Working Area Data Assimilation

Progress Report

Prepared by:	Area Leader Benedikt Strajnar
Period:	2019 (from January to August)
Date:	09/09/2019

Progress summary

The report summarizes the RC LACE DA activities between January and August of 2019. One RC LACE stay was so far executed and this supported activities on Mode-S observations in Slovakia. As usual, considerable part of the DA efforts were devoted to upgrades in the local DA systems and maintenance duties. These mainly local DA efforts are summarized in the first section of this report.

As anticipated in the 2019 work plan, much manpower was spent on development of hourly cycled systems, with Austrian AROME-RUC as the first such system in LACE to become fully operational. Their final setup takes advantage of both incremental analysis update to decrease spin-up, and nudging techniques to keep the system close to fresh observations. At the same time, the system will operationally assimilate (part of potentially available) radar observations which is another notable achievement. The hourly system is also extensively studied in Hungary, where the investigation is focused to issues with frequent surface and soil assimilation. The outcome will be very relevant for forthcoming hourly systems in other Members.

Within the algorithmic developments, efforts were also devoted to adjustments and recalculations of the B-matrices and evaluation of flow dependent components (EDA). Considerable manpower was also directed into investigation and implementation of EKF and assimilation of remote sensing-based surface observations.

A persistent development is seen in the usage and operational dissemination meso- and convective-scale observation sources, for instance Mode-S. Implementation of GNSS-based observations are also supported by a project in Austria, and developments in STD are becoming more coordinated also with HIRLAM community.

Regarding the radar data assimilation, development is slower than expected in most of the Member countries. In Slovenia, a first assimilation impact study was carried out with positive impact especially on surface scores. Dealiasing methods are also under investigation by a newcomer. Unfortunately, two planned radar-related stays had to be canceled for different reasons. In order to accomplish the planned achievements (i.e. successful reflectivity data assimilation in 2019) the members will have to invest more manpower to this area still in 2019. Further and improved coordination between Members on distribution of tasks related to radar DA would be advisable.

The report covers the items of the plan for DA area in 2019 (with one item added) and indicates the spent manpower and current results.

Action/Subject/Deliverable: ***Towards operational implementation of full (upper-air and surface) DA systems***

Description and objectives:

An overview of the current operational DA systems in RC LACE countries is presented in the following table (yellow colors indicate the system upgrades and additions made in 2019):

DA	AUSTRIA ALARO	AUSTRIA AROME	AUSTRIA AROME-RUC	CROATIA ALARO	CZECH ALARO	HUNGARY ALARO	HUNGARY AROME	SLOVAKIA ALARO	SLOVENIA ALARO	ROMANIA ALARO (prep.)
Resol.	4.8L60	2.5L90, 600 x 432	1.2L90 900 x 576	4.0L73 480 x 432	2.3L87 (NH) 1069 x 853	8L49	2.5L60	4.5L63	4.4L87 432 x 432	6.5L60
Cycle	40t1	40t1	40t1	38t1_bf8	43t2_bf10	40t1	40t1	40t1	43t2_bf10	40t1
LBC	IFS 3h (lagged)	IFS 1h (lagged)	AROME 1h	IFS 3h (lagged)	ARP 3h	IFS 3h (lagged)	IFS 1h (lagged)	ARP 3h	IFS 1h/3h (lagged)	ARP 3h
Method	OI + dyn. adapt	OI_main MESCAN + 3d-Var	OI_main MESCAN + 3d-Var + LHN + FDDA + IAU	OI + 3D-Var	OI + BlendVar	OI + 3D-Var	OI_main + 3D-Var	OI + DF Blending	OI + 3D-Var	OI + 3D-Var
Cycling	6h	3h	1h	3h	6h	6h	3h	6h	3h	6h
B matrix	-	Downscaled LAEF 11 km	Static ENS from AROME-RUC EDA	NMC method	Downscaled AEARP	ALARO EDA	AROME EDA	-	Downscaled ECMWF ENS	Downscaled AEARP
Initialization	DFI	No (SCC)	No	No (SCC)	IDFI in production, SCC	DFI		No	No (SCC)	No (SCC)
Obs.	Synop + AS	Synop + AS Amdar Geowind Temp Pilot Seviri AMSUA/ MHS/HIRS ASCAT Snowgrid/ MODIS snowmask.	Synop + AS Amdar/MRAR/ EHS Geowind Temp Pilot Seviri AMSUA/MHS/ HIRS/ATMS ASCAT Radar RH/Dow INCA + AS at hig.freq. MODIS snowmask.	Synop Amdar/ MRAR Geowind Temp Seviri	Synop Amdar/MRAR/ EHS Geowind Temp Seviri	Synop + AS Amdar Geowind Temp Seviri AMSUA/ MHS ASCAT	Synop + AS GNSS ZTD Amdar/ MRAR/EHS Geowind Temp Seviri AMSUA/ MHS/IASI ASCAT	Synop + AS Amdar/ MRAR/EHS Geowind Temp Seviri AMSUA/ MHS/IASI ASCAT	Synop + AS Amdar/ MRAR/EHS Geowind Temp Seviri AMSUA/ MHS/IASI ASCAT	Synop Temp AMSUA/ MHS Seviri

In Austria, the operational ALARO (only OI-surface) and AROME (3DVAR+OI_MAIN) DA systems (all cy40t1 export) run unchanged. The new AROME-RUC system (work on this is described under “Hourly updated DA systems” section) is now run in real time pre-operational mode and is expected to become fully operational by the end of 2019. The same holds for the ensemble system CLAEF at 2.5 km, which shares several assimilation components with AROME-RUC.

In Croatia, the operational suite did not change. New model cycle (43t2-bf10) was installed and first tests and script modifications were made.

In Czech Republic, local efforts were mainly dedicated to implementation of new operational configuration ALARO-NH at 2.3 km resolution. The local Mode-S MRAR observations were made available to all RC LACE Members from June 2019. In order to extend use of existing observations work on a quality assessment of the national synoptic data, high-resolution winds and wind profiler data has started. This work is still ongoing.

In Hungary, the use of aircraft observations was modified by extending the time window from +/- 60 min to +/- 90. An evaluation showed that such a modification can be justified by improvements in scores (temperature, humidity). An attempt to better visualize the ODB content by using Python libraries for visualization was made and this effort is ongoing.

In Slovakia, new OBSOUL from SHMU AWS were prepared, and those are to be shared via OPLACE. Furthermore, DA settings for CANARI were revised which was triggered by observed unrealistic CAPE values. Missing soil moisture increments were detected due to a bug introduced during recent implementation of cy40t1. Work on this issue is ongoing. As preparation for RUC, an automatic QC for automatic weather stations based on weather station data, radar data and NWP is under development. It is planned that such a procedure would run every 1h to control previous 1h data.

In Slovenia, the operational assimilation system was upgraded to cy43t2. Additionally, observational use was extended with Mode-S MRAR observations from Czech Republic.

In Romania, the assimilation suite stays in a pre-operational state. Since July, experiment on a new 4.4 km domain are ongoing, and B-matrix is also already available. The new setup provided some encouraging results on a convective case.

Efforts: 5 months (local work)

Contributors: roughly 1 person/month per country

Documentation: Reports on RC LACE web

Status: ONGOING

Action/Subject/Deliverable: ***Hourly updated DA systems (RUC, RAP, cycled and non-cycled hourly DA systems)***

Description and objectives:

In Austria, the final setup of the pre-operational AROME-RUC at 1.2 km was chosen and the system now runs in real-time mode. The spin-up is reduced by applying the incremental analysis update (IAU) to the main assimilation cycle in the time interval between -1h and -15 min relative to analysis time, applied to an earlier first guess forecast. For the 12h production run, IAU is also applied in a small, 7.5 min time frame, and realism of forecast is further enhanced by latent heat nudging (LHN) and four dimensional data assimilation (FDDA) nudging of recent surface observations and rapid INCA analysis and nowcasting. The hydrometeors are blended to the latest analysis from the production cycle as IAU was shown to cause degradations in this field (Fig. H1). Assimilation of soil is kept consistent with AROME 2.5 km by replacement of soil and SST fields once per day from this model. Such combination of assimilation and nowcasting techniques ensures the noise level in the assimilation cycle is reasonable even in the hourly assimilation cycling, and, at the same time, incorporates the latest available information from observations during the forecast run (Fig. H2). The system is expected to become operational by the end of 2019.

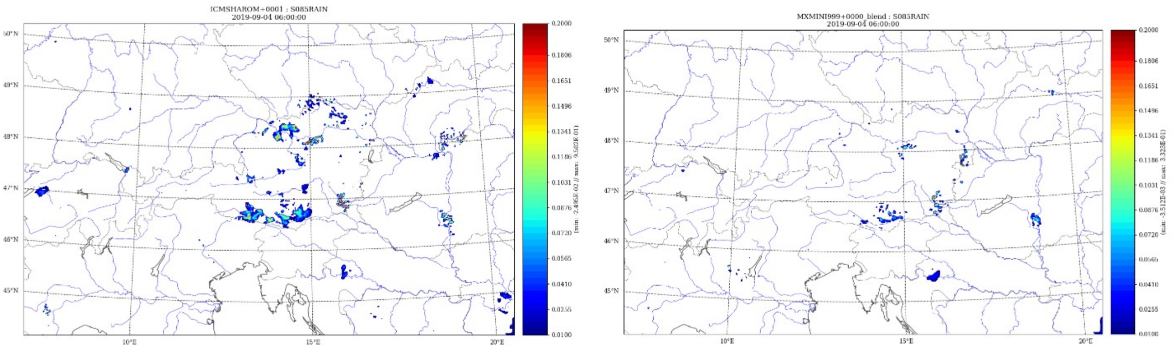

Figure H1: Rain at level 85 (close to the ground) in g/kg at +1h in AROME-RUC after +15min-+60min IAU towards analysis (left) and from free running forecast (IAU stops after +7.5min) (right). Observation should be 0 over whole Austria (sunshine). The IAU creates worse hydrometeor initialization than free forecast also in other cases. Therefore additional blending is done at init time.

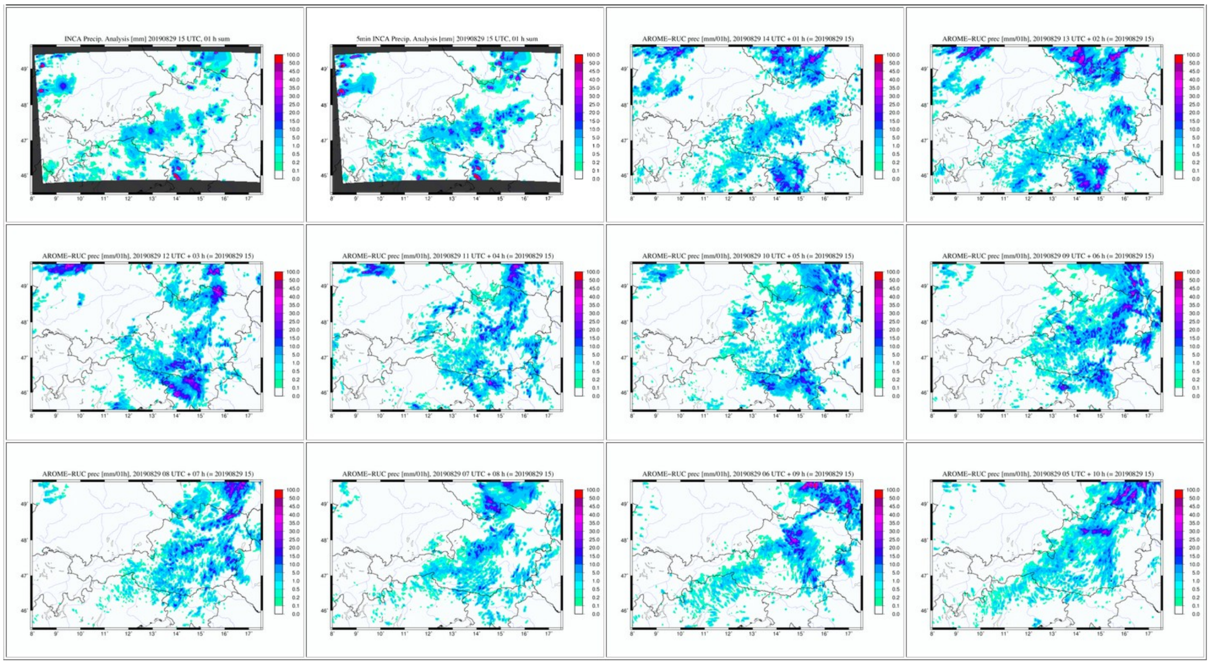

Figure H2: 1h precipitation at 20190829 15 UTC INCA analyses (first two top left) and AROME-RUC forecast from different runs for the same hour. The age of the runs increase from left to right and from top to bottom. The observed very local isolated thunderstorm over Vienna was only captured by the 1h forecast.

Earlier in 2018, investigation of hourly cycling in Hungary indicated that combining the 3- and 6-hourly OI in the hourly system improved 2 m temperature and relative humidity and well as precipitation scores compared to 1-hourly surface data assimilation. This unexpected issue was further investigated in 2019 on two rather long time periods (one month in winter and summer), and earlier results were confirmed (Fig. H3). Unlike in the earlier experiments, the impact on precipitation was not significant. Moreover, it was shown that somewhat smaller data counts for hourly analysis with respect to three-hourly one was not the main reason for degrading hourly surface analysis. Such conclusions are valid for 0,6,12 UTC runs while the scores of evening runs (18 UTC) did not show significant discrepancies in scores between 6-, 3- or 1-hourly analysis.

In Czech Republic, the Rapid refresh (RAP) system using hourly VarCanPack analysis on the operational ALARO domain was extended with the RUP system (up to 12-hour forecast). The RUP is evaluated in terms of spin-up and the impact is evaluated especially for surface variables such as wind gusts and precipitation.

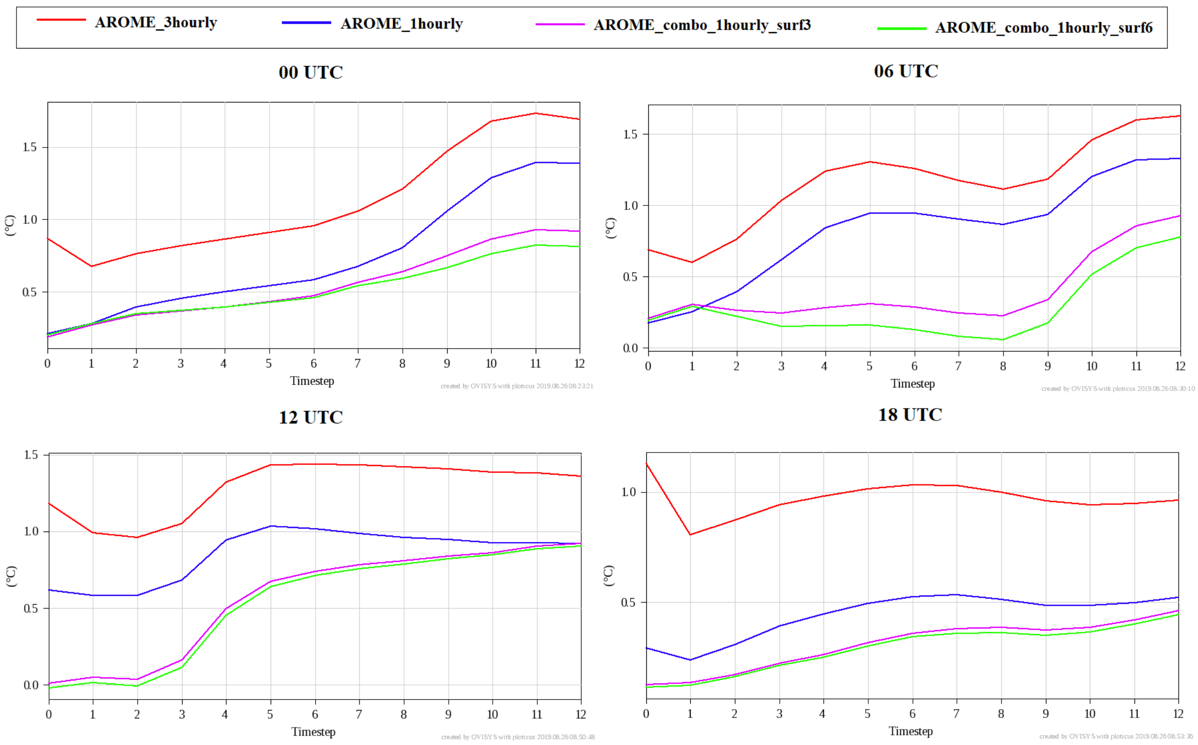

Figure H3: The BIAS of 2m temperature for different combinations of hourly 3D-Var and 1-,3 or 6-hourly OI at different analysis times in winter (AROME-HU).

Efforts: 12 months

Contributors: F. Meier (At) 4, P. Scheffknecht (At) 2, A. Várkonyi (Hu) 4, P. Benáček (Cz) 1, Alena Trojáková (Cz) 1

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Studies of background error statistics in 3DVAR***

Description and objectives:

In Slovenia, an experimental EDA system was developed at a current horizontal resolution of 4.4 km, with 20 ensemble members. Ensemble members are generated by random perturbations of assimilated observations. Ensemble is used to compute background error covariances on daily basis (with the sample size of 160 differences over the last 8 analysis times). First evaluation of the system has just started. Figure B1 shows a comparison of vertical profiles of background error variances for the variables contained in control vector for assimilation. Preliminary results show that the daily profiles are much different from the operational (climatological) ones, and that variation from day to day is significant. The same holds for correlation length scales.

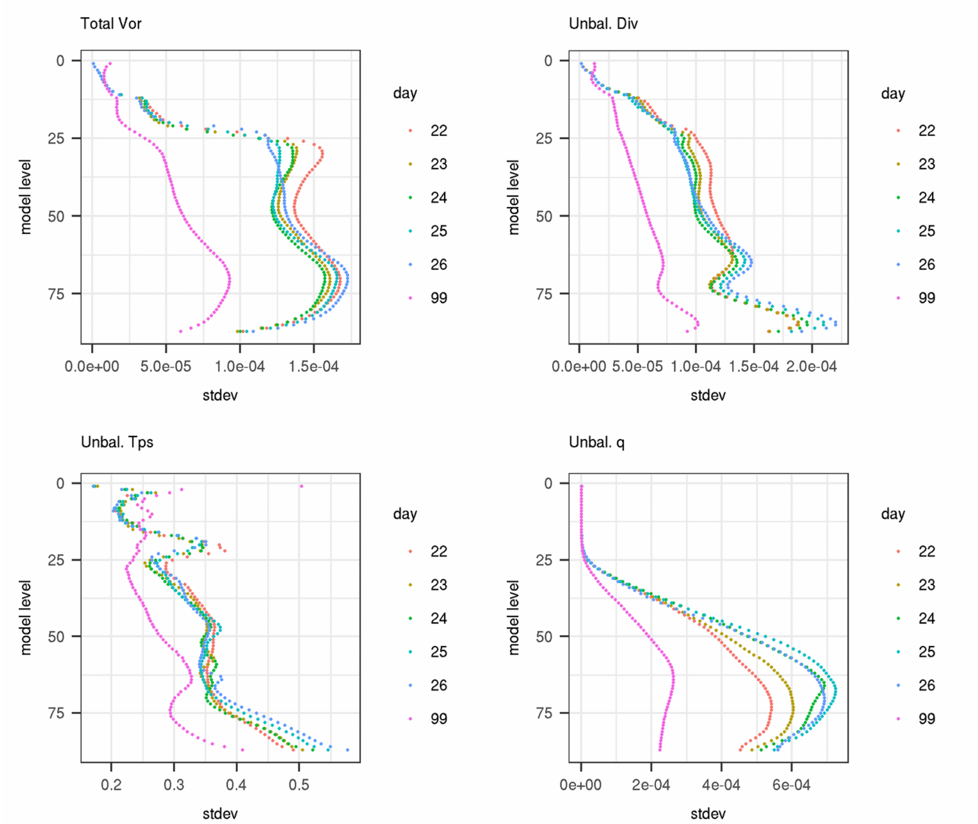

Figure B1: Vertical profiles of background error variances for analyzed variables. Different colors correspond to different subsequent days from 22th to 26th May 2019. Number 99 represents the current operational climatological variances in ALADIN/SI.

In Austria, a new B-matrix was designed for the AROME-RUC 1.2 km system. The ensemble data assimilation (EDA) was applied to the hourly RUC forecasts to produce a total of 178 differences. On top of that differences between the two parallel short term forecasts (IAU and nudging approaches) were added to the sample to somewhat improve flow-dependency (Fig. B2). LBCs for this experiment came from CLAEF 2.5 km ensemble system.

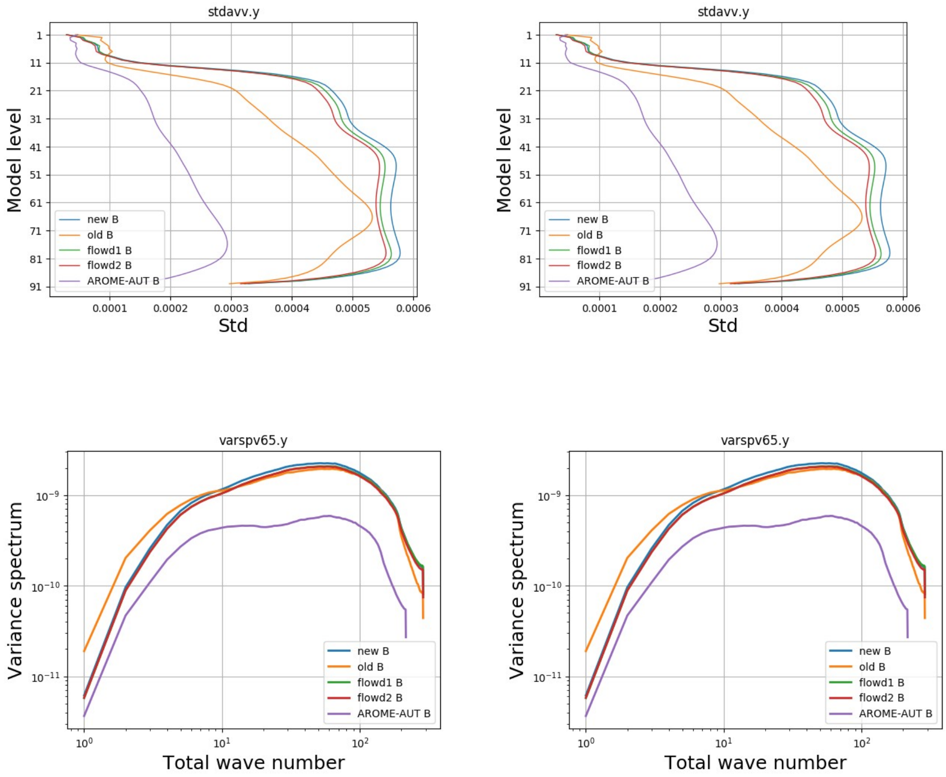

Figure B2: Standard deviation and variance spectrum of vorticity (left) and specific humidity (right). The B-matrices are old AROME-RUC version till spring 2019 (yellow), new EDA based (blue), two versions with additional differences of the day (see text) in green and red and 2.5km AROME B-Matrix (purple).

Recalculation of the B-matrix also took place in Hungary, where this action was triggered by identification of some instabilities in operational AROME with 60 levels vertical resolution linked to high model top. The new computer makes it possible to run the model with 90 vertical levels. First, a downscaled EDA forecast data set was constructed, and this comprises 15 days in each of the four seasons. The biggest difference between the seasons can be seen in the standard deviation for summer humidity, which has a big impact for the overall B-matrix as well (see Fig. B3). A comparison of the new result with the previously computed B-matrix at 60 levels (both spin-up and full EDA) was also made. However the comparison was limited by the fact that the old experiments used 6 h cycling only. The new B-matrix was validated by single observations experiments.

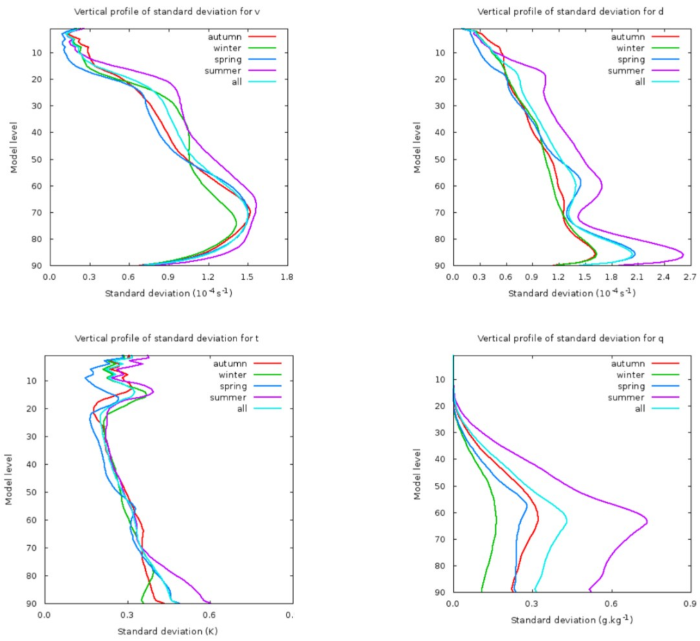

Figure B3: Vertical profiles of standard deviation for vorticity, divergence, temperature and humidity in the four seasons all together and separately. Results from AROME/HU.

Last but not least, a set of scripts needed to compute the B-matrix was updated at the LACE forum, thanks to contribution from Czech Republic. Included are also scripts for visualization of components of the B-matrix.

Efforts: 3.5 months

Contributors: B. Strajnar(Si) 0.5, F. Meier (At) 0.5, A. Bučánek (Cz) 0.5, B. Strajnar(SI) V. Homonnai(Hu) 2

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Surface Data Assimilation using Optimal Interpolation and Extended Kalman Filter***

Description and objectives:

In Austria, the use of locally sampled soil moisture observation errors instead of global ones (XERROBS_M) has been further validated by intensive verification against different in-situ observations and model data. The conclusion stays that the impact of local observation errors is more or less neutral. The work on assimilation of surface temperature continued by preparation of input satellite-derive observations (MSG land surface temperature downscaled with Sentinel 3 data). Figure S1 shows an example of such downscaling to 1 km from original ~5 km grid boxes. The assimilation is technically working and tests to define the ideal length of the offline runs to estimate the background error are ongoing.

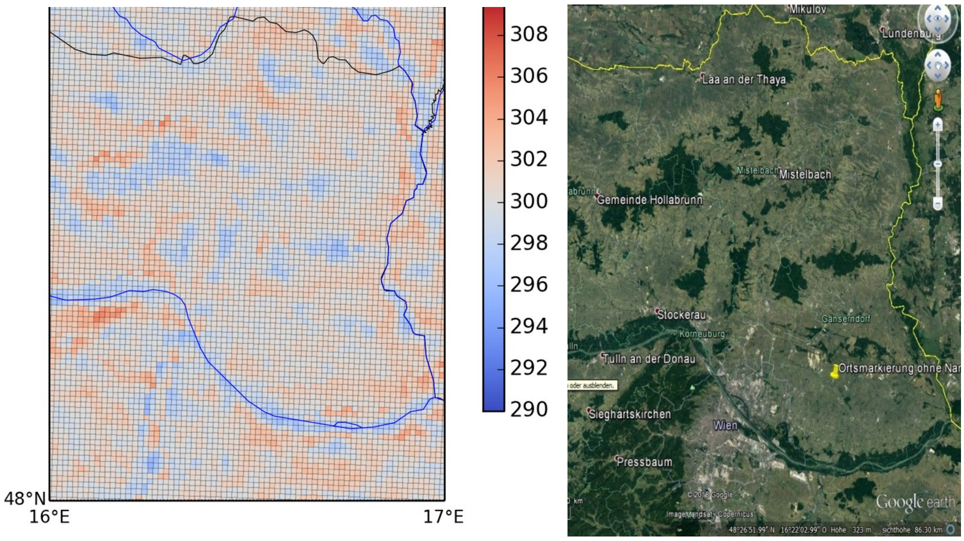

Figure S1: A strong correlation of MSG LST (left) and landcover (picture on the right side from Google Maps) after the downscaling with Sentinel 3 – wooded regions are cooler than agricultural areas in this summer case.

In Slovakia, several issues with surface data assimilation for SURFEX V8.1 on a local HPC were investigated, including porting previous offline SURFEX versions. Problem with SODA not reading original CANARI FA file (used as gridded obs.) was solved by converting it first to ASCII format. Issue with map of analysis increments contained large portion of blank areas over INCA-SK domain was solved by setting CTOWN=TEB instead of CTOWN=NONE in the namelist (Fig. S2). Orography in PGD was made consistent with model orography when used over operational domain. Soil moisture and temperature analysis is performed by SEKF (by J. F. Mahfouf) within SODA, using 4 control variables. Assimilation cycle is now fully implemented for operational SHMU and INCA-SK domains. Reanalysis experiment for July-August 2019 period was started. Validation and verification for whole period will be performed.

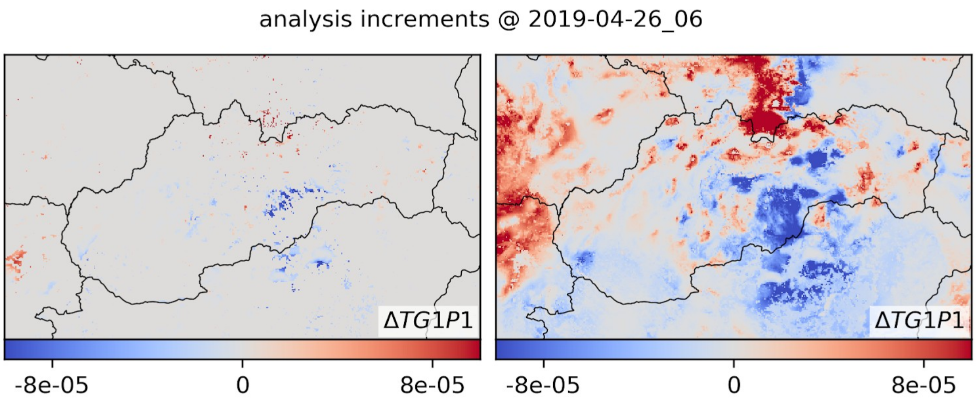

Figure S2: Difference in maps of SEKF analysis increments for soil surface temperature TG1P1 (chosen just for illustration) with setting CTOWN='NONE' (left) and CTOWN='TEB' (right) in PGD namelist. With CTOWN='NONE' all grid boxes with town fraction greater then 0 are effectively discarded from analysis leading to zero increments for them.

Efforts: 14 months

Contributors: S. Schneider (At) 3.5, J. Vural (At) 7.5, V. Tarjáni (Sk) 3

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Object (OOPS) and LACE's contributions to Oriented code refactoring***

Description and objectives:

No action has been made in 2019 in terms of LACE's contribution in OOPS refactoring.

Efforts: 0 months

Contributors:

Documentation: /

Status: ON HOLD (no manpower)

Action/Subject/Deliverable: ***Assimilation of radiance observations (ATOVS, IASI, SEVIRI) in DA systems***

Description and objectives:

Radiance observations from NOAA and METOP satellites are already in operational use at many LACE centre's DA systems. However, its use and more accurate assimilation requires further examination. Unfortunately, no significant manpower was put to new developments on this item in 2019. In Austria, ATMS data from OPLACE (NOAA-20 and SUOMI-SNPP) are passively assimilated within AROME-RUC.

The long-term work by P. Benáček (CZ) on variational bias correction (Var-BC) approaches in LAM was consolidated by improving and publishing a scientific paper and defending a PhD thesis on non-conventional observations in LAM. Extensive underlying research showed that the VarBC-LAM methods outperform the use of global coefficients from ARPEGE providing the better quality of the model first guess (3-h forecast), in the assimilation cycle with the largest normalized impact of 2%–3% for temperature and wind components in the mid troposphere. Compared to the global coefficients, there was little forecast impact between 24 and 48h from using the VarBC-LAM coefficients.

Efforts: 2 months

Contributors: P. Benáček (Cz) 2

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Implementation of RADAR reflectivity and radial wind***

Description and objectives:

RADAR reflectivity and radial wind observations are essential components of a mesoscale DA system especially with increased analysis cycle frequency. Since last year the cooperation of RC LACE Members on this has strengthened and 1 person year per Members was promised to be allocated to this development in 2019. A common video conference on this item was held in the beginning of 2019, and several sub items were discussed in a smaller groups (e.g., a video meeting between AT and SI on wind dealiasing). However the Members so far spend much less manpower on this and 3 planned stays were canceled for different reasons. Although this slows down the way to operational implementation of radar data in most of LACE countries, some actions in the area were taken.

The HOOF tool for homogenization of OPERA/OIFS radar measurements was improved with minor corrections based on user feedback.

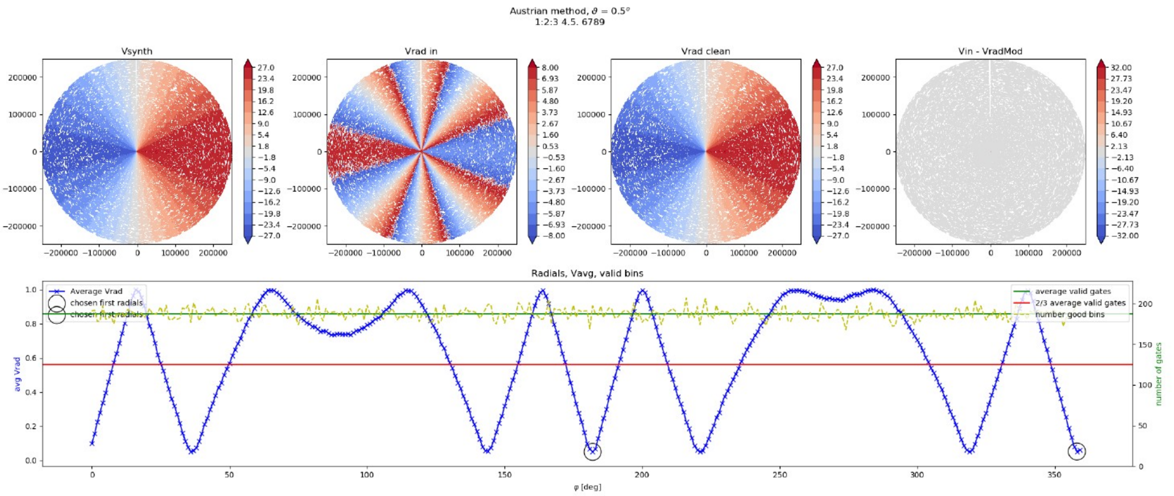

Figure R1: Example of simple synthetic radial velocity field with artificial noise. From left to right: input field, aliased field using a given Nyquist velocity, dealiased field using a method currently implemented in Austria (He et al.) and dealiasing error.

In Slovenia, a newcomer in remote sensing department was directed to Doppler wind processing with focus also on NWP requirements. An overview of existing methods for dealiasing wind fields for radars with low Nyquist velocity was made, and a few of the relevant methods were implemented and tested on synthetic (Fig. R1) and real cases. It is planned that the most prominent method would be included to the HOOF software. This activity may partly overlap with activity of OPERA (where de-aliasing is to be implemented in a later perspective). However a reliable wind processing in the near future is a must over the LACE area (where wind-optimized radars measurements are typically not performed), so we assume the investment of manpower into this is justified.

A first evaluation of impact OPERA reflectivity data was carried out in Slovenia, with data from 40 radars in Europe assimilated over 14 days. The setting of preprocessing and assimilation followed choices made by Meteo France except that HOOF was applied to check the data homogeneity. German radars were not used because the required quality indices were not always available. Verification showed improvements of surface scores (bias of temperature, humidity) due to assimilated reflectivities. Impact on upper-air scores was mixed: temperature was somewhat improved while humidity at around 700 hPa was notably degraded (dry bias, Fig. R2). The later is also in agreement with degradations seen in cloudiness. The experimentation needs to be extended to more cases and weather regimes.

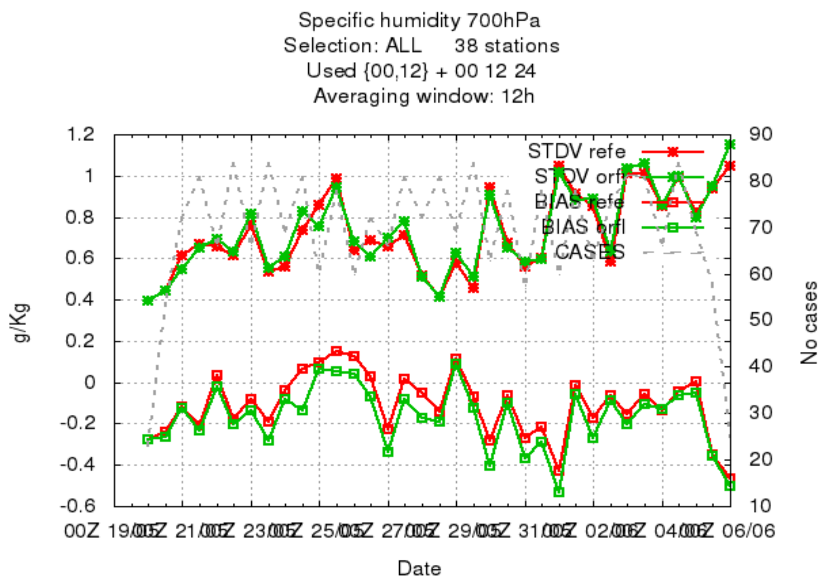

Figure R2: Systematic degradation of humidity bias at 700 hPa (green line) due to assimilated OPERA radar reflectivities with respect to reference (red line) in ALADIN/SI.

Radar assimilation is becoming operational in Austria with their AROME-RUC by the end of 2019. The national data and data received through bilateral exchange (D, SI, AT, CH) is combined with OPERA data (CZ, SK, HR, CH, F). The non-OPERA data are subject to wind dealiasing procedure (based on He et al.) while Doppler winds from OPERA are not used if the Nyquist velocity is low. Var-QC was applied this year to the Doppler winds and pseudo humidity profiles. It was found that the observation error assumed in the model for Doppler winds might be too low by a factor of 2 for AROME-RUC. The first guess rejection limit of 20 m/s also seems to be inappropriate (Fig. R3). A visitor to ZAMG is expected to work on dealiasing and this action should be coordinated with activities in other RC LACE Members.

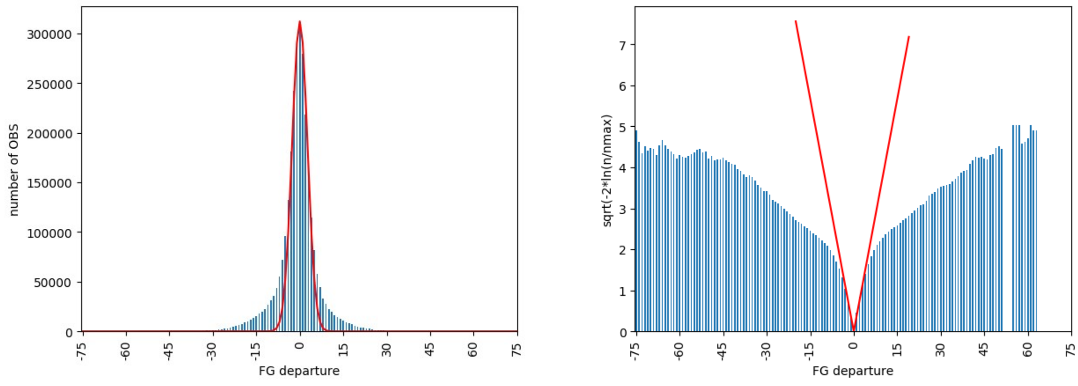

Figure R4: Doppler wind first guess departures collected from August 2019. The red line indicates the Gaussian distribution function multiplying the mean observation error (from NODE file) by a factor of two. Right is the re-scaled distribution as proposed by IFS to tune VARQC. The limits for gross errors are set where real distribution deviates from linear behavior in the rescaled graph. The standard rejection limit of 20 m/s is far outside this interval.

In Slovakia, the BATOR cy46 was back-phased to be used with ALARO model. This work is to be consolidated with the work of the rest of the group.

Efforts: 6.75 months

Contributors: V. Švagelj (Si) 1.5, P. Smerkol (Si) 0.25, B. Strajnar (Si) 0.75, F. Meier (At) 1, M. Neštiak (Sk) 3, A. Trojáková (Cz) 0.25

Documentation: Software and documentation

Status: ONGOING

Action/Subject/Deliverable: ***Assimilation of (ZTD, STD, refractivity index, gradient, etc) GNSS path delays***

Description and objectives:

The usage of GNSS-derived observations is planned in most of the RC LACE member countries, but currently only operational in Hungary.

In Austria, GNSS-based data is evaluated with the scope of AROSA project. GPS-RO observations were not available in satisfying numbers in time, an OSSE experiment was continued. Observation error model for SPIRE LEOs was provided by the Wegener Institute in Graz and implemented. Artificial observations were generated from observational data base (ODB) by using real Metop GPS-RO observations at other times and regions and compute first guess departures, which are in turn used to get simulated observations from AROME nature run. Such observations data sets are further enlarged by adding perturbations in screening. As a comparison, this methodology is applied also to conventional observations. The final experiment compares perturbed real conventional observations, perturbed synthetic GNSS-RO, perturbed synthetic conventional observations, and both perturbed synthetic observation types. All runs are verified against the nature run. The experiment was run using 3-hourly cycling over two days in August 2018. Results show a positive impact of GPS-RO on CRPS score above 500hPa and especially near the tropopause mainly on temperature and wind, while the results were mixed at lower levels (Fig. G1).

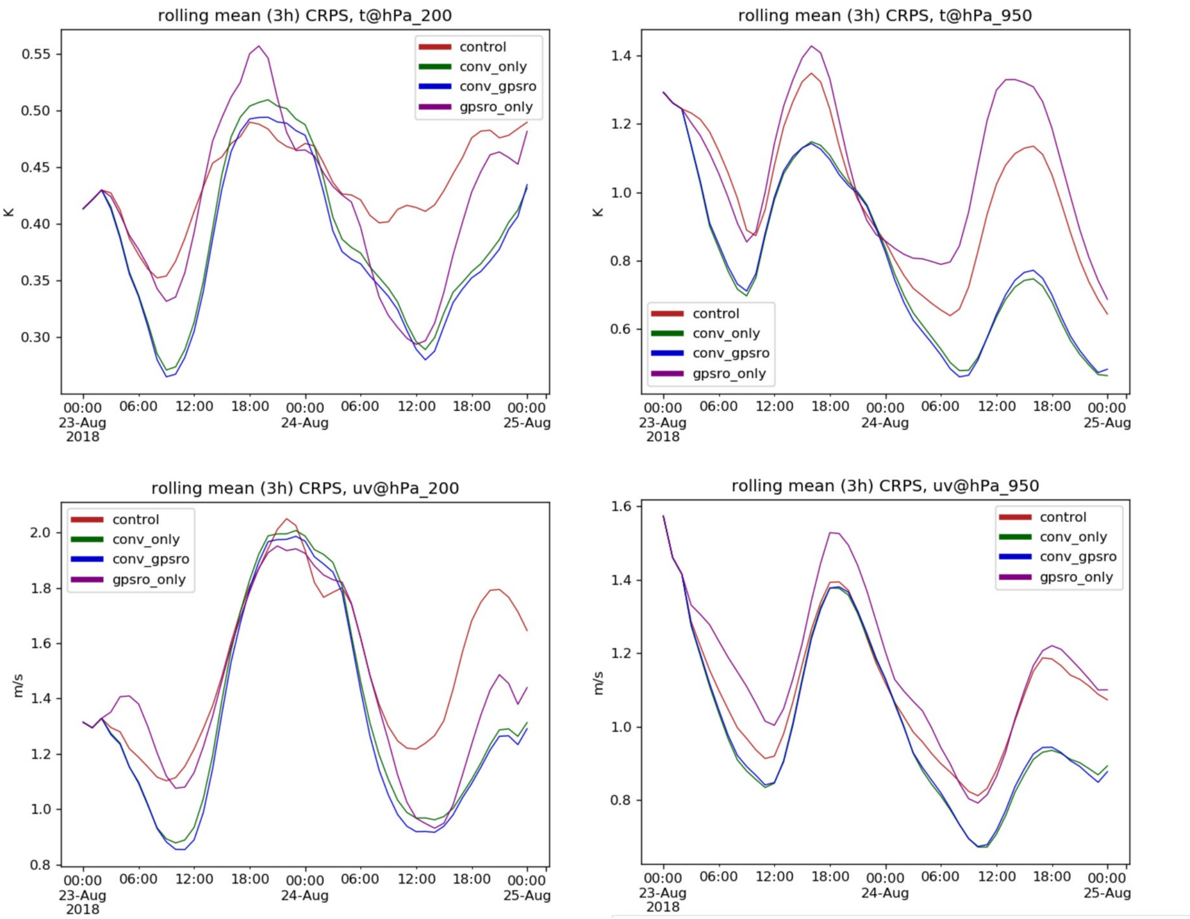

Figure G1: Comparison in CRPS for T (top) and wind (bottom) on two levels for the different OSSE ensembles. Lower values indicate a better forecast. The strong daily variations are caused by differences in convective activity at different times of the day.

A study of slant total delay observations (STD) also continued in Austria with adaptation of model code from KNMI to the ZAMG's 40t1 model version. Tests with artificial observations (Fig. G2) and real observations (Austrian national data) were carried out. A simple static bias correction based on the ODB statistics was applied for the STD data. Based on 24 AROME-RUC runs the DFS of STD data was calculated which indicated a slightly larger impact on the analysis than the ZTD data. A validation of one month test data is ongoing.

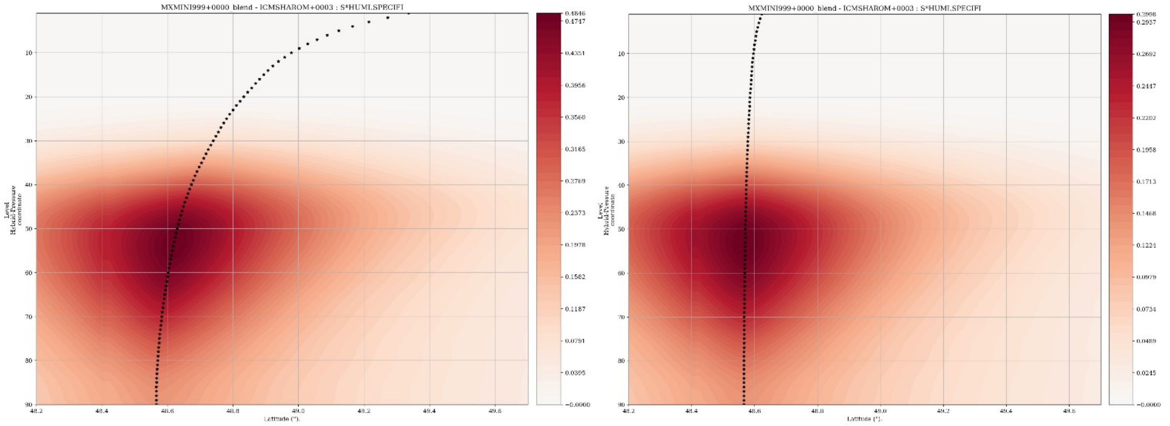

Figure G2: Analysis increment of specific humidity for single observation experiment, for two elevations. Asterisks mark position where STD-Path crosses the model level.

In Slovenia, an impact study of E-GVAP and local GPS observations confirmed earlier results of biased local data. It was agreed with data provider to verify its observations by comparison to E-GVAP data.

In Slovakia, the impact of ZTD observations is evaluated during long term (6 months) assimilation in AROME and validated against ECMWF analysis. Performance of ZTD is studied especially during heavy precipitation events, where positive impact was detected (Fig. G3).

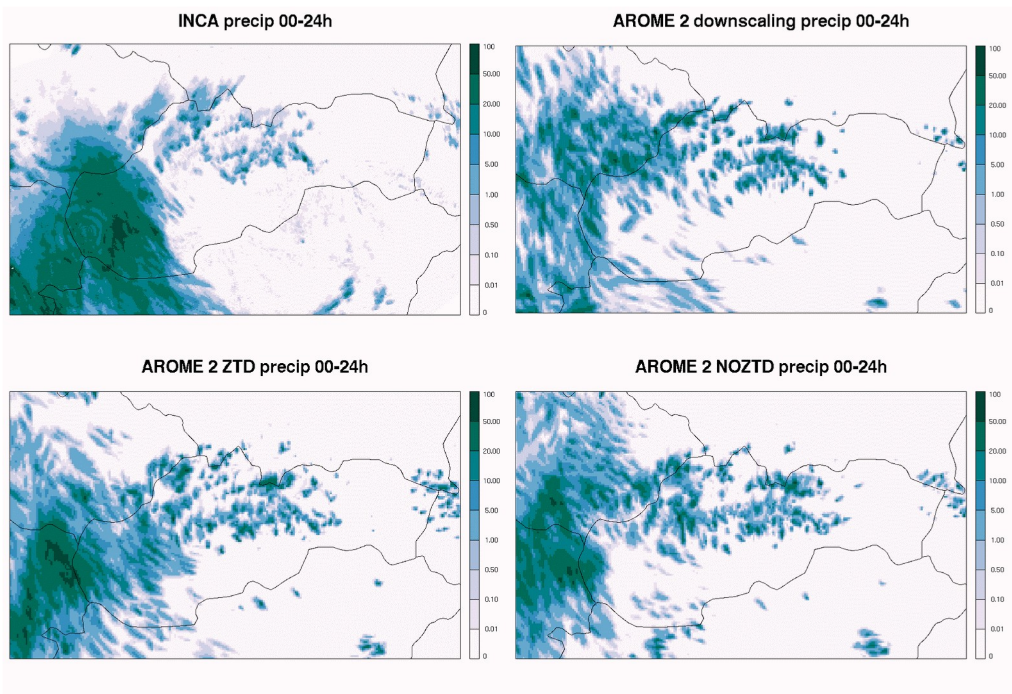

Figure G3: Impact of ZTD observations: 24-hourly INCA precipitation analysis (top left), downscaled AROME run (top right), assimilation run using ZTD observations (bottom left) and reference assimilation run without ZTD.

Efforts: 9.25 months

Contributors: M. Imrišek (Sk) 2, B. Strajnar (Si) 0.25, F. Weidle (At) 3, P. Scheffknecht (At) 4

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Assimilation of Mode-S observations***

Description and objectives:

The use of Mode-S high-resolution aircraft observations (both MRAR and EHS sub types) are fast growing observations network with increasing importance in mesoscale DA systems.

In the Czech Republic, Mode-S MRAR observations was made available to all RC LACE members from June 2019. A whitelist for these observations was recalculated. During a stay of Slovakian colleague the quality assessment of observations against NWP was carried out.

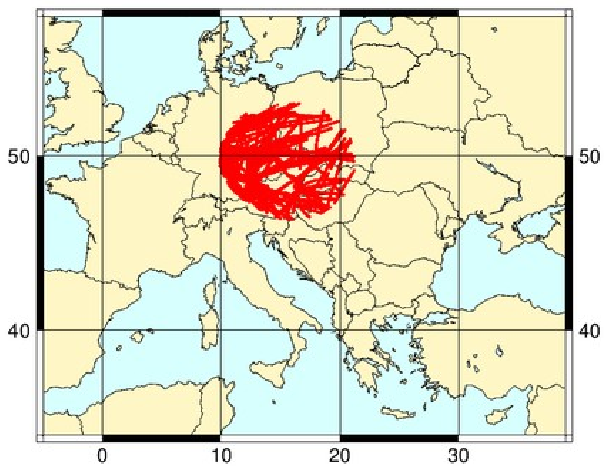

Figure M1: Coverage of Mode-S MRAR data from Czech Republic which are shared through OPLACE.

In Croatia, local Mode-S MRAR data were obtained from ATC (Croatia Control), so far on daily basis only. Figure M2 shows data availability analysis over two months.

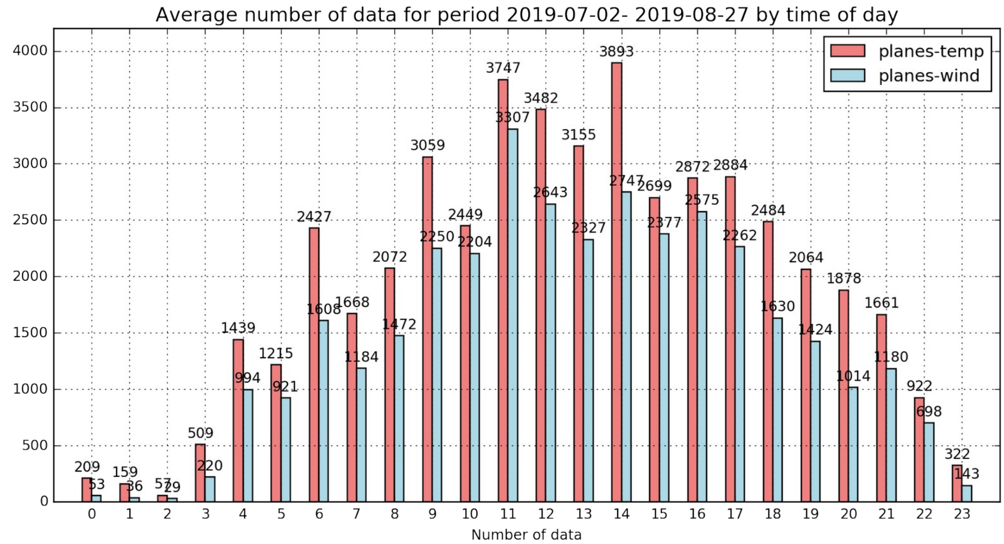

Figure M2: Number of wind and temperature observations in Croatian Mode-S MRAR data set by hour of day.

In Slovakia, there is ongoing negotiation with Slovak Air Traffic service to provide local Mode-S data. Stay of K. Čatlošová in Czech Republic was devoted to analysis of Mode-S EHS and MRAR from four radars in CZ, SK and AT, and the impact of whitelisting on the quality of observations for assimilation (Fig. M3). The results were comparable to previous studies in CZ and SI, except that the quality of MRAR from Vienna airport is reported to be worse than in the earlier studies.

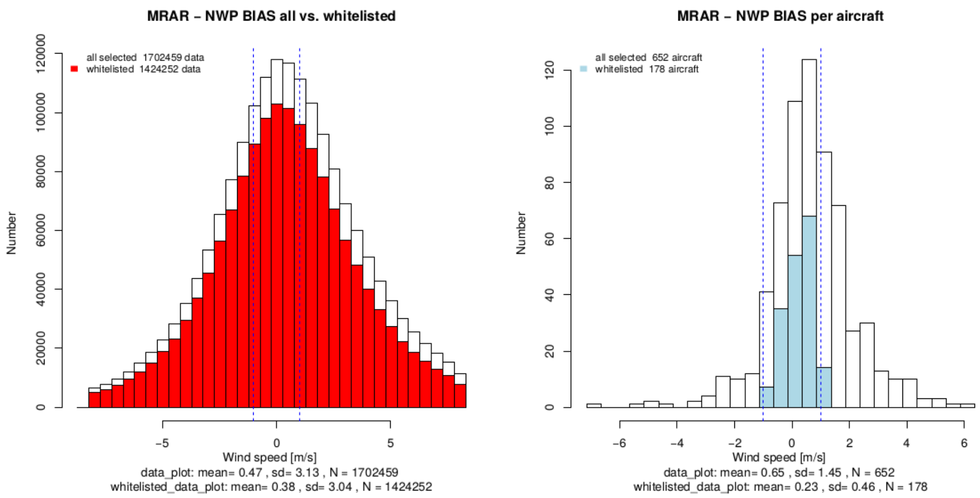

Figure M3: Example of positive whitelist impact on MRAR wind speed data sample from Jan-Feb 2018 from Vienna (Austria) and Buchtuv kopec (Czech republic) radars. Shown are the whole dataset (left) and data computed per aircraft (right).

In Slovenia, an attempt was made to recalculate the whitelist for SI MRAR data, also shared through OPLACE. A 3-month passive monitoring with respect to operational model was carried out. However, the resulting whitelist contained less aircraft and the OMG statistics for the selected aircraft were somewhat worse that those using the operational whitelist over the same time period. It is proposed that the evaluation period is further increased (original whitelist was obtained over 2 years of data).

In Austria, data from OPLACE (EHS, MRAR) are used in the AROME-RUC system. National Mode S EHS data were further studied and it was found that wrong coordinates of foreign ATS radar stations were provided.

In Hungary, an evaluation of Czech Mode-S MRAR data is ongoing, as well as efforts to obtain the national data and start its evaluation.

Efforts: 6.25 months

Contributors: A. Stanešić (Cr) 0.25, F. Meier (At) 0.5, K. Čatlošová (Sk) 4, B. Strajnar (Si) 0.25 , A. Trojáková (Cz) 0.75, V. Homonnai (Hu) 0.5

Documentation: report on LACE web page

Status: ONGOING

Action/Subject/Deliverable: ***Assimilation of Meteosat HRW AMVs***

Description and objectives:

In Czech Republic, a monitoring study was carried out with aim to extend the use of existing observations. High-resolution winds (HRW), wind profiler and scatterometer data are evaluated. This work is still in progress.

In Austria, HR-AMVs from OPLACE are now applied within AROME-RUC. Compared to GEOWIND-only the number of assimilated observations increased drastically. However, no validation of the impact was done so far.

Efforts: 1 month

Contributors: A. Trojáková (Cz) 1

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Assimilation of attenuation in telecommunication microwave links***

Description and objectives:

The attenuation of telecommunication inter-antenna links in cellular networks due to rain is an attractive new observation data source (introduced by A. Overeem & H. Leijnse). In Slovenia, the feasibility study with an example test data from one of Slovenian mobile service provider continued in 2019. A first task was to efficiently separate attenuation data in rainy and dry conditions. This is not trivial because the emitted (and received) signal power change in time, so that the dry attenuation is not exactly known. Moreover, the attenuation can be increased also in non-rainy conditions if emitting/receiving antenna is wet. A solution based on histogram analysis was proposed (example in Fig. L1). The attenuation data marked as rainy was fitted against precipitation estimates (from INCA) in order to obtain a useful attenuation/rain rate relation.

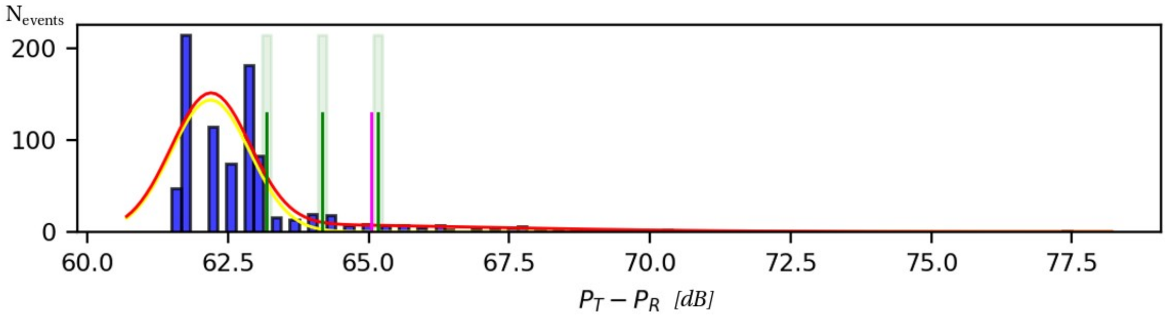

*Figure L1: A fit to the distribution of total link attenuation (transmitted - received power) for 4 days of link data at 5 minute intervals. Fit is made to determine the attenuation baseline: the attenuation of the dry period, either via fit, where the baseline is determined as fit average + 3 * fit sigma (the third green line) or via calculation of IQR (interquartile range) of the histogram (violet line).*

Efforts: 1.5 month

Contributors: P. Smerkol (Si) 1.5

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Assimilation of scatterometer data (ASCAT, OSCAT, HSCAT)***

Description and objectives:

The scatterometer data are one of the rare low-level data source over water and thus important for domains with considerable ratios of sea. A sample of HSCAT (HY-2A) and OSCAT (Oceansat-2) data still have to be validated. No manpower was put to this item in this year so far.

Efforts: 0 month

Contributors:

Documentation: /

Status: ONGOING

Action/Subject/Deliverable: ***Assimilation of Synop and national surface observations***

Description and objectives:

A study of existing national observations was carried out in Czech Republic by performing a quality assessment of 3 months of hourly Synop data. The assessment revealed several data problems which were fixed, including a time stamp issue in Austrian data, the position of one of Croatian stations, and the format of new Slovak national data. Initially, the motivation was to compare the quality of the national data and GTS data from each RC LACE country. Next objective was to define thresholds for a local station blacklisting based on observation minus guess departures (OMG). The stations with insufficient sample are blacklisted, then the gross errors are filtered out from the dataset. The stations which have more than 1 % of gross errors are blacklisted. Finally, thresholds for bias and standard deviations were applied. Figure N1 shows a comparison of SYNOP quality between different LACE and non-LACE countries. It can be seen that bias is larger for Swiss and Italian stations, while the national and Synop data are comparable elsewhere.

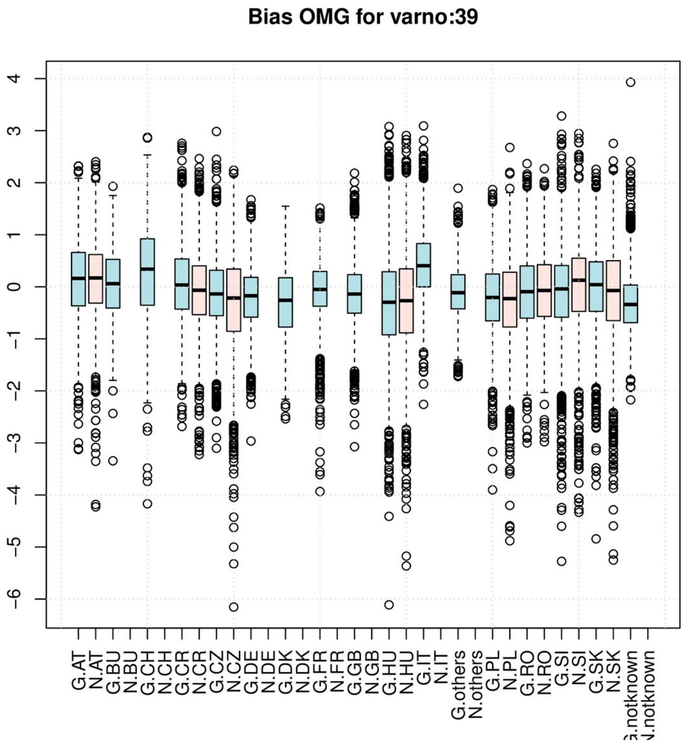

Figure N1: Distribution of hourly bias per country: G stands for GTS data (blue box), N denotes the national data (pink box).

Efforts: 1 month

Contributors: A. Bučánek (Cz) 1

Documentation: /

Status: ONGOING

Documents and publications

Scientific papers

- Benáček, P., Mile, M. (2019): Satellite bias correction in the regional model ALADIN/CZ: comparison of different VarBC approaches. Monthly Weather Review, vol. 147, no. 9, https://doi.org/10.1175/MWR-D-18-0359.1

- Trojáková A, Mile M., Tudor M. (2019): Observation Preprocessing System for RC LACE (OPLACE), accepted, ASR.

- Scherllin-Pirscher, Barbara, A. K. Steiner, G. Kirchengast, Y.-H. Kuo, and Ulrich Foelsche. Empirical analysis and modeling of errors of atmospheric profiles from GPS radio occultation." Atmospheric Measurement Techniques (Copernicus GmbH) 4 (2011): 1875-1890.

- Schneider, S. and Bauer-Marschallinger, B.: Assimilation of SCATSAR Soil Wetness Index in SURFEX 8.0 to improve weather forecasts, ongoing.

List of stay reports:

- Katarína Čatlošová, 2019/03: Slovak Mode-S data assimilation into AROME/SHMU

- Maria Monteiro, 2019/02: Use of existing observations - radar

Other documentation

- Peter Smerkol (updated): Documentation for the Homogenization Of Opera files (HOOF) tool

RC LACE DA at 29th ALADIN Workshop & HIRLAM All Staff Meeting 2019, 1-5 April 2019, Madrid, Spain

List of presentations:

- Benedikt Strajnar: Overview of RC LACE data assimilation activities

- Florian Meier: Nowcasting with AROME - recent challenges and developments in Austria

Posters:

- Phillip Scheffknecht: GSPRO Assimilation Experiments with AROME using Synthetic Data

National posters: Austria, Croatia, Czech Republic, Hungary, Slovakia, Slovenia, Romania.

Activities of management, coordination and communication

1) Internal hangout meeting on RC LACE radar DA in 2019, 29 January, coordinated by AL

2) Attendance to ALADIN/HIRLAM Common DA Training (AL and two lecturers from Cz), 11-15 February 2019, Budapest

3) Joint 29th ALADIN Workshop & HIRLAM All Staff Meeting 2019, 1-5 April 2019, Madrid, Spain

4) LSC meetings

Summary of resources

Action (PM)	**Resource**		**LACE stays (month)**	
	Planned	**Realized**	**Planned**	**Realized**
Local DA system	7	5	-	-
Hourly RUC	13	12	1	0
B-matrix	12	3.5	-	-
Surface EKF	8	14	1	-
Radiance obs	1	2	-	-
RADAR obs	18	6.75	2	0
GNSS obs	8	9.25	1	0
Mode-S obs	7	6.25	0	0.5
AMV obs	2	1	-	-
RAINLINK obs	3	1.5	-	-
SCAT obs	1	0	-	-
SYNOP obs	-	1	-	-
Total	**82**	**62.25**	**5**	**0.5**

Problems and opportunities

The main problems in 2019 were:

- As usual, a lot of manpower is spent for local validation, maintenance and technical issues, partial duplication of work.
- Realized work on radar DA is so far much below the planned (and even further below to 1 py per Member as discussed at the LACE Counsil). One of the reports from 2018 was still not provided.

Opportunities for more effective future work are:

- To increase the level of cooperation inside and outside RC LACE and support cooperation with other areas (e.g. DA & EPS common activities). Idea is to organize additional videoconference of LACE DA group at least once per year and regularly attend videoconferences organized by HIRLAM group.
- To try to unify the local developments, e.g. to try to achieve approximately the same level of development in all member countries.
- Increase communication with DA colleagues at Météo France, AL should try to collect issues to be addressed to them.
- Actively participate in discussions and knowledge exchange regarding EUMETNET observations such as E-ABO and OPERA.