
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 system received operational status at ZAMG in 2014 and has undergone several major upgrades during the last years. 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). The main characteristics of AROME-Aut can be seen in Table 1 below. The reduction of aircraft data due to Covid-19 lock down has been a topic also for the AROME-Aut system. Missing AMDAR data was partly compensated by an extended use of MODE-S data (see Fig. 1).

| 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

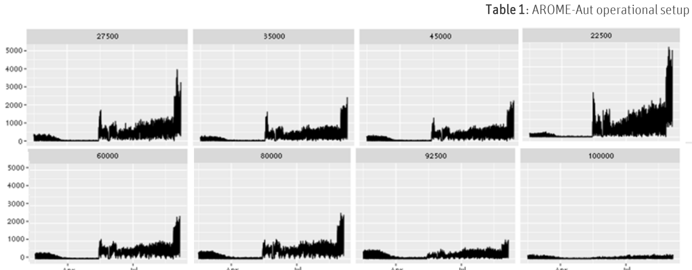

**Fig. 1**: Number of aircraft observations entering AROME-Aut during March – September 2020; shown for different pressure levels, i.e from 1000hPa (lower right) to 275hPa (upper left). In May EMADDC-Mode-S data were added.

**C-LAEF (2.5 km)**

The C-LAEF (Convection Permitting - Limited Area Ensemble Forecasting) is a comprehensive ensemble system trying to considers all major sources of uncertainties: **Uncertainties in the initial conditions** (through Ensemble Data Assimilation for atmosphere and surface (EDA) and Ensemble-Jk); **Uncertainties in the lateral boundary conditions** (through coupling with ECMWF ENS); **Model uncertainties** (through a hybrid stochastic scheme combining perturbations of tendencies in shallow convection, radiation and microphysics, with a parameter perturbation scheme in the turbulence). C-LAEF 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.

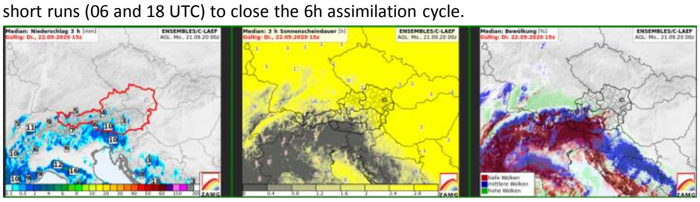

**Fig. 2**: C-LAEF ensemble mean for 3h precipitation (left), 3h sunshine duration and cloudiness (right)

| 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

**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 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. Assimilation of GNSS tropospheric parameters

**ZTD (Zenit Total Delay) observations:**

Observations from 58 stations across Austria are retrieved in real-time from EPOSA network and processed by TU Vienna. Several tests (case studies and tests over periods) have shown the benefit of this data type. In the current AROME-RUC system ZTD observations are assimilated using variational bias correction.

**Fig. 3**: EPOSA station network with available ZTD observations for AROME/AROME-RUC.

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**Feasibility study with real-time processing of ZTD observations:**

The tight schedule of the nowcasting system AROME-RUC requires the availability of observations in near real time. The current data flow of ZTD observations takes 45 minutes, so in operational AROME-RUC ZTD observations are assimilated with a time delay of 60-120 minutes. Within the research project GNSSnow funded by Austrian Space Application Program, ZTD data processed with a faster but less accurate (approx. 3x worse) software were provided for a feasibility study to investigate the impact of up to date against more accurate but older ZTD observations. First results indicate that fast-processed ZTD observations add value to AROME-RUC.

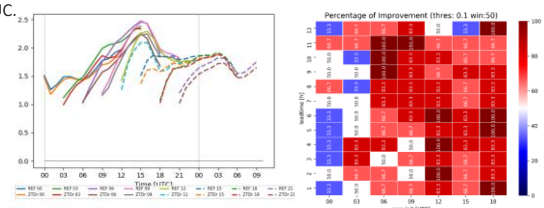

**Fig. 4**: Left: 2m Temperature BIAS for experiment with rapid observation processing (ZTDr) and reference (REF) for selected AROME-RUC initial times. Right: FSS of precipitation for threshold > 0.1mm/h, window size 50; percentage of events for one period where experiment with rapid observation processing outperforms reference run

## 3. Assimilation of wind profiler data

Within the AROME-RUC system, assimilation of wind profiler data from OPLACE/GTS and two Austrian SODAR instruments (Linz and Vienna) has been implemented. The standard operator interpolates measurement height to model levels assuming standard atmosphere which can lead to significant errors (20m and more) in height attribution. Therefore the interpolation is done with a modified operator using the temperature and pressure profile from the FG. Results show very slightly positive impact on 10m wind forecasts. However, the impact of SODAR was negative. This is assumed to be related to the bigger FG departures SODAR show compared to GTS WP. Therefore quality control has to be further adapted for SODAR. The work is partly performed within the project "WINDSOR".

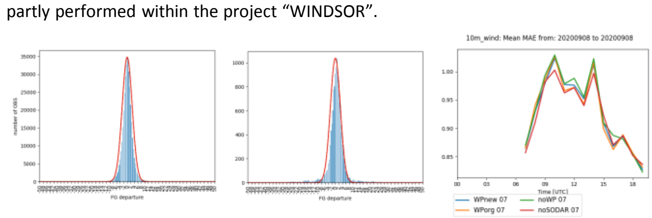

**Fig. 5**: Left: First guess departure of zonal wind off all GTS wind profilers 19th-31st August 2020 (blue boxes) and assumed observation error distribution (red line). Middle: Same for the two more noisy AT SODARs. Right: Case study showing MAE for 10m wind over Austria using no profiler data (green), Wind profiler + SODAR and the standard interpolation (yellow), the new FG based interpolation (blue) or as blue but only GTS WP no SODAR (red).

## 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 6**: SGI at ZAMG