ZAMG
Zentralanstalt für Meteorologie und Geodynamik

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NWP related activities in AUSTRIA

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1. Operational systems

AROME-Aut (2.5 km):

The 2.5km AROME-Aut is already in operations for several years and has undergone several major upgrades during its lifetime. At ZAMG it serves as one major backbone for operational forecasts and warnings and for several downstream models and applications (e.g. INCA nowcasting system, WRF-Chem system). The main characteristics of AROME-Aut can be read from Table 1 below. An operational switch to cy43 is currently in preparation.

Domain		Model characteristics		LBC	
Grid points:	600x432	Code version:	cy40t1	Coupl. model:	IFS
Horizon. resolution:	2.5km	Time step:	60s	Coupl. frequency:	1h
Levels:	90	Integration time:	60h (00,03,....21 UTC)	Retrieval:	Internet/ RMDCN
Grid:	linear	Physics:	AROME/Meso-NH		
Orography:	mean	Dynamics:	non-hydrostatic		
		Initialization:	CANARI/OIMAIN 3DVAR		

Table 1: AROME-Aut operational setup

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 operationally since November 2019 at the ECMWF HPC facility as TC2 application. The C-LAEF grid has a horizontal resolution of 2.5km (identical to AROME-Aut) and is running four times a day with two long runs (+60h for 00 UTC, +48 for 12 UTC) and two short runs (06 and 18 UTC) to close the 6h assimilation cycle. The main characteristics of C-LAEF are listed in table 2. To strengthen the usage of C-LAEF in the forecasting centers, strong focus has recently been put on the development of EPS products like probability maps or EPSgrams (see Figures 1 and 2).

Domain		Model characteristics		LBC	
Grid points:	600x432	Code version:	CY40T1	Coupl. model:	ECMWF-EPS
Horizon. resolution:	2.5km	Time step:	60s	Coupl. frequency:	3h
Levels:	90	Integration time:	60/48h for 00/12 UTC run		
Grid:	linear	Physics:	AROME/Meso-NH incl. HSPP (stoch. Scheme)	Archive:	local + MARS (with 2020)
Orography:	mean	Initialization:	EDA + surface EDA Ensemble JK		
		Ensemble size:	16 perturbed + 1 control		

Table 2: C-LAEF operational setup

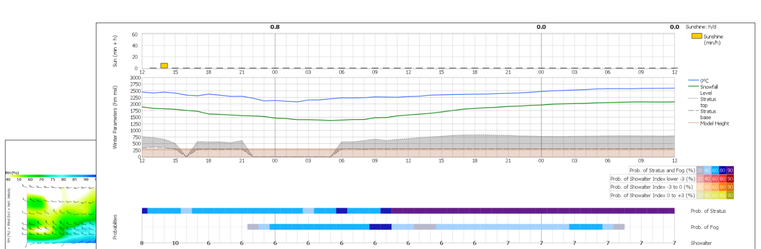
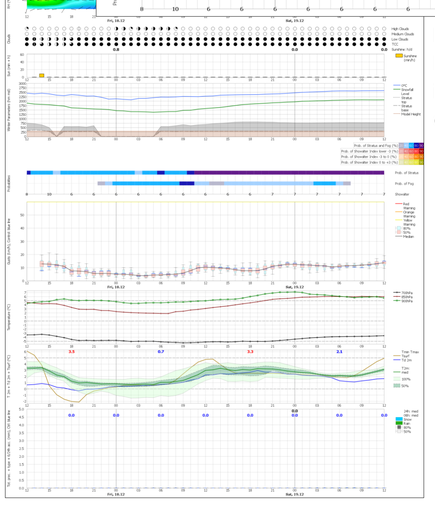


Figure 1 (left): "Winter version " of Met/EPSgram for AROME/C-LAEF including extended stratus and fog diagnostics



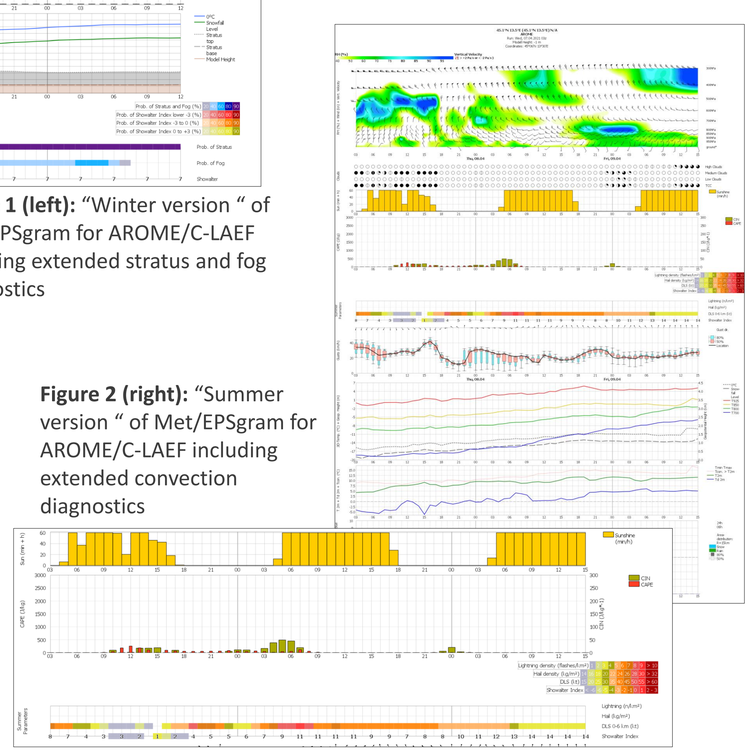


Figure 2 (right): "Summer version " of Met/EPSgram for AROME/C-LAEF including extended convection diagnostics

AROME-RUC (1.2 km):

A nowcasting version of AROME is 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 RADAR are integrated into the system. Compared to the AROME-Aut system, most improvements can be seen for forecasts of precipitation, 10m wind and gusts.

Domain		Model characteristics		LBC	
Grid points:	900x576	Code version:	cy40t1 +	Coupl. model:	AROME 2.5
Horizon. resolution:	1.2km	Time step:	30s	Coupl. frequency:	1h
Levels:	90	Integration time:	12h 24x	Retrieval:	local
Grid:	linear	Physics:	AROME/Meso-NH		
Orography:	mean	Dynamics:	non-hydrostatic		
		Initialization:	CANARI/OIMAIN 3D-VAR+LHN+FDDA IAU		

Table 3: AROME-RUC operational setup

2. New observations for AROME-RUC

The availability of rapidly processed observations with a high temporal and spatial resolution is crucial for the performance of a NWP-based nowcasting system. Hence several project that investigate the usage of new/alternative observations in AROME-RUC are on-going at ZAMG.

ZTD processed from GNSS receivers on trains:

Currently more than 1000 trains of Austrians federal railway company (OEBB) are equipped with GNSS receivers, providing the potential of significantly increase the available number of ZTD observations in the future. First evaluations of ZTD retrievals with ERA5 (PhD Aichinger-Rosenberger, TU-Vienna) showed that differences are in the range of few mm but can exceed the cm-range in some cases. Case studies and test periods will be carried out to evaluate whether the data quality is sufficient to improve the analysis in AROME-RUC.

Rain Rate Information from Microwave Links

In cooperation with the mobile network provider Huchison Drei Austria, the University of Applied Science St. Pölten and the Hydrographical Service Styria the usability of microwave links for numerical weather prediction is explored. Such links connect cell phone towers to each other and their signals are attenuated by rain. The signal attenuation is used to derive rain rates which can be used to feed INCA and obtain gridded precipitation data or they might be assimilated into AROME, for example as point observation at the mid point between the towers.

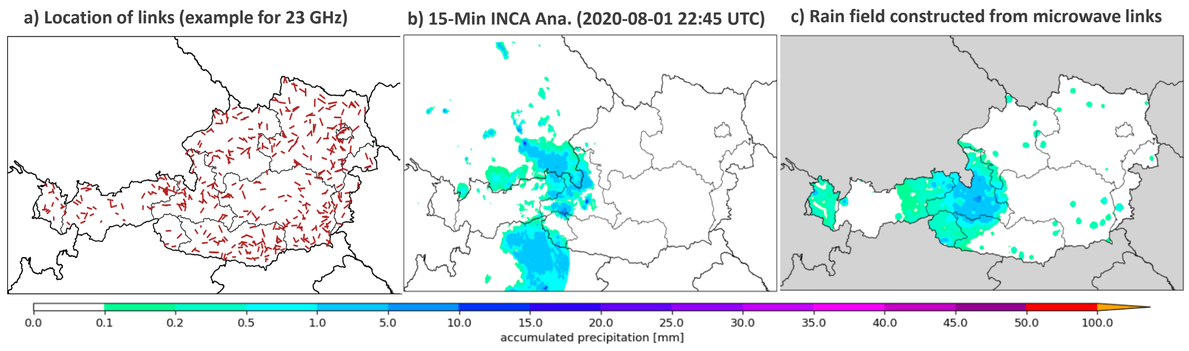


Figure 3: Locations of the 23 GHz links in Austria (a), INCA analysis of the 15-minute accumulated rain (b) and data obtained from microwave links using the RAINLINK python package[1] (c). Information from links is not available outside of Austria.

3.Comparing ForceRestore and Diffusion soil schemes

To better represent physical processes in soil and the assimilation of satellite-based soil moisture, surface temperature, and LAI, the current Force-Restore soil scheme is planned to be replaced by the Diffusion soil scheme with 14 layers in the vertical.

As a first step, the performance of the two was compared in CY43T2 for Austria. For this purpose, AROME was computed for 2018-07 to 2020-06 (00UTC-runs, +24hours, cycled soil parameters, no data assimilation, coupled to IFS)

Using the diffusion scheme results in warmer and drier soil and consequently higher average T2M and lower HU2M. The comparison to Austrian station data shows a slight improvement while, the precipitation fields differ but their scores are similar (see fig. 4). In conclusion, using the diffusion scheme is beneficial in AROME CY43.

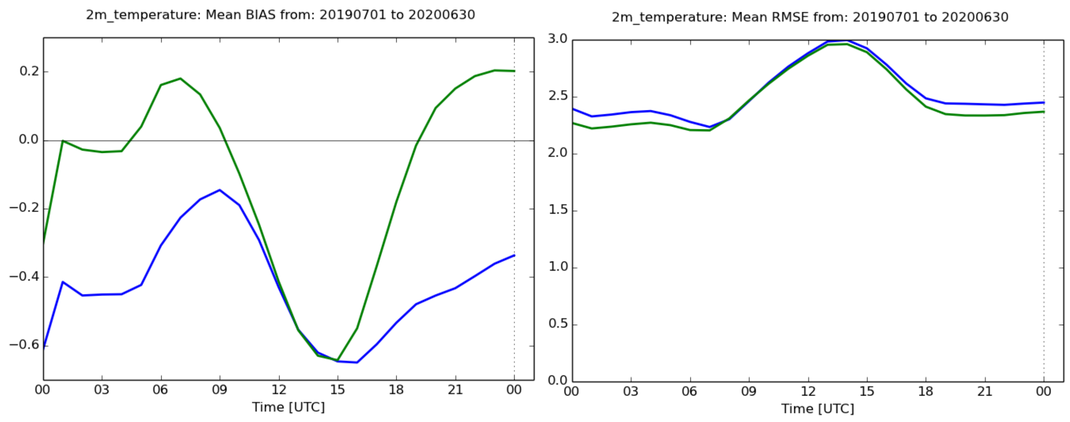


Figure 4: Mean BIAS (left) and RMSE (right) for the ForceRestore (blue) and Diffusion (green) soil scheme for one year (07/2019-06/2020) and all SYNOP stations in Austria.

4. HPC System

HPE Apollo 8600 (=SGI ICE-XA)

192 nodes with 18-core SKL 6140@2.4GHz
96 GB RAM per node 2 frontend nodes (à 2x8 processors, 64 GB RAM)
OmniPath enhanced hypercube network
Lustre Filesystem with total capacity of 350TB
PBSpro scheduling system.

Figure 5: SGI at ZAMG

[1]Overeem, A., Leijnse, H., and Uijlenhoet, R., 2016: Retrieval algorithm for rainfall mapping from microwave links in a cellular communication network, Atmospheric Measurement Techniques, 9, 2425-2444, https://doi.org/10.5194/amt-9-2425-2016