Report on LACE Data Assimilation Working Days 2012
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Introduction

The 3rd LACE Data Assimilation Working Days were held in Prague to show progress towards operational data assimilation (DA) in LACE countries and to share experiences in development and implementation of DA systems. Participants from non LACE countries greatly contributed to this meeting via presentation of their latest developments or via valuable opinions on various presented problems.

The program included national progress presentations at first, which were followed by thematic presentations on surface data assimilation, other observation related talks and the last part of the meeting was dedicated to long term LACE planning discussion.

Overview of the tasks from last DAWD

1. To clarify the lack of surface moisture increments and a relation of SWI and screen level diagnostics.
    Not solved.
2. Alena Trojakova tries suggested tests in order to understand results of temperature (from radiosonds) assimilation using BlendVar (DFI blending followed by 3DVar) which implied a degradation of the geopotential forecast after 6 hours.
    Univariate humidity treatment was tried but it doesn't explain reached problem. Remaining suggestion were not explored in details.
3. Alena Trojakova posts on RC LACE Forum more details on probable bug in computation of relative humidity
    Alena didn't manage to get in contact with Patrik Moll to clarify this issue.
4. Colleagues from Austria and Hungary try to reproduce negative humidity values in local AROME DA system.
    Still question, not yet solved.
5. Tomislav Kovacic collects information on the local formats of radar data in LACE and publish it on RC LACE Forum.
    Not completely finished.
6. Gergely Bölöni investigates data policy of E-GVAP whether these data can be redistributed via OPLACE .
    Presently only Croatia and Hungary are members of the E-GVAP programme, which means that they can have a free access to all E-GVAP data. We have been in contact with the E-GVAP programme manager (PM) to sort out whether other LACE countries can access (and if yes how) the E-GVAP data through OPLACE? Presently we are waiting for the answer of the E-GVAP PM.
7. Gergely Bölöni explores possibility to include LandSAF data (e.g. albedo) in OPLACE
    Not tackled.

Overview of national DA systems

Czech Republic (Alena Trojakova, Patrik Benacek)

Operational setup: CY36t1, resolution 4.7km, 87levels, 3h coupling with ARPEGE, SST from Arpege, surface CANARI, upper-air DFI Blending, 6h cycling.
The VarBlend (3DVar + DFI Blending) is slightly better than BlendVar (DFI Blending followed by 3DVar), in BlendVar options is nice improvement in analysis time but this improvement is lost after 6 hour prediction time. Two diagnostics experiments are set to investigate quick lost of information: 1) 3DVar (SYNOP, TEMP) on top of dynamical adaptation against dynamical adaptation (both without digital filter). Scores show continuous degreasing of mean difference between the experiments. 2) 3DVar (assimilating all available observations) against dynamical adaptation to quickly check the impact of assimilating more data. Results shows improvement in analysis time and

also in some forecast ranges but no in all levels – no particular change of general impact with more data was found.

Surface assimilation procedure was simplified. All necessary coping of fields is done inside CANARI configuration (SST for ARPEGE, prognostic GFL fields). And packing precision of grid point GFL fields was increased to 30 bits.

In verification tool (VERAL) a new key LDIRCLSMOD (&NAMDPHY) was tested. This key allows to read 2m diagnostics directly from the input file instead of re-computation inside VERAL. In VERAL is necessary to use the same 2m diagnostics as in model integration. New key doesn't give the bit identical results, it exhibits weak signal in the scores but simplification of the verification procedures leads to its operational use.

Satellite assimilation – improved use of satellites at top of the model (channel selection and proper VARBC predictor setting). AMSU-A gives slight improvement of temperature in high atmosphere. AMSU-B has nice impact on humidity lasting for 24h (against ECMWF analysis). Work will continue with SEVIRI and IASI data. The impact study showed the loss of impact in production, which will be investigated further (setting of IDFI is suspected in particular).

Austria (Xin Yan)

Operational setup: CY35T1, resolution 4.8km, 60 levels, coupled with ECMWF, SST from ECMWF, surface CANARI (CY36T1), upper air downscaled ECMWF, 6h cycling. New set up improves T2m, RH2m bias and over all RMSE.
ALADIN-9.6km ASSIM was switched off at 30th November 2011 – no further development planned.
ALADIN-LAEF – resolution 18km, 37 levels, up to +60h, dynamical adaptation of ECMWF, surface CANARI with perturbed observations implemented - operational till end of 2012.
AROME – resolution 2.5km, 60 levels, 3DVar + CANARI + OI_MAIN, 3h cycling, 3h assimilation window, SURFEX 3L + TEB, operational till end of next year. Vertical correlation function activated in CANARI+OI_MAIN. B-Matrix from LAEF. AROME with assimilation nicely models gusts in case with strong wind over Austria. Radar assimilation – technically works.

Croatia (Antonio Stanesic)

Operational setup: CY32T3, ALADIN-HR resolution 8km, 37 levels, up to +72H, coupled with ARPEGE. ALADIN-HR22 resolution 2km, 37 levels, up to +24H dynamical adaptation.
The **3DVar assimilation became operational at end of 2011**, using 6h cycling, SYNOP, TEMP, AIREP, GEOWIND and satellite radiances (NOAA, MSG) assimilated.

Study of SNMC versus ensemble based B matrix. Seasonal ensemble B – main difference between seasons is in humidity. Tests with more surface observations – CRO ATM, SLO ATM, Meteo France RADOME stations. Slight improvement of T2m scores is seen after use of these automatic stations. Radar assimilation – conversion to MF BUFR technically works but still some work has to be done.

Future plans: test ECMWF coupling, continue testing of seasonal dependence of B matrix, radar data assimilation, SURFEX implementation and DA on 2km resolution.

Slovakia (Maria Derkova)

Operational setup: ALARO+3MT, CY36t1.10, resolution 9km, 37 levels, up to +72h, 3h coupling with ARPEGE, upper air DFI blending, **surface CANARI (RH2m, T2m) became operational in April 2012** with data from OPLACE and local database.

Corrupted OPLACE data appear from time to time – at the end of SYNOP message appears a part of TEMP message - bug is not reproducible. Upgraded "obsoul-merge" script was developed, which solve OPLACE problem and produces additional data checking (wrong date, wrong observation type, duplicities,..).

Surface CANARI has generally positive impact on the analysis and subsequent forecasts; on the surface and also in lower levels namely for temperature and humidity. The impact is more pronounced in summer period. Worsening of the daytime scores (in the summer) in the forecasts for 12 and 18h day time for any starting analysis time and any forecast length – so called CANARI "summer problem". Also a cold temperature BIAS (winter) was noticed.

Radar assimilation in AROME/HU – technical development of 3DVar radial wind assimilation.

Plans: solve T2m CANARI summer problem, increase horizontal and vertical resolution, test with coupling of ECMWF, 3DVar/ALADIN installation, 3DVar/AROME installation.

Hungary (Mate Mile)

Operational setup: ALARO resolution 8km, 49levels, +60h, upper air 3DVar, surface CANARI (SST from ECMWF), 3h ECMWF coupling;

AROME resolution 2.5km, 60levels, hourly ALARO coupling, upper air dynamical adaptation of ALARO, ISBA in SURFEX, ongoing tests of AROME 3DVar/OI.

B matrix for ALADIN/ALARO is newly sampled from ALADIN EDA (consists of 3DVar with rescaled randomly perturbed observations). New B matrix improves scores of temperature and relative humidity and also improves relation between spread and RMSE.

A bug found in computing of GP field of humidity differences for AROME B matrix. AROME is used without DFI initialization, this approach was found as quite suitable because spin-up of surface pressure is relaxed after 2h. Space consistency coupling (first coupling file (LBC0) is LAM analysis) seems better for spin-up than time consistency coupling (LBC0 is interpolated global model analysis), no propagation of noise from borders.

Radar assimilation – reflectivity and radial winds assimilation was tested, increments are realistic, in the case study radar observation speed-up frontal precipitation. New ATOVS channel selection is applied with slight positive impact. Atmospheric motion vectors are assimilated also with slight positive impact.

Plans: make operational 3DVar in AROME; test of IDFI in ALARO; reduce CPU cost of AROME minimization; use of more observations – high resolution AMV, IASI, GPS; relax thinning distances of observation.

Slovenia (presented by Tomislav Kovacic)

Operational setup: ALARO, CY35t1, resolution 4.4km 43levels, upper air 3DVar, surface CANARI (including SST replacement), ensemble based B matrix from downscaled AEARP, 6h cycling. All OPLACE data: SYNOP, TEMP, AIREP, GEOWIND and satellite radiances (NOAA, MSG) assimilated + local SYNOP data

Static satellite bias correction used at the moment as problems were experienced with cycling of VARBC coefficients (unsuccessful minimisations after a few days or weeks, a cold start of VARBC helps) - still not explained nor fully understood. Mean analysis increments were used to diagnose of model biases - mostly cold bias of near-surface temperature and under-estimated diurnal cycle.

DA system has clear improvement of T2m, RH2m and has neutral impact on upper-air fields. Ongoing test of AMSU, IASI and MODE-S data.

Plans: resolve problems with bias correction and include more data.

Surface DA related presentations

The 2mT daytime problem in CANARI surface assimilation (Maria Derkova)

Surface CANARI has generally positive impact on the analysis and subsequent forecasts, on the surface and also in lower levels, namely for temperature and humidity. The impact is more pronounced in summer period, but the problem is worsening of the daytime scores (in the summer) in the forecasts for 12 and 18h day time for any starting analysis time and any forecast length. Any hints for to solve this problem is more than welcome.

CANARI "summer problem" (Antonio Stanesic)

Quite similar problem with CANARI as in Slovakia. CANARI increases bias T2m, RH2m. SWI increments are polarized – night increments are positive and day increments are negative, mainly in summer. When overall SWI is dryer than reference experiment it implies better T2m, RH2m scores and vice versa. Biases are removed when ARPEGE soil fields are used. Switching off RH2m analysis at 00UTC has big influence on verification scores. Changing of horizontal length scales or error standard deviation has little effect on scores.

Meteo France experts suggested:
- rather to tune analysis scheme than switch it off completely (RH2m during night);
- blacklisting of stations should be done in more systematic way than blacklist station which has for long time the same direction of increment;
- generally blacklisting should be based on quality of data not on their time availability;
- further details of current Meteo France namelist setting and their last surface analysis scheme tuning was provided via mail. For more information please check RC LACE Forum thread CANARI "summer problem", http://www.rclace.eu/forum/viewtopic.php?f=34&t=305&sid=7b2ab4c363c0d0453172969dc05bd4f3

Recent activities on surface assimilation using SURFEX in RMI (Rafiq Hamdi)

SURFace EXtrenalise (SURFEX) was created 2003, serves surface boundary condition for atmospheric radiation and turbulence scheme, one important feature is tilling – each grid point is divided to 4 elementary units called tiles according to fraction of cover (bare ground, rocks, conifer forest, water, sea …).

Scores over Belgium shows better performance using SURFEX during summer mainly bias of T2m, in winter is seen degradation of high elevated stations – is due to not well set operational snow scheme.

Overview of implementation of Extended Kalman Filter (EKF) with observation operator computed by finite difference method and comparison between offline and coupled EKF was given. Offline - surface scheme decoupled from atmospheric model with forcing taken from the lowest model level. Coupled – surface scheme coupled to atmospheric model, interaction is possible between atmosphere and surface. Linear assumption is better satisfied for offline SURFEX. Offline and Coupled EKF have similar patterns but different values of increments. Offline EKF has more details in patterns than OI or Coupled EKF. Preliminary results of 3Dvar with SURFEX EKF shows better RH2m RMSE, BIAS. And BIAS of T2m is slightly better during night.

Promising results of a feasibility study using Short Time Augmented Extended Kalman Filter (STAEKF) algorithm was presented in the end.

Data related presentations

WMO observation impact workshop (Roger Randriamampianina)

Short overview of WMO observation impact workshop outcomes was given. Regarding impact of observations on global forecasting models - following methods are used in evaluation: Observing System Experiments (OSEs), Forecast Sensitivity to Observation (FSO), Degree of Freedom for Signal (DFS); top 5 types of observation with impact to global models are: AMSU-A, IASI, radiosondes, AMDAR, Atmospheric motion vectors (AMV); Radio occultation (GPS RO) has important role to anchor radiance data assimilation.

Concerning impact of observation on regional models - top 5 for regional models can't be selected because importance of different observation varies from region to region; results of impact studies supports exchange of more local data between countries in the same region (GPS-ZTD, radar, MODE-S, hourly surface observation …); progress has been made on addressing model spin-up.

Scientific issues: EUCOS – useful model for coordination and optimization of regional observation network. Need for new metrics to evaluate high-impact weather. There is some hesitation amongst the scientists about getting too closely involved in policy decisions, especially regarding elimination of observations.

Status of radar data assimilation in LACE (Tomislav Kovacic)

BATOR reads only MF BUFR format of radar data in Cartesian coordinates, for conversion is used tool CONRAD which reads data in PRORAD, OPERA BUFR, HDF-5 formats. It can be used with new extension CONRAD-RC which can handle polar coordinates and BUFR from Austria, IRIS RAW from Croatia and Slovenia.

Quality control issues: LACE has not common QC scheme, possible choices are BALTRAD QC or INCA QC, radial winds can be still aliased even when processed by radar software. Also different calibration of each radar should be considered.

Future plans: choose QC scheme, compare differences due to calibration, impact studies, some work has to be done with radar observation operator from AROME to work correctly in ALARO (some species are missing in ALARO).

LACE should be in contact with COOP project in order to incorporate and/or follow development related to radar data.
TASK: Tomislav Kovacic will put his latest CONRAD-RC development to Conrad repository (in approximately one month).

Radar assimilation in Norway (Martin S. Grønsleth)

Comprehensive report of assimilation of radar DA in HARMONIE and a document on quality control of radar data for NWP assimilation using PRORAD and CONRAD was kindly provided (both can be found on the RC LACE web). Due to problems with video-conference connection the presentation was just briefly commented and Martin answered following questions:

Michal: Different number of rays in each elevation could make a problem?
Martin: There exist new way of making columns in CONRAD, MF BUFR requires it to be the same number of rays in each elevation.

Xin: How to produce single observation experiment?
Martin: CONRAD has a test program for that, it is in "prg/" folder, name conrad_patterns.F90.

Alena: HIRLAM is dealing with radar data in AROME, do you work also with ALADIN, have you experienced any problem with observation operator in ALADIN/ALARO?
Martin: It was not tested.

Operational assimilation of radar data at convective scale in AROME France (Thibaut Montmerle)

Currently operational AROME has 3h assimilation cycle with 24 radars and there is a plan to have 1h cycle in 2014. Radar data are 40% of all observations used in rainy days. Forecast error is reduced due to radars in average especially humidity fields. Doppler winds are helping with localization of convergence lines. There are developed tools for separation of non-rainy pixels. Relative humidity is assimilated in 3DVar as pseudo observation.

Meteo France is involved in EUMETNET OPERA program in QC and volume distribution to NWP. Many ongoing tests of CONRAD in France (Spanish radar DA within HyMex), Norway, Netherlands, Austria, Croatia,...

Optimization of the use of radar data – use of specific background error covariances B in precipitating areas, analysed field are then better balanced, computation of the observation error matrix R using a posteriori diagnostics, revision of thinning method to use more radar data.

Conclusions: radar data are important in AROME, assimilation of Doppler winds (DOW) and radar reflectivity together gives better results, an efficient pre-processing is essential to unfold DOW and to identify clutters, especially non-rainy echoes.

Further comments: Radar data people should give you "echo type", BATOR is reading raw data and removes only spurious data. From CY38 possibility of use of polar data is available.
Q: Is it possible add more radars in once?
Re: You can add as many as you want, just specify in BATOR.

Short description of radar and SAFNWC data APIs (Michal Nestiak)

A short overview of latest Integrated Nowcasting through Comprehensive Analysis for Central Europe (INCA-CE) developments, update every 15-30 minutes, version 2 improvement with parallelization (OpenMP), direct reading of files (aladin grib, hdf-5 radar, …) was given.

Overview of radar and SAFNWC data Application Programming Interfaces (APIs) developed at SHMI in order to improve quantitative estimation and nowcasting of precipitation was presented. The solution uses output of SAFNWC and radars and provides various quality control indexes. Further plans - introduce quality indexes of rainfall estimation from radar data, rain gauges data and also the combination of all measurements.

Alena: What is relevance to current CONRAD system?
Michal: This thing is doing the same as PRORAD and produces input for CONRAD.
Alena: Does it helps our radar people to check and produce quality flags?
Michal: All radar data are checked in each institution and its better, we should believe to them.
TASK: As quality information is essential for DA it would be nice to make an overview of local quality control (QC) performed and/or available in MF BUFR data format. Especially for common LACE radar data study, eventually for envisaged radar data exchange, such overview could serve as input for decision making between local QC or a common LACE QC system (based on for example on BALTRAD, Slovak APIs, or any other tool). Tomislav Kovacic tries to collect information about local radar data QC and/or QC flags available in MF BUFR format.

IASI data assimilation within RC LACE (Alena Trojakova, Patrik Benacek)

Short overview of IASI sensor was given (has 8461 channels, allows retrieval of temperature and humidity profiles at 1km vertical resolution, 1K accuracy, horizontal resolution 50 km) and practical aspects of IASI data usage in ALADIN LAM application for the subset of 366 channels available in OPLACE was summarized (necessary change of default number of channels (314), BATOR options for data reading and one should not forget on blacklisting). LACE monitoring extension for IASI data can be provided up on request. First results showed problems with bias correction, neutral impact but encouraging to continue.

Further investigation of variational bias correction (VARBC) clarified that there are 3 different setting of cold start available: 1) Set bias parameters to zero 2) Use available bias information form VARBC file and 3) Use first guess departures as first information – default but not working correctly ! To avoid problems use ncstart = 0. Also there is an issue with stratospheric predictors 5 and 6, which are often over the top of the model and in that case their usage should be avoided.

Afterwards channel selection based on observation monitoring statistics was done and neutral or slightly negative impact for relative humidity, slightly positive for temperature and geopotential was found.

Future plan comprises testing other channel selection methods (based on Moist Total Energy Norm (MTEN) and progressive active assimilation of particular groups of channels (sensitive to H2O, CO2, …).

High-resolution Mode-S aircraft observations and its potential for data assimilation (Benedikt Strajnar presented by Tomislav Kovacic)

A method to retrieve wind and temperature information from all aircraft in the vicinity of a tracking and ranging radar has been developed. These observations are gathered using the Selective Mode of the radar, and are therefore called Mode-S observations. Presentation summarized the first results of Mode-S impact study.

Slovenian data used in the study are available in area about 250 km around airports with update frequency 4 s (temperature, pressure altitude, wind speed) with little latency. Mode-S data has good agreement with AMDAR data. Mode-S data has smaller errors against radiosondes than estimated AMDARs error. Mode-S data helps to capture temperature inversions when sounding not assimilated. First results of use Mode-S data gives neutral impact on the forecast so far.

GPS (Xin Yan)

Not much new development since last year (results from an impact study were not so spectacular; only Austrian data from several private companies (University of Vienna was in charge to collect the data from 30-40 stations) were used with white-list approach (screening for 20 days and obtain a bias and based on that pre-selection of the stations is done). There is a plan to redo the impact study using AROME.

For OPLACE implementation of GPS data the data policy has to be clarified. Gergely Bölöni is in touch with EUMETNET E-GVAP Program Manager in this respect. Only Croatia and Hungary are members of E-GVAP and they can access data easily. As data can't be provided to all LACE Members further steps related to pre-treatment of GPS data and adding those data to OPLACE were postponed.

Overview of Meteo France plans (Claude Fischer)

Following areas of main interest were presented: data information diagnostics (DFS, reduction of error variance), increase of DA frequency (together with model spin-up properties), background error estimation (error variances derived from an ensemble, heterogeneous background errors treatment, wavelet approach in correlation modelling). Regarding observations cloudy/rainy radiances, GPS and radar data, SEVIRI data over land and surface albedo from LandSAF will be of their main focus.

Notes on HARMONIE plans of DA&UO status/plans/contact persons (Jelena Bojarova)

Due to problems with video-conference connection the presentations was briefly commented to give an overview of main areas of HARMONIE research and development. More details can be found in the presentation.

Possible areas of LACE future development

The last part of the meeting was dedicated to a brainstorming on possible areas of future LACE plans. Here follows main identified items.

Data information diagnostics and verifications

Evaluation of observation impact on analysis by implementation of DFS (degree of freedom for signal) and reduction of variance diagnostics. Impact of data on forecast could be evaluated by Moist Total Energy Norm (MTEN) method developed by Roger Randriamampianina, which can also help with channel selection. Also adjoint method (adjoint code should be checked) or case studies can be considered. We should also keep in mind meso-scale tools for verification and diagnostics. Like comparing structures and patterns – some development is ongoing in Meteo France COPMAS group. Also HIRLAM common verification package – run off-line and easy to use, local implementation should be possible.

System performance improvements

Observation and background error statistics tuning (e.g. Desroziers (2005)). Our systems are using static background error statistics. We should take a step forward to flow dependency. But flow dependent statistics are mainly triggered by ensemble systems and only variances are usually updated (variances of the day). Another way is to consider usage of seasonal B matrices. Rapid update cycles can also help, 3h or even 1h cycle.

Surface analysis

A solution for "CANARI summer problem" is needed. And more efforts should be dedicated to surface data DA aspects (SURFEX local implementations, 2D interpolation tool (extension for precipitation, snow,...) , satellite data, ..).

OPLACE data

Technical maintenance of OPLACE should be clarified. How the maintenance could be done, so far Hungary is doing everything, OPLACE data should be in operational application and this will demand more and more work.
Proposal for new data – radar, ASCAT, GPS, LandSAF, high resolution AMV, snow data (from SYNOP) and MODE-S.
TASK: Alena Trojakova get in touch with Antonio Stanesic, who pointed a problem that sometimes HU prefix for local Hugarian data is missing in OPLACE.
TASK: Alena Trojakova tries to investigate current availability of TEMP data in BUFR format in GTS and status of direct TEMP BUFR data reading in BATOR.

Radar data

Exchange of data should be clarified. Some quality control should be implemented based on Slovak APIs or BALTRAD and some QC flags have added to raw radar data. There is promising use of radar data in rapid update cycles.
TASK: Tomislav Kovacic tries to clarify specification (format, time frequency, included QC information, ...) of the data which are to be collected for autumn RC LACE stay of Michal Nestiak.
TASK: Michal Nestiak tries to get more details about ongoing (neighbouring country) radar data exchange within OPERA (AT,CZ,PL,SK). Also any information about data policy, possibilities to add wind velocity data and potential to extend the exchange for more countries would be highly appreciated.
TASK: Alena Trojakova provide support to Michal Nestiak to get CONRAD source code form HIRLAM/HARMONIE repository.

Any Other Business

HARMONIE scripting system – powerful tool for testing and development, it is user friendly and set up of experiments is fast, it could be good for students. It is implemented in Hungary but not fully tested, it will be reported later. Slovaks will try to install afterwards the others are interested.

Roger Randriamampianina promoted a common namelist tool for preparation of namelists for various model configurations.
TASK: Roger puts the namelist tool with further details on RC LACE Forum.

Importance of spreading information and sharing experiences was expressed and more extensive use of RC LACE web page and/or Forum was proposed, e.g. technical specification about radars, observation diagnostics, etc.
TASK: Roger with Alena's help put more information about MTEN and DFS diagnostics on RC LACE Forum.

References

Desroziers (2005) - Q. J. R. Meteorol. Soc. (2005), 131, pp. 3385–3396