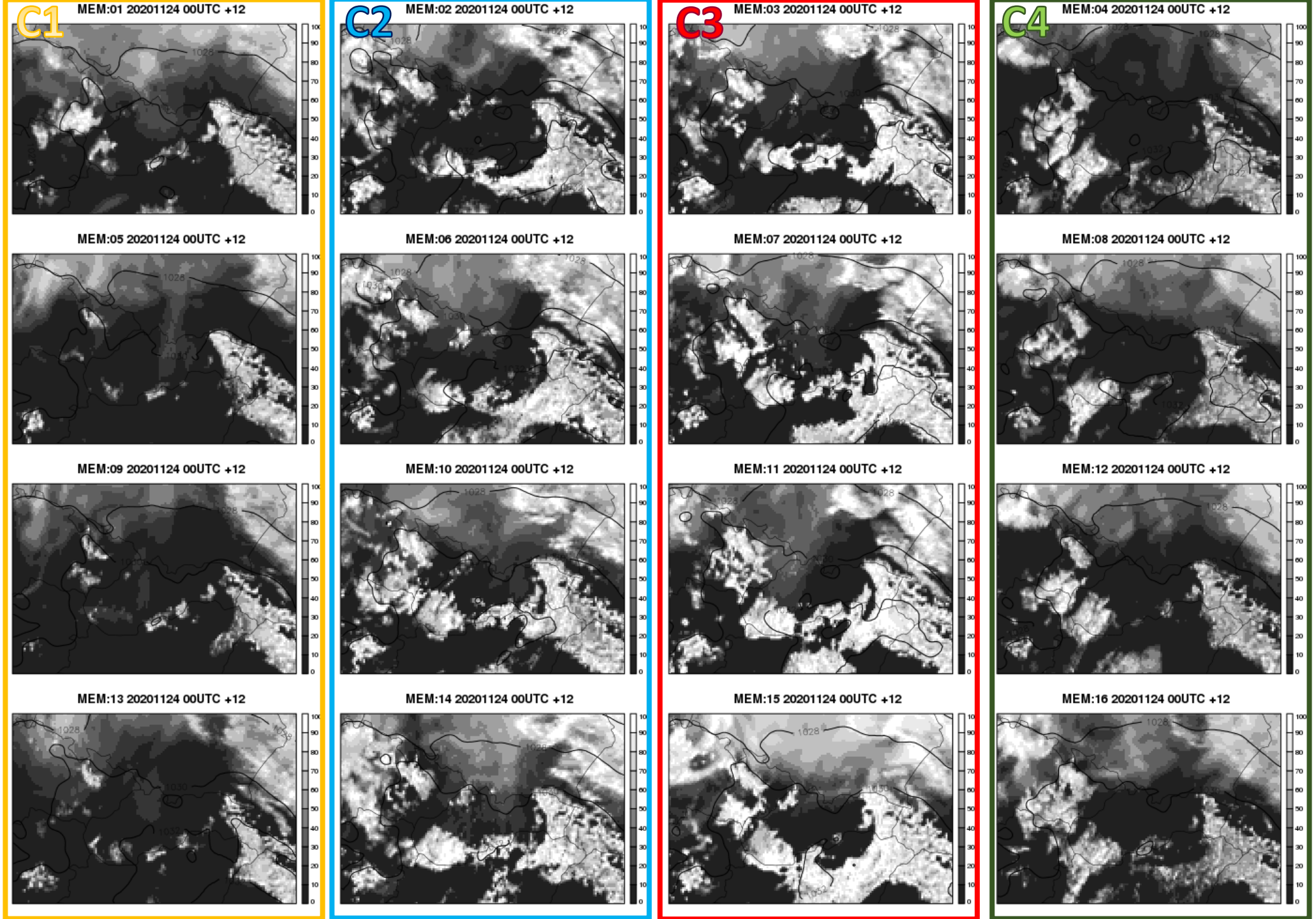






A-LAEF forecast by members

- Those members of A-LAEF which predicted that the cloudiness will vanish were in cluster 1 (C1). Low cloudiness was present mostly in clusters 2, 3 (member 15 was probably the best). Also the reference (cluster 4) was better than results of some deterministic models at similar resolution.



Setup of A-LAEF clusters briefly:

- cluster 1: ALARO-1 modified microphysics + deep convection
- cluster 2: ALARO-1 modified turbulence (QNSE scheme)
  cluster 3: ALARO-1 modified turbulence (QNSE) + microphysics and deep convection
  cluster 4: ALARO-1 reference (as for ALARO SHMÚ 4.5km, but + stochastic physics and ECMWF coupling using ESDA assimilation)
- Stochastic perturbation of physical tendencies is used in every cluster

Example of the physics setup for the cluster 3:

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Multiphysics (cy40t1, 5 km, 60 lev) CLUSTER 3

	set	ref	description of parameter
CGMIXLEN	EL3	EL0	ALARO-1 TOUCANS: equivalent of 'AY' in ALARO-0
CGTURS	QNSE	MD2	ALARO-1 TOUCANS: turbulence model II
LCVGQM	F	T	ALARO-0: modulation of humidity convergence closure
LCVGQD	F		
LENTCH	F	T	ALARO-0: memory in adaptive detrainment
LPRGML	F	T	ALARO-0: situation-dependent mixing length
LSCMF	F	T	ALARO-0: mesh fraction's influence on the entrainment rate
LSMGCDEV	T		
LXRCDEV	F	T	ALARO-0: Xu-Randall used in adjustment
C3TKEFREE	1.39	1.183	ALARO-1 TOUCANS
C_EPSILON	0.798	0.871	ALARO-1 TOUCANS
ETKE_OLAM	0.324	0.29	ALARO-1 TOUCANS
NUPTKE	0.504	0.5265	ALARO-1 TOUCANS

A-LAEF members			
01	05	09	13
02	06	10	14
03	07	11	15
04	08	12	16

Statements/questions

- Despite of problematic forecasts of global models, LAM-s can improve the forecasts of low cloudiness. The reason of errors is not easy to understand without deep analysis – it could be partially due to advective changes influencing the low-level thermal stability (thus the forecasts can be sensitive on the way of assimilation and coupling) but also due to physical parameterization setting – mainly turbulence as indicated by A-LAEF
- Orography did not always play the major role, since there were large differences between the respective runs in lowlands
- It is interesting that some dynamic adaptations performed a bit better than operational models with assimilaton, etc. (The question is why? Blending issues?)
- Although not perfect but using LAMEPS forecasts with perturbed physics and knowing the bacground/sensitivity of each clusters can be helpful in forecasting similar situations. Here the clusters partially behaved as separate models.
- Forecast of near-surface visibility is closely related with the forecast of the cloud-liquid water, which vanished rapidly at noon but in the reality, the fog remained. Thus, even a fairly good forecast of low clouds is not necessarily successful in terms of visibility and fog.