

# Working Area Data Assimilation

## **Work Plan**

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<b>Period:</b>	2019
<b>Date:</b>	13/09/2018

## Introduction and background

During the recent years, LACE data assimilation activities focused on the local development of “baseline” data assimilation systems at the LACE centers. It meant usually time demanding and technical challenges for the colleagues to build and later to maintain these local systems beside the their scientific works. The LACE DA Work Plan is trying to support this local efforts with basically short-term portable developments and also to target common achievable goals for long-term researches. For example short-term developments like the use of (new) observations and its pre-processing are recognized as vital and well-shared activities in LACE. On the other hand the limitations of the widely used 3DVAR require long-term developments to alleviate e.g. the representativity error in time by increased assimilation cycle frequency.

The Work Plan of 2019 will deliver actions already started in the previous years and also will give few updates to common actions. These DA activities can be grouped into algorithmic developments and the use of observations.

## Goal

The main data assimilation goals to be attained in 2019 are the following:

In algorithmic developments the work will focus on frequently updated analysis cycle in LACE. In 2019 the work on mainly RUC DA systems is being continued for operational and nowcasting purposes. In connection with the RUC assimilation systems, a better specification background errors is going to be studied in a separate action. Another important action is to improve surface assimilation system based on Extended Kalman-Filter (EKF) method which action was started around 2014-2015 and to be continued further in 2019. Both conventional observations and satellite-derived products are going to be tested for operational and special project purposes. However, the developments of OOPS project would be important to closely track, it seems there is no manpower to be able to do so. Most probably the OOPS novelties are going to be validated, checked during implementations (cy43t1, cy45t1, etc).

More effective use of observations is a priority of LACE DA systems. In order to improve local DA systems, the most natural way is to extend the observation set and to maintain and monitor the quality of already used observations. More experiments are expected in 2019 with the studies and possible operational implementation of GNSS ZTD, Mode-S (EHS and MRAR) and AMV (Geowind, HRW, Multi-Metop) observations in different LACE DA systems. Regarding the use of RADAR reflectivity and radial wind, the OPERA data and pre-processing are more and more examined. Cooperation and collaboration in this field will be continued

in 2019. All these observational activities will be and have to be harmonized with OPLACE maintenance and development for the possibility of (re)distribution and pre-processing of these data sources.

## Main activities

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

**Description and objectives:**

The more frequently updated assimilation approach ensures efficient method to employ more observations with reduced representativity error in time. Hourly analyses can be carried out by fully cycled (RUC) and non-cycled data assimilation systems. In 2019 the following studies are going to be carried out:

- The experiments of AROME/Nowcasting (ZAMG) test version will continue in 2019. The 1.2km experiments will include hourly 3DVar in 2-hourly cycling, RADAR data assimilation latent heat nudging and IAU as well. Further work will include finishing the test months, evaluation, tuning of latent heat nudging and wind nudging, work on cloud analysis, inclusion of MODE-S and GNSS-ZTD. Also a revision of 1.2km B-Matrix is envisaged
- Construction of a RUC system gets more attention between LACE members next year. In Hungary a newcomer, Aniko Varkony will focus on experimenting with AROME-RUC on new super computer. In the Czech republic the diagnostic ALARO non-cycled system should be extended to a cycled one. In Slovenia, the plan is to increase frequency of analysis in assimilation cycle.

**Proposed contributors, Estimated efforts:** F. Meier (AT), P. Scheffknecht (AT), F. Weidle (AT), B. Strajnar (SL), M. Nestiak(SK), A. Varkony (HU), A. Trojakova, 13PM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

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

The more accurate representation of background error statistics is crucial in mesoscale DA systems with its flow-dependent nature. Recently the following ideas/tasks are foreseen to be potentially feasible in this subject:

- Representation of time-dependent background errors in a high resolution LAM EDA providing robust daily statistics. Also objective filtering procedure has to be considered to avoid possible spurious sampling noises.
- Representation of spatially varying background errors by the previously tested grid-point  $\sigma_b$  maps. The upcoming model cycles (cy43t1 and cy45t1) will also deliver related source code developments which can be also considered.
- Last but not least local efforts to perform more accurate B matrices or to upgrade background error representation for high resolution are going to be reported in the LACE action.
- Error statistics for the methods allowing to preserve results of host model analysis in a LAM domain (BlendVar, JK) will be sampled and further optimized.

**Proposed contributors, Estimated efforts:** B. Strajnar (SL), K. R. Javorne (HU), V. Homonnai (HU), A. Stanesic (CR), A. Bucanek (CZ), E. Keresturi (CR), 12PM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

**Action/Subject/Deliverable: *Surface Assimilation using Extended Kalman-Filter*****Description and objectives:**

The Extended Kalman-Filter approach is able to use conventional and non-conventional observations to generate surface analysis. In this LACE action both AROME and ALARO models are considered to be utilized with EKF, but more experiments have been carried out and currently are planned to execute with AROME model. In 2019 the following actions are foreseen:

- Continue 1D-column validation with conventional observations

- Assess the impact of the EKF analysis at the beginning and at the end of the assimilation window.
- Optimization for operational framework
- Validation of newer model cycles and SURFEX releases
- Test the ISBA diffusion soil scheme
- Study the use of ASCAT-Sentinel-1 (soil moisture) and Sentinel-3 (surface temperature) products in EKF for special project purposes

**Proposed contributors, Estimated efforts:** S. Schneider

(AT), J. Vural (AT), V. Tarjani (SK), 6PM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

**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. The list of activities that should be investigated:

- Monitoring and first evaluation of the use of radiance observations from SuomiNPP and DMSP
- Improve bias correction scheme for radiance observations (LAM aspects, LAM VARBC predictors, etc)
- Investigate use of microwave sensor ATMS that will replace AMSU-B/MHS on polar satellites. The benefit of ATMS data is that they allow its assimilation in cloudy areas.
- More effort should be putted to assimilation of infrared sensor IASI, which is now available on polar satellites (Metop) since it will be soon on board of geostationary satellites (Meteosat Third Generation - MTG).
- Effort should be putted to analysis of clouds.

**Proposed contributors, Estimated efforts:** OPM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

**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 cycles frequency. In 2017 discussion was started to target the common RADAR data assimilation goals in LACE for the next 3 years and moreover to request additional (manpower) support from LACE Council. In 2018 the cooperation was strengthened and allowed for more efforts on RADAR assimilation that will be continued in 2019. In advance (before the DAWD and Council meetings) the following actions are foreseen now:

- The new OPERA data pre-processor and homogenization tool will be validated.
- The validation and the use of OPERA volume data in HDF5 reader of Bator will continue. Local implementation of RADAR assimilation at several LACE Members is ongoing.
- Comparison of different RADAR QCs in terms of quality indices and error signals. Furthermore, a more effective cooperation between NWP DA and remote sensing colleagues is also wished.

**Proposed contributors, Estimated efforts:** B. Strajnar (SL), P. Smerkol (SL), M. Nestiak (SK), A. Dumitru (RO), M. Mester (HU), A. Stanesic (CR), K. Horvath (CR), A. Bucanek (CZ), A. Trojakova (CZ), 16PM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

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

The meteorological use of GNSS path delays are getting wider and wider by the development of new types of GNSS products. The most commonly tested ZTD is going to be closer to operational implementation at many centers, but other products like slant delay (and its observation operator) is just under development. In 2019 the following activities are foreseen for this action:

- Examination of the impact of GNSS RO products.
- Sharing the experience with VARBC tuning for ZTD data between LACE members, and local implementation of ZTD assimilation.

- Examination of ZTD data assimilation in case of short cutoff times where degradation is observed.
- Examination of Slant Delays in cooperation with HIRLAM is expected in 2019.

**Proposed contributors, Estimated efforts:** F. Meier (AT), C. Wittmann (AT), F. Weidle(AT), B. Strajnar (SL), M. Imrisek (SK), S. Panezic (CR), 8PM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

**Action/Subject/Deliverable:** *Assimilation of Mode-S (EHS and MRAR) observations*

**Description and objectives:**

The aircraft derived Mode-S EHS and MRAR observations have a growing network inside LACE and in ALADIN/HIRLAM community as well. In 2019 more efforts will be put on the work of this type of observations. The following activities are currently planned:

- Explore the newly available Mode-S EHS and MRAR observations
- Investigate the impact of Mode-S EHS
- Continue the application of Mode-S observations in DA systems with increased assimilation cycle frequency.

**Proposed contributors, Estimated efforts:** P. Scheffknecht (AT), B. Strajnar (SL), K. Catlosova (SK), 6.5PM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

**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 data assimilation systems. Beside the long time used Geowind AMV, the new type of AMVs with increased number of wind vectors can serve considerable amount of data in a relatively small NWP domain. In 2019 the following actions are planned:

- The tuning and separation of AMV observation errors with respect to retrieval channels.

- Study the distribution and quality of new Multi-Metop AMVs in LAM DA systems.
- Impact studies with HRW AMVs.

**Proposed contributors, Estimated efforts:** Z. Kocsis (HU), 2PM

**Planned timeframe:** whole year

**Planned deliverables:** report on LACE webpage

## Summary of resources

Subject	Estimated manpower (PM)	From LACE	Other (HIRLAM, ALADIN)
Hourly RUC	13	13	
B matrix	12	12	
Surface EKF	6	6	
RADAR obs	16	16	
GNSS obs	8	8	
Mode-S obs	6.5	6.5	
AMV obs	2	2	
<b>Total</b>	<b>63.5</b>	<b>63.5</b>	



## **Meetings, events and list of LACE stays**

### **AL travels:**

- 1) Joint 29th ALADIN Workshop & HIRLAM All Staff Meeting 2019, 1-5 April 2019, Madrid, Spain
- 2) 41th EWGLAM meeting and 26th SRNWP workshop 2018
- 3) Spring and autumn LSC meeting and possibly RCLACE management meeting
- 4) 7 participants at DA Working Days 2019

### **LACE stays:**

- 1) Martin Imrisek (GNSS assimilation) - 1 month
- 2) Katarina Catlosova (Mode-S assimilation) - 0.5 month
- 3) Michal Nestiak (Radar assimilation) - 1 month
- 4) Alina Dumitru (Radar assimilation) - 1 month
- 5) Mate Mester (Radar assimilation) - 1 month
- 6) Viktor Tarjani (EKF Assimilation) - 1 month (Postponed from 2018)