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ZAMG
Zentralanstalt für Meteorologie und Geodynamik

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NWP related activities in AUSTRIA

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1. Operational Status

Three NWP systems are currently in operations at ZAMG: Two deterministic (AROME, ALARO) and one ensemble system (LAEF):

AROME (2.5 km):

The current operational setup can be read from Table 1. The next upgrade for AROME system is planned for summer 2016. Apart from upgrading to cy40t1 several additional developments will enter the current AROME-ESUITE:

- ororad-scheme (orographic effects on surface radiation)
- modified cloud diagnostics (see example in Figure 1)
- initialization of snow height using ZAMG SNOWGRID model
- extended convection diagnostics (e.g. lightning)

Domain		Model characteristics		LBC	
Grid points:	600x432	Code version:	CY38T1/CY37T1	Coupl. model:	IFS
Horizon. resolution:	2.5km	Time step:	60s	Coupl. frequency:	3h
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 operational setup

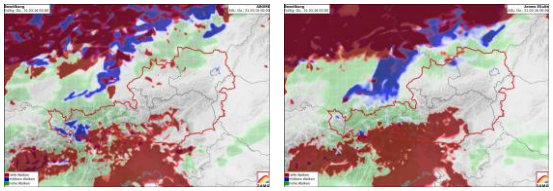

Figure 1: AROME-OPER cloudiness (left) and AROME-ESUITE using modified diagnostics (right)

ALARO (5 km):

The operational model version at ZAMG is run with a grid mesh size of approx. 5km using the ALARO-0 physics package (baseline version). An operational upgrade to ALARO-1 is planned. The main characteristics can be summarized as:

Domain		Model characteristics		LBC	
Grid points:	600x540	Code version:	CY38T1/CY36T1	Coupl. model:	IFS
Horizon. resolution:	4.8km	Time step:	180s	Coupl. frequency:	3h
Levels:	60	Integration time:	72h (00, 06, 12,18UTC)	Retrieval:	Internet/ RMDCN
Grid:	linear	Physics:	ALARO-0 baseline		
Orography:	mean	Dynamics:	hydrostatic kernel		
		Initialization:	CANARI for surface IFS for 3D fields DFI		

Table 2: ALARO operational setup

LAEF (11 km):

ALADIN-LAEF, the limited area ensemble system operated at the HPC facilities of ECMWF, is being developed at ZAMG in cooperation with LACE members and the National Weather Service of Turkey. The main characteristics of the current system are:

Domain		Model characteristics		LBC	
Grid points:	500x600	Code version:	CY36T1	Coupl. model:	ECMWF-EPS
Horizon. resolution:	10.9km	Time step:	450s	Coupl. frequency:	6h
Levels:	45	Integration time:	72h (00, 12UTC)	Dissemination:	AUT,TR, SLO, SK, CZ
Grid:	quadratic	Physics:	Multi-physics	Archive:	MARS
Orography:	mean	Initialization:	**CANARI** with perturbed observations for surface **Breeding-Blending** for atmosphere		
		Ensemble size:	16 perturbed + 1 control		

Table 3: LAEF system setup

2. HPC System

SGI ICE-X (in operations since 2013)
252 nodes (à 2x8 processor cores, 32 GB RAM, Intel Sandy Bridge)
2 frontend nodes (à 2x8 processors, 64 GB RAM, ...)
Panasas file system (120 TB netto capacity)
Total: 4064 cores, 8 TB memory, theor. peak perform.: 82 Tflops
Time spent for model integration (conf 001):
AROME approx. 18min (on 1536 cores, setup see table 1)

An upgrade of the ZAMG HPC system is targeted for summer 2017.

Figure 2: SGI at ZAMG

3. Assimilation of GNSS 3D refractivity

Within the project "GNSS-ATOM" funded by the Austrian Space application program, first tests were carried out to assimilate GNSS ground based 3D refractivity data in AROME. The 3D refractivity observations are modeled by the Technical University of Vienna for two 3D test regions (see yellow rectangles in Figure 3) using a GNSS tomography approach. Surface pressure observation and 3D refractivity background fields derived from AROME (or ALARO) are needed. Before entering AROME 3DVAR, the refractivity observations are converted into T,q – profiles using a 1DVAR method in order to assimilate them as observation type radiosonde. Tests were carried out using 2 different background fields (ZG03: ALARO, ZG04: AROME) for selected cases and finally for a two-week-period. Results were compared to a reference run (no GNSS, ZG01) and other two version using ZTD observations (ZG03 with bias corr., ZG05 without bias corr.).

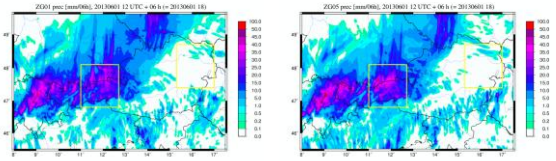

Figure 3: AROME +6h precipitation forecast for version with GNSS refractivity (right) and reference without (left). Yellow rectangle represent areas were observations are available.

The impact was found to be rather strong with an overall drying effect on the lower troposphere compared to the reference. This can be seen either in case studies (Figure 3) or for a longer verification period (Figure 4). Further investigations needed including extended pre-processing (quality control, bias correction) and a direct implementation into 3DVAR.

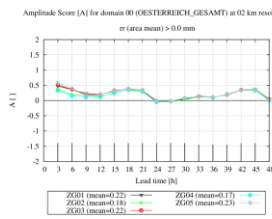

Figure 4: 2-week A component of SAL for reference (ZG01) and runs using refractivity (ZG02,ZG04) and ZTD (ZG03,ZG04)

4. Nowcasting with AROME

In addition to the operational version (AROME-OPER; see Table 1) an AROME version targeting on the very short forecast range (up to 12 hours, AROME-NC) is currently under development at ZAMG.

AROME-NC is run on higher resolution (1.2km) than AROME-OPER but on a smaller domain (mainly due to computational limits). The system is developed to bring benefit for (convective) precipitation forecasts for the first 6 to 12 hours. In its final stage it will be combined or serve as background information of the existing INCA analysis and nowcasting system.

	AROME-OPER	AROME-NC
horiz. resolution	2.5km	1.2km
grid points	600 x 432	900x576
vertical levels	90	90
runs / day	8	24
forecast range (h)	60	12
time step	60s	30s
init 3D	3D VAR	3D VAR
init soil	CANARI	AROME-OPER
coupling model	IFS	AROME-OPER

Table 4: characteristic of the new AROME version

High frequent assimilation of observation data (radar, Mode-S, etc.) plays a major role for AROME-NC. In addition to a 3DVAR version using radar data (reflectivity and wind) another version running with 3DVAR in combination with latent heat nudging of INCA precipitation data is currently under investigation (see example in Figure 5).

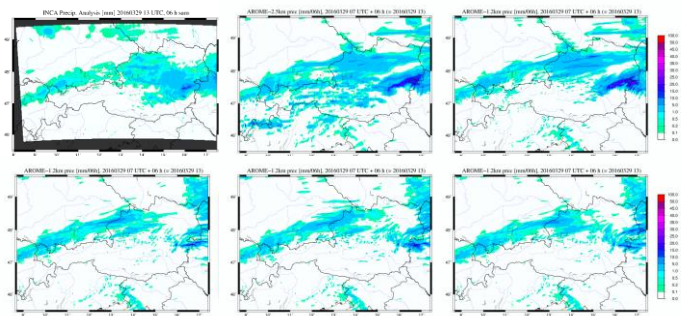

Figure 5: INCA 6h analysis (top left); AROME 6h forecasts (all with 3DVAR): 2.5km no radar, 1.2km no radar (top right), 1.2km radar (bottom left), 1.2km radar + LHN INCA, 1.2 radar + LHN rapid INCA forecast (bottom right)