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ZAMG
Zentralanstalt für Meteorologie und Geodynamik

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Clemens Wastl, Christoph Wittmann, Yong Wang, Nauman Awan, Josef Kemetmüller, Florian Meier, Florian Weidle

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 last upgrade for the AROME system was done in summer 2016. Apart from upgrading to cy40t1 several additional developments entered the new version:

- 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:	CY40T1/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

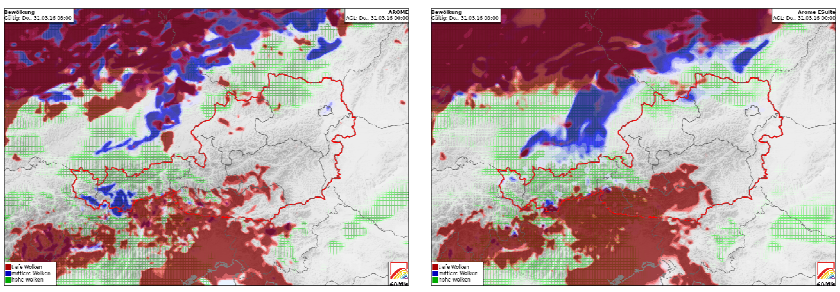

Figure 1: AROME-OPER cloudiness (left) and AROME-ESUITE using modified diagnostics (right)

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):

LACE nwp central europe

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):
ALARO approx. 10min (on 1024 cores)
AROME approx. 18min (on 1536 cores)
An upgrade of the ZAMG HPC system is targeted for summer 2017.

Figure 2: SGI at ZAMG

3. High resolution EPS at ZAMG

ZAMG is aiming to improve the probabilistic forecasting system AROME-EPS by applying different methods of model error representations. AROME-EPS is working on the convection permitting scale and was initially developed by Meteo France (Bouttier et al., 2012).

The focus of this study lies on the development and improvement of stochastic physics techniques which add random noise with spatial and temporal correlation to the model.

Following methods are tested and optimized for the topographically complex terrain of Austria:

- classical stochastically perturbed parameterized tendencies (SPPT, perturbation of total tendencies of U, V, T, Q; Buizza et al., 1999) – optimization of settings for Austrian domain
- Stochastic perturbation of partial tendencies (separate perturbation of shallow convection, turbulence, microphysics)
- Independent partial tendencies (different patterns for shallow convection, turbulence, microphysics)
- Perturbation of single parameters or atmospheric processes (perturbation of key parameters in microphysics and turbulence)

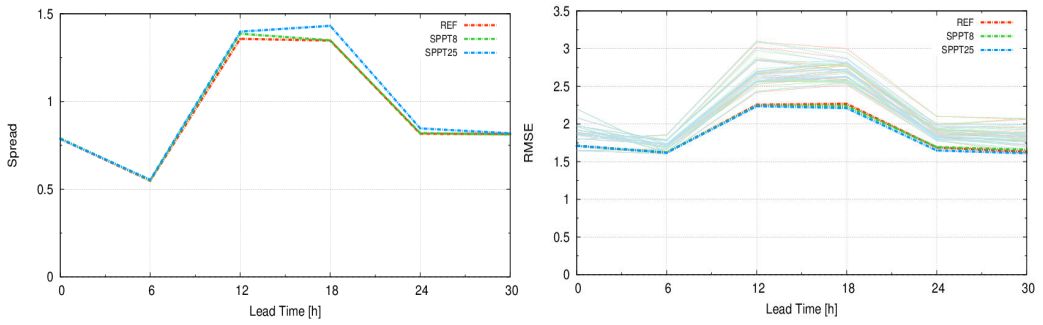

Figure 3: Spread (left) and RMSE (right) for different settings of SPPT for a convective period in June 2011. Red line shows the reference experiment without SPPT, green line is the classical SPPT approach, blue line shows an experiment with partial tendencies and optimized stochastic pattern.

Ref.: Buizza, R., M. Miller, T. N. Palmer, 1999: Stochastic representation of model uncertainties in the ECMWF Ensemble Prediction System. Q. J. R. Meteorol. Soc., 125, 2887–2908.
Bouttier, F., B. Vié, O. Nuissier, L. Raynaud, 2012: Impact of Stochastic Physics in a Convection-Permitting Ensemble. Mon. Wea. Rev., 140, 3706–3721.

4. Nowcasting with AROME

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 benefits 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: Characteristics of the new AROME version

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.

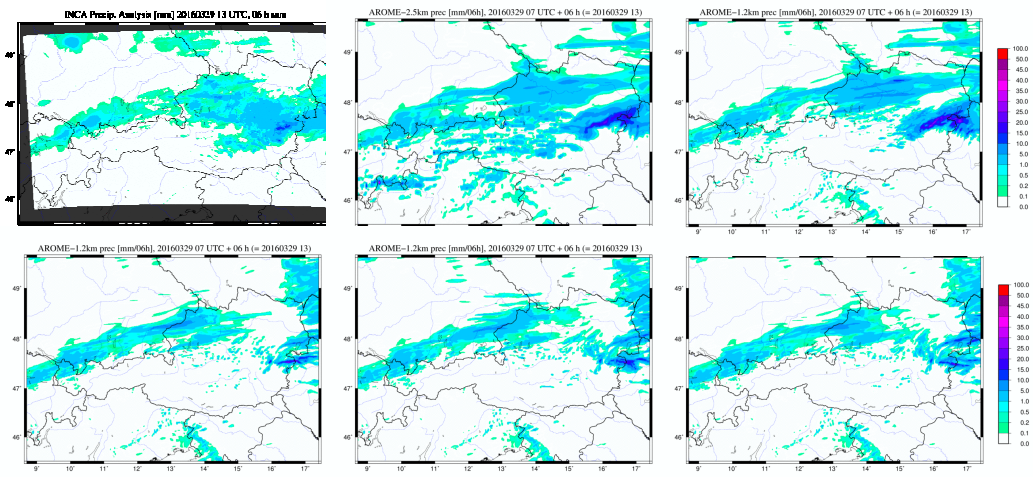

Figure 4: INCA 6h analysis (top left); AROME 6h forecasts (all with 3DVAR): 2.5km no radar, 1.2km no radar (top right), 1.2km radar (bottom left), 1.2km radar + LHN INCA, 1.2 radar + LHN rapid INCA forecast (bottom right)