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NWP related activities in AUSTRIA

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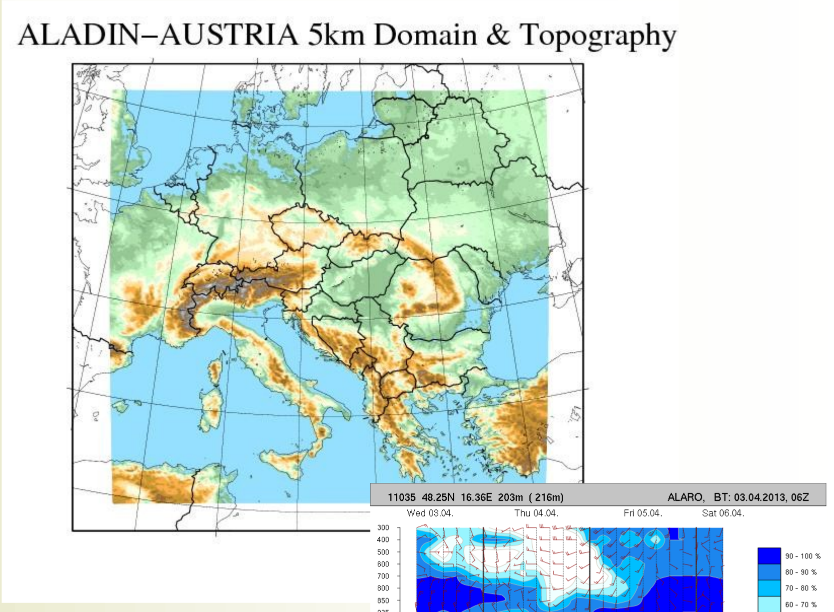
ALARO: The operational forecast system in Austria:

The operational ALADIN version at ZAMG is named ALARO5-AUSTRIA and was set to operations at ZAMG in March 2011. It runs on a horizontal resolution of 4.8km using 60 levels. The model is coupled to the ECMWF IFS model (in time lagged mode). The main characteristics of the model setup can be summarized as:

Domain:
- Grid points: 600x540
- Horizon. meshsize: 4.8km
- Levels: 60
- Grid: linear
- Orography: mean

LBC:
- Coupl. model: IFS (time lagged)
- Coupl. frequency: 3h
- Retrieval: internet and RMDCN

Model characteristics:
- Code version: CY36T1
- Time step: 180s
- Integration time: 72h (00, 06, 12 and 18 UTC)
- Physics: ALARO-0, SK-sub inversion scheme
- Dynamics: hydrostatic kernel
- Initialization: CANARI-OI surface assimilation, IFS downscaling for 3D fields, digital filter initialization



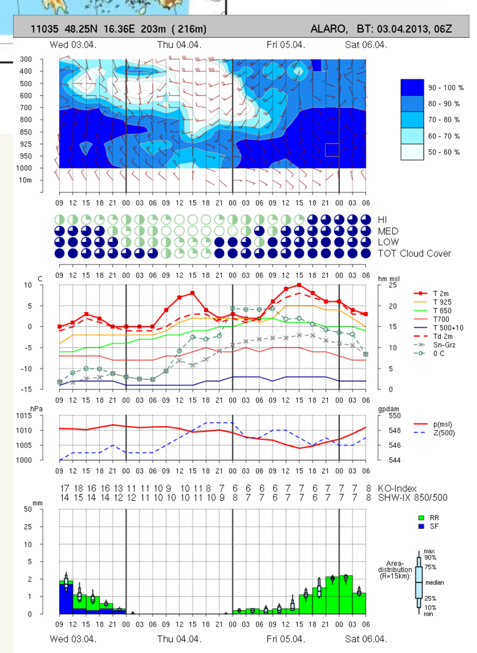


Figure 2 + 3: Operational ALARO integration domain and ALARO meteogram

In January 2013, the operational ALARO physics was upgraded to the ALARO-0 baseline version (or something very close to it) which was released in December 2012. Compared to the previous operational ALARO version (based on CY35t1) significant improvements (especially for precipitation) could be observed for a 6 month evaluation phase (July 2012 - December 2012). As one of the next steps, an increase of the vertical resolution (to approx. 90 level) is planned.

Upgrade of ALADIN-LAEF system:

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 in Turkey. It was upgraded to the current operational system in July 2013. The main specifications of the updated version are:

Ensemble size:	17 (16 perturbed, 1 control)
Forecast range:	72h
LBC:	16 ECMWF-EPS members (time lagged)
Code version:	based on CY36T1
Perturbation model:	Revised Multiphysics scheme (ALARO / ALADIN physics)
Perturbation surface:	Ensemble CANARI with perturbed observations
Perturbation upper air:	Breeding-Blending cycle (blending of small scale perturbations from ALADIN- Bred vectors into ECMWF-EPS IC)
Availability:	00 UTC run: ca. 04:30 UTC, 12 UTC run: ca: 16:30
Archive:	Data archived in MARS

ALADIN-LAEF is one of the forecast systems ZAMG provides for the WWRP FROST-2014 (Forecast and Research: The Olympic Sotchi Testbed). Further, the ALADIN-LAEF control run is used to drive INCA.-SOTCHI, an analysis and nowcasting system run on 1km horizontal resolution in the area around Sotchi.

Further, the post-processing environment of ALADIN-LAEF to create products needed in the TIGGE-LAM archive was set-up and is ready to be launched.

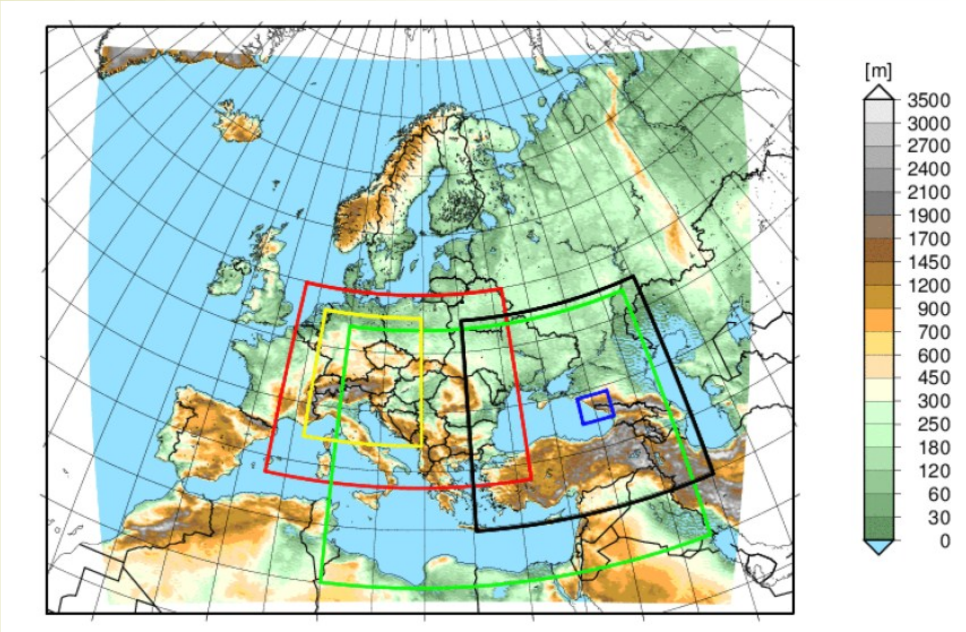
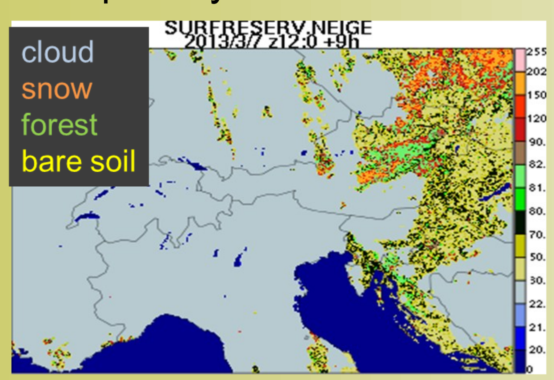


Figure 8: ALADIN-LAEF domain and current Post-processing domains (LACE, INCA, Turkey, Sotchi)

Initializing snow cover in AROME / ALARO:

During winter, initialization of snow cover in a numerical model can play a crucial role for the forecast quality of near surface parameters. Further, snow cover over Alpine regions can have some influence on the triggering of convection e.g. in spring time. Up to now, no local snow analysis was in service at ZAMG. Recently, a project to make first steps towards an operational snow analysis has been started.
First an evaluation of the usability of the fractional snow cover product, provided from the EU funded project CryoLand, based on MODIS instrument observations has been performed.
Figure 10 shows the CryoLand fractional snow cover product (available on resolutions up to 250m) interpolated to the AROME-Austria model domain. This product is used as a simple yes/no information to modify the snow cover fields before entering the model.
In a second step, a snow model is being developed to provide information about snow water equivalent quantity.



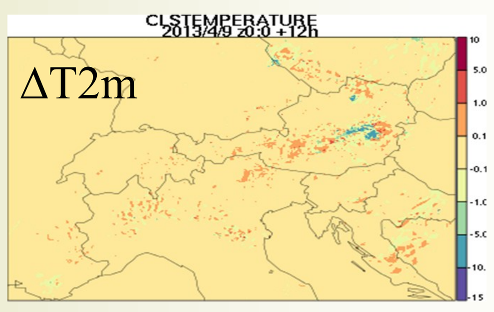


Figure 10: Fractional snow cover (orig. resolution 250m) serving as an input to modify the snow cover in AROME (and ALARO) and the effect on T2m +12h forecast (exp-reference)

HPC system at ZAMG:

In November 2012 the old operational HPC system at ZAMG (NEX SX-8R) was officially replaced by a SGI ICE X system:

5 water-cooled 19" SGI D-Racks with
252 SGI X Dakota nodes (each with: 2 Intel Xeon Sandy Bridge 8 processor cores, 32 GB Memory)
2 SGI Summit frontend nodes (2 Intel Xeon Sandy, 64 GB)
Panasas ActiveStore 12 Cluster filesystem (120 TB netto capacity)
Total: 4064 cores, about 8 TB memory, (theor.) peak perform.: 82 Tflops

CPU time spent for model integration:
ALARO5-AUSTRIA about 10min (on 1024 cores)
AROME-AUSTRIA about 10min (on 512 cores)

Figure 1: HPC system at ZAMG

AROME: High resolution forecasts over the Alpine area

In addition to the operational ALARO 5km version an AROME 2.5km forecast system including assimilation was set up at ZAMG and is now running in a pre-operational mode. Until the operational start (which is envisaged till the end of 2013) several possible upgrades of the system are undergoing intense evaluation to find an optimal set-up for the first operational version. The tests include: alternative model version and physics options, enlargement of the domain (see Figure 7), increase of vertical resolution (see Figures 5 and 6), increase of coupling frequency, addition of new observation types for assimilation, coupling model (IFS vs. ALARO vs. ARPEGE), etc.

The main characteristics of the current AROME system (and tested options) can be summarized as follows:

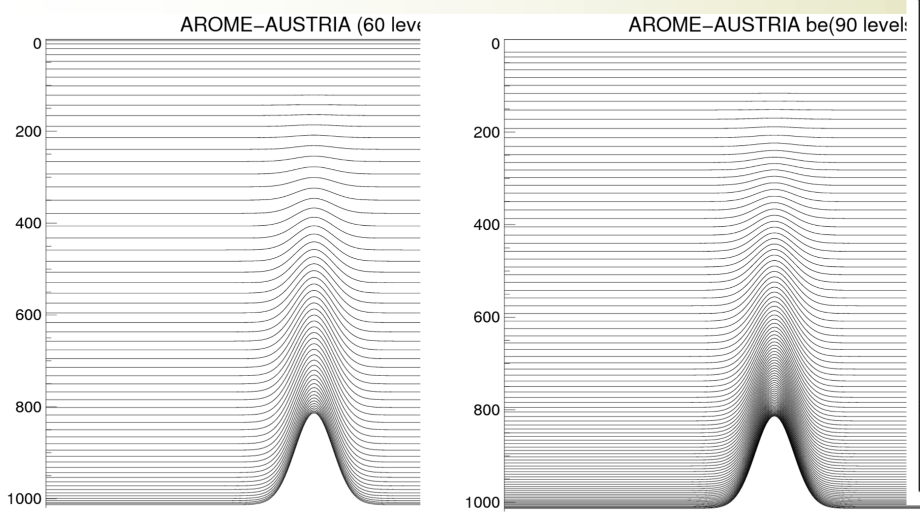
- Domain: 432x320 or 600x432 GP
- Horizon. meshsize: 2.5km
- Levels: 60 or 90
- Coupl. model: IFS or ALARO
- Coupl. frequency: 3h / 1h
- Code version: CY36T1/CY37T1op1
- Time step: 60s
- Forecast range : 30h(48h) (8x / day)
- Initialization: 3D-VAR + OI (soil)

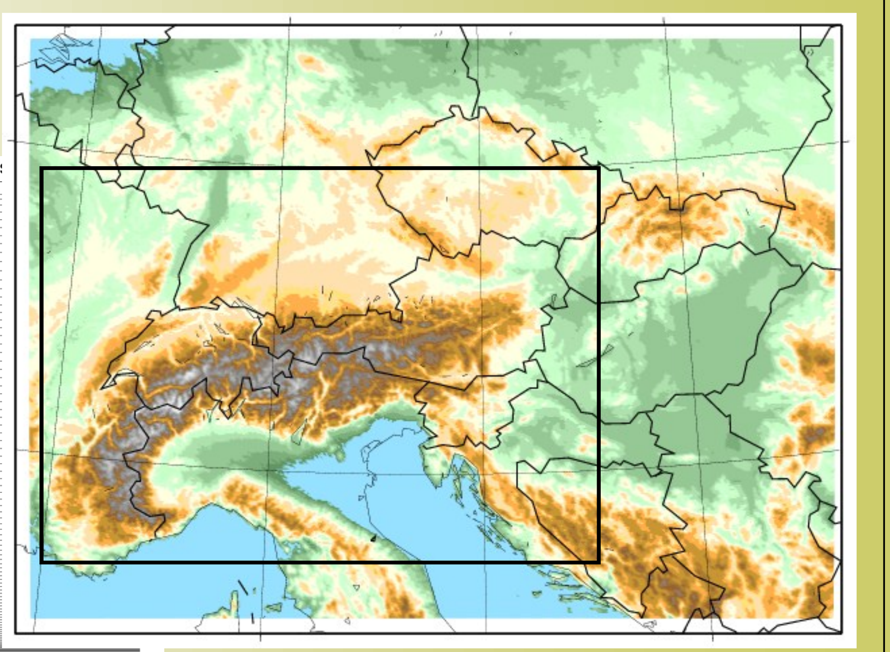
Observation type	assimilated fields	Data source
SYNOP+TAWES	T2m,RH2m,U10m,V10m,ϕ	ZAMG+OPLACE
AMDAR (aicraft)	U,V,T	ZAMG+OPLACE
GEOWIND (SAT-winds) MSG3	U,V	OPLACE
TEMP (radio soundings)	U,V,T,Q,ϕ	ZAMG+OPLACE
PILOT	U,V	ZAMG
WINDPROFILER*)	U,V	ECMWF MARSARCHIVE/OPLACE
MSG2->MSG3-SEVIRI	WV-radiances	OPLACE
NOAA16/18/19+MetOp-A-B AMSU-A,-B,MHS,HIRS	radiances	OPLACE
MetOp-A IASI	radiances	OPLACE
ASCAT 10m sea winds	U10m,V10m (25km)	ZAMG/EUMETSAT
GPS*)	zenith total delay (ZTD)	TU-Vienna
RADAR*)	reflectivity	Austrocontrol/CONRAD
Lake surface temperatures *)	TS_WATER in OIMAIN	Hydrological services
MODIS-snow cover *)	Snow yes / no	ENVEO-CRYOLAND

*) Tests; not regularily

Figure 4: Observation types entering the AROME assimilation system

Figures 5 and 6 (below): Different vertical resolutions are tested for AROME version: 60 level (left) and 90 level (right) version.





Figures 7: Extended domain for AROME (600x432 grid points)

Assimilation of GPS derived data in AROME:

The improvement in forecasting of convective dominated precipitation over the Alpine area is one main focus of the NWP team at ZAMG. Missing detailed information about the vertical distribution of humidity is one of the main reasons for deficiencies in the forecast of convective precipitation over complex terrain. Precipitation forecast areas during convective season are often overestimated and triggered too early during daytime. This behaviour is the same for all models on different horizontal scales.

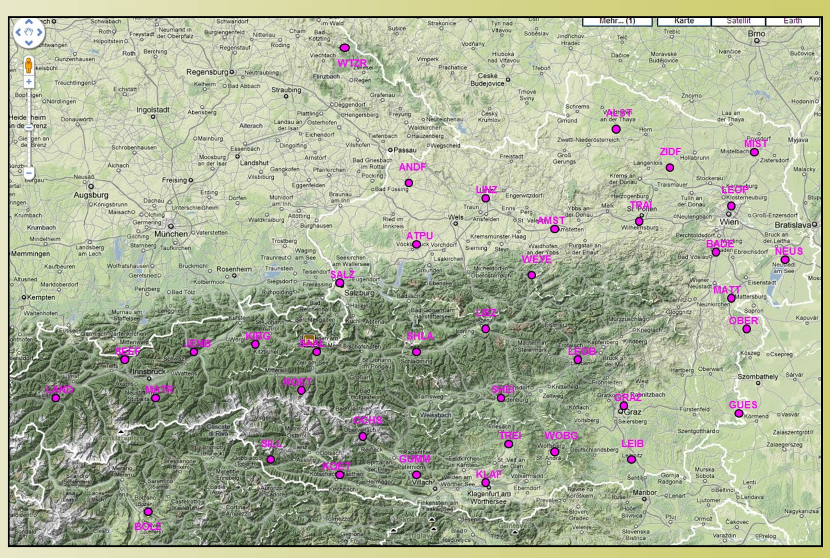


Figure 9: GNSS reference stations in Austria

In cooperation with the Technical University of Vienna, experiments have been conducted to evaluate the benefit of using GPS derived humidity data (zenith total delay, ZTD) in the AROME assimilation system. Similar studies have already been carried out in 2010 using a 9.6km ALADIN model version. The results with AROME are more promising and seem to justify an operational usage. For the period May - July 2011 the verification shows that using GPS data in the assimilation has a small, but overall positive impact on the scores for the amount, shape and distribution of the simulated precipitation (SAL method)

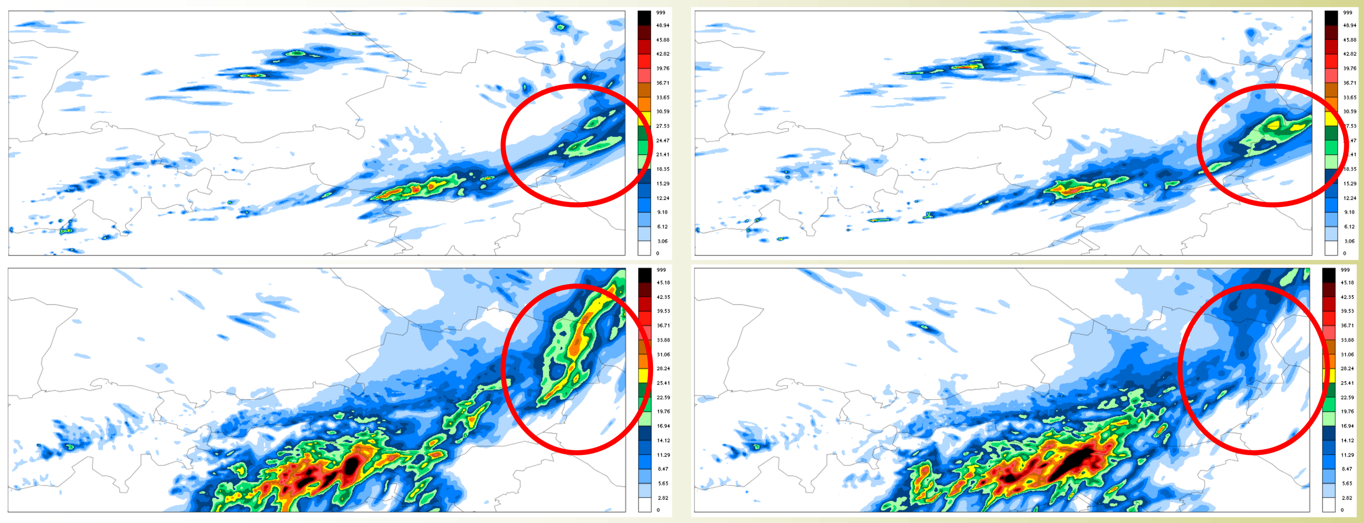


Figure 11-14: AROME with (left) and without (right) use of GPS in data assim. Areas showing significant differences highlighted in red.