

Working Area Data Assimilation

Work Plan

Prepared by:	Area Leader Benedikt Strajnar
Period:	2020
Date:	07/03/2019

Introduction and background

RC LACE data assimilation activities have traditionally been focused on the local development of data assimilation systems at the LACE centers. One of the main issues encountered in this area is that local DA teams are typically understaffed while the upgrades to DA systems are usually technically demanding and specific to each institution in terms of code compilation and maintenance, data flow and archiving, and extensive computations.

The LACE DA work plan is trying to support and consolidate this efforts by encouraging exchange of information withing the group as well as with other ALADIN and HIRLAM partners. It encourages short-term portable developments and also targets commonly achievable mid-term and, less frequently, long-term research. For example short-term developments related to the use of new observations and their pre-processing or diagnostic studies regarding data assimilation system performance are recognized as vital and well-shared activities in RC LACE. On the other hand the extensions to standard 3D-Var for upper-air or extended Kalman filter (EKF) require longer-term research developments. The group tightly follows developments by Météo France on these topics, which is the most pragmatic approach taking into account the group's limited manpower.

Starting with year 2019, the planning of work in ALADIN/HIRLAM/LACE consortium has started to become more and more unified. The current RC LACE plan for 2020 is therefore highly incorporated in the common Rolling Work Plan (RWP) 2020, and reference to RWP is made for each of the actions in this plan.

Goal

The contribution of RC LACE now clearly focuses on algorithmic developments needed to move to nowcasting/convective scale and observations suited for these systems. In terms of algorithmic developments for upper-air DA the Members will be focused on implementation to frequently (hourly) updated analysis cycle, or further refinement in Austria where pre-operational RUC is already running. Feasible improvements to specification of background errors for such systems is going to be studied in a separate action. As in the last years, efforts will be put towards Extended Kalman Filter (EKF) as the default method for soil and surface assimilation.

More effective use of observations also stays the top priority of LACE DA group. Apart from algorithmic developments listed above, the most straight-forward approach to this goal is to extend the observation set and to maintain and monitor the quality of already used observations. Most of the efforts in upper-air data assimilation would be invested to implementation of the radar data assimilation. This subject was understaffed in 2019 but it is planned to work on it more 2020. Apart from radar reflectivities we would like to move to radial winds, which still needs further algorithmic developments. We would like to target nowcasting area also by improving use of other observations,

like several types of GNSS-derived data, by further extending the coverage of locally received Mode-S EHS and MRAR as well as their quality control (VarBC), revising use of wind profilers, atmospheric motion vectors, scatterometers and possibly wind turbines, as well as implementing preprocessing and assimilation of microwave link delays. Surface data will regain attention after several years by revisiting the QC procedures and evaluation of private observation networks. Unfortunately, less manpower will be available in 2020 available for assimilation of satellite radiances. However, satellite products relevant to surface and soil assimilation with EKF will be intensively studied.

Main activities

Action/Subject/Deliverable: *Maintenance and evolution of state-of-the-art DA systems [DA 1.6]*

Description and objectives:

Considerable part of the DA efforts is expected to be spent on maintenance, validation and development of operational DA systems. This includes implementation and validation of DA configurations of newer model cycles, design and implementation of e-suites, coordination and reporting within the consortium.

Proposed contributors, Estimated efforts: A. Trojáková (Cz) 2, A. Bučánek (Cz) 3, A. Stanešić (Cr) 1.5, B. Strajnar (Si) 1, F. Meier (At), V. Homonnai (Hu), M. Derkova (Sk) ~ 10 PM

Planned time frame: whole year

Planned deliverables: reports on LACE DA working days, ALADIN/HIRLAM newsletters

Action/Subject/Deliverable: *Development of assimilation systems suited for nowcasting (RUC, RAP, cycled and non-cycled hourly DA systems) [DA 5.2, DA 5.5]*

Description and objectives:

The frequently updated assimilation approach ensures to employ more observations with reduced representativeness error in time. Hourly analyses can be carried out by fully cycled (RUC) and non-cycled data assimilation systems (e.g. RAP) or combination of both. In 2020, the following experimental (pre)operational RUC setups are planned:

- In Austria, the AROME-RUC is planned to become operational soon. The system uses hourly 3D-Var analysis, applied through IAU, in combination with latent heat and wind nudging. Further work will include tuning and improvements in use of observations.
- In Hungary, their AROME-RUC is under extensive evaluation, with considerable efforts put into studying interactions between upper-air and soil assimilation. The system will be gradually improved by using more observations (e.g., radar).
- In the Czech Republic, design of a NWP-based nowcasting is planned, starting from the current evaluation of Rapid update (RUP) system.

- In Slovenia, a prototype of 1.3 km hourly RUC (which is to be available by the end of 2019) will be evaluated on the upgraded HPC.

Proposed contributors, Estimated efforts: F. Meier (At) 0.5, A Várkonyi (Hu) 5, P. Benáček (Cz) 0.25, A. Trojáková (Cz) 1, A. Bučánek (Cz) 3, B. Strajnar (Si) 1, 10.25 PM

Planned time frame: whole year

Planned deliverables: reports on LACE web

Studies of background error statistics in 3D-Var [DA 1.2 – 1.4, 2.5]

Description and objectives:

The representation of background error statistics with actual properties of the meso- and convective-scale systems (flow-dependency) improves the analysis of those systems. Recently the following ideas/tasks are foreseen to be potentially feasible in this subject:

- Recalculation of climatological B-matrix based on local ensemble data assimilation (EDA) is expected for members that are improving the spatial and temporal resolution of their DA systems.
- Representation of time-dependent background errors in a high resolution LAM EDA, providing robust daily statistics. It should be determined whether filtering is necessary.
- Error statistics for the methods allowing to preserve results of host model analysis in a LAM domain (BlendVar, Jk) will be investigated and possible further optimized.

Proposed contributors, Estimated efforts: V. Homonnai (Hu) 2, A. Stanešić (Cr) 0.5, B. Strajnar (Si) 0.5, 3 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: Surface Assimilation using Extended Kalman Filter [SU 3.4]

Description and objectives:

The Extended Kalman Filter (EKF) approach allows for assimilation of conventional and non-conventional observations to generate surface analysis. In this LACE action both AROME and ALARO models are considered to be utilized within EKF, but more experiments have so far been carried out with AROME. In 2020 the following actions are foreseen:

- Validation of EKF with SYNOP observations using force-restore method (Sk).
- Activation, development and validation of SURFEX diffusion scheme combined with SEKF in an online full version of AROME (At).

- Validation of newer model cycles and SURFEX releases.

Proposed contributors, Estimated efforts: S. Schneider (At) 0.5, V. Tarjáni (Sk) 3, 3.5 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: *Observations suitable for soil schemes [SU 2.2.3, SU 2.5.2]*

Description and objectives:

One of the main advantages offered by the Extended Kalman Filter (EKF) approach to surface and soil data assimilation is to be able to successfully assimilate non-conventional observations. This action is devoted to make benefit from rapidly evolving satellite soil observation methods (e.g. downscaling geostationary satellite data with high-resolution Sentinel information). The following two tasks are planned for 2020:

- Continuation of experiments with SCATSAR-SWI ASCAT-Sentinel-1 (soil moisture).
- Evaluation of MSG+Sentinel-3 (surface temperature) products in EKF (SURFEX 8.1).

Proposed contributors, Estimated efforts: S. Schneider (At) 3, J. Vural (At) 7.5, 10.5 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: *Assimilation of surface observations (SYNOP, national data, private observation networks) for upper-air data assimilation*

Description and objectives:

Evolving rapidly updated systems at high resolution require more observations. SYNOP data, enhanced by national reports available on OPLACE, require further optimizations to ensure quality and representativeness. On the same time, massively available private measurements offer a big potential to improve data counts, but at the same time are related to quality issues. The following tasks are planned:

- Evaluation and assimilation of private weather networks (NETATMO), development of the necessary QC and pre-processing.
- Further evaluation and general improvement of QC for all surface data (e.g., national reports).

Proposed contributors, Estimated efforts: F. Meier (At) 1.5, M. Nestiak (Sk) 1, A. Trojáková (Cz) 0.5, 2.5 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: *Assimilation of radiance observations in DA systems*

Description and objectives:

The main goal of this action is to maximize the benefit of the use of satellite radiance data available via OPLACE system. However, the Members are planning to invest little efforts in this area in 2020. Some countries plan the validation and operational implementation of the available (polar satellite) sensors in their systems. Other tasks to be considered (in case of sufficient manpower):

- Investigate the impact of microwave sensor ATMS that will replace AMSU-B/MHS on polar satellites. The advantage of ATMS data is that it can be used in cloudy areas.
- More attention to assimilation of IASI, which will be included on board the next generation geostationary satellites (MTG).

Proposed contributors, Estimated efforts: A.Trojáková (Cz) 0.5, A. Bučánek (Cz) 0.5, 1 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: *Implementation of RADAR reflectivity and radial wind [DA 3.1]*

Description and objectives:

RADAR reflectivity and radial wind observations are expected to become the main observation type of a frequently-run mesoscale DA system, and the systems will be mostly based on OPERA/OIFS data (plus national data or data from bilateral exchange in some countries). The tasks concerning the OPERA/OIFS data set:

- Continuation of evaluation and impact studies in order to optimize the assimilation of reflectivity (thinning, superobbing, quality control decisions), feedback to be provided to the OPERA User Group.
- Validation of solutions for wind dealiasing and quality control in cooperation with the OPERA User group. The common homogenization tool (HOOF) will be extended with functionality for wind dealiasing.
- Impact studies with de-aliased OPERA Doppler wind data.

Proposed contributors, Estimated efforts: B. Strajnar (Si) 1, P. Smerkol (Si) 1.5, V. Švagelj (Si) 2, M. Neštiak (SK) 5, Hu colleague? 3, A. Stanešić (Cr) 1.5, A.Trojáková (Cz) 0.5, A. Bučánek (Cz) 0.5, 15 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: *Assimilation of GNSS path delays (ZTD, STD, GNSS-RO, refractivity index, gradient, etc) [DA 3.3, DA 4.2, DA 5.1]*

Description and objectives:

The meteorological use of GNSS-based path delays is increasing due to high demand for humidity data in convective-scale NWP and the development of new types in this category. The most commonly tested ZTD is going to be closer to operational implementation in many Members, while other products like slant delay (and its observation operator) are under development. Tasks:

- Local implementation of ZTD assimilation, experience with VARBC tuning for ZTD data to be shared among LACE members.
- Evaluation of ZTD from E-GVAP data which will become available at OPLACE,
- Cooperation on research and developments related to GNSS-RO products within an external project (At),
- Finalization of the implementation of Slant Tropospheric Delays (STD) in the common model cycles (in cooperation with HIRLAM).
- Feasibility study of assimilation of precipitable water vapor (PWV) maps from Sentinel-1 is planned if ESA-funded project is confirmed (At).

Proposed contributors, Estimated efforts: B. Strajnar (SI) 0.5, M. Imrišek (SK) 4, F. Meier (AT) 1.5, P. Scheffknecht (AT) 1, F. Weidle (AT) 0.5, S. Schneider (AT) 0.5, 8 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Action/Subject/Deliverable: *Assimilation of Mode-S (EHS and MRAR) observations [DA 3.2, DA 5.1]*

Description and objectives:

The availability and use of aircraft derived Mode-S EHS and MRAR observations are subject to persistent growth within the LACE area. In 2020, the following activities are currently planned:

- Extend and explore impact of newly available Mode-S EHS and MRAR observations (SK, SI, HU).

- Refine the application of Mode-S observations in DA systems with increased assimilation cycle frequency, including application of variational bias correction (Var-BC) procedures (subject of a RC LACE stay).
- Coordination of exchange of local Mode-S EHS data with KNMI (Czech Republic, Slovakia, Slovenia, Austria).

Proposed contributors, Estimated efforts: V. Homonnai (Hu) 2, B. Strajnar (Si) 0.25, K. Čatlošová (Sk) 6, M. Derkova (Sk) 2, F. Meier (At) 0.5, P. Scheffknecht (At) 1 A.Trojáková (Cz) 0.5, A. Bučánek (Cz) 0.5, 12.75 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Action/Subject/Deliverable: *The use of AMV products (Geowind, HRW and Multi-Metop)[[]]*

Description and objectives:

The atmospheric motion vectors provide reliable wind information to NWP. Beside the long time used Geowind AMV, the new type of AMVs with increased number of wind vectors can provide considerable amount of data in a relatively small NWP domain. In 2020 the following action is planned:

- Optimization of the use of existing AMV observations, including high resolution winds (NWC/ GEO-HRW), performing impact studies.

Proposed contributors, Estimated efforts: Z. Kocsis (Hu) 1 PM, A.Trojáková (Cz) 0.5, A. Bučánek (Cz) 0.5, 2 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Action/Subject/Deliverable: *Assimilation of wind profilers and wind turbine data*

Description and objectives:

The wind profiler measurements are important upper-air wind data source. However they have been underutilized in LACE during last years, partly due to in-homogeneity and lack of experience about the quality of these measurements. Several LACE countries now plan to revise their use of wind profilers. An interesting atmospheric wind source are also wind farms with their own measurements. Tasks in this action:

- Reevaluate wind profiler impact and addition of new sites (e.g., Vienna airport).
- Experimental assimilation of wind information from wind turbines (At).

Proposed contributors, Estimated efforts: A.Trojáková (Cz) 0.5, A. Bučánek (Cz) 0.5, F. Meier (At) 1.5, 1.5 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Action/Subject/Deliverable: *Assimilation of attenuation in telecommunication microwave links [DA 4.11]*

Description and objectives:

The attenuation of telecommunication inter-antenna links in cellular networks due to rain is an attractive new observation data source. The feasibility study in Slovenia will continue in 2020, with the following goals:

- Refinement of the preprocessing to efficiently separate dry and wet attenuation, which should lead to a reliable relationship between attenuation and rain rate.
- Preparation of a concept of observation operator for this type of measurements.

Proposed contributors, Estimated efforts: B. Strajnar (Si) 1.5, P. Smerkol (Si) 2, total 3.5 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web, code developments

Action/Subject/Deliverable: *Assimilation of scatterometer data (ASCAT, OSCAT, HSCAT) [DA 3.4]*

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. The ASCAT data from Metop satellites are available from OPLACE and operationally assimilated in Slovenia and Austria. The goal of this item is to investigate potential of other scatterometers which were recently made available (HSCAT (HY-2A) and OSCAT (Oceansat-2) data and assist their possible dissemination through OPLACE.

Proposed contributors, Estimated efforts: B. Strajnar (Si) 0.5

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Summary of resources

Subject	Estimated manpower (PM)	From LACE	Other (HIRLAM, ALADIN)
Maintenance, evol. of oper. systems	10	10	
Hourly RUC	10.25	10.25	
B matrix	3	3	
Surface EKF	3.5	3.5	
Surface obs	10.5	10.5	
RADAR obs	15	15	
SYNOP obs	2.5	2.5	
Radiance obs	1	1	
GNSS obs	8	8	
Mode-S obs	12.75	12.75	
AMV obs	2	2	
SCAT obs	0.5	0.5	
PROFILER obs	1.5	1.5	
MICROLINK obs	3.5	3.5	
Total	84	84	

Meetings, events and list of RC LACE stays

AL travels:

- 1) 42th EWGLAM meeting and 27th SRNWP workshop 2020
- 2) Spring and autumn LSC meetings and RC LACE management meeting

- 3) Participation of AL to one of the HIRLAM working weeks
- 4) 7 participants at DA Working Days 2020

LACE stays:

- 1) Anikó Várkonyi (hourly RUC) – Ljubljana (1 month)
- 2) K. Čatlošová (VarBC for Mode-S) – Prague (1 month)
- 3) Florian Meier (radar assimilation) – ?