ZAMG
Zentralanstalt für Meteorologie und Geodynamik

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NWP related activities in AUSTRIA

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1. Operational systems

In December 2021, a major upgrade of the operational model systems at ZAMG (AROME-Aut, C-LAEF and AROME-RUC) was performed. Beside the change of the model cycle (cy40t1 -> cy43t2) several modifications were included into the upgrade (see below and ACCORD Newsletter #1 and #2 for more details). The main characteristics/setup of the systems can be read from table 1 below.

	AROME-Aut	C-LAEF	AROME-RUC
Model version	cy43t2bf11	cy43t2bf11	cy43t2bf11
Resolution	2.5km	2.5km	1.2km
Area	Alpine area (600x432)	Alpine area (600x432)	Austrian area (900x576)
Members	1	16 + 1	1
Levels (lowest/highest)	90	90	90
	(5m / 35km)	(5m / 35km)	(5m / 35km)
Starting times	00, 03, … 21 UTC	00, 03, … 21 UTC	00, 01,…,22,23 UTC
Forecast range	60 hours	60 hours / 48 hours	12/25 hours
Time step	60s	60s	30s
Output Frequency	1h 2D/3D	1h 2D/3D	15min 2D/1h 3D
Orography / physiography	GMTED2010	GMTED2010	SRTM 90m
	ECOCLIMAP 1	ECOCLIMAP 1	ECOCLIMAP 1
LBC model	ECMWF HRES	ECMWF ENS	AROME-Aut
LBC update	1h	1h	1h
Surface scheme	SURFEX 8.0	SURFEX 8.0	SURFEX 8.0
Initial conditions (3D / Surf.)	3DVAR / OI	Ens 3DVAR+Jk / Ens OI	3DVAR / OI +IAU+Nudging/LHN
Cycle interval	3 hours	3 hours	1 hour
Assimilation Window	-90min-+90min	-90min-+90min	-90min-+30min
B-Matrix	C-LAEF EDA climatologic	C-LAEF EDA climatologic	AROME-RUC EDA climatologic
Hardware	HPE Apollo 8600 (ZAMG)	Cray XC40 (ECMWF)	HPE Apollo 8600 (ZAMG)

Table 1: Setup of operational model systems at ZAMG

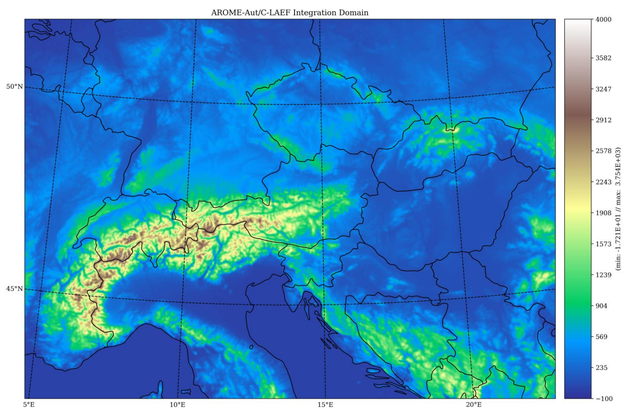

Figure 1: Integration domain AROME-Aut/C-LAEF

Figure 2: Current ZAMG HPC (HPE Apollo 8600)

AROME-Aut (2.5 km):

The 2.5km AROME-Aut is in operations at ZAMG for several years and serves as one major backbone for operational forecasts and warnings as well as for several downstream models and applications (e.g. INCA nowcasting system, WRF-Chem system). With the latest upgrade several modifications were introduced:

- Adapted screening level diagnostics (for LCANOPY=.T. case) to improve the T2m/RH2m performance in the Alpine region
- Modified 3DVAR setup (e.g. new Bmatrix, REDNMC tuning)
- Switch from GTOPO30 to GMTED as orography input data base
- Additional forecast parameters: Precipitation type, updraft helicity, weather symbol code

C-LAEF (2.5 km)

C-LAEF (Convection Permitting - Limited Area Ensemble Forecasting) has been developed at ZAMG and is an AROME-based EPS, running on the ECMWF HPC facility as TC2 application. The C-LAEF system is run on the same grid as AROME-Aut. With the latest upgrade, the C-LAEF control member uses now the identical setup as AROME-Aut and thus serves as backup. In addition to the modifications listed above for AROME-Aut (which were also introduced in C-LAEF), the latest upgrade also included:

- Switch from 6-hour to 3-hour assimilation cycle
- Implementation of a surface perturbation scheme to improve the skill/spread ratio for near surface parameters

AROME-RUC (1.2 km):

AROME-RUC is the nowcasting version of AROME running operational at ZAMG since 2019. The AROME-RUC system runs with an hourly 3D-Var, Latent Heat Nudging of INCA precipitation analyses and forecasts and FDDA nudging of surface stations (T2m, RH2m, u10m). Also, additional observations like MODE-S, GNSS-ZTD/-RO, WP, SODAR and 3D-RADAR are integrated into the system. Recent changes in AROME-RUC included:

- Modification of the screening level diagnostics (recently coded option N2M=3)
- Adapted/extended windfarm parametrization
- Additional Mode-S data, E-GVAP ZTD and bufrtemp data

Outlook:

At ZAMG first steps towards a development of a C-LAEF 1km system are currently taken. It is planned to merge the AROME-Aut and C-LAEF system while keeping AROME-RUC as a nowcasting version at resolutions < 1km.

2. Low stratus forecast

During last winter season, low stratus was underestimated in several situations in our AROME systems, which was not the case in to that extent in the previous version (cy40t1). This behaviour was more closely studied on the 11th March case (Fig. 3).

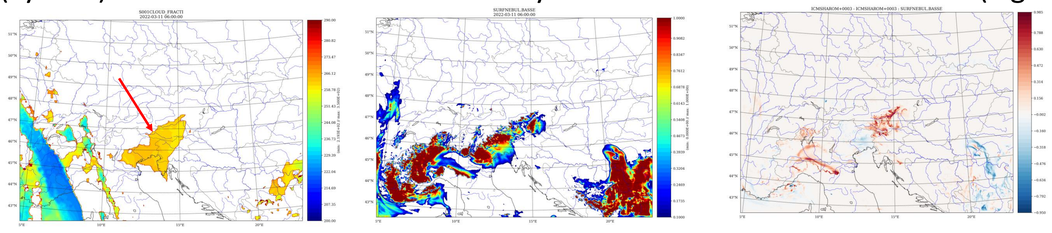

Figure 3: 11th March 2022 06UTC: NWC-SAF CTTP (left), AROME-AUT +3h low clouds (reference, middle) and additional low clouds if SYNOP 2m is not used in 3D-Var (right)

We found that removing all 2m observations (T2m,RH2m) from 3D-Var could significantly improve the amount of low stratus in the model forecast as the 2m obs even further dry the atmosphere in the stratus area. The problem could be also mitigated if the 2m values from CANARI were used as First Guess in 3D-Var instead of the pre-CANARI values (smaller 2m-FG departures) and if a different B-Matrix was used instead of the operational one (see also Fig.5). Finally, it was tested to add pseudo-RH observations from Austrian ceilometers (RH => 100% point obs depending on cloud cover and height from ceilometers using profiler operator). This could also significantly improve the forecast (Fig.4). The experiments indicate a moisture deficit in cloud level due to 2m assimilation.

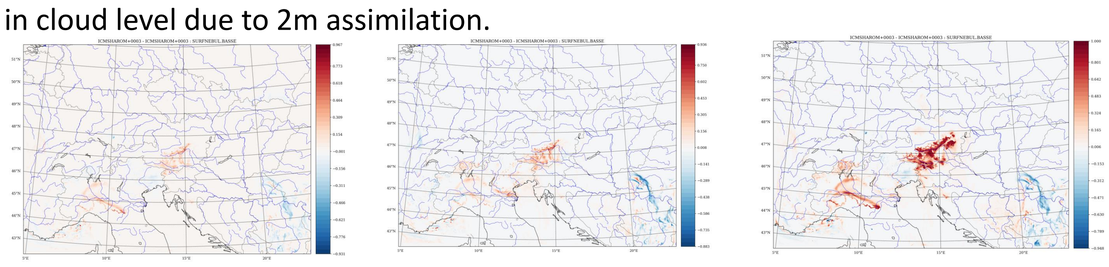

Figure 4: additional low clouds AROME-Aut+3h if using CANARI 2m as guess (left), new B-Matrix (middle) and additional ceilometer pseudo RH obs + no SYNOP 2m (right).

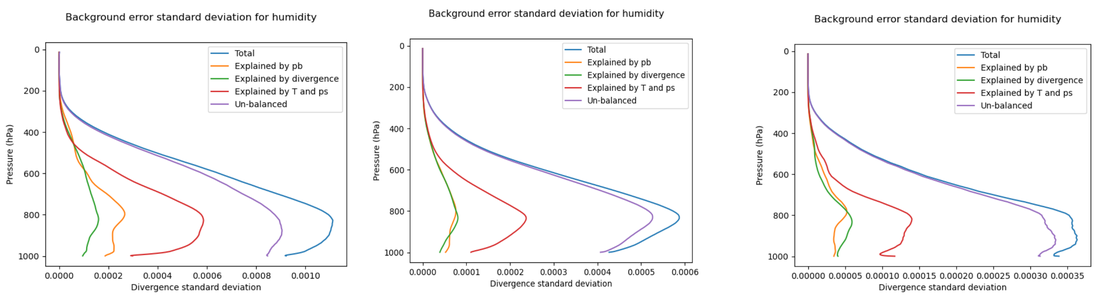

Figure 5: Standard deviation of Q in B-Matrix: operational till December 2021 downscaling (left), operational EDA now (cy43t2, middle) and newly calculated EDA B (right). Downscaling and OPER was based on 6h forecast, the new on 3h forecast.

3.Event based verification

Beside the classical verification procedures/tools and metrics to evaluate the performance of NWP systems over longer periods, an (extreme) event-based verification received more and more importance at ZAMG during last years. A case-study based evaluation of model runs has always been important for model developers and users, but with the rising number of available model systems and in particular the rising number of model updates (e.g. hourly RUC systems) it becomes more and more difficult to condensate the information and draw conclusions like "this model version or this particular model run performed best for this given target area and event". Especially for warning situations and extreme events, such questions need to be answered.

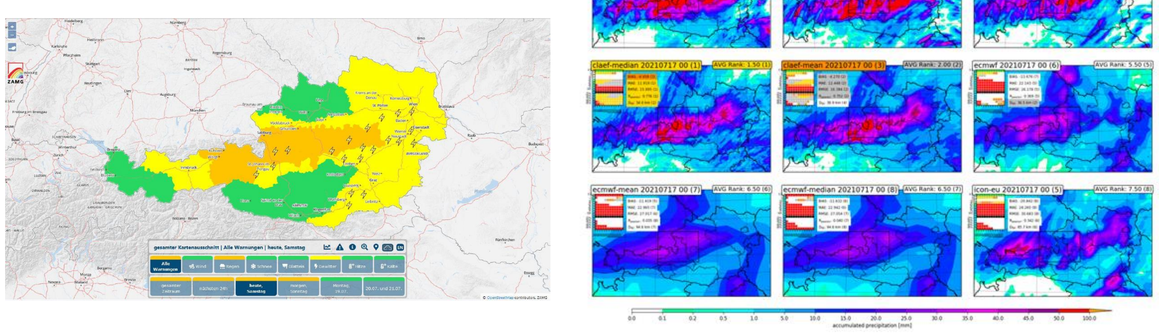

Figure 6: Case study of a flash flood in July 2021 in Austria. Issued warnings (left) and model verification based on panelification (right).

That is why the idea of a "panelification" was created, which combines visualization of model results (panels) with verification metrics and tries to give an overview of model performance and suggest a ranking "best -> worst" for all models and/or runs. This type of verification started with precipitation, and is now being extended to parameters like lightning, hail and sunshine duration. Figure 6 shows an example for a case in summer 2021 (local flash flood event in Austria).